

Geology, lithogeochemistry, age, and genesis of the Zn-Pb-Cu-Ag-(Au)-barite AG volcanogenic massive sulfide (VMS) deposit, Haines, Alaska.

by

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Abstract

The AG volcanogenic massive sulfide (VMS) deposit is hosted within the Late Triassic (Hyd and Tats Group) bimodal volcanic rocks of the Alexander Triassic metallogenic belt (ATMB). The AG deposit is composed of both exhalative- and replacement-style, barite-rich VMS mineralization with an inferred resource of 4.3 Mt grading 4.64% Zn, 0.12% Cu, 0.96% Pb, 119.5 g/t Ag, 0.53 g/t Au and 34.8% BaSO₄. The volcanic sequence that hosts the AG deposit includes: (1) enriched mid-ocean ridge basalt (EMORB)-like pillowed flows of tholeiitic basalts, (2) effusive flows of ferroandesites (FeA) and FIIIa ferrodacites (FeD) that are capped by FIIIa ferrorhyolitic lapilli tuffs (FeR), all of which have weak "arc-like" geochemical signatures and mixed tholeiitic/calc-alkaline affinities (3) EMORB-like pillowed flows of FeTi-rich, variolitic basalts (Z-FeTiB) that are intercalated with barite clast-bearing heterolithic fragmental rocks, (4) pyroclastic deposits of EMORB-like, FeTi-rich, hanging wall (HW) basalts (HW-FeTiB), and (5) syn-volcanic sills of FIIIb high-silica rhyolites (HSR).

The AG deposit is a bimodal-mafic deposit with a flow-dominated stratigraphic footwall and a volcaniclastic-dominated hangingwall. Most of the AG deposit formed at the contact of the Fe-rich, intermediate to felsic rocks with weak "arc-like" geochemical signatures and the EMORB-like FeTi-rich basalts. Mineralization is intercalated with FeTi-rich, variolitic pillowed basalts and heterolithic fragmental rocks. The heterolithic fragmental rocks are considered debris flow deposits that were emplaced along an interpreted syn-volcanic fault, the Finch fault. The Finch fault also controlled the distribution of HSR sills, sharp lateral changes in hydrothermal alteration intensity, the thicknesses and facies of units, and VMS mineralization.

Litho- and chemo-stratigraphic reconstruction of the volcanic environment suggests the rocks hosting the AG VMS deposit formed in a propagating intra-arc rift associated with basin

development where high temperature (> 900 °C), shallow (< 10 km) magmatic processes included basaltic underplating, crystal fractionation, assimilation of arc crust, and periodic magmatic replenishment. The tectono-magmatic conditions that were essential for initiating and sustaining the hydrothermal convection required to form the AG VMS deposit are both physically and chemically reflected in the AG volcanic sequence.

Zircons from the FeR and HSR yield new chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) U-Pb crystallization dates of 210.35 ± 0.27 , and 210.52 ± 0.08 Ma, respectively (Fig. 2.17; Table 2.4, Table 2.5) that constrain the timing (210.60 Ma to 210.08 Ma) of the AG mineralization and corroborate the Norian (ca. 227–208.5 Ma) conodonts in the Tats Group rocks that host the Windy Craggy VMS deposit and the timing of VMS mineralization at the Palmer deposit (213 ± 5 Ma; Hyd Group).

The AG volcanic rocks have geochemical and geologic features that are like assemblages documented in Neoarchean VMS-hosting rocks in the Abitibi greenstone belt, suggesting that the tectono-magmatic processes responsible for forming the AG volcanic rocks in the Late Triassic may have been operative in the Neoarchean.

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This thesis is dedicated to all those who have chipped away at understanding our Earth. Pictured here is the late Bruce Hickock, Kennecott geologist, rock sampling at the Nunatak prospect (AG deposit area) next to the Saksaia Glacier circa mid 1980s. Permission to use this photo granted courtesy of the photographer, Lance Miller.

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List of Acronyms

% RD	Percent relative difference
% RSD	Percent relative standard deviation
2D	Two dimensions
3D	Three dimensions
Ab	Albite
ACC	Average continental crust
AFC	Assimilation fractional crystallization
Aln	Allanite
AMC	Axial magma chamber
Amp	Amphibole
Ank	Ankerite
Ар	Apatite
ATMB	Alexander Triassic metallogenic belt
BAB	Back-arc basin
BABB	Back-arc basin basalt
BC	British Columbia
BCGS	British Columbia Geological Survey
Brt	Barite
BSE	Backscatter electron
BSU IGL	Boise State University Isotope Geology Laboratory
Bt	Biotite
CAB	Calc-alkaline basalt
Cal	Calcite
CA-ID-TIMS	Chemical abrasion isotope dilution thermal ionization mass spectrometry
Сср	Chalcopyrite
Chl	Chlorite
CL	Cathodoluminescence
cm	Centimeter
cn	Chondrite
CV _{avg}	Average coefficient of variation
EDS	Energy dispersive spectrometer
EMORB	Enriched mid-ocean ridge basalt
Ер	Epidote
EPMA	Electron probe microanalyzer
F	Batch melting
FC	Fractional crystallization
$Fe_2O_3^T$	Total Fe expressed as Fe ₂ O ₃
FeA	Ferroandesites
FeD	Ferrodacites
FeO ^T	Total Fe expressed as FeO
FeR	Ferrorhyolites
Fig(s)	Figure(s)
FOV	Field of view

Fsp	Feldspar
FW	Footwall (stratigraphic)
FW-B	Footwall basalts
FW-FeB	Footwall ferrobasalts
g/t	Grams per ton
Gn	Galena
НС	Hydrothermal convection
Hem	Hematite
HFSE	High field strength elements
HREE	Heavy rare earth elements
HSR	High-silica rhyolites
HW	Hangingwall (stratigraphic)
HW-FeTiB	Hangingwall FeTi basalts
IAB	Island arc basalt
IAT	Island arc tholeiite
ICP-AES	Inductively coupled plasma - atomic emission spectroscopy
ICP-MS	Inductively coupled plasma - mass spectrometry
Ilm	Ilmenite
IR	infrared spectroscopy
km	Kilometer
LA-ICPMS	Laser ablation inductively coupled mass spectrometry
LFSE	Low field strength elements
LIP	Large igneous province
LOD	Limit of detection
LOI	Loss on ignition
LREE	Light rare earth elements
m	Meter
Ma	Million years ago
Mag	Magnetite
mm	Milometer
Mnz	Monazite
MORB	Mid-ocean ridge basalt
MREE	Middle rare earth elements
Ms	Muscovite
Mt	Million tonne
n	number of samples
nm	Nanometer
NMORB	Normal mid-ocean ridge basalt
OIB	Ocean island basalt
pН	Potential hydrogen
Pl	Plagioclase
pm	Primitive mantle
ppm	Parts per million
Ру	Pyrite
QAQC	Quality assurance and quality control
Qz	Quartz

R	Replenishment
Rt	Rutile
SEM	Scanning electron microscope
Sp	Sphalerite
SRM	Standard reference material
SZ	Subduction zone
ТВ	Tholeiitic basalt
Ti-mag	Titanomagnetite
USGS	United States Geological Survey
VAB	Volcanic arc basalt
VMS	Volcanogenic massive sulfide
WPB	Within plate basalt
WPT	Within plate tholeiite
Wt %	Weight percent
XRF	X-Ray fluorescence spectroscopy
Z-FeTiB	Zone FeTi basalts
Zm	Zircon
μm	Micrometer

Chapter 1. Introduction to the AG VMS deposit

1.1. Introduction

The rocks of the Alexander Triassic metallogenic belt (ATMB) in the North American Cordillera are well endowed with volcanogenic massive sulfide (VMS) deposits, including the supergiant (~300 Mt) Cu-Co Windy Craggy deposit, the Ag-rich Greens Creek deposit, and the polymetallic (Zn-Cu-Pb-Ag-Au-Ba) Palmer deposit (Figs. 1.1, 1.2; Taylor et al., 2008). Despite the economic significance of the ATMB, it remains understudied compared to other global VMS districts (such as those reviewed by Allen et al., 2002; Franklin et al., 2005; Monecke et al., 2017a). The most recent discovery (2017) in the ATMB, the AG VMS deposit, is located 3 km from the 10 Mt Palmer deposit on Constantine Mining LLC's advanced stage Palmer VMS Project (Fig. 1.4). It is hosted in bimodal volcanic rocks and is composed of both exhalative- and replacement-style, barite-rich VMS mineralization with an inferred resource of 4.3 Mt grading 4.64% Zn, 0.12% Cu, 0.96% Pb, 119.5 g/t Ag, 0.53 g/t Au and 34.8% BaSO4 (Gray and Cunningham-Dunlop, 2018). No detailed study of the deposit-scale stratigraphy, lithogeochemistry, and structural architecture exists for this deposit.

The focus of this thesis is to integrate observations from geologic mapping, core logging, petrography, lithogeochemistry, and U-Pb zircon geochronology to: (1) reconstruct the AG volcanic architecture, (2) improve our understanding of the relationships between the magmatic, tectonic, and hydrothermal processes that formed the AG VMS deposit, and (3) constrain the timing of VMS formation at AG.

Much of our understanding of VMS genesis arises from exploration and studies of numerous ancient deposits and studies of modern analogues on the seafloor (Allen et al., 2002;

Franklin et al., 2005; Galley et al., 2007; Gibson et al., 2007). The goal of this thesis is to better understand the setting and genesis of the AG deposit to guide future exploration efforts, facilitate correlations with nearby VMS occurrences on the Palmer property, and contribute to the growing knowledge of Late Triassic VMS systems in the ATMB and VMS systems worldwide.

1.2. Regional setting

1.2.1. Alexander terrane

The Alexander terrane spans the Saint Elias Mountains in southwestern Yukon and northwestern British Columbia (BC), most of the Alexander Archipelago in southeastern Alaska, and a minor part of western BC near Prince Rupert (Fig. 1.1). It has a nearly complete rock record beginning from at least the Ediacaran (a felsic metavolcanic with a U-Pb zircon date of 595 ± 20 Ma; Gehrels et al., 1996) and spanning until it was accreted to the North American continental margin during the Middle Jurassic to Late Cretaceous (Berg et al., 1972; Plafker and Berg, 1994; Nelson et al., 2013b). The Alexander terrane is composed of the Craig and Admiralty subterranes, which are crustal fragments that are differentiated based on their pre-Permian stratigraphy (Gehrels and Saleeby, 1987; Karl et al., 2010; Beranek et al., 2014) and the recently proposed Saint Elias subterrane, which has a pericratonic signature (Nelson et al., 2013a). The Alexander terrane originated in the paleo-Arctic during the Neoproterozoic (Beranek et al., 2012; Nelson et al., 2013b; White et al., 2016), and faunal and isotopic evidence suggests that it had low latitude affinities with Siberia or Baltica in the late Silurian to Early Devonian (Soja and Antoshkina, 1997). In general, the tectonic evolution of the terrane included: (1) Neoproterozoic to Silurian oceanic arc magmatism, including the formation of Neoproterozoic and Ordovician to Silurian VMS deposits (Ayuso et al., 2005; Slack et al., 2007; Beranek et al., 2012; Nelson et al., 2013a), (2) a period of quiescence during the Devonian to Permian with the Alexander and its subterranes

joined to the Wrangellia-Peninsular super-terrane by the late Permian (Capitanian) (Karl et al., 2010; Beranek et al., 2014; Israel et al., 2014; Sack et al., 2016), (3) the formation of the economically significant Late Triassic VMS deposits during extension along the eastern edge of the Alexander terrane in a 200-800m thick sequence of rocks known as the Alexander Triassic metallogenic belt (ATMB) (Gehrels and Saleeby, 1987; Gehrels and Berg H.C., 1994; Newberry et al., 1997; Katvala and Stanley, 2008; Taylor et al., 2008; Steeves et al., 2016; Steeves, 2018), and (4) accretion of the composite Alexander-Wrangellia-Peninsular superterrane to the North American continental margin during the Middle Jurassic to Late Cretaceous, as marked by Gravina (and related) overlap assemblages (Berg et al., 1972; Plafker and Berg, 1994; Nelson et al., 2013b).

1.2.2. Alexander Triassic metallogenic belt (ATMB)

Late Triassic rifting of the Alexander terrane coincided with the deposition of volcanic and sedimentary rocks and VMS deposit formation in a northwest-trending belt - the Alexander Triassic metallogenic belt (ATMB) (Fig. 1.2; Taylor et al., 2008). These rocks formed in an asymmetrical back-arc or intra-arc rift and are discontinuously exposed over a strike length of ~750 km along the eastern margin of the Alexander terrane in southeastern Alaska and northwestern BC (Taylor et al., 2008). The ATMB includes the Hyd Group in Alaska (Loney, 1964; Muffler, 1967; Wilson et al., 2015) and the Tats Group (MacIntyre et al., 1992; Cui et al., 2017) in northwestern BC. The Randall Formation (Woodsworth and Orchard, 1985) on Randall Island in BC near Prince Rupert may also be equivalent to the Hyd Group.

The most complete lithostratigraphic and biostratigraphic section through the ATMB is in Keku Strait (Muffler, 1967; Katvala and Stanley, 2008). The ATMB stratigraphy includes a basal conglomerate overlain by a lower volcanic section, a middle sedimentary section, and a thick

mafic volcanic cap (Loney, 1964; Taylor et al., 2008; Sack et al., 2016). Regionally, the lower volcanic section is rhyolite-dominant in the southeast (e.g., the Keku Inlet (KI) section) and thins and transitions to bimodal and mafic-dominant in the northwest (Taylor et al., 2008; Fig. 1.2).

In addition to the AG deposit, the ATMB hosts three other significant VMS deposits (Table 1.1). The ~300 Mt Cu-Co Windy Craggy deposit is the world's largest known Besshi (pelitic-mafic)-type deposit though it is protected from production by BC provincial park status (Peter and Scott, 1997). The 24.2 Mt Greens Creek deposit, with 13.9% Zn, 5.1% Pb, 658 g/t Ag, and 5.1 g/t Au, is consistently among the top ten Ag producers worldwide (Bennett, 2016; Steeves, 2018). The 10 Mt Cu-Zn-Ag-Au-Ba Palmer deposit is 3 km from the AG deposit on the Palmer property (Fig. 1.4; Goodwin et al., 2019).

The ATMB also hosts the small, past-producing, 0.75 Mt, Ba-rich Castle Island deposit in the Duncan Canal area. Several VMS-related prospects on the Cornwallis Peninsula at the north end of Kuiu Island are proximal to the 150–200 ton Ag-Pb-Zn Kuiu prospect, which was mined between 1937–1938 (Still et al., 2002). On Annette Island, the Sylburn Peninsula hosts several VMS-related prospects and drilling results from 1976, combined with soil geochemical anomalies, defined a ~1–2 Mt ore body averaging 32% barite and 2-3% combined Pb and Zn (Taylor, 1993).

Several authors (Karl et al., 2010; White et al., 2016) suggest that restoring the ~180 km post-middle Cretaceous and pre-Holocene (Hudson et al., 1982) dextral movement along the Chatham Strait fault would place the Palmer property deposits approximately 30-50 km from Greens Creek (Fig. 1.2). The Greens Creek deposit formed after the emplacement of a Hyd Group rhyolite with a chemical abrasion isotope dilution-thermal ionization mass spectrometry (CA-ID-TIMS) U-Pb zircon date of 226.86 ± 0.24 Ma (Sack et al., 2011; Sack et al., 2016) interpreted to

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stratigraphically underlie argillites that hosts the Greens Creek deposit (Steeves, 2018). These argillites contain conodonts assigned to the Carnian-Norian boundary (~227 Ma) (Premo et al., 2010; Steeves, 2018). Previous conodont studies on the Palmer property confirmed that the host rocks for VMS mineralization are Late Triassic (Norian to Rhaetian; Green, 2001; Green et al., 2003) and an ID-TIMS U-Pb zircon date of 213 ± 5 Ma from a hydrothermally altered rhyolite constrains the timing of mineralization at the Palmer deposit (Green, 2001). These geochronologic constraints suggest that the Palmer deposit could be at least 10 - 15 million years younger than the Greens Creek deposit.

1.3. Local setting - the Palmer VMS Project

The Palmer volcanogenic massive sulfide (VMS) project is an advanced-stage Cu-Zn-Au-Ag VMS exploration project located within the ATMB near Haines, Alaska (Goodwin et al., 2019). The Palmer VMS project includes both the Palmer and AG VMS deposits as well as several other VMS prospects and occurrences (Fig. 1.3; Fig. 1.4). The Palmer VMS deposit contains 4.7 Mt of indicated resources grading 5.23 % Zn, 1.49 % Cu, 30.8 g/t Ag, 0.30 gt Au, 23.9 % BaSO₄ and 5.3 Mt of inferred resources grading 5.20 % Zn, 0.96 % Cu, 29.2 g/t Ag, 0.28 g/t Au, 22.0 % BaSO₄ (Goodwin et al., 2019). The AG VMS deposit contains 4.3 Mt of inferred resources grading 4.64 % Zn, 0.12 % Cu, 0.96 % Pb, 119.5 g/t Ag, 0.53 g/t Au, 34.8 % BaSO₄ (Goodwin et al., 2019).

1.3.1. Previous studies and exploration history

The Palmer property is in the Porcupine Mining Area within the Skagway B-4 Quadrangle. Active mining in the area began in 1898 with the discovery of placer gold in Porcupine Creek and Glacier Creek (Still, 1991). In 1969, a local prospector, Merrill Palmer, first discovered VMS-style massive barite and base-metal sulfides in the Glacier Creek prospect area. Since then, several VMS-related mineral occurrences and prospects, and two VMS deposits hosted within Upper Triassic volcanic rocks have been identified on the property (Figs. 1.4, 1.3).

The geology of the property has been established through the regional mapping and geochemical sampling efforts of MacKevett Jr. et al. (1974), Redman et al. (1985), Forbes et al. (1989), and Still (1991). Since 1979, 206 drill holes totaling ~76,900 m have been drilled on the property. Various operators conducted drilling programs between 1979-1989, including Anaconda (1979), Bear Creek Mining/Kennecott Exploration (1984 and 1985), Granges Exploration Inc. (1989), and Newmont Exploration Ltd. (1987-1989). In 1999, Rubicon Minerals Corporation drilled the Palmer deposit discovery hole into the RW zone. In 2007, Constantine drilled the discovery hole into the Southwall zone. Between 2006 and 2022, Constantine explored and defined the Palmer deposit, which consists of the Southwall and RW zones (Green et al., 2003; Steeves et al., 2016). In 2017, Constantine drilled the AG discovery hole and subsequent drilling and mapping to 2018 resulted in the definition of the first inferred resource (Gray and Cunningham-Dunlop, 2018).

Two Master of Sciences theses (Green, 2001; Steeves, 2013), two research projects associated with applied Master of Sciences programs (Doherty, 2018; Transburg, 2020), one undergraduate honors thesis (Miller, 2015), and many generations of internal company reports are the basis of the geological knowledge base of the Palmer Project area.

1.3.2. District Geology

The Palmer property is underlain by Paleozoic to Mesozoic marine metavolcanic and metasedimentary rocks that are intruded by Mesozoic granodiorite plutons (MacKevett Jr. et al.,

1974; Macintyre and Schroeter, 1985; Redman et al., 1985; Still, 1991; Green et al., 2003; Wilson et al., 2015; Proffett, 2019). Figure 1.4 highlights the distribution of regional geologic units as compiled by Wilson et al. (2015). Geochronologic data includes fossils (Green et al., 2003), U-Pb zircon dates from the Palmer rhyolite (213 Ma) (Green, 2001), and U-Pb dates from detrital zircons (Karl et al., 2020). The locations of radiometric data from Green (2001) and Karl et al. (2020) are presented in Figure 1.4.

Thinly bedded limestone and marble of the Devonian basement rocks are in depositional contact with the overlying, informally-named Porcupine slates (Redman et al., 1985; Karl et al., 2010). The Porcupine slates are likely correlative with the Devonian to Early Permian Cannery Formation (Karl et al., 2010; Wilson et al., 2015). The Porcupine slates and Cannery Formation consist of cherty graywacke and argillite with subordinate conglomerate, limestone, and volcanic interbeds (Redman et al., 1985; Karl et al., 2010; Wilson et al., 2010; Wilson et al., 2015). The youngest Paleozoic rocks are Early Permian and contain brachiopods in limestone that were documented in 1904 by C.W. Wright at a poorly referenced location along Porcupine Creek (Karl et al., 2010).

The Permian-Triassic boundary at Palmer is not easily distinguishable. Thick sequences of pillowed basalt of the Hyd Group provide the best indication of Triassic stratigraphy. Locally, Permian argillite is in contact with Triassic argillite but is often challenging to differentiate. Elsewhere in the Alexander terrane, the Permian-Triassic boundary is unconformable and marked by a distinct polymictic conglomerate (or breccia) containing locally derived Paleozoic clasts (Loney, 1964; Muffler, 1967; Taylor et al., 2008; Karl et al., 2010). At Greens Creek, mineralization is hosted in Upper Triassic sedimentary rocks directly above the Permian-Triassic unconformity, and is an economically significant contact regionally (Taylor et al., 2010; Steeves, 2018).

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Geologic mapping and petrography by Proffett (2019) helped characterize the Permian-Triassic boundary near the headwaters of Sara Creek immediately to the north of the Jurassic argillites that are immediately north of the Palmer deposit (Fig. 1.4). Proffett (2019) identified marble clast-bearing conglomerates unconformably overlying marbles and greenstones of probable Paleozoic age; petrographic evidence also suggested the clasts were derived from underlying marbles and greenstones. Stratigraphically above the conglomerates are black limestone and a thick pile of pillowed basalts. An older foliation in the marbles and greenstones is truncated by the marble-clast conglomerate contact and crenulated by the main foliation observed in the rocks stratigraphically above the conglomerates occur at the Permian-Triassic boundary. Similar but more deformed marble clast conglomerates were documented by the author in 2018 on the hillsides flanking the eastern margin of the Jarvis Glacier; they may also represent the unconformable Triassic-Permian boundary, but more evidence is needed to test this hypothesis.

Lower to Middle Triassic rocks are not documented on the property and are mostly absent from the rock record in the Alexander terrane; an Anisian (Middle Triassic) conodont fossil from a limestone debris flow found east of Keku Strait is the only known pre-Late Triassic fossil in the Alexander terrane (Katvala and Stanley, 2008). Volcanogenic massive sulfide mineralization is hosted within Upper Triassic mafic-dominated, bimodal volcanic sequences with associated volcaniclastic rocks and minor fine-grained sedimentary and tuffaceous interbeds (Green et al., 2003; Steeves et al., 2016). The age of mineralization at Palmer is constrained by a U-Pb age of 213 +/- 5 Ma from a hydrothermally altered rhyolite at the Palmer deposit with stratiform mineralization above and below (Green et al., 2003). The Triassic section is capped by volcanic breccias at the top of Mt. Morlan (Green et al., 2003), near the Palmer deposit, and black argillites that occupy a syncline (Proffett, 2019) to the north of the Palmer deposit. The igneous crystallization age for the volcanic breccia is ~195 Ma based on U-Pb zircon dates (Karl et al., 2020), and the black argillites have a young population of detrital zircons with U-Pb zircon dates of ~144 Ma (Karl et al., 2020).

Regional metamorphism and deformation

Mid-Cretaceous deformation of the Alexander terrane (Karl et al., 1999; Nelson et al., 2013b) resulted in four main deformation events (D1 to D4) that affected the rocks in the Palmer area (Lewis, 1998; Green et al., 2003). A north-south contractional deformation event (D1) is characterized by south-verging folds and thrust faults and slatey cleavage (S1) (Lewis, 1998; Green et al., 2003). It is best displayed by the deposit-scale geometry of Palmer, consisting of a south-verging, overturned anticline with ~ 200 m displacement along a thrust fault proximal to the axial surface of the anticline (Green et al., 2003; Steeves et al., 2016). D2 is marked by tight to open, north-northwest-plunging folds (Green et al., 2003). D3 is weakly manifested as NEstriking crenulation cleavage in some rocks (Lewis, 1998; Green et al., 2003). D4 consists of poorly understood, late, SW- and NW-striking, high-angle brittle faults related to the post-middle Cretaceous and pre-Holocene (Hudson et al., 1982) dextral transpression that formed the Chatham Strait fault system (Karl et al., 1999; Steeves et al., 2016). Proffett (2019) documented an older foliation (pre-D1) in rocks of apparent Paleozoic age compared to the overlying Mesozoic rocks. Peak, lower to mid-greenschist facies, regional metamorphism (Green et al., 2003) was reached before the emplacement of non-metamorphosed granitic rocks with cooling ages between 110-120 Ma (Forbes et al., 1989). Reverse faults, normal faults (Lewis, 1998; Wasteneys, 2009), strike-slip faults (Proffett, 2016), and south-verging thrusts (Green et al., 2003) occur on the Palmer property.

1.4. AG Deposit Geology

The AG deposit is a tabular, steeply northeast dipping barite- and sulfide-rich lens underlain predominantly by coherent mafic flows and subordinate rhyolite (Gray and Cunningham-Dunlop, 2018). The immediate stratigraphic footwall to the deposit is comprised of rhyolitic lapilli tuffs and most mineralization is associated with these felsic tuffs and with basalts that contain distinctive white ovoid features that company geologists have called spherulites (Gray and Cunningham-Dunlop, 2018). The deposit is overlain by mafic volcaniclastic rocks that are overlain by argillite (Gray and Cunningham-Dunlop, 2018).

Based on the metal tenor, the AG deposit is divided into the "Main," "Zinc," "Hinge," and "Upper" zones (Gray and Cunningham-Dunlop, 2018). Barite is a major phase, especially in the exhalative-style ores, and also occurs within veins ("stringers") that are commonly sulfidebearing (Doherty, 2018). Pyrite, sphalerite, galena, sulfosalts, and rare chalcopyrite are present as disseminated, vein, semi-massive, and massive sulfide facies (Doherty, 2018). Hydrothermal alteration assemblages in the stratigraphic footwall are dominated by pervasive fine-grained white mica (colloquially referred to as sericite), disseminated pyrite, and variable pervasive to selective quartz (Gray and Cunningham-Dunlop, 2018). Hyperspectral imaging of white micas shows that short wave infrared Al-OH feature absorption wavelengths range from 2190 nm to 2215 nm, indicating the presence of paragonite (2,195 nm), muscovite (2,200 nm) and phengite (2,210 nm), however these data were insufficient to document the distribution of mica species in the deposit area (Transburg, 2020).

1.5. VMS Deposits

Volcanogenic massive sulfide (VMS) deposits are stratiform concentrations of sulfide minerals that precipitate on or near the seafloor from hydrothermal fluids that form by the convective circulation of seawater through ocean crust in thermally driven, submarine, extensional regimes (Fig. 1.6; Franklin et al., 2005; Hannington et al., 2005; Galley et al., 2007). Volcanogenic massive sulfide deposits are syngenetic and stratigraphic setting exerts a first-order control on their formation. Structures and permeability of substrate control the migration of hydrothermal fluids and can influence deposit morphology (Gibson et al., 1999). Further, the volcano-sedimentary sequences that host VMS deposits are diverse and can reflect complex and dynamic volcanic, sedimentary, tectonic, and alteration processes, which can influence metal tenor, size, geometry, mineralization styles, and preservation.

1.5.1. VMS model

Extensional submarine environments and high-temperature magmatism are essential components for the formation of VMS deposits (Lesher et al., 1986; Hart et al., 2004; Franklin et al., 2005; Hannington et al., 2005; Galley et al., 2007; Piercey, 2010). Rift environments contain extensional faults that serve as fluid pathways for hydrothermal convective cells and provide void space for upwelling high-temperature magmatism within shallow (3–10 km) crustal levels initiates and sustains hydrothermal convective cell(s) by drawing seawater (with dissolved Cl⁻ and SO4²⁻) down through the brittle section of crust (1–3 km) where it is modified by a series of high-temperature fluid-rock chemical reactions to become a high-temperature (250–400°C), acidic fluid (Fig. 1.6; Franklin et al., 2005; Herzig and Hannington, 2006; Galley et al., 2007; Gibson et al., 2007; Hannington, 2013). This highly reactive fluid can leach metals (such as Li, K, Rb, Ca,

Ba, Fe, Mn, Cu, Zn, Au, Ag, and some Si) from the wall rock putting them into solution as chloride complexes (Herzig and Hannington, 2006). In some systems, magmatic fluids and gases may also contribute metals to the hydrothermal fluids (Hannington et al., 2005; Piercey et al., 2015). These hot, metalliferous fluids above high-level magma chambers are buoyant and migrate through the crust to the seafloor, preferentially along major structures, but they can also migrate laterally through porous substrates. The abrupt change in conditions at or near the seafloor causes sulfide or sulfate minerals to precipitate as the hydrothermal fluids mix with ambient seawater $(\sim 2^{\circ} C)$. The complete convective cycle of seawater through the crust occurs within an estimated three years or less (Herzig and Hannington, 2006). Volcanogenic massive sulfide mineralization emplaced within the existing seafloor substrate is replacement-style, whereas mineralization formed by exhalation on the seafloor is exhalative-style (Doyle and Allen, 2003; Piercey, 2015). Black smokers on the modern seafloor, modern analogs to some ancient VMS deposits, are the physical expressions of exhalative-style mineralization. They result from the venting of hydrothermal fluids (generally >300°C to 400°C) containing sufficient metal and sulfur to precipitate iron sulfide and iron oxide particles, whereas white smokers result from the venting of cooler (<10°C to 50°C) hydrothermal fluids that are not capable of transporting significant dissolved metals and instead produce minerals such as anhydrite, barite, or siliceous Feoxyhydroxides, Mn-oxides and silica (Herzig and Hannington, 2006). Chemical sedimentary rocks that are products of exhalative processes have been referred to by many names depending on their character (e.g., barite-rich rocks, chert, jasper, Algoma-type iron formations) and all can broadly be termed "exhalites" (James, 1954; Gross, 1983; Spry et al., 2000; Peter, 2003). Because they are genetically linked to hydrothermal fluids they can be spatially and temporally associated with VMS deposits (Peter, 2003).

Many factors influence the size, geometry, and metal endowment of VMS deposits, including host substrate composition (Barrie and Hannington, 1999) and texture/permeability (Gibson et al., 1999), tectonic spreading rates (Hannington et al., 2005; Patten et al., 2016), redox conditions (Herzig and Hannington, 2006), or presence of a sediment pile (Herzig and Hannington, 2006). These factors are not critical to forming VMS deposits but can account for unique features observed between deposits (Franklin et al., 2005).

The growth of a VMS deposit requires a period of volcanic quiescence to allow for the undisturbed deposition of metals. Larger and higher-grade deposits generally have more complex growth patterns and result from "zone refinement" processes (Piercey et al., 2015). Zone refinement is the redistribution of metals in the massive sulfide mound caused by the progressive dissolution and sequential precipitation of metals in response to decreasing temperature and increasing pH during mixing with cold seawater (Eldridge et al., 1983; Lydon, 1988; Gibson et al., 2007). The sulfide mound can trap metals before they are diluted and dispersed at the vent site. This process is especially important in the genesis of Zn-rich VMS deposits (Piercey et al., 2015). Finally, the preservation of a deposit relies on shielding from natural submarine erosion and weathering processes, generally through subsequent burial.

1.5.2. Classification

Several classification schemes for VMS deposits have been proposed based mainly on ore composition or host-rock lithology (Franklin et al., 1981). The most widely-used classification is non-genetic, based on the pre-alteration host-rock lithologies and geodynamic setting, and includes mafic, mafic siliciclastic, bimodal mafic, bimodal felsic and felsic siliciclastic (Barrie and Hannington, 1997; Franklin et al., 2005; Galley et al., 2007; Piercey, 2011; Piercey et al., 2015). Piercey (2011) summarizes the petrochemical associations and

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tectonic implications of these end-member classes (Fig. 1.6) and shows that some volcanic successions have progressive geochemical variations throughout their stratigraphy that reflect shifting geodynamic regimes. As such, this classification scheme is closely linked to the tectonic setting of formation.

1.5.3. Tectono-magmatic associations

Volcanogenic massive sulfide deposits form in extensional environments that range from primitive to more evolved (continental) settings, including mid-ocean ridges (ophiolites), intraoceanic arc rifts, back-arc basins, evolved rifted arcs, rifted continental margins, or intracontinental rifts (Fig. 1.8; Barrett and MacLean, 1999; Galley et al., 2007; Piercey, 2010). Each tectonic setting is associated with distinct suites of igneous rocks that reflect magmatic source(s), melting depth(s), degree(s) of melting, melt temperature(s), and mantle flow regimes.

In an extensional environment, two important things happen:

- the crust attenuates, causing a decrease in lithostatic pressure, which may induce upwelling of the mantle and associated adiabatic melting; and
- (2) networks of extensional faults develop to accommodate brittle deformation and serve as fluid pathways for the hydrothermal convective cell and, in some cases, for ascending magmas (Piercey, 2011).

Hot, mafic melts derived from the mantle are generally not buoyant in the crust, resulting in ponding at the base of the crust in a process referred to as basaltic underplating (Fig. 1.9; Galley et al., 2007; Winter, 2010; Piercey, 2011). The thermal input of these ponded basalts is essential to induce crustal, partial melting resulting in the formation of intermediate to silicic melts (Huppert and Sparks, 1988). The mechanisms that drive VMS formation and the nuances specific to each tectonic setting of formation are geochemically and petrologically reflected in the overall volcanic successions that host these deposits.

1.5.4. Using geochemistry for VMS exploration

Geochemistry can be used to investigate precursor composition, alteration, and orebearing potential of host rocks to VMS mineralization. Primary igneous lithogeochemical signatures provide insight into an assemblage's tectonic and petrologic history (Lesher et al., 1986; Hart et al., 2004; Piercey, 2010; Piercey, 2011). Immobile elements are unaffected by metasomatism and, therefore, can be used to investigate magmatic processes, precursor composition, and tectonic setting (e.g., Pearce et al., 1984; Lesher et al., 1986; Hart et al., 2004; Piercey, 2010; Ross and Bédard, 2009; Piercey, 2010; Pearce, 2014). Common immobile elements include Al₂O₃, TiO₂, high field strength elements (HFSE; Zr, Hf, Nb, Ta, Y, Sc, Ti, V), and rare earth elements (REE) (Piercey, 2010). The Cann (1970) correlation method can be applied to test the mobility of elements in any given suite of rocks prior to lithogeochemical determinations that rely on the assumptions of immobility.

Altered rocks near VMS deposits may include hydrothermal alteration products, diagenesis, seafloor weathering and oxidation, and regional metamorphism (Gifkins et al., 2005). Hydrothermally altered rocks in VMS systems reflect the large-scale convective cell that drives fluid circulation associated with ore deposition and the associated redistribution of elements (Galley, 1993; Gifkins et al., 2005). Major element ratios, normative calculations, alteration indices, and mass balance calculations can be used to evaluate hydrothermal alteration (Barrett and MacLean, 1994; Large et al., 2001; Mathieu, 2018). Establishing that a hydrothermal system is present, understanding the chemical reactions that produce alteration mineral assemblages, and

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then quantifying the intensity and extent of the alteration provides insight into the genesis of a deposit and guides exploration efforts.

1.6. Fundamental research questions and approaches

This thesis aims to use detailed mapping, core logging, petrography, geochemistry, and geologic modeling to reconstruct the volcanic environment hosting the AG deposit and to develop a genetic model for the AG deposit. Furthermore, geochronologic studies will help to understand the timing of hydrothermal mineralization. This research will also set the framework for future detailed studies on other aspects of the deposit.

This thesis aims to:

- 1. Characterize the lithostratigraphy by:
 - a. logging drill core at a scale of 1:400.
 - b. geologic mapping near the AG zone deposit at a scale of 1:1,000.
 - c. collecting hand samples from the surface and drill core
 - d. describing the mineralogy, mineral assemblages, and textures of the rocks.
 - e. conducting petrographic analysis using both transmitted and reflected light microscopy.
 - f. identifying textures and minerals that are indistinguishable by transmitted and reflected light microscopy methods using:
 - i. a scanning electron microscope (SEM); and
 - ii. an electron probe microanalyzer (EPMA),
- 2. Establish the tectono-magmatic framework of the deposit by:

- a. distinguishing and interpreting volcano-sedimentary facies using geologic mapping and petrographic techniques; and
- investigating the lithogeochemistry using immobile element ratios, discrimination diagrams, multi-element normalized diagrams, and other geochemical and geostatistical methods.
- Present an updated geologic map and associated cross-section interpretations by:
 - a. incorporating core logging observations, surface geological mapping,
 lithogeochemical analyses, and structural observations into 2D
 - b. modeling the chemostratigraphy in LeapFrog Geo 3D software
- 4. Constrain the timing of VMS mineralization with a combination of:
 - a. laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) U-Pb zircon geochronology,
 - and chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) U-Pb zircon geochronology

1.7. Research goals and organization of the thesis

This research project aims to understand how the AG deposit formed and the main controls on this formation, the chemostratigraphy of volcanic units, their petrogenetic history and tectonic settings, the volcanic facies of these units, and their emplacement, and inter-relationships between units. Further, it will evaluate the structural architecture of the deposit and whether synvolcanic faults can be identified. This research will also evaluate the age of mineralization at AG and compare when it formed with other VMS mineralization on the Palmer Property and in the ATMB. Further, petrogenetic information from both mafic and felsic igneous rocks may provide insight into the relationship of magmatism and tectonics to the formation of bimodal VMS deposits, and provide insight into the evolution of the ATMB.

This thesis includes three chapters with accompanying appendices. Chapter one provides background information and the research objectives. Chapter two is written as a scientific paper intended for publication and contains the lithologic descriptions, chemostratigraphic observations, geochronologic results, and a genetic model for the AG deposit based on mapping, core logging, petrography, lithogeochemical techniques, and U-Pb geochronology. Chapter three summarizes the research conclusions and proposes future research ideas. The appendices contain photographs of the AG deposit host stratigraphy, petrographic descriptions, geochemical data, geochronologic data, and electron probe microanalyzer (EPMA) data.

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Chapter 1 Tables

Table 1.1 Summary of significant VMS deposits in the ATMB. The VMS classifications are based on Barrie and Hannington (1997). Data for Windy Craggy are from Peter and Scott (1997) and Peter et al. (2014); data for Greens Creek are from Premo et al. (2010), Steeves (2018), Sack (2009) and Sack et al. (2016); data for the Palmer deposit are from Goodwin et al. (2019), Green (2001), and Steeves et al., (2016); data for the AG deposit are from Goodwin et al. (2019) and ¹this thesis.

	Windy Craggy deposit	Greens Creek deposit	Palmer deposit	AG deposit
Classification	Pelitic-mafic; Besshi type	Mafic of pelitic-mafic VMS; hybrid VMS-SEDEX	Bimodal-mafic; Kuroko type	Bimodal-mafic; Kuroko type
Main Commodities	Cu-Co-Au-Ag	Zn-Pb-Ag-Au	Zn-Cu-Ag-Au-BaSO ₄	Zn-Pb-Ag-Au-BaSO ₄
Tonnage	297.4 Mt	24.2 Mt	10.0 Mt	4.3 Mt
Grade	1.38% Cu, 0.07% Co, 0.2 g/t Au, 3.8 g/t Ag	13.9% Zn, 5.1% Pb, 658 g/t Ag, 5.1 g/t Au	 4.7 Mt indicated resource grading 5.23 % Zn, 1.49 % Cu, 30.8 g/t Ag, 0.30 gt Au, 23.9 % BaSO₄ 5.3 Mt inferred resrouce grading 5.20 % Zn, 0.96 % Cu, 29.2 g/t Ag, 0.28 g/t Au, 22.0 % BaSO₄ 	4.64 % Zn, 0.12 % Cu, 0.96 % Pb, 119.5 g/t Ag, 0.53 g/t Au, 34.8 % BaSO ₄ (inferred)
Host rocks	Argillites and alkalic basaltic flows and dikes/sills	Graphitic argillite, dolomite, and sedimentary breccias; footwall Mississipian (340 - 330 Ma) tholeiitic mafic volcanic rocks and phyllites (volcaniclastic rocks mixed with graphitic sedimentary component)	Tholeiitic plagioclase-phyric basalt, volcaniclastic rocks, rhyolite, tuffaceous rocks, argillites	Tholeiitic basalts including FeTi basalts, ferro-andesites, ferro- dacites, FIIIa ferro-rhyolites, FIIIb high-silica rhyolites, volcaniclastic rocks, minor argillites ¹
Age	Early Norian (~225 Ma) based on conodonts collected within sedimentary beds hosting the deposit.	Younger than (1) a Hyd Group rhyolite with a CA-ID-TIMS U-Pb zircon date of 226.86 \pm 0.24 Ma and (2) arglilite with Norian-Carnian (227 \pm 4.4 Ma) condonts. These argillites are intruded by gabbros with a LA-ICP-QMS U-Pb zircon date of 219 \pm 8 Ma. Possibly coeval with nearby altered mafic-ultramafic intrusions that have fuchsite with a ⁴⁰ Ar/ ³⁰ Ar plateau age of 210.3 \pm 0.3 Ma.		Between 210.60 Ma to 210.08 Ma based on coeval rhyolites with CA-ID-TIMS U-Pb zircon dates of 210.35 \pm 0.27, and 210.52 \pm 0.08 Ma. ¹

Chapter 1 Figures

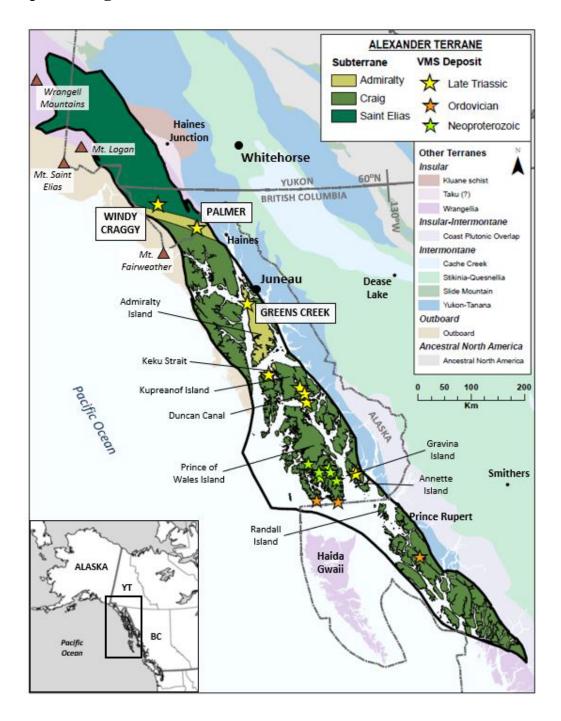


Fig. 1.1 Terrane map of the northwestern Cordillera highlighting the Alexander terrane and subterranes. Pre-Triassic VMS deposits are from Slack et al. (2007) and Nelson et al. (2013b). Terrane boundaries are from Colpron and Nelson (2011).

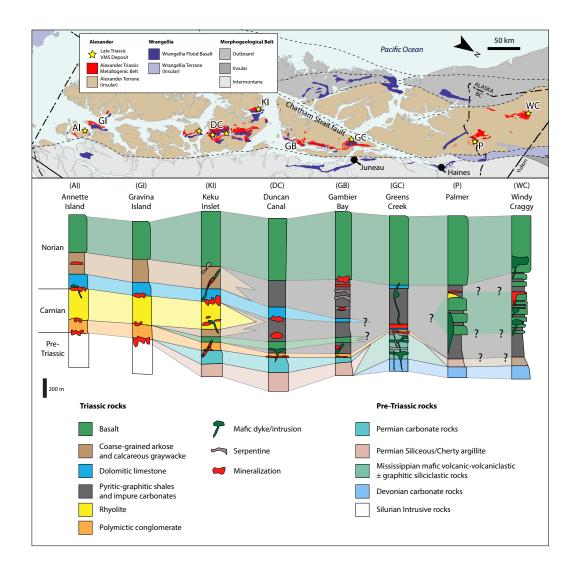


Fig. 1.2 Schematic stratigraphic section from southeast to northwest (left to right) through the Alexander Triassic metallogenic belt (ATMB) modified after Steeves (2018) and Taylor et al. (2008). The corresponding map at the top shows the Alexander Triassic Metallogenic Belt (ATMB; red) and the Wrangellia Flood Basalts (WFB; dark blue). Terrane boundaries are from Colpron and Nelson (2011), the ATMB is derived from digital files of the USGS (Wilson et al., 2015) and the WFB are from the digital files of Greene et al. (2010).

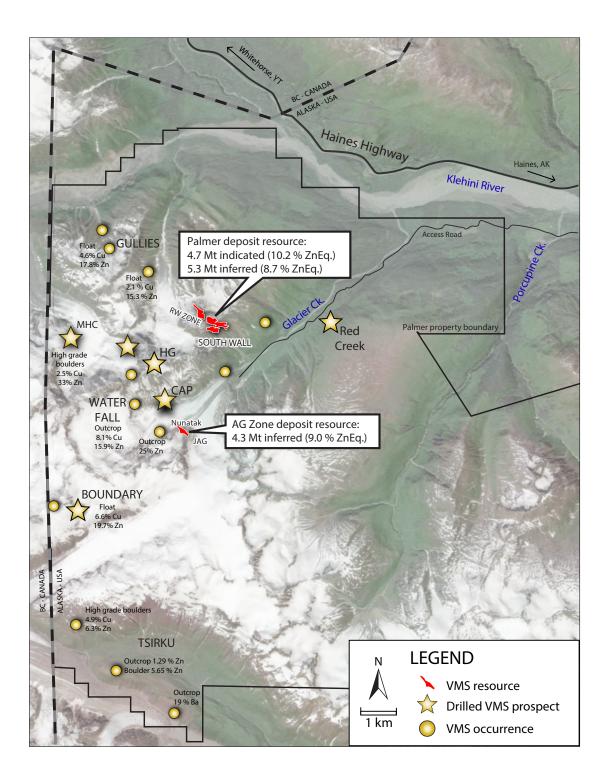
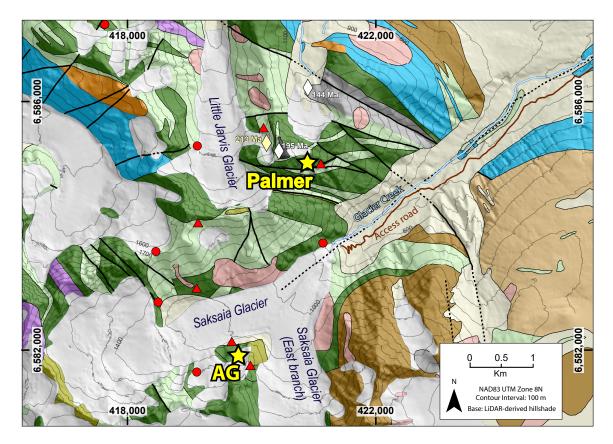


Fig. 1.3 Palmer property VMS occurrences, prospects, and deposits location map.



Palmer property lithology

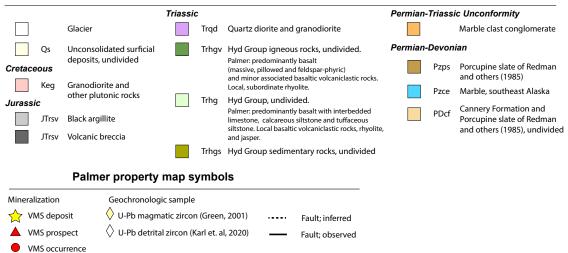


Fig. 1.4 Regional geology near the Palmer property based on the Alaska digital geology compilation by the USGS (Wilson et al., 2015). The locations of the Palmer and AG VMS deposits and several VMS prospects are shown. Geochronologic data includes a U-Pb zircon date of 213 Ma from the Palmer rhyolite (Green, 2001) and U-Pb dates from detrital zircons (Karl et al., 2020).

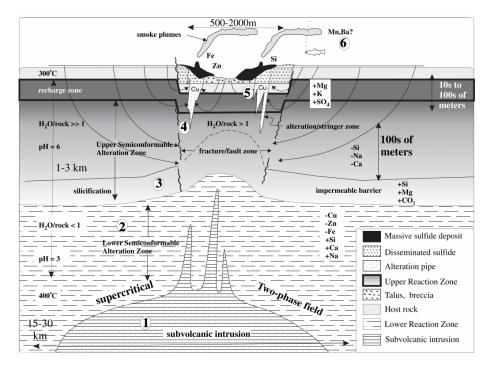


Fig. 1.5 VMS convective hydrothermal system and components from Franklin et al. (2005) after Galley (1993) and Gibson et al. (2007). The numbers reflect (1) a heat source, (2) a high-temperature reaction zone, (3) synvolcanic faults and fissures, (4) a footwall alteration zone, (5) massive sulfide deposits, and (6) distal hydrothermal products that may be mixed with background sedimentation.

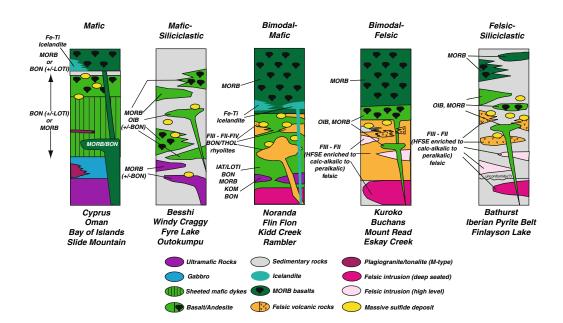


Fig. 1.6 Lithostratigraphic classification of VMS deposits shown with their respective stratigraphic relationships and associated petrochemical assemblages by Piercey (2011).

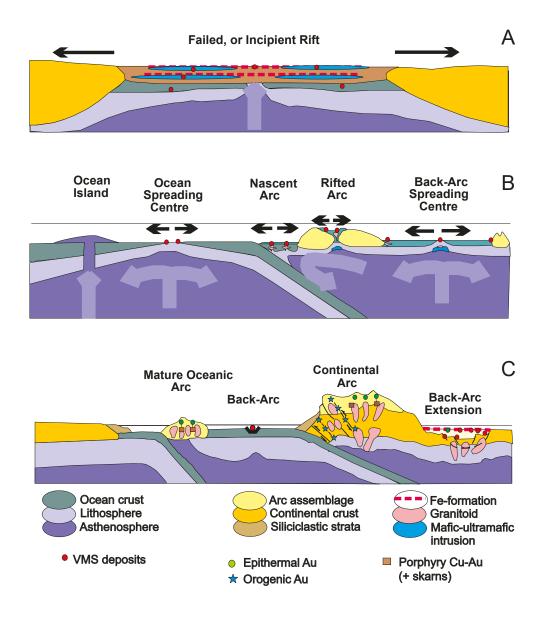


Fig. 1.7 Tectonic settings where VMS deposits form with black arrows showing extension direction and pale arrows showing mantle movement from Galley et al. (2007). A) Incipient rift environments such as those formed from vigorous mantle plume activity in early Earth evolution or those formed in the Phanerozoic during transpressional, back-arc rifting. B) Mafic-dominated deposits form in ocean spreading centers. The formation of oceanic arcs at subduction zones commonly coincides with extension in the arc or back-arc parts of the system were bimodal mafic, bimodal felsic, and mafic-dominated VMS deposits form. C) Felsic-dominated and bimodal siliciclastic VMS deposits form in more evolved settings such as mature oceanic back-arc basins and continental back-arc basins.

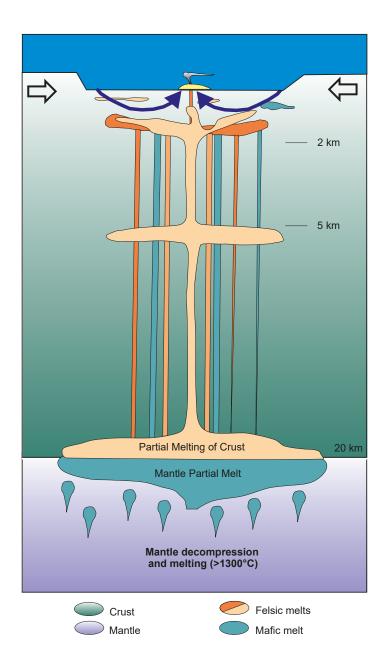


Fig. 1.8 Extension-related magmatic plumbing system including crustal thinning, mantle decompression melting, the generation of basaltic melts that underplate the crust, and the generation of felsic melts by partially melting the crust. From Galley et al. (2007).

Chapter 2. Geology, lithogeochemistry, age, and genesis of the AG VMS deposit, Alaska

2.1. Abstract

The 4.3 Mt, bimodal-mafic AG volcanogenic massive sulfide (VMS) deposit contains both exhalative- and replacement-style, barite-rich, Zn-Ag-Pb-Cu-Au VMS mineralization hosted by Late Triassic (Hyd Group) volcano-sedimentary rocks of the Alexander Triassic metallogenic belt (ATMB) near Haines, Alaska. The immediate stratigraphic footwall consists of coherent to volcaniclastic Fe-rich, intermediate to felsic rocks with weak "arc-like" geochemical signatures, including FIIIa felsic rocks that were derived from high-temperature (T > 900°C) melts that were generated at shallow (< 10 km) depths in the crust. Mineralization is intercalated with FeTi-rich, enriched mid-ocean ridge basalt (EMORB)-like, variolitic pillowed basalts and heterolithic fragmental rocks. The heterolithic fragmental rocks are considered debris flow deposits that were emplaced along an interpreted syn-volcanic fault. This syn-volcanic structure also controlled the distribution of FIIIb high-silica rhyolite (HSR) sills, sharp lateral changes in hydrothermal alteration intensity, the thicknesses and facies of units, and VMS mineralization. The AG deposit is capped by volcaniclastic, FeTi-rich basalts that are interpreted to be products of explosive submarine volcanism.

Two new high-precision chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) U-Pb geochronology dates from zircons of hydrothermally altered FIIIa ferrorhyolite lapilli tuffs (FeR), 210.35 ± 0.27 Ma, and FIIIb HSR, 210.52 ± 0.08 Ma, constrain the timing of the AG hydrothermal activity. Litho- and chemo-stratigraphic reconstruction of the volcanic environment suggests the AG VMS deposit formed in a propagating intra-arc rift associated with basin development where high temperature, shallow magmatic processes included basaltic underplating, crystal fractionation, assimilation of arc crust, and periodic magmatic replenishment. The AG volcanic rocks have geochemical and geologic features that are like assemblages documented in Neoarchean VMS-hosting rocks in the Abitibi greenstone belt, suggesting that the tectonomagmatic processes responsible for forming the AG volcanic rocks in the Late Triassic may have been operative in the Neoarchean.

2.2. Introduction

Volcanogenic massive sulfide (VMS) deposits are synvolcanic, stratiform concentrations of sulfide minerals that form in submarine, rifted environments associated with high-temperature magmatism (Franklin et al., 2005; Galley et al., 2007; Gibson et al., 2007; Piercey, 2011). Reconstructing the physical volcanic environment is critical to identify favorable intervals that may host VMS deposits and to map out primary structures (e.g., syn-volcanic faults, rift basins, and calderas) that may control the siting of mineralization (Gibson et al., 1999; Allen et al., 2002). Additionally, the geochemical signatures of VMS-hosting volcanic sequences can be used to evaluate petrogenetic settings and predict VMS-favorable successions (Lesher et al., 1986; Kerrich and Wyman, 1996; Lentz, 1998; Barrett and MacLean, 1999; Barrie and Hannington, 1999; Hart et al., 2004; Piercey, 2010; Piercey, 2011). Combining the physical volcanology with litho- and chemo-stratigraphy of VMS-hosting volcanic sequences provides an opportunity to understand the interplay between the magmatic, tectonic, and hydrothermal processes that form these deposits.

The Alexander terrane in the North American Cordillera contains abundant volcanogenic massive sulfide (VMS) deposits in the Late Triassic rift-related intra-oceanic island arc rocks of the Alexander Triassic metallogenic belt (ATMB) (Fig. 2.1; Taylor et al., 2008). The belt contains the supergiant (~300 Mt) Cu-Co Windy Craggy deposit (Peter and Scott, 1997), the Agrich Greens Creek deposit (Taylor et al., 2010), and the 10 Mt polymetallic (Zn-Cu-Pb-Ag-Au-Ba) Palmer deposit (Green et al., 2003; Steeves et al., 2016); however, there are limited studies detailing the geodynamics of individual deposits within the ATMB (Taylor et al., 2008; Sack, 2009; Peter et al., 2014). Chemostratigraphic reconstructions at Greens Creek have been difficult because the VMS mineralization is hosted in highly deformed sedimentary rocks located directly above a regional unconformity (Sack, 2009; Steeves, 2018). The Windy Craggy deposit is hosted in mafic rocks intercalated with voluminous sedimentary rocks (Peter and Scott, 1997) and is postulated to have formed in a subduction zone setting associated with a slab window (Peter et al., 2014). The rocks at the Palmer property provide an opportunity to improve our understanding of the tectonostratigraphic, magmatic, and hydrothermal evolution of VMS deposits in the ATMB as they contain well-preserved and well-exposed mafic and felsic rocks, which have only undergone greenschist facies metamorphism and minimal deformation, with stratigraphy well preserved in structural panels.

Massive barite outcrops were first discovered at the Nunatak prospect in the 1970s that eventually led to the drill discovery of the AG deposit in 2017; the AG deposit is located 3 km from the 10 Mt Palmer deposit on the Palmer property (Fig. 2.2). Drilling and geologic mapping data up to 2018 was used to calculate an inferred resource for AG of 4.3 Mt grading 4.64% Zn, 0.12% Cu, 0.96% Pb, 119.5 g/t Ag, 0.53 g/t Au and 34.8% BaSO₄ (Gray and Cunningham-Dunlop, 2018). Diamond drilling programs between 2017-2019 have totaled 12,000 m. Over 800 whole rock geochemical samples from the AG stratigraphy were collected from the surface and

drill core between 2014-2021. The systematic sampling programs paired with high-quality, modern analytical data provide a unique opportunity to apply lithogeochemical methods to understand the evolution of the volcanic succession that hosts this deposit. The Palmer deposit has been the focus of deposit-scale studies published on the Palmer property (Green et al., 2003; Steeves et al., 2016); descriptions of the geology in the vicinity of the AG deposit have only been documented in a few company reports and technical documents (Gray and Cunningham-Dunlop, 2018). This contribution represents the first comprehensive description of the AG deposit geology. It aims to integrate observations from geologic mapping, core logging, petrography, lithogeochemistry, and U-Pb zircon geochronology to: (1) reconstruct the volcanic stratigraphy through facies analysis and chemostratigraphic correlation, (2) evaluate the petrogenesis of the AG volcanic units, (3) propose a model for the genesis of the AG deposit, and (4) constrain the timing of the formation of the AG deposit.

This study highlights the importance of the Late Triassic intra-arc rifting that: (1) formed the geochemically distinct syn-rift felsic and mafic volcanic rocks hosting the AG deposit and (2) led to the development of syn-volcanic structures and rift basins where replacement- and exhalative-style VMS mineralized bodies were localized. The relationships of the tectonomagmatic evolution of the host rocks to the AG deposit and the deposit genesis can potentially improve future exploration efforts at the Palmer property, the ATMB, and in other analogous VMS environments globally.

2.3. Geological setting

2.3.1. Regional geology

The AG deposit is in southeast Alaska and occurs within the Alexander terrane (Fig. 2.1). The Alexander terrane includes a near complete Ediacaran to Late Cretaceous rock record (Muffler, 1967; Saleeby, 1983; Gehrels and Saleeby, 1987; Gehrels and Berg, 1994; Gehrels et al., 1996, Nelson et al., 2013b) and radiogenic isotopic signatures of the contained rocks suggest it formed in a wholly oceanic realm (Samson and Patchett, 1991; Peter and Scott, 1997; Peter et al., 2014; Steeves et al., 2016). The early geologic history of the terrane includes Ediacaran to Silurian intraoceanic arc magmatism followed by deposition of Devonian to Permian shallow marine carbonate and minor greenstone rocks (Gehrels and Saleeby, 1987; Gehrels et al., 1996; Plafker and Berg, 1994; Taylor et al., 2008). From the Pennsylvanian to the earliest Permian, the Alexander terrane had a shared geologic history with the Wrangellia and Peninsular terranes, forming the Alexander-Wrangellia-Peninsular superterrane (Gardner et al., 1988; Beranek et al., 2014; Israel et al., 2014). The Middle Triassic was marked by renewed volcanism in the Alexander-Wrangellia-Peninsular superterrane and thick accumulations of tholeiitic basalts that formed the Wrangellia flood basalts (or large igneous province) during the middle Ladinian to Norian (239 – 225 Ma) (Nelson et al., 2013b). Late Triassic island arc rifting coincided with the deposition of the Hyd (Loney, 1964; Muffler, 1967; Wilson et al., 2015) and Tats Group (MacIntyre et al., 1992) volcanic and sedimentary rocks that host numerous metal occurrences and deposits in a ~750 km northwest-trending belt: the Alexander Triassic metallogenic belt (ATMB) (Fig. 2.1; Taylor et al., 2008). Significant VMS deposits in the ATMB include the supergiant Windy Craggy deposit, the Ag-rich Greens Creek deposit, and the polymetallic Palmer deposit (Fig. 2.1).

2.3.2. Palmer property geology

The Palmer property contains the AG and Palmer VMS deposits along with fifteen VMS prospects hosted within a Late Triassic mafic-dominated bimodal volcanic belt that contains associated volcaniclastic rocks and minor fine-grained sedimentary and tuffaceous interbeds (Fig. 2.2A; Redman et al., 1985; Green et al., 2003; Wilson et al., 2015). In places, a marble clastbearing conglomerate marks the base of the Late Triassic rocks on the Palmer property and is interpreted to be a Permian-Triassic unconformity (Proffett, 2019). The timing of mineralization at the Palmer deposit is constrained by an isotope dilution-thermal ionization mass spectrometry (ID-TIMS) U-Pb zircon date of 213 ± 5 Ma from a hydrothermally altered rhyolite (Green, 2001). Jurassic volcanic breccias and black argillites cap the Triassic section; the igneous crystallization age for the volcanic breccia is ~195 Ma based on U-Pb zircon dates from the tuffaceous matrix of the volcanic breccia, and the black argillites have a young population of detrital zircons with U-Pb zircon dates of ~144 Ma (Karl et al., 2020). Rocks at the Palmer property have undergone multiple phases of deformation, greenschist facies metamorphism, and local contact metamorphism (Forbes et al., 1989; Lewis, 1998; Green et al., 2003; Steeves et al., 2016), yet are remarkably well-preserved and contain primary stratigraphic and volcanic textures, despite these overprints.

2.4. Geology and lithostratigraphy of the AG deposit

2.4.1. Methodology

Geologic bedrock mapping (1:1,000) and core logging was utilized to document volcanic textures and lithofacies, contact relationships, and hydrothermal alteration mineral assemblages. Nine drill holes totaling about 3,700 m were relogged, but all core logs and photos for the

~12,000 m of available drill core were reviewed. Appendix 1 contains additional photographs of the AG deposit geology. The volcanic rocks are broadly categorized as coherent or volcaniclastic (McPhie et al., 1993). The volcaniclastic rocks are classified using the non-genetic, granulometric terms of tuff, lapilli, and block/bomb of Fisher (1966) with the transport- and depositional-focused descriptive terminology of White and Houghton (2006).

Petrographic analyses using transmitted and reflected light microscopy were completed on polished thin sections. A subset was further investigated using a JEOL JSM 7100F scanning electron microscope (SEM) operating at 15 kV at Memorial University. Textures were identified with backscatter electron (BSE) imaging, whereas mineral chemistry was explored with semiquantitative energy dispersive spectrometer (EDS) point analysis. See Appendix 2 for petrographic descriptions, including microphotographs and BSE images. Quantitative analysis of plagioclase and FeTi oxide mineral chemistry was investigated using a JEOL JXA-8230 electron probe microanalyzer (EPMA) equipped with four energy dispersive spectrometers (EDS) at Memorial University. The EPMA analytical methods and results are summarized in Appendix 6.

Prior to this study, only basalt and rhyolite compositions were identified in the stratigraphy. Lithogeochemical investigations of the volcanic rocks were critical to identify geochemically unique units (including basaltic, andesitic, dacitic, and rhyolitic compositions), to recognize genetically related units, and to reconstruct the volcanic stratigraphy. All samples were classified with lithogeochemical techniques (section 2.5) using ioGAS 8.0 software and then explored in Seequent's Leapfrog Geo 6.0 software to visualize their distribution in 2D and 3D space. There is a strong correlation between stratigraphic position and the primary geochemistry of the volcanic rocks (section 2.5), so new geochemical nomenclature for the units was created and is used throughout for consistency and to highlight chemostratigraphic relationships. Some

units are readily identified in the field, but most volcanic units in the stratigraphic footwall, especially where strongly hydrothermally altered, are typically only distinguishable with lithogeochemistry. The reconstruction of the AG volcanic stratigraphy was an iterative process involving mapping, core logging, lithogeochemical classification, and 2D to 3D visualization. A new geologic bedrock map at a scale of 1:1,000 reflects the distribution of the newly identified geologic units and other geologic features (Fig. 2.2B). Graphic logs and associated cross-section interpretations are consistent with the updated geologic bedrock map and are presented in Figures 2.3 and 2.4, respectively.

2.4.2. Geology of AG deposit

The AG deposit is a tabular, steeply northeast dipping barite- and sulfide-rich lens that varies in thickness from tens of centimeters to 15 m and that extends for ~600 m along strike (see Fig. 2.2B) and ~100–250 m downdip. It is underlain by locally mineralized coherent volcanic and volcaniclastic rocks. Most mineralization is along strike of and intercalated with basalts with a distinct variolitic texture, referred to as the Zone FeTi basalts (Z-FeTiB) (Figs. 2.3, 2.4, 2.6). Local heterolithic fragmental rocks and minor, thin (typically sub-meter or thinner) discontinuous beds of argillite and chemical sedimentary rocks (e.g., jasper-magnetite and chert) are also spatially associated with mineralization. The immediate footwall is comprised of rhyolitic lapilli tuffs, referred to as the ferrorhyolites (FeR), that also locally host replacement-style VMS mineralization (Fig. 2.5). Most of the footwall consists of basalt, andesite, and dacite flows. Mafic volcaniclastic rocks, termed the hangingwall FeTi basalts (HW-FeTiB; Fig. 2.7), overlie the deposit and are capped by argillite.

Alteration and metamorphism

The footwall volcanic rocks locally contain hydrothermal alteration assemblages dominated by pervasive fine-grained white mica (colloquially referred to as sericite), disseminated pyrite, and variable pervasive to selective quartz. Hydrothermal alteration extends up to at least ~200 m into the footwall. The Z-FeTiB and the HW-FeTiB locally contain alteration assemblages composed of chlorite, Fe- and Ca-carbonate, magnetite, quartz, hematite, and sericite. In places, hydrothermal alteration is present tens of meters into the hanging wall basalts (the HW-FeTiB). The rocks have undergone regional greenschist facies metamorphism, and metamorphic assemblages of chlorite, calcite, quartz, and epidote are typical where rocks are less impacted by hydrothermal alteration. Local, intense epidote-garnet-chlorite-biotite is present in some units proximal to Mesozoic intrusions and is interpreted to have formed from contact metamorphism. Although the volcanic rocks are affected by metamorphism and VMS-related alteration, primary textures, and lithologic contacts are well-preserved in much of the stratigraphy. The "meta" prefix is not attached to the rock names, but it is implied.

Deformation

Mapping (Fig. 2.2B), core logging (Fig. 2.3), cross-section interpretations (Fig. 2.4), and chemostratigraphic studies (section 2.5) show that the stratigraphic sequence is folded along a deposit-scale syncline. The axial trace of the syncline is consistent with northwest-oriented schistose foliation that is best developed in strongly hydrothermally altered rocks and may be related to the north-south contractional deformation event (D1) displayed by the geometry of the Palmer deposit (3 km to the north) (Fig. 2.2A), consisting of a south-verging overturned anticline disrupted by a thrust fault (Lewis, 1998; Green et al., 2003; Steeves et al., 2016). Local occurrences of northeast striking schistosity at AG suggest that the axial traces of the D1 folds

were broadly warped by a later deformation event (D2), though interference patterns are poorly understood.

Hanging wall sedimentary rocks are well exposed along a prominent north-south ridge in the northeast part of the deposit mapping area (Fig. 2.2B). This sedimentary package has widely varied bedding orientations and a major fault, the "Main" fault, which divides two structural domains, herein referred to as the "Jag panel" and the "Nunatak panel," which host the Jag and Nunatak prospects, respectively. The Main fault is a steep (~70° dip), north-northeast dipping (~22° dip-azimuth), 0.5–1 m wide recessively-weathered reverse fault composed of sheared rock and gouge that roughly parallels the hinge of the deposit-scale syncline between the JAG and Nunatak prospects. The Main fault may be related to other, poorly understood late, SW- and NWstriking, high-angle brittle faults on the property referred to as D4 events (Lewis, 1998; Green et al., 2003) attributed to the post-middle Cretaceous and pre-Holocene (Hudson et al., 1982) dextral transpression that formed the Chatham Strait fault system (Karl et al., 1999; Steeves et al., 2016). The stratigraphy to the south of the Main fault within the JAG panel is upright and steeply northdipping. The stratigraphy north of the Main fault within the Nunatak panel is parasitically folded within the hinge of the deposit-scale syncline (Fig. 2.2B and 2.4). It is also faulted.

The Nunatak panel

The Nunatak prospect consists of two massive barite beds layered with pyrite, sphalerite, galena, and sulfosalts on talus-dominated north-facing slopes. The more northern exposures (at elevations 1140 m and 1162 m) are within a steeply south-dipping bed between strongly hydrothermally altered ferroandesitic (FeA) volcanic rocks to the south and a chloritic, strongly foliated undifferentiated mafic volcanic unit to the north (Fig. 2.2B). The southern exposures crop out at 1222 m. They are folded in a tight syncline marked by fragmental basalts (HW-FeTiB) in

the core of the syncline and strongly hydrothermally altered rhyolitic fragmental rocks (FeR) underlying the moderately south-dipping limb. Stratigraphic reconstruction of the Nunatak panel has been hindered by chaotic folding, poorly understood faulting, intense hydrothermal alteration, and limited drilling in this area. Most of the Nunatak outcrops are strongly quartz-sericite-pyrite altered, and lithogeochemistry is critical in determining protolith composition.

The JAG panel

The JAG panel hosts the bulk of the AG deposit, including its surface expression at the JAG prospect on an east-facing cliff between elevations 1310 m to 1410 m (Fig. 2.2B). Here, upright, steeply NNW-dipping beds of baritic massive sulfide with laminations of pyrite, sphalerite, sulfosalts, and galena overlie strongly hydrothermally altered rhyolite (FeR) and are overlain by basalt flows (Z-FeTiB) with intense chlorite, carbonate, and magnetite alteration (Fig. 2.5C). Cross-section interpretations show that the northeastern extent of the AG deposit, where mineralization is the thickest, is truncated by the Finch fault (Fig. 2.4). The Finch fault is only identified on the JAG panel. It dips $\sim 64^{\circ}$ towards the southwest, strikes $\sim 145^{\circ}$, and projects to the surface beneath the talus between the JAG prospect and East AG (Fig. 2.2B). The Finch fault is defined by the complete discontinuation of units (e.g., the barite-rich beds and heterolithic fragmental rocks), the sharp changes in the thickness of units (particularly the Z-FeTiB), and the repetition of units (e.g., drill hole 120; Fig. 2.4) as defined by chemostratigraphic patterns (section 2.5). Intrusive felsic rocks, chemically defined as high-silica rhyolites (HSR; section 2.5), are localized on the southwestern side of this fault and taper in thickness away from this structure (Fig. 2.4). In drill core, the Finch fault is obscured by intrusive rocks interpreted to postdate mineralization.

Compared to the Nunatak panel, the JAG panel contains a more densely drilled and straightforward section of ~ 400 m of stratigraphy that occupies the steeply northeast-dipping, upright limb of the northeast closing deposit-scale syncline (Fig. 2.4). Based mainly on the intact JAG panel, the AG succession is herein divided into six informal litho- and chemo-stratigraphic sequences that are presented from the base to the top of the section and include the: (1) footwall basalts (FW-B) and ferrobasalts (FW-FeB), (2) footwall Fe-rich silicic rocks including ferroandesites (FeA), ferrodacites (FeD), and ferrorhyolites (FeR), (3) Zone FeTi basalts (Z-FeTiB) and associated fragmental rocks, (4) hangingwall FeTi basalts (HW-FeTiB), (5) High silica rhyolites (HSR), and (6) argillite. Most mineralization is hosted in Sequence 3, but Sequence 2 is an important host for replacement-style mineralization. The entire succession, particularly sequence 6, is intruded by various undifferentiated dykes and sills (e.g., Fig. 2.3), which are not described herein.

Sequence 1 – Footwall basalts and ferrobasalts

In Figure 2.2B, the footwall basalts (FW-B) and ferrobasalts (FW-FeB) are merged into one lithologic unit, described together as the footwall basalts because they have similar field characteristics, occur laterally along strike from each other, and have similar geochemical signatures (section 2.5). The FW-B are more abundant in the west, and the FW-FeB are more common in the east part of the study area. They are the lowermost stratigraphic sequence with a thickness of >150 m. Their lower contact is not intersected in drilling. They comprise predominantly pillowed, amygdaloidal flows that locally grade into flow-margin breccias such as hyaloclastite and autoclastite (monomictic, locally jigsaw-fit, matrix-poor breccias) and pillow breccias. They have a fine-grained dark grey to green groundmass commonly metamorphosed to chlorite, calcite, quartz, albite, and epidote. Sparse plagioclase-phenocrysts (up to ~5 mm in length) are selectively replaced by muscovite.

Sequence 2 – Footwall Fe-rich silicic rocks

Sequence 2 is composed predominantly of coherent ferroandesite (FeA) and ferrodacite (FeD) flows and is capped by lesser ferrorhyolitic lapilli tuffs (FeR). The FeD are discontinuous, up to 40 m thick, and dominated by sparsely amygdaloidal pillowed to lobate flows with an aphanitic, grey groundmass. They have some monomictic brecciated facies associated with intense chlorite alteration, which occur along the margins of individual pillows and flow margins, including at their upper contacts with the base of the FeA. The FeA are predominantly massive and contain minor amygdules and sparse feldspar phenocrysts that locally form glomerocrysts in a fine-grained, green chloritic groundmass. The FeA unit reaches thicknesses exceeding ~30m, but in some places, it is less than 8 m thick. Monomictic breccias with local jigsaw-fit textures up to 3 m thick are common at their flow margins and contacts with other units. They commonly underlie the FeR lapilli tuffs (e.g., at the JAG prospect; Fig. 2.5C), but where the FeR are absent, they directly underlie the Z-FeTiB. They share their lower contacts with any of the FeD, footwall basalts, or the HSR.

The ferrorhyolitic (FeR) lapilli tuffs locally host replacement-style mineralization (Fig. 2.5G) and generally immediately underlie exhalites, including massive baritic sulfides, chert, and jasper-magnetite (Fig. 2.5B-C). In some places, they underlie the Z-FeTiB. They vary in thickness from 1–25 m. They are exclusively fragmental and dominated by poorly sorted, matrix-supported lapilli tuffs (Fig. 2.5A-B, E-H). In general, they are non-stratified, although sparse sections (< 50 cm thick) are composed of laminated tuffs (Fig. 2.5E). Where discernable, fragments include subangular chloritic clasts (primary glassy fragments?), lapilli with ragged to winged margins or wispy to fiamme-like textures (Fig. 2.5A-B, E-H). Some fiamme-like clasts are locally aligned and define a foliation (Fig. 2.5A-B). Clasts with abundant 1 – 5 mm ovoid features (typically composed of quartz but locally sulfides) may represent original pumice clasts

that have had their vesicles later filled by quartz and sulfides (Fig. 2.5G). In thin section, the FeR have muscovite-rich matrices that are presumably altered tuffaceous material (Fig. 2.5E). In some places, especially where pyrite is absent, they contain disseminated euhedral magnetite (~2%) (Fig. 2.5F). Accessory euhedral zircon crystals up to 170 µm are typically fractured (see Appendix 2). Backscattered electron (BSE) images combined with semi-quantitative EDS point analyses show that allanite is an accessory phase and that the FeR contain globular features ("globules") up to 150 µm in diameter composed of random and disorganized arrangements of anhedral rutile masses intergrown with variably anhedral to euhedral sub-micrometer zircon and monazite, and rare apatite (Fig. 2.5E). Based on: (1) their ubiquitous fragmental character and lack of an association with an effusive facies (Figs. 2.3, 2.4, 2.5), (2) the presence of wispy and fiamme-like fragments, and pumice (Figs. 2.5A-B, E-I) that could by pyroclasts (White and Houghton, 2006), (3) their tuffaceous-rich matrices (devitrified mainly to muscovite; Fig. 2.5E-I) and (4) their lithofacies consisting dominantly of massive, poorly sorted, matrix-supported lapilli tuffs with rare laminated tuffaceous sections (Fig. 2.5E-I), the FeR may be subaqueous pyroclastic flow deposits (Gibson et al., 1999).

Sequence 3 – The zone FeTi basalts and heterolithic fragmental rocks

Sequence 3 hosts most of the AG exhalative- and replacement-style VMS mineralization (Fig. 2.3 and 2.4) and consists of the Zone FeTi basalts (Z-FeTiB) (2.6A-E) and heterolithic fragmental rocks (Fig. 2.6F-G). In some places, the Z-FeTiB directly underlie exhalative massive sulfides (e.g., drill hole 109; Fig. 2.3 and 2.4), and in some areas, they directly overlie exhalative massive sulfides (e.g., at the JAG prospect or drill hole 128; Fig. 2.4 and Fig. 2.5C). Some of the thickest intersections of mineralization occur near accumulations of hydrothermally altered heterolithic fragmental rocks that have sharp lateral transitions into thick sequences of relatively

less altered Z-FeTiB flows that help define the Finch fault (Fig. 2.3 and 2.4). Sequence 3 is dominantly clastic southwest of the Finch fault, but flow-dominant northeast of the Finch fault.

The Z-FeTiB pillowed (up to 3 m in diameter) flows reach total accumulated thicknesses of up to 90 m. Individual flows can be less than a few meters thick and are marked by matrixpoor, flow margin breccias that have monomictic cuspate to winged clasts (0.5 - 10 cm) with local jigsaw-fit textures (Fig. 2.6C). They contain a grey-green, fine-grained groundmass consisting of plagioclase microlites set in a mesostasis of intersertal, cryptocrystalline biotite, chlorite, lesser epidote, and minor apatite, amphibole, and quartz (Fig. 2.6D-E). Disseminated magnetite and ilmenite reach combined modal abundances of >10%. Sparse, lath-shaped plagioclase phenocrysts up to 1.5 mm are partially replaced by albite, muscovite, chlorite, biotite, and minor epidote (Appendix 2). Abundant (up to 30%) leucocratic varioles (see Fowler et al., 2002) are a distinguishing feature of the Z-FeTiB (Fig. 2.6 B-E). They are white (dominated by quartz and plagioclase), 0.5–5 mm in diameter, locally coalesce to form wormy trains, and have sharp mineral phase boundaries with the groundmass (Fig. 2.6 B-E). The varioles are commonly zoned with an outer rim of recrystallized polycrystalline quartz and cores that are typically composed of plagioclase partially to wholly replaced by muscovite, epidote, and minor chlorite, biotite, and amphibole (Fig. 2.6 B, D-E). Greenschist facies metamorphism has obscured the primary textures and mineralogy of the distinct leucocratic varioles. However, some varioles have preserved features that are consistent with spherulitic crystallization, including: (1) fibrous plagioclase crystals radiating from a somewhat lath-shaped plagioclase core with interstitial mafic phases that could have been primary glassy components that later recrystallized (Fig. 2.6E), and (2) the coalescence of varioles to form wormy trains (Fig. 2.6D; Lofgren, 1974; Philpotts, 1977; McPhie et al., 1993; Fowler et al., 2002). Further detailed evidence for spherulitic crystallization is discussed in Appendix 6.

The heterolithic fragmental rocks are intercalated with the Z-FeTiB and vary in thickness from $\sim 5-50$ m. At the surface adjacent to the hanging glacier above the Nunatak prospect near an elevation of 1350 m (Fig. 2.2B; intersected by section line D-D'), the fragmental rocks are a chaotic mixture of subrounded to subangular volcanic, exhalite, and minor sedimentary fragments supported in a fine-grained chloritic matrix with patchy Fe-carbonate alteration (Fig. 2.6F-G). Most fragments are 3–50 cm in apparent maximum dimension, but some larger blocks and bombs are greater than 1 m. Some elongate fragments are aligned, defining a crude foliation. The fragments are mainly white, siliceous, aphyric, subangular to subround rhyolite (?), or highly altered basalt (?) that locally contain abundant ovoid features that may be amygdules or varioles. Some green-colored blocks of the Z-FeTiB are recognized based on their distinct variolitic texture. Subround to oval-shaped, massive barite clasts are up to 30 cm long and are commonly rimmed with Fe-carbonate, magnetite, and pyrite (Fig. 2.6G). Minor discontinuous and deformed lenses (~ 10 cm x ~ 50 cm) of argillite are minor. Fragments of jasper and chert are rare but present. Irregular-shaped gossanous patches are undifferentiated hydrothermally altered fragments (Fig. 2.6E). In places (e.g., drill hole 110), strong hydrothermal alteration obscures the identification of the heterolithic fragmental rocks. They can be recognized by chaotic, brecciated intervals with variable fine-grained silica, pyrite, and sericite matrix that contain amygdaloidal(?) volcanic fragments with variable chlorite to sericite alteration, lesser pale grey-white cherty fragments, and local tuffaceous parts. A few clasts have been geochemically identified as Z-FeTiB, FeR, and chert, suggesting the clasts are of local origin (e.g., samples W812865 and W812866 in Appendix 3).

Sequence 4 – The hangingwall FeTi basalts

The 40–80 m thick HW-FeTiB were the last major volcanic rocks to erupt in the AG stratigraphy. They overlie Z-FeTiB flows, exhalative massive sulfides (e.g., Nunatak prospect;

drill hole 109), and thin beds of pelagic sedimentary rocks, and they are not appreciably offset by the Finch fault (Figs. 2.3, 2.4). Their lower contact is typically sharp and locally chaotic. Their upper contacts are poorly understood because they are often obscured by abundant dykes (Fig. 2.3). The HW-FeTiB have exclusively volcaniclastic textures with diverse particle sizes, components, and lithofacies (Figs. 2.7). They have two generalized facies that include: (1) a thick (> 30 m) basal section of monolithic, locally crystal-bearing, massive lapilli tuffs with minor bombs (Fig. 2.7A-E, H), and (2) a thinner (< 10 m) capping sequence of laminated tuffs with sparse lapilli (Fig. 2.7F-G, I-K).

The basal lapilli tuffs lack internal structures except for local, crude foliations defined by aligned lapilli to bombs. The tuffaceous matrix contains recrystallized chlorite, magnetite, quartz, calcite, ankerite, and muscovite (Fig. 2.7H). The abundance of fragments ranges from 20 to 60 %. Most are subangular to subround green, grey, or black, strongly magnetic basalt lapilli that are locally plagioclase-phyric. Some contain abundant ovoid features that may be amygdules, indicating that these are potentially scoria. Clasts vary in form and can be wispy with cuspate to ragged margins (Fig. 2.7C-D) or have ameboidal (Fig. 2.7E) to fiamme-like shapes (Fig. 2.7H). Ovoid basaltic bombs up to 10 cm long occur, especially in the more matrix-rich facies, and some have pale alteration fronts along their margins (Fig. 2.7A). Juvenile plagioclase crystals occur in varied abundances and are typically wholly replaced by quartz, muscovite, and lesser calcite and chlorite (Fig. 2.7C-D). Selective alteration of clasts locally imparts an apparent heterolithic texture. Generally, the larger lapilli and bombs with more abundant ovoid features are more strongly altered to quartz, carbonate, and muscovite, imparting variable pale grey, tan, to pale pink colors. Some basalt clasts are partially to wholly replaced by bright red jasper-magnetite (Fig. 2.7C, E).

The basalt lapilli tuffs gradationally transition into medium-bedded tuffs with sparse lapilli overlain by laminated tuffs (Fig. 2.7F-G, I-K). The medium-bedded tuffs typically have pale tan-brownish tuffaceous matrices recrystallized to quartz, magnetite, muscovite, and chlorite (Fig. 2.7I). They have up to 10% disseminated lapilli composed of recrystallized magnetite. Some lapilli with honeycomb textures outlined by FeTi oxide minerals have deformed and stretched-out appearances and could be tube-scoria fragments (Fig. 2.7I). The laminated tuffs have sharp, planar, chlorite- and magnetite-rich laminations alternating with beige-tan-pink, predominantly quartz and muscovite laminations (Fig. 2.7G). Some laminated tuffs are strongly altered to chlorite, carbonate, and FeTi oxide minerals, resembling Algoma-type iron formations (Spry et al., 2000). Some tuff-rich layers contain abundant cuspate, Y- to X-shaped (McPhie et al., 1993, p.28) shards (Fig. 2.7K) and microscopically-identified concentrically zoned accretionary lapilli (Fig. 2.7J).

Like the FeR, the HW-FeTiB have many features consistent with pyroclastic origins, including their: (1) ubiquitous fragmental character and lack of an association with effusive facies, (2) abundance and variety of pyroclastic particles like shards, wispy/fiamme-like lapilli, scoria, bombs with ameboidal to fluidal margins, plagioclase crystals, and rare accretionary lapilli (Fig. 2.7; White and Houghton, 2006), (3) tuffaceous-rich matrices (devitrified to quartz, calcite, magnetite, ankerite, muscovite, and chlorite) that locally contain shards (Fig. 2.7), and (4) their internal organization of unstratified, poorly-sorted, matrix-supported lapilli tuffs overlain by laminated tuffs that is similar to stratigraphic patterns described for deposits of pyroclastic density currents (Figs. 2.3, 2.4; McPhie et al., 1993; Gibson et al., 1999).

Sequence 5 – The high-silica rhyolites

The high-silica rhyolites (HSR) are strongly siliceous, aphyric, pale grey-white, massive lens-like bodies that occupy multiple stratigraphic levels (Fig. 2.4 and 2.8). They vary in thickness from 0.1 - 125 m, but they may reach estimated true thicknesses greater than 200 m where their lower contacts were not intersected in drilling beneath AG west (Fig. 2.2, 2.4, and 2.8B). Thick occurrences of the HSR are localized along the Finch fault. They taper with distance from this structure (Fig. 2.4). They are interpreted as a sill complex because they are generally massive with a distinct homogeneous-texture (Fig. 2.8C) and have intrusive relationships observed in several locations, including: (1) a swarm of 10-50 cm dykes with sharp, chilled margins that intruded the footwall basalts in drill hole 109 (Figs. 2.3 and 2.4), (2) their sharp contacts that bound the FeD flows in drill hole 114 (Fig. 2.4), and (3) a 15 m thick tabular body with sharp contacts with the Z-FeTiB and underlying FeR at East AG (Fig. 2.8A). They contain some monomictic in-situ brecciated facies with subangular clasts up to 6 cm in a matrix that resembles the composition of the clasts, but this does not preclude them from being intrusive, as brecciated margins have been documented on some felsic cryptodomes (e.g., Goto and McPhie, 1998). Based on cross-cutting relationships, some HSR bodies are at least younger than the Z-FeTiB. The relative timing between the emplacement of the HSR and the HW-FeTiB is uncertain because no contact relationships were observed between these two units. Because the HSR locally contain hydrothermal chlorite, pyrite, and muscovite, hydrothermal activity is interpreted to have occurred following their emplacement. However, they are typically less altered than the HW-FeTiB, suggesting that they may post-date the HW-FeTiB. In thin section, the HSR groundmass is dominated by fine-grained muscovite and quartz (Fig. 2.8D-E). Quartz is interstitial, and some grains are rounded and composed of a single quartz crystal (up to 0.3 mm in diameter) that may be quartz eyes. Accessory epidote locally has allanite cores with Ce, La, and Nd (as deduced from EDS spectra); other accessory minerals include magnetite, zircon, apatite, and rutile (Fig. 2.8D-E). Rare microscopic grains of disseminated rutile contain minor Nb (as deduced from EDS spectra; Appendices 2, 6).

Sequence 6 – Argillite

The capping sequence to the volcanic stratigraphy includes a 5–20 m section of undifferentiated tuffs thinly interbedded with pelagic sedimentary rocks (argillite) that gradationally transitions into a ~60 m section of argillite. The tuffs are laminated to thinly bedded and range in color from pale grey, light to medium green, and pale brown to maroon. They are commonly calcareous. The argillite unit comprises laminated to thinly bedded siliciclastic mudstone, siltstone, and rare sandstone. The sedimentary sequences vary from pale grey to black, locally have water escape structures including flames, and resemble distal turbidite formations (Bouma and Ravenne, 2004). Most of the argillite is calcareous, although it is darker grey, non-calcareous, and siliceous in a few places. Rare oval-shaped fossils composed of calcium carbonate occur in a few sandier beds and are interpreted as Late Triassic sponges called *Heterastridium?* (Appendix 1; Karl et al., 2020). This entire unit was intruded by mafic to felsic dykes and pale hornfels is common in the wall rocks along the intrusive contacts.

Mineralization

The AG deposit comprises exhalative-, replacement-, and minor vein-style mineralization (e.g., Doyle and Allen, 2003; Piercey, 2015). Barite is a major phase, especially in the exhalativestyle ores, and occurs within veins ("stringers") that are commonly sulfide-bearing. Pyrite, sphalerite, galena, sulfosalts, and sparse chalcopyrite are disseminated, vein, semi-massive, and massive sulfide facies. Silver is mainly hosted in freibergite-tetrahedrite-tennantite solid solution minerals, whereas the residency of gold is undetermined except for being hosted in a rare visible electrum grain (Doherty, 2018).

Exhalative-style mineralization occurs in beds that vary in approximate true thickness from tens of centimeters to greater than 15 m. Surface exposures of exhalative-style mineralization are located at the JAG and Nunatak prospects where sub-meter to 4 m thick massive barite beds with lesser quartz contain minor laminations of pyrite, sphalerite, galena, and sulfosalts (Fig. 2.2B and 2.5C). Exhalative mineralization consists of sulfide- and sulfosaltbearing massive barite (Fig. 2.5D) and mineralized chert is a minor mineralization type, which is typically more Ag- and Au-rich than replacement-style mineralization (Gray and Cunningham-Dunlop, 2018). Exhalative mineralization contains laminated to diffusely layered sulfide, sulfate, and silicate minerals that likely reflects a combination of primary bedding, post-depositional zone refining processes, and possibly tectonic foliations (Lydon, 1988; Gibson et al., 2007; Lafrance et al., 2020). Deposition on the seafloor is supported by: (1) the presence of chemical sedimentary rocks, such as jasper- and magnetite-rich iron formations, along strike or directly overlying the massive barite- and sulfide-rich beds (Fig. 2.5B-C), (2) the local accumulation of fine-grained, laminated pelagic sedimentary rocks at or near these horizons (e.g., drill hole 110; Fig. 2.3), and (3) significantly more intense hydrothermal alteration of the stratigraphic footwall rocks compared to the hangingwall sequences (e.g., Doyle and Allen, 2003).

Underlying the exhalative style mineralization is mineralization interpreted to be subseafloor replacement-style based on the presence of relict volcanic facies such as pumicebearing felsic lapilli tuffs (FeR) that have tuffaceous matrices replaced by sericite, barite and pyrite and pumice clasts replaced by quartz, barite, sphalerite, galena, and sulfosalts (Fig. 2.5G). The heterolithic fragmental rocks are locally mineralized, especially near the Finch fault and gradually become less altered with distance from the Finch fault, consistent with a subseafloortype replacement model where replacement fronts are a diagnostic feature (Doyle and Allen, 2003). The felsic lapilli tuffs (FeR) and heterolithic fragmental rocks are the predominant hosts to replacement-style mineralization.

2.5. Primary lithogeochemistry

2.5.1. Analytical methods

Between 2014 to 2021, 661 drill core and 122 surface rock samples were prepared and analyzed by Constantine Metals at the ALS Minerals laboratory in North Vancouver, BC using the complete characterization package (ALS code CCP-PKG-03). As part of this study, an additional 22 drill core samples were collected and analyzed using the same methods and laboratory. Three of these samples were duplicates of samples in the company database used to assess the reproducibility of the company's whole rock dataset. In addition, six standard reference materials ("SRM"; three samples each of LK-NIP-1 diabase and ORCA-1 rhyolite) were analyzed to monitor analytical accuracy and precision. The whole rock lithogeochemical data for the 22 drill core samples and six SRM are provided in Appendix 3. An assessment of the accuracy and precision is provided in Appendix 4. The geochemical results presented in this section include only samples of volcanic and syn-volcanic rocks (n = 428) that represent the stratigraphic sequence hosting the AG deposit. Intrusive rocks interpreted to post-date the VMS-hosting volcanic sequence are not presented here.

Rock samples were crushed in an oscillating steel jaw crusher (>70% of the sample passing through a 6 mm screen), followed by a riffle split of 250 grams using a Boyd crusher/rotary splitter combination, then pulverized in a carbon steel ring mill (>85% of the

sample passing through a 75 µm screen). A 1g sample was ignited in a furnace at 1000°C, cooled, and weighed to determine loss on ignition (LOI). Major oxides (Al₂O₃, BaO, CaO, Cr₂O₃, Fe₂O₃, K₂O, MgO, MnO, Na₂O, P₂O₅, SiO₂, SrO, and TiO₂) were obtained by fusing a prepared sample (0.66g) with a lithium tetraborate and lithium metaborate flux and creating a disk that was then analyzed by X-ray fluorescence (XRF). The "total" presented is the combination of the major/minor element oxides and LOI. Sulfur and carbon were determined using combustion and a LECO infrared spectroscopy analyzer. Chalcophile and siderophile elements (Ag, Cd, Co, Cu, Mo, Ni, Pb, Zn) and lithophile elements (Li and Sc) were determined by 4-acid digestion with an inductively coupled plasma - atomic emission spectroscopy (ICP-AES) analytical finish. Volatile elements (As, Bi, Hg, In, Sb, Se, Tl, Te, Re) were determined by aqua regia digestion and an inductively coupled plasma - mass spectrometry (ICP-MS) analytical finish. The high field strength elements (HFSE; Ga, Y, Zr, Nb, Hf, and Ta), the low field strength elements (LFSE; Rb, Sr, Cs, and Ba), rare earth elements (REE; La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu), transition elements (V and Cr) and other elements (Ge, Sn, and W) were determined by a lithium borate fusion technique followed by a 3-acid (HF-HNO₃-HCl) dissolution and ICP-MS analytical finish.

2.5.2. Lithogeochemical methods

The AG host volcanic rocks have been variably affected by ocean floor metamorphism, local hydrothermal alteration, regional greenschist facies metamorphism, and local intrusionrelated metamorphism. Under these conditions, many major elements (Na, Mg, Si, K, Ca, Mn, Fe) and LFSE (Ba, Sr, Rb) are mobile (Cann, 1970; MacLean, 1990; Jenner, 1996; Barrett and MacLean, 1999), and cannot be relied upon for use in traditional volcanic rock classification schemes (e.g., Peacock, 1931; Irvine and Baragar, 1971; Peccerillo and Taylor, 1976; Le Bas et al., 1986; Le Maitre, 2002). Common immobile elements in VMS settings include Al +/- P, HFSE (Y, Sc, Th, Zr, Hf, Ti, Nb, Ta) and REE, and some transitional elements (+/-V, +/- Cr, +/-Ni)(Pearce and Cann, 1973; MacLean and Kranidiotis, 1987; Barrett and Maclean, 1994; Barrett and MacLean, 1999; Piercey, 2010). However, some traditionally immobile elements can be mobile under certain conditions (e.g., high fluid-to-rock ratio or in the presence of dissolved species such as CO₂ or F) or in proximity to major structures (Finlow-Bates and Stumpfl, 1981; Campbell et al., 1984; Humphris, 1984; MacLean, 1988; Rubin et al., 1993; Liaghat and MacLean, 1995; Pearce, 1996; Polat and Hofmann, 2003). Identifying compositionally uniform volcanic units and establishing element immobility was accomplished using bivariate plots of potentially immobile elements and their ratios (Cann, 1970; MacLean, 1990; Maclean and Barrett, 1993; Barrett and Maclean, 1994; Gifkins et al., 2005). This method confirmed that the most highly immobile elements in the AG dataset are Al₂O₃, TiO₂, Nb, Zr, Th, and the HREE, especially Gd and Yb. The LREE are mainly immobile except in the most intensely hydrothermally altered samples. Yttrium, Sc, V, and P₂O₅ showed variable mobility. The most immobile elements were used to classify and interpret the petrogenesis of the volcanic rocks in the AG suite; some plots based on mobile elements supplement the immobile element observations (Figs. 2.9 to 2.16). Niobium was selected as a fractionation monitor because it is highly resistant to the most intense alteration (Mathieu, 2018), and it behaves incompatibly for all units (Fig. 2.10). To improve all classifications, the least altered samples representative of each unit were identified by visual observation, textural characteristics and using several geochemical criteria (Table 2.1; Spitz and Darling, 1978; Campbell et al., 1984; Barrett and MacLean, 1994; Large et al., 2001; Gifkins et al., 2005; Mathieu, 2018; Rollinson and Pease, 2021). Coherent facies were preferentially selected over fragmental facies for representative least altered samples, but the FeR and HW-FeTiB are exclusively clastic and are included herein. All samples of the

FeR and the HW-FeTiB are moderately altered, likely owing to their volcaniclastic nature, so the least-altered samples do not meet the criteria of Table 2.1, but the best, least altered candidates were selected. Many samples of the FW-B are monomictic breccias with considerable amounts of glassy components (hyaloclastite) and breccia cement. These samples typically had major element abundances that totaled more than 100%; they were omitted from plots in favor of the more crystalline and homogeneous samples for this unit. Any samples with visible weathering or oxidation were also omitted.

The major and trace element whole rock lithogeochemical data for 22 representative, least altered samples are presented in Table 2.2, and significant element ratios are summarized in Table 2.3. The least altered samples are depicted as the largest symbols on all lithogeochemical plots, whereas smaller symbols represent variably altered samples (Figs. 2.9 to 2.16). Major elements in the lithogeochemical plots are presented as original values and have not been recalculated on a volatile-free basis. Iron is reported as $Fe_2O_3^T$, denoting total iron expressed as Fe_2O_3 . The fractionations of Nb, Zr, Ti, and Eu compared to their neighboring elements on pmnormalized diagrams (Nb anomaly = Nb/Nb* _{pm}; Zr anomaly = Zr/Zr*_{pm}; Ti anomaly = Ti/Ti*_{pm}; Eu anomaly = Eu/Eu*_{en}) were quantified using geometric means following the method outlined in McLennan and Taylor (2012) (Table 2.3). Unless otherwise specified, normalizing reference values for primitive mantle (pm) and chondrite (cn) are from Sun and McDonough (1989). Plots with the reference mantle reservoirs, pm, enriched mid-ocean ridge basalt (EMORB), normal mid-ocean ridge basalt (NMORB), and ocean island basalt (OIB) are from Sun and McDonough (1989). The average continental crust (ACC) is from Rudnick and Gao (2014).

2.5.3. Results

The AG volcanic rocks show a mainly bimodal distribution on the Nb/Y versus Zr/Ti plot, where they cluster predominantly in the basalt and rhyolite fields (Fig. 2.9A) with the exception of a tight cluster of samples in the basaltic-andesite field and a more dispersed population of samples that plot across the basaltic-andesite to rhyolite-dacite boundary (Fig. 2.9A). Most samples are subalkaline (Nb/Y < 0.7), except one population of rhyolites (the HSR), and some altered FeTi basalts (Fig. 2.9A). Immobile element plots involving Al₂O₃, TiO₂, and Zr demonstrate that these elements are highly immobile and suggest that there are eight compositionally homogeneous populations in the AG stratigraphy (Fig. 2.9B): footwall basalts (FW-B; n = 32), footwall ferrobasalts (FW-FeB; n = 41), ferroandesites (FeA; n = 63), ferrodacites (FeD; n = 25), ferrorhyolites (FeR; n = 49), zone FeTi basalts (Z-FeTiB; n = 81), hanging wall FeTi basalts (HW-FeTiB; n = 84), and high-silica rhyolites (HSR; n = 53). Based on empirical diagrams (Figs. 2.9, 2.13–2.16), fractionation trends of the least altered samples (Fig. 2.10), ratios of HFSE (Table 2.3), and pm- and cn-normalized signatures (Figs. 2.11 and 2.12), these units are grouped into four distinct magmatic suites: footwall basalt suite (FW-B and FW-FeB), Fe-rich silicic suite (FeA, FeD, and FeR), FeTi basalt suite (Z-FeTiB and HW-FeTiB) and high silica rhyolite suite (HSR). These geochemical suites are highly correlated with stratigraphic position (see section 2.4). The FW-B, FW-FeB, and FeA are indistinguishable in the field, especially where strongly hydrothermally altered. The FeD can be confused with altered basalts without geochemical classification. The FeTi-rich basalts and the two unique rhyolites (FeR and HSR) have distinct lithological and petrographic features (see section 2.4). However, where strongly hydrothermally altered, the FeR lapilli tuffs can be confused with altered fragmental basalts or heterolithic fragmental rocks. Strongly hydrothermally altered Z-FeTiB can be misclassified without the aid of lithogeochemistry.

The footwall basalt suite (FW-B and FW-FeB)

The pillowed flows of this suite have basaltic Zr/Ti ratios and subalkaline Nb/Y ratios (Fig. 2.9A; Pearce, 1996). Ratios of Zr/Al₂O₃ and Al₂O₃/TiO₂ indicate that the footwall basalts (FW-B) and ferrobasalts (FW-FeB) are two compositionally homogeneous units (Fig. 2.9B). The FW-FeB are more evolved than the FW-B and have lower Al₂O₃, Ni, Sc and higher Fe₂O₃, TiO₂, P₂O₅, and Σ REE (Fig. 2.10) and exhibit a typical tholeiitic magmatic trend (Maclean and Barrett, 1993; Koepke et al., 2018). The FW-FeB have Fe₂O₃^T > 14.32 wt.% and TiO₂ < 1.9 wt.% (Table 2.3) and are classified as ferrobasalts (FeO^T > 12 wt % and TiO₂ < 2 wt %; Perfit et al., 1999; Christie et al., 2005). The Fe-rich nature of the FW-FeB is reflected by their classification as high-Fe tholeiitic basalts on the Jensen (1976) cation plot, whereas the FW-B plot on the boundary between calc-alkaline basalts and tholeiitic andesites (Fig. 2.9C). In addition to their Fe-enrichment trends, the FW-B and the FW-FeB have tholeiitic Zr/Y versus Th/Yb ratios (Fig. 2.9D; Ross and Bédard, 2009) and within plate tholeiite (WPT) Th-Zr-Nb signatures (Fig. 2.13; Wood, 1980).

The FW-B and FW-FeB have similar typical non-arc EMORB-like (Sun and McDonough, 1989) signatures on pm- and cn-normalized plots (Figs. 2.11 and 2.12), with: (1) LREE enrichment compared to HREE and MREE, (2) flat HREE patterns, (3) no significant Nb or Zr anomalies, and (4) slight negative Ti anomalies (Table 2.3). They also have EMORB-like Zr-Th-Nb-Yb-TiO₂ systematics on several tectono-magmatic discrimination diagrams (Figs. 2.13A-C, 2.16). They have MORB/back-arc basin basalt (BABB) Ti/V ratios (Fig. 2.13D; Vermeesch, 2006; Shervais, 2022).

The Fe-rich silicic suite (FeA, FeD, and FeR)

These units have subalkaline Nb/Y ratios (except one least altered FeR sample has Nb/Y = 0.72) and Zr/Ti ratios indicative of andesitic, dacitic, and rhyolitic compositions (Fig. 2.9A; Pearce, 1996). The three compositionally homogeneous units are also differentiated based on ratios of Zr/Al₂O₃ and Al₂O₃/TiO₂ (Fig. 2.9B). These units are interpreted to be more evolved than the footwall basalts that precede them in the stratigraphy based on their fractionation trends (Fig. 2.10). Relative to the footwall basalts, they show decreasing Fe and Ti with fractionation, typical of intermediate compositions fractionating FeTi phases in either tholeiitic or calc-alkaline magmatic systems (Juster et al., 1989; Barrett and MacLean, 1999; Frost and Frost, 2011; Charlier et al., 2013; Koepke et al., 2018). The least altered FeA have Al-Mg-Ti-Fe contents like high-Fe tholeiitic basalts (Fig. 2.9C; Jensen, 1976), reflecting their relatively high concentrations of TiO₂ (TiO₂ = 1.5–1.7 wt.%) and Fe₂O₃^T (Fe₂O₃^T = 12.7–16.8 wt.%) compared to typical orogenic andesites (Fe₂O₃^T < 12 wt.% and typically Fe₂O₃^T is closer to 8.5 to 9 wt.% and TiO₂ = 0.8–1.0 wt.%; Gill, 1981). This suggests that they are Fe- and Ti-rich andesites, also known as ferroandesites or icelandites (Gill, 1981; Gibson et al., 2007). Their high P_2O_5 contents (P_2O_5 = 0.52–0.57 wt.%) are also consistent with their classification in the icelandite/ferroandesite family, as typical orogenic andesites have $P_2O_5 = 0.05-0.30$ wt.% (Gill, 1981, p. 112). The FeD have Al-Mg-Ti-Fe contents like tholeiitic andesites (Fig. 2.9C; Jensen, 1976), reflecting their relatively high concentrations of TiO₂ (TiO₂ wt.% = 0.82-0.85 %) and Fe₂O₃^T (Fe₂O₃^T wt.% = 8.9-11.1) compared to typical dacites (e.g., $Fe_2O_3^T \sim 4.75$ % and $TiO_2 \sim 0.60$ %; Mathieu, 2018), suggesting that they are FeTi-rich dacites, or ferrodacites (Barrett and MacLean, 1999). The FeR have Al-Mg-Ti-Fe contents like tholeiitic dacites to andesites (Fig. 2.9C; Jensen, 1976) reflecting their relatively average TiO₂ (TiO₂ = 0.26–0.36 wt.%) and high concentrations of $Fe_2O_3^T$ (Fe₂O₃^T = 8.19–8.64 wt.%) compared to typical rhyolites (e.g., $Fe_2O_3^T \sim 2.71$ wt.% and $TiO_2 \sim 0.36$ wt.%;

Mathieu, 2018), suggesting that they are ferrorhyolites. Most of the FeR and FeD samples have ferroan ("tholeiitic") SiO₂ versus Fe* signatures, but some of the least altered samples plot within the magnesian ("calc-alkaline") field near the ferroan-magnesian boundary (Fig. 2.14B; Frost et al., 2001). The Fe-rich nature of the FeA, FeD, and FeR lithologies, combined with the FIIIa-like signatures (Fig. 2.14A; Hart et al., 2004) of the felsic units strongly supports that they are tholeiitic. Furthermore, the A-type affinities (Fig. 2.14B, D; Pearce et al., 1984; Frost et al., 2001) of the felsic units (FeD and FeR) shows that they have characteristically high Fe/(Fe + Mg) (Bonin, 2007; Frost and Frost, 2011); a feature more typical of the tholeiites. However, the FeA have transitional to nearly calc-alkaline Th-Yb-Zr-Y affinities (Fig. 2.9D; Ross and Bédard, 2009), and the FeD and FeR have calc-alkaline Th-Yb-Zr-Y signatures (Fig. 2.9D; Ross and Bédard, 2009). Furthermore, the FeD have subalkaline Zr contents, and the FeR have peralkaline Zr abundances (Table 2.3; Fig. 2.14C; Leat et al., 1986; Piercey, 2010).

The FeA, FeD, and FeR have similar, irregular signatures on pm- and cn-normalized plots (Figs. 2.11 and 2.12), with: (1) LREE enrichment relative to HREE and MREE (2) relatively flat HREE patterns, (3) negative Nb, Ti, and Eu anomalies, and (4) positive Zr anomalies (Table 2.3). The intensity of their LREE-enrichments and the magnitudes of their Nb, Ti, Eu, and Zr anomalies increase as the rock types become more evolved from andesitic (FeA), to dacitic (FeD), to rhyolitic (Fer) compositions. These pm-normalized signatures are more typical of arc-related rocks (Kerrich and Wyman, 1996). Arc-like influences are also supported by tectono-magmatic discrimination diagrams that show that they are enriched in Th relative to Nb (Figs. 2.13A-B, 2.15A-C, 2.16; Wood, 1980; Condie, 2005; Pearce, 2008).

The FeTi basalt suite (Z-FeTiB and HW-FeTiB)

These units have basaltic Zr/Ti ratios and subalkaline Nb/Y ratios (Fig. 2.9A; Pearce, 1996). Ratios of Zr/Al₂O₃ and Al₂O₃/TiO₂ indicate that the Z-FeTiB and HW-FeTiB are two compositionally homogeneous units (Fig. 2.9B). The Z-FeTiB are more evolved than the HW-FeTiB based on their lower Al₂O₃ and Ni and higher TiO₂, P₂O₅, and Σ REE relative to Nb (Fig. 2.10) and exhibit typical tholeiitic magmatic trends (Maclean and Barrett, 1993; Koepke et al., 2018). Relative to the footwall basalts, both the Z-FeTiB and the HW-FeTiB show extreme Feand Ti-enrichment trends and relatively high concentrations of TiO₂ (Z-FeTiB TiO₂ = 2.78–3.16 wt.% and HW-FeTiB TiO₂ = 2.38–2.68 wt.%) and Fe₂O₃ (Z-FeTiB Fe₂O₃ ^T = 13.05–22.19 wt.% and HW-FeTiB Fe₂O₃ ^T = 17.04–20.00 wt.%), typical of FeTi basalts (FeO^T > 12 wt % and TiO₂ > 2 wt %; Byerly et al., 1976; Perfit et al., 1999; Christie et al., 2005). Their tholeiitic, Fe-rich nature is also supported by their classification as high-Fe tholeiitic basalts on the Jensen (1976) cation plot (Fig. 2.9C) and their within plate tholeiitic (WPT) Th-Zr-Nb signatures (Fig. 2.13; Wood, 1980). However, the FeTi basalts have tholeiitic to transitional affinities based on the trace elements Zr, Y, Th, and Yb (Fig. 2.9D; Ross and Bédard, 2009).

The FeTi basalts have similar typical non-arc EMORB-like (Sun and McDonough, 1989) signatures on pm- and cn-normalized plots (Figs. 2.11 and 2.12), with: (1) LREE enrichment compared to HREE and MREE, (2) relatively flat HREE patterns, (3) no significant Nb or Zr anomalies, and (4) slight negative Ti and Eu anomalies (Table 2.3). They also have EMORB-like Zr-Th-Nb-Yb-TiO₂ systematics on several tectono-magmatic discrimination diagrams (Figs. 2.13A-C, 2.16). They typically plot within (Fig. 2.13C) or slightly above (2.16A-B) MORB-ocean island basalt (OIB) arrays. The Z-FeTiB have OIB-like Ti/V ratios and the HW-FeTiB have MORB/BABB- to OIB-like Ti/V ratios (Fig. 2.13C-D; Vermeesch, 2006; Shervais, 2022). Compared to all other mafic units, the HW-FeTiB have the most fractionated HREE patterns

 $(Gd_{pm}/Yb_{pm} = 1.42-1.48)$, but these are still closer to EMORB $(Gd_{pm}/Yb_{pm} = 1.04)$ than OIB $(Gd_{pm}/Yb_{pm} = 2.92)$ (Sun and McDonough, 1989). They also have TiO₂-Yb-Nb signatures that straddle the boundary between EMORB and OIB (Fig. 2.13C). Compared to the footwall basalt suite, the FeTi basalts are slightly more Th-enriched relative to Nb (Figs. 2.13A-B, 2.15A-C).

The high silica rhyolite suite (HSR)

Both the large HSR bodies and thinner dykes and sills have rhyolitic Zr/Ti ratios and plot within the alkali rhyolite field on the modified Floyd-Winchester volcanic discrimination plot (Fig. 2.9A; Pearce,1996). They form a tight cluster on the Al₂O₃/TiO₂ versus Zr/Al₂O₃ plot (Fig. 2.9B). The least altered HSR have 71.26–75.06 SiO₂ wt % (Table 2.2), extreme HFSE-REE enrichments (Figs. 2.11, 2.12), flat REE patterns with negative Eu anomalies (Fig. 2.12), Y > 108.5 ppm, La_{cn}/Yb_{cn} = 2.62–5.5 (Fig. 2.14A), and anomalously low Zr/Hf ratios (Table 2.3; Fig. 2.10), consistent with other high-silica rhyolites (Barrie et al., 1993; Barrie and Pattison, 1999; Galley, 2003; Claiborne et al., 2018); they are the most evolved of all units (Fig. 2.10).

Although they plot in the alkali rhyolite field (Fig. 2.9A) and have Th-Zr-Nb systematics that more closely resemble those of alkali basalts (Fig. 2.13A-B), their Nb/Y (Nb/Y = 0.43–0.59), Zr/Y (Zr/Y = 2.09–2.50), and La_{cn}/Yb_{cn} (La_{cn}/Yb_{cn} = 2.6–5.6) ratios, and Zr abundances (Zr = 271–378 ppm; Fig. 2.14C) are more akin to tholeiitic felsic magmas (Nb/Y < 0.7; Zr/Y = 2–7; La_{cn}/Yb_{cn} < 6; Zr = 200–500 ppm) as opposed to alkaline (Nb/Y >> 0.7; Zr/Y > 7; La_{cn}/Yb_{cn} >> 6; Zr > 500 ppm) or calc-alkaline (Nb/Y <0.7; Zr/Y > 7; La_{cn}/Yb_{cn} > 6; Zr < 500 ppm) felsic magmas (see Lentz, 1998). Furthermore, their A-type (Fig. 2.14B, D) and FIIIb affinities (Fig. 2.14A) are more typical of tholeiitic melts (Hart et al., 2004; Fassbender et al., 2022). However, they have tholeiitic to transitional Th-Yb-Zr-Y affinities (Fig. 2.9D; Ross and Bédard, 2009). Furthermore, the least altered HSR have calc-alkaline major element signatures and plot near tholeiitic/calc-alkaline dividing boundaries (Fig. 2.9C, Jensen, 1976; Fig. 2.14B; Frost et al., 2001). In summary, their magmatic affinity is undetermined due to these varied classifications based on major and trace element signatures; a common trait of A-type felsic rocks (Bonin, 2007).

The HSR have irregular signatures on pm- and cn-normalized plots (Figs. 2.11 and 2.12), with: (1) LREE enrichment relative to HREE and MREE (2) relatively flat HREE patterns, and (4) weak negative Nb anomalies, strong negative Zr and Eu anomalies, and very strong negative Ti anomalies (Table 2.3); typical of arc-related rocks (Kerrich and Wyman, 1996). Arc-like influences are also supported by their Th-enrichment relative to Nb; they are much more Th-enriched relative to Nb compared to all the basalts but less so compared to the Fe-rich silicic suite (Figs. 2.13A-B, 2.15A-C, 2.16).

2.6. U-Pb zircon geochronology

2.6.1. Sample selection

Two samples of felsic rocks from the AG stratigraphy were collected from drill hole 110 to constrain the timing of VMS mineralization at AG based on their stratigraphic location, lithology, and geochemical attributes (Fig. 2.3 and 2.4). Sample 110-322 is a hydrothermally altered FeR lapilli tuff located along the strike of exhalative VMS mineralization and underlies hydrothermally altered and mineralized heterolithic fragmental rocks. Sample 110-368 is massive high-silica rhyolite (HSR) with patchy chlorite, calcite, and epidote alteration that intrudes FeA flows downhole of the FeR lapilli tuffs. The samples were analyzed at the Boise State University Isotope Geology Laboratory (BSU IGL) in Idaho. Mineral separation and extraction, imaging, laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS), and chemical

abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) were all performed at the BSU IGL. The results presented here are adapted from an internal BSU IGL report presented in Appendix 4.

2.6.2. Analytical methodology

Individual zircon grains were separated and prepared using standard techniques. Cathodoluminescence (CL) images were obtained with a JEOL JSM-300 scanning electron microscope (SEM) and Gatan MiniC (Fig. A5. 3, Fig. A5. 4). Laser ablation was performed on each zircon grain using a Teledyne Photon Machines Analyte Excite+ 193 nm excimer laser ablation system with HeIEx II Active two-volume ablation cell. An iCAP RQ Quadrupole ICP-MS was used to analyze the ablated material for U-Th-Pb isotopic ratios and trace element concentrations. A selected subset of zircon grains were removed from the epoxy mounts for CA-ID-TIMS dating based on the CL images and LA-ICPMS ages. Chemical abrasion was performed on individual grains following methods modified after Mattinson (2005) that are detailed in Appendix 4. Isotopic measurements for U and Pb were made on a GV Isoprobe-T or IsotopX Phoenix multi-collector TIMS equipped with an ion-counting Daly detector. More in-depth details on sample preparation, analytical methods, quality assurance, quality control, and data reduction calculations are provided in Appendix 4.

2.6.3. Results

A total of 11 and 49 zircon grains were analyzed by LA-ICPMS for samples 110-322 and 110-368, respectively. In sample 110-322, the zircons were difficult to recover due to the presence of pyrite and the eleven recovered anhedral to subhedral grains were small; they yielded LA-ICPMS 206 Pb/ 238 U dates of 212 ± 6 to 194 ± 5 Ma. Sample 110-368 contained abundant

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euhedral, prismatic, and oscillatory-zoned zircon grains; they yielded LA-ICPMS $^{206}Pb/^{238}U$ dates of 213 ± 5 to 189 ± 4 Ma. The LA-ICP MS U-Pb geochronologic analyses and trace element concentrations are provided in Appendix 4.

A total of seven and six zircon grains were analyzed by CA-ID-TIMS for samples 110-322 and 110-368, respectively. Four older grains in 110-322 yielded ${}^{206}Pb/{}^{238}U$ dates of 211.03 ± 0.32 to 210.68 ± 0.17 Ma and are interpreted as containing inherited components. The three youngest zircon grains from 110-322 yielded a weighted mean ${}^{206}Pb/{}^{238}U$ date of 210.35 ± 0.27 Ma, the interpreted igneous crystallization age. The six zircon grains analyzed by CA-ID-TIMS from sample 110-368 yielded a weighted mean ${}^{206}Pb/{}^{238}U$ date of 210.52 ± 0.08, the interpreted igneous crystallization age. The Six zircon isotopic data is presented in Table 2.4. Concordia diagrams displaying CA-ID-TIMS U-Pb dates are shown in Figure 2.17. The U-Pb geochronology results are summarized in Table 2.5.

2.7. Discussion

2.7.1. Volcanic controls on AG VMS mineralization

The location, style and hydrothermal alteration footprints of VMS deposits are influenced by the types of volcanic rocks that host them (Gibson et al., 1999). In flow-dominated host successions, hydrothermal fluid pathways are typically restricted to syn-volcanic normal faults (Sillitoe, 1982; Gibson et al., 1999; Lafrance et al., 2020) and VMS-style mineralization is precipitated immediately below the seafloor in stringer and replacement zones and at the seafloor as exhalative mineralization (Gibson et al., 1999). In the rock record, syn-volcanic faults can be recognized by sharp lateral changes in volcanic lithofacies, discontinuous units, local thickening of units, and offset stratigraphy (Nelson, 1998; Gibson et al., 1999; Allen et al., 2002; Lafrance et al., 2020). In volcaniclastic-dominated successions, hydrothermal fluid migration is less restricted, favoring the formation of subseafloor replacement-style deposits associated with pervasive, widespread stratigraphy-parallel alteration zones and the development of multiple, coalescing vent sites at the seafloor (Gibson et al., 1999; Piercey, 2015). Whether VMS deposits are hosted by flow- or volcaniclastic-dominated substrates, a commonality is that they form in proximal (near-vent) environments that can be recognized by distinct lithofacies associations (McPhie et al., 1993; Gibson et al., 1999; Allen et al., 2002).

At AG, the footwall rocks are dominated by effusive flows. However, the main mineralized succession includes a mix of volcaniclastic (FeR, heterolithic fragmental rocks) and coherent volcanic rocks (Z-FeTiB), and minor sedimentary units (Fig. 2.4). The pumice-bearing FeR lapilli tuffs are especially thick (up to 25 m) where they underlie the first barite- and sulfiderich exhalite at AG (e.g., drill hole 109; Figs. 2.3, 2.4). This may indicate that the thickest parts of the FeR represent a proximal volcanic center (Gibson et al., 1999) and that the location of some VMS mineralization at AG coincided with the same structures that may have fed the FeR eruptions. Further, most VMS mineralization is focused along the southwest side of the Finch fault (Figs. 2.3, 2.4), where the heterolithic fragmental rocks are thickest (Fig. 2.4, 2.6F-H) and coincide with barite-rich beds layered with sulfides and minor argillite suggesting that the localization of both volcaniclastic rocks and mineralization here is because they are basin-filling sequences and that the Finch fault was a synvolcanic fault. The above units are locally underlain by Z-FeTiB and they sharply transition laterally into a thick package of Z-FeTiB flows, suggesting that the Z-FeTiB were likely uplifted and eroded during basin subsidence along the rift shoulder of the Finch fault (Figs. 2.3, 2.4). In other words, the Finch fault is interpreted to have been a topographic scarp that formed after the emplacement of the Z-FeTiB and was present at the time of VMS deposition (Fig 2.18F). Further, based on their lithofacies, clast components,

and volcano-stratigraphic relationships, the heterolithic fragmental rocks that were deposited proximal to the Finch fault may be debris flow deposits that reworked some of the previously deposited units (Z-FeTiB, FeR, massive barite) (Fig. 2.18E-F) during synvolcanic faulting (e.g., McPhie et al., 1993; Hampton et al., 1996; Hughes et al., 2021). Following the emplacement of the heterolithic fragmental rocks, the thickest deposits of barite- and sulfide-rich exhalites accumulated adjacent to the Finch fault, suggesting that the Finch fault provided the pathways for hydrothermal fluids to reach the seafloor (Fig. 2.4). In addition, the heterolithic fragmental rocks are strongly hydrothermally altered to quartz, sericite, and pyrite, and locally mineralized adjacent to the Finch fault is synvolcanic (Fig. 2.2). Minor, thin flows of Z-FeTiB were emplaced between the deposition of the barite- and sulfide-rich exhalites, but in general, volcanism was subdued, and allowed for VMS mineralization and background pelagic sedimentation to accumulate.

The mineralized sequences are overlain by the HW-FeTiB, whose upper contacts are not appreciably offset at the Finch fault, further supporting that this is a synvolcanic structure (Gibson et al., 1999). These units are also thick (up to 80m), and have features including their (1) abundance and variety of pyroclastic particles like shards, wispy/fiamme-like lapilli, scoria, bombs with ameboidal to fluidal margins, plagioclase crystals, and rare accretionary lapilli (Fig. 2.7; White and Houghton, 2006), and (2) their internal organization of unstratified, poorly-sorted, matrix-supported lapilli tuffs overlain by laminated tuffs that suggest the HW-FeTiB are also pyroclastic flow deposits (Figs. 2.3, 2.4; McPhie et al., 1993; Gibson et al., 1999) and given their proximity to the synvolcanic Finch fault, they were likely emplaced in a proximal volcanic center (Gibson et al., 1999). Their field relationships suggest they may have filled the paleo AG basin

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and spilled over its walls, thus capping the AG deposit and likely helping to preserve the exhalative parts of the deposit from erosion and oxidation on the seafloor (Figs.2.4, 2.18G).

The HSR intrusions are interpreted as the last phase of magmatism in the AG volcanic succession. Because felsic magmas are viscous, their occurrence, especially where they form thick flows or abundant intrusions, typically mark vent-proximal locations and synvolcanic faults (McPhie et al., 1993; Gibson et al., 1999; Franklin et al., 2005) The thickest parts of the HSR intrusions are localized along the Finch fault and they taper in thickness with distance from it, implying this fault acted as the conduit for HSR emplacement. The HSR intrusions likely plugged this conduit, impeded hydrothermal fluid flow, or redirected it and potential VMS mineralization elsewhere. This is supported by the absence of VMS mineralization within or above the HW-FeTiB.

In the sequence (FeR \rightarrow Z-FeTiB \rightarrow heterolithic fragmental rocks \rightarrow HW-FeTiB \rightarrow HSR) that hosts the AG deposit, rift-related features (the Finch fault and the heterolithic fragmental rocks), basin-filling sequences (exhalites, minor sedimentary rocks, HW-FeTiB), and vent-proximal volcanic deposits (FeR, HW-FeTiB, and HSR) demonstrate that AG formed in a rift basin near an active volcanic center. The flow-dominated footwall sequence (FW-B, FW-FeB, FeD, and FeA) includes relatively impermeable host-rocks that restricted hydrothermal fluids to permeable synvolcanic structures (e.g., Gibson et al., 1999), such as the Finch fault, that controlled the siting of most of the AG mineralization. The HSR intrusions may have ultimately quenched the hydrothermal system by plugging crustal structures and hindering hydrothermal fluid flow.

2.7.2. Petrogenesis of the AG volcanic rocks

Petrogenesis of the footwall basalt suite

The footwall basalts (FW-B) and ferrobasalts (FW-FeB) were the first to erupt in the volcanic sequence in the AG deposit. Their EMORB signatures (Figs. 2.11, 2.12) and Zr-Nb-Yb-Ti systematics (Figs. 2.13A-C, 2.16) indicate they were derived from an HFSE-REE-enriched mantle and have not been influenced by subducted slab fluids (Pearce, 2008; Pearce, 2014). Their TiO₂/Yb ratios (Fig. 2.13C) and relatively flat HREE patterns (Figs. 2.11 and 2.12) show that garnet was not a residual phase, typical of shallow (< 2.5 Gpa; < 80 km) melts (Pearce, 2008; Pearce, 2014). The FW-B and the FW-FeB are interpreted to be related to one another by fractional crystallization based on their decreasing Al_2O_3 , Ni, Sc, and increasing Fe_2O_3 , TiO₂, P_2O_5 , and ΣREE relative to Nb (Fig. 2.10). These are typical major and trace element fractionation trends for low pressure, shallow-level fractional crystallization in tholeiitic magmas that are dominated by Fe-poor and Al-rich mineral phases such as plagioclase, olivine (Nibearing), and clinopyroxene (Sc-bearing), creating residual melts that become increasingly Fe-Ti-P-rich and Al-Ni-Sc-poor at somewhat constant SiO₂ during fractionation (Juster et al., 1989; Perfit et al., 1999; Charlier et al., 2013; Grove and Brown, 2018; Koepke et al., 2018). Fractionating tholeiitic melts also exhibit steadily increasing HFSE and REE concentrations (Brophy, 2009) without a change in the pattern of their primitive mantle-normalized signatures, except for total concentrations of said elements (Maclean and Barrett, 1993), a trend observed from the FW-B to the FW-FeB. Their non-arc, within-plate EMORB signatures (Figs. 2.11, 2.12, 2.13A-C, 2.16) and MORB/BABB-like Ti/V ratios (Fig. 2.13D) are also consistent with their formation in an extensional setting like a mid-ocean ridge (MOR) or back-arc basin (BAB) where thinned crust allowed enriched asthenosphere to upwell and partially melt by decompression (Fig. 2.18B; Sun and McDonough, 1989; Kerrich and Wyman, 1996; Pearce, 1996). These basaltic

magmas probably rapidly intruded cold crust and likely cooled quickly, favoring fractional crystallization processes (e.g., Christie and Sinton, 1981; Huppert and Sparks, 1988).

Petrogenesis of the Fe-rich silicic suite

The Fe-rich silicic suite was emplaced following the footwall basalt suite. They are tholeiitic (Fig. 2.9C) and have Nb/Yb ratios that are comparable to the footwall basalt suite, suggesting derivation from similarly enriched mantle sources (Fig.2.16; Pearce, 2008). Similar mantle sources are also supported by the comparable Nb/Ta (Table 2.3) for both suites that more closely resemble the mantle (Nb/Ta \sim 17.5) than crustal values (Nb/Ta \sim 11–12) (Green, 1995). However, the Fe-rich silicic rocks have trace element signatures (Fig. 2.9, 2.13A-B, 2.16) and distinctly negative Nb and Ti anomalies (Fig. 2.11; Table 2.3) that are more typical of arc-like volcanic rocks (Saunders et al., 1980; Pearce and Peate, 1995; Elliott, 2004; Pearce and Stern, 2006; Pearce, 2008). The FIIIa-type signatures of the felsic rocks (Fig. 2.14A), suggests they formed within the upper 10 km of the crust at low pressure (< 0.5 GPa) and high temperatures (1,100–900°C) (Hart et al., 2004). Their high abundances of REE and HFSE (Fig. 2.11, 2.12, Table 2.2) also indicate that they were anomalously hot, depolymerized melts, such that they could accommodate these highly incompatible elements (e.g., Zr > 200 ppm; Fig. 2.14C) (Leat et al., 1986; Lentz, 1998; Hart et al., 2004; Piercey, 2011). These geochemical features, combined with their within plate (A-type) signatures (Fig. 2.14B, D), are typical of tholeiitic felsic rocks derived from extension-related magmatism, such as those that form in intra-oceanic back arcs and arc-related rifts (Lesher et al., 1986; Hart et al., 2004; Piercey, 2011; Fassbender et al., 2022). The arc-like Fe-rich silicic suite is stratigraphically bound by non-arc, EMORB-like basalts (discussed above and below) providing strong evidence that the AG succession formed in an arc-related extensional setting since both arc-like and MOR-like rocks can be spatially and temporally juxtaposed in these environments (Pearce and Stern, 2006).

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The origin of extension-related intermediate to felsic lavas in oceanic arc settings has been attributed to: (1) fractional crystallization of a basaltic parent (Fretzdorff et al., 2006; Haase et al., 2011; Beier et al., 2015; Ma et al., 2017), (2) partially melting mixed MORB-like (dry) and arc-like (wet) mantle sources (Stern et al., 1990; Arai and Dunn, 2014; Caratori Tontini et al., 2019), (3) partially melting arc crust (Haraguchi et al., 2017), typically by basaltic underplating (Lesher et al., 1986; Lentz, 1998; Hart et al., 2004; Piercey, 2011) - these partial melts may further contaminate the basaltic intrusions (Kent et al., 2002), or (4) a combination of these processes, such as assimilation fractional crystallization (AFC) (DePaolo, 1981; Kondo et al., 2000; Marty et al., 2001).

Fractional crystallization is inefficient at changing incompatible element ratios (O'Neill and Jenner, 2012) and so the Fe-rich silicic suite cannot be related to the footwall basalt suite by fractional crystallization because the Fe-rich silicic suite has distinct Th-enrichment relative to Nb, Zr-Hf enrichments relative to Sm, and they have more fractionated LREE patterns compared to the footwall basalt suite (Table 2.3, Fig. 2.11, 2.15A-C). Their weak negative Nb anomalies could be explained by melts derived from mixed MORB-like and arc-like mantle sources in a back-arc setting (Stern et al., 1990; Pearce and Stern, 2006), but this contradicts their consistent positive Zr anomalies (Table 2.3, Fig. 2.11) since subduction-related melts typically have negative (or flat) Zr anomalies (Kelemen et al., 1993; Pearce and Peate, 1995; Kerrich and Wyman, 1996; Niu et al., 1999; Pearce and Stern, 2006). Even though the FeA, FeD, and FeR could be related to each other by fractional crystallization based on decreasing Al-Ti-Fe-Sc-P (plagioclase, FeTi oxide, clinopyroxene, and apatite fractionation) and increasing ΣREE as Nb increases (Fig. 2.10), this process alone cannot account for why the magnitudes of (La/Sm)_{pm}, the negative Nb anomalies, and the positive Zr anomalies that increase from andesitic (FeA), to dacitic (FeD), to rhyolitic (FeR) compositions. Instead, contamination by arc crust is likely why

this suite shows these systematic compositional trends, consistent with AFC processes (Fig.2.16; DePaolo, 1981; Pearce, 2008). For example, the FeA, FeD, and FeR show a negative compositional trend of increasing (La/Sm)_{pm} and Zr with decreasing (Nb/Th)_{pm} (Fig. 2.15A-B), typical of rocks derived from crustal contamination (e.g., Piercey et al., 2006; Ordóñez-Calderón et al., 2016). Assimilating arc crust into a fractionating tholeiitic magma also resolves why this Fe-rich, tholeiitic suite has trace element patterns that are transitional between tholeiitic and calcalkaline (Fig. 2.9D). To explain their enrichments in Zr-Hf relative to Sm, the crustal contaminant could have been partially melted hydrated mafic crust, since the decoupling of Zr-Hf relative to Sm is a feature shared by silicic melts experimentally-derived from partially melted mafic rocks under conditions (low pressure, high temperature, hydrous, and highly oxidizing) simulating the tops of magma chambers beneath spreading centers (France et al., 2010; France et al., 2014). This argument is supported by the SiO₂-TiO₂ systematics (Fig. 2.15D; Koepke et al., 2007) of the FeR and FeD and their FIIIa signatures (Hart et al., 2004), which are consistent with derivation from hydrous partial melting of mafic crust. The distribution of the FeA, FeD, and FeR across the fields of MORB differentiation and hydrous partial melting suggests that fractional crystallization was an important process, but assimilation was especially significant for the more felsic melts (Fig. 2.15D). The interpretation that the Fe-rich silicic suite is made up of contaminated tholeiites mirrors that proposed for hybrid tholeiitic/calc-alkaline rocks associated with VMS deposits in the Archean Abitibi greenstone belt (Gélinas and Ludden, 1984; Laflèche et al., 1992a). It may also explain why the FeR have distinct Ti-rich globules observed in thin section (Fig. 2.5I); perhaps these are disequilibrium features derived from mixed magmatic sources. For example, quenched mafic globules in felsic tuffs from the Kamiskotia VMS area in the Abitibi greenstone belt have been interpreted as evidence that mafic and felsic liquids co-existed in a subvolcanic magma chamber (Barrie et al., 1993).

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Basaltic underplating beneath a rifted arc can best explain the geochemical features of the Fe-rich silicic suite. In this model, thinned island arc crust promoted the upwelling of hot asthenosphere to shallow depths beneath the rift where it partially melted by decompression and these melts intruded the arc crust (Lesher et al., 1986; Huppert and Sparks, 1988; Lentz, 1998; Hart et al., 2004; Shukuno et al., 2006; Galley et al., 2007; Piercey, 2011). The basaltic melts may have been sourced from a similarly enriched type of mantle to the footwall basalt suite (e.g., Fig. 2.16). The thermal input of fractionating, tholeiitic, mafic magmas in the arc crust likely caused the geothermal gradient to increase and induced partial melting of the arc crust. The silicic, partial melts of arc crust were assimilated by the Fe-rich basaltic intrusions, forming the Fe-rich silicic suite with mixed crust-mantle signatures (Fig. 2.18C; Huppert and Sparks, 1988; Galley et al., 2007; Piercey, 2011). The most felsic compositions were formed by basaltic intrusions that assimilated the highest amounts of crustal contaminants. Since assimilation requires sustained, anomalous heat at crustal levels (Grove and Brown, 2018), it can be surmised that the Fe-rich silicic suite formed in a thermally anomalous geodynamic setting, a feature that is critical in the development of hydrothermal systems (Maclennan et al., 2005; Piercey, 2011). The Fe-rich silicic suite immediately precedes the emplacement of the first beds of barite- and sulfide-rich exhalite and it is interpreted that the heat necessary to form the Fe-rich silicic suite also drove the hydrothermal system that formed the AG deposit.

Petrogenesis of the FeTi basalt suite

A volcanic hiatus between the emplacement of the Fe-rich silicic suite and the Z-FeTiB is indicated by exhalative massive sulfides that locally marks the contact between them (Figs. 2.3, 2.4). Because both the Z-FeTiB and HW-FeTiB (the FeTi basalts) have EMORB-like Zr-Nb-Y-Ti systematics (Figs. 2.13A-C, 2.16A-B; Pearce, 2008; Pearce, 2014) and smooth primitive mantle-normalized signatures that are more similar to the footwall basalts (Fig. 2.11), it is possible that

they were derived from similar shallow, extension-related, enriched magmatic sources as the footwall basalts. However, their unique primitive mantle-normalized signatures relative to the preceding Fe-rich silicic suite suggests that these suites probably formed in separate magma chambers from that suite (Figs. Fig. 2.11, 2.18D). The FeTi basalts likely evolved by extensive fractional crystallization given their extreme enrichments in Fe₂O₃, TiO₂, P₂O₅, Σ REE relative to Nb (Fig. 2.10). The FeTi basalts have slightly lower Nb/Th (Figs. 2.13A-C, 2.15A-C, 2.16) compared to the footwall basalts, indicating that their enriched mantle sources also had slight additions from subducted slab-related fluids (Pearce, 2008). Further, because the FeTi basalts have lower Nbpm/Thpm relative to other monitors of crustal contamination, like Lapm/Smpm and Zr, than the footwall basalt suite (Fig 2.15A-B; e.g., Piercey et al., 2006; Ordóñez-Calderón et al., 2016), their Th-enrichment relative to Nb is interpreted to represent minor crustal contamination. These interpretations are consistent with petrologic studies that have shown that the formation of FeTi basalts is primarily attributed to extensive low-pressure (<1-3 kbars) fractional crystallization of typical MORB (Byerly et al., 1976; Juster et al., 1989) and some studies have shown that, in addition, minor assimilation of oceanic crustal material is also important in their genesis (Perfit et al., 1999). The Z-FeTiB were emplaced synchronous with rifting and VMS mineralization (as discussed above) and fractional crystallization was important in their formation. Collectively, these features suggest that hydrothermal convective circulation was efficient at transferring heat (and metals) from the crust to the seafloor when they formed (Fig. 2.18D; e.g., Maclennan et al., 2005; Liu and Lowell, 2011), also promoting VMS formation. By association, Fe- and Ti-rich mafic rocks like the Z-FeTiB may be prospective for VMS in other districts. In fact, Fe- and Ti-rich basalts are associated with several VMS deposits and districts globally including in the Abitibi greenstone belt (Matagami, Kamiskotia, and Noranda camps), the Wawa subprovince greenstone belts (Geco, Nama Creek, and Winston Lake deposits), the

Uchi subprovince greenstone belts (South Bay deposit), and the Flin Flon belt (Cuprus and White Lake deposits) (Barrie and Pattison, 1999; Gibson et al., 2007; Kerrich et al., 2008 and references therein; Syme et al., 2000).

The HW-FeTiB were the last to erupt in the AG host sequence (Figs. 2.3, 2.4). They have highly correlated Nb/Th values to the Z-FeTiB (Figs. 2.13A-C, 2.16), suggesting these units had similar levels of crustal contamination. However, the HW-FeTiB do not follow expected AFC fractionation vectors relative to the Z-FeTiB (Fig. 2.16A-B). The HW-FeTiB are less evolved than the Z-FeTiB based on their higher Al₂O₃-Sc-Ni and lower TiO₂-P₂O₅-ΣREE relative to Nb (Fig. 2.10); they have Ni and P_2O_5 abundances that are comparable to the FW-B (Table 2.2). These geochemical trends suggest that the HW-FeTiB cannot be related to the Z-FeTiB by crystal fractionation or AFC processes. They could, however, be derived from the same magma chamber that was replenished by influxes of new mafic magmas that could have reset the residual melts, resulting in lower TiO₂-Fe₂O₃-P₂O₅ and higher Al₂O₃-Ni-Sc relative to Nb. If the replenishing magmas were derived from a slightly deeper or more enriched source, this would help explain why the HW-FeTiB trend toward slightly more alkaline compositions (Fig. 2.16) and why they have a more intermediate depth signatures (Fig. 2.13C) and somewhat more fractionated HREE patterns (Figs. 2.11, 2.12). Furthermore, magmatic replenishment provides a mechanism to trigger explosive eruptions (Sparks et al., 1977; Fujibayashi and Sakai, 2003; Head and Wilson, 2003; Cassidy et al., 2016; Leeman and Smith, 2018) consistent with the pyroclastic textures exhibited by the HW-FeTiB.

Petrogenesis of the HSR suite

The HSR are the most evolved of all the units based on their high silica contents (Fig. 2.15), FIIIb classifications (Fig.2.14), and their most extreme abundances of HFSE and REE

(Figs.2.10, 2.11, 2.12; Table 2.2). They are interpreted to be a sill complex and based on crosscutting relationships - some of the HSR sills are younger than the Z-FeTiB (Figs. 2.2B, 2.8A) but their timing of emplacement relative to the HW-FeTiB is uncertain. They have Nb/Yb and Nb/Ta ratios that are comparable to the HW-FeTiB (Table 2.3), suggesting derivation from similar mantle sources, however, they plot above the MORB-OIB array, indicating that they have been modified by subduction zone-related influences (Fig.2.16).

The formation of FIIIb high-silica rhyolites like the HSR has been attributed to extensive fractional crystallization of a basaltic parent (Lesher et al., 1986), or shallow (< 10 km), high-temperature (1,100°–900°C) hydrous partial melting of mafic crust where clinopyroxene is more stable than amphibole (Lesher et al., 1986; Barrie et al., 1993; Barrie and Pattison, 1999; Hart et al., 2004). Plagioclase, clinopyroxene, and titanite could have been fractionating phases as indicated by negative Eu anomalies, low Sc contents (Sc < 1 ppm), and extreme negative Ti anomalies, respectively, in the HSR suite (Table 2.3, Fig. 2.11). Furthermore, the HSR have anomalously low Zr/Hf (Zr/Hf = 24.20–28.21) relative to chondritic meteorites (Zr/Hf = 34.08–37.09) and the primitive mantle (Zr/Hf = 34.17 – 37.10) (Sun and McDonough, 1989; Mcdonough and Sun, 1995; Palme and O'Neill, 2014) that could also be explained by the fractionation of zircon, clinopyroxene, or titanite (Linnen and Keppler, 2002; Claiborne et al., 2018). Zircon fractionation is also supported by their accessory euhedral zircon crystals (Fig. 2.8D-E) including grains recovered from the geochronologic sample 110-368 (Table 2.5; Appendix 4) that were interpreted as igneous and not inherited grains.

Their extremely low Fe and Ti, high Si nature, and high abundance of HREE could also reflect hydrous partial melting of mafic crust (Table 2.3; Fig. 2.15D, Koepke et al., 2007; Wanless et al., 2010; Fassbender et al., 2022). Their elevated Th/Nb (Fig. 2.13A-B, 2.15A-C,

2.16) relative to the footwall basaltic and FeTi basalt suites suggests that mafic arc crust was the likely contaminant. Derivation from mixed crust-mantle sources best explains their variable tholeiitic (Fig.2.14A,C) and calc-alkaline (Figs. 2.9C, 2.14B) major and trace element signatures. Some of their transitional (Figs. 2.9D) to alkaline (Figs. 2.9A, 2.13A-B) trace element signatures may not be reliable since Zr behaved compatibly during zircon fractionation. For example, they have higher Nb relative to Zr compared to the FeR (Fig. 2.14C). The HSR probably formed by high-temperature, low-pressure crustal partial melting followed by fractional crystallization since they: (1) have relatively constant compositions, (2) are hosted in a bimodal volcanic succession, and (3) none of the other volcanic suites are related to each other purely by fractional crystallization suggesting the absence of a single, large, fractionating magma chamber (e.g., Hart et al., 2004).

Magmatic replenishment by slightly deeper (or possibly somewhat more alkaline) sources was invoked to relate the HW-FeTiB to the Z-FeTiB (described above). Perhaps such an influx of hot mafic magma into the crust may have promoted crustal melting to generate the HSR. Once the HSR melts were generated, they may have further evolved by fractional crystallization. These petrogenetic interpretations are consistent with those postulated for some high silica rhyolites with FIIIb signatures elsewhere (Barrie et al., 1993; Barrie and Pattison, 1999; Hart et al., 2004), including some high Zr/Ti felsic composite intrusions that postdate the main VMS-forming events in Precambrian VMS camps (Galley, 2003); the HSR are interpreted to postdate the main AG VMS-forming period.

2.7.3. Tectonic controls on the AG VMS deposit genesis

In the ancient rock record an estimated 80% of all VMS deposits are interpreted to have formed in rifted arc settings (Hannington et al., 2005). The VMS deposits of the ATMB are

postulated to have formed in a propagating intra-arc rift (Taylor et al., 2008) and radiogenic isotopic signatures of rocks in the Alexander terrane suggest it formed in a wholly oceanic realm (Samson and Patchett, 1991; Peter and Scott, 1997; Peter et al., 2014; Steeves et al., 2016). Rifting is the first stage in arc extension that may occur over several millions of years before true ocean floor spreading allows mantle material to upwell passively in a back-arc basin (Barrett and MacLean, 1999; Hannington et al., 2005; Stern, 2010). The rifting stage is typically geochemically and spatially disorganized (Gill et al., 2021). In sufficiently wide (~200 km) backarc basins with true seafloor spreading (Hannington et al., 2005), volcanism is dominated by monotonous piles of effusive MORB-like basalts with minimal felsic to intermediate rocks and especially minor volcaniclastic facies (Syme et al., 2000). Given that the AG volcanic stratigraphy includes diverse rock compositions, especially highly evolved compositions (e.g., FeTi basalts, andesitic through rhyolitic compositions including high-silica rhyolites) with variable MOR-like to arc-like geochemical features, and volcaniclastic facies (FeR, heterolithic fragmental rocks, HW-FeTiB) are volumetrically significant in the AG suite, an intra-arc rift is the preferred tectonic setting (Fig. 2.19). Intra-arc rifting is the most common cause of mantle enrichment, with enriched compositions typically migrating into the space beneath the rift during and immediately after arc rifting (Hawkins, 2003; Hochstaedter et al., 1990; Pearce and Peate, 1995; Gill et al., 2021), consistent with the enriched mantle signatures of the AG units. The FIIIa signatures of the FeR and FeD are also common in felsic rocks associated with rifted intraoceanic island arcs (Fassbender et al., 2022).

Evolved basalts enriched in Fe and Ti, like the Z-FeTiB and HW-FeTiB, are not common on the seafloor, but in arc settings, many have been sampled in association with ridge discontinuities such as propagating rifts, transform faults, and overlapping spreading centers (Sinton et al., 1993; Pearce et al., 1994; Caroff and Fleutelot, 2003; Sinton et al., 2003; Fleutelot

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et al., 2005; Fretzdorff et al., 2006). The formation of evolved lavas by AFC processes in intraoceanic island arc settings, such as the Fe-rich silicic suite and the HSR, has also been linked to propagating rift tips (Fassbender et al., 2022), where the opportunities for these meltgenerating processes are highest (Pearce and Stern, 2006). The lithogeochemical associations with propagating rift tips reflect the unique tectonic, thermal, and magmatic regimes at ridge discontinuities governed by episodic magmatic supply rates that favor the formation of isolated magma chambers where fractional crystallization processes dominate (Sinton et al., 1983; Pearce et al., 1994) but where assimilation can also occur (Pearce and Stern, 2006), especially following magmatic replenishment cycles (Grove and Brown, 2018). A propagating intra-arc rift provides the mechanism for basin development where upwelling asthenosphere brings heat to crustal levels. The injection of asthenosphere-derived partial melts into cold crust favors fractional crystallization processes (e.g., Christie and Sinton, 1981; Huppert and Sparks, 1988), generating basalts like the footwall basalt suite (Fig. 2.18B). High heat flow from basaltic intrusions in rifted crust also initiates hydrothermal convective circulation and induces partial crustal melting to create geochemically distinct units like the Fe-rich silicic suite and the HSR (Fig. 2.19C, H). Ridge discontinuities may result in the development of disconnected magma chambers that are cut off from magmatic replenishment (Sinton et al., 1983), favoring fractional crystallization processes and the development of highly evolved basalts, like the FeTi basalts. The cooling of these isolated magma chambers may be enhanced in rifted basins that create conduits for hydrothermal fluids to efficiently transfer heat (and metals) from the crust to the seafloor (e.g., Maclennan et al., 2005; Liu and Lowell, 2011), a process critical in the development of VMS deposits.

The formation of the AG deposit in a propagating intra-arc rift agrees with previous interpretations for the VMS deposits of the ATMB (Taylor et al., 2008) and this tectonic setting is

common for bimodal-mafic VMS deposits globally (Allen et al., 2002; Galley et al., 2007; Piercey, 2011). The thermally anomalous, extension-related tectono-magmatic processes at propagating intra-arc rifts are conducive to VMS formation, and furthermore, the volcanic rocks that form in these settings have distinct lithogeochemical associations that can be used to guide VMS exploration.

2.7.4. Age of the AG VMS deposit and implications for the timing of hydrothermal activity in the ATMB

Generalized stratigraphic columns with geochronologic data for Greens Creek, Palmer, AG, and Windy Craggy are provided in Fig. 2.19. Previous conodont studies on the Palmer property confirmed that the host rocks for VMS mineralization are Late Triassic (Norian to Rhaetian; Green, 2001; Green et al., 2003) and an ID-TIMS U-Pb zircon date of 213 ± 5 Ma from a hydrothermally altered rhyolite constrains the timing of mineralization at the Palmer deposit (Green, 2001). Zircons from the FeR and HSR at AG yield new CA-ID-TIMS U-Pb crystallization dates of 210.35 ± 0.27 , and 210.52 ± 0.08 Ma, respectively (Fig. 2.17; Table 2.4, Table 2.5) that are in agreement with these previous age constraints on the Palmer property. The FeR crystallized at 210.35 ± 0.27 Ma, marking a break in volcanism, the onset of hydrothermal activity, and the accumulation of exhalative massive barite laminated with sulfides. Therefore, this date provides a reasonable constraint on the age of hydrothermal activity at AG. The HSR are interpreted to be emplaced as high-level intrusions, some of which were emplaced after the Z-FeTiB when VMS mineralization was interpreted to be at a maximum. They are locally hydrothermally altered, suggesting they were emplaced synchronously with hydrothermal activity. The HSR sill that intrudes the FeA in drill hole 110 crystallized at 210.52 ± 0.08 Ma. This date also provides a reliable constraint on the age of hydrothermal activity at AG. The HSR sill is interpreted to have formed after the FeR, based on their stratigraphic relationship. The

overlapping date ranges for the FeR and the HSR suggest that the immediate volcanic hosts to the AG deposit (FeR, Z-FeTiB, HSR) were emplaced within less than million years of each other and that the deposit formed sometime between 210.60 Ma (oldest limit of HSR) to 210.08 Ma (youngest limit of FeR).

It has been suggested that Greens Creek mineralization formed mainly by subseafloor replacement on a 100 million year unconformity (Steeves, 2018) and occurred after the deposition of argillite containing conodonts assigned to the Norian-Carnian boundary (220.7 ± 4.4 Ma; Premo et al., 2010). According to the current Norian-Carnian boundary (227 Ma; Walker et al., 2018), the argillite is estimated to have been deposited around 227 Ma (Steeves, 2018). A Hyd Group rhyolite interpreted to be stratigraphically above the argillite and post-dating the Greens Creek mineralization returned a CA-ID-TIMS U-Pb zircon date of 226.86 ± 0.24 Ma (Sack et al., 2011; Sack et al., 2016) suggesting that the AG deposit could be at least 15 million years younger than the Greens Creek deposit. However, field mapping and structural interpretations suggest that this Hyd Group rhyolite is actually structurally above the argillite in an overturned sequence, making it stratigraphically older than the argillite and thus older than Greens Creek mineralization (Steeves, 2018). The argillites are intruded by gabbros with a LA-ICP quadrupole mass spectrometry (QMS) U-Pb zircon date of 219 ± 8 Ma. Hydrothermal mineralization at Greens Creek may be linked to mafic-ultramafic intrusions emplaced between 215 and 211 Ma in Gambier Bay (Premo et al., 2010). Fuchsite from one of these altered ultramafic bodies has a 40 Ar/ 39 Ar plateau age of 210.3 ± 0.3 Ma, representing the time that the intrusion cooled to below 300°C and when hydrothermal activity is interpreted to have ceased (Premo et al., 2010). Furthermore, a mineralized sample at Greens Creek yielded a LA-ICP-MS U-Pb age of 209 ± 9.4 Ma from hydrothermal monazite, however, this age was deemed unreliable due to Pb contamination from sulfides and also possible Pb loss from later metamorphism (Steeves, 2018).

The age of mineralization at AG is very similar to the interpreted age of hydrothermal activity near Greens Creek based on the mafic-ultramafic intrusions (Premo et al., 2010). This is significant because the Palmer property that hosts the AG and Palmer deposits may have formed only 30-50 km from Greens Creek after restoring the ~180 km post-middle Cretaceous and pre-Holocene dextral movement along the Chatham Strait fault (Hudson et al., 1982). The overlapping ages of interpreted hydrothermal activity at AG and near Greens Creek suggests that the AG and Greens Creek deposits could be broadly coeval. This differs from previous interpretations that suggest that the AG and Palmer deposits formed from two different hydrothermal events approximately 10–15 million years apart (Sack et al., 2016). Until the timing of mineralization at Greens Creek can be determined with higher confidence, the possibility that AG and Greens Creek could be coeval remains valid and testable.

2.7.5. The association of VMS deposits with Fe-rich volcanic rocks and highsilica rhyolites – comparisons to the Neoarchean Blake River Group, Abitibi greenstone belt

Fe-rich volcanic rocks and high-Si rhyolites are common in many bimodal-mafic settings, including the Archean Abitibi greenstone belt, which hosts world-class VMS deposits in various similar sequences, many of which are within the Blake River Group ("BRG") in Ontario and Quebec (Barrett and MacLean, 1999; Barrie and Pattison, 1999; Franklin et al., 2005; Gibson et al., 2007; Hathway et al., 2008; Kerrich et al., 2008). The BRG rocks have many similarities to the AG volcanic stratigraphy, including: (1) variolitic, Fe-rich basalts (Gélinas et al., 1976; Gélinas et al., 1984; Fowler et al., 1987), (2) Fe-rich volcanic rocks of varied compositions, including some with hybrid tholeiitic to calc-alkaline affinities (Dimroth et al., 1982; Gélinas et al., 1984; Gélinas and Ludden, 1984; Fowler and Jensen, 1989; Gibson, 1990; Barrett et al., 1991; Laflèche et al., 1992b; Barrie et al., 1993), (3) FIII-type high-silica rhyolites and FeTi-rich mafic

rocks with VMS mineralization (Lesher et al., 1986; Barrie and Pattison, 1999; Hart et al., 2004; Hathway et al., 2008), (4) pyroclastic deposits within VMS-hosting stratigraphy (Barrie and Pattison, 1999; Ross et al., 2011), and (5) formation in rifted arc geodynamic settings (Laflèche et al., 1992b; Wyman, 2003). The stratigraphy of the Aldermac VMS deposit (2700.2 ± 0.9 Ma; McNicoll et al., 2014) is similar to AG, mineralization formed at the end of an andesite, dacite, and Fe-rich rhyolite extrusive cycle and was followed by the emplacement of a large dome of mainly massive to brecciated high-Si rhyolite and high-Ti andesite (Barrett et al., 1991). In the Kamiskotia volcanic complex, the Kam Kotia VMS deposit occurs along strike from FeTi basalts and they occur in the immediate stratigraphic hangingwall; mixed basalt-rhyolite lapilli tuffs are broadly synchronous with mineralization; and the deposit is both underlain and overlain by highsilica rhyolites (Barrie and Pattison, 1999). The spatial association of FeTi-rich mafic rocks, FIIItype high-silica rhyolites, and volcaniclastic rocks with VMS mineralization at Kam Kotia are like some of the AG units (Fig. 2.20).

The similarities between the AG volcanic stratigraphy and sequences hosting VMS deposits in the BRG indicate the Late Triassic intra-oceanic island arc rift processes proposed to have formed the AG rocks may have also been operative in the Neoarchean. Interestingly, it has been suggested that the BRG may have formed by plume-arc interaction (Wyman, 2003). By association, could mantle plume events or the products of plume events, such as oceanic plateaus and large igneous provinces (LIP), be linked to the formation of the ATMB? In the Alexander-Wrangellia-Peninsular composite super-terrane, thick (> 6,000 m) accumulations of plume-related Ladinian to Norian (239–225 Ma; Nelson et al., 2013b) tholeiitic basalts were deposited in the Wrangellia flood basalt province (Lassiter et al., 1995; Greene et al., 2008; Greene et al., 2009), immediately prior to the emplacement of the rhyolite (226.86 \pm 0.24 Ma; Sack et al., 2011; Sack et al., 2016) postulated to be in the Greens Creek stratigraphic footwall (Steeves, 2018) and

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about 15 million years before the AG deposit formed (between 210.60 to 210.08; this study) in the rifted arc rocks of the ATMB. The interaction of mantle plumes or products of mantle plumes (e.g., LIP) with intra-oceanic island arc systems has been documented in some modern settings, such as the Tonga-Lau intraoceanic arc system (Ewart et al., 1998; Falloon et al., 2007; Lupton et al., 2012; Price et al., 2014; Timm et al., 2014; Lupton et al., 2015; Gill et al., 2021) and the New Hebrides Island arc system (Anderson et al., 2016). Large igneous provinces can plug subduction zones, cause subduction zone reversals, initiate rifting, impact the dynamics of ridge segmentation, and subduction of these LIPs can enhance magmatism (Hall, 2002; Stern, 2004; de Ronde et al., 2007; Hastie and Kerr, 2010; Anderson, 2018). Peter et al. (2014) combined observations from geochemistry, isotope studies, and geological relationships to infer that the Late Triassic ATMB Windy Craggy deposit hosted by argillite and alkalic basalts formed in a back-arc setting associated with a slab window; similar tectonic configurations are proposed in the northern Lau basin in the southwest Pacific (Regelous et al., 2008; Lupton et al., 2009; Price et al., 2014) where seismic evidence suggests that there is a tear in the Pacific plate associated with the hotspot volcanism of the Samoan Islands (Millen and Hamburger, 1998). It is possible that the Wrangellia flood basalt events imparted complex and heterogeneous stresses to the Late Triassic Alexander intra-oceanic arc system that eventually rifted to form the ATMB (e.g., Nelson et al., 2013b). Furthermore, these thick, buoyant masses may have helped to preserve the VMS-hosting crust during terrane accretion. FIIIb rhyolites like the HSR at AG are much more common in the Archean (Hart et al., 2004; Piercey, 2011), possibly because the mantle was hotter in the Archean (Abbott et al., 1994), but it could also reflect the low preservation potential of mid-ocean ridge or mature back-arc basin oceanic crust where FIIIb rhyolites are mainly formed today (Fassbender et al., 2022). Complex microplate configurations associated with buoyant crust (e.g., LIP such as the Wrangellia flood basalts) may have been critical to initiate arc rifting in the ATMB and preserve it from subduction (Dilek and Furnes, 2014).

2.8. Conclusions

Reconstruction of the AG volcanic architecture with the aid of lithogeochemical investigations indicates that the AG deposit is a bimodal-mafic VMS deposit hosted by FIII-type rhyolites and FeTi-rich basalts. The primary geochemical signatures of the volcanic rocks are highly correlated with their stratigraphic position; chemostratigraphic patterns show that most of the deposit formed at the contact between the Fe-rich silicic suite and the FeTi basalt suite. Field relationships, geochemical observations, and geochronologic evidence suggest that the AG deposit formed in a propagating intra-arc rift sometime between 210.60 to 210.08 million years ago. A propagating intra-arc rift provided the mechanism for basin development where:

- Thinned arc crust promoted enriched asthenosphere to upwell and partially melt by decompression, forming the pillowed, footwall basalt suite that have tholeiitic, EMORBlike geochemical signatures.
- 2. Fractionating tholeiitic basaltic intrusions at shallow (< 10 km from surface) levels in the arc crust induced partial crustal melting and assimilated those crustal melts to create the Fe-rich silicic suite, including FIIIa- and A-type felsic rocks, which have mixed tholeiitic and calc-alkaline geochemical signatures. The high heat flow required to sustain assimilation processes was also critical in the development of hydrothermal convective circulation. Barite- and sulfide-rich exhalites accumulated above the thickest parts of the FeR lapilli tuffs that have a crystallization age of 210.35 ± 0.27 Ma.
- 3. Propagating rift tectonics allowed the development of a disconnected magma chamber that could evolve by extensive fractional crystallization and minor crustal assimilation to form

the EMORB-like Z-FeTiB. The cooling of the Z-FeTiB magma chamber may have been enhanced in a rifted basin where synvolcanic structures created conduits for hydrothermal fluids to efficiently transfer heat from the crust to the seafloor. The Z-FeTiB variolitic, pillowed flows were emplaced synchronous with rift-related heterolithic fragmental rocks and VMS mineralization. One synvolcanic fault, the Finch fault, was responsible for the sharp lateral changes in the thicknesses and facies of units and the focus of VMS mineralization.

- 4. Magma recharge in the same crustal magma chamber that fed the Z-FeTiB may have triggered the explosive volcanic eruption of the volcaniclastic HW-FeTiB that cap the AG deposit, and likely helped to preserve the exhalative parts of the deposit.
- 5. The influx of mafic magma related to the HW-FeTiB is interpreted to have promoted high-temperature (1,100°–900°C), low-pressure (< 10 km) crustal melting followed by fractional crystallization (e.g., zircon fractionation) to generate the FIIIb HSR. The HSR intrusions were the last magmatic phase in the AG volcanic succession and crystallized at 210.52 ± 0.08 Ma. They were emplaced as intrusions along the Finch fault, and they likely plugged this conduit, possibly quenched the hydrothermal system, or redirected it elsewhere.</p>

Collectively, the FIIIa FeR, Z-FeTiB, and heterolithic fragmental rocks are the most important hosts to VMS mineralization at AG. Hydrothermal mineralization was intimately associated with basin development in a rifted arc environment near an active volcanic center. Volcanic rocks with weak arc-like geochemical signatures that are derived from AFC processes, such as the Fe-rich silicic suite and the HSR, signify a thermally anomalous geodynamic setting; a feature that is critical in the development of hydrothermal systems. Fe- and Ti-rich basalts, like the Z-FeTiB and HW-FeTiB are also prospective for VMS because they may coincide with rifted settings governed by efficient heat transfer from the crust to the seafloor.

The lithostratigraphic and geochemical features of the AG host volcanic rocks help to elucidate the tectono-magmatic conditions governing the formation of the AG VMS deposit. These insights can help to improve our understanding of how VMS deposits form. They can also identify VMS-favorable successions and guide exploration at the property- to belt-scale and in similar intra-arc rift settings globally, from the Neo-Archean to the present.

Chapter 2 References

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Chapter 2 Tables

Alteration test	Least altered sample criteria	Rationale	Reference
Visual Assessment	Absence of abundant hydrothermal minerals (sulphides, brt, qz, sericite, chl, carbonate, and ep). Absence of abundant contact metamorphism minerals (bt, grt, chl and ep).	Fresh volcanic rocks are not hydrothermally altered and haven't undergone contact metamorphism.	Barrett and Maclean (1994)
Na2O (wt %)	1.5 to 5	Na ₂ O wt % for average fresh volcanic rocks from basaltic to rhyolitic compositions varies from 2.56% to 3.87%. Na-depletion is characteristic of sericite- or chlorite-alteration.	Mathieu (2018)
Al ₂ O ₃ (wt %)	> 10	Al ₂ O ₃ wt % for average, fresh volcanic rocks from basaltic to rhyolitic compositions varies from 13.24% to 16.67%	Mathieu (2018)
Al ₂ O ₃ /Na ₂ O	< 10	Monitors Na-depletion caused by feldspar destruction while Al is conserved. Ideal for samples containing plagioclase. Felsdspars break down into sericite and quartz.	Spitz- Darling (1978)
Ishikawa alteration index (AI)	20 - 60	The principal rock-forming elements that are gained and lost during sericite and chlorite alteration (MgO, K ₂ O, Na ₂ O, CaO) define the AI.	Large et al. (2001)
Chlorite-carbonate-pyrite Index (CCPI)	15 - 85	The increase in MgO and FeO associated with chlorite, Mg-Fe-carbonate, pyrite, magnetite or hematite alteration defines the CCPI.	Large et al. (2001)
Loss on ignition (LOI)	< 7 %	LOI is a proxy for volatile phases such as H ₂ O, CO ₂ , sulfur oxides and fluorine. Altered rocks typically contain more volatile phases than fresh volcanic rocks. Many variables can impact LOI and its significance should be interpreted with caution.	Gifkins et al. (2005)
LREE signatures on multi-element normalized diagrams	Absence of extreme depletion in LREE compared to neighbouring HFSE	LREE can be mobile under high fluid to rock ratio, for example, in fluid upflow zones. U-shaped patterns signifying strong depletion compared to neighbouring elements.	Campbell et al. (1984)
Zn (ppm)	< 300		
Cu (ppm)	< 100		
Pb (ppm)	< 10	Enriched by hydrothermal fluids	
Ag (g/t)	< 0.5		
BaO (%)	< 0.2		
S (%)	< 0.75	High S in the presence of sulfides/sulfates	
C (%)	< 1.6	High C may be attributed to presence of CO_2 for example, in carbonate mineral.	
Total (%)	98-102	Analysis reliability indicator - major element oxides should total to about 100%	Rollinson and Pease (2021)

Table 2.1 Summary of criteria used to select the least altered samples.

	FeTi basalts						
		Hangingwall			Zone-equivalent		
Sample	S039241	W605535	W814293	8037015	W420988	W420983	
Unit	HW-FeTiB	HW-FeTiB	HW-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	
Texture	Tuff	Lapilli tuff	Lapilli tuff	Pillowed, variolitic	Pillowed	Variolitic	
Туре	DDH	DDH	DDH	Outcrop	DDH	DDH	
SiO ₂ (wt %)	45.43	50.87	47.31	56.71	47.11	41.94	
Al ₂ O ₃	13.02	14.84	15.19	13.87	12.68	14.12	
Fe ₂ O ₃	17.36	20	17.04	13.05	22.19	15.82	
TiO ₂	2.38	2.61	2.68	3.16	2.78	3.06	
MnO	0.1	0.01	0.14	0.11	0.08	0.21	
MgO	5.07 4.35	2.19 0.61	5.53 4.74	3.14 3.12	3.31 3.45	3.7 7.42	
CaO K ₂ O	3.49	5.34	2.04	1.53	4.26	3.57	
Na ₂ O	0.11	0.71	0.09	3.42	1.51	1.94	
P_2O_5	0.25	0.2	0.28	0.64	0.4	1.07	
BaO	0.13	0.05	0.2	0.06	0.06	0.07	
Cr ₂ O ₃	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	
SrO	0.02	0.01	0.04	0.04	0.03	0.03	
s	0.04	< 0.01	0.23	0.45	0.01	0.01	
C	1.54	0.09	0.41	0.01	0.44	1.46	
LOI Total	7.3 99.26	1.97 99.52	4.34 100.45	1.04 101.2	2.05 100.05	6.7 99.81	
Se (ppm)	0.5	<0.2	0.6	0.9	0.3	<0.2	
Li	20	20	20	20	20	10	
Sc	32	31	38	36	33	36	
V	479	257	572	343	329	367	
Cr	30	40	40	10	10	20	
Co	29	36	55	35	21	31	
Ni	21	25	34	11	12	11	
Cu Zn	11 208	<1 121	67 189	59 136	1 181	3 233	
Ga	19.4	24.2	23.4	22.2	21.8	23.9	
Ge	<5	<5	<5	<5	7	<5	
As	26.9	3.9	7.5	0.6	1	1.3	
Mo	<1	<1	1	3	1	1	
Ag	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Cd In	0.7 0.031	<0.5 0.013	<0.5 0.015	<0.5 0.009	<0.5 0.043	<0.5 0.052	
Sn	1	2	2	2	1	2	
Sb	4.21	3.28	2.91	0.08	0.27	0.49	
Te	< 0.01	< 0.01	0.02	0.04	< 0.01	< 0.01	
W	2	1	1	<1	1	1	
Re	< 0.001	< 0.001	0.002	0.004	< 0.001	< 0.001	
Hg	0.012	< 0.005	< 0.005	0.006	<0.005	< 0.005	
Tl Bi	4.51 0.02	1.5 0.02	1.81 0.02	0.25 0.05	0.47 0.01	0.22 0.02	
Rb	100	170	40.7	36.5	138.5	96.7	
Sr	185	100.5	353	375	269	281	
Cs	3.09	5.24	1.09	1.1	4.78	2.43	
Ba	1180	438	1735	488	631	652	
Pb	<2	7	17	<2	7	<2	
Th	1.73	2.11	2 2.65	2.06	2.16	2.38	
U Y	1.74 37.2	0.23 34.9	2.65 34.2	1.64 51.2	0.86 59.5	1.77 95.3	
Zr	152	176	160	176	197	194	
Nb	15.5	17.5	18.6	18.8	19.1	20.1	
Hf	3.8	4.5	4.1	4.3	5	5.2	
Та	0.9	1	1.1	1.2	1	1.1	
La	20.2	20	18.1	22.3	21.3	25.2	
Ce	40.8	44.7	42.8	46.5	48.9	53.2	
Pr Nd	5.58 23.6	5.64 25.7	5.54 25.5	5.78 27.4	6.74 30.4	7.34	
Sm	6.02	6.37	23.3	7.29	8.2	8.83	
Eu	2.07	1.98	2.16	2.03	2.71	2.87	
Gd	7.04	6.26	7.2	8.2	9.73	10.95	
ТЬ	1.18	0.95	1.26	1.51	1.72	1.92	
Dy	7.44	6.58	7.13	9.45	11.15	12.9	
Ho	1.57	1.32	1.57	2.05	2.37	3.04	
Er	4.48	3.78	4.22	5.66	6.46	8.64	
Tm Yb	0.61 4.06	0.51	0.63 4.18	0.82	0.97 6.12	1.37 8.54	
ro Lu	0.58	0.51	4.18	0.83	0.99	8.54 1.42	
	0.00	0.01	0.00	0.00	0177	4 - Tár	

Table 2.2 Whole rock lithogeochemical data of twenty-two representative, least-altered samples of the eight geochemical volcanic units of the AG deposit.

	Ferro-basalts Footwall		Basalts Footwall		High-silica rhyolites (HSR) Multiple stratigraphic levels	
Sample	W600902	W605561	W604981	W604985	W605034	W605521
Unit	FW-FeB	FW-FeB	FW-B	FW-B	HSR	HSR
Texture	Massive; feldspar- phyric	Massive; feldspar- phyric	Pillowed; hyaloclastic	Hyaloclastic	Massive	Massive
Туре	Outcrop	DDH	DDH	DDH	DDH	DDH
SiO2 (wt %)	47.66	48.71	53.84	51.59	71.26	75.06
Al ₂ O ₃	13.29	14.28	14.36	14.84	14	12.08
Fe ₂ O ₃ TiO ₂	14.32 1.81	14.95 1.9	10.2 1.17	9.76 1.2	3.58 0.14	2.31 0.12
MnO	0.28	0.23	0.18	0.15	0.02	0.03
MgO	2.88	2.66	4.02	4.06	1.14	0.56
CaO	7.95	7.02	8.77	9.4	1.34	1.98
K ₂ O	0.22	0.28	1.83	2.18	3.3	2.69
Na ₂ O P ₂ O ₅	4.24 0.31	4.46 0.36	2.5 0.27	3.01 0.33	2.26 0.03	2.27 0.04
BaO	0.02	0.03	0.07	0.06	0.13	0.1
Cr_2O_3	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01
SrO	0.04	0.04	0.04	0.02	0.02	0.01
s C	0.12	0.17 0.91	0.26 0.43	0.5 0.75	0.06	0.49
LOI	1.49 6.01	0.91 3.97	0.43	0.75 3.32	0.09 1.57	0.42 2.28
Total	99.44	99.5	100.3	101.25	99.02	100.45
Se (ppm)	0.2	0.5	0.7	0.5	0.5	0.2
Li	10	10	10	10	10	10
Sc	37	39	43	44	1	1
V Cr	327 10	347 10	325 30	340 40	6 <10	8 <10
Co	40	45	25	55	1	2
Ni	8	8	13	29	<1	<1
Cu	30	36	31	61	5	6
Zn	170	158	110	132	73	33
Ga Ge	18 <5	18.5 <5	16.9 <5	17.2	35.6 <5	32.2 <5
As	2.8	1.6	2.2	5.6	0.4	1.2
Mo	2	11	1	2	1	1
Ag	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cd	0.5	<0.5	0.7	0.7	<0.5	<0.5
In Sn	0.021	0.015	0.015 <1	0.011 <1	0.036	0.029 7
Sb	0.11	0.77	0.19	0.2	0.15	0.13
Te	< 0.01	0.01	0.01	0.03	0.01	0.01
W	1	1	1	1	1	1
Re	0.001	0.003	< 0.001	0.006	0.001	0.001
Hg Tl	0.009 0.04	0.005 0.03	<0.005 0.72	<0.005 0.83	<0.005 0.3	0.011 0.04
Bi	0.04	<0.01	0.02	0.02	0.02	0.04
Rb	3.3	4.5	51	50	43.4	32.2
Sr	385	302	319	196.5	164.5	100.5
Cs	0.3	0.27	1.78	1.56	1.4	0.33
Ва Рb	112 3	252 2	534 8	513 4	1325 7	932 8
Th	0.94	1.12	0.85	0.92	12.6	11.2
U	0.47	0.56	0.99	3.1	3.51	2.49
Y	36.5	40.3	26.4	29.4	180.5	108.5
Zr	111 9.3	125	69	74 9.2	378 77.1	271 64.5
Nb Hf	9.3 3.2	11 3.4	8.8 1.7	9.2	13.4	64.5 11.2
Ta	0.5	0.7	0.6	0.5	4.4	3.8
La	10.5	12.6	9.6	10	91.8	97.8
Ce	23.8	27.1	19.5	21.6	193.5	202
Pr Nd	3.35 15.7	3.77 18	2.5 11.4	2.76 13.5	24.5 95.6	24.3 98.9
Nd Sm	4.62	5.15	11.4 3.09	13.5 3.56	95.6 22.5	98.9 22.3
Eu	1.41	1.74	1.03	1.06	3.93	3.64
Gd	5.37	6.48	4	4.64	25	22.4
Tb	1.11	1.21	0.81	0.83	4.59	3.5
Dy	6.6	7.15	5.01	5.27	30.6	22.1
Ho Er	1.41 4.07	1.62 4.55	0.98 3.05	1.13 3.43	7.67 22.8	4.39 12.25
Er Tm	4.07	4.55	0.46	5.45 0.48	3.59	12.25
Yb	4.24	4.36	2.96	3.08	23.4	11.75
Lu	0.62	0.67	0.4	0.48	3.19	1.61

	Ferro-andesites (FeA)							
	Footwall							
Sample	W420955	W605563	W812314	W812316	W812317	W813093		
Unit	FeA	FeA	FeA	FeA	FeA	FeA		
Texture	Massive; sparse FP	Massive; sparse FP	Massive; sparse FP	Massive; sparse FP	Massive; sparse FP	Massive; sparse FP		
Туре	DDH	DDH	DDH	DDH	DDH	DDH		
SiO ₂ (wt %)	52.42	52.82	55.36	54.36	55.28	50.57		
Al_2O_3	13.46	11.71	12.99	13.23	13.02	13.52		
Fe ₂ O ₃	16.79	12.69	14.27	14.65	14.52	15.29		
TiO ₂	1.74	1.51	1.62	1.64	1.73	1.66		
MnO MrO	0.25	0.15	0.14	0.23	0.14	0.17		
MgO CaO	4.72 2.98	3.42 7.35	5.43 3.04	4.23	4.67 3.1	5.03 5.26		
K ₂ O	1.39	1.38	0.84	4	1.31	2		
Na ₂ O	3.91	2.81	3.13	3.57	3.73	2.41		
P ₂ O ₅	0.55	0.57	0.53	0.55	0.52	0.53		
BaO	0.04	0.06	0.04	0.04	0.04	0.05		
Cr_2O_3	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01		
SrO	0.03	0.04	0.03	0.04	0.05	0.04		
S	0.15	0.3	0.16	0.13	0.14	0.56		
С	0.01	1.07	0.06	0.03	0.03	0.08		
LOI	1.59	4.45	2.26	0.99	1.22	2.08		
Total	100.35	99.75	100.2	99.36	99.79	100.3		
Se (ppm)	0.3	0.7	0.6	1.6	0.5	0.5		
Li	20	10	20	10	10	20		
Sc	25	20	22	23	25	24		
V	181	151	159	160	192	169		
Cr	10	<10	10	10	10	10		
Co	34	27 5	29 3	29 5	32 5	31 5		
Ni	6 31	5 26	3 26	5 29	5 32	23		
Cu Zn	137	126	138	143	127	113		
Ga	18.7	18.2	21.2	20.6	19.9	20.6		
Ge	<5	<5	<5	<5	<5	<5		
As	1.4	2.6	0.8	1.2	1	1.4		
Mo	<1	1	<1	1	1	1		
Ag	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		
Cd	<0.5	<0.5	<0.5	0.7	0.6	0.8		
In	0.02	0.009	0.021	0.032	0.03	0.009		
Sn	2	2	2	2	2	2		
Sb	0.16	0.13	0.18	0.24	0.21	0.17		
Te	0.03	< 0.01	0.01	0.03	0.02	0.03		
W	1	1	1	1	1	1		
Re	< 0.001	0.002	0.001	0.001	0.001	0.005		
Hg	< 0.005	0.005	<0.005	< 0.005	<0.005	< 0.005		
TI	0.25	0.38	0.14	0.31	0.37	0.4		
Bi	0.02	0.01	0.01	0.03	0.03	0.01		
Rb	29.8	30.2	18.9	31.4	39.3	50		
Sr Cs	225 3.28	303 1.42	225 1.61	313 4.01	420 3.36	290 2.01		
Cs Ba	3.28	588	274	307	267	2.01 434		
Ba Pb	305 <2	588	5	6	267	434		
Th	3.52	3.57	3.93	4.1	3.51	3.92		
U	1.8	3.54	2.31	3.42	2	2.3		
Y	52.3	53.8	54.3	55.7	57.3	54.8		
Zr	220	238	263	253	216	261		
Nb	14.3	15.2	16.2	20.1	16.1	16.4		
Hf	5.5	5.6	6.4	6.3	5.1	6.2		
Ta	0.7	0.9	1.1	1	0.9	1.1		
La	20.9	26.9	23.3	24.4	22	21.7		
Ce	43.7	51.3	49.8	52.5	47.2	47.6		
Pr	5.69	6.41	6.14	6.43	5.97	6.38		
Nd	24.6	27.3	28.3	29.6	26.9	27.5		
Sm	6.25	7.36	6.92	7.73	6.92	7.04		
Eu	1.88	1.92	1.95	2.05	1.82	1.87		
Gd	7.53	8.35	8.63	8.55	8.29	8.56		
Tb	1.38	1.44	1.48	1.54	1.43	1.46		
Dy	8.57	8.9	9.15	9.78	9.26	9.36		
Ho	1.92	2.01	1.97	2.13	2.03	2.07		
Er	5.4	5.74	5.68	6.54	6.43	6.12		
Tm	0.85	0.95	0.89	0.96	0.99	0.94		
Yb	5.51	6.55	6.32	6.4	6.2	5.99		
Lu	0.89	0.95	0.94	1.03	0.92	0.91		

	Ferro-dae	cites (FeD)	Ferro-rhyoiltes (FeR)			
	Foo	twall	Footwall			
Sample	W605416	W812877	W601175	W813071		
Unit	FeD	FeD	FeR	FeR		
Texture	Pillowed; hyaloclastite	Pillowed; amygdaloidal	Lapilli tuff	Lapilli tuff		
Туре	DDH	DDH	DDH	DDH		
SiO2 (wt %)	59.48	65.63	64.2	69.08		
Al ₂ O ₃	12.65	11.79 8.93	14.54	11.62 8.19		
Fe ₂ O ₃ TiO ₂	11.1 0.82	8.93	8.64 0.36	8.19 0.26		
MnO	0.18	0.1	0.04	0.03		
MgO	1.76	2.14	2.26	2.2		
CaO	6.75	3.44	2.05	1.32		
K ₂ O Na ₂ O	1.72 1.97	1.04 3.71	4.47 0.72	3.21 0.16		
P ₂ O ₅	0.28	0.32	0.05	0.04		
BaO	0.01	0.03	0.14	0.1		
Cr ₂ O ₃	< 0.01	< 0.01	0.01	0.005		
SrO S	0.03 0.01	0.03 0.07	0.02 0.17	0.03 0.07		
c	0.65	0.25	0.05	0.17		
LOI	3.53	1.6	1.9	2.37		
Total	100.35	99.85	99.9	99.1		
Se (ppm) Li	0.3 10	0.2 10	0.9 20	0.2 10		
Sc	10	10	11	2		
v	8	18	79	21		
Cr	<10	10	20	10		
Co Ni	10 <1	9 <1	8 4	6 14		
Cu	5	16	13	1520		
Zn	110	101	100	1145		
Ga	21.2	18.5	25.6	22		
Ge As	<5 0.5	<5 0.9	5 1.4	2.5 2.3		
Mo	2	2	<1	0.5		
Ag	<0.5	<0.5	<0.5	6		
Cd	<0.5	<0.5	<0.5	0.7		
In Sn	0.015	0.007	0.014	0.084		
Sh	4 0.16	4	0.21	28 2.06		
Te	< 0.01	< 0.01	0.01	0.02		
W	1	1	1	1		
Re	0.001 <0.005	<0.001 <0.005	0.001 <0.005	0.0005 0.008		
Hg Tl	<0.005 0.18	<0.005	< 0.005	0.15		
Bi	0.01	0.01	0.02	0.14		
Rb	33	28.4	93.3	65.9		
Sr Cs	277 0.92	332 0.99	222	158.5		
Cs Ba	249	231	2.61 1205	935		
Pb	8	5	4	115		
Th	6.69	6.41	15.25	12.1		
U Y	2.99 60.4	2.96 56.7	5.45 108	4.33 52		
Y Zr	339	335	627	52		
Nb	20.3	19	42.6	37.3		
Hf	8.1	8	15.7	12.4		
Та	1.1	1.2	2.5	2.2		
La Ce	28.1 60.6	27.9 57.2	67.5 141	46.5 98.1		
Pr	7.53	6.87	16.5	11.2		
Nd	30.6	27.3	69.1	47.3		
Sm	7.89	6.99	15.85	11.25		
Eu Gd	1.9 8.64	1.61 7.56	2.46 16.15	1.71 11.4		
Tb	1.58	1.4	3.1	1.93		
Dy	10.2	9.31	19.5	12.2		
Ho	2.26	2.08	4.2	2.3		
Er Tm	6.7 1.06	6.9 1.04	12.15 1.9	6.73 0.96		
Yb	6.47	7.22	11.95	6.97		
Lu	1.02	1.06	1.74	1.01		

Table 2.3 Summary of significant element ratios of the least altered AG volcanic rocks.

	FeTi	basalts	Footwa	ll basalts	F	High-silica rhyolites		
	HW-FeTiB	Z-FeTiB	FW-FeB	FW-B	FeA	FeD	FeR	HSR
Zr/Ti	0.01	0.01	0.01	0.01	0.02 - 0.03	0.07	0.28 - 0.33	0.38 - 0.45
Nb/Y	0.42 - 0.54	0.21 - 0.37	0.25 - 0.27	0.31 - 0.33	0.27 - 0.36	0.34	0.39 - 0.72	0.43 - 0.59
Al ₂ O ₃ /TiO ₂	5.47 - 5.69	4.39 - 4.61	7.34 - 7.52	12.27 - 12.37	7.74 - 8.14	13.87 - 15.43	40.39 - 44.69	100.00 - 100.67
Zr/Al ₂ O ₃	10.53 -11.86	12.69 - 15.54	8.35 - 8.75	4.81 - 4.99	16.34 - 20.25	26.80 - 28.41	43.12 - 44.41	22.43 - 27.00
Ti/V	28.09 - 60.88	49.99 - 55.23	32.83 - 33.18	21.16 - 21.58	54.02 - 61.45	283.10 - 614.50	27.32 - 74.22	89.93 - 139.89
La/Yb	4.33 - 5.71	2.95 - 3.91	2.48 - 2.89	3.24 - 3.25	3.55 - 4.11	3.86 - 4.34	5.65 - 6.67	3.92 - 8.32
Zr/Y	4.09 - 5.04	2.04 - 3.44	3.04 - 3.10	2.52 - 2.61	3.77 - 4.84	5.61 - 5.91	5.81 - 9.92	2.09 - 2.50
Th/Yb	1.47 - 1.65	1.50 - 1.62	1.39 - 1.40	1.32 - 1.37	2.80 - 3.37	4.52 - 4.62	1.28 - 1.74	2.24 - 2.38
Nb/Zr	0.10 - 0.12	0.10 - 0.11	0.08 - 0.09	0.12 - 0.13	0.06 - 0.08	0.06	0.06 - 0.07	0.20 - 0.24
Th/Zr	0.01	0.01	0.01	0.01	0.01 - 0.02	0.02	0.02	0.03 - 0.04
Th/Nb	0.11 - 0.12	0.11 - 0.12	0.10	0.10	0.20 - 0.25	0.33 - 0.34	0.32 - 0.36	0.16 - 0.17
La/Th	9.05 - 11.68	9.86 - 10.83	11.17 - 11.25	10.87 - 11.29	5.54 - 7.54	4.20 - 4.35	3.84 - 4.43	7.29 - 8.73
Nb/Yb	3.82 - 5.00	2.35 - 3.30	2.19 - 2.52	2.97 - 2.99	2.32 - 3.14	2.63 - 3.14	3.56 - 5.35	3.29 - 5.49
TiO ₂ /Yb	0.59 - 0.75	0.36 - 0.55	0.43 - 0.44	0.39 - 0.40	0.23 - 0.32	0.12 - 0.13	0.03	0.01
Nb/Ta	16.91 - 17.50	15.67 - 19.10	15.71 - 18.60	14.67 - 18.40	14.73 - 20.43	15.83 - 18.45	16.95 - 17.04	16.97 - 17.52
Zr/Hf	39.02 - 40.00	37.31 - 40.93	34.69 - 36.76	38.95 - 40.59	40.00 - 42.50	41.85 - 41.88	39.93 - 41.61	24.20 - 28.21
(Hf/Sm)pm	0.84 - 1.02	0.85 - 0.86	0.95 - 1.00	0.77 - 0.79	1.06 - 1.33	1.48 - 1.64	1.42 - 1.58	0.72 - 0.86
(Zr/Sm)pm	0.91 - 1.10	0.87 - 0.95	0.95 - 0.96	0.82 - 0.89	1.24 - 1.51	1.70 - 1.90	1.57 - 1.82	0.48 - 0.67
(La/Yb) _{pm}	3.11 - 4.10	2.12 - 2.81	1.78 - 2.07	2.33	2.55 - 2.95	2.77 - 3.12	4.05 - 4.78	2.82 - 5.97
(La/Sm)pm	1.67 - 2.17	1.68 - 1.98	1.47 - 1.58	1.82 - 2.01	1.99 - 2.36	2.30 - 2.58	2.67 - 2.75	2.64 - 2.83
(Gd/Yb) _{pm}	1.42 - 1.48	1.06 - 1.32	1.05 - 1.23	1.12 - 1.25	1.05 - 1.18	0.87 - 1.10	1.12 - 1.35	0.88 - 1.58
(Nb/Nb*)pm	0.89 - 1.05	0.88 - 0.95	0.99 - 1.00	1.03 - 1.04	0.53 - 0.68	0.48 - 0.50	0.45 - 0.53	0.66 - 0.77
(Zr/Zr*)pm	1.04 - 1.28	0.91 - 1.05	0.99 - 1.02	0.84 - 0.90	1.31 - 1.56	1.89 - 2.12	1.80 - 2.09	0.56 - 0.73
(Ti/Ti*) _{pm}	0.87 - 0.90	0.74 - 0.97	0.78 - 0.86	0.70 - 0.79	0.46 - 0.60	0.24 - 0.28	0.05	0.01
(Eu/Eu*)cn	0.93 - 0.97	0.80 - 0.93	0.87 - 0.92	0.80 - 0.90	0.73 - 0.84	0.68 - 0.70	0.46 - 0.47	0.50 - 0.51
Th_N/Nb_N	1.47 - 1.65	1.50 - 1.62	1.39 - 1.40	1.32 - 1.37	2.80 - 3.37	4.52 - 4.62	4.45 - 4.91	2.24 - 2.38
ΣREE	125.23 - 127.94	145.52 - 178.82	83.45 - 95.06	64.79 - 71.82	135.07 - 159.64	164.44 - 174.55	259.56 - 383.10	528.72 - 552.67
AI	61.05 - 85.08	41.66 - 60.42	20.27 - 20.39	33.46 - 34.17	32.09 - 50.4	28.52 - 30.78	28.52 - 30.78	43.33 - 55.22
CCPI	76.94 - 90.74 20.90 - 168.78	75.04 - 80.14 4.06 - 8.40	77.27 - 77.95 3.13 - 3.20	71.22 - 75.30 4.93 - 5.74	77.79 - 82.15 3.44 - 5.61	68.17 - 76.10 3.18 - 6.42	68.17 - 76.10 20.19 - 72.63	34.72 - 43.96 5.32 - 6.19
AI_2O_3/Na_2O	20.90 - 108.78	4.00 - 8.40	3.13 - 3.20	4.93 - 3.74	3.44 - 3.01	3.18 - 0.42	20.19 - 72.03	3.32 - 0.19

Table 2.4 Chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) U-Pb zircon isotopic data for felsic rocks in the AG stratigraphy.

			Compositional parameters Radiogenic Isotope Ratios									Isotopic Dates											
CA- TIMS	mass	LA- ICPMS	<u>Th</u>	²⁰⁶ Pb*	mol %	Pb*	Pbc	<u>Pb*</u>	206Pb	208Pb	207Pb		207Pb		206Pb		corr.	207Pb		207Pb		206Pb	
label	spectrometer	label	U	x10 ⁻¹³ mol	²⁰⁶ Pb*	(pg)	(pg)	Pb_c	²⁰⁴ Pb	²⁰⁶ Pb	²⁰⁶ Pb	% err	²³⁵ U	% err	²³⁸ U	% err	coef.	²⁰⁶ Pb	±	²³⁵ U	±	²³⁸ U	±
(a)			(b)	(c)	(c)	(c)	(c)	(c)	(d)	(e)	(e)	(f)	(e)	(f)	(e)	(f)		(g)	(f)	(g)	(f)	(g)	(f)
Samp	le 110-322																						
:6	Phoenix	222	0.396	0.1296	98.01%	3.1	0.22	14.4	904	0.126	0.050	0.745	0.231	0.817	0.033	0.153	0.547	214.99	17.24	211.36	1.56	211.03	0.3
9	Isoprobe-T	217	0.369	0.0915	97.01%	2.2	0.23	9.4	602	0.117	0.050	0.963	0.230	1.044	0.033	0.105	0.802	199.40	22.35	209.95	1.98	210.89	0.2
5	Phoenix	215	0.324	0.1122	97.69%	2.7	0.22	12.1	779	0.103	0.050	0.634	0.230	0.698	0.033	0.097	0.700	207.74	14.69	210.56	1.33	210.81	0.2
4	Phoenix	213	0.397	0.2343	98.85%	5.7	0.23	25.1	1564	0.126	0.050	0.394	0.230	0.444	0.033	0.084	0.656	202.86	9.15	210.04	0.84	210.68	0.
7	Isoprobe-T	214	0.422	0.0795	97.41%	1.9	0.18	11.1	696	0.134	0.050	0.927	0.230	1.005	0.033	0.130	0.641	205.21	21.51	210.08	1.91	210.51	0.
8	Isoprobe-T	219	0.300	0.0719	97.23%	1.7	0.17	10.0	652	0.095	0.050	0.902	0.230	0.978	0.033	0.118	0.679	203.48	20.93	209.82	1.85	210.38	0.
1	Phoenix	221	0.344	0.2088	98.79%	5.0	0.21	23.5	1488	0.109	0.050	0.392	0.230	0.443	0.033	0.082	0.679	209.63	9.09	210.23	0.84	210.28	0.
amp	le 110-368																						
2	Phoenix	225	0.421	1.3891	99.75%	33.9	0.29	116.0	7127	0.134	0.050	0.128	0.231	0.181	0.033	0.073	0.819	215.25	2.97	211.05	0.34	210.67	0.1
6	Phoenix	233	0.416	1.1943	99.72%	29.1	0.28	105.1	6473	0.132	0.050	0.117	0.231	0.172	0.033	0.071	0.863	212.41	2.70	210.70	0.33	210.54	0.
1	Phoenix	251	0.408	1.0170	99.33%	24.8	0.57	43.4	2692	0.130	0.050	0.168	0.231	0.220	0.033	0.071	0.803	213.26	3.90	210.73	0.42	210.50	0.
4	Phoenix	228	0.397	1.1534	99.62%	28.0	0.36	77.2	4781	0.126	0.050	0.174	0.230	0.220	0.033	0.075	0.726	211.55	4.03	210.58	0.42	210.50	0.
3	Phoenix	249	0.369	1.6959	99.71%	40.8	0.41	99.5	6208	0.117	0.050	0.153	0.231	0.199	0.033	0.074	0.735	214.18	3.55	210.79	0.38	210.48	0.
5	Phoenix	246	0.423	1.4452	99.60%	35.3	0.48	73.9	4544	0.134	0.050	0.140	0.231	0.192	0.033	0.073	0.809	215.22	3.24	210.82	0.37	210.43	0.

(b) Model Th/U ratio calculated from radiogenic ²⁰⁸Pb/²⁰⁶Pb ratio and ²⁰⁷Pb/²³⁵U date.

(c) Pb* and Pb_c are radiogenic and common Pb, respectively. mol % ²⁰⁶Pb* is with respect to radiogenic and blank Pb.

(d) Measured ratio corrected for spike and fractionation only. Pb fractionation correction is 0.18 ± 0.03 (1 sigma) %/amu (atomic mass unit) for single-collector Daly analyses done on Isoprobe-T mass spectrometer and 0.24 ± 0.03 (1 sigma) %/amu (atomic mass unit) for single-collector Daly analyses done on the Phoenix mass spectrometer, both based on recent analyses of EARTHTIME ²⁰⁰Pb-²⁰⁵Pb ET2535 tracer solution.

(c) Corrected for fractionation and spike. Common Pb in zircon analyses is assigned to procedural blank with composition of 208 Pb/ 204 Pb = 18.04 ± 0.61%; 207 Pb/ 204 Pb = 15.54 ± 0.52%; 208 Pb/ 204 Pb = 37.69 ± 0.63% (1 sigma). 206 Pb/ 238 U and 207 Pb/ 206 Pb ratios corrected for initial disequilibrium in 230 Th/ 230 Th/ 230 Th/ 230 Th/ 230 Th/ 230 Pb/ 230 Pb/ 204 Pb = 15.54 ± 0.52%; 208 Pb/ 204 Pb = 37.69 ± 0.63% (1 sigma). 206 Pb/ 238 U asing a D(Th/U) of 0.20 ± 0.05 (1 sigma). (f) Errors are 2 sigma, propagated using algorithms of Schmitz and Schoene (2007) and Crowley et al. (2007).

(g) Calculations based on the decay constants of Jaffey et al. (1971). 206/pb/238U and 207/pb/266/pb dates corrected for initial disequilibrium in 230/Th/238U using a D(Th/U) of 0.20 ± 0.05 (1 sigma).

Table 2.5 Summary of U-Pb geochronology results.

		Sample Attributes			LA-I	CPMS	CA-TIMS						
Sample	Lithology	Location description	Drillhole ID	Sample depth in core (m)	Number of zircon grains analyzed	²⁰⁶ Pb/ ²³⁸ U dates (Ma)	Number of zircon grains analysed	Number of analyses used in weighted mean	Mean square of weighted deviates (MSWD)	Probability of fit	Weighted mean ²⁰⁶ Pb/ ²³⁸ U date (Ma)		
110-322	FIIIa Ferro- rhyolite (FeR) lapilli tuff	Stratigraphically underlying hydrothermally altered heterolithic fragmental unit and along strike of exhalative VMS mineralization.	CMR18- 110	322	11	$212 \pm 6 \text{ to}$ 194 ± 5	7	3	1.1	0.32	210.35 ± 0.27		
110-368	Massive FIIIb High- silica rhyolite (HSR)	Suspect this is a high-level, syn-volcanic intrusion. Intrudes ferro-andesite (FeA) flows.	CMR18- 110	368	49	$\begin{array}{c} 213\pm5 \text{ to}\\ 189\pm4 \end{array}$	6	6	1.2	0.29	210.52 ± 0.08		

Chapter 2 Figures

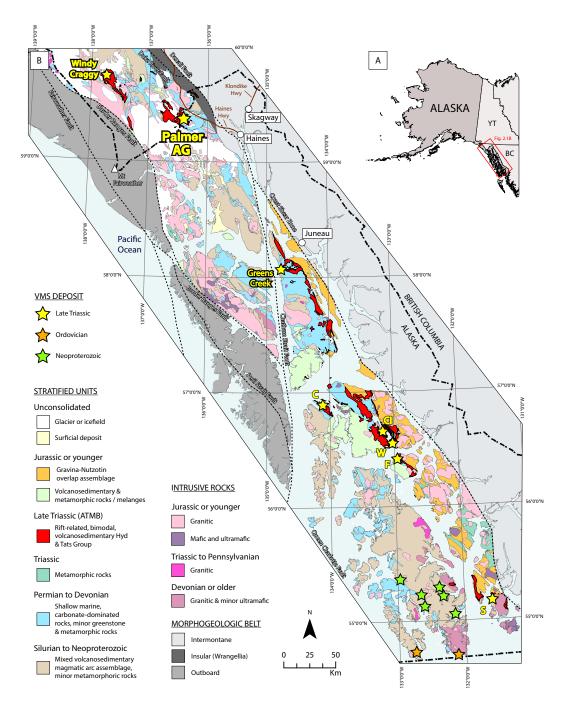
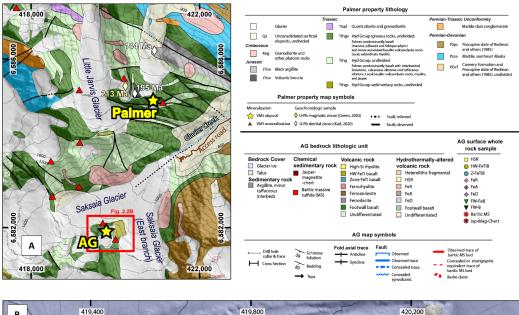


Fig. 2.1 (A) Location of the Alexander terrane. (B) Regional geology of the Alexander terrane in southeastern Alaska and northwestern British Columbia. Stratified units and intrusive rocks of Alaska and British Columbia are based on digital files from the USGS (Wilson et al., 2015) and the BCGS (Cui et al., 2017), respectively. They are grouped to reflect the generalized tectonic environments of the terrane (Gehrels and Saleeby, 1987). The terrane boundaries are from Colpron and Nelson (2011). The Alexander Triassic metallogenic belt (ATMB) hosts several VMS deposits, including Windy Craggy, Palmer and AG, Greens Creek, C: Cornwallis Peninsula (Kuiu), CI: Castle Island, WI: Woewodski Island, F: Frenchie, and S: Sylburn Peninsula.



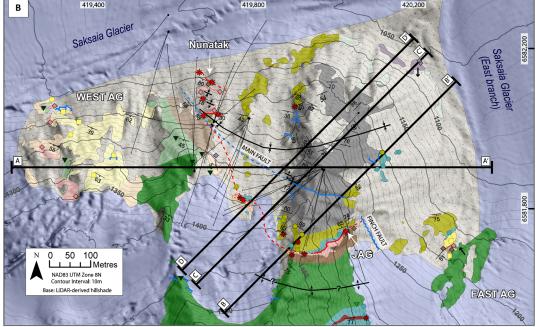


Fig. 2.2 (A) Regional geology of the Palmer property modified from the Alaska digital geology compilation (Wilson et al., 2015). The locations of the Palmer and AG VMS deposits and several VMS prospects are shown. Geochronologic data includes one U-Pb zircon date from the Palmer rhyolite (213 Ma) (Green, 2001) and U-Pb dates from detrital zircons (Karl et al., 2020). (B) Bedrock geology in the vicinity of the AG deposit. Map units coincide with the new chemostratigraphic nomenclature developed in this study from surface mapping, drill core logging, and lithogeochemical studies. The locations of the oblique section (A-A') and cross sections (B-B', C-C', and D-D') shown in Fig. 2.4 are displayed.

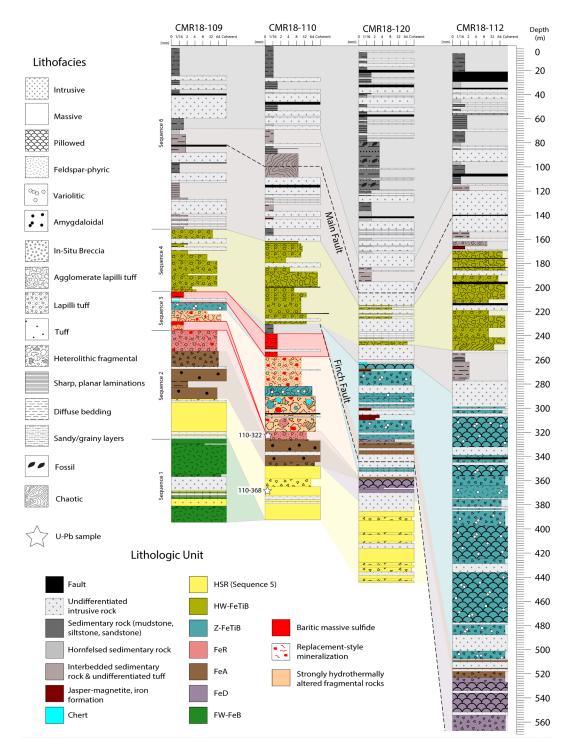


Fig. 2.3 Graphic logs for four representative drill holes through the JAG panel that coincide with the cross-section, C-C', shown in Fig. 2.4. Note that sequence 5, the HSR, is an intrusive sill complex that has massive and brecciated facies.

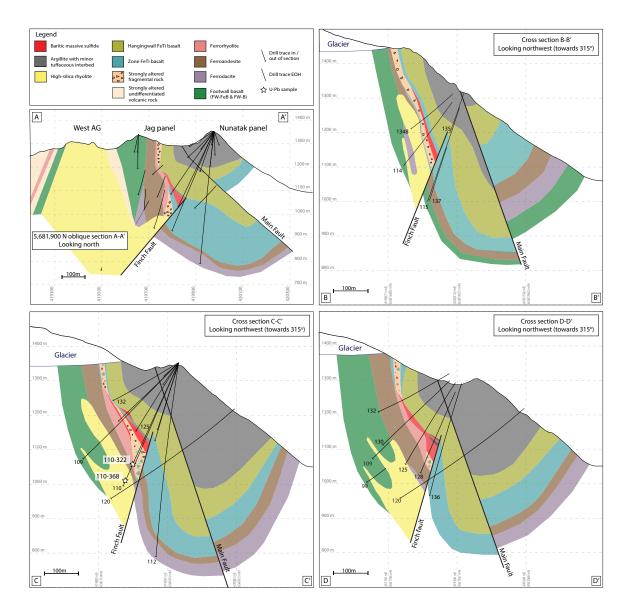


Fig. 2.4 Oblique section (A-A') across the AG deposit map area and cross sections (B-B', C-C', and D-D') highlighting the JAG panel stratigraphy. Section locations are shown in Fig. 2.2B. Detailed graphic logs associated with section C-C' are displayed in Fig. 2.3.

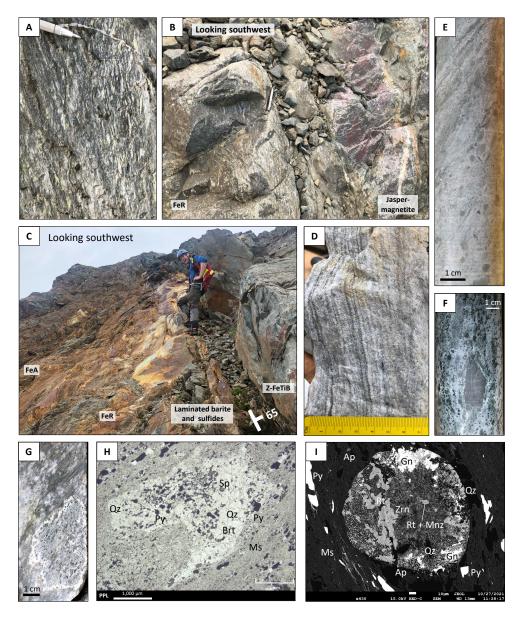


Fig. 2.5 Photographs (A-C; E-G) and microphotographs (H-I) of the ferrorhyolites (FeR). (A-B) At East AG, the FeR lapilli tuff is foliated and contains lighter-colored fiamme-like lapilli in a magnetic, dark grey matrix. A bed of jasper-magnetite conformably overlies the FeR. (C-D) The JAG prospect consists of upright, steeply north-dipping massive barite with minor laminations of pyrite, sphalerite, galena, and sulfosalts (hand sample shown in D). The exhalative-style VMS mineralization is underlain by strongly hydrothermally altered ferrorhyolites (FeR) and ferroandesites (FeA) and is overlain by Zone FeTi basalt (Z-FeTiB) flows. (E) FeR lapilli tuff grading into laminated tuffaceous facies. (F) Subround to subangular glassy felsic lapilli altered to chlorite supported in a muscovite-quartz-chlorite-magnetite matrix (devitrified tuff?). (G) Pumice (?) clast reaction rim around ragged margins contains abundant amygdules (?) composed of galena, sphalerite, and sulfosalts. Patchy barite and very fine-grained muscovite-pyrite replace the tuffaceous matrix. (H) Microphotograph in plane-polarized light (PPL) of the FeR lapilli tuff in PPL showing a wispy clast with cuspate and winged margins. The clast is predominantly quartz with minor muscovite and contains barite, sphalerite, and pyrite. The matrix surrounding the clast comprises very fine-grained, aligned muscovite (defining foliation), disseminated pyrite, and minor quartz. (I) Back scattered electron (BSE) image of a 150 μ m globular feature ("globule") composed of anhedral masses and symplectic intergrowths of rutile, zircon, and monazite in the FeR. Abbreviations: Qz = quartz, py = pyrite, sp = sphalerite, ms = muscovite, brt = barite, ap = apatite, zrn = zircon, mnz = monazite, rt = rutile.

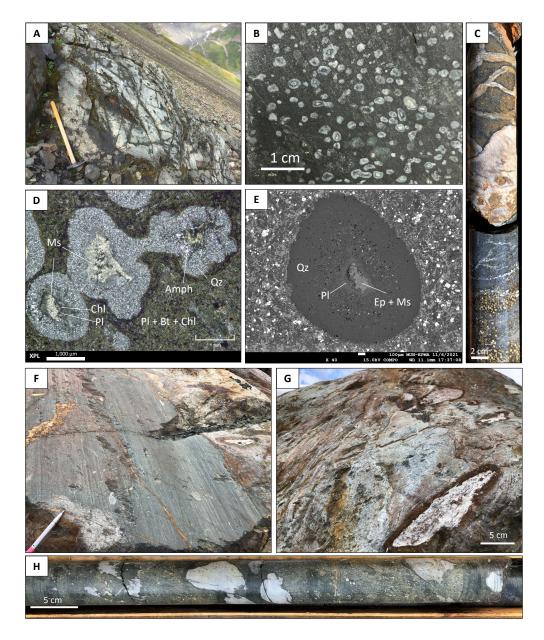


Fig. 2.6 Photos of the Zone FeTi basalts (Z-FeTiB) (A-E) and associated heterolithic fragmental rocks (F-H). (A) Variolitic, pillowed basalt flows of the Z-FeTiB in outcrop northeast of the JAG prospect. Some pillows have iron carbonate cores. (B) The varioles are concentrically zoned, 1–5 mm, leucocratic features composed of quartz and muscovite (C) Jigsaw-fit monomictic breccia texture at a pillow margin. The interpillow space is quartz with some magnetite and iron carbonate. Iron carbonate overprints the Z-FeTiB here. Varioles are composed of quartz, muscovite, and iron carbonate. (D) Microphotograph in cross-polarized light (XPL) of larger, coalescing varioles that have cores of plagioclase variably replaced by albite, muscovite, epidote, chlorite, amphibole, and biotite. The outer rims of the varioles are composed of recrystallized quartz (E) Back scattered electron (BSE) image of a variole with well-defined zoning from the plagioclase (partially replaced by epidote and muscovite) core. (F) Heterolithic fragmental with varied clasts, including pale grey, siliceous rhyolite(?), gossan patches, and barite clasts. (G) Close-up of oval-shaped massive barite clasts rimmed with magnetite and iron carbonate and set in a chloritic matrix. (H) Subround to ragged white, siliceous (felsic? Chert?) clasts and green (mafic?) lapilli supported in a green, chlorite- and carbonate-altered matrix. Abbreviations: Qz = quartz, pl = plagioclase, amph = amphibole, ms = muscovite, bt = biotite, chl = chlorite, ep = epidote.

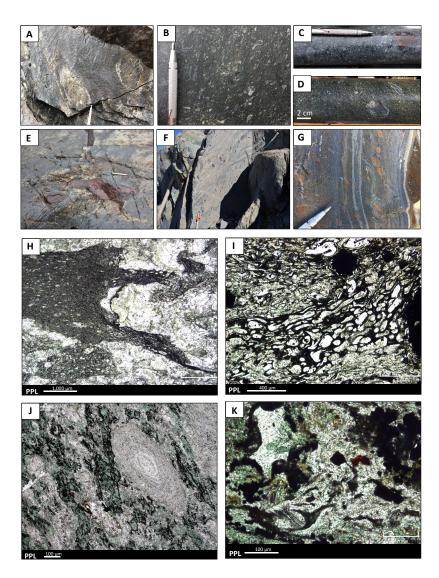


Fig. 2.7 Outcrop (A, B, E-G) and drill core (C-E) photographs and microphotographs (H-K) of the hangingwall FeTi basalts (HW-FeTiB). The laminated facies with sparse lapilli are shown in F-G and I-K. (A) Rounded bombs of basalt with distinct reaction rims on their margins supported in a tuffaceous basalt matrix. (B) Lapilli-rich facies with abundant cuspate particles. (C) Some grey basalt lapilli have relict plagioclase phenocrysts and are amygdaloidal. Some basalt clasts have jasper alteration. (D) Crystal-rich (plagioclase) lapilli tuff facies. (E) Fluidal clast of basalt altered to jasper and magnetite supported in a chloritic matrix. (F) Strongly quartz, muscovite, and magnetite-altered laminated tuffs with sparse lapilli that are wholly altered to magnetite. (G) Strongly chlorite-, iron carbonate- and magnetite-altered laminated tuffs with sparse lapilli. (H-K) Microphotographs (PPL) of different pyroclastic particles in the HW-FeTiB. (H) Scoriaceous lapilli with fiamme-like ("flame-like") textures. Lapilli are outlined by opaque magnetite. The tuffaceous matrix comprises aggregates of recrystallized very fine-grained calcite, quartz, ankerite, and chlorite with disseminated magnetite, rare pyrite, and chalcopyrite. (I) Stretched and deformed tube scoria fragments that resemble reticulite ("thread-lace scoria") with a honeycomb texture. Groundmass of scoria is mainly FeTi oxide minerals. Amygdules are quartz with minor muscovite. The matrix is very fine-grained muscovite, quartz, and chlorite. (J) An oval-shaped accretionary lapilli (2.8 mm long) has alternating quartz-rich and muscovite-rich layers that create a concentric zoning pattern. Matrix is recrystallized tuffaceous material composed of magnetite- and chlorite-rich domains and quartz-, calcite-, and muscovite-rich domains. (K) A Y-shaped shard composed of very fine-grained magnetite. The matrix is a mix of quartz, chlorite, magnetite, muscovite, and carbonate with patches of brown, grungy material. Some oxidized FeTi oxide minerals have a reddish-brown hue in PPL.

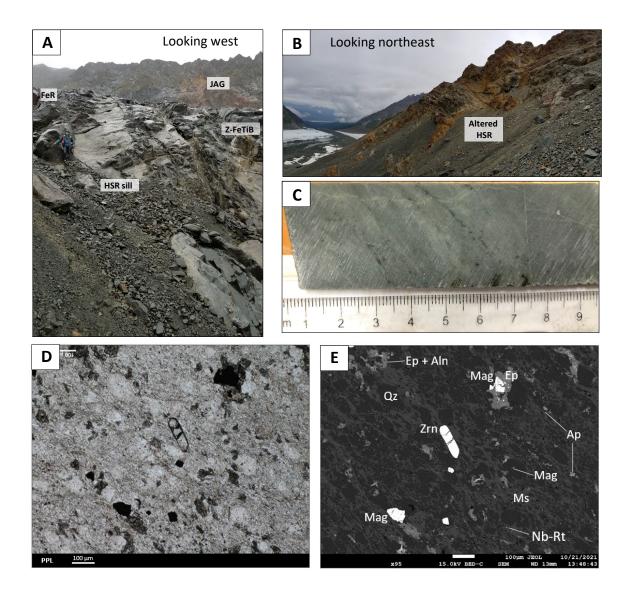


Fig. 2.8 Outcrop photographs (A-B), hand sample photograph (C), and microphotographs (D-E) of the FIIIb high-silica rhyolites (HSR). (A) At East AG, a 15 m thick HSR sill intrudes the contact between the Z-FeTiB and underlying FeR and FeA. (B) West AG has the most extensive exposure of HSR and consists of rusty-colored, rounded, bluff-forming outcrops that dominate the hillside. (C) Hand sample photograph of the massive HSR. (D-E) Microphotographs of the same area in PPL (D) and a backscattered electron image (BSE) image (E). A euhedral zircon crystal is within a groundmass of muscovite grains woven around rounded quartz domains (quartz eyes?) and disseminated epidote. Epidote locally has allanite cores (brighter in the BSE image) with Ce, La, and Nd spectra. Apatite and magnetite are accessory phases, and rare rutile grains with Nb spectra are disseminated. Abbreviations: Qz = quartz, ms = muscovite, mag = magnetite, ap = apatite, zrn = zircon, ep = epidote, aln = allanite, Nb-rt = rutile with Nb EDS spectra.

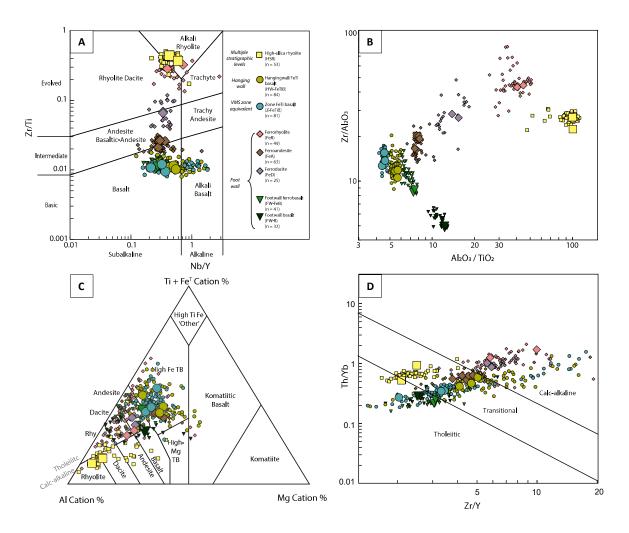


Fig. 2.9 Major and trace element discrimination plots for the mafic and felsic rocks of the AG stratigraphy. The largest symbols are the least altered samples, and rocks are color-coded by geochemical affinity. (A) The modified Winchester and Floyd (1977) volcanic rock discrimination diagram (Pearce, 1996). (B) Al_2O_3/TiO_2 versus Zr/ Al2O₃ ratios define eight geochemically distinct volcanic units. (C) The Jensen (1976) cation plot for classifying subalkaline rocks; TB = tholeiitic basalt. (D) Magmatic affinity diagram of Ross and Bédard (2009) modified from concepts in Maclean and Barrett (1993) and Barrett and MacLean (1999).

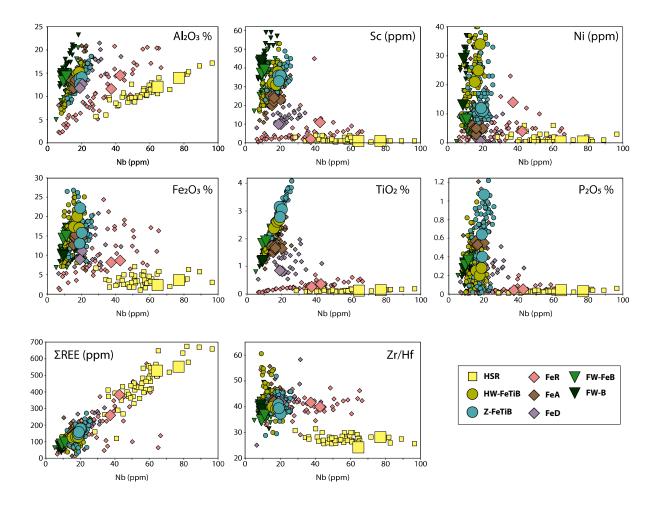


Fig. 2.10 Variation diagrams of Nb versus selected major and trace elements for the AG volcanic rocks.

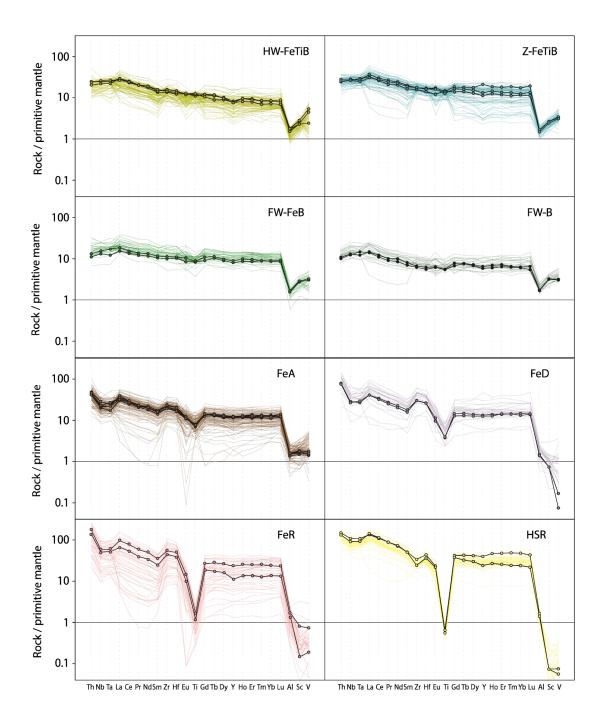


Fig. 2.11 Multi-element primitive mantle normalized plots for the eight volcanic units. The least altered samples are presented as bold lines with dots. The more altered samples are shown as thin-colored lines. Samples within each geochemical unit have parallel multi-element patterns that can be offset due to mass balance changes associated with the alteration. Note the REE mobility of some intensely altered samples as evidenced by the swooping, U-shaped LREE patterns. The normalizing factor is the primitive mantle (pm) from Sun and McDonough (1989).

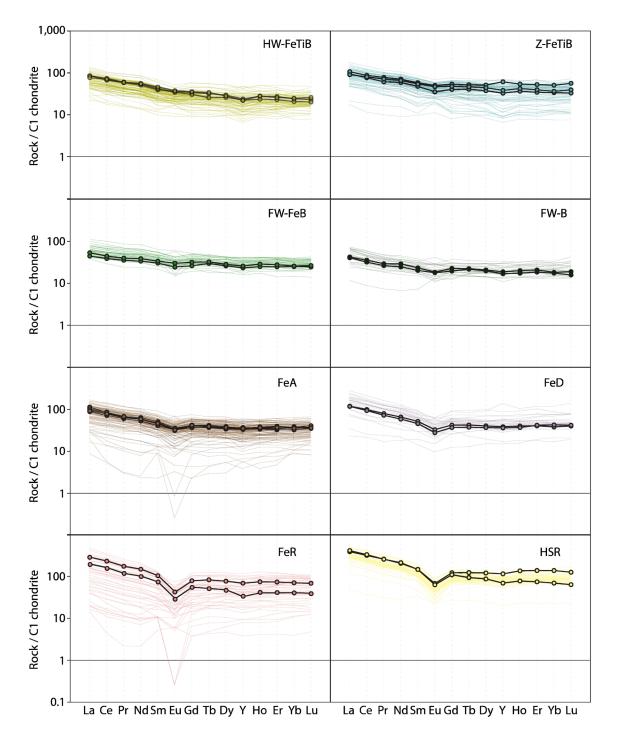


Fig. 2.12 Rare Earth element (REE) chondrite normalized plots for the eight volcanic units. The least altered samples are presented as bold lines with dots. The more altered samples are shown as thin-colored lines. The FeD, FeR, and HSR have strong negative Eu anomalies. Intensely altered samples have extreme negative Eu anomalies and mobile REE, especially LREE. The normalizing factor is the C1 chondrite (cn) from Sun and McDonough (1989).

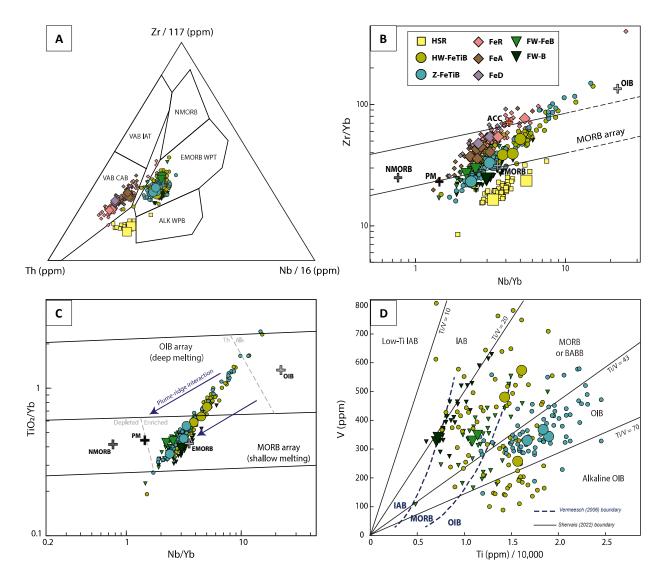


Fig. 2.13 Tectono-magmatic plots (A-D). (A) Th-Zr-Nb plot by Rollinson (1993; p. 182-185) after Wood (1980). (B) Nb/Th versus Zr/Nb (Condie, 2005). Vectors indicate the effects of subduction zone component (SZ) and batch melting (F). Isotopic mantle reservoirs EM2 and HIMU are from Condie (2005). (C) Nb/Yb versus TiO₂/Yb (Pearce, 2008) (D) The Ti-V basalt discrimination diagram of Shervais (2022) after Shervais (1982). The modified boundaries of Vermeesch (2006) are shown as dark blue dashed lines and labeled in dark blue in the lower left corner near the origin. Reference earth reservoir values are shown as crosses on some plots and include normal midocean ridge basalt (NMORB), enriched MORB (EMORB), and ocean island basalt (OIB) from Sun and McDonough (1989). Abbreviations: VAB - volcanic arc basalt; IAT - island arc tholeiite; CAB - calc-alkaline basalt; WPT – within plate tholeiite; WPB – within plate basalt; BABB – back-arc basin basalt; IAB – island arc basalt.

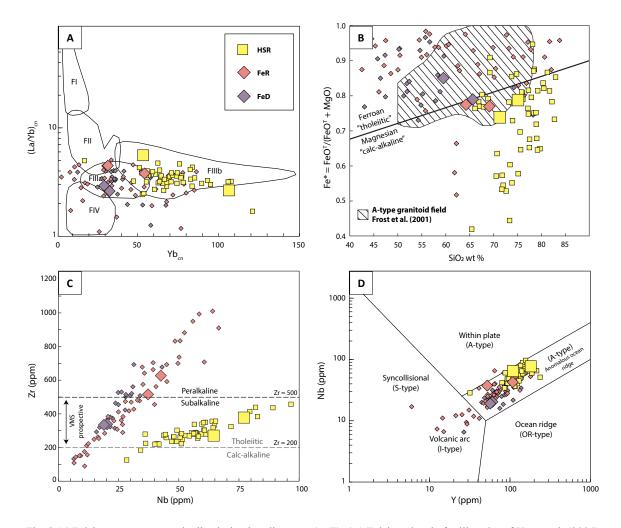


Fig. 2.14 Felsic tectono-magmatic discrimination diagrams (A-E). (A) Felsic volcanic fertility plot of Hart et al. (2004), where cn denotes chondrite-normalized values from Nakamura (1974). (B) The Fe* versus SiO₂ granitoid plot of Frost et al. (2001), showing the boundary between ferroan (tholeiitic) and magnesian (calc-alkaline) granitoids and the field for A-type granitoid rocks. (C) The Nb versus Zr VMS-prospective felsic diagram after Leat et al. (1986) and Piercey (2010). VMS-hosting felsic volcanic rocks are characterized by higher concentrations of HFSE (e.g., Zr > 200). Generally, tholeiitic felsic magmas have Zr between 200–500 ppm, and calc-alkaline felsic magmas have Zr < 200 ppm (Lentz, 1998). (D) The Y versus Nb granite discrimination diagram of Pearce et al. (1984b).

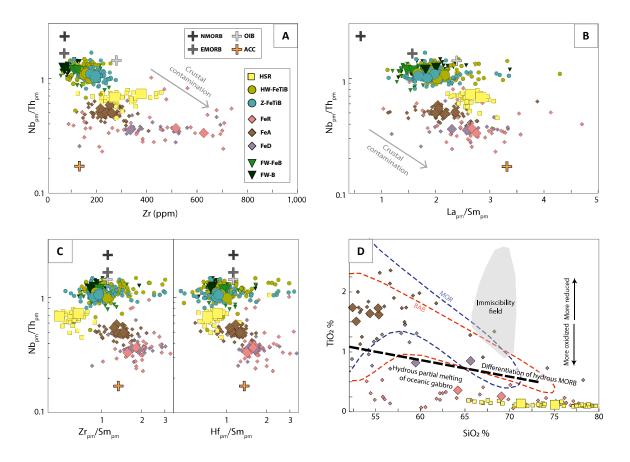


Fig. 2.15 Zr versus Nb_{pm}/Th_{pm} (A) and La_{pm}/Sm_{pm} versus Nb_{pm}/Th_{pm} (B) after Piercey et al. (2006) and Ordóñez-Calderón et al. (2016), indicating that crustal assimilation was minor for the FeTi basalts, but more significant for the silicic rocks. (C) Zr_{pm}/Sm_{pm} and Hf_{pm}/Sm_{pm} versus Nb_{pm}/Th_{pm}, showing that the Fe-rich silicic suite rocks have Zr and Hf enrichments relative to Sm. The HSR Hf_{pm}/Sm_{pm} values are like the basalts but have anomalously low Zr_{pm}/Sm_{pm}. For A-C, reference earth reservoir values are shown as crosses. Normal midocean ridge basalt (NMORB), enriched MORB (EMORB), and ocean island basalt (OIB) are from Sun and McDonough (1989). The average continental crust (ACC) is from Rudnick and Gao (2014). (D) SiO₂ versus TiO₂ plot of Koepke et al. (2007). The black dashed line marks the boundary between fields for Si-enriched volcanic melts experimentally derived from hydrous partial melting of oceanic gabbro versus those from fractional crystallization of hydrous MORB under oxidizing conditions. The field for Si-rich melts generated by liquid immiscibility is also shown. The fields for mid-ocean ridge (MOR) and back-arc basin (BAB) are from Koepke et al. (2007) and were constructed based on samples of Si-rich volcanic glasses collected from these settings.

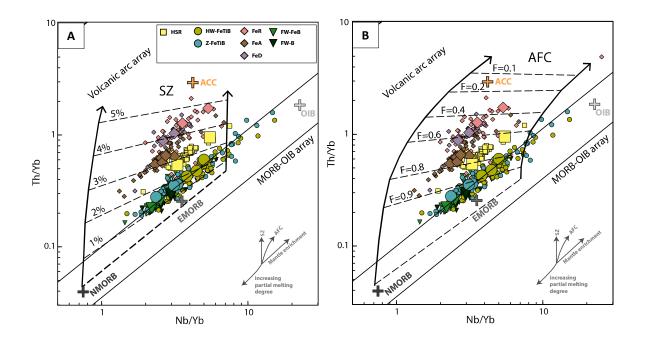


Fig. 2.16 Nb/Yb versus Th/Yb plots assessing magmatic differentiation trends and showing petrogenetic vectors (Pearce, 2008). (A) Vectors indicating the addition of subduction zone components (SZ) are given as a percentage. (B) Vectors indicating assimilation fractional crystallization (AFC) where F is the fraction of melt remaining after AFC based on r = 0.3 (assimilation rate relative to the crystallization rate). Reference earth reservoir values are shown as crosses. Normal midocean ridge basalt (NMORB), enriched MORB (EMORB), and ocean island basalt (OIB) are from Sun and McDonough (1989). The average continental crust (ACC) is from Rudnick and Gao (2014).

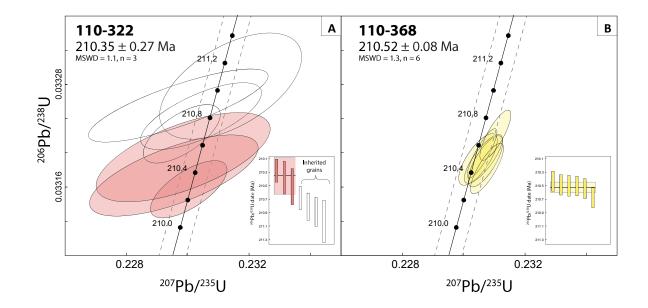


Fig. 2.17 Concordia diagrams displaying CA-ID-TIMS U-Pb dates from zircon grains in the felsic rocks of the AG stratigraphy. (A) FIIIa ferrorhyolite lapilli tuffs that underlie heterolithic fragmental rocks and are along strike of exhalative VMS mineralization. (B) Massive FIIIb high-silica rhyolites that intruded the ferroandesites (FeA) downhole of the ferrorhyolites. See Figs. 2.3 and 2.4 for sample locations. Colored ellipses and bars represent analyses used to calculate the weighted mean $^{206}Pb/^{238}U$ date. Each ellipse has uncertainties plotted at the 2σ error level. Dashed grey lines show the error due to the uncertainties in the U decay constants. Inset panels show the results of each single grain analysis and their 2σ error as vertical bars; the calculated weighted mean $^{206}Pb/^{238}U$ date is indicated by the horizontal solid black line and derived from the grains marked by colored bars; grains interpreted to be inherited in the FeR were not used to calculate the weighted mean $^{206}Pb/^{238}U$ date; the colored box behind the error bars indicates the weighted mean date. MSWD = mean square of the weighted deviates; n = the number of grains used to calculate the weighted mean $^{206}Pb/^{238}U$ date.

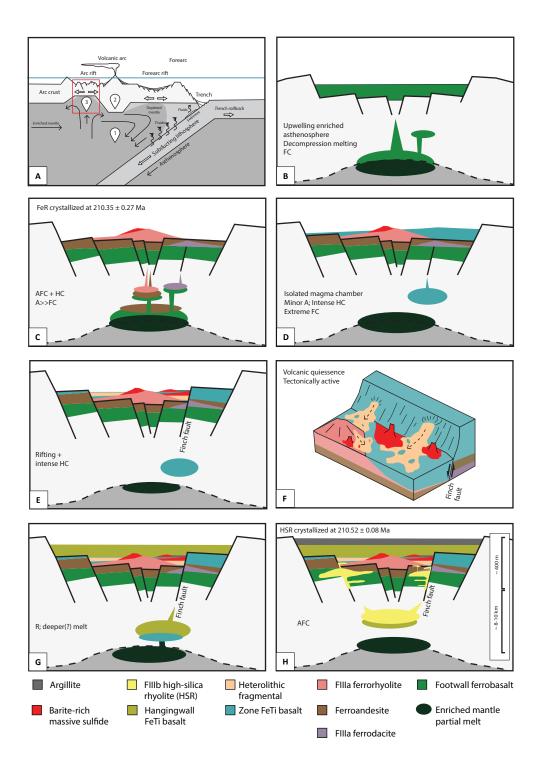


Fig. 2.18 Idealized schematic illustrating the tectono-magmatic evolution of the AG volcanic sequence (A-H). See text for details. (A) Schematic of an intra-oceanic island arc system after Stern (2010) and Hawkins (2003) showing melt generation in the metasomatized mantle wedge (1), within the arc crust (2), and at shallower levels in an unorganized rift basin beneath attenuated arc crust (3). The arc rift basin may eventually evolve to become a back-arc basin with true seafloor spreading. The red outline denotes the area represented by B-E and G-H. Abbreviations: A = assimilation, FC = fractional crystallization, R = replenishment, HC = hydrothermal circulation.

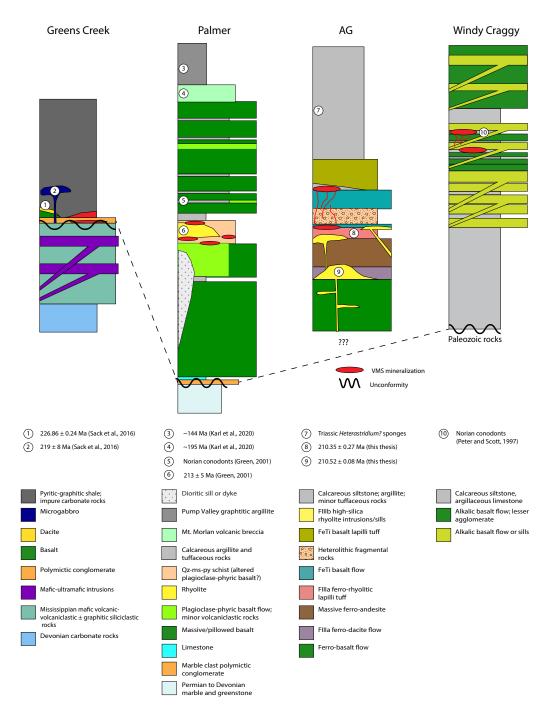


Fig. 2.19 Generalized stratigraphic columns of Greens Creek (unknown thickness), Palmer (~1,500–2,500 m), AG (~400 m), and Windy Craggy (~3,100–5,700 m). Data for Greens Creek are from Steeves (2018) and Sack et al. (2016); data for Palmer are from Green (2001), Steeves et al., (2016), Proffett (2019), and Karl et al. (2020); data for AG are from this study; data for Windy Craggy are from Peter and Scott (1997) and Peter et al. (2014).

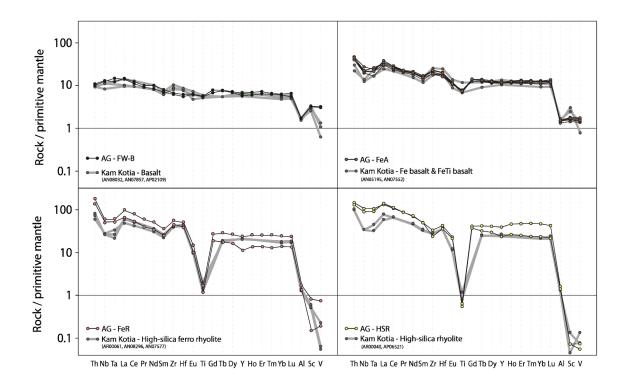


Fig. 2.20 Comparison of the multi-element primitive mantle normalized signatures of some volcanic samples from the Kam Kotia mine (Kamiskotia VMS camp; Upper Blake River Group) and some of the least altered samples in the AG volcanic stratigraphy. Kamiskotia samples are from Barrie and Pattison (1999), and sample ID labels are given on the plots. Primitive mantle (pm) values are from Sun and McDonough (1989).

Chapter 3. Summary and future research

The Late Triassic, bimodal-mafic polymetallic AG VMS deposit is hosted by FIII-type rhyolites and FeTi-rich basalts. The availability of a robust geochemical dataset (>800 whole rock geochemical samples) for the host rocks to the AG VMS deposit provided a unique opportunity to apply lithogeochemical methods to understand how its host volcanic succession formed. The integration of volcanic stratigraphy and lithogeochemical observations allowed for a greater understanding of the interplay between the magmatic, tectonic, and hydrothermal processes that formed the AG deposit. Furthermore, U-Pb geochronologic data has constrained the timing of VMS formation.

The major conclusions from this study include:

- (1) Based on empirical diagrams, fractionation trends of the least altered samples, ratios of HFSE, and primitive mantle and chondrite normalized signatures, there are at least eight geochemically distinct volcanic units hosting the AG deposit that are grouped into four distinct magmatic suites: the footwall basalt suite (FW-B and FW-FeB), the Fe-rich silicic suite (FeA, FeD, and FeR), the FeTi basalt suite (Z-FeTiB and HW-FeTiB) and the high silica rhyolite suite (HSR). These geochemically defined magmatic suites are highly correlated with stratigraphic position allowing for chemostratigraphic reconstruction of the AG volcanic succession.
- (2) From the base to the top of the stratigraphic section, the volcanic succession that hosts the AG deposit includes: (i) EMORB-like effusive pillowed flows of tholeiitic basalts, (ii) effusive flows of ferroandesites (FeA) and FIIIa ferrodacites (FeD), and FIIIa ferrorhyolite lapilli tuffs (FeR); all that have hybrid tholeiitic-calc-alkalic geochemical

signatures, (iii) pillowed flows of tholeiitic, FeTi-rich, variolitic basalts (Z-FeTiB) that are locally intercalated with heterolithic fragmental rocks, (iv) pyroclastic deposits of tholeiitic, FeTi-rich, basalts (HW-FeTiB). The volcanic succession is intruded by FIIIb high-silica rhyolite (HSR) syn-volcanic sills that occur at multiple stratigraphic levels.

- (3) The footwall basalts formed by decompression melting of enriched asthenosphere and evolved by tholeiitic fractional crystallization. The Fe-rich silicic rocks were derived from ferrobasaltic magmas that assimilated partially melted arc crust and evolved by AFC processes. The Z-FeTiB formed by extensive tholeiitic fractional crystallization with minor crustal contamination. The HW-FeTiB are interpreted to be the products of pyroclastic eruptions triggered by magma recharge in a crustal magma chamber. The FIIIb HSR were derived from partially melted mafic arc crust and evolved further by fractional crystallization.
- (4) Most of the AG deposit formed following the emplacement of the FIIIa FeR, followed by the Z-FeTiB and heterolithic fragmental rocks. The Finch fault is an important synvolcanic structure that acted as a conduit for hydrothermal fluids and magmas. Most of the AG VMS mineralization is localized along this structure.
- (5) The FeTi basalts and FIIIa FeR are identified as property- to belt-scale exploration targets. The FIIIb HSR sills and pyroclastic HW-FeTiB are locally hydrothermally altered, suggesting that they were also emplaced synchronous with hydrothermal activity and may also be important units to consider in exploration.

- (6) The rocks hosting the AG VMS deposit probably formed in a propagating oceanic intra-arc rift associated with high temperature (T > 900°C), shallow-level (<10 km from surface) magmatism where the development of synvolcanic structures, partial melting of enriched asthenosphere, extensive shallow-level crystal fractionation, assimilation of partially melted arc crust, and periodic magmatic replenishment were all important processes.
- (7) The timing of the AG mineralization is constrained by two new high-precision CA-ID-TIMS U-Pb geochronology dates from hydrothermally altered FeR and HSR that have interpreted crystallization dates of at 210.35 ± 0.27 Ma and 210.52 ± 0.08 Ma, respectively. The overlapping date ranges suggest that the immediate volcanic host rocks to the AG deposit (FeR, Z-FeTiB, and HSR) were emplaced in less than one million years.

3.1. Directions for future consideration

This study has helped to provide a framework for future studies on other aspects of the AG deposit or for more in-depth studies on topics covered in this thesis. This research has successfully addressed many questions about the AG VMS deposit and, in doing so, has generated even more questions. Potential topics to explore in the future include:

(1) More detailed studies of each unique volcanic unit delineated in this study. Can the origins of the volcaniclastic units (FeR, heterolithic fragmental rocks, HW-FeTiB) be better understood by more detailed volcanic facies mapping? Understanding the origins of the volcaniclastic units would help to further refine the reconstructions of

the basin architecture. No petrographic work was done on the least altered samples of the FeA or FeD. If these are products of mantle-crust interaction, are any petrographic features preserved that would support this? These units immediately precede VMS mineralization at AG, and therefore they merit more detailed geologic descriptions than what was accomplished here. The HSR were interpreted as an intrusive complex, but is there any convincing evidence that some of the HSR could be extrusive? If so, this would have significant implications for how the tectono-magmatic evolution of the AG volcanic sequence is modeled. Sulfide-bearing argillite and exhalites like jasper and chert are spatially associated with VMS mineralization. What are their geochemical signatures like? What do these signatures tell us about their provenance and for the exhalites, the hydrothermal systems they originated from? How do their signatures compare to exhalites or metalliferous sedimentary rocks in other VMS districts?

(2) Application of chemostratigraphic and volcanic facies mapping studies to the larger AG deposit area. The stratigraphy on the Nunatak panel is parasitically folded and disrupted by several faults. Can the chemostratigraphic patterns of the JAG panel be used to unravel the complexities of the Nunatak panel? Within the general AG deposit map area, rocks in some outcrops remain undifferentiated and could be classified with the help of lithogeochemical investigations. Geochemistry in the West AG area has defined important units (HSR, FeR); perhaps the strongly altered volcanic stratigraphy in this area can be better mapped at the surface, knowing where some of these units occur. To the south of the JAG prospect, Z-FeTiB have been sampled in contact with exhalites like jasper. Could this bed of Z-FeTiB represent a limb of a north-closing anticline related to the deposit-scale syncline? AG West and AG East have prospective units (HSR and FeR at AG West; FeR, HSR, and Z-FeTiB at AG East) that merit targeting with drill programs.

- (3) More detailed alteration studies could help to map out alteration facies, identify fluid pathways, and unravel the geometry of the alteration zones (stinger, pipe, semi-concordant zone). These studies may help further refine the volcanic architecture model by highlighting vent sites. Furthermore, understanding the chemical reactions that produce alteration mineral assemblages and then quantifying the intensity and extent of the alteration to provide insight into the siting and style of the VMS mineralization and act as guides exploration efforts.
- (4) Additional geochronologic studies. Dating the HSR sill at East AG that intruded the Z-FeTiB could provide a capping age of VMS mineralization. There are minor intermediate to felsic tuffs intercalated with sedimentary rocks above the HW-FeTiB that could also give a capping age of VMS mineralization. Acquiring high-precision U-Pb dates from zircons in these units may help to constrain how long it took for the AG VMS deposit to form. One rare sub-micrometer zircon was observed in a variole in the Z-FeTiB, so this unit is also a possible candidate for U-Pb dating. Re-analyzing the RW rhyolite in the Palmer deposit using modern U-Pb geochronology techniques, like CA-ID-TIMS, may help show if the AG and Palmer deposits are coeval or if VMS mineralization occurred at different times within the Palmer property stratigraphy.
- (5) Application of chemostratigraphic and volcanic facies mapping studies to the entire Palmer property. Including the AG area, the Palmer property whole rock

lithogeochemical database includes ~ 2,700 samples analyzed by the same modern analytical techniques at the ALS laboratory in Vancouver (ALS code CCP-PKG03). Lithogeochemical studies at AG were critical to identify geochemically unique units, to recognize genetically related units, and to reconstruct the volcanic stratigraphy. The insights from this work could be used to train and test all other data on the property using machine learning methods. This may reveal what other types of rocks occur in the Triassic stratigraphy and if any volcanic successions at nearby prospects resemble the AG host stratigraphy. This could help to determine if VMS mineralization is confined to one stratigraphic level, or multiple. Using these insights could inform where to drill next to target new VMS mineralization or expand known VMS mineralization.

(6) Updated belt-scale studies that incorporate the insights gleaned from this thesis. Are FeTi basalts, FIIIa ferrorhyolites, and FIIIb high-silica rhyolites observed elsewhere in the ATMB? Can these belt-scale studies be used to identify potential VMS targets in the ATMB? **Appendix 1. Supplementary photographs of the AG deposit geology**

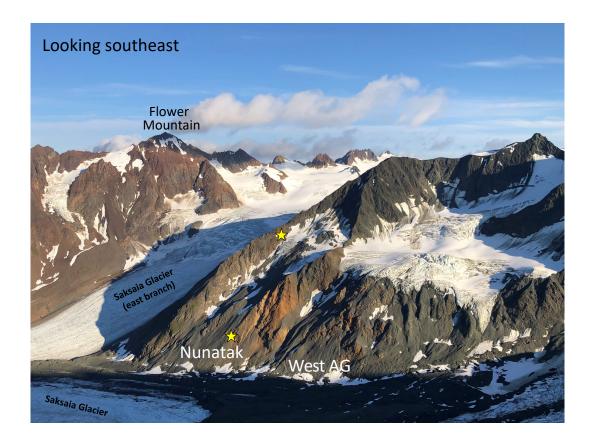


Fig. A1. 1 The AG deposit area (looking southeast). The yellow stars show the location of the Nunatak prospect (labeled) and the western continuation of the JAG prospect.

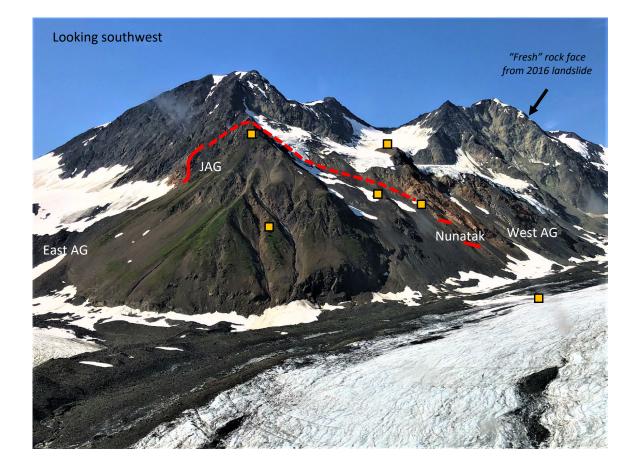


Fig. A1. 2 AG deposit area. Orange squares depict drill pad locations. The red line is the exhalative mineralization (solid) trace and concealed or equivalent stratigraphy to the mineralized zone (dashed).

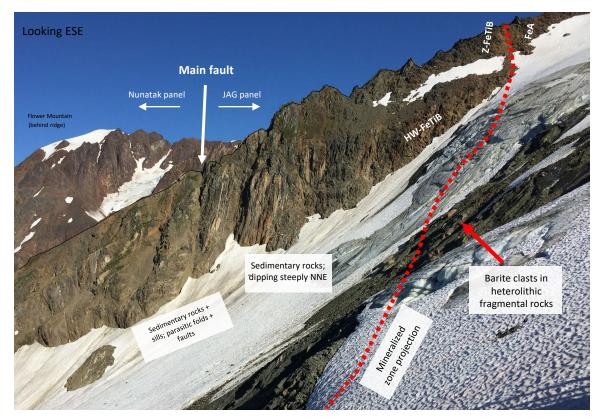


Fig. A1. 3 Ridgeline with exposures of folded and faulted sedimentary rocks in the capping sequence. The Main fault divides the Nunatak panel (north of the fault) from the JAG panel (south of the fault). Barite-clast-bearing heterolithic breccias are exposed in the glacially polished outcrops between glacial ice and talus and along strike of the Z-FeTiB.



Fig. A1. 4 Close-up photographs of the Main fault looking to the southeast.

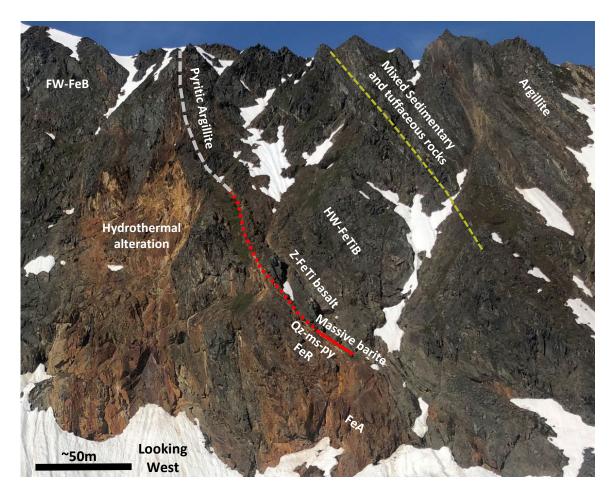


Fig. A1. 5 The JAG prospect geology.

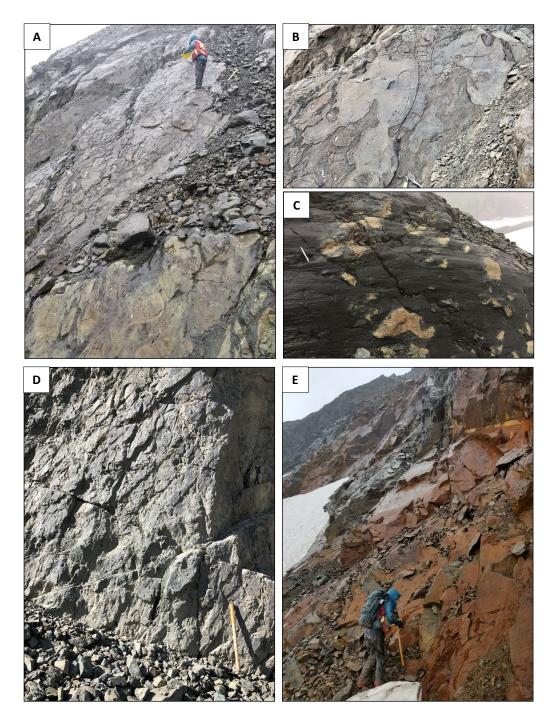


Fig. A1. 6 Outcrop photographs of coherent volcanic units in the stratigraphic footwall (A-E). (A-B) Pillowed ferrobasalts (FW-FeB) with tops to the north at East AG. Some of the FW-FeB have strong epidote. (C) The pillowed ferrobasalts grade into pillow breccias with pillow fragments that have quartz, chlorite, epidote, and locally garnet-bearing metamorphic assemblages. (D) Pillowed and lobate flows of the ferrodacites (FeD) located in the mapping area's northeast part. Pillowed tops are to the south. (E) Rust-stained cliffs of massive ferroandesites (FeA) in the stratigraphic footwall to the JAG prospect.



Fig. A1. 7 Drill core photograph of ferroandesite (FeA) with sparse feldspar phenocrysts. Sample W813093 in drill hole 112 @ 515.4 m.

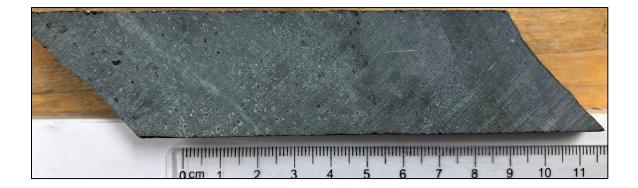


Fig. A1. 8 Drill core photograph of chlorite-altered, amygdaloidal ferroandesite (FeA). Sample W605024 in drill hole 120 @ 330.1 m.

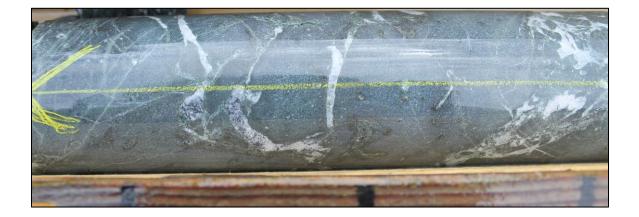


Fig. A1. 9 Drill core photograph of amygdaloidal ferrodacite (FeD). Sample W605516 in drill hole 114 @ 243.9 m.



Fig. A1. 10 Pillowed textures of FeD with intense interpillow chlorite alteration. Photo taken in drill hole 112 @ 539 m.



Fig. A1. 11 High-silica rhyolite (HSR) dykes (pale grey) intrude weakly to moderately sericite- and pyrite-altered FW-FeB (medium to pale green, grey) in drill hole 109 @ 372.5 m. Both the HSR and FW-FeB are intruded by later green dykes.



Fig. A1. 12 Sharp contact between the HSR (paler color) and overlying FeA (darker) in drill hole 134B @ 207.5 m.



Fig. A1. 13 Argillite with rare oval-shaped fossil composed of calcium carbonate that is interpreted to be a Late Triassic sponge called *Heterastridium?* (drill hole 120 @ 87 m).



Fig. A1. 14 Exhalative-style barite-rich massive sulfide mineralization in drill hole 109 @ 206 m. Layers of honey-brown sphalerite contain disseminated sulfosalts and alternate with white, barite-rich layers.



Fig. A1. 15 Replacement-style VMS mineralization in drill hole 110 @ 263.6 m. Blebby honey brown sphalerite and white barite replaced the tuffaceous matrix. Relic lapilli (darker shades) are replaced by very fine-grained sericite and pyrite.

Appendix 2. Petrographic descriptions, microphotographs, and backscattered electron (BSE) images

W605013 – Iron Formation

Sample ID: W605013

Drill hole: CMR18-120 **Drill hole depth (m):** 268.4 m

Rock Name: Jasper-clast bearing massive magnetite **Geochemical Suite**: Chemical sediment/iron formation

Lithofacies and textures:

Clastic

Hand sample description:

60% dark grey vfg-fg massive magnetite. 40% red-white, subangular-subround jasper clasts 1 cm to >3 cm. Jsp clasts have "grainy" textures with vfg-cg 1-3mm, subround-round "grains". Tr cal vfg-fg blebs in clasts.

Petrographic description:

Euhedral grains (0.01-0.1mm) of mag and interstitial hematite with a "shreddy" appearance. Quartz and albite are interstitial. Rare barite and chlorite. Amoeboid jasper clast >2.5cm and composed of qz with up to 15% vfg specks of red translucent (PPL) mineral (Fe-ox?), that likely imparts red hue. Ovoid features within jasper amoeboid are 0.3-1 mm and composed of qz and outlined by mt – perhaps original colloidal gel-like features?

Mineral	Residence	%	Size max (µm)	Habit	Comments
Muscovite	Groundmass	50%	50?	Fibrous, platy	Aligned grains define moderate foliation, interconnected fibrous wisps weave around qz grains. Probably replacing all primary fsp.
Quartz	Groundmass, micropheno (qz-eye), vein	40%	320	Subround, qz- eyes, interstitial	Most grains are 0.05 - 0.1 mm. Some grains are rounded and may possibly be quartz eyes? Some of the more elongate grains are weakly aligned to foliation. Some qz is interstitial to muscovite.
Epidote	Groundmass, vein	5%	220	Subhedral, Tabular, lath, skeletal	Locally twinned crystal growth, up to 0.22mm, dirty appearance in PPL.
Allanite	Cores of epidote crystals	1%	40	Subhedral	Local cores of epidote crystals that mirror epidote crystal shape. Hosting LREE - spectra for La-Ce-Nd observed using the SEM.
Magnetite	Groundmass	1%	100	Euhedral- subhedral, equant	Probe work determined this to be stoichiometric magnetite with lower Ti-V compared to mag in basalt samples. Hydrothermal(?) or igneous (with low Ti-V reflecting low abundances in rhyolitic melt).
Apatite	Groundmass	Trace	20	Anhedral- subhedral	F-bearing spectra.
Zircon	Groundmass	Trace	160	Euhedral	Larger isolated euhedral xls (some cracked) or tiny clusters containing vfg xls.
Chlorite	Qz-eye?	Rare	100	Flakey	Within a qz-eye(?) associated with epidote. Typically, not in muscovite-rich part of groundmass.
Albite	Groundmass	Rare	10	Interstitial	10-micron area between muscovite identified with SEM.
Rutile	Groundmass	Rare	0.1	Anhedral- euhedral, acicular	Main Nb-host. Grains too small to get spectra free from interference (common to see Fe-Si from ep-qz). Vary from acicular to anhedral blebs.





Fig. A2. 1 Hand sample photograph (above) and thin section scan (below) of sample W605013.

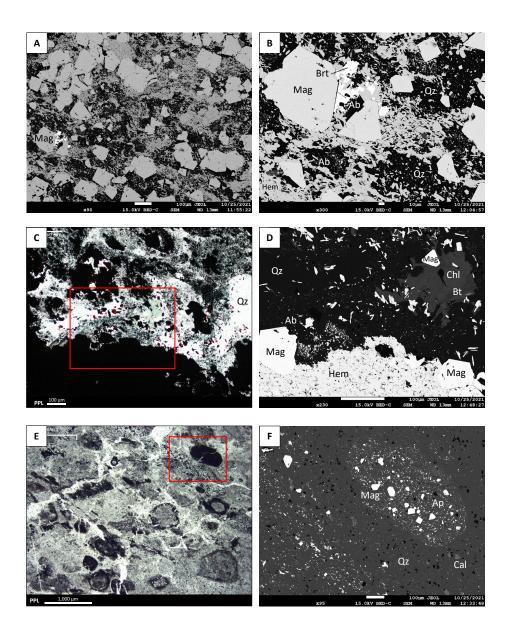


Fig. A2. 2 (A-F) Microphotographs of sample W605013. (A-B) BSE images of massive euhedral magnetite with albite, quartz, and shreddy-textured hematite in between the larger grains. Minor barite along some grain boundaries. (C-D) Edge of massive magnetite section where it contacts more quartz- and jasper-rich section in PPL (C) and an BSE image (D). The red box in (C) is the same area in (D). In PPL, oxidized FeTi oxide mineral (rutile?) are tiny red specks that impart red colour to jasper. (E-F) The jasper-rich section has ovoid features (colloidal gels?) shown in PPL (E) and one ovoid feature (outlined in red box) is shown in an BSE image in (F). The ovoid feature is made up of fine-grained magnetite, quartz, and sparse, very fine-grained apatite.

W605041 - HSR

Sample ID: W605041

Drill hole: CMR18-120 **Drill hole depth (m):** 443.4m

Rock Name: Ms-qz-ep, qz-eye bearing, massive rhyolite **Geochemical Suite:** FIIIb High-silica rhyolite (HSR)

Lithofacies and textures: Massive, foliated Aphanitic, aphyric, qz-eyes (?)

Hand sample description:

Aphanitic light gray massive rhyolite with greenish hue imparted by ep. Sparse discontinuous greenish streaks of ep +/- chl. Tr fg-mg blebs of mt.

Petrographic description:

Groundmass is dominated by wispy vfg muscovite ("sericite") that weaves around vfg-fg qz grains, some of which are rounded and composed of a single qz crystal that may be qz-eyes. All fsp gone to ms, except rare interstitial albite. Epidote is the predominant mafic mineral, commonly skeletal with resorbed crystal edges and locally contains cores of allanite. Apatite is F-bearing.

Vein:

0.02-0.34mm quartz-epidote vein, pinches and swells, contains largest ep crystals

Mineral	Residence	%	Size max (µm)	Habit	Comments
Muscovite	Groundmass	50%	50?	Fibrous, platy	Aligned grains define moderate foliation, interconnected fibrous wisps weave around qz grains. Probably replacing all primary fsp.
Quartz	Groundmass, micropheno (qz-eye), vein	40%	320	Subround, qz- eyes, interstitial	Most grains are 0.05 - 0.1 mm. Some grains are rounded and may possibly be quartz eyes? Some of the more elongate grains are weakly aligned to foliation. Some qz is interstitial to muscovite.
Epidote	Groundmass, vein	5%	220	Subhedral, Tabular, lath, skeletal	Locally twinned crystal growth, up to 0.22mm, dirty appearance in PPL.
Allanite	Cores of epidote crystals	1%	40	Subhedral	Local cores of epidote crystals that mirror epidote crystal shape. Hosting LREE - spectra for La-Ce-Nd observed using the SEM.
Magnetite	Groundmass	1%	100	Euhedral- subhedral, equant	Probe work determined this to be stoichiometric magnetite with lower Ti-V compared to mag in basalt samples. Hydrothermal(?) or igneous (with low Ti-V reflecting low abundances in rhyolitic melt).
Apatite	Groundmass	Trace	20	Anhedral- subhedral	F-bearing spectra.
Zircon	Groundmass	Trace	160	Euhedral	Larger isolated euhedral xls (some cracked) or tiny clusters containing vfg xls.
Chlorite	Qz-eye?	Rare	100	Flakey	Within a qz-eye(?) associated with epidote. Typically, not in muscovite-rich part of groundmass.
Albite	Groundmass	Rare	10	Interstitial	10-micron area between muscovite identified with SEM.
Rutile	Groundmass	Rare	0.1	Anhedral- euhedral, acicular	Main Nb-host. Grains too small to get spectra free from interference (common to see Fe-Si from ep-qz). Vary from acicular to anhedral blebs.



Fig. A2. 3 Hand sample photograph (above) and thin section scan (below) of sample W605041.

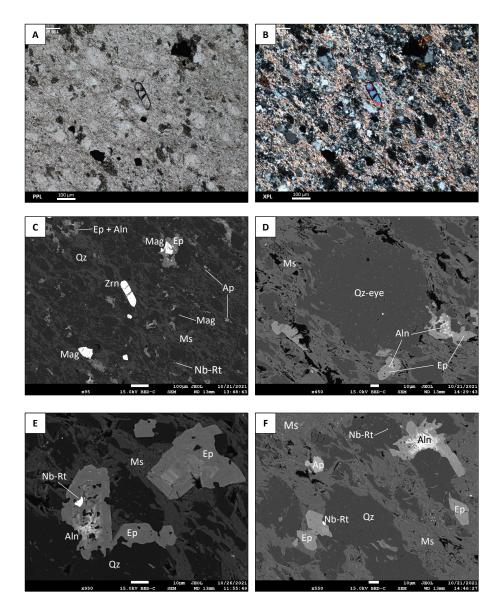


Fig. A2. 4 Microphotographs of sample W605041. (A-C) show the same area in PPL (A), XPL (B) and an BSE image (C). A euhedral zircon crystal is within a groundmass of muscovite with qz-eyes and disseminated epidote. Epidote locally has allanite cores (brighter in BSE image) with Ce, La, and Nd spectra. Apatite and magnetite are accessory phases. Trace Nb-rich rutile grains. (D) BSE image of a quartz eye surrounded by muscovite and quartz. A few epidote crystals have allanite cores. (E) BSE image of epidote crystals with zoned pattern and allanite (brighter shade) interiors. A bleb of rutile with Nb EDS spectra is within the epidote grain. (F) BSE image of muscovite and quartz groundmass with accessory phases of epidote and apatite. A Nb-bearing rutile grain is along the edge an epidote crystal, and another is within a quartz-rich part of the rock. The tiny, bright disseminated specks are zircon, and some are Nb-bearing rutile.

S039314 – HW-FeTiB

Sample ID: S039314

Surface Sample - UTM NAD 83 Zone 8NEasting: 419917 mNorthing: 6581736 m

Elevation: 1436 m

Rock Name: Chl-mag-qz-bt-ms-carbonate, laminated tuff Geochemical Suite: Hangingwall FeTi basalt (HW-FeTiB)

Lithofacies and textures:

Laminated, shards, crossbedding?

Hand sample description:

Laminated basaltic tuff. Dark green, chl- and mag-rich layers alternate w/ beige-tan-pinkish qzand ms-rich layers. One lam w/ purplish hematite. Moderately pervasive fizzy.

Petrographic description:

Laminations are up to 1cm, and there are at least three differentiable compositions.

The dominant laminations are chl- and mag-rich. Chl (55%), qz (15%), mag (10%), bt (5%), carbonate (5%), ms (5%) and trace euhedral py with rare cpy blebs. Py is 0.08-1mm and mag generally less than 0.04mm. Some of the opaque features in PPL look like cuspate, Y-shaped to platy shards.

Creamy pink layers - Qz- and ms-rich layer with minor vfg mag (5%) wisps and patches of vfg brown crud. Minor chl.

Vfg reddish-brown layers: Two layers. One is 5mm and is vfg dark brownish crud (PPL) with 5% qz +/- ms+/- chl subround to subangular features and the other is a 2.1mm lam with wavy, deformed internal structure.

Mineral	Residence	%	Size max (µm)	Habit	Comments
Chlorite	Matrix	55		Anhedral, recrystallized	Recrystallized tuffaceous material?
Magnetite	Matrix, shards	10		Subhedral, euhedral	Some oxidized. Commonly outlines shapes of shards.
Quartz	Matrix	20		Anhedral	
Carbonate	Matrix	5			Recrystallized tuffaceous material?
Biotite	Matrix	5			Vfg cruddy brown material
Muscovite	Matrix	5			Cryptocrystalline
Pyrite	Disseminated	Trace		Subhedral to euhedral	Some spongey w/ ccp inclusions. Commonly rimmed by mag.
Chalcopyrite	Inclusions in py	Rare		Anhedral	Rare blebs as inclusions in spongey py grains



Fig. A2. 5 Hand sample photograph (above) and thin section scan (below) of sample S039314.

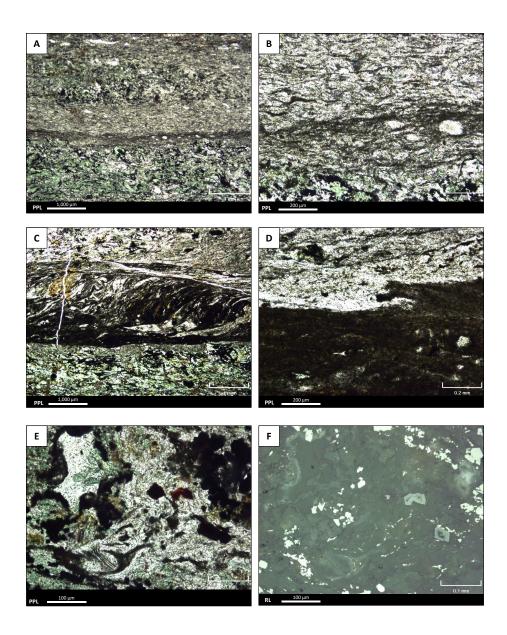


Fig. A2. 6 Microphotographs of sample S039314 (A-F). (A-B) The pinkish, very fine-grained, and smooth layers (middle layer in FOV in A) are composed of quartz, muscovite, and magnetite (PPL). (B) Close up of the pinkish layer with the more chlorite-, magnetite-, and carbonate-rich layer at bottom of FOV (PPL). Opaque minerals are FeTi oxides (probably magnetite) that outline Y-shaped shards. (C) A 2.1mm lamination of the reddish-brown layer with wavy, deformed internal structure that may be crossbedding? The layer below is chlorite rich. (D) Flame-like bedding structure between the quartz- and muscovite-rich lamination (top FOV) and the very fine-grained dark brown layer (bottom FOV). (E-F) Cuspate, 0.15mm Y-shaped shard in chlorite-rich layer is outlined by opaque minerals (FeTi oxides; probably magnetite). The matrix is quartz, chlorite, magnetite, muscovite, and carbonate with patches of brown, grungy material. Some oxidized FeTi oxides are reddish in PPL (E) and darker grey in RL (F).

S039313 - HW-FeTiB

Sample ID: S039313

Surface Sample - UTM NAD 83 Zone 8N Easting: 419917 m Northing: 6581736 m

Elevation: 1436 m

Rock Name: Qz-mag-ms-chl, laminated, tube pumice(?)-bearing basaltic lapilli tuff **Geochemical Suite:** Hangingwall FeTi basalt (HW-FeTiB)

Lithofacies and textures:

Matrix-supported, poorly sorted, tube-pumice(?), scoria(?), shards

Hand sample description:

Laminated tan-brown-pink-orange tuff with 15% diss clots of massive mag up to 1cm. Some laminations are pinkish w/ more concentrated fg mag. Very weak pervasive calcite (fizzy). Some wormy chl-mag veinlets. Weak-mod pervasive very fine-grained muscovite ("sericite").

Petrographic description:

The lighter tan layers are composed of ms-qz with minor chl. Some of these contain abundant cuspate (Y- to X-shaped) and platy shards. The shards were likely originally glassy and are devitrified to vfg FeTi-oxide minerals (magnetite and/or rutile). Layers with a pinkish hue have clusters of cryptocrystalline minerals with a deep reddish-brown hue in PPL. These brownish patches are mainly composed of a mixture of vfg chl-bt-qz and rutile, locally with some ms and dark blebs of glass. The BSE image reveals that rutile locally forms polygonal networks and is filled with qz-bt-chl.

The larger dark clots are predominantly composed of recrystallized, euhedral magnetite grains (commonly with vfg qz inclusions). They have spongey interiors composed mainly of qz, some Fe-Ti oxides and minor muscovite-chl. Lapilli (~3%) contain abundant ovoid qz +/- ms +/- chl +/- carbonate features rimmed by vfg mag. If the ovoid features are amygs, then these are scoria. Some of these abundant-ovoid lapilli between larger mag-clots have a stretched-out, ductile appearance and could possibly be tube-scoria fragments that resemble reticulite ("thread-lace scoria") with a honeycomb texture. These ovoid-rich lapilli commonly warp around margins of the larger mag clots. The groundmass of the lapilli is rutile, mag, qz, chl, ms, apatite and rare epidote, allanite, and albite. The mag clots are likely primary lapilli that are strongly altered and recrystallized. Disseminated cubes of vfg-fg mag throughout all laminations, and especially abundant in the pinkish layers. Larger mag xls are commonly spongey. Magnetite is near stoichiometric endmember with ulvospinel content averaging 0.1 %. Rutile is Nb-bearing.

Mineral	Residence	%	Size max (µm)	Habit	Comments
Quartz	Matrix, clasts, ovoids	40		Anhedral, interstitial	
Magnetite	Clasts, matrix	20	500	Subhedral, euhedral	Recrystallized, spongey cubes in larger clots. In smaller lapilli, finer grained and can be intergrown with rutile and outline ovoid features. Generally stoichiometric, but a few grains have some Ti-enrichment, but not enough to be ilmenite. Some of the mag grains have more hematite-like chemistry at their rims. Possible hem in center of a few ovoids.

Muscovite	Matrix, clasts, ovoids	20		Fibrous	Intergrown w/ chl. Most abundant in matrix but can be in groundmass of lapilli and in ovoid features.
Chlorite	Matrix, clasts	7		Fibrous	
Biotite	Matrix, clasts	5		Fibrous	Intergrown w/ chl-ms.
Rutile	Clasts, matrix	5	20	Anhedral to euhedral	Blebby masses or acicular needles, most common in groundmass of lapilli. Imparts reddish-brown hue (PPL) to parts of tuffaceous matrix where intergrown w/ chl-ms-bt.
Ankerite	Matrix, clasts	1			Interstitial bits in matrix or in clasts.
Calcite	Matrix, clasts	1			Interstitial bits in matrix or in clasts.
Apatite	Clast	Trace			Most common as blebs intergrown w/ rutile in the groundmass of the lapilli surrounding ovoid features
Epidote	Clast	Trace			Rare in groundmass of lapilli
Allanite	Clast	Trace			Rare in groundmass of one lapilli. Has La, Ce, Nd in SEM spectra.
Albite	Clast	Trace			Some interstitial blebs in groundmass of one basaltic lapilli



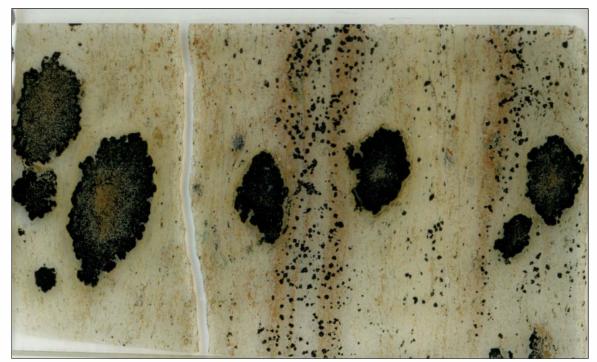


Fig. A2. 7 Hand sample photograph (above) and thin section scan (below) of sample S039313.

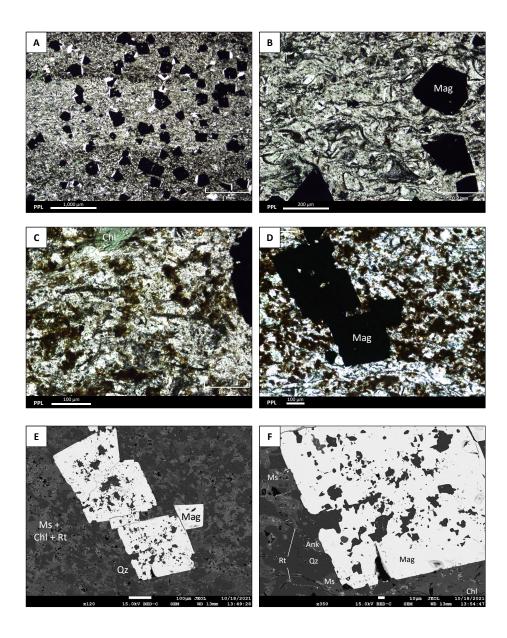


Fig. A2. 8 (A-E) Microphotographs of tuffaceous laminations with disseminated magnetite. (A) Layers with a pinkish hue in hand sample are the top and bottom layers in this FOV and contain more opaque rutile, and the paler tan-colored layer is in the middle and is more quartz- and muscovite-rich (PPL). (B) Cuspate (Y- and X-shaped) shards in the more tan-colored layer. (C-F) Microphotographs of the layers with a more pinkish hue. (C-D) In PPL, this layer has brownish-red patches. (E-F) BSE images reveal that the tuffaceous material is a mixture of very fine-grained rutile needles, muscovite, chlorite, and quartz. Euhedral magnetite crystals are spongey and contain inclusion of matrix minerals, like quartz.

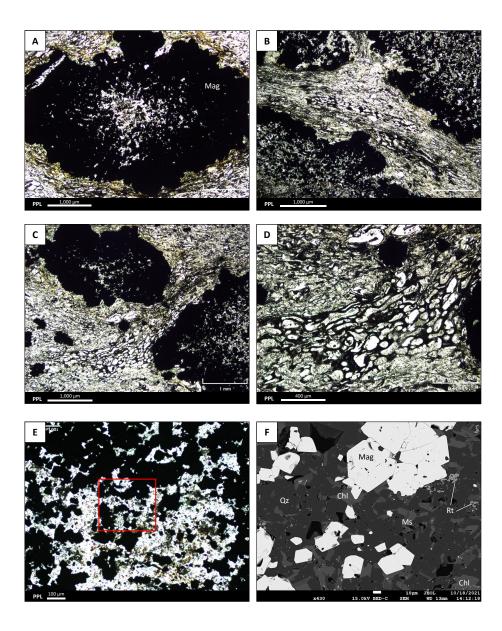


Fig. A2. 9 (A-E) Microphotographs of the larger magnetite-rich clots (likely recrystallized basaltic lapilli). (B-D) Between the larger magnetite-rich clots, there are deformed, stretched-out tuff to lapilli-sized fragments of basaltic material with abundant ovoid features (amygdules?) that may be tube pumice. (E-F) Microphotographs from the center of the magnetite-rich clots. The red box in (E) marks the location of the BSE image in (F). The center of the magnetite clot is composed of quartz, chlorite, and muscovite and has minor clusters of very fine-grained rutile needles.

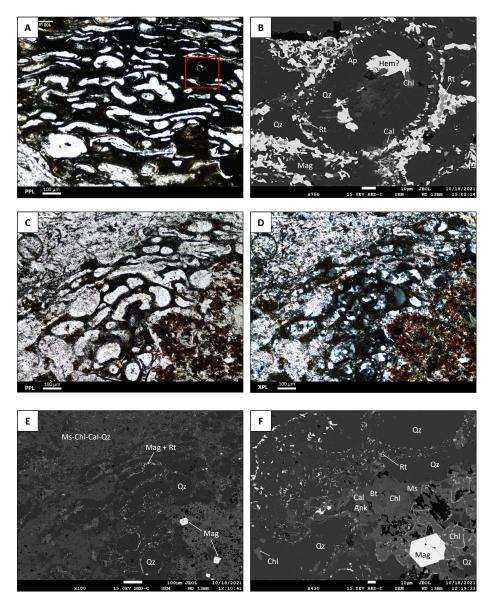


Fig. A2. 10 Microphotographs of some of the lapilli to tuff sized fragments that contain abundant ovoid features (amygdules?). (A) The opaque FeTi oxide minerals are magnetite and rutile with possible rare hematite that outline the ovoid features. The red box in (A) marks the location of the BSE image in (B). (C-D) Microphotographs of the ovoid-rich lapilli within a tuffaceous matrix composed of muscovite, chlorite, and quartz with some calcite. The ovoid features are quartz, and some have muscovite, chlorite. The brown cruddy material (PPL) is composed of very fine-grained intergrown biotite, chlorite, quartz, muscovite, and rutile. The rutile locally forms polygonal networks.

94-31 – HW-FeTiB

Sample ID: 94-31

Drill hole: CMR17-94 Drill hole depth (m): 31 m

Rock Name: Chl-qz-cal-mag basaltic tuff with sparse lapilli and fsp crystals (?) **Geochemical Suite:** Hangingwall FeTi basalt (HW-FeTiB)

Lithofacies and textures:

Tuffaceous-rich, poorly-moderately sorted

Hand sample description:

Fg-mg, green, magnetic, tuffaceous-rich volcaniclastic with 20% chloritic, angular 0.5-2 mm grains, and 10% white, qz-rich, 1-2mm grains in a pale green (ms + chl?) finer-grained matrix. White cal interstitial. Rare dark grey vfg 2mm clast. Trace orange fecarb blebs associated with chloritic parts.

Petrographic description:

Distinguishing clast versus matrix is challenging due to tuffaceous nature of rock that has irregular, recrystallized chl-mag versus qz-ms-carbonate domains. A few convincing lapilli with distinct margins are either mainly qz-ms, or chl-mag (mixed lapilli compositions?) One chl- and mag-rich lapilli has irregular, winged, cuspate margins and a core composed of ankerite. Some mag-chl clasts have interconnected mag that outlines round chl features that could be relic amygs or spherulites. One 2.8 mm oval-shaped lapilli has alternating ms-rich and qz-rich layers that create a concentric zoning pattern reminiscent of armored lapilli. A few domains where shreddy muscovite is concentrated may represent relic pl xls. Magnetite is near stochiometric endmember, ulvospinel content averages 0.1 %. Rutile is Nb-bearing. Some of the muscovite has Ba spectra peak.

Mineral	Residence	%	Size max (µm)	Habit	Comments
Chlorite	Matrix, clasts	40		Anhedral	Anhedral masses of lapilli or tuffaceous patches
Magnetite	Matrix, clasts	10	40	Subhedral, euhedral	Associated w/ chl. Locally outlines lapilli
Quartz	Matrix, clasts	25			Associated w/ ms-carbonate tuffaceous domains. Recrystallized
Calcite	Matrix, clasts	15	100		Associated w/ qz-ms tuffaceous domains.
Muscovite	Matrix, clasts	10			Shreddy patches. Forms layers in the one concentrically zoned lapilli.
Ankerite	Matrix, clasts	Tr	100		Rare within core of chl-mag lapilli. Some blebs in tuffaceous matrix.
Rutile	Matrix, clasts	Tr	20		Disseminated
Apatite	Matrix, clasts	Tr	20		Disseminated
Epidote	Matrix	Tr	10	Subhedral, euhedral	Sparse clusters of xls in matrix



Fig. A2. 11 Hand sample photograph (above) and thin section scan (below) of sample 94-31.

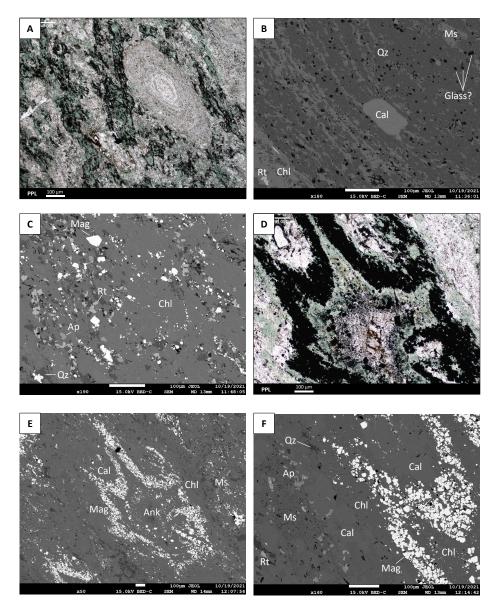


Fig. A2. 12 (A) Oval lapilli (2.8 mm long) has alternating quartz-rich and muscovite-rich layers that create a concentric zoning pattern reminiscent of accretionary lapilli (PPL). Matrix is recrystallized tuffaceous material composed of magnetite- and chlorite-rich domains and quartz-, calcite-, and muscovite-rich domains. (B) BSE image of part of the zoned lapilli showing the alternating quartz-rich and muscovite-rich layers, and larger euhedral calcite grain. The lapilli has abundant, very fine-grained dark blebs (glass?) with mixed Na-Mg-Al-Si-S-K-Ca-Ti-Fe spectra. (C) BSE image of the more mafic, chloritic tuffaceous part of the rock to the left of the lapilli in the FOV of (A). This is chlorite with minor interstitial quartz and disseminated apatite, rutile, and magnetite. (D-F) A chlorite- and magnetite-rich lapilli with irregular, winged, cuspate margins and a core composed of ankerite. Shown in PPL (D) and BSE images at different scales (E-F). Surrounded by mixed calcite, chlorite, muscovite tuffaceous material with disseminated apatite and rutile.

W600919 - HW-FeTiB

Sample ID: W600919

Surface Sample - UTM NAD 83 Zone 8NEasting: 419876 mNorthing: 6581777 mElevation: 1377 m

Rock Name: Cal-qz-mag-chl, fiamme-bearing basaltic lapilli tuff. **Geochemical Suite:** Hangingwall FeTi basalt (HW-FeTiB)

Lithofacies and textures:

Matrix-supported, poorly sorted, juvenile fiamme, monolithic, moderately foliated

Hand sample description:

Matrix-supported lapilli tuff. Matrix is chl, cal, ank. Dark grey lapilli are elongate and aligned (defining foliation), 0.2-2 cm, with ragged edges and fiamme-like shapes. Tr fg py.

Petrographic description:

Matrix is cryptocrystalline calcite, ankerite, qz, chl, with disseminated mag and rare py, and ccp. Clasts are subangular, commonly with ragged margins and fiamme-like shapes, and are aligned along foliation. Clasts have ovoid features (10-30%) that are cal, ms, qz. Groundmass of clasts if mainly vfg cal, qz, mag, and chl. Clasts are probably juvenile.

Mineral	Residence	%	Size max (µm)	Habit	Comments
Calcite	Matrix, ovoid features, replacing phenocrysts	40	500	Recrystallized	Predominant mineral in tuffaceous matrix, recrystallized and intimately intergrown w/ chl and qz. Wholly replaces some relic fsp phenocrysts in lapilli. Common in ovoid features w/ qz.
Quartz	Matrix, ovoid features	20		Recrystallized	Recrystallized in matrix. Ovoid features in lapilli.
Magnetite	Clasts, matrix	20	100	Subhedral	Most abundant in groundmass of clasts. Disseminated in matrix.
Ankerite	Matrix, ovoid features, replacing phenocrysts	10		Recrystallized	Imparts pumpkin-orange colour on weathered surface of hand sample.
Chlorite	Matrix, clasts	10	100	Subhedral, interstitial, fibrous	Aligned along foliation.
Pyrite	Matrix	Rare	10	Bleb	Connected w/ ccp blebs
Chalcopyrite	Matrix	Rare	10	Bleb	

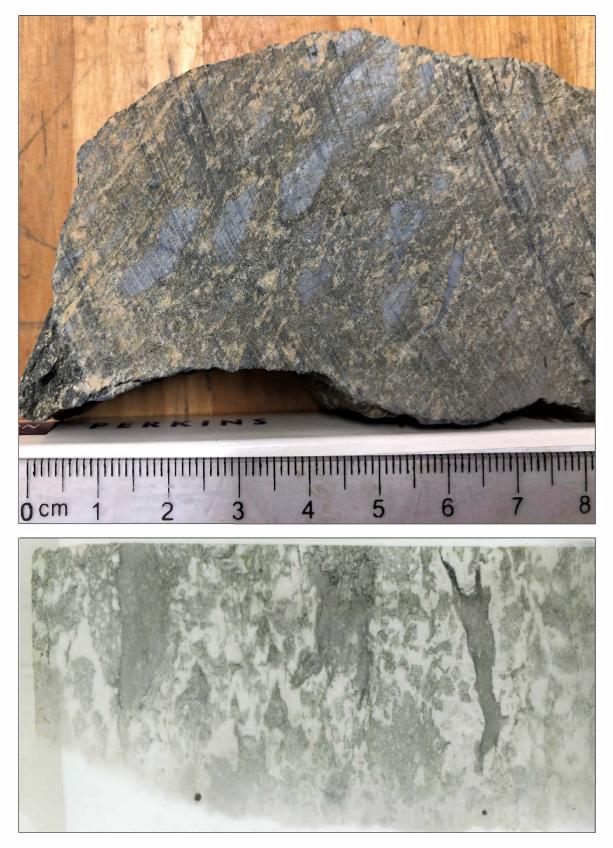


Fig. A2. 13 Hand sample photograph (above) and thin section scan (below) of sample W600919.

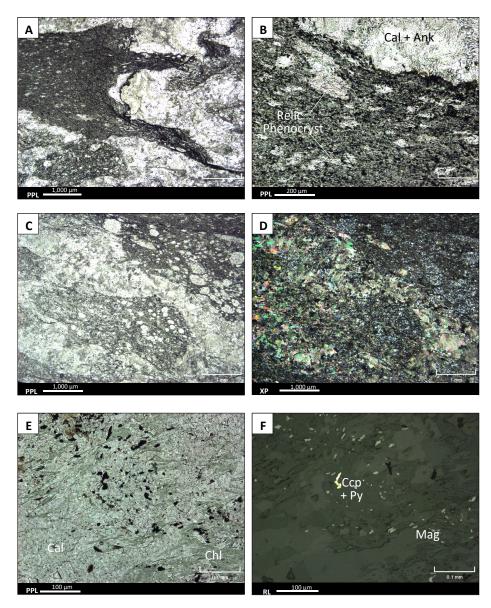


Fig. A2. 14 (A-E) Microphotographs of juvenile fiamme-like basaltic lapilli and associated calcite-rich tuffaceous matrix. Lapilli are outlined by opaque (PPL and XPL) magnetite (A-D) and tuffaceous matrix (A-E) has a dirty appearance and is composed of aggregates of recrystallized very fine-grained calcite, quartz, ankerite, and chlorite with disseminated magnetite and rare pyrite and chalcopyrite.

109-185 – HW-FeTiB

Sample ID: 109-185

Drill hole: CMR18-109 **Drill hole depth (m):** 185 m

Rock Name: Qz-cal-chl-ilm-ap, scoria (?)-bearing, monolithic, poorly sorted basaltic pl-crystalpoor lapilli tuff **Geochemical Suite:** Hangingwall FeTi basalt (HW-FeTiB)

Lithofacies and textures:

Matrix supported, poorly sorted, monolithic

Hand sample description:

White qz-cal fg matrix w/ 25% green-chloritic clasts of basalt, that are 1-10 mm. Clasts have irregular margins including varied cuspate, curviplanar, ragged, and rounded textures. One clast has an appreciably rounded margin on one side and is quite ragged and cuspate on the side. Some clasts have cal-qz ovoid features (amygs?). Some clasts may be original glassy shards. Non-magnetic. Tr vfg py. Matrix supported, poorly sorted, monomictic.

Petrographic description:

Matrix is predominantly calcite-quartz with trace apatite and sparse vfg py. One plagioclase crystal fragment (>1.8mm) at edge of thin section is wholly replaced by qz-ms-cal-chl.

Clasts are volcanic (mafic) up to 1.4 cm. Groundmass of clasts is typically cryptocrystalline with a dirty brownish appearance in PPL. BSE imaging revealed the groundmass of the clasts is composed mainly of vfg ilm, chl, minor apatite and trace ep, ms, and qz. Ilmenite it typically restricted to the clasts. Some clasts have up to 30% ovoid features that are typically 0.1-0.2 mm and composed of chl with minor cal that may be relic amygs or varioles. Some larger ovoid features or amalgamated clusters (up to 1.8mm) are composed of more calcite + qz + chlorite. Rare larger amyg(?) with 0.7mm diameter has mag-(py)-ccp in core surrounded by calcite and then chlorite. Rare perfectly round wholly qz amyg?. Rare lath-shaped pl phenocryst (0.75 x 0.15 mm) in clasts, suggesting clast source is probably pl-phyric basalt. If majority of the chl-qz-carb ovoid features are amyg, then these are scoria clasts.

Mineral	Residence	%	Size max (µm)	Habit	Comments
Calcite	Matrix	35	200	Subhedral- euhedral	Probably recrystallized – aggregates w/ triple junctions.
Quartz	Matrix	30		Interstitial	Throughout matrix or replaces pl phenos
Chlorite	Clasts, matrix	20	100	Subhedral- anhedral, masses or fibers	Predominant in clasts, minor amounts in matrix. Some fibers are elongate, lath shaped. In ovoid features, chl is anhedral masses.
Ilmenite	Clasts	10	20	Subhedral, euhedral, acicular	Opaque (PPL) part of clasts is composed of vfg interconnected needles of ilmenite. In places, these trains of ilmenite outline the chl- qz-carbonate ovoid features
Apatite	Clasts, matrix	2	20	Anhedral- subhedral, blebs	Interconnected vfg xls in groundmass of clasts. Tr blebs in matrix.
Muscovite	Pl crystals, clasts	1		Fibrous	Replaces pl crystals (broken one in matrix), or microphenocrysts in clasts

Epidote +/- Allanite	Clast	Tr	40	Anhedral	Tr blebs typically only within clasts. Some have brighter specks that have noise in spectra (La-Nd-Ce) and are probably REE-bearing allanite.
Ру	Matrix, amyg?	Tr	20	Anhedral- euhedral	Inclusions in rare mag grain within amyg. Rare cubes in matrix.
Mag	Amyg?	Rare	100	Cube	Inclusions of py
Ccp	Amyg?	Rare	10	Bleb	Rare bleb near mag grain within a qz-chl amyg(?)

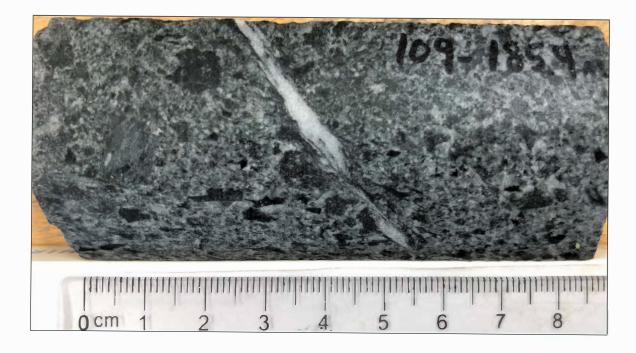




Fig. A2. 15 Hand sample photograph (A) and thin section scan (B) of sample 109-185.

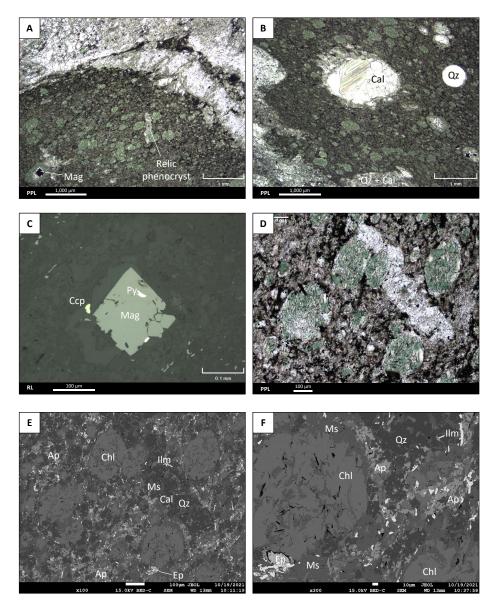


Fig. A2. 16 (A-E) Microphotographs of the largest basaltic lapilli fragment in the thin section. (A) Subround margin of clast next to qz-calcite dominant matrix (PPL). The clast groundmass has a dirty appearance in PPL and opaque FeTi oxide minerals are abundant. The clast contains abundant chlorite-rich ovoid features that may be amygdules (and so this would be a scoria clast) or they could be relic spherulites modified by later alteration and metamorphism. A magnetite crystal is in the center of one of the larger ovoid features. Lath shaped tabular features composed of quartz, muscovite, and minor calcite are wholly replaced plagioclase phenocrysts. (B) A more ragged, cuspate margin of the clast. A larger ovoid feature composed of polycrystalline calcite and a perfectly round ovoid feature composed of polycrystalline quartz may are markedly different from the green, chlorite-rich ovoid features dominant in the clast. Perhaps the chloritic features are spherulites and the larger qz-calcite dominant features are amygdules? (C) RL microphotograph of the magnetite crystal within a chlorite, quartz. Calcite ovoid feature labelled in (A). The magnetite crystal has an inclusion of pyrite. A bleb of chalcopyrite (yellowish hue) is nearby. (D-E) Close up of the relic plagioclase phenocryst labelled in (A), but the FOV is at a different orientation. In PPL (D), the groundmass has a dirty brown appearance. The BSE image (E) in the same FOV and a more close-up BSE image (F) show that the groundmass is composed of very fine-grained apatite, ilmenite, muscovite, and trace epidote. The ovoid features are chlorite with minor muscovite. The plagioclase phenocryst is wholly replaced by quartz, muscovite, and calcite.

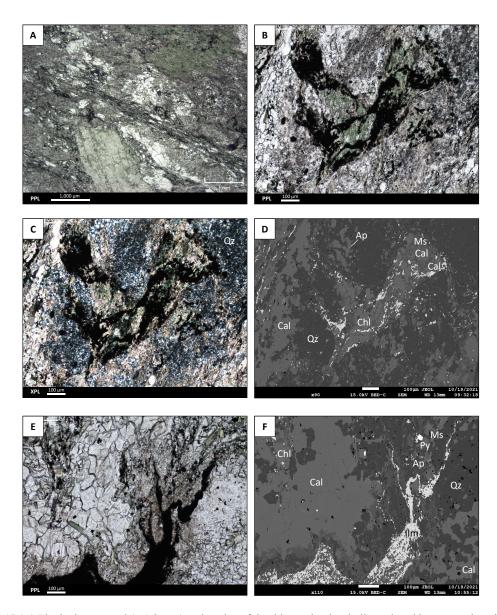


Fig. A2. 17 (A) Plagioclase crystal (> 1.8 mm) at the edge of the thin section is wholly replaced by muscovite with minor quartz and chlorite (PPL). Deformed, fiamme-like basaltic lapilli are darker green, black (chlorite- and ilmenite-rich) components amidst a calcite and quartz dominant matrix. (B-D) An irregular shaped lapilli fragment supported in a calcite and quartz matrix. Opaque minerals (PPL and XPL) are concentrated in the lapilli fragment and are very fine-grained interconnected acicular needles of ilmenite that outline ovoid chloritic features. (E-F) Deformed, ragged margin of a basaltic, ilmenite-rich lapilli in PPL (E) and an BSE image (F).

99-49 - HW-FeTiB

Sample ID: 99-49

Drill hole: CMR17-99 Drill hole depth (m): 49 m

Rock Name: Bt-mag-qz-cal-chl scoria(?)-bearing basaltic lapilli tuff **Geochemical Suite:** Hangingwall FeTi basalt (HW-FeTiB)

Lithofacies and textures:

Matrix-supported, very poorly sorted, chaotic, monolithic?

Hand sample description:

Dark grey, strongly magnetic, matrix supported, very poorly sorted lapilli tuff with even more strongly magnetic clasts. One clast >3 cm consists of 3 discrete 0.5-2 cm pinkish sil-mt altd patches with 5% diss 1mm ovoid features (amygs?) composed of fg mt and these patches are separated but enclosed within an ameboidal grey to weakly buff colored grainy matrix w/ mag-qz-cal and rare 1mm Jsp bleb. This may have been a pumiceous clast that was only partly altered giving it an apparent clastic texture just within the clast. Other rounded clasts include amorphous, dark gray basalt with 0.5-1 mm cal amygs(?) that are similar color to matrix, just slightly finer-grained and markedly more magnetic than matrix. A thin lens of mag that is 1cm long may be a relic clast? A subtle, yet discrete ovoid 2 cm area of cal-mag-chl and minor hematite may be another altered clast. Sparse 6mm, irregular somewhat lath-like sericitic features may be fsp xls.

Petrographic description:

Matrix is cryptocrystalline bt-chl-qz-cal and sparse epidote with 4% 0.1-0.15mm euhedral disseminated mag grains. Overall matrix has a hectic deformed wavy texture, and some clast margins blend into matrix by alteration (local clusters of ovoid "amygs" may indicate clast). Sparse patches of chl.

Most clasts are predominantly composed of mag, making their groundmass opaque in PPL. One black basalt clast (2 cm) has subangular fragment with cuspate, irregular margins, locally embayed, with a discontinuous reaction rim up to 0.34m of calcite, biotite, epidote and qz. Fragment is composed of 30% vfg mag that masks identification of surrounding minerals by its opaqueness in PPL. Contains 25% ovoid features that are mostly 0.05-1 mm, composed of calcite +/- minor biotite-ep-qz. Largest ovoid is 1.5 mm and composed of calcite with sparse biotite and epidote. Some elongate, lath-like features are likely relic fsp phenocrysts that have been replaced by calcite and are aligned in the clast and define a foliation. The largest convincing lath-like feature is 0.6 mm.

One paler clast (>1.8 cm) has cryptocrystalline groundmass, but likely mix of qz-calcite and 5% vfg mag. Not as much of the vfg mag in groundmass compared to other clast, but mostly aggregates (10%) of larger grains, some up to 1 mm, but most ~0.5 mm. Ovoid features (20%) are up to 0.8 mm, most are 0.1mm, composed of calcite +/- qz and rare ep. Feld phenos (1%) are 0.04-0.18 mm, laths, replaced by qz.

This volcaniclastic rock is probably monolithic and the basalt clasts have differential alteration giving it a polylithic appearance.

Mineral R	esidence	%	Size max (µm)	Habit	Comments
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Biotite	Matrix, clasts	30	100	Cryptocrystall ine	Vfg parts of matrix and clasts, and in some ovoid features.
Magnetite	Clasts, matrix	25	300	Subhedral, euhedral	Abundant in lapilli as vfg interconnected crystals that commonly outline ovoid (amyg?) shapes. Also disseminated cubes in matrix.
Quartz	Matrix, clasts	20		Cryptocrystall ine	Vfg parts of matrix and clasts. Commonly wholly replaces relic fsp phenocrysts. Within ovoid features.
Calcite	Matrix, clasts	10	100	Cryptocrystall ine	Vfg in matrix and groundmass of clasts. Common as slightly larger xls in ovoid features in clasts. Highly anomalous, washed-out interference colours in XPL.
Chlorite	Matrix, clasts	10		Cryptocrystall ine	Vfg parts of matrix and clasts
Epidote	Matrix, clasts	2	300	Subhedral, euhedral	Disseminated in matrix and clasts.





Fig. A2. 18 Hand sample photograph (above) and thin section scan (below) of sample 99-49.

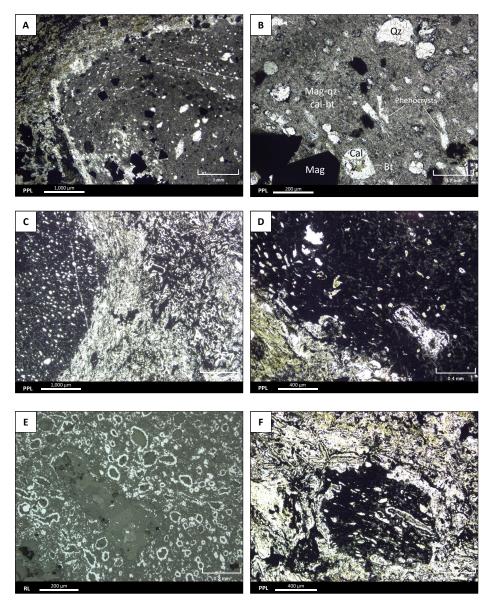


Fig. A2. 19 (A-E) Microphotographs of basaltic lapilli with relic plagioclase phenocrysts replaced by quartz, and ovoid features (amygdules?) composed of quartz, calcite, and lesser biotite. The groundmass of the lapilli is dominated by very fine-grained magnetite, and includes cryptocrystalline quartz, calcite, and biotite. The tuffaceous matrix is biotite and quartz, with lesser calcite, and chlorite. (A-B) Microphotographs of the paler lapilli. This lapilli has less magnetite than the darker lapilli. (C-E) Dark grey-black basalt lapilli. The RL image (E) highlights the texture of magnetite rimming ovoid features in the basalt lapilli, but magnetite is generally not within the relic lath shaped plagioclase phenocrysts. (F) The tuffaceous matrix includes tuff sized fragments of basalt with the same character as the lapilli fragments.

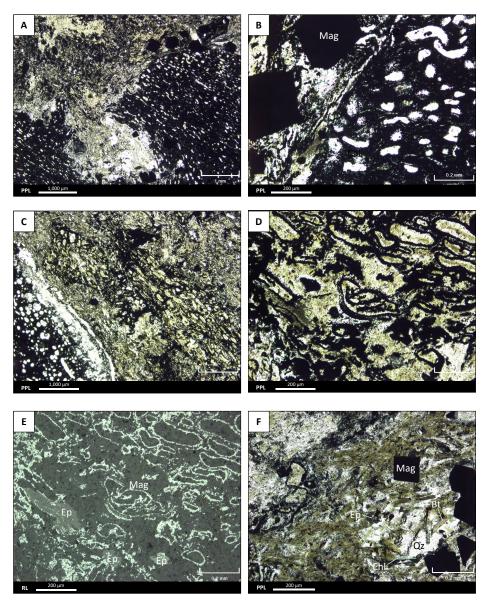


Fig. A2. 20 (A-E) Microphotographs of basaltic lapilli and tuffaceous matrix. (A) Irregular, cuspate, embayed margin of the basaltic lapilli. (B) Close up of the ovoid features within the basaltic lapilli. Some are deformed and U-shaped. (C-E) Lapilli with abundant ovoid features with less sharp margins compared to the darker lapilli. (D-E) Magnetite defines compact ovoid features that may be relic amygdules. (F) Tuffaceous matrix is very-fine grained aggregates of biotite, quartz, and chlorite with minor disseminated larger crystals of epidote and magnetite.

S037015 - Z-FeTiB

Sample ID: S037015

Surface Sample - UTM NAD 83 Zone 8NEasting: 420134 mNorthing: 6581924 mElevation: 1203 m

Rock Name: Bt-chl-mag-ilm-ep, variolitic, sparsely plagioclase-phyric basalt **Geochemical Suite**: Zone FeTi Basalt (Z-FeTiB)

Lithofacies and textures: Variolitic, porphyritic

Hand sample description:

Dark grey green, vfg, moderately magnetic and chloritic basalt w/ 40% leucocratic varioles. Varioles are subround to splatter-shaped and locally coalesce. Most varioles are concentrically zoned with sericitic core and qz rim.

Petrographic description:

The groundmass is dominated by plagioclase microlites (typically 0.1 - 0.2 mm, but up to 0.5 mm) set in mesostasis with a cruddy brownish-green appearance in PPL. SEM work revealed that this mesostasis is mainly intersertal cryptocrystalline bt-chl (likely devitried glass) and dark glassy blebs that have amphibole-like spectra. The groundmass also contains minor apatite, and trace ep, amp, qz and py. Magnetite and ilmenite are typically restricted to the groundmass. Magnetite is spongey with Inclusions of ap, ank, chl, ilm or glass. Mag edges are commonly embayed and may be resorption features or could be a result of rapid growth due to undercooling. Ilmenite needles are disseminated, some of which form masses in the shape of larger (up to 60 um), boxy, skeletal crystals with hollow cores filled with bt-chl-ep-pl. Sparse, larger pl phenocrysts up to 1.5 mm are typically lath-shaped and partially replaced by ab, ms, chl, bt and minor ep. Plag microlite and phenocrysts have average andesine composition (An₃₅).

Varioles range from ~0.5 mm to 3.67 mm, and are most commonly zoned, with an outer rim of annealed polycrystalline qz with triple junctions at grain boundaries. The cores are typically plagioclase with variable ms, ep, chl, amp replacement. Chloritic cores with amphibole are less common. BSE images show a few varioles that may have nucleated on a lath-shaped plagioclase phenocryst (partially replaced by ep-ms) and have fibrous bits of pl radiating out from core like bicycle spokes with interstices composed of qz and Fe-Mg-Ti minerals like chl, amp, mag. The recrystallization and greenschist facies metamorphism obscure primary textures, but these interstitial Fe-Mg-Ti minerals could have been primarily glassy components between the pl fibers that formed by spherulitic growth. Some of the smallest varioles (0.5 mm) are nearly wholly qz with trace tiny disseminated xls between the qz grains of pl, amp, chl, bt and the odd py or mag. Py is rare in groundmass, but some varioles contain py and one larger variole has large py xl with ccp inclusion and hematite rim surrounded by amphibole needles and chl-bt. The largest variole has a diameter of 3.67mm.

A few ovoid chloritic features (0.4 - 2.9 mm) may be amygdules. These "amygs" are typically not zoned like the white varioles. They are composed of massive chl with trace bt, ep, amp (up to

0.17 mm), and mag. Distinct bt-mag rims are common. Locally the leucocratic varioles are partially composed of the same chloritic features, or they are impinged upon and altered this way? If these chloritic features were primary vesicles, and the varioles are spherulites, then this may indicate that some spherulitic crystallization nucleated on vesicles.

Mineral	Residence	%	Size max (µm)	Habit	Comments
Plagioclase	Phenocryst	2%	1000	Subhedral- euhedral, blocky to lath	Some are very subtle, the largest one is offset along a fracture and is ~6mm long. The others are mainly about 0.5-1.5mm. Partially replaced by alb, chl, bt, and ep.
Plagioclase	Groundmass	50%	350	Anhedral- subhedral, microlites, interstitial	Average Andesine composition (An35). Partially replaced by biotite- chlorite
Biotite	Groundmass	20%	60	Flakes, intersertal	Predominant component of groundmass - interstitial. Interwoven w/ chl.
Chlorite	Groundmass	10%	30	Flakes, intersertal	Anomalous brown in XPL. Interwoven w/ bt.
Magnetite	Groundmass	7%	80	Euhedral, spongey	Generally restricted to the groundmass and not disseminated in fsp phenocrysts. Inclusions of ap, chl, ilm, glass and ank.
Ilmenite	Groundmass	5%	20	Anhedral- euhedral, needle, lath, skeletal	Disseminated needles in groundmass and locally manifest as several interconnected xls forming larger, blocky, skeletal masses with cores of bt-plag-ep-chl-glass. Some blocky xls have tiny inclusions of apatite.
Apatite	Groundmass	1%	10	Subhedral- euhedral	Disseminated.
Epidote	Groundmass	Tr	100	Subhedral- euhedral, lath	Partially replacing larger pl phenos or pl in groundmass.
Amphibole	Groundmass	Tr		Subhedral to euhedral	Disseminated
Allanite	Epidote core	Rare	25	Subhedral	A rare ep xl has aln core.
Quartz	Groundmass	Rare	10	Interstitial	Tr interstitial bits in groundmass.
Pyrite	Groundmass	Rare	4000	Euhedral	Disseminated. Up to 4mm in hand sample.
Ankerite	Magnetite inclusion	Rare	< 1	Inclusion, bleb	Inclusion within spongey mag

Mineral	Residence	%	Size max (µm)	Habit	Comments
Plagioclase	Variole 5 - 20%			Relic blocky/lath.	Forms core of variole, relic blocky to lath shapes may suggest spherulitic growth nucleated on primary phenocryst. Predominantly andesine but varies from oligoclase to labradorite. Labradorite (up to An ₆₅) is restricted to the cores of a few varioles. Partially to wholly replaced by ms, ep, alb, bt, and chl.
Quartz	Variole	30 - 90%	0.05	Annealed, recrystallized, triple junctions	Equant and interlocking grains with triple junctions (polygonal) form rims of varioles of varied thickness, or locally makeup the entire variole, especially the smaller ones. Qz xls are generally 0.01- 0.03mm, locally up to 0.05mm.
Muscovite	Variole	2-50%		Replacing plagioclase.	Vfg - sericite. Some have Ba in spectra.
Chlorite	Variole	Trace		Replacing plagioclase.	Within the core of some varioles.
Epidote	Variole	Trace		Replacing plagioclase.	Within the core of some varioles. Some spongey, ragged. Likely replacing pl.
Amphibole	Variole	Trace		Replacing plagioclase.	Within the core of some varioles.
Magnetite	Variole	Trace	10		
Pyrite	Variole	Rare	100	Euhedral	Rare cubes in a few varioles.
Zircon	Variole	Rare	10		One ~10 um crystal identified with SEM near core of variole.
Chalcopyrite	Variole	Rare	20		Rare in core of variole surrounded by py which is rimmed with hematite, and then all that is surrounded by amp-qz-chl-bt.

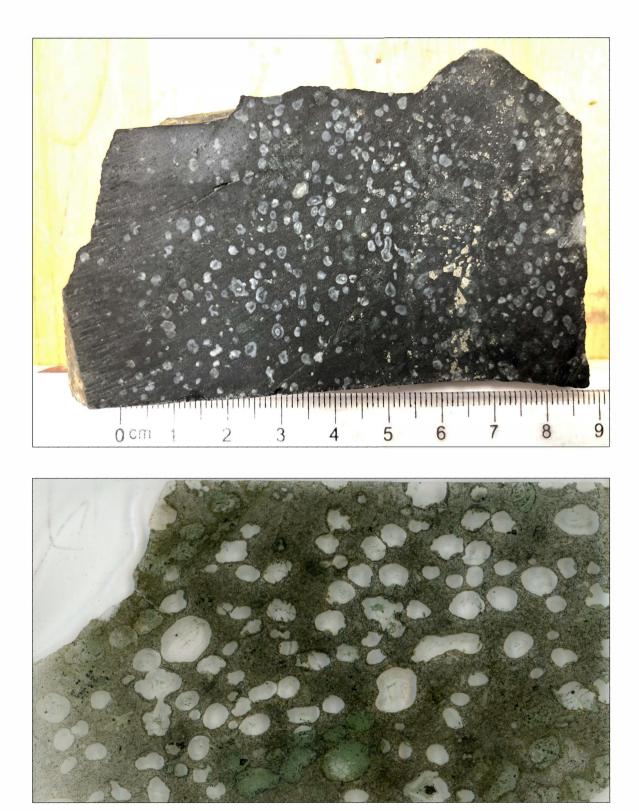


Fig. A2. 21 Hand sample photograph (above) and thin section scan (below) of sample S037015.

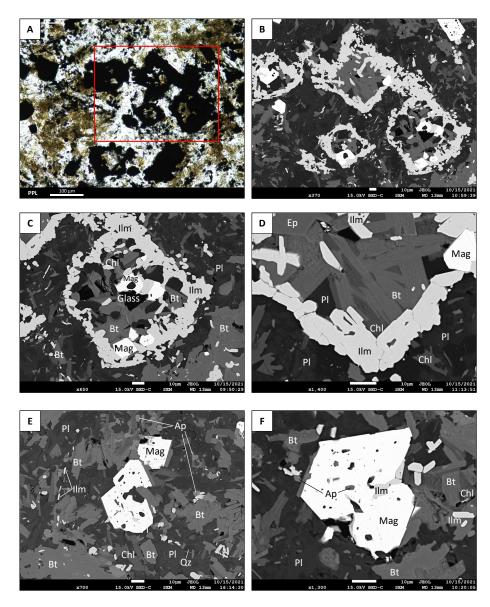


Fig. A2. 22 Microphotographs of the groundmass of sample S037015. (A) Blocky opaque FeTi oxide minerals disseminated in a groundmass composed of plagioclase microlites and a greenish brown mesostasis (PPL). The red box outlines the area of (B). (B-D) BSE images showing that the opaque minerals are ilmenite and magnetite, and the mesostasis is composed of biotite, chlorite, and minor epidote. Acicular ilmenite crystals and magnetite are interconnected to form larger blocky, skeletal crystals. (E-F) Disseminated magnetite crystals commonly have embayed margins and spongey interiors with inclusions of groundmass minerals. Apatite is an accessory phase and trace quartz is interstitial.

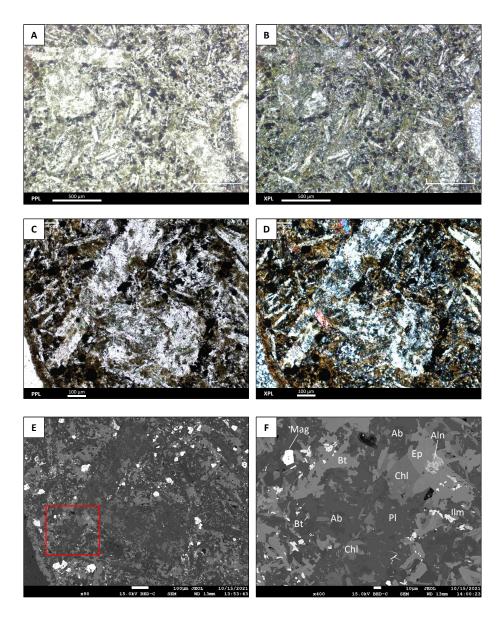


Fig. A2. 23 Microphotographs of plagioclase phenocrysts in sample S037015. (A-B) Twinned plagioclase phenocrysts (top left) and one lath-shaped plagioclase phenocryst (bottom right) in PPL (A) and the same view in XPL (B). (C-D) Close-up of the twinned plagioclase phenocrysts in PPL (C) and XPL (D) at a different orientation than A-B. The same FOV is shown in the BSE image in (E), with the red box denoting the area shown in (F). The plagioclase phenocrysts are partially replaced by albite, chlorite, biotite, and epidote. The brighter core of the epidote crystal is allanite. Note that magnetite and ilmenite (brighter minerals in BSE image) are generally restricted to the groundmass.

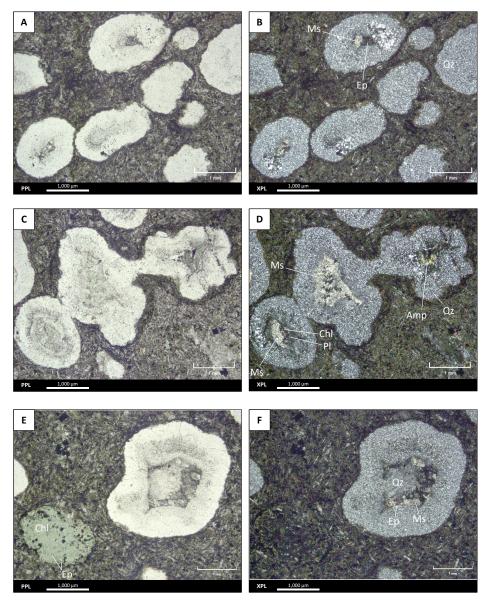


Fig. A2. 24 Microphotographs of varioles in sample S037015. (A-F) Larger varioles have cores of plagioclase variably replaced by albite, muscovite, epidote, chlorite, amphibole, and biotite. The outer rims of the varioles are composed of recrystallized quartz. Some of the smaller varioles are composed predominantly of quartz with no defined core. Varioles locally coalesce (C-D). Ovoid chloritic features that lack concentric zoning are interpreted to be amygdules (E-F).

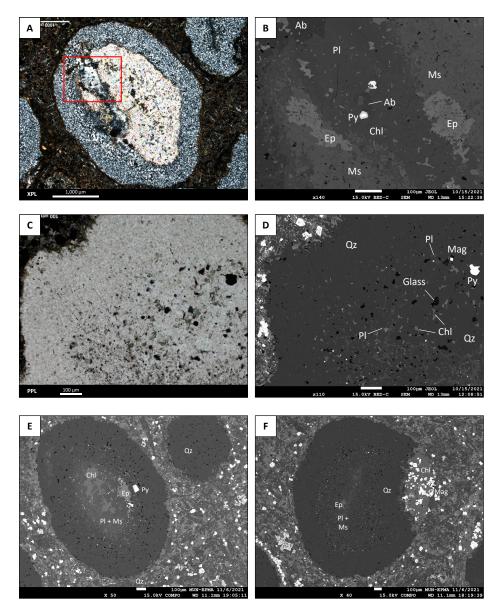


Fig. A2. 25 Microphotographs of varioles in sample S037015. (A) Larger variole with distinct quartz rim and muscoviterich interior (XPL). Relic plagioclase is within the red box and this area is shown in (B). (B) BSE image showing plagioclase partially replaced by muscovite, epidote, albite, and chlorite. Pyrite is minor and locally has oxidation rims. Spectra for the muscovite show a slight barium peak, suggesting some of the muscovite is barium rich. (C-D) A smaller quartz-rich variole that lacks concentric zoning in PPL (C) and an BSE image (D). Tiny (<1 μ m to 10 μ m) crystals of chlorite, plagioclase, biotite, magnetite, and pyrite occupy the spaces in between the larger grains of quartz. Dark blebs are glass with amphibole-like spectra. (E-F) More examples of varioles with plagioclase cores partially replaced by muscovite and epidote. The variole in (F) has a chlorite- and magnetite-rich component (right) that may be an amygdule. The variole zoning is deflected parallel to this chlorite-magnetite feature.

W605318 – FeR

Sample ID: W605318

Drill hole: CMR18-109 **Drill hole depth (m):** 242.4m

Rock Name: Ms-qz-brt-py, pumiceous (?), globule-bearing rhyolitic lapilli tuff **Geochemical Suite:** Ferrorhyolite (FeR)

Lithofacies and textures:

Foliated Matrix-supported, very-poorly sorted Pumice (?)- and globule-bearing

Hand sample description:

Strongly qz-ms-py-brt altered lapilli tuff with disseminated bleb of tan sph and sparse gn. Patchy/selective(?) alteration obscures boundaries "matrix" and "clasts." "Clasts" are darker grey with qz-py dominant alteration, >3-5cm, and some have ovoid-shaped (relic amyg?) features that are replaced by qz-brt. "Matrix" is white-coloured, vfg-mg ms-brt-sph-py-gn. Disseminated sp is pale, tan.

Petrographic description:

Matrix:

Strong foliation is defined by aligned wisps of ms. Lesser interstitial qz. Ms-rich matrix is presumably altered felsic (fsp-rich) tuffaceous component. Disseminated py is euhedral to subhedral, grains up to 0.8mm, but most under 0.5mm. Both ms and py are more abundant in matrix compared to clasts. Allanite is sparse, and always connected to py grains. Minor gn common along py edges. Rare vfg ccp blebs within py. Rare vfg bleb tetrahedrite (grey with brownish tint in RL) along py margin. Euhedral zircon crystals occur in both clasts and matrix. They are commonly fractured and rimmed with mnz, brt +/- gn. Mnz along zrn rims is bead-like. Some zrn have spongey interiors with inclusions of gn, mnz and felsic glassy material (SEM spectra contains Na, K, Al, Si). Some portions that are flooded with interlocking larger grains of brt, qz and sph may also be recrystallized matrix? Here larger grains of sp have ccp disease and gn discontinuously along margins. Barite is bladed, with blades up to 1.3 mm long.

Clasts:

Qz-brt-ms-sp clasts up to at least 1 cm are deformed, locally with cuspate to winged margins. Clasts are predominantly qz with minor brt, sp, py, and ms. Pyrite is generally <5% in clasts. Barite commonly has bladed texture. Rare, sub-micron ccp inclusions in sp (ccp disease). One clast is ~ 3 mm and is composed of vfg ms with a rare zircon grain and contains somewhat ovoid aggregates of polycrystalline qz that may be relic vesicles (altered pumice clast?). Sph locally has ccp-disease with <0.5% cpy (observed in larger bleb).

Globules:

Trace, discrete ovoid features up to 150 microns are composed of rutile, monazite, zircon, and locally galena, and rare apatite. In PPL, some globules can be identified by their dark reddishbrown hue, likely imparted by rutile. Rutile forms anhedral masses and commonly contains a Nb SEM spectra peak. Rutile is intergrown with vermicular zircon and monazite (symplectic texture). Locally, the sub-micron zrn or mnz crystals are arranged in chain-like successions with dendritic patterns that impart an overall "feathery" to "lace-like" appearance. Galena typically occurs as larger discrete masses but can be intergrown with zircon. The arrangement of minerals is disorderly and random within the globules.

Mineral	Residence	%	Size max (µm)	Habit	Comments
Muscovite	Matrix, clasts	50%	50	Flakes, fibrous	Defines strong foliation predominant in the vfg matrix. Some with Ba in spectra.
Quartz	Clasts, matrix	30%	500	Interstitial	Interstitial to ms in matrix.
Pyrite	Matrix, clasts	10%	800	Subhedral- euhedral	Most < 0.5 mm.
Barite	Clasts, matrix	3%	1300	Bladed	Largest blades are in parts of sample flooded w/ recrystallized brt-qz (matrix??). Smaller blades in qz-rich clasts too.
Sphalerite	Clasts, matrix	2%	2200	Anhedral- subhedral	Brown in PPL. Locally has galena blebs at margins. Grains are typically < 0.5 mm. Ccp disease observed in one larger bleb. Typically, more abundant in the more qz-brt rich parts interpreted to be clasts.
Galena	Grain boundaries, globules	1%	800	Anhedral- subhedral	Typically, along grain boundaries of py, zrn, and sp. Locally forms anhedral masses within globules.
Allanite	Py edges	Trace		100	Occurs along some py grains and some grains enclose py xls up to 10 micron.
Zircon	Clasts, matrix, globules	Trace	120	Anhedral to Euhedral	Larger grains are commonly fractured and rimmed with mnz, +/- brt. Gn is common in fractures and as inclusions in one spongey grain. Occur in sericitic-py matrix, qz-barite-rich clasts, and globules. In globules, zrn has a vermicular or "lace-like" texture.
Monazite	Rims zircon; part of globules	Trace	< 1	Anhedral	Blebs locally rimming zircon grains, giving a "doily" appearance. Vermicular textures within globules intergrown w/ rt and zrn.
Rutile	Globules	Trace		Subhedral- anhedral.	Most common as anhedral masses within globules intergrown w/ vermicular zrn and mnz. Some lath-shaped grains observed proximal to globules. Local reddish-brown hue (PPL) of globules is likely derived from rutile.
Apatite	Matrix, globule	Trace	80	Subhedral, spongey	Some spongey w/ felsic glassy inclusions. Rare in globules (P-phase is typically mnz in globules).
Chalcopyrite	Inclusions in py, sp	Rare	< 5	Blebs	Ccp disease in a few sp and py grains.
Tetrahedrite	Grain boundaries	Rare	< 1	Anhedral	Grey with brownish tint in RL. Rare vfg bleb along py margin.

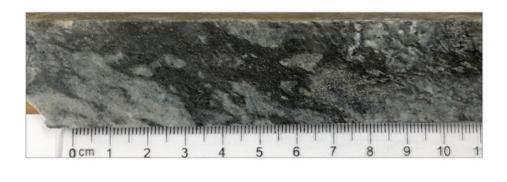




Fig. A2. 26 Hand sample photograph (above) and thin section scan (below) of sample W605318.

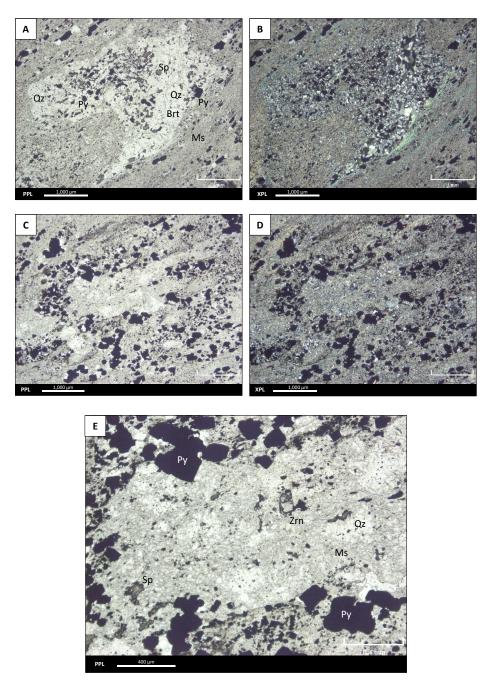


Fig. A2. 27 Microphotographs of lapilli. (A-B) Irregular-shaped clast with cuspate and winged margins shown in PPL (A) and XPL (B). The clast is quartz with minor muscovite and contains a disaggregated band of barite. Brown-colored (PPL) sphalerite and euhedral pyrite are disseminated in the clast. The matrix surrounding the clast is composed mostly of very fine-grained, muscovite (defining foliation), disseminated pyrite and minor quartz. (C-E) Possible pumice clast with a zircon crystal. The clast is composed of very fine-grained muscovite and quartz and ovoid aggregates of polycrystalline qz that may be relic vesicles. Pyrite is more abundant in the matrix and helps to define clast boundary.

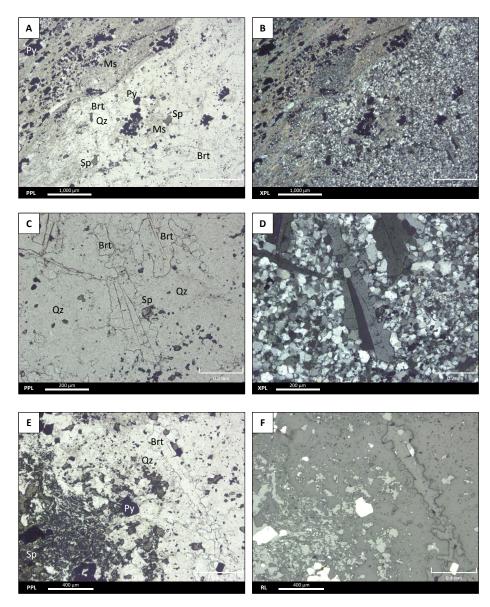


Fig. A2. 28 (A-D) Microphotographs of contact between lapilli and matrix showing bladed barite within the clast. (A-B) The matrix (top left FOV) is muscovite- and pyrite-rich compared to the quartz-rich clast with disseminated sphalerite, pyrite, and bladed barite (lower right FOV). (C-D) Close-up of the bladed barite texture in PPL (C) and XPL (D). (E-F) Another example of bladed barite in a sphalerite-rich section of the rock in PPL (E) and RL (F). Barite has a high relief.

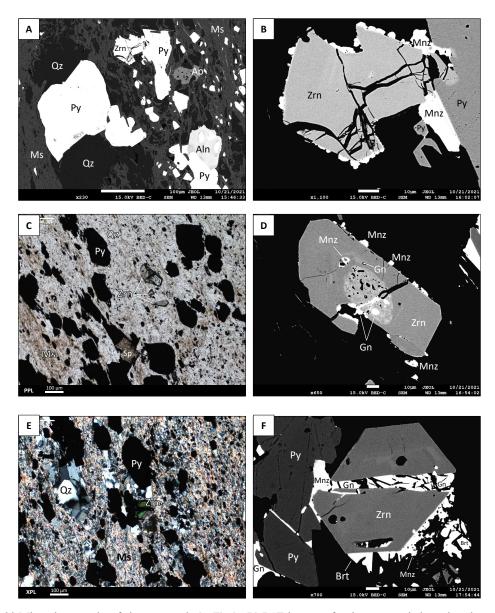


Fig. A2. 29 Microphotographs of zircon crystals (A-E). (A-B) BSE images of a zircon crystal along the edge of a pyrite grain within muscovite-quartz matrix. The BSE image in (B) is a close-up of the labeled zircon grain in (A) with a high contrast highlighting the boundaries between the heavier mineral phases (e.g., the quartz-muscovite matrix is black). The euhedral zircon grain is fractured and rimmed by beads of monazite. This texture is affectionately coined the monazite "doily" by the Piercey research group. (C) A cluster of zircon crystals in a muscovite-quartz matrix (PPL) and an BSE image of the larger zircon crystal in (D). The euhedral zircon crystal has beads of monazite along its edges and a spongey interior with inclusions of monazite, galena and felsic glass with Na, K, Al, Si spectra peaks. (E-F) A fractured zircon crystal shown in XPL (E) and a close-up BSE image (F) of the same crystal. The euhedral zircon crystal is rimmed with monazite and barite and the fracture is filled with galena.

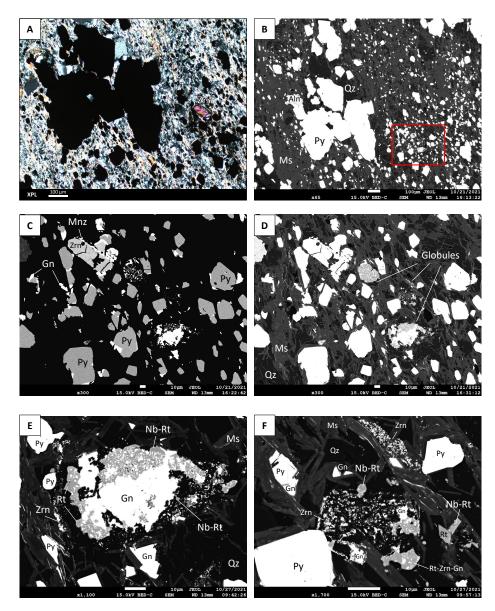


Fig. A2. 30 Microphotographs of an area containing globules near a broken zircon crystal (A-F). (A-B) Similar FOV in XPL and BSE image of muscovite and quartz matrix with disseminated pyrite. Allanite is along pyrite edge. The red box in (B) outlines the area shown in (C; high contrast) and (D; lower contrast). (C) The high contrast shows galena (white shade) discontinuously concentrated along pyrite grains (grey shade). Monazite (also white) is concentrated along margins of the zircon crystal. (D) Three globules occur near the broken zircon grain within the same foliated layer. (E-F) Close up of the globules shown in (D). (E) The globule is composed of galena but also has a titanium oxide mineral (rutile or anatase) that locally has a Nb spectra peak. Cryptocrystalline zircon crystals are disseminated in and around the globule. (F) Globule composed of feathery zircon crystals with blebs to crystals of galena, and Nb-bearing rutile.

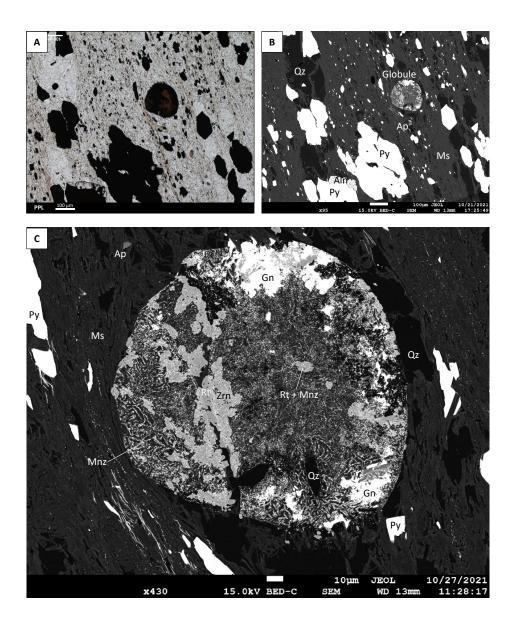


Fig. A2. 31 Microphotographs of a 150-micron globule (A-C). In PPL (A) the globule has a dark reddish-brown colour, imparted by rutile. (B) BSE image of the same FOV of as (A). (C) Close-up of the globule showing symplectic textures of rutile, zircon, and monazite. Anhedral masses of rutile are intergrown with zircon and monazite. Some of the rutile has Nb spectra peaks. The zircon and monazite crystals form vermicular textures. Patches of galena occur near the margins of the globule.

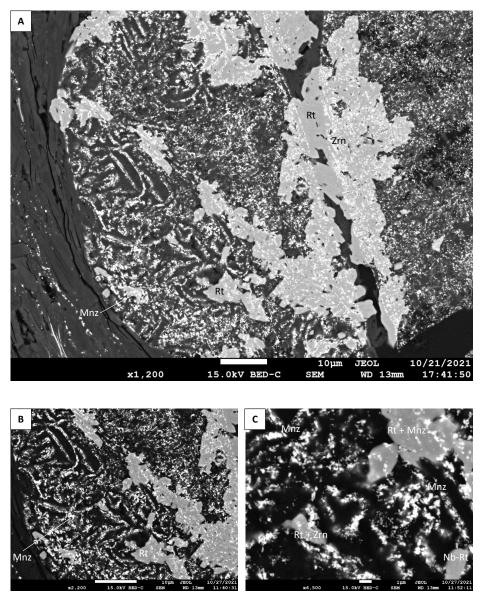


Fig. A2. 32 BSE images at different scales of the same globule as above (A-C). (A) Monazite and zircon (white) form vermicular textures within the globule. Rutile (grey) occurs as anhedral masses. (B-C) Close-up BSE images of the vermicular texture of sub-micron-sized zircon and monazite. The texture is reminiscent of ice crystals freezing on a windshield.

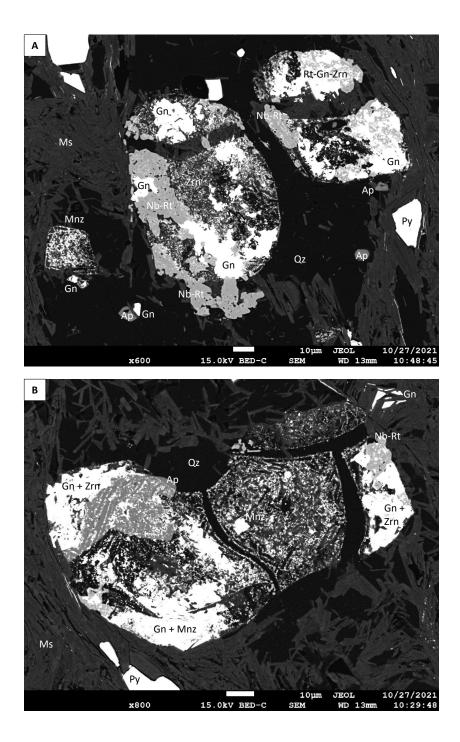


Fig. A2. 33 BSE images of examples of other globules in sample W605318 (A-B). (A) Three discrete globules composed of rutile, zircon, monazite, and galena. (B) Globule that looks fractured into four distinct parts. The larger anhedral bleb of monazite in the middle of the globule has Dy and Th spectra peaks. The apatite grain has a F spectra peak.

99-362 - FW-FeB

Sample ID: 99-362

Drill hole: CMR17-99 Drill hole depth (m): 362 m

Rock Name: Chl-qz-alb-cal-mag, plagioclase-phyric, amygdaloidal basalt **Geochemical Suite**: Footwall ferrobasalt (FW-FeB)

Lithofacies and textures:

Porphyritic, amygdaloidal

Hand sample description:

Fg green, chl-cal groundmass w/ 10% diss fg mag. Plagioclase phenocrysts are white, soft (ms-replaced), subhedral laths 2-5mm. Tr fg py in clots.

Petrographic description:

The groundmass is mainly qz, chl, fsp (both pl and ab), and calcite with ~ 8% disseminated skeletal titaniferous magnetite. Ap and ep are accessory phases. Pl phenocrysts (~ 5%) are generally 2 – 3 mm long, but reach lengths up to 5 mm. They are typically lath-shaped, but some are equant and boxy. They are partially replaced by muscovite and lesser ab, chl and ep. Ms replacement locally has a cleavage and rim texture giving the muscovite a cross-hatched appearance. The larger pl phenocrysts are more strongly altered than the pl in the groundmass. Both pl phenocrysts and interstitial pl in groundmass have average andesine compositions, with pl phenocrysts having average anorthite content of 32% and (An₃₂) and pl in groundmass having average anorthite content of 32% and stoichiometry distinguish between titaniferous magnetite, magnetite, and ilmenite. Titaniferous magnetite is the most abundant FeTi oxide mineral and is commonly skeletal. Tiny ilmenite crystals are rare. FeTi grains closer to stoichiometric magnetite compositions (Ulvospinel content ~ 4%) are also rare. Sparse (~25), relict amygdules are 0.5 – 1.3 mm. Some are deformed/flattened. They are composed of chlorite, calcite and quartz that are coarser-grained crystals than the groundmass.

Mineral	eral Residence %		Size max (µm)	Habit	Comments
Chlorite	Groundmass, amyg	40	100	Subhedral- euhedral fibrous flakes	Some patches rim fsp phenocrysts.
Quartz	Groundmass, amyg	30	40	Anhedral- euhedral, interstitial	Recrystallized grains occupy interstitial space between other groundmass grains.
Titaniferous magnetite	Groundmass	8	200	Subhedral- euhedral, Skeletal	Shreddy margins, skeletal forms w/ hollow parts composed of groundmass minerals.
Plagioclase	Groundmass	5	100	Subhedral, interstitial, relic microlites?	Some may be relic microlites.
Albite	Replaces Pl	5 50		Anhedral, interstitial	Patchy replacement of pl in phenos, groundmass
Calcite	Groundmass, amyg	3	100	Subhedral, interstitial	Coarser grains with triple junctions are more common in amygs
Epidote	Groundmass	2	200	Subhedral- euhedral, Skeletal	Skeletal texture and embayed edges common. Minor partial replacement of some fsp phenocrysts. Can be lath-shaped in places.

Muscovite	Replaces Pl mainly in phenocrysts	4	50	Subhedral- euhedral fibrous flakes	Partially replace fps phenocrysts. Local cross-hatched texture (cleavage and rim replacement of primary twinning?). Some has minor Ba peak in SEM spectra.
Plagioclase	Phenocryst	1	5000	Subhedral, euhedral, lath	Pseudomorphs of pl are 5% of that, pl maybe accounts for 1% of rock?
Apatite	Groundmass	Tr	10	Subhedral	
Ilmenite	Groundmass, Ti-mag	Rare	8	Blebs	Rare in groundmass, or as bleb intergrown w/ Ti-mag.
Magnetite	Groundmass, Ti-mag	Rare	10	Euhedral	Rare in groundmass, or as bleb intergrown w/ Ti-mag. Generally smooth and not skeletal or ragged like Ti-mag.
Pyrite	Groundmass, amyg	Rare	100	Subhedral	Rare grain next to amyg
Chalcopyrite	Groundmass	Rare	10	Subhedral- euhedral	



Fig. A2. 34 Hand sample photograph (above) and thin section scan (below) of sample 99-362.

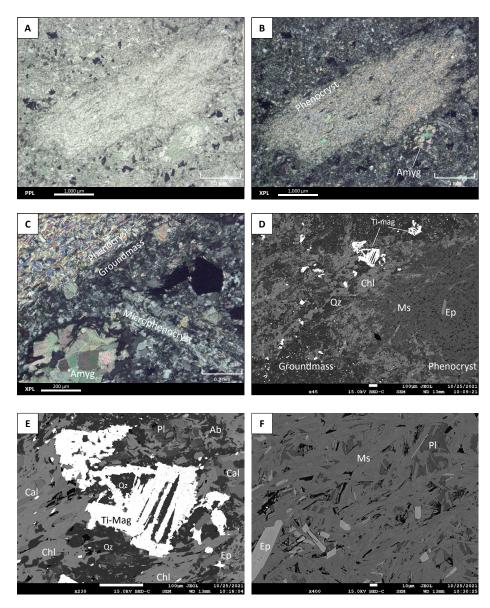


Fig. A2. 35 (A-E) Microphotographs and BSE images of a plagioclase phenocryst in groundmass. (A-B) Overview of plagioclase phenocryst that is nearly wholly replaced by muscovite in PPL (A) and XPL (B). An amygdule is composed of coarse recrystallized calcite (to bottom right of the phenocryst in the FOV). (C) Close up of the same phenocryst near the calcite amygdule in XPL. A Microphenocryst of plagioclase in the groundmass is less altered than the larger plagioclase phenocryst that has cross-hatched textured muscovite replacing it. (D) BSE image of the upper left edge of the same phenocryst in (A-B). Groundmass is chlorite and quartz with disseminated skeletal crystals of titaniferous magnetite. A few epidote grains also partially replace the plagioclase phenocryst. Chlorite is concentrated along the boundary between the phenocryst and groundmass. (E) Close-up BSE image of the same plagioclase phenocryst in (D). (F) Close up BSE image of the same plagioclase phenocryst that is nearly wholly replaced by muscovite and minor epidote.

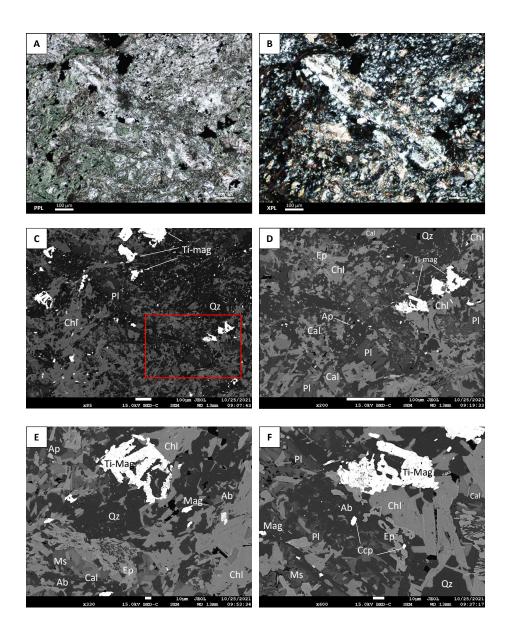


Fig. A2. 36 (A-E) Microphotographs and BSE images of the groundmass and relic plagioclase phenocrysts. (A-D) Plagioclase phenocryst in chlorite and quartz dominated groundmass. Titaniferous magnetite is disseminated.

Appendix 3. Whole rock geochemical data

Table A3. 1 Summary of Analytical Methods

ALS Code	Sample Decomposition	Analytical Method	# Analytes	Analytes
ME-XRF26	Li-borate fusion disk	XRF	15	Al ₂ O ₃ , BaO, CaO, Cr ₂ O ₃ , Fe ₂ O ₃ , K ₂ O, MgO, MnO, Na ₂ O, P ₂ O ₅ , SiO ₂ , SrO, TiO ₂ , LOI, Total
ME-IR08	LECO induction furnace	IR	2	C, S
ME-MS81	Li-borate fusion + 3-acid	ICP-MS	31	Ba, Ce, Cr, Cs, Dy, Er, Eu, Ga, Gd, Ge, Hf, Ho, La, Lu, Nb, Nd, Pr, Rb, Sm, Sn, Sr, Ta, Tb, Th, Tm, U, V, W, Y, Yb, Zr
ME-MS42	Aqua Regia	ICP-MS	9	As, Bi, Hg, In, Re, Sb, Se, Te, Tl
ME-4ACD81	4-acid	ICP-AES	10	Ag, Cd, Co, Cu, Li, Mo, Ni, Pb, Sc, Zn
Au-ICP21	Fire assay fusion	ICP - AES	1	Au
ME-OG62*	4-acid	ICP-AES	2	Pb, Zn

ICP-AES: Inductively Coupled Plasma - Atomic Emission Spectroscopy

ICP-MS: Inductively Coupled Plasma - Mass Spectrometry

IR: Infrared Spectroscopy

XRF: X-Ray Fluorescence Spectroscopy

4-acid: HF-HNO₃-HClO₄ acid digestion with HCl leach

3-acid: HF-HNO₃-HCl acid digestion

*Samples with Zn and Pb values that exceeded the upper detection limits (10,000 ppm) of the ME-4ACD81 method were analyzed using ALS method ME-OG62. The prepared sample is digested in the same four acids and then evaporated to incipient dryness. HCl and de-ionized water is added for further digestion, and the sample is heated. The sample is then cooled to room temperature and transferred to a volumetric flask (100 mL), diluted to volume with de-ionized water, homogenized and analyzed by ICP-AES.

Table A3. 1 Whole rock lithogeochemical data of twenty-two drill core samples from the AG stratigraphy and six standard reference materials (ALS laboratory certificate #VA20253932). Three samples are duplicates of samples in the company database.

Hele	W812851	W812852	W812853	W812854	W812855	W812856	W812857	W812858	W812859	W812860
Hole rom-To (m)		109 250 - 251.3	109 269.8 - 270.9	109 352.3 - 352.8	109 391.9 - 392.3	110 33.6 - 34.2		110 120.2 - 120.5	110 141.8 - 142.5	110 167.4 - 168
Unit	Orca-1	FcR	FcA(?)	FW-FeB	FW-FeB	Argillite	LK-NIP I	Trachyte dyke	Sed/Tuff	HW-FeTiB
Texture		Lapilli tuff	Flow margin breccia	Massive, Fsp- phyric, amygdaloidal 1	Massive; Fsp- phyric; amygdaloidal	Laminated		Fsp-porphyritic (25% fsp- phenocrysts)	Laminated	Lapilli tuff
Alteration		Qz-scr-py-brt	Qz-scr-py	Chl-ser-cal-mag-py	Chl-cp-cal-mag	Calcareous, trace py			Qz-ep	Mag-qz-scr
QAQC	SRM						SRM	DUP of W604724		
SiO ₂ (wt %)	74.77	56.01	40.25	46.67	49.64	41.41	49.46	55.89	75.75	51.6
Al ₂ O ₃ Fe ₂ O ₃	12.75 2.91	7.87 6.75	23.32 12.88	13.17 16.61	13.19 16.93	3.89 5.61	15.6 13.78	19.31 4.82	6.98 4.33	12.08 23.8
TiO ₂	0.29	0.21	2.61	1.95	1.88	0.18	1.18	0.53	0.4	2.39
MnO	0.06	0.04	0.02	0.24	0.25	0.09	0.19	0.13	0.07	0.03
MgO	0.48	0.55	1.7	2.68	4.31	4.54	7.4	1.3	1.37	2.09
CaO	1.15	0.87	0.49	7.63	6.97	24.2	10.45	4.6	5.12	1.58
K20	2.14	2.23	7.15	2.02	0.11	0.01	0.46	2.34	1.39	4.51
Na ₂ O P ₂ O ₅	4.61 0.05	0.05	0.36	0.87	2.25 0.34	-0.01 0.11	2.39 0.11	6.49 0.22	0.06 0.15	0.13 0.07
P ₂ O ₅ BaO	0.05	13.35	0.33	0.39	0.34	0.11	0.11	0.22	0.15	0.07
Cr ₂ O ₃	0.03	0.01	0.02	-0.01	-0.01	-0.01	0.03	-0.01	0.12	-0.01
SrO	0.01	0.38	0.02	0.03	0.04	0.03	0.02	0.18	0.02	0.01
s	0.01	7.67	9.54	1.08	0.2	1	0.04	0.16	0.08	0.01
С	0.02	0.15	0.01	1.38	0.48	5.18	0.02	0.65	0.86	0.3
LOI	0.61	5.11	9.14	5.78	3.74	18.5	-0.11	3.28	3.64	1.46
Total	99.94 0.2	110	110	101 0.4	100.3	101.15	101.25	100.45 0.2	99.65 2.4	99.99 0.3
Se (ppm) Li	0.2	-10	1 20	0.4	0.3	2.3	0.3	0.2	2.4	0.3
Sc	7	-10	59	39	39	6	31	3	7	33
v	14	44	625	316	355	129	295	95	60	140
Cr	80	-10	90	10	10	40	160	20	100	30
Co	3	2	81	35	44	3	56	6	5	25
Ni	4	-1	44	4	8	13	151	3	17	27
Cu	12	366	215	82	32	16	167	8	31	-1
Zn Ga	59 16.5	8590 16.4	1525 33.3	161 20.1	167 18.8	122 6	105 19.2	80 26.1	51 11.8	121 19.4
Ga Ge	-5	-5	-5	-5	-5	-5	-5	-5	-5	19.4
As	1	41.2	109	5.7	2.6	0.6	0.9	0.7	2.6	1.4
Mo	4	3	4	1	1	1	1	-1	2	1
Ag	-0.5	5.7	6	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Cd	-0.5	31.5	5.2	0.6	0.5	0.5	-0.5	-0.5	-0.5	-0.5
In	0.023	0.066	0.078	0.012	0.011	0.019	0.015	0.006	0.009	0.015
Sn	4	3	1	1	1	-1	1	1	1	1
Sb Te	0.12	4.18	29.6 0.01	0.45	0.38	0.37 0.06	-0.05 -0.01	0.25	0.18 0.15	0.55
W	-0.01	-0.01	8	1	-0.01	1	-0.01	-0.01	0.15	-0.01
Re	0.001	0.001	0.005	0.002	0.001	0.003	0.001	-0.001	0.001	-0.001
Hg	0.005	0.336	0.15	0.005	-0.005	-0.005	-0.005	-0.005	0.006	0.011
TI	0.02	0.84	0.65	0.08	0.04	0.03	0.08	0.39	0.04	1.21
Bi	0.05	0.08	0.07	0.03	0.02	0.1	0.02	0.06	0.12	0.02
Rb	52.9	42	134	30.3	2.3	0.3	12.2	62.2	24.9	133
Sr	71.6	3100	117.5	222	349	285	164	1690	148.5	102.5
Cs Ba	0.56 392	0.73 10000	2.15 10000	0.42 615	0.16	0.05 24.2	0.6 140.5	1.17 9130	0.26	4.56 1060
ва Рb	5	2970	1475	15	120.5	6	7	9130	1085	-2
Th	5.27	8.45	2	1.21	0.96	1.59	1.48	27.6	2.62	1.31
U	1.41	3.68	1.47	0.43	0.36	3.21	0.44	13	0.67	0.24
Y	72.4	65.7	61.7	45.1	39.9	37.5	21	31.8	17.3	18.7
Zr	264	359	172	138	119	98	86	374	82	183
Nb	11.4	23.1	15.3	11.3	10.2	3.1	4.6	24.5	6.5	15.3
Hf Ta	8 1.1	9.1 1.4	4.5 0.9	3.6 0.8	3 0.7	1.6 0.3	2.2 0.4	8.2 1.3	3 0.5	3.4
La	29.1	32.6	21.3	12.8	11.2	12.8	8.4	1.3	19.9	15.2
Ce	64.9	64	42.8	29.2	25.4	16.7	18.6	198	28.6	33
Pr	8.76	7.74	5.66	4.28	3.48	2.88	2.44	22.7	5.25	4.32
Nd	37.3	31.5	25.9	19.6	16.2	12.7	11.3	84.5	24.2	19.6
Sm	9.82	9.26	7.59	5.64	5.1	3.04	3.07	14.55	5.57	5.05
Eu	1.34	0.57	1.67	1.7	1.51	0.63	1.05	3.36	1.13	1.61
Gd	10.5	9.31 1.78	9.57 1.72	6.66	6.28 1.06	4.81 0.83	3.72	9.55	5.02 0.65	5.12 0.83
Tb Dy	1.79 11.7	1.78	1.72	1.2 7.68	1.06	0.83	0.61 3.85	1.22 6.17	0.65	0.83 4.92
Dy Ho	2.56	2.43	2.46	1.66	1.56	5.27	3.85 0.89	6.17 1.16	3.52 0.66	4.92
Er	7.9	7.29	7.29	5.06	4.61	3.43	2.41	3.02	1.69	3.23
Tm	1.17	1.09	1.11	0.76	0.67	0.48	0.32	0.43	0.23	0.46
Yb	7.99	7.51	6.76	4.82	4.32	2.62	2.08	2.83	1.44	3.15
10		1.13	1.03	0.75	0.66	0.39	0.32	0.46	0.22	0.48
Lu	1.26									
	1.26 0.013	0.03	0.078	0.006	0.002	0.004	NSS	-0.001	0.003	0.002

Table A3. 1 continued

Sample	W812861	W812862	W812863	W812864	W812865	W812866	W812867	W812868	W812869	W812870
Hole From-To (m)	110 189 - 189.6	110 224.24 - 224.9		110 233.7 - 234.7	110 272.4 - 273.4	110 290.3 - 291.1	110 319.7 - 320.3	110 332.5 - 333		110 337.6 - 338
Unit	HW-FeTiB	HW-FeTiB	Orca-1	Argillite	Mineralized heterolithic fragmental	FcR block(?) in heterolithic fragmental	FeR	FeA	LK-NIP 1	Mafic dyke
Texture	Agglomerate lapilli tuff	Lapilli tuff		Laminated	Chaotic; Lapilli tuff	Lapilli tuff	Lapilli tuff	Massive; amygdaloidal		Massive; felted
Alteration	Mag-qz-ser-chl- jasper	FeCarb-cal-mag- chl-qz-jasper		Calcareous, trace py	Py-brt-sph-ser-qz	Qz-py-chl-cal- FeCarb	Qz-ser-py-mag-chl	Chl-FeCarb-cal-mag		Chl-ep
QAQC			SRM						SRM	
SiO2 (wt %)	55.86	32.19	74.71	41.06	29.97	76.82	48.5	53.01	49.18	47.17
Al_2O_3	13	10.16	12.74	5.83	9.46	3.25	17.14	15.27	15.48	13.28
Fe ₂ O ₃	17.6	15.19	2.91	8.99	25.47	7.12	17.13	13.6	13.6	9.95
TiO ₂	2.52	1.7	0.29	0.29	0.93	0.11	0.6	2 0.1	1.16	0.77
MnO MgO	2.22	5.6	0.08	6.26	0.55	0.11 1.26	2.44	3.44	7.33	10.2
CaO	1.14	14.4	1.15	14.95	0.15	3.47	1.91	6.65	10.35	11.75
K ₂ O	4.85	3.08	2.15	1.31	2.68	0.56	3.07	1.87	0.46	0.23
Na ₂ O	0.2	0.17	4.62	0.14	0.08	0.31	0.72	0.09	2.38	2.23
P_2O_5	0.08	0.5	0.05	0.19	0.02	0.02	0.04	0.33	0.11	0.12
BaO	0.07	0.23	0.05	0.58	8.19	0.45	0.36	0.14	0.03	0.02
Cr ₂ O ₃	-0.01	-0.01	0.01	0.01	-0.01	-0.01	-0.01	-0.01	0.02	0.1
SrO	0.01	0.05	0.01	0.02	0.09	0.02	0.02	0.06	0.02	0.04
s C	0.01	0.02	0.01	2.74	23.7	4.58 1.01	7.65 0.12	0.31	0.03 0.02	0.03
LOI	0.2	4.2	0.65	5.75	17.86	5.35	7.81	3.53	-0.06	4.24
Total	99.4	100.05	99.91	102.8	110	109.65	110	101.05	100.45	100.45
Se (ppm)	0.2	0.2	-0.2	4.2	33.3	0.3	0.4	0.9	-0.2	-0.2
Li	10	10	10	-10	10	10	20	20	10	10
Sc	34	26	7	7	11	2	9	29	31	40
v	492	442	12	166	109	18	61	239	339	327
Cr	40 27	30 24	70 3	90 8	10	10	10	10	180 57	780 40
Co Ni	27	24 16	5	8 26	10 2	1	11 2	32 4	57	40 74
Cu	1	1	11	36	1010	10	11	34	171	5
Zn	127	95	56	27	10000	167	122	226	106	129
Ga	22.6	16.4	17.2	7.7	18.6	4.8	34.4	26	20.9	14.8
Ge	-5	-5	-5	-5	-5	-5	-5	6	-5	-5
As	1.5	2.1	0.6	79.7	250	108.5	12.3	5.1	1	2.7
Mo	1	-1	5	2	16	4	18	1	1	2
Ag Cd	-0.5 -0.5	-0.5 1.4	-0.5 -0.5	2.4 0.5	86.1 89.3	0.7 0.7	-0.5 -0.5	-0.5 -0.5	-0.5 -0.5	-0.5 0.5
In	-0.5	0.026	-0.5	0.008	0.056	0.01	-0.5	0.012	0.018	0.009
Sn	1	1	4	-1	1	1	6	2	1	1
Sb	1.01	2.7	0.11	10.25	250	3.44	0.71	1.24	-0.05	0.45
Te	-0.01	-0.01	-0.01	0.06	0.01	-0.01	-0.01	0.01	-0.01	-0.01
W	-1	1	1	2	24	-1	1	2	1	1
Re	-0.001	-0.001	0.001	0.026	0.019	0.001	0.003	0.002	0.001	0.001
Hg Tl	-0.005	-0.005	-0.005	0.02	1.44	0.316	0.016	0.006	-0.005	-0.005 0.14
Bi	0.01	4.18	0.02	0.1	0.03	0.03	0.09	0.04	0.07	0.14
Rb	153	96.6	56	27.3	56.2	13.9	64.6	38.2	13.8	3.7
Sr	86	424	74	191	704	125.5	214	518	181	382
Cs	5.24	2.99	0.6	0.31	1.11	0.55	1.87	0.7	0.59	0.18
Ba	575	2260	406	5760	10000	4570	3650	1260	155	111
Pb	2	8	6	13	10000	56	8	66	2	7
Th U	1.94 0.28	1.6 0.61	5.13 1.3	1.51 2.33	1.81 8.47	3.29 1.58	17.75 3.29	4.26 3.5	1.57 0.46	1.51 0.79
Y	28.5	45.6	72,4	2.33	26.2	1.58	3.29 83.7	3.5 61	22.7	0.79
Zr	152	165	270	51	133	90	708	283	86	61
Nb	17.3	12.4	11.8	3.9	9.6	11	60.6	18.5	4.9	3.2
Hf	3,7	3.6	7.9	1.4	3,3	2.6	19	6.5	2.4	1.8
Ta	1	0.8	1	0.3	0.5	0.6	3.1	1	0.4	0.2
La C-	15.9 34.6	17.4 39.8	27.7 63.9	13.9 17	24.7 46.1	12 23.8	70.5	26.5 57	8.8 19.5	8.1 17.7
Ce Pr	34.6 4.6	39.8 5.29	63.9 8.44	17 3.04	46.1 5.78	23.8 2.56	155.5 17.95	57 7.28	19.5	2.43
Nd	19.8	22.5	35.1	12.4	23.5	8.5	69.2	30.6	11.8	10.6
Sm	5.06	5.82	9.65	2.6	6.34	1.65	17.05	8.12	3.3	2.98
Eu	1.74	1.78	1.3	0.62	2.27	0.34	2.72	2.23	1.1	0.98
Gd	5.73	6.58	10.3	3	5.26	1.79	16.7	9.94	4.1	3.32
Tb	0.98	1.17	1.87	0.5	0.93	0.41	2.9	1.76	0.67	0.53
Dy	5.6	7.1	11.85	3.46	5.38	2.7	17.25	11.35	4.01	3.2
Ho Er	1.13 3.32	1.56 4.88	2.54 8.25	0.78 2.49	1.12 3.36	0.6 2.14	3.54 10.75	2.42 7.31	0.84 2.49	0.66 1.98
Er Tm	3.32	4.88	8.25	2.49	3.30	2.14	10.75	7.31	2.49	0.28
Yb	3.1	4.61	8.42	2.44	3.25	2.42	1.0	7.29	2.24	1.85
Lu	0.47	0.76	1.22	0.37	0.46	0.36	1.47	1.06	0.33	0.28
Au	0.001	-0.001	0.003	0.016	0.088	-0.001	0.001	0.002	0.009	-0.001
					1.145					
Pb (wt %)										

Table A3. 1 continued

	W812871	W812872	W812873	W812874	W812875	W812876	W812877	W812878
Hole	110	110	120	120	120		112	
om-To (m)	367.7 - 368.1	377.8 - 378.2	301.1 - 302	323.1 - 323.4	330.9 - 331.7		536.4 - 536.9	
_		Calc-alkaline	Jasper-magnetite					
Unit	HSR	andesitic dyke	exhalite	Z-FeTiB	FeA	Orca-1	FeD (least altered)	LK-NIP 1
Texture	Massive	Fsp- and Amp- phyric	Splotchy	Amygdaloidal; variolitic	Massive, amygdaloidal		Amygdaloidal	
		1-0						
Alteration	Qz-ep-chl(?)	Chl-ep-cal	Qz-Mag-cal	Mag-chl-cal	Chl-mag-cal-jasper		Chl-qz-ep	
QAQC	DUP of W604709	DUP of W604712				SRM		SRM
SiO ₂ (wt %) Al ₂ O ₃	67.86 14.74	53.41 17.86	32.22 0.23	42.25 13.71	50.44 12.2	74.82 12.76	65.63 11.79	49.45 15.54
Fe ₂ O ₃	3.58	8.14	15.02	16.78	13.59	2.92	8.93	13.74
TiO ₂	0.15	0.66	0.01	3.04	1.64	0.29	0.85	1.18
MnO	0.03	0.12	0.29	0.22	0.11	0.06	0.1	0.19
MgO	0.97	3.87	0.42	4.48	4.53	0.48	2.14	7.41
CaO K O	4.27	8.25	29.1	8.74	7.91	1.15	3.44	10.4
K2O Na2O	3.56 0.37	0.88	0.03	3.04 1.4	2.09 0.43	2.14 4.61	1.04 3.71	0.46 2.41
P_2O_5	0.37	0.15	-0.01	0.93	0.43	0.05	0.32	0.11
BaO	0.25	0.07	0.1	0.09	0.18	0.05	0.03	0.03
Cr ₂ O ₃	-0.01	-0.01	-0.01	-0.01	-0.01	0.01	-0.01	0.02
SrO	0.02	0.1	0.04	0.05	0.05	0.01	0.03	0.02
s	0.04	0.2	0.12	0.01	0.19	0.02	0.07	0.03
C	0.5	0.21	6.27	0.98	0.97	0.01	0.25	0.02
LOI Total	3.68 99.64	3.04 100.25	22.36 100.2	4.96 99.84	5.49 99.84	0.64 100.05	1.6 99.85	-0.11 101.1
Total Se (ppm)	-0.2	0.3	-0.2	0.2	0.4	-0.2	0.2	-0.2
Li	10	20	-10	20	20	10	10	10
Sc	1	16	-1	35	25	7	10	32
v	5	254	59	358	195	13	18	330
Cr	-10	10	10	20	10	90	10	170
Co	2 2	24	3	27	24	4	9	59 159
Ni Cu	2	5 24	3	10	4	5	-1 16	159 180
Zn	99	24 78	4 10	182	41	56	101	180
Ga	36.8	21.4	0.8	23.1	20.1	17.7	18.5	20.3
Ge	-5	-5	-5	5	5	-5	-5	-5
As	0.6	2.5	0.9	1.5	1.9	0.9	0.9	0.9
Mo	1	1	5	2	1	5	2	1
Ag Cd	-0.5 -0.5	-0.5 -0.5	-0.5 0.8	-0.5 0.7	-0.5 0.5	-0.5 -0.5	-0.5 -0.5	-0.5 0.9
Cd In	-0.5	-0.5	-0.005	0.7	0.5	-0.5	-0.5	0.9
Sn	9	1	-1	2	2	4	4	1
Sb	0.99	0.42	0.19	0.2	0.36	0.12	0.18	-0.05
Те	0.01	0.01	0.01	-0.01	0.01	-0.01	-0.01	0.01
W	1	1	1	1	1	1	1	1
Re	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.001
Hg Tl	-0.005 0.19	-0.005 0.22	-0.005 -0.02	-0.005 0.42	-0.005 0.39	-0.005 0.02	-0.005 0.17	-0.005 0.07
Bi	0.19	0.22	-0.02	-0.01	0.39	0.02	0.17	0.07
Rb	54.5	20.1	0.03	93.2	58.3	58.2	28.4	13.6
Sr	179	938	377	403	399	76.3	332	175
Cs	1.24	1	0.03	3.33	1.95	0.62	0.99	0.57
Ba	2540	611	869	749	1670	418	231	145.5
Pb	7	17	4	5	-2	-2	5	2
Th U	13.95 3.52	3.11	0.08	2.25	3.09 1.63	5.33 1.39	6.41 2.96	1.55 0.48
Y	3.52	1.28	2.6	91.3	57.5	74.8	2.96	21.8
Zr	414	95	31	201	240	281	335	83
Nb	79.5	5.2	0.6	20.7	13.5	12.3	19	4.7
Hf	14.9	2.7	0,3	4.6	4.5	8.3	8	2.4
Та	4.8	0.4	0.1	1.2	0.8	1.1	1.2	0.3
La	111.5	15.9	0.9	28.2	21.9	28.3	27.9	8.7
Ce	240 28.4	31.7 4.05	1.4 0.2	60.4 8.13	48.1	65.7 8.66	57.2	19 2.55
Pr Nd	28.4	4.05	0.2	8.13 35.9	6.39 27	8.66	6.87 27.3	2.55
Sm	28.3	3.77	0.9	10.1	7.38	9.68	6.99	3.26
Eu	5.03	1.08	0.08	3.08	2.04	1.42	1.61	1.11
Gd	28.8	3.19	0.33	12.7	8.65	11	7.56	3.94
ТЬ	5.15	0.46	0.06	2.2	1.56	1.98	1.4	0.66
Dy	29.5	2.55	0.33	14.05	9.96	11.9	9.31	3.93
Ho	5.7	0.52	0.09	3.08	2.16	2.6	2.08	0.83
Er	17.25	1.55	0.28	9.82	6.9	8.53	6.9	2.48
Tm Yb	2.63 18.15	0.24	0.04	1.35 9.17	1.04 7.29	1.32 8.6	1.04	0.37 2.16
		0.25	0.37	9.17	1.1	1.28	1.06	0.35
	2.63							
Lu Au	2.63 -0.001	0.001	0.047	-0.001	0.003	-0.001	-0.001	0.021

Appendix 4. Quality control and quality assurance (QAQC)

Researcher: Kei Quinn Principal Investigator: Steve Piercey Lab Name: ALS Certificate #: VA20253932 Method: See Table A3. 1 for a summary of analytical methods

For this study, six in-house reference materials (three LK-NIP-1 diabase and three ORCA-1 rhyolite) and three blind duplicates were analyzed at ALS Laboratories in North Vancouver to monitor analytical accuracy and precision (Appendix 4). These reference materials were chosen as they represented the matrix of materials in the project area and the broad range of analytes. The ALS lab also inserted and analyzed 37 lab-chosen standards and 16 blanks during the run.

The LK-NIP-1 diabase (a sill from the Kitto Township, south of Beardmore, Ontario, Canada) and the ORCA-1 rhyolite (calc-alkaline rhyolite collected from Pontiac Township, 35 km northeast of Kirkland Lake, Ontario, Canada) samples were assessed for both accuracy and precision using percent relative difference (%RD) and percent relative standard deviation (%RSD) (Abzalov, 2008; Piercey, 2014). Precision was also estimated using the average coefficient of variation (CV_{avg}) from duplicate samples (Abzalov, 2008; Piercey, 2014). Quality ratings for accuracy and precision are summarized in Table A4. 1 (Jenner, 1996). Results are summarized in Table A4. 2 to Table A4. 4.

The accuracy of all analytes reported in the provisional data sheet for the standard reference materials was tested by calculating the percent relative difference:

$$\% RD = 100 x \frac{\mu_i - STD_i}{STD_i}$$

Where μ_i is the mean value of element i in the standard over a number of analytical runs, and STDi is the certified value of element i in the standard reference material. Most major elements returned absolute percent relative difference (% RD) values < 2%, except P₂O₅ (<12%) and MnO (<5% for LK-NIP-1). Most trace elements gave %RD values <10%, with many below 5%. Most trace elements gave %RD values <10%, with many below 5%. Trace elements with %RD > 10% included Cr (for ORCA-1), Cs (for LK-NIP-1), Ta (for LK-NIP-1), As (for ORCA-1), Bi (for ORCA-1), Re (for ORCA-1), Se (LK-NIP-1), Te (LK-NIP-1), Cd (LK-NIP-1), Mo (ORCA-1), Ni (ORCA-1), Pb (both ORCA-1 and LK-NIP-1), and Au (both ORCA-1 and LK-NIP-1), Co (for ORCA-1), Li (for ORCA-1), Mo (for LK-NIP-1), Ni (ORCA-1), Pb (both ORCA-1 and LK-NIP-1), Ni (ORCA-1), Pb (both ORCA-1). For the most part, the results were within a reasonable magnitude compared to the accepted value, and elevated % RD values were associated with analytes with concentrations at or near the lower detection limit.

To evaluate the reproducibility of the analytical results, the relative standard deviation (% RSD) was calculated as follows:

$$\% RSD = 100 x \frac{s_i}{\mu_i}$$

Where μ_i is the mean value of element i in the standard over a number of analytical runs, and s_i is the standard deviation of the mean from the analytical runs for element i. Most major elements returned absolute percent relative standard deviation (% RSD) values < 1%, except MgO (<2% for ORCA-1). Most trace elements gave %RSD values <10%, with many below 5%. Trace elements with %RSD > 10% include Cr (for ORCA-1), Ta (for LK-NIP-1), W (for ORCA-1), V (for ORCA-1), Zr (for ORCA-1), Tl (for both ORCA-1 and LK-NIP-1), Co (for ORCA-1), Li (for ORCA-1), Mo (for LK-NIP-1), Ni (ORCA-1), Pb (both ORCA-1 and LK-NIP-1), and Au (both ORCA-1 and LK-NIP-1). Results with elevated % RSD values are generally attributed to analytes with concentrations at or near the lower detection limit.

A total of three duplicate samples were collected. The original samples were collected by Company geologists as half-core samples and analyzed in 2018. The duplicate samples were quartered portions of the remaining core and analyzed using the same methods in 2020. Relatively homogeneous samples (massive high-silica rhyolite, a trachyte dyke, and a basalticandesite calc-alkaline dyke) were selected because any inherent inhomogeneity in samples makes them less ideal for assessing precision. The pairs were assessed using the average coefficient of variation for all analytes determined. The average coefficient of variation (CV_{avg}) is defined as:

CVavg (%) = 100 x
$$\sqrt{\left(\frac{2}{N}\right)\sum_{i=1}^{N}\left(\frac{(a_i-b_i)^2}{(a_i+b_i)^2}\right)}$$

where a_i = the original sample and b_i = the duplicate sample of i pairs, and N is the total number of duplicate pairs. The average coefficient of variation is a robust and efficient method to assess the precision of duplicate data. It applies to datasets with a normal or non-normal distribution of errors. The CV_{avg} for three duplicate pairs returned results of all majors less than 10%, except for BaO (<23.22%) and P₂O₅ (< 10.09%). All HFSE were < 10% except for Ta (13.61%). The CV_{avg} for all REE was <10%. Other trace elements with CV_{avg} >10% include Ba, Cr, As, Bi, In, Sb, Sc, Tl, Co, Cu, Ni, and Pb. Poor precision was common for analytes near the lower limit of detection.

% RD (±) for accuracy	% CV _{avg} or % RSD for precision	Quality
0–3	0–3	Excellent
3–7	3–7	Very good
7–10	7–10	Good
>10	>10	Poor

Table A4. 1 Summary of precision and accuracy quality ranking system proposed by Jenner (1996).

					QAQC - LK-NIP-1									
ALS Method	Anal	yte	LOD	3.3 LOD = LOQ	LK-NIP 1 accepted values	W812851	W812863	W812876	Avg	Stdev	%RSD	%RD	Comments on precision	Comments on accuracy
ME-XRF26	SiO_2	%	0.01	0.03	49.65	49.46	49.18	49.45	49.36	0.16	0.32	-0.58		
ME-XRF26	Al ₂ O ₃	%	0.01	0.03	15.84	15.6	15.48	15.54	15.54	0.06	0.39	-1.89		
ME-XRF26	Fe ₂ O ₃ CaO	%	0.01	0.03	13.79 10.46	13.78	13.6	13.74	13.71	0.09	0.69	-0.60 -0.57		
ME-XRF26 ME-XRF26	MgO	%	0.01 0.01	0.03	7.38	10.45 7.4	10.35 7.33	10.4 7.41	10.40 7.38	0.05 0.04	0.48	-0.57		
ME-XRF20 ME-XRF26	Na ₂ O	%	0.01	0.03	2.43	2.39	2.38	2.41	2.39	0.04	0.59	-1.51		
ME-XRF20 ME-XRF26	K ₂ O	%	0.01	0.03	0.47	0.46	0.46	0.46	0.46	0.02	0.04	-2.13		
ME-XRF26	Cr ₂ O ₃	%	0.01	0.03	0.47	0.02	0.02	0.02	0.02	0.00	0.00	-4.15		
ME-XRF26	TiO ₂	%	0.01	0.03	1.18	1.18	1.16	1.18	1.17	0.01	0.98	-0.56		
ME-XRF26	MnO	%	0.01	0.03	0.2	0.19	0.19	0.19	0.19	0.00	0.00	-5.00		
ME-XRF26	P_2O_5	%	0.01	0.03	0.1	0.11	0.11	0.11	0.11	0.00	0.00	10.00		In the ballpark
ME-XRF26	SrO	%	0.01	0.03		0.02	0.02	0.02	0.02	0.00	0.00			
ME-XRF26	BaO	%	0.01	0.03		0.03	0.03	0.03	0.03	0.00	0.00			
OA-GRA05	LOI	%	0.01	0.03	0.17	-0.11	-0.06	-0.11	-0.09	0.03	-30.93	-154.90	Near LOQ	Near LOQ
TOT-ICP06	Total	%	0.01	0.03		101.25	100.45	101.1	100.93	0.43	0.42			
C-IR07	С	%	0.01	0.03		0.02	0.02	0.02	0.02	0.00	0.00			
S-IR08	S	%	0.01	0.03	0.02	0.04	0.03	0.03	0.03	0.01	17.32	66.67	Near LOQ	Near LOQ
ME-MS81	Ba	ppm	0.5	1.65	142.3 20.59	140.5	155	145.5	147	7.37	5.01	3.30		
ME-MS81	Ce	ppm	0.1	0.33		18.6	19.5	19	19.0 170	0.45	2.37	-7.56 -7.10		Consistent 1
ME-MS81	Cr	ppm	10	33.00	183	160	180	170		10.00	5.88			Consistently lower
ME-MS81	Cs	ppm	0.01	0.03	0.69 4.238	0.6 3.85	0.59 4.01	0.57 3.93	0.59 3.93	0.02	2.60 2.04	-14.98		Near LOQ
ME-MS81 ME-MS81	Dy Er	ppm ppm	0.05	0.17	4.238	3.85	4.01 2.49	3.93 2.48	3.93	0.08	2.04	-7.27		
ME-MS81 ME-MS81	Eu	ppm	0.02	0.07	1.174	1.05	1.1	1.11	2.40	0.04	2.96	-7.44		
ME-MS81 ME-MS81	Ga	ppm	0.02	0.33	19.8	19.2	20.9	20.3	20.1	0.86	4.28	1.68		
ME-MS81	Gd	ppm	0.05	0.17	4.072	3.72	4.1	3.94	3.9	0.19	4.87	-3.73		
ME-MS81	Ge	ppm	5	16.50		-5	-5	-5	-5	0.00	0.00			
ME-MS81	Hf	ppm	0.5	1.65	2.5	2.2	2.4	2.4	2.3	0.12	4.95	-6.67		
ME-MS81	Ho	ppm	0.01	0.03	0.888	0.89	0.84	0.83	0.85	0.03	3.77	-3.90		
ME-MS81	La	ppm	0.1	0.33	9.27	8.4	8.8	8.7	8.6	0.21	2.41	-6.87		
ME-MS81	Lu	ppm	0.01	0.03	0.352	0.32	0.33	0.35	0.33	0.02	4.58	-5.30		
ME-MS81	Nb	ppm	0.1	0.33	4.9	4.6	4.9	4.7	4.7	0.15	3.23	-3.40		
ME-MS81	Nd	ppm	0.1	0.33	12.5	11.3	11.8	11.1	11.4	0.36	3.16	-8.80		
ME-MS81	Pr	ppm	0.02	0.07	2.776	2.44	2.67	2.55	2.55	0.12	4.51	-8.02		
ME-MS81 ME-MS81	Rb	ppm	0.2	0.66	14.04 3.33	12.2	13.8 3.3	13.6 3.26	13.2	0.87 0.12	6.60 3.83	-5.98		
ME-MS81 ME-MS81	Sm Sn	ppm	0.03	3.30	3.33	3.07	3.3	3.26	3.21	0.12	3.83	-3.60		
ME-MS81 ME-MS81	Sn	ppm ppm	0.1	0.33	176.9	164	181	175	173	8.62	4.97	-2.02		
ME-MS81	Та	ppm	0.1	0.33	0.3	0.4	0.4	0.3	0.4	0.06	15.75	22.22	Near LOQ	In the ballpark;
														near LOQ
ME-MS81	Tb	ppm	0.01	0.03	0.682	0.61	0.67	0.66	0.65	0.03	4.97	-5.18		
ME-MS81 ME-MS81	Th Tm	ppm	0.05 0.01	0.17 0.03	1.65 0.368	1.48	1.57 0.37	1.55 0.37	1.53 0.35	0.05	3.08 8.17	-7.07 -3.99		
ME-MS81 ME-MS81	U	ppm ppm	0.01	0.03	0.485	0.32	0.37	0.37	0.35	0.03	4 35	-5.15		
ME-MS81	v	ppm	5	16.50	306	295	339	330	321	23.25	7.23	5.01		
ME-MS81	w	ppm	1	3.30	500	1	1	1	1	0.00	0.00	5.01		
ME-MS81	Y	ppm	0.1	0.33	23.37	21	22.7	21.8	21.83	0.85	3.90	-6.58		
ME-MS81	Yb	ppm	0.03	0.10	2.36	2.08	2.24	2.16	2.16	0.08	3.70	-8.47		
ME-MS81	Zr	ppm	2	6.60	84	86	86	83	85.00	1.73	2.04	1.19		
ME-MS42	As	ppm	0.1	0.33		0.9	1	0.9	0.93	0.06	6.19		-	
ME-MS42	Bi	ppm	0.01	0.03		0.02	0.02	0.02	0.02	0.00	0.00			
ME-MS42	Hg	ppm	0.005	0.02		-0.005	-0.005	-0.005	-0.01	0.00	0.00			
ME-MS42	In	ppm	0.005	0.02		0.015	0.018	0.016	0.02	0.00	9.35			
ME-MS42	Re	ppm	0.001	0.00		0.001	0.001	0.001	0.00	0.00	0.00			
ME-MS42	Sb	ppm	0.05	0.17		-0.05	-0.05	-0.05	-0.05	0.00	0.00			
ME-MS42	Se	ppm	0.2	0.66		0.3	-0.2	-0.2	-0.03	0.29	-866.03		Near LOQ	
ME-MS42 ME-MS42	Te Tl	ppm	0.01 0.02	0.03	0.11	-0.01 0.08	-0.01 0.07	0.01 0.07	0.00 0.07	0.01	-346.41 7.87	-33.33	Near LOQ Near LOQ	
ME-MS42 ME-4ACD81		ppm	0.02	0.07	V.11	-0.5	-0.5	-0.5	-0.5	0.01	0.00	-33.53	ivear LOQ	
ME-4ACD81 ME-4ACD81	Ag Cd	ppm ppm	0.01	0.03		-0.5	-0.5	-0.5	-0.5	0.00	-2424.87		Near LOQ	
ME-4ACD81 ME-4ACD81	Co	ppm ppm	0.02	0.07	60.6	-0.5	-0.5	59	57	1.53	-2424.87	-5.39	Iveal LUQ	
ME-4ACD81 ME-4ACD81	Cu	ppm	0.1	0.66	165.3	167	171	180	173	6.66	3.86	4.46		
ME-4ACD81 ME-4ACD81	Li	ppm	0.2	0.66	n/a	10	10	10	10	0.00	0.00			
ME-4ACD81	Mo	ppm	0.05	0.17	1.42	1	1	1	1	0.00	0.00	-29.58		Very low
ME-4ACD81	Ni	ppm	0.2	0.66	160.5	151	154	159	155	4.04	2.61	-3.63		concentration
ME-4ACD81	Pb	ppm	0.2	1.65	3.3	7	2	2	4	2.89	78.73	11.11	Not great for W812851 - possible carry- over from	Not great for W812851 - possible carry- over from
ME-4ACD81	Sc	ppm	0.1	0.33	34.9	31	31	32	31	0.58	1.84	-10.22	previous batch??	previous batch??
ME-4ACD81	Zn	ppm	2	6.60	98	105	106	109	107	2.08	1.95	8.84		Consistently higher than
Au-ICP21	Au	ppm	0.001	0.00	99	NSS	0.009	0.021	0	0.01	56.57	-99.98	Near LOQ	accepted value Near LOQ

Table A4. 2 Whole rock lithogeochemical data and summary of percent relative difference (% RD) and percent relativestandarddeviation(% RSD)resultsfortheLK-NIP-1standardreferencematerials.

									QAG	QC - ORCA	A 1			
ALS Method	Anal	yte	LOD	3.3 LOD = LOQ	Orca-1 accepted values	W812851	W812863	W812876	Avg	Stdev	%RSD	%RD	Comments on precision	Comments on accuracy
ME-ICP06	SiO ₂	%	0.01	0.03	49.65	49.46	49.18	49.45	49.36	0.16	0.32	-0.58		
ME-ICP06	Al_2O_3	%	0.01	0.03	15.84	15.6	15.48	15.54	15.54	0.06	0.39	-1.89		
ME-ICP06	Fe ₂ O ₃	%	0.01	0.03	13.79	13.78	13.6	13.74	13.71	0.09	0.69	-0.60		
ME-ICP06	CaO	%	0.01	0.03	10.46	10.45	10.35	10.4	10.40	0.05	0.48	-0.57		
ME-ICP06	MgO	%	0.01	0.03	7.38	7.4	7.33	7.41	7.38	0.04	0.59	0.00		
ME-ICP06 ME-ICP06	Na ₂ O K ₂ O	%	0.01	0.03	2.43 0.47	2.39 0.46	2.38	2.41 0.46	2.39 0.46	0.02	0.64	-1.51 -2.13		
ME-ICP06	Cr ₂ O ₃	%	0.01	0.03	0.47	0.40	0.40	0.40	0.40	0.00	0.00	-2.13		
ME-ICP06	TiO	%	0.01	0.03	1.18	1.18	1.16	1.18	1.17	0.01	0.98	-0.56		
ME-ICP06	MnO	%	0.01	0.03	0.2	0.19	0.19	0.19	0.19	0.00	0.00	-5.00		
ME-ICP06	P_2O_5	%	0.01	0.03	0.1	0.11	0.11	0.11	0.11	0.00	0.00	10.00		in the ballpark
ME-ICP06	SrO	%	0.01	0.03		0.02	0.02	0.02	0.02	0.00	0.00			
ME-ICP06	BaO	%	0.01	0.03		0.03	0.03	0.03	0.03	0.00	0.00			
OA-GRA05	LOI	%	0.01	0.03	0.17	-0.11	-0.06	-0.11	-0.09	0.03	-30.93	-154.90	Near LOQ	Near LOQ
TOT-ICP06	Total	%	0.01	0.03		101.25	100.45	101.1	100.93	0.43	0.42			
C-IR07 S-IR08	C S	% %	0.01 0.01	0.03	0.02	0.02	0.02	0.02	0.02	0.00	0.00 17.32	66.67	Near LOO	Near LOO
S-IR08 ME-MS81	Ba		0.01	1.65	142.3	0.04	155	145.5	0.03	7.37	5.01	3.30	Near LOQ	Near LOQ
ME-MS81 ME-MS81	Се	ppm ppm	0.1	0.33	20.59	140.5	19.5	145.5	19.0	0.45	2.37	-7.56		
ME-MS81	Cr	ppm	10	33.00	183	160	180	170	170	10.00	5.88	-7.10		Consistently lowe
ME-MS81	Cs	ppm	0.01	0.03	0.69	0.6	0.59	0.57	0.59	0.02	2.60	-14.98		Near LOQ
ME-MS81 ME-MS81	Dv	ppm	0.01	0.03	4.238	3.85	4.01	3.93	3.93	0.02	2.00	-7.27		mul LOQ
ME-MS81	Er	ppm	0.02	0.07	2.553	2.41	2.49	2.48	2.46	0.04	1.77	-3.64		
ME-MS81	Eu	ppm	0.02	0.07	1.174	1.05	1.1	1.11	1.1	0.03	2.96	-7.44		
ME-MS81	Ga	ppm	0.1	0.33	19.8	19.2	20.9	20.3	20.1	0.86	4.28	1.68		
ME-MS81	Gd	ppm	0.05	0.17	4.072	3.72	4.1	3.94	3.9	0.19	4.87	-3.73		
ME-MS81	Ge	ppm	5	16.50		-5	-5	-5	-5	0.00	0.00			
ME-MS81	Hf	ppm	0.5	1.65	2.5	2.2	2.4	2.4	2.3	0.12	4.95	-6.67		
ME-MS81	Ho	ppm	0.01	0.03	0.888	0.89	0.84	0.83	0.85	0.03	3.77	-3.90		
ME-MS81 ME-MS81	La	ppm	0.1 0.01	0.33	9.27 0.352	8.4 0.32	8.8 0.33	8.7 0.35	8.6 0.33	0.21	2.41 4.58	-6.87 -5.30		
ME-MS81 ME-MS81	Lu Nb	ppm ppm	0.01	0.03	4.9	4.6	4.9	4.7	4.7	0.02	4.58	-3.30 -3.40		
ME-MS81 ME-MS81	Nd	ppm	0.1	0.33	12.5	11.3	11.8	11.1	11.4	0.36	3.16	-8.80		
ME-MS81	Pr	ppm	0.02	0.07	2.776	2.44	2.67	2.55	2.55	0.12	4.51	-8.02		
ME-MS81	Rb	ppm	0.2	0.66	14.04	12.2	13.8	13.6	13.2	0.87	6.60	-5.98		
ME-MS81	Sm	ppm	0.03	0.10	3.33	3.07	3.3	3.26	3.21	0.12	3.83	-3.60		
ME-MS81 ME-MS81	Sn Sr	ppm ppm	1 0.1	3.30 0.33	176.9	1 164	1 181	1 175	1 173	0.00 8.62	0.00 4.97	-2.02		
ME-MS81	Та	ppm	0.1	0.33	0.3	0.4	0.4	0.3	0.4	0.02	15.75	22.22	Near LOQ	In the ballpark;
ME-MS81	Tb		0.01	0.03	0.682	0.61	0.67	0.66	0.65	0.03	4 97	-5.18		near LOQ
ME-MS81 ME-MS81	Th	ppm ppm	0.01	0.03	1.65	1.48	1.57	1.55	1.53	0.05	3.08	-7.07		
ME-MS81	Tm	ppm	0.03	0.03	0.368	0.32	0.37	0.37	0.35	0.03	8.17	-3.99		
ME-MS81	U	ppm	0.05	0.17	0.485	0.44	0.46	0.48	0.46	0.02	4.35	-5.15		
ME-MS81	v	ppm	5	16.50	306	295	339	330	321	23.25	7.23	5.01		
ME-MS81	w	ppm	1	3.30		1	1	1	1	0.00	0.00			
ME-MS81	Y	ppm	0.1	0.33	23.37	21	22.7	21.8	21.83	0.85	3.90	-6.58		
ME-MS81	Yb	ppm	0.03	0.10	2.36	2.08	2.24	2.16	2.16	0.08	3.70	-8.47		
ME-MS81	Zr	ppm	2	6.60	84	86	86	83	85.00	1.73	2.04	1.19	l i i i i i i i i i i i i i i i i i i i	
ME-MS42	As D:	ppm	0.1	0.33		0.9	1	0.9	0.93	0.06	6.19			
ME-MS42 ME-MS42	Bi	ppm	0.01 0.005	0.03		0.02	0.02	0.02	0.02 -0.01	0.00	0.00			
ME-MS42 ME-MS42	Hg In	ppm ppm	0.005	0.02		-0.005	-0.005	-0.005	-0.01	0.00	9.35			
ME-MS42 ME-MS42	Re	ppm ppm	0.005	0.02		0.015	0.018	0.018	0.02	0.00	0.00			
ME-MS42 ME-MS42	Sb	ppm	0.05	0.17		-0.05	-0.05	-0.05	-0.05	0.00	0.00			
ME-MS42 ME-MS42	Se	ppm	0.2	0.66		0.3	-0.2	-0.2	-0.03	0.29	-866.03		Near LOQ	
ME-MS42	Te	ppm	0.01	0.03		-0.01	-0.01	0.01	0.00	0.01	-346.41		Near LOQ	
ME-MS42	T1	ppm	0.02	0.07	0.11	0.08	0.07	0.07	0.07	0.01	7.87	-33.33	Near LOQ	
/IE-4ACD81	Ag	ppm	0.01	0.03		-0.5	-0.5	-0.5	-0.5	0.00	0.00			
AE-4ACD81	Cd	ppm	0.02	0.07		-0.5	-0.5	0.9	0.0	0.81	-2424.87		Near LOQ	
ME-4ACD81	Co	ppm	0.1	0.33	60.6	56	57	59	57	1.53	2.66	-5.39		
/E-4ACD81	Cu	ppm	0.2	0.66	165.3	167	171	180	173	6.66	3.86	4.46		
/IE-4ACD81	Li	ppm	0.2	0.66	n/a	10	10	10	10	0.00	0.00			Vandar
/IE-4ACD81	Mo	ppm	0.05	0.17	1.42	1	1	1	1	0.00	0.00	-29.58		Very low concentration
/IE-4ACD81	Ni	ppm	0.2	0.66	160.5	151	154	159	155	4.04	2.61	-3.63	Not great for	Not great for
/IE-4ACD81	Pb	ppm	0.5	1.65	3.3	7	2	2	4	2.89	78.73	11.11	W812851 - possible carry- over from previous batch??	W812851 - possible carry- over from previous batch??
/IE-4ACD81	Sc	ppm	0.1	0.33	34.9	31	31	32	31	0.58	1.84	-10.22		Consistently
/E-4ACD81	Zn	ppm	2	6.60	98	105	106	109	107	2.08	1.95	8.84		Consistently higher than accepted value
Au-ICP21	Au	ppm	0.001	0.00	99	NSS	0.009	0.021	0	0.01	56,57	-99.98	Near LOQ	Near LOQ

Table A4. 3 Whole rock lithogeochemical data and summary of percent relative difference (% RD) and percent relative standard deviation (% RSD) results for the ORCA-1 standard reference materials.

Table A4. 4 Summary	of average	coefficient	of variation	for three	duplicate]	pairs.

			~		Duplica			te pair 2	Duplica		-
	-		Sample		W604709	W812871	W604712	W812872	W604724	W812858	-
				Certificate	KL18175066	VA20253932	KL18175066	VA20253932	KL18175066	VA20253932	
ALS Method	Anal	yte	LOD	LOQ	High-silic	a rhyolite	Mafie	c Dyke	Trachy	te Dyke	Cva
ME-XRF26	SiO_2	%	0.01	0.03	67.01	67.86	53.17	53.41	53.38	55.89	1.9
ME-XRF26	Al_2O_3	%	0.01	0.03	14.80	14.74	17.53	17.86	18.59	19.31	1.7
ME-XRF26	Fe ₂ O ₃	%	0.01	0.03	3.87	3.58	8.08	8.14	5.32	4.82	5.1
ME-XRF26	CaO	%	0.01	0.03	4.09	4.27	8.30	8.25	5.50	4.60	7.4
ME-XRF26	MgO	%	0.01	0.03	1.04	0.97	3.89	3.87	1.58	1.30	8.4
ME-XRF26	Na ₂ O	%	0.01	0.03	3.59	3.56	0.88	0.88	2.41	2.34	1.2
ME-XRF26	K ₂ O	%	0.01	0.03	0.35	0.37	3.04	3.11	5.84	6.49	4.9
ME-XRF26	Cr_2O_3	%	0.01	0.03	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.0
ME-XRF26	TiO ₂	%	0.01	0.03	0.15	0.15	0.65	0.66	0.55	0.53	1.6
ME-XRF26	MnO	%	0.01	0.03	0.03	0.03	0.12	0.12	0.16	0.13	8.4
ME-XRF26	P_2O_5	%	0.01	0.03	0.05	0.04	0.16	0.15	0.24	0.22	10.0
ME-XRF26	SrO	%	0.01	0.03	0.02	0.02	0.10	0.10	0.19	0.18	2.2
ME-XRF26	BaO	%	0.01	0.03	0.24	0.25	0.04	0.07	0.77	0.90	23.2
OA-GRA05	LOI	%	0.01	0.03	3.59	3.68	3.15	3.04	3.83	3.28	6.5
TOT-ICP06	Total	%	0.01	0.03	98.94	99.64	99.66	100.25	98.77	100.45	0.7
C-IR07	С	%	0.01	0.03	0.48	0.50	0.28	0.21	0.88	0.65	17.0
S-IR08	s	%	0.01	0.03	0.02	0.04	0.20	0.20	0.14	0.16	27.3
ME-MS81	Ba	ppm	0.5	1.65	2410	2540	556	611	7090	9130	11.1
ME-MS81	Ce	ppm	0.1	0.33	252.00	240.00	31.20	31.70	172.50	198.00	6.0
ME-MS81	Cr	ppm	10	33.00	-10	-10	10	10	10	20	27.2
ME-MS81	Cs	ppm	0.01	0.03	1.36	1.24	1.16	1.00	1.25	1.17	7.6
ME-MS81	Dy	ppm	0.05	0.17	32.50	29.50	2.55	2.55	5.22	6.17	7.8
ME-MS81	Er	ppm	0.02	0.07	18.00	17.25	1.41	1.55	2.67	3.02	6.5
ME-MS81	Eu	ppm	0.02	0.07	5.11	5.03	0.97	1.08	3.22	3.36	4.7
ME-MS81	Ga	ppm	0.1	0.33	35.9	36.8	20.4	21.4	24.4	26.1	3.5
ME-MS81	Gd	ppm	0.05	0.17	29.60	28.80	2.88	3.19	8.62	9.55	6.0
ME-MS81	Ge	ppm	5	16.50	-5	-5	-5	-5	-5	-5	0.0
ME-MS81	Hf	ppm	0.5	1.65	15.6	14.9	2.4	2.7	7.3	8.2	7.0
ME-MS81	Но	ppm	0.01	0.03	6.29	5.70	0.54	0.52	0.98	1.16	8.1
ME-MS81	La	ppm	0.1	0.33	119.0	111.5	15.5	15.9	94.3	108.0	6.2
ME-MS81	Lu	ppm	0.01	0.03	2.76	2.63	0.25	0.25	0.43	0.46	3.3
ME-MS81	Nb	ppm	0.1	0.33	81.9	79.5	4.6	5.2	20.7	24.5	8.5
ME-MS81	Nd	ppm	0.1	0.33	122.5	111.5	16.5	16.2	74.7	84.5	6.3
ME-MS81	Pr	ppm	0.02	0.07	31.00	28.40	3.82	4.05	19.75	22.70	7.1
ME-MS81	Rb	ppm	0.2	0.66	52.6 29.40	54.5	18.9	20.1	63.8	62.2	3.0
ME-MS81	Sm Sm	ppm	0.03	0.10 3.30	29.40	28.30 9	3.69	3.77	13.25	14.55	4.2
ME-MS81 ME-MS81	Sn	ppm	1	0.33	182	179	1 931	1 938	1 1650	1 1690	1.2
	Sr Ta	ppm	0.1								
ME-MS81 ME-MS81	Ta Tb	ppm	0.1 0.01	0.33	5.0 5.29	4.8 5.15	0.3 0.43	0.4 0.46	1.1 1.01	1.3 1.22	13.0
ME-MS81 ME-MS81	Th	ppm	0.01	0.03	14.10	13.95	3.05	3.11	24.70	27.60	4.6
ME-MS81 ME-MS81		ppm	0.03	0.03	2.89	2.63	0.22	0.24	0.37	0.43	8.0
ME-MS81 ME-MS81	Tm U	ppm ppm	0.01	0.03	3.85	3.52	1.29	1.28	11.95	13.00	5.0
ME-MS81 ME-MS81	v		5	16.50	5.85	5	225	254	11.95	95	8.0
ME-MS81 ME-MS81	w	ppm	1	3.30	1	1	1	1	2	2	0.0
ME-MS81 ME-MS81	Y	ppm	0.1	0.33	139.5	135.0	14.3	14.5	28.8	31.8	4.3
ME-MS81	Yb	ppm	0.03	0.10	18.45	18.15	1.38	1.55	2.72	2.83	5.0
ME-MS81 ME-MS81	Zr	ppm ppm	2	6.60	439.00	414.00	92.00	95.00	320.00	374.00	6.9
ME-MS42	As	ppm	0.1	0.33	0.4	0.6	2.2	2.5	0.9	0.7	19.
ME-MS42	Bi	ppm	0.01	0.03	0.01	0.01	0.01	0.01	0.09	0.06	16.3
ME-MS42	Hg	ppm	0.005	0.02	0.01	-0.01	-0.01	-0.01	-0.01	-0.01	10
ME-MS42 ME-MS42	In	ppm	0.005	0.02	0.03	0.02	0.01	0.01	0.01	0.01	28.
ME-MS42	Re	ppm	0.001	0.02	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.0
ME-MS42	Sb	ppm	0.001	0.17	0.16	0.99	0.30	0.42	0.28	0.25	60.
ME-MS42	Se	ppm	0.2	0.66	0.3	0.3	3.8	2.6	1.6	0.7	35.
ME-MS42	Te	ppm	0.01	0.03	-0.01	0.01	-0.01	0.01	0.01	-0.01	
ME-MS42 ME-MS42	TI	ppm	0.02	0.07	0.23	0.19	0.26	0.22	0.53	0.39	16.
ME-4ACD81	Ag	ppm	0.02	0.03	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	0.0
ME-4ACD81	Cd	ppm	0.01	0.07	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	0.0
ME-4ACD81 ME-4ACD81	Co	ppm	0.02	0.33	-0.5	2	25	24	8	6	29.
ME-4ACD81 ME-4ACD81	Cu	ppm	0.1	0.66	11	9	30	24	8	8	31.
ME-4ACD81 ME-4ACD81	Li	ppm ppm	0.2	0.66	10	10	20	24 20	10	8 10	0.0
ME-4ACD81 ME-4ACD81	Mo		0.2	0.17	-1	1	-1	1	-1	-1	0.0
ME-4ACD81 ME-4ACD81	Ni	ppm	0.05	0.66	-1	2	-1	5	-1 3	-1	28.
ME-4ACD81 ME-4ACD81	Pb	ppm		1.65	7	2 7	6 7	5 17	3 13	3	28. 37.
MIC-HACDOI	r0	ppm	0.5							У	
ME-4ACD81	Sc	ppm	0.1	0.33	1	1	16	16	6	3	27.

Appendix 4 References

- Abzalov, M., 2008, Quality control of assay data: a review of procedures for measuring and monitoring precision and accuracy: Exploration and Mining Geology, v. 17, p. 131–144.
- Jenner, G., 1996, Trace element geochemistry of igneous rocks: geochemical nomenclature and analytical geochemistry: Geological Association of Canada, Short Course Notes, p. 51–77.
- Piercey, S.J., 2014, A review of quality assurance and quality control (QA/QC) procedures for lithogeochemical data: Geoscience Canada, v. 41, p. 75–88.

Appendix 5. U-Pb geochronology

Sample collection

Two samples of felsic rocks from the AG stratigraphy were collected from drill hole 110 to constrain the timing of VMS mineralization at AG based on their stratigraphic location, lithology, and geochemical attributes. Sample 110-322 is a hydrothermally altered FeR lapilli tuff collected at a downhole depth of 322 m (Fig. A5. 1); this FeR lapilli tuff is along strike of exhalative VMS mineralization and underlies hydrothermally altered and mineralized heterolithic fragmental rocks and overlies FeA flows. Sample 110-368 is massive high-silica rhyolite (HSR) with patchy epidote, chlorite, and calcite alteration collected at a downhole depth of 368 m (Fig. A5. 2); this HSR intrudes the FeA flows downhole of the ferrorhyolite lapilli tuffs. The samples were collected during the summer of 2020 and sent to the Boise State University Isotope Geology Laboratory (BSU IGL) in Idaho in the Spring of 2021.

Analytical methodology

Mineral separation and extraction, imaging, laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS), and chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) were all performed by Dr. James Crowley and his team at the BSU IGL Isotope Geology Laboratory. Dr. James Crowley of the Boise State University Isotope Geology Laboratory provided the following text for analytical methods:

LA-ICPMS methodology

Zircon grains were separated from rocks using standard techniques, annealed at 900°C for 60 hours in a muffle furnace, and mounted in epoxy and polished until their centers were exposed. Cathodoluminescence (CL) images were obtained with a JEOL JSM-300 scanning electron microscope and Gatan MiniCL. Zircon was analyzed by laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) using an iCAP RQ Quadrupole ICP-MS and Teledyne Photon Machines Analyte Excite+ 193 nm excimer laser ablation system with HelEx II Active two-volume ablation cell. In-house analytical protocols, standard materials, and data reduction software were used for acquisition and calibration of U-Pb dates and a suite of high field strength elements (HFSE) and rare earth elements (REE). Zircon was ablated with a laser spot of 20 µm wide using fluence and pulse rates of 2.5 J/cm² and 10 Hz, respectively, during a 25 second analysis (15 sec gas blank, 10 sec ablation) that excavated a pit $\sim 8 \,\mu m$ deep. Ablated material was carried by a 0.25 L/min He gas stream in the inner cell and a 1.25 L/min He gas stream in the outer cell. Dwell times are given in Table A5. 1 and Table A5. 2. Background count rates for each analyte were obtained prior to each spot analysis and subtracted from the raw count rate for each analyte. Ablations pits that appear to have intersected glass or mineral inclusions were identified based on Ti and P. U-Pb dates from these analyses are considered valid if the U-Pb ratios appear to have been unaffected by the inclusions. Analyses that appear contaminated by common Pb were rejected based on mass 204 being above baseline. For concentration calculations, background-subtracted count rates for each analyte were internally normalized to ²⁹Si and calibrated with respect to NIST SRM-610 and -612 glasses as the primary standards. Temperature was calculated from the Ti-in-zircon thermometer (Watson et al., 2006). Because there are no constraints on the activity of TiO₂, an average value in crustal rocks of 0.6 was used.

Data was obtained in two experiments in March 2022. For U-Pb and ²⁰⁷Pb/²⁰⁶Pb dates, instrumental fractionation of the background-subtracted ratios was corrected, and dates were calibrated with respect to interspersed measurements of zircon standards and reference materials. The primary standard Plešovice zircon (Sláma et al., 2008) was used to monitor time-dependent instrumental fractionation based on two analyses for every 12 analyses of unknown zircon. A secondary correction to the ²⁰⁶Pb/²³⁸U dates was made based on results from the zircon standards Seiland (531 Ma, Kuiper et al., 2022) and 91500 (1065 Ma, Wiedenbeck et al., 1995), which were treated as unknowns and measured once for every 12 analyses of unknown zircon. These results (Table A5. 6; Table A5. 5) showed a linear age bias of several percent that is related to the ²⁰⁶Pb count rate. The secondary correction is thought to mitigate matrix-dependent variations due to contrasting compositions and ablation characteristics between the Plešovice zircon and other standards (and unknowns).

Radiogenic isotope ratio and age error propagation for all analyses includes uncertainty contributions from counting statistics and background subtraction. Errors without and with the standard calibration uncertainty are shown in Table A5. 3 and Table A5. 4. This uncertainty is the local standard deviation of the polynomial fit to the interspersed primary standard measurements versus time for the time-dependent, relatively larger U/Pb fractionation factor, and the standard error of the mean of the consistently time-invariant and smaller 207 Pb/ 206 Pb fractionation factor. These uncertainties are shown in Table A5. 1 and Table A5. 2. Errors on single analyses without the standard calibration uncertainty are given below. Age interpretations are based on 206 Pb/ 238 U. Discordance, defined as the relative difference between the 207 Pb/ 235 U and 206 Pb/ 238 U dates, outside of uncertainty of 5% is flagged with strikethrough font in Table A5. 3 and Table A5. 4. Discordant results were not used to interpret age. Errors are at 2 \Box .

CA-ID-TIMS U-Pb geochronology method

U-Pb dates were obtained by the chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) method from analyses composed of single zircon grains (Table 2.4), modified after Mattinson (2005). Zircon was removed from the epoxy mounts for dating based on CL images (Fig. A5. 3, Fig. A5. 4) and LA-ICPMS data (Table A5. 3, Table A5. 4). Zircon was put into 3 ml Teflon PFA beakers and loaded into 300 µl Teflon PFA microcapsules. Fifteen microcapsules were placed in a large-capacity Parr vessel and the zircon partially dissolved in 120 µl of 29 M HF for 12 hours at 190°C. Zircon was returned to 3 ml Teflon PFA beakers, HF was removed, and zircon was immersed in 3.5 M HNO₃, ultrasonically cleaned for an hour, and fluxed on a hotplate at 80°C for an hour. The HNO₃ was removed, and zircon was rinsed twice in ultrapure H₂O before being reloaded into the 300 µl Teflon PFA microcapsules (rinsed and fluxed in 6 M HCl during sonication and washing of the zircon) and spiked with the Boise State University mixed ²³³U-²³⁵U-²⁰⁵Pb tracer solution (BSU-1B). Zircon was dissolved in Parr vessels in 120 µl of 29 M HF with a trace of 3.5 M HNO₃ at 220°C for 48 hours, dried to fluorides, and re-dissolved in 6 M HCl at 180°C overnight. U and Pb were separated from the zircon matrix using an HCl-based anion-exchange chromatographic procedure (Krogh, 1973), eluted together and dried with 2 µl of 0.05 N H₃PO₄.

Pb and U were loaded on a single outgassed Re filament in 5 μ l of a silica-gel/phosphoric acid mixture (Gerstenberger and Haase, 1997), and U and Pb isotopic measurements made on a GV Isoprobe-T or IsotopX Phoenix multicollector thermal ionization mass spectrometer equipped with an ion-counting Daly detector. Pb isotopes were measured by peak-jumping all isotopes on the Daly detector for 160-250 cycles and corrected for $0.18 \pm 0.03\%/a.m.u.$ (1 σ) mass fractionation for analyses done on the GV Isoprobe-T and $0.24 \pm 0.03\%/a.m.u.$ (1 σ) mass fractionation for analyses done on the IsotopX Phoenix. Transitory isobaric interferences due to high-molecular weight organics, particularly on ²⁰⁴Pb and ²⁰⁷Pb, disappeared within approximately 60 cycles, while ionization efficiency averaged 10⁴ cps/pg of each Pb isotope. Linearity (to $\geq 1.4 \times 10^6$ cps) and the associated deadtime correction of the Daly detector were determined by analysis of NBS982. Uranium was analyzed as UO₂⁺ ions in static Faraday mode on 10^{12} ohm resistors for 200-300 cycles and corrected for isobaric interference of $^{233}U^{18}O^{16}O$ on $^{235}U^{16}O^{16}O$ with an $^{18}O/^{16}O$ of 0.00206. Ionization efficiency averaged 20 mV/ng of each U isotope. U mass fractionation was corrected using the known $^{233}U/^{235}U$ ratio of the Boise State University tracer solution.

U-Pb dates and uncertainties were calculated using the algorithms of Schmitz and Schoene (2007), calibration of BSU-1B tracer solution of $^{235}U/^{205}Pb$ of 77.93 and $^{233}U/^{235}U$ of 1.007066 for, U decay constants recommended by Jaffey et al., (1971), and $^{238}U/^{235}U$ of 137.818 (Hiess et al., 2012). $^{206}Pb/^{238}U$ ratios and dates were corrected for initial ^{230}Th disequilibrium using D_{Th/U} = 0.20 ± 0.05 (1 σ) and the algorithms of Crowley et al. (2007), resulting in an increase in the $^{206}Pb/^{238}U$ dates of ~0.09 Ma. All common Pb in analyses was attributed to laboratory blank and subtracted based on the measured laboratory Pb isotopic composition and associated uncertainty. U blanks are estimated at 0.013 pg.

Weighted mean ²⁰⁶Pb/²³⁸U dates are calculated from equivalent dates (probability of fit >0.05) using Isoplot 3.0 (Ludwig, 2003) with error at the 95% confidence interval. Error is computed as the internal standard deviation multiplied by the Student's t-distribution multiplier for a two-tailed 95% critical interval and n-1 degrees of freedom when the reduced chi-squared statistic, mean squared weighted deviation (MSWD) (Wendt and Carl, 1991), takes a value less than its expectation value plus its standard deviation at the same confidence interval, which is when MSWD is <1+2*sqrt[2/(n-1)]. This error is expanded via multiplication by the sqrt (MSWD) when the MSWD is \geq 1+2*sqrt[2/(n-1)] to accommodate unknown sources of over dispersion. Errors on the weighted mean dates are given as $\pm x / y / z$, where x is the internal error based on analytical uncertainties only, including counting statistics, subtraction of tracer solution, and blank and initial common Pb subtraction, y includes the tracer calibration uncertainty

propagated in quadrature, and z includes the ²³⁸U decay constant uncertainty propagated in quadrature. Internal errors should be considered when comparing our dates with ²⁰⁶Pb/²³⁸U dates from other laboratories that used the same tracer solution or a tracer solution that was cross calibrated using EARTHTIME gravimetric standards. Errors including the uncertainty in the tracer calibration should be considered when comparing our dates with those derived from other geochronological methods using the U-Pb decay scheme (e.g., laser ablation ICPMS). Errors including uncertainties in the tracer calibration and ²³⁸U decay constant (Jaffey et al., 1971) should be considered when comparing our dates with those derived from other decay schemes (e.g., ⁴⁰Ar/³⁹Ar, ¹⁸⁷Re-¹⁸⁷Os). Errors on dates from individual analyses are 2 σ .

Results

Dr. James Crowley of the Boise State University Isotope Geology Laboratory provided the following text for results:

Eleven zircon grains from CMR-110-322 analyzed by LA-ICPMS yield dates of 212 ± 6 to 194 ± 5 Ma. Seven zircon grains were analyzed by CA-ID-TIMS. The three youngest dates yield a weighted mean date of 210.35 ± 0.27 (random) / 0.27 (+ tracer) / 0.35 (+ decay constant) Ma (MSWD = 1.1, probability of fit = 0.32). Four other grains that yield dates of 211.03 ± 0.32 to 210.68 ± 0.17 Ma are interpreted as containing inherited components.

Forty-nine zircon grains from CMR-110-368 analyzed by LA-ICPMS yield dates of 213 \pm 5 to 189 \pm 4 Ma. Six zircon grains analyzed by CA-ID-TIMS yield a weighted mean date of 210.52 \pm 0.08 / 0.10 / 0.25 Ma (MSWD = 1.2, probability of fit = 0.29). This is the interpreted igneous crystallization age.

Table A5. 1 Metadata for LA-ICPMS U-Pb analyses for sample 110-322.

Laboratory and Sample Preparation	Sample 110-322
Laboratory name	Boise State University Isotope Geology Laboratory
Sample type/mineral	Zircon
Sample preparation	Conventional mineral separation, 1 inch resin mount, 0.3 μm polish to finish
Imaging	CL, JEOL T300, 10 nA, 17 mm working distance
Laser ablation system Make, Model and type	Teledyne (Photon Machines) Analyte Excite+
Ablation cell and volume	HelEx II active 2-volume ablation cell
Laser wavelength (nm)	193 nm ArF excimer
Pulse width (ns)	4 ns
Fluence (J cm ⁻²)	energy stabilization mode, set daily at ~2.5 J cm ⁻² using in-cell EPC utility
Repetition rate (Hz)	10 Hz
Ablation duration (s)	10 s
Ablation pit depth / ablation rate	10 µm pit depth, measured using an optical microscope, equivalent to 0.1 µm/pulse
Spot diameter (µm)	20 µm
Sampling mode / pattern	Static spot ablation
Cell carrier gas flow (I min ⁻¹)	0.25 L min ⁻¹ He cup flow, 1.25 L min ⁻¹ He cell flow
ICP-MS Instrument	
Make, Model and type	ThermoElectron, iCAP-RQ, single quadrupole mass spectrometer
Sample introduction	190 cm long, 1 cm i.d. PFA tubing with Glass Expansion sample mixing chamber, 2.5 mm quartz injector; Ni cones, high-sensitivity skimmer insert
RF power (W)	1400 W
Make-up gas flow (I min ⁻¹)	~0.65 l min ⁻¹ Ar and 2 mL min ⁻¹ N ₂ gas introduced in mixing bulbs between cell and torch
Detection system	single ion-counting SEM
Masses measured and dwell times per peak (ms)	89,91,177(2); 31,93,140,146,147,157,159,163,165,166,169,172,175,181(5); 29,139,141,202,204,232,238(10); 206(40); 207(60);49(100)
Total integration time (s)	~0.371 s
'Sensitivity' as useful yield	0.8% U [(#ions detected/#atoms sampled)*100; Schaltegger et al. 2015]
IC Dead time (ns)	44 ns
Data Processing	
Gas blank	15 s on-peak zero subtracted.
Calibration strategy Common-Pb correction	Mean of ratios; mass discrimination from interspersed zircon standard materials. No common-Pb correction applied; sweeps with mass 204 signals above background rejected.
Data processing packages	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation.
Uncertainty level and propagation	Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate.
Discordance criteria	Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2.
Interpreted age transition	The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁶ Pb to ²⁰⁶ Pb/ ²⁸⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2.
	²⁰⁷ Pb/ ²⁰⁶ Pb fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1]
	²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.62% (1 sigma) [Zircon_08March2022_Miscellaneous_1]
Mass discrimination corrections	²⁰⁸ Pb/ ³³² Th fractionation error (from PL): 1.81% (1 sigma) [Zircon_08March2022_Miscellaneous_1]
	Plešovice (PL) (Slama et al. 2008); 336.9 Ma
Quality control & validation standards	91500 (Wiedenbeck et al., 1995); 1065.4 Ma
	Seiland (Kuiper et al. 2022); 530.6 Ma
	Zircon_08March2022_Miscellaneous_1: 91500 (²⁰⁶ Pb/ ²⁸³ U) = 1088 ± 13 (95% c.i., MSWD = 0.9, pof = 0.53, n = 9)
	Zircon_08March2022_Miscellaneous_1: 91500 (²⁰⁷ Pb) ²⁰⁸ Pb) = 1057 ± 36 (95% c.i., MSWD = 0.9, pof = 0.53, n = 9)
Quality control & validation results	Zircon_08March2022_Miscellaneous_1: Seiland (²⁰⁰ Pb/ ¹³⁸ U) = 527 ± 7 (95% c.i., MSWD = 0.6, pof = 0.77, n = 10)

Table A5. 2 Metadata for LA-ICPMS U-Pb analyses for sample 110-368.

Laboratory and Sample Preparation	Sample 110-368
Laboratory name	Boise State University Isotope Geology Laboratory
Sample type/mineral	Zircon
Sample preparation	Conventional mineral separation, 1 inch resin mount, 0.3 μ m polish to finish
Imaging	CL, JEOL T300, 10 nA, 17 mm working distance
Laser ablation system Make, Model and type	Teledyne (Photon Machines) Analyte Excite+
Ablation cell and volume	HelEx II active 2-volume ablation cell
Laser wavelength (nm)	193 nm ArF excimer
Pulse width (ns)	4 ns
Fluence (J cm ⁻²)	energy stabilization mode, set daily at ~2.5 J cm ⁻² using in-cell EPC utility
Repetition rate (Hz) Ablation duration (s)	10 Hz 10 s
Ablation pit depth / ablation rate	10 μm pit depth, measured using an optical microscope, equivalent to 0.1 μm/pulse
Spot diameter (µm)	20 µm
Sampling mode / pattern	Static spot ablation
Cell carrier gas flow (I min ⁻¹)	0.25 L min ⁻¹ He cup flow, 1.25 L min ⁻¹ He cell flow
ICP-MS Instrument Make, Model and type	ThermoElectron, iCAP-RQ, single quadrupole mass spectrometer
Sample introduction	190 cm long, 1 cm i.d. PFA tubing with Glass Expansion sample mixing chamber, 2.5 mm quartz injector; Ni cones, high-sensitivity skimmer insert
RF power (W)	1400 W
Make-up gas flow (I min ⁻¹)	$^{\sim}$ 0.65 l min $^{-1}$ Ar and 2 mL min $^{-1}$ N $_2$ gas introduced in mixing bulbs between cell and torch
Detection system	single ion-counting SEM
Masses measured and dwell times per peak (ms)	89,91,177(2); 31,93,140,146,147,157,159,163,165,166,169,172,175,181(5); 29,139,141,202,204,232,238(10); 206(40); 207(60);49(100)
Total integration time (s)	~ 0.371 s
'Sensitivity' as useful yield	0.8% U [(#ions detected/#atoms sampled)*100; Schaltegger et al. 2015]
IC Dead time (ns)	44 ns
Data Processing	
Gas blank Calibration strategy	15 s on-peak zero subtracted. Mean of ratios; mass discrimination from interspersed zircon standard materials.
	mean of ratios, mass discrimination from interspersed zircon standard materials.
Common-Pb correction	No common-Pb correction applied; sweeps with mass 204 signals above background rejected.
Common-Pb correction	No common-Pb correction applied; sweeps with mass 204 signals above background rejected. ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation.
	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data
Data processing packages	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference
Data processing packages Uncertainty level and propagation	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of
Data processing packages Uncertainty level and propagation Discordance criteria	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁸ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ³⁰⁷ Pb/ ²⁰⁸ Pb to ²⁰⁸ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2.
Data processing packages Uncertainty level and propagation Discordance criteria	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2 <i>s</i> absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁶ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁶ Pb to ²⁰⁶ Pb/ ²³⁶ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2.
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁸ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ³⁰⁷ Pb/ ²⁰⁸ Pb to ²⁰⁸ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2.
Data processing packages Uncertainty level and propagation Discordance criteria	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁶ Pb /o ²⁰⁶ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁵ Pb fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1]
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁸ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁹ Pb to ²⁰⁸ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ Pb fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁸ Pb/ ²³⁸ U fractionation error (from PL): 1.81% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁸ Pb/ ²³⁸ D fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2]
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁶ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁶ Pb to ²⁰⁶ Pb/ ²³⁶ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ Pb fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.31% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁷ Pb/ ²⁰⁶ Pb fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁶ U fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁷ Th fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁷ Th fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁷ Th fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2]
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁸ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁹ Pb to ²⁰⁸ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ Pb fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁸ Pb/ ²³⁸ U fractionation error (from PL): 1.81% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁸ Pb/ ²³⁸ D fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁹ Pb/ ²³⁸ U fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2]
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁶ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁶ Pb to ²⁰⁶ Pb/ ²³⁶ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ Pb fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.31% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁷ Pb/ ²⁰⁶ Pb fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁶ U fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁷ Th fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁷ Th fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁷ Th fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2]
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition Mass discrimination corrections	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁸ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ⁷⁰⁸ Pb of ²⁰⁸ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. The transition error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.42% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁷ Pb/ ²⁰⁸ Pb fractionation error (from PL): 0.33% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2]
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition Mass discrimination corrections	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2 <i>s</i> absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁶ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁶ Pb to ²⁰⁶ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ D fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.62% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁷ Pb/ ²⁰⁸ D fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁷ Pb/ ²⁰⁸ D fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.55% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 1.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fract
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition Mass discrimination corrections	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁶ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ³⁰⁷ Pb/ ²⁰⁶ Pb to ²⁰⁶ Pb/ ²³⁶ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ Pb fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.62% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.65% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.65% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.65% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionati
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition Mass discrimination corrections Quality control & validation standards	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁶ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁵ Pb to ²⁰⁸ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ Pb fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.42% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.35% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 1.61% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 1.61% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 1.61% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 1.61% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 1.61% (1 sigma) [Zircon_08March2022_Miscellaneou
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition Mass discrimination corrections	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁸ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ⁷⁰⁵ Pb to ²⁰⁶ Pb/ ⁷²⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ D fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁸ Pb/ ²³⁸ U fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.43% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ Th fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.67% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.67% (1 sigma) Zircon_08March2022_Miscellaneous_2] ²⁰⁷ Pb/ ²⁰⁸ D fractionation error (from PL): 0.67% (1 sigma) Zircon_08March2022_Miscellaneous_3] ²⁰⁸ Pb/ ²³⁸ D fractionation error (from PL): 0.67% (1 sigma) Zircon_08March2022_Miscellaneous_3] ²⁰⁸ Pb/ ²³⁸ D fractionation error (from
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition Mass discrimination corrections Quality control & validation standards	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁶ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ²⁰⁷ Pb/ ²⁰⁶ Pb to ²⁰⁶ Pb/ ²³⁸ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²³⁶ D fractionation error (from PL): 0.40% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁶ Pb/ ²³⁸ U fractionation error (from PL): 0.62% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁷ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁷ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 1.61% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionatio
Data processing packages Uncertainty level and propagation Discordance criteria Interpreted age transition Mass discrimination corrections Quality control & validation standards	ThermoElectron Qtegra TRA software for integrated cps acquisition; in-house Microsoft VBA coded spreadsheet for data normalisation, concentration calibration, uncertainty propagation and age calculation. Ages quoted at 2s absolute; propagation is by quadratic addition. Systematic errors from reproducibility of primary reference material propagated where appropriate. Discordance is the relative difference between the measured ²⁰⁷ Pb/ ²³⁵ U and ²⁰⁶ Pb/ ²³⁶ U dates; discordance outside of uncertainty of 5% is flagged with strikethrough font in Table S2. The transition from preferred interpretation of ³⁰⁷ Pb/ ²⁰⁶ Pb to ²⁰⁶ Pb/ ²³⁶ U dates is set at 1500 Ma; preferred date is flagged with bold font in Table S2. ²⁰⁷ Pb/ ²⁰⁸ Pb fractionation error (from PL): 0.62% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁸ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_1] ²⁰⁹ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.63% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.65% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.65% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.65% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.65% (1 sigma) [Zircon_08March2022_Miscellaneous_2] ²⁰⁶ Pb/ ²³⁸ D fractionation error (from PL): 0.65% (1 sigma

					c	ompositio	un -							Cor	rected isotop	c ratios						
LA ICPMS	CA- TIMS	U		Th	Pb		^{a s} Pb	Pt			200 Pb	±28	Pb	<u>12</u> 8	200 PO	128	error	<u>~"U</u>	<u>±2</u> 8	22-	Po	_28
laba	le oel	pom		PP~	ppm	TH/U	cps	×4PE		±′s	²³² Th	(%)	²⁰⁰ U	(%)	²⁸ U	(%)	coʻr	xspt	(36)	23	РЪ	(%)
	-					0.536	28542	1198				E 107			0.03338		0.7.000			0.04		
215 215	27 25	786		423 62	31.4 7.5	0.538	28542	7068		342 127	0.00937	5.107 13.5628	0.2285	4.0 9.0	0.03338	30 34	0.71568; 0.36598;					2.7 8.3
215	zß	236		86	8.7	0.373	5377	451		5	0.01002	7.323322		5.9	0.03189	41	0.400900					9.1
212		327		121	12.0	0.372	11409	796		-9	0.00935			6.7	0.03184	3.9	0.443876					7.8
213 218	24	533 206		224 58	19.6 7.3	0.421	19041 8051	1593 8051		105 °	0.00853			8.7 10.0	0.03178	22	0.30702/ 0.401683					6.3 9.1
215	z6	327		123	11.8	0.271	13105	579		5	0.00943			5.8	0.03142	2.5	0.40723					5.2
220		208		64	7.4	0.305	5217	329		2	0.00958	10 65895		7.4	0.03133	35	0.456523					6.6
210		206		55	7.3	0.274	7732	922		-7	0.01011	12 87218		9.3	0.03132	26	0.264623			0.04		8.5
221 217	z1 29	216 452		64 192	7.6 16.2	0.298	8405 16386	415 724		5 33	0.00956			7.9 7.5	0.03112 0.03058	32	0.388375					7.2
									Dat	os (Ma)								20	7-method	2	119m-60	bor
LA ICPMS	CA- TIMS	TRPb		128 1	25 sys	20/Pb	±25	_29 sy	e 4	^c 'Pb	_25	126 sys	arepb	128	128 sys	disc	<u>±2</u> 8	230 Pb	128	<u></u>	<u>>b*</u>	<u>12</u> 6
laba	ls sel	²⁵⁰ Th	;	(Ma)	(Ma)	ж _{ро}	(Ma)	(Ma)		U	(Ma)	(Ma)	²³⁸ U	(Ma)	(Ma)	(%)	(%)	236 _U	(Ma)	236	U.	(Ma)
215	z7	188 519	8	10	11.9	179.7	62	85		208	8	8.00	211.57	6	6.66	-1.25	47	211.	і в	213	5.28	7
215	z5	215 546		29	30.2	52.3	198	169		191	16	15 85	202.87	7	7.17	-5.99	63	201.1			0.47	7
215	z8	201 558 189 004		16	16.5 16.3	76.6	216 179	216 190		193 205	17 18	17 64 16 40	202.37 202.05	8	8.46 8.22	-4.98 1.50	10.4	201.3).77 1.37	9 8
213	z4	171 770		10	12.2	178.9	147	148		200	12	12 37	201.67	4	4.99	-0.90	65	200.1			272	5
218		188 627		23	23.8	211.3	211	212		202	18	18 48	201.10	8	8.45	0.40	8.9	199.4			9.89	8
222 220	26	175 742		19 21	20.3 21.8	346.5 158.6	118 154	120 155		211 198	1′ 13	11 40 13 49	199.45 195.85	5	5.45 7.23	5.84 -1.58	54	197.			9.51 7.46	57
216		203 382		23	27.1	198.9	206	209		195	17	10.95	196.85	5	5.60	0.39	59	197.3			3.91	5
221	z1	192 377		28	29.2	256.4	165	166		202	14	14 64	197.55	6	6.58	2.28	76	195.			5.15	7
217	Z9	177 528	2	15	16.3	334.5	157	158		205	14	14 14	194.20	5	5.75	5.40	69	192.4	5	194	1.22	8
											Concer	trations (p	pm)									
LA-	CA TIMS																					
leosi	label	Р	Ti	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gi T	o Dy	Но	Er	Tm YI	- Li	Hf	Та	Th	
215 215	27 25	253.70 151.38	8	2771.94				23.906 3.781	0.1	2.838 0.434	713206		171 2 621 6			455 175	93 83 38 35			6	423.2	
215	23 28	135.09	5	1180.61	58870			4.266	0.0	0.434	2 81		582 8			203	44 40			2	51.9	
212		155.48	5	2062.10	55361	0 0		6.135	0.1	2.327	6.52	1.8 5	1.90 19	.8 246.	7 96	444	92 77	4 13	10409	2	121.3	: :
213	24	215.20	4	6108.58			0.0	7.920	0.2	3 751	17.22		12.66 40			831	187 140			3	224.5	
218 222	26	139.01 164.62	5	1415.50 2359.85			0.0	3.622 5.413	0.1	1.270	2 70 5 06		934 10 684 11			243 398	53 48 84 73		10943 10285	2	55.7 123.2	
220		145.69	5	1072.14				3.795	0.0	0.503	2 30		807 7			184	40 36		11145	2	54.2	
216		104.90	5	1223.77	59236	3 4		2.900	0.1	1.046	3 05	0.5 2	161 8	2 '03.	0 45	2'5	45 43	3 70	10381	2	56.4	
221	z' z9	145.11 202.48	5	1345.89				6.263 9.114	0.0	1.069 3,704	2.97		476 9 656 25			233 629	51 45 130 11			2	84.4 192.4	
217																						

Table A5. 3 LA-ICPMS U-Pb geochronologic analyses, trace element concentrations, and Ti-in-zircon thermometer results for sample 110-322.

Table A5. 4 LA-ICPMS U-Pb geochronologic analyses, trace element concentrations, and Ti-in-zircon thermometer results for sample 110-368. Data from experiment "Zircon_08March2022_Miscellaneous_1" is in black text and "Zircon_08March2022_Miscellaneous_2" is in blue text. Discordance, defined as the relative difference between the $^{207}Pb/^{235}U$ and $^{206}Pb/^{238}U$ dates, outside of uncertainty of 5% is flagged with strikethrough font and was not interpreted for age.

					Compositio	n						Corre	cted isotope	ratios					
LA-ICPMS	CA- TIMS	u	Th	РЬ		×арь	2.96 _{Pb}		^{ros} Pb	±25	^{5.90} Pb	±2s	×*pg	±2s	BLIOL	<u>**u</u>	±2s	×"Po	:25
labe	la.oel	pom	pp~	ppm	Th/U	cps	a-ipb	1' S	²⁷⁶ Th	(%)	²³⁰ U	(36)	=*U	(%)	C0/F	^{are} Pb	(%)	^{acs} Pb	(95)
245		200	54.3	7.50	0.272	6671	359	5	0.01040	7.750822	0.2224	5.4	0.03364	24	0.244404	29.72	2.4	0.04794	9.1
240		415	170	16.3	0.405	17661	908	9	0.00904	6.705661	0.2329	6.5	0.03354	3.8	0.572*38	29.62	3.8	0.05235	5.3
248		269	97.1	10.3	0.361	11503	11503	152	0.00993	9746968	0.2386	8.7	0.03308	3.5	0.506605	30.24	2.5	0.05233	5.7
233	26	310	130	12.0	0.418	13383	12758	174	0.00982	7.162692	0.2104	8.1	0.03299	2.6	0.310715	30.31	2.6	0.04828	7.7
237		509	291	20.5	0.572	22586	1982	15	0.00966	4.04244	0.2254	5.7	0.03295	28	0.483359	30.35	2.8	0.04661	4.6
244		314	87.8	42.0	0.314	44:34	4693	46	0.01168	11.0938	0.2659	7.9	0.03287	27	0.324862	33.42	2.7	0.05555	7.5
238		657	300	25.7	0.457	28856	1965	22	0.01022	6 538093	0.2151	6.7	0.03282	26	0.434237	30.47	2.6	0.04753	5.1
258		384	134	13.5	0.368	15804	15804	110	0.00873	7.228431	0.2080	8.4	0.03255	31	0.360509	30.72	3.1	0.04591	7.8
235		672	236	25.2	0.351	26097	4040	49	0.00980	7.145042	0.2155	5.5	0.03245	18	0.295051	30.82	1.8	0.04818	5.2
273		413	184	16.9	0./45	10036	659	8	0.01377	8.755955	0.3423	8.8	0.03241	38	0.552105	30.66	3.8	0.07661	5.6
272		607	325	23.6	0.535	25561	665	17	0.00938	6.550491	0.2240	7.7	0.03241	44	0.557609	30.66	4.4	0.05214	6.4
252		357	133	14.0	0.371	15114	928	10	0.01270	6.751987	0.2929	7.1	0.03232	3.1	0.41565	30.94	3.1	0.06573	6.5
230		278	94.9	10.6	0.342	11510	115-0	434	0.01255	8.798886	0.2704	7.3	0.03228	2.8	0.371683	31.00	2.8	0.06080	6.7
246	23	339	440	13.2	0.324	44267	2624	8	0.01419	13-53548	0.3044	42.9	0.03217	2-6	0.198186	31.09	2.6	0.06863	42.6
238		687	390	26.9	0.568	28667	10795	135	0.00964	4.874625	0.2134	6.3	0.03213	18	0.314113	31.12	1.8	0.04817	5.0
253		434	175	16.3	0.404	17804	749	6	0.01003	5.26473	0.2246	5.2	0.03197	25	0.463264	31.28	2.5	0.05295	4.5
264		657	245	21.1	0.442	23571	414	24	0.0101*	4.518947	0.2336	7.4	0.03189	28	0.368067	31.36	2.8	0.05245	6.9
222		434	200	46.7	0.462	45736	284	4	0.04084	5.607482	0.2642	7.3	0.03474	3-1	0.402345	31.50	3	0.05967	6,7
265		212	73 4	7.87	0.347	8765	818	13	0.00932	12 30015	0.2187	7.7	0.03169	37	0.47245	31.56	3.7	0.05005	6.8
255		23'	65 1	8.23	0.295	5501	614	7	0.00877	10 34853	0.2128	10.0	0.03167	35	0.337604	31.58	3.5	0.04974	9.4
243		449	194	16.6	0.433	19631	1046	20	0.00866	6.439212	0.2126	6.2	0.03163	15	0.216761	31.61	1.δ	0.04974	6.0
238		540	257	20.3	0.475	23217	23217	308	0.00920	6.093751	0.2237	5.6	0.03162	21	0.355861	31.63	2.*	0.05131	5.2
265		545	241	20.3	0.442	22132	6113	75	0.00965	4.616934	0.2192	8.8	0.03160	3.5	0.499424	31.84	3.5	0.05031	5.8
257		377	130	13.7	0.345	15932	432	5	0.01027	8.332779	0.2062	8.0	0.03159	42	0.511881	31.86	4.2	0.04734	6.8
267		1046	730	41.6	0.698	43459	4541	41	0.00925	3.718324	0.2286	5.2	0.03154	32	0.603153	31.70	3.2	0.05257	4.1
242		651	324	24.8	0.497	27061	1407	-2	0.00984	4.741957	0.2213	6.6	0.03151	29	0.518865	31.73	2.9	0.05293	4.7
250		488	207	48.5	0.416	20235	689	8	0.00934	5.368792	0.2453	4.5	0.03449	2.0	0.414704	31.76	2.0	0.05650	4.0
241		236	84.5	8.80	0.358	10105	880	12	0.00944	7.657926	0.2305	8.3	0.03148	3 1	0.363521	31.78	3.1	0.05313	7.7
263		336	105	11.1	0.345	12303	12303	272	0.00977	6.591801	0.2206	5.5	0.03145	32	0.473334	31.60	3.2	0.05087	5.7
269		327	105	11.8	0.322	13860	447	5	0.01024	6.893992	0.2236	6.0	0.03135	32	0.387708	31.68	3.2	0.05171	7.3
254		326	111	11.8	0.341	13524	172	13	0.00977	9.922537	0.2051	6.1	0.03134	27	0.511446	31.91	2.7	0.04747	4.3
228		253	80-9	8.74	0.320	40380	8719	467	0.01627	9.320712	0.3168	8.6	0.03124	3-3	0.478335	32.01	3.3	0.07425	5.7
258		483	227	17.8	0.470	15665	621	60	0.00912	6.782473	0.2138	7.1	0.03124	31	0.425186	32.61	3.1	0.04563	6.4
225	z2	429	152	15.5	0.354	16979	549	5	0.00959	5.13065	0.2212	4.8	0.03120	27	0.530758	32.06	2.7	0.05144	4.0
247	100	614	274	19.4	0.534	21565	1836	35	0.00940	3.340196	0.2079	8.5	0.03115	24	0.361544	32.10	2.4	0.04840	6.0
251	21	378	142	13.7	0.375	16084	2347	38	0.00976	5.701844	0.2130	5.2	0.03110	25	0.465414	32.16	2.5	0.04967	4.5
246	25	806	455	30.7	0.565	33831	33831	234	0.00969	3.560088	0.2171	3.5	0.03099	23	0.613906	32.27	2.3	0.05081	2.7
232		734	344	29.6	0.465	30341	432	÷	0.01482	4.307217	0.3383	5.6	0.03298	27	0./66895	32.23	2.7	0.07518	4.5
228	z4	256	113	10.8	0.383	11669	445	7	0.01065	8.154272	0.2128	6.0	0.03297	33	0.395909	32.29	3.3	0.04085	7.3
223		452	187	16.5	0.413	17416	3620	55	0.01029	5.354781	0.2317	7.3	0.03079	26	0.342223	32.48	2.6	0.05458	6.8
260		579	262	21.1	0.453	23239	558	5	0.00938	6.344329	0.2198	8.4	0.03065	20	0.286837	32.83	2.0	0.05202	6.1
261		246	73.2	8.62	0.298	9797	169	19	0.01038	9.45102	0.2254	7.6	0.03065	35	0.454091	32.63	3.5	0.05334	6.7
271		358	132	12.7	0.365	14803	130	11	0.00949	8.917217	0.2255	5.6	0.03063	25	0.42387	32.85	2.5	0.05339	5.0
262		855	362	30.9	0.423	35209	35205	604	0.00954	4.025701	0.2069	6.4	0.03262	3 4	0.605376	32.55	3.4	0.04999	4.2
266		595	284	21.8	0.477	23987	873	-4	0.00959	7.215653	0.2091	8.2	0.03060	20	0.297947	32.68	2.0	0.04957	5.9
255		660	249	23.3	0.378	26895	664	9	0.00875	5.776636	0.2050	5.1	0.03055	26	0.472354	32.74	2.6	0.04868	4.5
224		308	125	11.0	0.405	11493	11493	80	0.01056	7.314643	0.2238	7.2	0.03015	17	0.20487	33.16	1.7	0.05382	7.0
356		649	308	24.1	0.475	25-44	649	Ŧ	0.01185	5.701436	0.2415	6	0.02586	24	0.248264	33.60	2. -	0.05865	7.0
234		39-	432	13.6	0.337	15329	2130	46	9.01052	7.935:41	0.2295	<u>6</u>	0.02982	23	0.432806	33.64	2.3	0.06582	4.5

Table A5. 4 continued.

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Table A5. 5 LA-ICPMS U-Pb isotope ratios and trace element concentrations for standard data collected during sample 110-322 analyses.

			Co	omposit	ion							Corre	cted isc	otope	ratios											D	ates (N	1a)					
	U	Th	Pb		206Pb	206	Pb	- 1	<u>208Pb</u>	±2s	<u>207P</u>	2 ±2s	2068	<u>чь</u>	±2s e	rror 💈	238U	±2s	<u>207Pb</u>	±2s	<u>208Pb</u>	±2s	±2s- sys	<u>207Pb</u>	±2s	±2s- svs	207Pb	±2s	±2s- svs	206Pb	±2s	±2s- svs	disc ±2s
Analysis	ppm	ppm	ppm	Th/U	cps	204		15	232Th	(%)	235L	(%)	238	U	(%) c	orr. 2	206Pb	(%)	206Pb		232Th		aya	206Pb		(Ma)	235U		aya	238U		(Ma)	(%) (%)
Promy unantatis PL 298 PL 298 PL 290 PL 300 PL 301 PL 301 PL 304 PL 305 PL 304 PL 315 PL 314 PL 323 PL 323 PL 323 PL 323 PL 333 PL 334 PL 335 PL 339 PL 342 PL 339 PL 342 PL 351 PL 351 PL 355 PL 355 PL 355	463.5 641.8 611.1 720.4 717.2 510.9 423.6 573.7 1094.4 600.3 581.8 704.1 755.1 744.8 704.1 755.1 743.3 432.8 697.2 435.6 588.9 565.8 565.8	41.4 60.7 54.1 64.9 76.1 42.8 35.5 43.2 47.9 62.9 62.2 66.1 62.3 42.9 35.8 62.2 66.1 62.3 42.9 35.8 42.9 51.3 55.5 51.3 8 50.5 51.3 8 50.5 51.3	27.56 38.14 35.22 40.97 41.71 28.02 24.22 33.51 9 60.22 36.03 34.35 40.42 42.34 42.34 43.51 40.44 24.85 40.45 25.87 27.65 33.65 25.87 27.65 32.38 32.38	0.083 0.089 0.095 0.089 0.095 0.080 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.090 0.081 0.082 0.075 0.084 0.084 0.087 0.086 0.087 0.086 0.087 0.086 0.087 0.086 0.087 0.086 0.087 0.086 0.097 0.097 0.097 0.097 0.087 0.088 0.087 0.087 0.087 0.097 0.087 0.088 0.087 0.087 0.087 0.087 0.087 0.088 </td <td>25527 39234 35975 41250 243955 41830 28755 243955 49290 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 Table A5. 6 LA-ICPMS U-Pb isotope ratios and trace element concentrations for standard data collected during sample

 110-368
 analyses. Experiment "Zircon_08March2022_Miscellaneous_1" is in black text and

 "Zircon_08March2022_Miscellaneous_2" is in blue text.

			Cor	nposit	on							Corr	rected	isotopi	e ratios	5										D	ates (N	la)					
	U	Th	Pb		206Pb	<u>206</u> F	ъ	- 1	<u>208Pb</u>	±2s	207	<u>b</u> ±2	s <u>2</u>	06Pb	±2s	error	<u>238U</u>	±2s	<u>207Pb</u>	±2s	208Pb	±2s	±2s- sys	<u>207Pb</u>	±2s	±2s- sys	<u>207Pb</u>	±2s	±2s- sys	206Pb	±2s	±2s- sys	disc ±2
Analysis	ppm	ppm	ppm	Th/U	cps	204	°b ±	1s	232Th	(%)) 235	U (%	5) 2	238U	(%)	corr.	206Pb	(%)	206Pb	(%)	232Th	(Ma)	(Ma)	206Pb	(Ma)		235U	(Ma)	(Ma)	238U	(Ma)	(Ma)	(%) (%
Arraysis Primary stand PL 298 PL 299 PL 300 PL 301 PL 30	dards 428 463 642 720 717 511 424 1009 600 582 745 745 745 745 745 743 743 741 697 437 437	35.6 41.4 60.7 54.1 42.8 35.5 43.2 118 47.9 44.0 62.9 66.1 62.3 42.9 66.1 62.3 42.9 66.1 42.9 67.7 44.9	24.6 27.6 38.1 41.0 41.7 28.1 24.3 36.0 44.4 42.3 41.3 41.3 41.3 41.3 42.5 24.9 42.8 24.9 42.8 25.9 27.7 33.7 33.2 4	0.083 0.099 0.095 0.080 0.090 0.090 0.090 0.084 0.075 0.080 0.076 0.084 0.080 0.095 0.083 0.096 0.097 0.097 0.087	25527 32670 39234 35975 41250 41830 28759 24395 43575 402411 44487 43354 49290 51493 49290 51493 49290 51493 49290 51493 49290 51493 49290 51493 49290 51493 49290 51493 49290 51493 49290 51493 49290 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 2480 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 24808 41820 237411 4487 4180 4487 4487 4487 4487 4487 4487 4487 44	1422 101 3166 830600 777 148 6080 741 1455 1022 2767 1200 2177 3099 322 303 1955 2555 2	9 1 59 2 50 20 50 20	8 8 8 12 12 12 13 13 18 18 18 18 18 18 18 18 18 18 18 18 18	0.01644 0.01848 0.0157 0.01688 0.01682 0.01692 0.01612 0.01632 0.01632 0.01632 0.01792 0.01792 0.01792 0.01792 0.01592 0.01592 0.01592 0.01688 0.01688 0.01688 0.01688 0.01688 0.01688) 11.4) 9.3) 11.1) 8.1 2 11.2 2 11.2 2 11.2 2 11.2 2 6.6 2 5.9 2 8.9 2 6.6 10.0 9.7 2 7.45 4 18.2 5 10.2 5 10.2 2 15.1 3 10.2 15.3 10.0	4 0.39 i 0.39 i 0.40 i 0.40 2 0.39 5 0.38 5 0.37 i 0.38 5 0.37 i 0.38 3 0.42 i 0.39 3 0.42 i 0.59 3 0.42 i 0.59 3 0.42 i 0.59 3 0.59 3 0.42 i 0.59 3 0.59 3 0.42 i 0.59 i 0.59	19 6. 93 6.0 93 6.1 93 5.0 15 5.1 15 5.1 14 4.1 91 6.1 939 6.2 57 6.2 60 5.5 61 5.5 62 5.5 64 5.0 64 5.0 64 5.8 64 5.8 64 5.8 67 6.2 680 7.7 680 7.7 78 5.1 59 6.2	8 0. 0 0. 2 0. 6 0. 3 0. 6 0. 3 0. 6 0. 3 0. 6 0. 4 0. 3 1 0. 4 0. 4 0. 5 0. 0 0. 5 0. 8 0. 9 0.	05338 05492 05490 05328 050241 05328 05328 05324 05341 05341 05399 05596 05424 05456 05424 05456 05292 05224 05324 05345 05344	3.2 3.0 2.6 3.1 3.9 3.3 3.6 2.9 4.1 4.6 4.1 2.8 5.3 3.6 3.4 3.8 2.5	0.46 0.48 0.63 0.64 0.54 0.50 0.63 0.63 0.63 0.63 0.63 0.63 0.63 0.6		3.2 3.0 2.6 3.1 3.9 4.1 4.6 5.3 3.6 2.9 4.1 4.1 2.8 5.3 3.6 4.1 2.8 5.3 3.4 3.8 2.5 4.6 9 2.9 3.8 4.5 3.9 2.5 4.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 2.5 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0	2.069/0 0.05324 0.05273 0.05308 0.05444 0.05178 0.05178 0.05162 0.05162 0.05319 0.05367 0.053319 0.05465 0.05367 0.05319 0.05481 0.05481 0.05481 0.05481 0.05481 0.05481 0.05481 0.05481 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05454 0.05545 0.05545 0.05546 0.05545 0.05546 0.05546 0.05545 0.05546 0.05546 0.05546 0.05546 0.05546 0.05547 0.05546 0.05546 0.05546 0.05547 0.05546 0.05546 0.05547 0.05546 0.05547 0.05546 0.05546 0.05547 0.05546 0.05547 0.05546 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05547 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.05545 0.	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Table A5. 6 continued.

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	U	Th
 | <u>206P</u> | b | | <u>208Pb</u>
 | ±2s | <u>207P</u> | <u>b</u> ±2s
 | <u>206P</u>
 | <u>p</u> ±2s
 | error
 | <u>238U</u> ± | 2s ; | <u>207Pb</u>
 | ±2s | 208Pb | | ±2s-
sys
 | 207Pb | ±2s | ±2s-
sys | <u>207Pb</u> | ±2s | ±2s-
sys | 206Pb | ±2s | ±2s-
sys | disc disc |
| Analysis | ppm g | ppm | ppm | Th/U | cps
 | 204P | b ±1 | Is | 232Th
 | (%) | 2351 | J (%)
 | 238
 | J (%)
 | corr. 2
 | 206Pb (| %) | 206Pb
 | (%) | 232Th | (Ma) | (Ma)
 | 206Pb | (Ma) | (Ma) | 235U | (Ma) | (Ma) | 238U | (Ma) | (Ma) | (%) (|
| Virrary standards
PL 302 | | | 41.0 | | 47409
 | 4740 | | | 0.01690
 | 7.3 | 0.390 |
 |
 |
 |
 | | | 0.05175
 | 2.9 | | 24.4 |
 | 274 | 66.1 | 68.0 | 335 | 13.8 | 14.5 | 344 | 13.0 | | -2.6 |
| . 303
. 304 | | | 35.5
43.6 | | 44181
52146
 | 1053
5038 | | | 0.01642
0.01683
 | 11.8
7.4 | 0.405 |
 | 0.053
 |
 |
 | | 3.7 0 | 0.05467
0.05150
 | 4.1
5.0 | | 38.7
24.8 |
 | 399
263 | 91.0
114 | 92.4
115 | 345
325 | 16.8
17.1 | 17.3
17.6 | 337
333 | 13.3
11.9 | 14.0
12.6 | 2.3 |
| L 305
L 308 | | | 37.1
23.7 | | 44911
28657
 | 4491
2865 | | | 0.01745
 | 8.2 | 0.407 |
 |
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 |
 | | | 0.05488
 | 2.4
6.0 | 350
316 | 28.4
31.6 | 30.4
33.2
 | 407
301 | 54.5
136 | 56.8
137 | 347
324 | 10.7
19.4 | 11.6
19.8 | 338
327 | 8.95
11.5 | | 2.6 |
| 309
316 | 470 3 | 39.2 | 26.5
23.0 | 0.083 | 31732
27927
 | 2701 | 41 | 1 | 0.01556
 | 10.1 | 0.386 | 5 5.5
 | 0.052
 | 17 3.6
 | 0.63
 | 19.17 | 3.6 0 | 0.05373
 | 4.2
3.9 | 312 | 31.4
33.3 | 32.9
 | 360
356 | 95.5
89.2 | 96.8
90.6 | 332
337 | 15.7
14.5 | 16.3
15.1 | 328
335 | 11.5
10.2 | 12.2
11.1 | 1.2 |
| . 317 | 420 3 | 33.7 | 23.7 | 0.080.0 | 27836
 | 1244 | 18 | 5 | 0.01862
 | 9.2 | 0.390 | 1 7.0
 | 0.052
 | 3.3
 | 0.46
 | 19.22 | 3.3 0 | 0.05439
 | 6.2 | 373 | 34.1 | 36.3
 | 387 | 139 | 140 | 334 | 20.0 | 20.4 | 327 | 10.5 | 11.3 | 2.3 |
| . 320
. 321 | | | 37.9
47.9 | | 45218
58766
 | 2536 | | | 0.01825
 | 7.6
6.4 | 0.397 |
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 |
 |
 | | 4.1 C
4.4 C | 0.05256
 | 3.8
2.9 | 366
359 | 27.6
22.7 | 30.2
25.6
 | 310
341 | 85.9
65.4 | 87.4
67.3 | 339
351 | 16.1
15.7 | 16.7
16.3 | 344
353 | 13.8
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| L 324
325 | 705 6 | 61.7 | 41.6
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 | 7.9 | 0.399 | 7 5.0
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 | 3.5
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 | 18.44 | 3.5 0 | 0.05345
 | 3.7
5.2 | | 29.9
34.1 | 32.5
 | 348
316 | 83.0
119 | 84.5
120 | 341
339 | 14.6 | 15.3
18.2 | 340
343 | 11.5 | 12.3 | 0.3 |
| L 328 | 731 6 | 66.3 | 42.0 | 0.091 | 54973
 | 1355 | 4 26 | 50 | 0.01512
 | 6.1 | 0.389 | 4 4.8
 | 0.052
 | 6 3.9
 | 0.80
 | 18.88 | 3.9 0 | 0.05333
 | 2.8 | 303 | 18.5 | 21.1
 | 343 | 62.6 | 64.6 | 334 | 13.6 | 14.3 | 333 | 12.6 | 13.4 | 0.4 |
| 4L 329
4L 332 | | | 38.9
39.1 | | 52582
50371
 | 2148 | | | 0.01643
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31.5 |
 | 411
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85.8 | 76.8
87.3 | 348
331 | 15.1
15.7 | 15.7
16.3 | 339
336 | 12.8
13.4 | 13.5
14.1 | 2.7 |
| 4L 333
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 | 9393
3031 | | | 0.01515
 | 7.5
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 | | 3.5 0 | 0.05108
 | 3.2
1.5 | 304
345 | 22.7
25.2 | 24.9
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 | 244
281 | 74.6
35.1 | 76.3
38.6 | 319
326 | 13.1
10.3 | 13.8
11.2 | 329
332 | 11.3
10.9 | 12.1
11.8 | -3.2
-1.9 |
| 'L 337 | 659 | 59.7 | 36.6 | 0.091 | 51231
 | 3489 | 60 | 0 | 0.01542
 | 10.4 | 0.390 | 7 4.7
 | 0.050
 | 9 3.5
 | 0.73
 | 19.61 | 3.5 0 | 0.05558
 | 3.2 | 309 | 32.1 | 33.6
 | 436 | 70.5 | 72.2 | 335 | 13.4 | 14.1 | 321 | 10.9 | 11.7 | 4.3 |
| 4L 340
4L 341 | | | 23.8
33.4 | | 24833
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3044 | | | 0.01694 0.01685
 | 12.2
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 | 0.47
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 | | | 0.05133
0.05454
 | 5.7
4.3 | 340
338 | 41.2
32.5 | 42.6
34.3
 | 256
394 | 131
95.6 | 132
96.9 | 326
349 | 18.1
17.5 | 18.6
18.1 | 336
342 | 10.2
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| 9L 344
9L 345 | | | 30.6
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 | 410
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100 | 108
102 | 351
328 | 18.1
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332 | | | 2.5 |
| 4L 348
4L 349 | 563 | 52.0 | 32.5
31.9 | 0.092 | 37868
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 | 5415
1285 | 5 83 | 3 | 0.01717
 | 10.8 | 0.383 | 8 5.0
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 | 4.3
 | 0.85
 | 18.79 | 1.3 0 | 0.05231
 | 2.6
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357 | 36.8
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 | 299 | 58.2
85.6 | 60.4
87.1 | 330
341 | 14.0
16.1 | 14.7
16.7 | 334
335 | 13.9
13.3 | 14.6
14.0 | -1.3 |
| L 352 | 517 | 46.9 | 30.6 | 0.091 | 32415
 | 3197 | 60 | 0 | 0.01600
 | 10.1 | 0.408 | 1 5.5
 | 0.054
 | 3 4.8
 | 0.85
 | 18.27 | 4.8 0 | 0.05408
 | 2.8 | 321 | 38.9 | 40.1
 | 374 | 63.0 | 65.0 | 348 | 16.3 | 17.0 | 344 | 16.0 | 16.7 | 1.8
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| L 353
L 356 | | | 28.8
30.4 | | 31213
34012
 | 2705 | | | 0.01754
 | 8.9
7.4 | 0.377 |
 | 0.052
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 | | | 0.05243
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 | 4.2
4.2 | 352
363 | 31.0
26.6 | 32.8
28.8
 | 304
362 | 96.1
95.6 | 97.4
96.9 | 325
336 | 14.1
15.7 | 14.8
16.3 | 328
333 | 9.06
11.3 | 10.1
12.1 | -0.9
1.1 |
| L 357 | | | 32.0 | | 33694
 | 973 | 20 | | 0.01731
 | 10.7 | |
 |
 | 15 5.0
 | 0.77
 | | 5.0 0 | 0.05250
 | 4.0 | 347 | | 38.4
 | 307 | 91.6 | 93.0 | 343 | 18.7 | 19.3 | 348 | | 17.7 | -1.5 |
| 1500 384
1500 385 | 67.0 2
64.2 2 | | | | 13431
12762
 | 1477
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 | 9.5
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132 | 128
133 | | 45.1
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| 1500 388
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 | 1089
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105 | 122
106 | 1088
1069 | 51.0 | | 1087 | 47.1 | 48.9 | 0.0
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| 1500 392 | 63.0 | 20.1 | 13.6 | 0.319 | 13445
 | 808 | 37 | 7 | 0.05507
 | 6.2 | 1.884 | 7 7.7
 | 0.185
 | 8 6.1
 | 0.79
 | 5.40 | 6.1 0 | 0.07381
 | 4.7 | 1083 | 65.1 | 74.1
 | 1036 | 94.5 | 95.6 | 1076 | 50.8 | 51.8 | 1095 | 61.0 | 62.5 | -1.8 |
| 1500 393
1500 397 | 65.0 1
64.4 1 | 21.8 | 13.3 | 0.339 | 14170
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 | 324
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 | 7.6
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5.7 | 904
915 | 67.7
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63.9
 | 972
1061 | 107
115 | 108
116 | 1054
1058 | 45.8
42.3 | 46.9
43.5 | 1057 | 28.9 | 31.8 | |
| 1500 400 | 64.9 | | | | 14879
14308
 | | | | 0.05327
 | 6.0
9.7 | 1.809 |
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 | | | 0.07270
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5.7 | | 61.5
92.8 |
 | 1006
1060 | 105
115 | 106
116 | | 42.5
43.0 | | 1070
1022 | 38.6 | 40.9
34.0 | |
| 1500 404
1500 405 | 59.7
65.8 | | 12.9 | | 15419
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 | | 9 69 | 94 | 0.05726
 | 8.2
8.4 | 1.838 | 2 5.3
 | 0.184
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 | 0.43
 | 5.41 | 2.4 0 | 0.07217
 | 4.8
6.3 | 1125 | 90.1
88.6 | 96.3
 | 991
1026 | 96.7
127 | 97.8
128 | 1059 | 35.0
51.5 | 36.4 | 1093 | 23.9 | 27.6 | |
| eiland 360 | 64.3 | 53.8 | 6.89 | 0.837 | 5367
 | 1323 | 3 20 | 0 | 0.02318
 | 7.3 | 0.663 | 4 8.4
 | 0.083
 | 2 3.8
 | 0.45
 | 12.03 | 3.8 0 | 0.05789
 | 7.5 | 463 | 33.2 | 36.2
 | 525 | 164 | 165 | 517 | 34.1 | 34.6 | 515 | 19.0 | 20.0 | 0.4 |
| eiland 361
eiland 364 | 61.4
61.6 | | 6.92
6.79 | | 5372
5899
 | 301
496 | 6
12 | | 0.02387
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 | 4.7
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 | 0 5.0
 | 0.45
 | 11.75 | 5.0 0 | 0.05137
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 | 10.6
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498 | | 45.5
 | 258
380 | 244
216 | 244
217 | 493
500 | 42.8 | 44.7
43.2 | 545
526 | 25.1 | 22.2
26.0 | -10.6
-5.3 |
| eiland 365
eiland 368 | 62.1 | | | | 6455
5949
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2239 | | | 0.02401
 | 9.4
9.1 | 0.729 |
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 | 38 3.6
 | 0.36
 | 11.50
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472 | 44.6
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 | 634
554 | 194
198 | 195
199 | 556
526 | 41.5
41.9 | 42.0
42.4 | 538
519 | | 19.6
24.2 | 3.4 |
| eiland 369 | 61.9 | 52.0 | 6.68 | 0.840 | 5458
 | 173 | 4 | 1 | 0.02284
 | 7.5 | 0.667 | 9 11.5
 | 0.084
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 | 0.46
 | 11.90 | 5.3 0 | 0.05762
 | 10.2 | 456 | 33.9
44.0 | 37.1
 | 515 | 224 | 225 | 519 | 46.9 | 47.2 | 520 | 26.6 | 27.4 | -0.2 |
| eiland 372
eiland 373 | 65.4
63.4 | 54.5 | 6.94 | 0.860 | 5953
6335
 | 284
477 | 3 | 0 | 0.02362
0.02244
 | 9.4
6.4 | 0.680 | 1 11.0
 | 0.085
 | 35 3.3
 | 0.29
 | 11.65 | 3.3 0 | 0.05862
0.05340
 | 12.1
10.5 | 449 | 28.5 | 32.2
 | 553
346 | 264
236 | 265
237 | 497 | 43.1 | | 521
531 | 16.7 | | 1.1
-6.7 |
| eiland 376
eiland 377 | 63.7 5
62.0 5 | | | | 5652
5631
 | 317
5631 | 7 | 4 | 0.02454
 | 8.5
8.7 | 0.756 |
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 | | | 0.06339
 | 8.1
10.3 | 490
517 | 40.9
44.6 | 43.9
47.7
 | 721
231 | 171
238 | 172
239 | | | 41.7
41.6 | 535
514 | | 26.0
20.5 | |
| ailand 380
ailand 381 | 62.5 | | | | 6437
6486
 | 7082 | 2 16
5 | | 0.02441
 | 7.9
9.9 | 0.634 |
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 | 11.87 | 4.1 0 | 0.05460
 | 7.3
9.3 | 487
499 | | 41.1
51.2
 | 396
367 | 165
210 | 165
211 | 499
498 | 33.2
40.3 | 33.7
40.8 | 522
527 | 20.6
21.6 | 21.7
22.6 | -4.6
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| rimary standards | | _ | | | Nb
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 | у Но
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| inary standards
L 302
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30 | 4 1 | 80.9
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 | 0.012 | 2.10
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1.83
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 | Sm
3.91
3.51 | Eu
1.14
0.877 | Gd
14.4 5
10.2 4
 | 5.62 51
4.36 41
 | .4 15.9
.6 13.4
 | 9 52.0
4 45.5
 | 9.72
8.39 | 73.0
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 | 13742
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| imary standards
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 | 9.72
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 | 13742 | 2.44 | 63.5 | 692
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| imary standards
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 | 0.012 | 2.10
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 | 13742
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| imary standards
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 | 1.4 15.1
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| imary standards
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10.8 4
16.3 9
 | 5.62 51
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5.76 51
 | 1.4 15.5
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| imary standards
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Fig. A5. 1 Sample 110-322 of ferrorhyolite (FeR) lapilli tuff with strong quartz, sericite, and pyrite alteration.



Fig. A5. 2 Sample 110-368 of massive FIIIb high-silica rhyolite (HSR) with patchy epidote, calcite, and chlorite alteration.

Sample 110-322

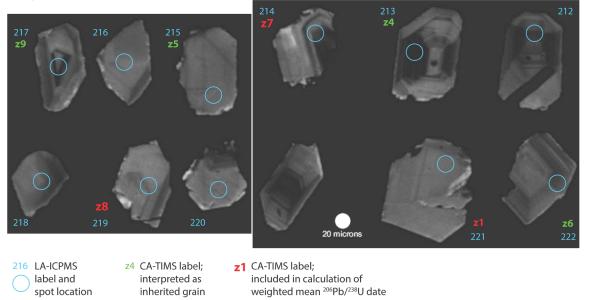
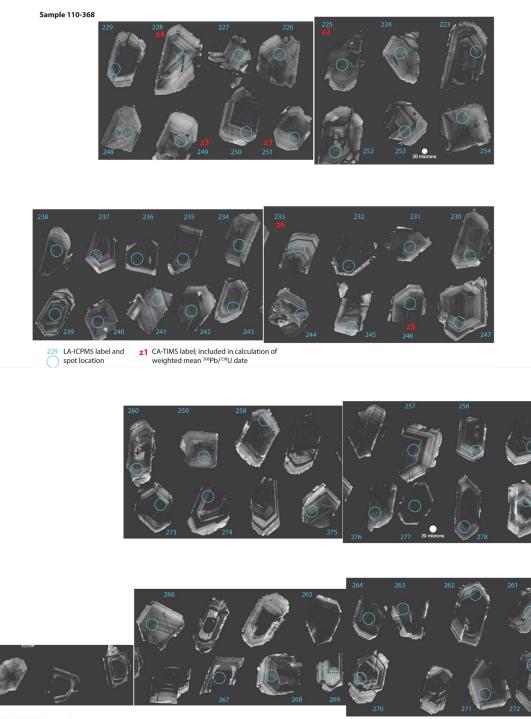


Fig. A5. 3 Cathodoluminescence (CL) images of zircon grains in sample 110-322. LA-ICPMS labels and spot locations are shown as blue text and circles, respectively. CA-ID-TIMS labels are also shown. Grains with red CA-ID-TIMS labels were used in the calculation of the weighted mean ²⁰⁶Pb/²³⁸U date. Grains with green CA-ID-TIMS labels were not used in the calculation of the weighted mean ²⁰⁶Pb/²³⁸U date; they are interpreted as inherited zircon grains.



229 LA-ICPMS label and spot location

Fig. A5. 4 Cathodoluminescence (CL) images of zircon grains in sample 110-368. LA-ICPMS labels and spot locations are shown as blue text and circles, respectively. CA-ID-TIMS labels are also shown. Grains with red CA-ID-TIMS labels were used in the calculation of the weighted mean $^{206}Pb/^{238}U$ date.

Appendix 5 References

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Appendix 6. Electron probe microanalyzer data

Analytical methods

Plagioclase and FeTi oxide mineral chemistry was investigated using a JEOL JXA-8230 electron probe microanalyzer (EPMA) equipped with four energy dispersive spectrometers (EDS) at the University of Memorial in St. John's, Newfoundland. Four hundred and ninety-nine spot analyses were conducted across eight polished, carbon-coated thin sections. The EPMA conditions are summarized in Table A6. 1 and Table A6. 2. Standard ZAF techniques with the JEOL software were used to correct the raw X-ray intensities. Astimex standards of plagioclase, rutile, and magnetite were used to assess the quality of the analyses (Table A6. 3, Table A6. 4, and Table A6. 5).

A total of 145 spot analyses were completed on plagioclase crystals on six thin sections. The feldspar end-members anorthite (An), albite (Ab), and orthoclase (Or) were calculated following the method of Deer et al. (2013), assuming eight oxygens per formula unit. The results are presented in Table A6. 6.

A total of 354 spot analyses were conducted on magnetite, ilmenite, and rutile grains (72 ilmenite, 82 rutile, and 200 magnetite spot analyses). Since the EPMA cannot detect the two oxidation states of iron, iron was measured as FeO (Fe²⁺), and the method of Droop (1987) was used to estimate the relative abundance of Fe²⁺ and Fe³⁺. The ulvospinel content of the FeTi oxides within the magnetite-ulvospinel series was calculated using the method of Stormer (1983) with a modified version of the ILMAT Microsoft Excel spreadsheet template created by Lepage (2003). Mineral formulae were calculated following the method of Deer et al. (2013), assuming 32, six, and two oxygens per formula unit for magnetite, ilmenite, and rutile, respectively.

Results

The plagioclase and FeTi oxide mineral chemistry data are yet to be thoroughly evaluated. However, the plagioclase mineral chemistry in the sample of Z-FeTiB (S037015) is discussed briefly here because it has important implications for understanding how the varioles in the Z-FeTiB may have formed. Variole is a non-genetic definition referring to "globular and spherical centimeter-scale, generally leucocratic masses visible on the weathered surfaces of mafic rock," and they may be products of spherulitic crystallization, magma mingling, liquid immiscibility, or superficial alteration (Fowler et al., 2002). Sample S037015 has larger plagioclase phenocrysts with a mean composition of andesine (An_{36}) ; this overlaps with the mean composition, An₃₅, of the plagioclase microlites and interstitial plagioclase in the groundmass, although these groundmass phases span a wider variety, including some oligoclase (Fig. A6. 1). The plagioclase in the varioles has a mean composition of An₃₃, although a few analyses of plagioclase preserved (e.g., not replaced by muscovite or epidote) in the core of the varioles have more Ca-rich compositions, reaching anorthite contents up to An_{65} (labradorite; Fig. A6. 1). Since spherulites are organized clusters of crystal fibers that originate from a common point or line (Lofgren, 1971; McPhie et al., 1993; Fowler et al., 2002), the plagioclase mineral chemistry in sample S037015 lends support to the interpretation that the varioles may have formed by spherulitic crystallization, whereby the more Ca-rich plagioclase cores crystallized before the outer, more Na-rich plagioclase parts (Lofgren, 1974). Spherulites can develop through primary magmatic crystallization (undercooling) or can be secondary and form due to devitrification (McPhie et al., 1993). Several petrologic features in the Z-FeTiB (see petrographic description for \$037015 in Appendix 2) are consistent with high degrees of undercooling, including (1) the presence of magnetite crystals with embayed edges that may be resorption features, but could also result from rapid growth due to high degrees of undercooling (Winter, 2010; p.41), (2) the high

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abundance of plagioclase microlites (McPhie et al., 1993; p. 23), (3) the glassy groundmass (devitried to biotite, chlorite, and lesser epidote), and (4) the coexistence of tabular plagioclase crystals and spherulites that is favored at higher degrees of undercooling (Lofgren, 1974). The petrographic features of the Z-FeTiB support the interpretation that they formed by high degrees of undercooling and their plagioclase mineral chemistry suggests that their variolitic texture is a result of spherulitic crystallization.

Table A6. 1 Summary of electron microprobe operating conditions for plagioclase analysis.

Element	X-ray	Crystal	Spectro- meter	Accelerating voltage (kV)	Beam size (µm)	Current (nA)	Peak position	Background lower (mm)	Background upper (mm)
Ba	Lα	LIFL	2	15	1	10	192.8	4.0	2.0
Κ	Κα	PETL	3	15	1	10	119.8	3.0	7.0
Ca	Κα	PETL	3	15	1	10	107.5	3.0	2.0
Sr	Lα	PETL	3	15	1	10	219.9	11.7	3.7
Na	Κα	TAP	4	15	1	10	129.4	4.7	6.2
Al	Κα	TAP	4	15	1	10	90.6	5.5	3.3
Si	Κα	TAP	4	15	1	10	77.4	3.3	4.1

Table A6. 2 Summary of electron microprobe operating conditions for FeTi oxide analysis.

Element	X-ray	Crystal	Spectro- meter	Accelerating voltage (kV)	Beam size (µm)	Current (nA)	Peak position	Background lower (mm)	Background upper (mm)
Nb	Lα	PETJ	1	15	1	100	183.1	4.8	8.1
Zn	Κα	LIFL	2	15	1	100	99.6	2.0	2.0
Cu	Κα	LIFL	2	15	1	100	107.0	3.0	3.0
Ni	Κα	LIFL	2	15	1	100	115.1	2.0	2.0
Co	Κα	LIFL	2	15	1	100	124.2	5.8	5.0
Fe	Κα	LIFL	2	15	1	100	134.5	3.5	3.0
K	Κα	PETL	3	15	1	100	119.8	3.0	7.0
Ca	Κα	PETL	3	15	1	100	107.5	3.0	2.0
Sn	Lα	PETL	3	15	1	100	115.2	2.3	2.5
Zr	Lα	PETL	3	15	1	100	194.4	4.0	6.0
Р	Κα	PETL	3	15	1	100	197.2	6.5	4.0
Al	Κα	TAP	4	15	1	100	90.6	5.5	3.3
Si	Κα	TAP	4	15	1	100	77.4	7.0	5.6
Mg	Κα	TAP	4	15	1	100	107.5	6.0	5.0
Mn	Κα	LIFH	5	15	1	100	146.3	6.0	3.3
Cr	Κα	LIFH	5	15	1	100	159.3	2.5	3.0
V	Κα	LIFH	5	15	1	100	174.1	2.0	3.0
Ti	Κα	LIFH	5	15	1	100	191.2	3.0	3.0

Table A6. 3 Electron microprobe results for the Astimex plagioclase standard.

Probe ID	Astimex plag																
BaO wt%	0.09	-0.10	0.00	0.00	-0.10	-0.02	-0.04	-0.05	0.01	0.09	0.09	0.02	-0.03	-0.02	-0.03	0.03	0.01
K ₂ O wt%	0.34	0.34	0.37	0.34	0.35	0.36	0.34	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.33	0.04	0.35
CaO wt%	11.89	12.01	11.89	11.92	11.66	11.97	11.90	11.85	11.87	11.93	11.87	11.88	11.97	11.84	11.76	0.70	11.82
SrO wt%	0.14	0.20	0.07	0.21	0.16	0.20	0.18	0.27	0.21	0.17	0.13	0.19	0.19	0.18	0.15	0.29	0.24
Na2O wt%	4.37	4.39	4.47	4.35	4.30	4.12	4.36	4.22	4.34	4.51	4.38	4.20	4.30	4.25	4.29	4.86	4.32
Al2O3 wt%	29.85	29.55	29.65	29.78	29.62	29.84	29.72	29.67	30.02	29.87	30.18	29.65	29.70	29.51	29.52	16.87	29.81
SiO2 wt%	52.15	52.07	52.46	51.83	52.35	52.05	52.49	52.48	52.42	52.45	52.48	51.94	52.12	52.32	52.16	67.96	52.56
Total wt%	98.82	98.47	98.91	98.44	98.33	98.51	98.95	98.79	99.22	99.37	99.47	98.23	98.60	98.43	98.17	90.75	99.11

Table A6. 4 Electron microprobe results for the Astimex rutile standard.

Probe ID	Astimex rutile	Astimes rutile											
SiO2wt%	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01
TiO2wt%	101.06	101.04	100.80	101.01	100.83	100.96	101.56	101.63	101.61	101.00	100.77	101.22	100.93
Al ₂ O ₃ wt%	0.05	0.02	0.24	0.04	0.04	0.06	0.05	0.05	0.04	0.04	0.05	0.04	0.04
Cr2O3 wt%	0.02	0.00	0.00	0.00	0.01	0.00	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.00
FeO wt%	0.02	0.03	0.02	0.00	0.02	0.02	0.00	0.00	0.01	0.02	0.02	0.01	0.02
MnO wt%	0.02	-0.01	0.00	-0.01	-0.01	0.01	-0.02	0.01	0.00	0.00	0.00	0.00	0.00
MgO wt%	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CaO wt%	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K ₃ O wt%	-0.01	0.00	0.00	0.00	0.00	0.00	0,00	0.00	0.00	0,00	0,00	0.00	0.00
Nb ₂ O ₄ wt%	0.04	0.01	-0.01	-0.03	0.00	0.00	0.01	-0.02	-0.01	0.01	-0.02	0.02	0.02
ZnO wt%	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.03	0.01	0.02
CuO wt%	0.00	0.02	0.01	-0.01	0.00	0.01	0.00	0.00	0.02	0.00	0.02	0.01	0.00
NiO wt%	0.01	0.02	0.01	0.00	-0.01	-0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00
CoO wt%	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.01	0.01	-0.01	-0.01
SnO ₂ wt%	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
$ZrO_2 wt \%$	0.00	-0.02	-0.01	0.00	-0.03	-0.01	-0.02	-0.01	0.00	0.00	0.01	0.01	-0.01
P2O5wt%	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
V ₂ O ₃ wt%	0.76	0.73	0.75	0.74	0.74	0.75	0.76	0.77	0.77	0.76	0.71	0.76	0.75
Total wt%	101.97	101.82	101.82	101.74	101.59	101.80	102.33	102.44	102.47	101.86	101.60	102.06	101.78
	Astimex	Astimex	Astimex										
Probe ID	rutile	rutile	rutile										
SiO ₂ wt%	0.01	0.01	0.01										
TiO2wt%	101.04	100.85	101.44										
Al2O3 wt%	0.04	0.04	0.05										
Cr2O3 wt%	0.00	0.00	0.00										
FeO wt%	0.00	0.00	0.02										
MnO wt%	0.00	0.01	-0.01										
MgO wt%	0.00	0.00	0.00										
CaO wt%	0.00	0.00	0.01										
K ₂ O wt%	0.00	0.00	0,00										
Nb2O5 wt%	0.01	0.01	0.01										
ZnO wt%	0.02	0.01	0.02										
CuO wt%	0.00	0.00	0.00										
NiO wt%	-0.01	0.00	0.00										
CoO wt%	-0.01	-0.01	0.01										
SnO2wt%	0.00	0.00	-0.01										
ZrO2wt%	-0.01	-0.02	0.00										
	0.00	-0.01	0.00										
P2O5wt%													
P ₂ O ₅ wt% V ₂ O ₃ wt% Total wt%	0.76 101.86	0.75 101.66	0.76 102.31										

Table A6. 5 Electron microprobe results for the Astimex magnetite standard.

	Astimex	Astimex	Astimex	Astimex	Astimex	Astimex	Astimex	Astimex	Astimex	Astimex	Astimex	Astimex	Astimex
Probe ID	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite
SiO2 wt%	0.02	0.00	0.02	0.01	0.01	-0.01	0.02	0.00	0.01	0.01	0.02	0.01	0.00
TiO ₂ wt%	0.03	0.04	0.05	0.06	0.04	0.05	0.25	0.07	0.10	0.12	0.04	0.05	0.05
Al ₂ O ₃ wt%	0.06	0.05	0.05	0.08	0.08	0.07	0.08	0.06	0.69	0.05	0.04	0.03	0.06
Cr ₂ O ₃ wt%	-0.01	-0.01	0.01	-0.01	0.00	0.00	0.00	-0.01	0.01	0.01	-0.01	0.00	0.00
FeO wt%	91.10	91.19	91.22	90.85	90.97	90.73	90.97	91.64	91.02	91.65	91.62	91.56	92.00
MnO wt%	0.30	0.25	0.23	0.28	0.26	0.29	0.37	0.34	0.31	0.35	0.20	0.25	0.26
MgO wt%	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CaO wt%	0.00	0.00	0.00	0.00	-0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
K ₂ O wt%	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nb2O5 wt%	0.01	-0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00
ZnO wt%	0.01	0.01	0.01	0.03	0.02	0.02	0.00	0.01	0.40	0.01	0.02	0.02	0.00
CuO wt%	0.01	-0.01	0.00	0.01	0.03	0.01	0.03	0.02	0.40	0.01	-0.02	0.03	0.00
NiO wt%	0.02	-0.01	0.01	0.02	0.00	-0.01	0.02	0.00	-0.01	0.01	-0.02	-0.01	0.00
	0.00	0.01	0.00	0.01	0.00	0.14	0.00	0.02	0.11	0.00	0.01	0.13	0.01
CoO wt%		-0.15		-0.22	-0.02						-0.09		
SnO2 wt%	-0.07		-0.01			0.00	-0.08	-0.01	-0.24	-0.05		-0.01	-0.01
ZrO ₂ wt%	-0.01	0.00	-0.01	0.01	0.00	0.00	-0.01	0.00	-0.02	0.00	0.01	-0.01	0.01
P ₂ O ₅ wt%	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	-0.01	0.00
V ₂ O ₃ wt%	0.03	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.03	0.02	0.03	0.01	0.02
Total wt%	91.60	91.51	91.74	91.29	91.52	91.31	91.78	92.27	92.45	92.26	92.02	92.07	92.53
Probe ID	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite	Astimex magnetite
	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	Astimex magnetite	Astimex magnetite	magnetite	magnetite	magnetite	Astimex magnetite
SiO2 wt%	magnetite 0.01	magnetite 0.01	magnetite 0.03	magnetite 0.00	magnetite 0.01	magnetite 0.00	magnetite 0.01	Astimex magnetite 0.02	Astimex magnetite 0.00	magnetite 0.01	magnetite 0.01	magnetite 0.01	Astimex magnetite 0.00
SiO2 wt% TiO2 wt%	0.01 0.09	magnetite	magnetite	magnetite	magnetite	magnetite	magnetite	Astimex magnetite	Astimex magnetite	magnetite	magnetite	magnetite	Astimex magnetite 0.00 0.04
SiO2 wt%	magnetite 0.01	magnetite 0.01 0.05	0.03 0.05	magnetite 0.00 0.04	magnetite 0.01 0.03	magnetite 0.00 0.08	0.01 0.07	Astimex magnetite 0.02 0.07	Astimex magnetite 0.00 0.31	magnetite 0.01 0.06	0.01 0.04	0.01 0.05	Astimex magnetite 0.00
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt%	magnetite 0.01 0.09 0.16	0.01 0.05 0.14	magnetite 0.03 0.05 0.06	magnetite 0.00 0.04 0.08	0.01 0.03 0.06	0.00 0.08 0.06	magnetite 0.01 0.07 0.04	Astimex magnetite 0.02 0.07 0.05	Astimex magnetite 0.00 0.31 0.06	magnetite 0.01 0.06 0.07	magnetite 0.01 0.04 0.06	magnetite 0.01 0.05 0.06	Astimex magnetite 0.00 0.04 0.05
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt%	0.01 0.09 0.16 -0.01	0.01 0.05 0.14 -0.01	magnetite 0.03 0.05 0.06 0.01	magnetite 0.00 0.04 0.08 0.00	magnetite 0.01 0.03 0.06 -0.01	magnetite 0.00 0.08 0.06 -0.01	0.01 0.07 0.04 -0.01	Astimex magnetite 0.02 0.07 0.05 0.00	Astimex magnetite 0.00 0.31 0.06 0.00	magnetite 0.01 0.06 0.07 0.00	magnetite 0.01 0.04 0.06 0.01	magnetite 0.01 0.05 0.06 -0.01	Astimex magnetite 0.00 0.04 0.05 -0.01
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt%	0.01 0.09 0.16 -0.01 91.61	0.01 0.05 0.14 -0.01 90.84	magnetite 0.03 0.05 0.06 0.01 91.31	magnetite 0.00 0.04 0.08 0.00 91.98	0.01 0.03 0.06 -0.01 92.05	0.00 0.08 0.06 -0.01 91.60	0.01 0.07 0.04 -0.01 91.26	Astimex magnetite 0.02 0.07 0.05 0.00 91.67	Astimex magnetite 0.00 0.31 0.06 0.00 90.88	0.01 0.06 0.07 0.00 91.73	0.01 0.04 0.06 0.01 91.82	0.01 0.05 0.06 -0.01 91.33	Astimex magnetite 0.00 0.04 0.05 -0.01 91.88 0.19 0.01
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% CaO wt%	magnetite 0.01 0.09 0.16 -0.01 91.61 0.30 0.01 0.00	magnetite 0.01 0.05 0.14 -0.01 90.84 0.27 0.01 0.00	magnetite 0.03 0.05 0.06 0.01 91.31 0.24 0.01 0.00	magnetite 0.00 0.04 0.08 0.00 91.98 0.23 0.01 0.00	magnetite 0.01 0.03 0.06 -0.01 92.05 0.25 0.00 0.00	magnetite 0.00 0.08 0.06 -0.01 91.60 0.36 0.02 0.00	magnetite 0.01 0.07 0.04 -0.01 91.26 0.33 0.02 0.00	Astimex magnetite 0.02 0.07 0.05 0.00 91.67 0.30 0.02 0.00	Astimex magnetite 0.00 0.31 0.06 0.00 90.88 0.48 0.01 0.01	magnetite 0.01 0.06 0.07 0.00 91.73 0.29 0.01 0.01	magnetite 0.01 0.04 0.06 0.01 91.82 0.27 0.02 0.00	magnetite 0.01 0.05 0.06 -0.01 91.33 0.27 0.01 0.00	Astimex magnetite 0.00 0.04 0.05 -0.01 91.88 0.19 0.01 0.00
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% CaO wt% K ₂ O wt%	magnetite 0.01 0.09 0.16 -0.01 91.61 0.30 0.01 0.00 0.00	magnetite 0.01 0.05 0.14 -0.01 90.84 0.27 0.01 0.00 0.00 0.00	magnetite 0.03 0.05 0.06 0.01 91.31 0.24 0.01 0.00 0.00	magnetite 0.00 0.04 0.08 0.00 91.98 0.23 0.01 0.00 0.00	magnetite 0.01 0.03 0.06 -0.01 92.05 0.25 0.00 0.00 0.00	magnetite 0.00 0.08 0.06 -0.01 91.60 0.36 0.02 0.00 0.00 0.00	magnetite 0.01 0.07 0.04 -0.01 91.26 0.33 0.02 0.00 -0.01	Astimex magnetite 0.02 0.07 0.05 0.00 91.67 0.30 0.02 0.00 0.00 0.00	Astimex magnetite 0.00 0.31 0.06 0.00 90.88 0.48 0.01 0.01 0.01 0.00	magnetite 0.01 0.06 0.07 0.00 91.73 0.29 0.01 0.01 0.00	magnetite 0.01 0.04 0.06 0.01 91.82 0.27 0.02 0.00 -0.01	magnetite 0.01 0.05 0.06 -0.01 91.33 0.27 0.01 0.00 0.00 0.00	Astimex magnetite 0.00 0.04 0.05 -0.01 91.88 0.19 0.01 0.00 0.00
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% K ₂ O wt% Nb ₂ O ₅ wt%	magnetite 0.01 0.09 0.16 -0.01 91.61 0.30 0.01 0.00 0.00 0.00 0.03	magnetite 0.01 0.05 0.14 -0.01 90.84 0.27 0.01 0.00 0.00 0.00 0.05	magnetite 0.03 0.05 0.06 0.01 91.31 0.24 0.01 0.00 0.00 0.00 -0.01	magnetite 0.00 0.04 0.08 0.00 91.98 0.23 0.01 0.00 0.00 0.00 0.02	magnetite 0.01 0.03 0.06 -0.01 92.05 0.25 0.00 0.00 0.00 0.00 -0.01	magnetite 0.00 0.08 0.06 -0.01 91.60 0.36 0.02 0.00 0.00 0.00 -0.03	magnetite 0.01 0.07 0.04 -0.01 91.26 0.33 0.02 0.00 -0.01 -0.01	Astimex magnetite 0.02 0.05 0.00 91.67 0.30 0.02 0.00 0.00 -0.01	Astimex magnetite 0.00 0.31 0.06 0.00 90.88 0.48 0.01 0.01 0.00 0.00	magnetite 0.01 0.06 0.07 0.00 91.73 0.29 0.01 0.01 0.00 0.00 0.02	magnetite 0.01 0.04 0.06 0.01 91.82 0.27 0.02 0.00 -0.01 0.01	magnetite 0.01 0.05 0.06 -0.01 91.33 0.27 0.01 0.00 0.00 0.00 0.00	Astimex magnetite 0.00 0.04 0.05 -0.01 91.88 0.19 0.01 0.00 0.00 0.00
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt% K ₂ O wt% Nb ₂ O ₅ wt% ZnO wt%	magnetite 0.01 0.09 0.16 -0.01 91.61 0.30 0.01 0.00 0.00 0.03 0.05	magnetite 0.01 0.05 0.14 -0.01 90.84 0.27 0.01 0.00 0.00 0.05 0.06	magnetite 0.03 0.05 0.06 0.01 91.31 0.24 0.01 0.00 0.00 -0.01 0.03	magnetite 0.00 0.04 0.08 0.00 91.98 0.23 0.01 0.00 0.00 0.00 0.02 -0.01	magnetite 0.01 0.03 0.06 -0.01 92.05 0.25 0.00 0.00 0.00 0.00 -0.01 0.02	magnetite 0,00 0,08 0,06 -0,01 91,60 0,36 0,02 0,00 0,00 -0,03 0,01	magnetite 0.01 0.07 0.04 -0.01 91.26 0.33 0.02 0.00 -0.01 -0.01 -0.01	Astimex magnetite 0.02 0.07 0.05 0.00 91.67 0.30 0.02 0.00 0.00 -0.01 0.02	Astimex magnetite 0.00 0.31 0.06 0.00 90.88 0.48 0.01 0.01 0.00 0.04 -0.01	magnetite 0.01 0.06 0.07 0.00 91.73 0.29 0.01 0.01 0.00 0.02 0.01	magnetite 0.01 0.04 0.06 0.01 91.82 0.27 0.02 0.00 -0.01 0.01 0.01	magnetite 0.01 0.05 0.06 -0.01 91.33 0.27 0.01 0.00 0.00 0.00 0.00 0.00	Astimex magnetite 0.00 0.04 0.05 -0.01 91.88 0.19 0.01 0.00 0.00 0.00 0.01 -0.01
SiO ₂ wt% TiO ₃ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% CaO wt% K ₂ O wt% Nb ₂ O ₅ wt% ZnO wt%	magnetite 0.01 0.09 0.16 -0.01 91.61 0.30 0.01 0.00 0.00 0.03 0.05 -0.01	magnetite 0.01 0.05 0.14 -0.01 90.84 0.27 0.01 0.00 0.00 0.05 0.06 -0.01	magnetite 0.03 0.05 0.06 0.01 91.31 0.24 0.01 0.00 0.00 -0.01 0.03 -0.01	magnetite 0.00 0.04 0.08 0.00 91.98 0.23 0.01 0.00 0.00 0.00 0.02 -0.01 0.01	magnetite 0.01 0.03 0.06 -0.01 92.05 0.25 0.00 0.00 0.00 0.00 -0.01 0.02 0.01	magnetite 0.00 0.08 0.06 -0.01 91.60 0.36 0.02 0.00 0.00 -0.03 0.01 0.01	magnetite 0.01 0.07 0.04 -0.01 91.26 0.33 0.02 0.00 -0.01 -0.01 -0.01 0.00	Astimex magnetite 0.02 0.07 0.05 0.00 91.67 0.30 0.02 0.00 0.00 0.00 0.00 0.00 0.00	Astimex magnetite 0.00 0.31 0.06 0.00 90.88 0.48 0.01 0.01 0.01 -0.01	magnetite 0.01 0.06 0.07 0.00 91.73 0.29 0.01 0.01 0.00 0.02 0.01 0.00 0.02 0.01	magnetite 0.01 0.04 0.06 0.01 91.82 0.27 0.02 0.00 -0.01 0.01 0.01 0.02	magnetite 0.01 0.05 0.06 -0.01 91.33 0.27 0.01 0.00 0.00 0.00 0.00 0.00 0.00	Astimex magnetite 0.00 0.04 0.05 -0.01 91.88 0.19 0.01 0.00 0.00 0.00 0.01 -0.01 0.01
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% CaO wt% Nb ₂ O ₅ wt% ZnO wt% CuO wt%	magnetite 0.01 0.09 0.16 -0.01 91.61 0.30 0.01 0.00 0.00 0.03 0.05 -0.01 -0.01	magnetite 0.01 0.05 0.14 -0.01 90.84 0.27 0.01 0.00 0.00 0.05 0.06 -0.01 0.00	magnetite 0.03 0.05 0.06 0.01 91.31 0.24 0.01 0.00 0.00 -0.01 0.03 -0.01 -0.01	magnetite 0.00 0.04 0.08 0.00 91.98 0.23 0.01 0.00 0.00 0.00 0.02 -0.01 0.01 0.01	magnetite 0.01 0.03 0.06 -0.01 92.05 0.25 0.00 0.00 0.00 -0.01 0.02 0.01 -0.01	magnetite 0.00 0.08 0.06 -0.01 91.60 0.02 0.00 0.00 -0.03 0.01 0.01 0.00	magnetite 0.01 0.07 0.04 -0.01 91.26 0.33 0.02 0.00 -0.01 -0.01 -0.01 0.00 0.00	Astimex magnetite 0.02 0.07 0.05 0.00 91.67 0.30 0.02 0.00 0.00 -0.01 0.02 0.01	Astimex magnetite 0.00 0.31 0.06 0.00 90.88 0.48 0.01 0.01 0.00 0.04 -0.01 -0.01	magnetite 0.01 0.06 0.07 0.00 91.73 0.29 0.01 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 -0.01	magnetite 0.01 0.04 0.06 0.01 91.82 0.27 0.02 0.00 -0.01 0.01 0.01 0.02 0.01	magnetite 0.01 0.05 0.06 -0.01 91.33 0.27 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	Astimex magnetite 0.00 0.04 0.05 -0.01 91.88 0.19 0.01 0.00 0.00 0.01 0.01 0.00
SiO ₂ wt% TiO ₃ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% CaO wt% K ₃ O wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt%	magnetite 0.01 0.09 0.16 -0.01 91.61 0.30 0.01 0.00 0.00 0.03 0.05 -0.01 -0.01 0.13	magnetite 0.01 0.05 0.14 -0.01 90.84 0.27 0.01 0.00 0.00 0.05 0.06 -0.01 0.00 0.13	magnetite 0,03 0,05 0,06 0,01 91.31 0,24 0,01 0,01 0,00 0,00 -0,01 0,03 -0,01 -0,01 0,14	magnetite 0,00 0,04 0,08 0,00 91,98 0,23 0,01 0,00 0,00 0,00 0,02 -0,01 0,01 0,14	magnetite 0,01 0,03 0,06 -0,01 92,05 0,25 0,25 0,25 0,25 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,01 0,25 0,25 0,25 0,25 0,01 0,03 0,06 0,01 92,05 0,01 0,03 0,06 0,01 92,05 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,00 0,0	magnetite 0.00 0.08 0.06 -0.01 91.60 0.36 0.02 0.00 0.00 -0.03 0.01 0.01 0.00 0.11	magnetite 0.01 0.07 0.04 -0.01 91.26 0.33 0.02 0.00 -0.01 -0.01 -0.01 0.00 0.00 0.00 0.13	Astimex magnetite 0.02 0.07 0.05 0.00 91.67 0.30 0.02 0.00 -0.01 0.02 0.01 0.02 0.01 0.01 0.14	Astimex magnetite 0.00 0.31 0.06 0.00 90.88 0.48 0.01 0.01 0.00 0.04 -0.01 -0.01 0.13	magnetite 0,01 0,06 0,07 0,00 91.73 0,29 0,01 0,01 0,01 0,00 0,02 0,01 0,00 -0,01 0,13	magnetite 0,01 0,04 0,06 0,01 91.82 0,27 0,02 0,00 -0,01 0,01 0,01 0,02 0,01 0,12	magnetite 0.01 0.05 0.06 -0.01 91.33 0.27 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.0	Astimex magnetite 0.00 0.04 0.05 -0.01 91.88 0.19 0.01 0.00 0.00 0.01 -0.01 0.01 0.01 0.0
SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MBO wt% CaO wt% ZaO wt% CaO wt% CaO wt% NiO wt% SnO ₂ wt%	magnetite 0.01 0.09 0.16 -0.01 91.61 0.30 0.01 0.00 0.00 0.03 0.05 -0.01 -0.01 -0.13 -0.24	magnetite 0.01 0.05 0.14 -0.01 90.84 0.27 0.01 0.00 0.05 0.06 -0.01 0.03 -0.01	magnetite 0.03 0.05 0.06 0.01 91.31 0.24 0.01 0.00 0.00 0.00 0.00 0.03 -0.01 0.03 -0.01 0.14 -0.01	magnetite 0.00 0.04 0.08 0.00 91.98 0.23 0.01 0.00 0.00 0.00 0.02 -0.01 0.01 0.01 0.01 0.14 -0.01	magnetite 0.01 0.03 0.06 -0.01 92.05 0.25 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.02 0.01 -0.01 0.02 0.01 0.03 -0.01 0.03 -0.06 -0.01 0.03 -0.06 -0.01 92.05 0.25 0.00 0.00 0.00 0.00 0.00 0.00 0.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.01 0.01 0.13 -0.14	magnetite 0.00 0.08 0.06 -0.01 91.60 0.36 0.02 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.02 0.00 0.03 0.01 0.01 0.02 0.00 0.00 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 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Probe ID P1 P2 P4 P8 P P5 _P6 P10 P11 _P12 P13 P14 P15 Sample W605013 W605013 W605013 W605013 W605013 W605013 W605013 S037015 S037015 S037015 S037015 S037015 S037015 S037015 S037015 S037015 Iron Iron Iron Iron formation Iron formation Iron formation Iron Rocktype formation Z-FeTiB Z-FeTiB Z-FeTiB Z-FeTiB Z-FeTiB Z-FeTiB Z-FeTiB Z-FeTiB Z-FeTiB formation formation formation Featur Interstitial Interctitie Variole Variolo Variole Groundma BaO wť 0.00 0.05 -0.03 0.06 5.77 0.11 8.30 25.31 62.28 101.81 K₂O wt% CaO wt% SrO wt% Na₂O wt% Al₂O₃ wt% SiO₂ wt% 0.04 0.94 0.07 10.69 0.05 5.66 0.16 8.38 0.65 5.88 0.08 7.16 0.05 0.43 0.01 11.56 20.67 70.08 102.79 0.04 0.69 -0.02 11.44 20.67 69.38 102.30 0.02 0.16 0.12 7.21 11.60 81.83 101.01 0.04 0.55 -0.02 10.46 20.61 70.02 101.64 0.05 0.89 0.07 10.91 20.76 69.22 101.93 0.05 0.96 0.09 11.03 20.75 69.10 101.96 0.08 5.66 0.09 8.42 24.93 61.55 100.68 0.07 6.20 0.12 8.18 25.46 60.72 100.75 0.08 5.85 0.06 8.39 24.91 61.34 100.60 0.08 6.29 0.07 8.01 25.47 60.88 100.83 0.10 6.06 0.08 8.27 25.15 60.99 100.57 0.08 6.68 0.20 7.73 25.92 60.13 100.80 Poble 10.69 20.83 68.23 100.75 8.38 25.22 62.22 101.72 7.16 24.60 58.31 96.67 An % Ab % Or % 27 73 29 70 28 72 30 69 0 28 72 32 67 27 73 30 66 2 98 3 97 1 99 0 3 97 0 5 95 0 5 95 29 71 4 95 Cale. Probe ID Sample S037015 S037015 S037015 Rocktype Z-FeTiB Groundmas Feature Variolo Variol Variolo Variole Phenocrys Variole Variol /microlites BaO wt% K₂O wt% CaO wt% SrO wt% Na₂O wt% Al₂O₃ wt% SiO₂ wt% Total wt% -0.01 0.08 10.33 -0.02 0.09 5.99 0.12 8.41 25.23 61.10 100.92 0.05 0.07 8.23 0.14 6.95 27.22 57.63 100.28 0.03 0.08 2.95 0.16 9.90 22.67 66.06 101.83 -0.04 0.08 7.89 -0.01 0.07 7.23 0.02 7.39 26.14 59.08 99.93 0.03 0.07 7.99 0.13 7.01 27.11 57.99 100.34 0.04 0.04 6.83 0.10 7.67 25.97 60.29 100.94 0.05 0.06 6.46 0.07 8.13 25.67 60.24 100.68 0.02 0.07 7.97 0.08 6.97 26.97 58.05 100.13 -0.03 0.06 7.48 0.06 7.33 26.63 58.61 100.14 0.05 0.53 0.06 11.31 20.04 72.97 104.97 0.10 0.88 0.08 0.03 0.02 0.06 0.02 0.19 0.67 98.61 99.54 0.05 0.06 7.77 0.15 7.06 26.64 58.77 100.41 0.11 6.05 0.09 8.30 24.86 60.36 99.73 0.11 7.20 26.95 58.09 100.29 0.13 5.63 29.03 55.06 100.24 11.51 20.41 69.82 102.81 39 61 29 71 36 64 33 67 0 39 61 15 79 38 62 30 69 0 14 85 0 38 62 35 65 0 28 71 50 49 39 60 0 An % Ab % Or % 3 4 95 Cale. S037015 7_ S037015 7_ S037015 7_ S037015 7_ S039313 5_ S039313 5_ S039313 5_ S039313 5_ 9362 2_P4 99362 2_P4 9 Probe ID Sample 99-362 99-362 99-362 99-362 99-362 99-362 99-362 Z-FeTiB HW-FeTiB HW-FeTiB HW-FeTiB FW-FeB FW-FeB FW-FeB FW-FeB FW-FeB FW-FeB FW-FeB FW-FeB FW-FeB Rocktype Z-FeTiB Z-FeTiB Jrounda. /microlit Featur BaO wt% K₂O wt% CaO wt% SrO wt% Na₂O wt% Al₂O₃ wt% SiO₂ wt% Total wt% 0.02 0.06 8.25 0.11 6.93 27.32 57.70 100.39 0.06 0.11 0.64 0.20 10.24 18.58 71.25 101.09 0.00 0.08 1.46 0.70 10.76 21.61 67.02 101.63 0.05 0.05 0.80 0.37 10.97 20.70 68.62 101.54 -0.05 0.04 0.67 0.29 8.52 16.32 66.09 91.89 -0.09 0.03 0.57 0.01 5.92 10.58 86.61 103.62 0.04 0.08 8.70 0.04 6.66 27.03 57.03 99.50 0.48 8.69 0.03 6.00 26.39 55.57 97.27 0.06 0.25 0.01 10.76 20.84 72.54 104.46 0.07 8.41 0.04 6.49 26.77 56.94 98.73 0.08 8.39 0.09 6.77 26.62 57.33 99.31 0.07 8.32 0.11 6.81 0.04 0.84 0.10 11.50 20.71 67.45 100.65 0.11 5.24 0.19 8.61 24.45 60.93 99.54 0.06 8.45 0.06 5.30 0.08 8.31 23.99 64.83 102.56 0.16 6.63 27.36 57.53 100.20 Probe 26.35 57.27 99.01 An % Ab % Or % 40 60 0 41 58 3 4 96 0 42 58 43 54 3 42 58 0 26 74 40 59 0 40 59 0 4 96 0 5 95 0 25 74 1 98 0 7 93 0 4 96 0 Cale. 96 1 99362 <u>2</u> P5 99362 Probe ID 99-362 99-362 99-362 99-362 99-362 99-362 99-362 99-362 Sample 99-362 99-362 99-362 99-362 99-362 99-362 99-362 99-362 FW-FeB Rocktype FW-FeB Featur BaO wt% K₂O wt% CaO wt% SrO wt% Na₂O wt% Al₂O₃ wt% SiO₂ wt% Total wt% -0.04 0.07 7.09 0.13 7.54 25.81 58.94 99.53 0.00 0.02 3.42 1.50 0.11 5.92 27.17 -0.01 0.09 2.00 0.09 10.81 21.76 66.94 101.67 0.12 6.18 0.11 8.01 25.44 59.78 99.65 0.12 3.06 0.12 9.75 0.08 0.09 8.73 0.14 6.51 26.79 56.44 98.69 1.76 5.28 0.08 5.98 27.11 58.26 98.47 0.05 8.14 0.04 6.99 26.34 57.09 98.74 0.08 8.44 0.06 6.68 27.12 57.12 99.52 0.05 0.06 6.32 0.12 7.86 25.18 59.92 99.42 0.06 8.23 0.01 6.78 26.69 57.22 99.00 0.09 7.41 0.08 6.87 25.60 56.88 96.98 0.04 0.38 0.04 11.52 20.50 70.32 102.74 8.32 0.12 6.78 26.77 57.01 99.01 6.89 0.19 7.63 25.72 59.13 99.72 0.10 10.96 21.44 67.35 101.67 9.75 22.83 64.76 100.69 60.86 99.01 An % Ab % Or % 42 57 39 61 34 66 0 33 66 41 59 0 37 62 40 59 31 69 0 40 60 0 30 70 1 15 85 29 59 12 2 98 0 8 92 9 66 25 Cale.

Table A6. 6 Electron microprobe results for plagioclase mineral chemistry and calculated mineral formulae based on eight oxygens.

_																	
_	Probe ID	99362_2_P6 6	99362_2_P6 7	99362_2_P6 8	W605041_3 _P69	W605318_9 _P70	W605318_9 _P71	W605318_9 _P72	W605318_9 _P73	W605318_9 _P74	W605318_9 _P75	S037015_A _P76	S037015_A _P77	S037015_A _P78	S037015_A _P79	S037015_A _P80	\$037015_A _P81
	Sample	99-362	99-362	99-362	W605041	W605318	W605318	W605318	W605318	W605318	W605318	S037015	S037015	S037015	S037015	S037015	S037015
	Rocktype	FW-FeB	FW-FeB	FW-FeB	HSR	FeR	FeR	FeR	FeR	FeR	FeR	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB
_	Feature		Phenocryst									Groundmass				Variole	Variole
	BaO wt% K2O wt% CaO wt%	-0.02 0.05 1.00	0.01 0.15 8.47	0.01 0.12 9.75	0.11 4.60 0.78	0.20 1.11 0.01	0.74 2.35 0.01	0.60 1.87 0.13	0.73 2.15 0.00	0.00 0.03 0.00	0.14 0.52 0.01	0.01 0.06 4.34	0.00 0.08 4.80	-0.03 0.06 6.64	-0.02 0.09 7.13	-0.05 0.04 8.08	-0.03 0.06 8.02
Probe data	SrO wt% Na ₂ O wt%	0.06 8.92	0.00 6.78	0.08 5.79	0.06 6.15	0.04 0.04	0.06 0.12	0.00 0.22	-0.04 0.10	-0.04 0.00	-0.01 0.03	0.08 8.98	0.10 8.94	0.17 7.92	0.18 7.55	0.13 7.04	0.09 7.06
Æ	Al ₂ O ₃ wt% SiO ₂ wt% Total wt%	20.59 59.06 89.65	26.56 56.72 98.69	27.86 55.58 99.18	24.39 60.87 96.96	3.66 94.15 99.22	7.86 89.38 100.51	5.85 84.47 93.14	7.10 88.76 98.81	0.05 98.50 98.55	1.71 96.26 98.67	23.90 63.29 100.65	24.77 63.00 101.70	25.81 60.19 100.76	26.35 59.80 101.08	27.24 58.29 100.77	26.96 58.36 100.52
6	An %	6	40	48	4	1	0	5	0	4	1	21	23	32	34	39	38
Cale	Ab % Or %	94 0	59 1	51 1	64 32	6 94	7 93	15 81	7 93	12 84	9 90	79 0	77 0	68 0	65 0	61 0	61 0
-		\$037015_A	\$037015_A	S037015_A	S037015 B	S037015 B	S037015 B	S037015 B	S037015 B	S037015 B	S037015 B	S037015_B	S037015 B	S037015 B	S037015 C	\$037015 C	\$037015 C
	Probe ID Sample	_P82 S037015	_P83 \$037015	_P84 S037015	_P85 S037015	_P86 S037015	_P87 S037015	_P88 S037015	_P89 S037015	_P90 S037015	_P91 S037015	_P92 S037015	_P93 S037015	_P94 S037015	_P95 S037015	_P96 S037015	_P97 S037015
	Rocktype	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB
	Feature	Variole	Variole	Variole	Groundmass	Groundmass	Groundmass	Groundmass	Groundmass	Groundmass	Groundmass	Groundmass	Groundmass	Groundmass	?	Variole	Variole
-	BaO wt%	0.01	-0.09	-0.07	0.00	-0.03	-0.05	0.00	-0.02	0.07	-0.02	-0.03	0.00	0.06	0.01	0.05	0.59
data	K ₂ O wt% CaO wt% SrO wt%	0.05 8.68 0.16	0.05 7.10 0.11	0.05 6.37 0.07	0.08 8.60 0.12	0.08 4.36 0.16	0.07 6.93 0.11	0.07 2.49 0.10	0.77 8.00 0.12	0.12 0.81 -0.02	0.07 0.65 0.05	0.05 3.95 0.14	0.07 5.69 0.07	0.10 1.12 0.05	0.21 9.33 0.16	0.07 13.19 0.12	9.33 0.75 0.04
Probe data	Na2O wt% Al2O3 wt%	6.66 27.53	7.67 26.43	7.39 24.19	6.72 27.68	9.02 24.04	7.67 25.99	9.84 22.61	6.55 26.93	11.47 21.37	11.30 21.13	9.71 23.50	7.38 23.70	4.61 22.42	5.98 28.38	3.92 31.53	0.62 31.60
	SiO ₂ wt% Total wt%	57.74 100.84	59.56 100.83	63.73 101.73	57.29 100.49	64.64 102.26	59.71 100.43	66.74 101.86	56.36 98.71	71.72 105.54	71.81 104.98	64.85 102.16	63.38 100.30	73.07 101.42	56.06 100.14	51.92 100.81	48.39 91.31
Cale.	An % Ab %	42 58 0	34 66 0	32 68 0	41 58 0	21 79 0	33 66 0	12 87 0	39 57 4	4 96 1	3 97 0	18 81 0	30 70 0	12 87	46 53 1	65 35 0	6 9 86
	Or %	0	0	0	0	0	0	0	4	1	0	0	0	1	I	0	80
_																	
	Probe ID	S037015_C _P98	S037015_C _P99	_P100	S037015_C _P101	_P102	S037015_C _P103	S037015_C _P104	_P105	_P106	_P107	S037015_D _P108	_P109	_P110	_P111	_P112	_P113
	Sample Rocktype	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB	S037015 Z-FeTiB
_	Feature BaO wt%	0.01	Variole	Variole 0.03	Variole	Variole	0.04	-0.02	Variole	0.00	Phenocryst 0.03	-0.01	-0.04	Phenocryst 0.00	-0.02	-0.01	-0.01
ata	K2O wt% CaO wt%	0.24	0.05 6.78	0.06 8.10	0.06 7.89	0.06	0.06	0.07 7.87	0.07 8.08	0.08	0.08 7.44	0.04 7.63	0.09 7.11	0.06 0.14	0.07 0.16	0.12 0.47	0.06 0.08
Probe data	SrO wt% Na ₂ O wt% Al ₂ O ₃ wt%	0.12 4.41 31.04	0.12 7.64 25.91	0.08 7.01 27.09	0.16 7.18 27.09	0.06 7.36 26.15	0.13 7.46 26.26	0.07 7.25 27.06	0.10 7.05 27.17	0.12 7.33 26.83	0.10 7.41 26.42	0.13 7.39 26.66	0.11 7.46 26.12	0.03 11.05 20.78	0.10 11.47 20.24	0.04 11.54 20.97	-0.03 11.97 20.58
	SiO2 wt% Total wt%	52.67 100.70	60.03 100.55	57.61 99.98	58.35 100.80	58.84 99.85	59.12 100.18	58.32 100.61	58.08 100.58	58.82 100.91	59.14 100.61	58.47 100.32	58.70 99.55	73.23 105.30	71.55 103.57	72.01 105.14	72.14 104.78
Cale.	An % Ab %	60 39	33 67	39 61	38 62	36 64	34 65	37 62	39 61	37 63	36 64	36 63	34 65	1 99	1 99	2 97	0 99
0	Or %	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
-	Probe ID	S037015_D P114	S037015_D P115	S037015_D P116	S037015_D _P117	S037015_D _P118	S037015_D _P119	S037015_E P120	S037015_E _P121	S037015_E P122	S037015_E P123	S037015_E P124	S037015_E P125	S037015_E P126	S037015_E P127	S037015_F P128	S037015_F P129
	Sample	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015	S037015
	Rocktype	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB
_	Feature				Groundmass			Variole	Variole	Variole	Variole				Groundmass	Variole	Variole
-	BaO wt% K ₂ O wt% CaO wt%	0.06 0.08 7.95	-0.02 0.05 0.20	0.02 0.06 4.95	-0.01 0.08 7.57	0.05 0.08 6.71	0.00 0.08 6.86	0.05 0.06 4.78	-0.10 0.06 5.88	0.05 0.06 6.44	0.05 0.06 7.11	0.04 0.06 6.57	0.05 0.05 6.64	-0.02 0.07 3.50	-0.06 0.19 7.84	-0.03 0.05 5.23	0.00 0.04 9.81
Probe data	SrO wt% Na ₂ O wt%	0.05 6.83	0.05 11.90	0.13 8.97	0.16 7.02	0.02 7.77	0.07 7.81	0.11 7.20	0.17 8.35	0.08 7.86	0.10 7.34	0.14 7.91	0.05 7.94	0.08 9.70	0.13 7.03	0.14 8.70	0.16 5.86
£	Al ₂ O ₃ wt% SiO ₂ wt% Total wt%	26.92 58.01 99.90	20.63 72.03 104.84	24.45 62.78 101.37	26.54 57.35 98.71	25.62 60.79 101.03	25.84 59.89 100.53	21.72 66.67 100.60	25.43 61.84 101.64	25.78 60.79 101.06	26.35 58.87 99.88	25.72 60.06 100.50	25.69 60.69 101.13	23.86 65.05 102.24	26.75 58.38 100.25	24.51 62.30 100.89	28.59 55.96 100.43
5	An %	39	1	23	37	32	33	27	28	31	35	31	32	17	38	25	48
Cale	Ab % Or %	61 0	99 0	76 0	62 0	67 0	67 0	73 0	72 0	69 0	65 0	68 0	68 0	83 0	61 1	75 0	52 0
-	Probe ID	S037015_F P130	S037015_F P131	S037015_F P132	S037015_F P133	S037015_F P134	S037015_F P135	S037015_F P136	S037015_F P137	S037015_H P138	S037015_H P139	S037015_H P140	S037015_H P141	S037015_H P142	S037015_H P143	S037015_H P144	S037015_H P145
	Sample	_P130 \$037015	_P131 \$037015	_F132 \$037015	_F133 S037015	_P134 S037015	_P133 S037015	_P130 S037015	_P137 8037015	_F138 S037015	_F139 S037015	_P140 S037015	_P141 S037015	_P142 S037015	_F143 \$037015	_P144 S037015	_P145 S037015
	Rocktype	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB
	Feature	Variole	Variole	Variole	Variole	Groundmass	Groundmass	Groundmass	Groundmass	Variole	Variole	Variole	Variole	Groundmass	Groundmass	Groundmass	Groundmass
-	BaO wt% K2O wt%	-0.05 0.06	0.01	0.03	-0.01 0.06	0.08	-0.04 0.07	-0.07 0.07	0.04	0.00	0.06	-0.07 0.07	0.05	0.02	-0.03 0.09	0.04	-0.07 0.06
Probe data	CaO wt% SrO wt% Na ₂ O wt%	7.41 0.15 7.17	5.71 0.11 8.20	7.50 0.13 7.57	6.54 0.05 7.82	6.22 0.11 6.01	7.00 0.06 7.64	6.59 0.14 7.89	5.88 0.08 8.35	7.41 0.07 7.45	5.99 0.07 7.90	5.60 0.09 8.67	6.93 0.19 7.79	9.29 0.13 6.36	3.88 0.20 9.87	8.11 0.11 7.13	8.35 0.09 7.05
Pro	Al ₂ O ₃ wt% SiO ₂ wt%	26.60 59.24	24.95 60.33	26.68 58.53	25.38 59.53	25.08 55.27	26.02 59.63	26.00 60.81	25.27 61.30	26.64 59.01	25.16 59.90	25.03 61.47	26.10 59.28	27.87 56.60	23.79 65.58	27.18 58.12	27.33 57.91
	Total wt%	100.58	99.37	100.49	99.38	94.68	100.38	101.43	100.99	100.63	99.48	100.87	100.39	100.33	103.38	100.76	100.71 39
Cale.	An % Ab % Or %	36 63 0	28 72 0	35 64 0	31 68 0	32 56 12	33 66 0	31 68 0	28 72 0	35 64 0	29 69 2	26 73 0	33 67 0	44 55 0	18 82 0	38 61 0	39 60 0

	Probe ID	9431_1_M 113	114	117	118	119	120	123	124	125	126	127	128	129	130	131	132
	Sample	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-3
	Rocktype	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW FeTi
	SiO2 wt%	0.03	0.75	0.40	54.23	0.05	0.06	0.09	0.05	0.04	0.00	0.03	0.02	0.00	0.00	0.00	0.0
	TiO2 wt%	0.01	0.29	2.42	0.26	0.02	0.40	0.30	0.51	0.34	0.28	0.10	-0.01	0.00	0.01	0.01	0.0
	Al ₂ O ₃ wt%	0.02	0.29	0.14	0.01	0.03	0.01	0.03	0.01	0.01	0.01	0.00	-0.01	-0.01	0.00	-0.01	-0.0
	Cr2O3 wt%	0.00	0.01	0.01	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.02	0.02	0.0
	FeO wt%	91.09	89.34	3.50	42.42	90.82	90.68	91.07	91.22	91.09	90.97	91.48	91.25	91.97	91.84	91.58	91.3
	MnO wt%	-0.01	0.00	1.19	0.00	0.03	0.00	0.00	0.00	0.00	-0.02	0.00	0.01	-0.01	-0.01	0.01	0.0
	MgO wt%	0.00	0.22	1.21	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.0
	CaO wt%	0.26	0.28	59.03	0.39	0.90	0.18	0.03	0.13	0.01	0.01	0.27	0.18	0.15	0.04	0.24	0.6
1000 0011	K2O wt%	0.00	0.13	0.14	0.03	0.02	0.02	0.08	0.02	0.04	0.06	0.00	0.01	-0.01	0.00	0.00	0.0
2	Nb ₂ O ₅ wt%	0.00	0.03	-0.02	0.01	0.02	0.05	0.00	0.01	-0.01	0.02	0.03	0.04	0.00	0.00	-0.03	0.0
	ZnO wt%	0.01	0.01	0.00	-0.01	0.00	0.01	0.00	0.01	0.00	-0.01	-0.02	0.00	0.01	0.01	0.00	0.0
•	CuO wt%	0.01	0.00	0.01	0.00	0.00	-0.01	0.01	0.00	0.01	0.00	0.00	-0.01	0.00	0.01	0.00	0.0
	NiO wt%	0.00	-0.01	-0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.01	-0.01	-0.01	0.0
	CoO wt%	0.14	0.12	0.01	0.06	0.11	0.13	0.14	0.11	0.14	0.14	0.13	0.13	0.09	0.13	0.14	0.1
	SnO2 wt%	-0.05	-0.01	-0.03	-0.10	-0.22	-0.08	-0.01	-0.01	-0.02	-0.01	-0.02	-0.22	-0.19	-0.01	-0.14	-0.
	ZrO2 wt%	0.00	-0.01	-0.01	0.09	-0.01	-0.01	0.04	0.01	0.00	0.00	0.00	-0.01	-0.03	0.00	-0.01	0.0
	P2O5 wt%	0.00	0.00	0.03	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.0
	V2O3 wt%	0.24	0.20	0.03	0.09	0.23	0.23	0.25	0.25	0.22	0.24	0.23	0.24	0.27	0.24	0.26	0.2
	Total wt%	91.75	91.63	68.04	97.49	92.06	91.69	92.03	92.34	91.86	91.70	92.26	91.64	92.25	92.28	92.08	92.
	Fe ₂ O3_%	67.68	65.21	3.50	0.00	68.03	66.71	67.11	66.96	67.11	67.18	67.82	67.74	68.25	68.09	68.08	68.
	FeO_%	30.20	30.67	0.00	42.42	29.60	30.65	30.67	30.97	30.70	30.52	30.45	30.29	30.56	30.57	30.32	29.
ţ	Total_%	98.61	98.19	68.11	97.62	99.11	98.48	98.77	99.06	98.62	98.47	99.11	98.69	99.35	99.14	99.10	99.
	Ti mol %	0.01	0.36	3.03	0.33	0.03	0.50	0.38	0.64	0.43	0.35	0.12	0.00	0.01	0.01	0.02	0.0
	Fe ²⁺ mol %	42.03	42.69	0.00	59.04	41.21	42.67	42.70	43.11	42.73	42.48	42.39	42.16	42.53	42.55	42.21	41.
3	Fe ³⁺ mol %	42.38	40.83	2.19	0.00	42.60	41.78	42.03	41.93	42.03	42.07	42.47	42.42	42.74	42.64	42.63	42.
	Usp Mol%	0.03	0.86	-15.08	-0.82	0.06	1.17	0.89	1.49	1.01	0.83	0.28	0.00	0.01	0.02	0.04	0.0
	Ilm Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0

 Table A6. 7 Electron microprobe results for magnetite mineral chemistry and calculated mineral formulae based on 32 oxygens.

	Probe ID	9431_3_M 133	9431_3_M 135	9431_3_M 136	9431_4_M 137	9431_4_M 138	9431_4_M 139	99362_2_I 33	99362_2_I 35	99362_2_I 36	99362_2_I 37	99362_2_I 38	99362_2_I 39	99362_2_I 40	99362_2_I 41	99362_2_I 43	99362_2_1 44
	Sample	94-31	94-31	94-31	94-31	94-31	94-31	99-362	99-362	99-362	99-362	99-362	99-362	99-362	99-362	99-362	99-362
	Rocktype	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	FW-FeB									
	SiO2 wt%	0.02	0.05	0.23	0.00	0.41	0.06	0.23	0.05	0.19	3.69	0.56	1.46	0.04	0.04	0.16	0.49
	TiO2 wt%	0.00	0.02	0.03	0.00	0.02	0.06	1.66	19.17	25.36	20.98	21.16	24.65	11.98	14.10	15.31	22.72
	Al ₂ O ₃ wt%	0.00	0.00	0.14	-0.01	0.17	0.05	0.16	0.01	0.11	0.04	0.02	0.03	0.03	0.03	0.00	0.37
	Cr2O3 wt%	0.01	0.00	0.00	0.00	0.00	0.02	0.03	0.01	0.00	0.01	0.04	-0.01	0.00	0.01	0.03	-0.01
	FeO wt%	91.81	90.48	90.58	91.97	91.16	91.24	89.71	73.82	67.73	68.58	71.45	68.71	81.21	79.28	77.72	69.02
	MnO wt%	0.00	0.00	0.01	0.00	0.00	-0.01	0.05	0.91	1.34	1.07	1.05	1.26	0.60	0.75	0.76	1.64
	MgO wt%	0.00	0.01	0.00	0.01	0.15	0.03	0.02	0.01	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.15
_	CaO wt%	0.23	0.01	0.61	0.01	0.03	0.01	0.02	0.05	0.05	0.10	0.02	0.07	0.01	0.01	0.02	0.08
Probe data	K2O wt%	0.00	0.00	0.07	0.00	0.00	0.00	0.03	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.01
ě	Nb ₂ O ₅ wt%	-0.02	0.01	0.04	0.01	0.02	0.03	0.01	0.03	0.00	0.05	0.01	0.01	0.00	-0.01	0.04	0.00
Pro	ZnO wt%	0.00	0.01	0.00	0.01	0.02	0.00	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.03	0.03	0.01
	CuO wt%	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.01	0.00	0.00
	NiO wt%	0.00	-0.01	0.00	0.00	-0.01	0.01	0.01	-0.01	0.00	0.00	0.00	-0.01	0.01	0.00	0.00	0.00
	CoO wt%	0.13	0.12	0.11	0.13	0.13	0.13	0.14	0.13	0.09	0.10	0.08	0.11	0.11	0.10	0.11	0.08
	SnO2 wt%	-0.09	-0.06	-0.13	-0.27	-0.18	-0.01	-0.03	-0.06	0.00	0.00	-0.16	-0.12	-0.03	-0.01	0.00	-0.16
	ZrO2 wt%	0.00	-0.01	-0.02	-0.02	0.01	0.01	0.00	0.00	-0.01	0.19	0.00	0.01	0.00	-0.01	-0.01	0.01
	P2O5 wt%	0.00	-0.01	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.01	0.00	-0.01	0.01	0.00	0.00	0.00
	V_2O_3 wt%	0.27	0.27	0.25	0.25	0.26	0.25	0.38	0.42	0.42	0.39	0.43	0.41	0.41	0.42	0.42	0.38
	Total wt%	92.36	90.89	91.91	92.10	92.20	91.86	92.43	94.55	95.33	95.26	94.70	96.59	94.39	94.77	94.57	94.78
	Fe ₂ O3_%	68.21	66.93	67.30	68.15	66.91	67.39	63.91	29.70	17.02	16.96	24.45	16.40	44.49	40.37	37.39	21.23
	FeO_%	30.43	30.25	30.02	30.65	30.95	30.60	32.20	47.09	52.42	53.31	49.44	53.96	41.17	42.95	44.07	49.92
p	Total_%	99.31	97.68	98.81	99.24	99.10	98.64	98.87	97.60	97.05	96.97	97.31	98.38	98.87	98.84	98.34	97.08
late	Ti mol %	0.00	0.03	0.03	0.01	0.02	0.08	2.07	24.01	31.75	26.27	26.50	30.86	15.00	17.66	19.16	28.44
Calculated	Fe ²⁺ mol %	42.36	42.11	41.78	42.66	43.08	42.59	44.83	65.55	72.96	74.21	68.83	75.11	57.31	59.79	61.35	69.49
ũ	Fe ³⁺ mol %	42.71	41.91	42.15	42.68	41.90	42.20	40.02	18.60	10.66	10.62	15.31	10.27	27.86	25.28	23.41	13.29
	Usp Mol%	0.00	0.07	0.07	0.01	0.05	0.18	4.95	55.90	74.60	70.68	62.99	74.69	34.71	40.75	44.61	67.92
	Ilm Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Probe ID	99362_2_I 45	99362_2_I 46	99362_2_I 48	99362_2_I 49	99362_2_I 50	99362_2_I 52	99362_2_I 53	99362_2_I 55	99362_2_I 58	99362_2_I 59	99362_2_I 60	99362_2_I 61	S037015_ A_M140	S037015_ A_M141	S037015_ A_M142	S037015_ A_M143
	Sample	99-362	99-362	99-362	99-362	99-362	99-362	99-362	99-362	99-362	99-362	99-362	99-362	S037015	S037015	S037015	S037015
	Rocktype	FW-FeB	FW-FeB	FW-FeB	FW-FeB	FW-FeB	FW-FeB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB						
	SiO2 wt%	0.58	0.07	0.47	0.14	0.19	0.22	0.05	0.07	0.09	1.25	3.75	1.56	0.10	0.06	0.57	0.30
	TiO ₂ wt%	30.45	15.40	9.18	17.86	6.48	20.76	0.95	7.67	14.78	7.09	6.07	22.47	0.09	0.04	0.06	0.08
	Al ₂ O ₃ wt% Cr ₂ O ₃ wt%	0.44 0.00	0.03	0.38	0.03	0.06	0.16 0.01	0.02	0.04	0.04	0.13	0.05 -0.01	0.59 -0.01	0.07 -0.01	0.03	0.05	0.16 0.04
	FeO wt%	62.65	77.03	81.74	76.11	85.45	71.64	90.65	84.23	77.89	84.20	82.94	67.90	92.27	92.14	91.14	91.50
	MnO wt%	1.68	0.78	0.51	0.79	0.13	1.62	0.05	0.39	0.83	0.36	0.31	1.10	0.00	0.00	0.02	0.00
	MgO wt%	0.24	0.01	0.15	0.01	0.00	0.05	0.00	0.00	0.01	0.05	0.01	0.06	0.02	0.00	0.05	0.11
	CaO wt%	0.02	0.05	0.05	0.01	0.05	0.07	0.15	0.05	0.07	0.04	0.04	0.14	0.04	0.01	0.01	0.01
lata	K2O wt%	0.03	0.01	0.06	0.00	0.01	0.02	0.00	0.01	0.01	0.01	0.00	0.09	0.00	0.00	0.04	0.02
Probe data	Nb2O5 wt%	0.05	0.05	0.02	0.09	0.03	0.00	0.02	0.03	0.07	0.00	0.00	0.05	0.01	-0.01	-0.02	0.03
Prof	ZnO wt%	0.03	0.00	0.02	0.01	0.01	0.02	0.00	-0.01	0.00	0.01	0.00	0.02	0.00	0.00	-0.02	0.00
_	CuO wt%	0.00	0.00	-0.01	0.01	0.00	0.00	-0.01	0.01	0.01	0.00	0.01	-0.01	0.00	0.00	0.00	0.00
	NiO wt%	0.00	0.00	0.00	-0.02	0.02	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
	CoO wt%	0.08	0.08	0.11	0.12	0.11	0.08	0.14	0.13	0.10	0.12	0.10	0.08	0.12	0.14	0.13	0.13
	SnO2 wt%	-0.03	-0.01	-0.05	0.00	-0.01	-0.02	-0.01	0.00	-0.01	-0.20	-0.10	0.01	-0.02	-0.24	-0.17	-0.01
	ZrO2 wt%	0.16	0.01	-0.01	0.00	0.01	-0.01	0.02	0.00	0.00	0.00	-0.01	-0.01	0.00	0.01	0.01	0.00
	P ₂ O ₅ wt%	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
	V2O3 wt%	0.44	0.39	0.56	0.48	0.42	0.43	0.29	0.49	0.39	0.36	0.34	0.41	0.47	0.45	0.44	0.46
	Total wt%	96.83	93.94	93.19	95.65	92.96	95.05	92.33	93.14	94.28	93.41	93.52	94.46	93.18	92.66	92.31	92.83
	Fe ₂ O3_%	5.98	36.90	47.94	32.74	54.36	26.26	65.93	52.28	38.41	51.00	46.94	18.42	67.99	68.02	66.52	67.16
	FeO_%	57.26	43.83	38.60	46.64	36.53	48.02	31.33	37.19	43.33	38.31	40.70	51.32	31.09	30.93	31.28	31.07
ted	Total_%	97.47	97.65	98.07	98.95	98.43	97.72	98.96	98.39	98.14	98.72	98.34	96.33	100.02	99.74	99.18	99.58
Calculated	Ti mol %	38.13	19.28	11.50	22.36	8.11	25.99	1.19	9.61	18.51	8.88	7.60	28.13	0.11	0.06	0.08	0.10
alc	Fe ²⁺ mol %	79.71	61.01	53.73	64.93	50.85	66.84	43.60	51.77	60.31	53.33	56.66	71.44	43.28	43.06	43.54	43.25
0	Fe ³⁺ mol %	3.75	23.11	30.02	20.50	34.04	16.44	41.28	32.74	24.05	31.93	29.39	11.54	42.57	42.59	41.65	42.05
	Usp Mol% Ilm Mol%	91.55 0.00	45.03 0.00	27.59 0.00	51.72 0.00	19.21 0.00	60.69 0.00	2.80 0.00	22.54 0.00	43.00 0.00	21.63 0.00	20.43 0.00	71.65 0.00	0.26 0.00	0.13	0.19 0.00	0.25 0.00
	1111 14101 70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
_	Probe ID	S037015_ A_M144	S037015_ A_M145	S037015_ A_M146	S037015_ A_M147	S037015_ A_M148	S037015_ A_M149	S037015_ A_M150	S037015_ B_M151	S037015_ B_M152	S037015_ B_M153	S037015_ B_M154	S037015_ B_M155	S037015_ B_M156	S037015_ B_M157	S037015_ B_M158	S037015_ C_M159
	Probe ID Sample																
		A_M144	A_M145	A_M146	A_M147	A_M148	A_M149	A_M150	B_M151	B_M152	B_M153	B_M154	B_M155	B_M156	B_M157	B_M158	C_M159
	Sample	A_M144 S037015	A_M145 S037015	A_M146 S037015	A_M147 S037015	A_M148 S037015	A_M149 S037015	A_M150 S037015	B_M151 S037015	B_M152 S037015	B_M153 S037015	B_M154 S037015	B_M155 S037015	B_M156 S037015	B_M157 S037015	B_M158 S037015	C_M159 S037015
	Sample Rocktype	A_M144 S037015 Z-FeTiB	A_M145 S037015 Z-FeTiB	A_M146 S037015 Z-FeTiB	A_M147 S037015 Z-FeTiB	A_M148 S037015 Z-FeTiB	A_M149 S037015 Z-FeTiB	A_M150 S037015 Z-FeTiB	B_M151 S037015 Z-FeTiB	B_M152 S037015 Z-FeTiB	B_M153 S037015 Z-FeTiB	B_M154 S037015 Z-FeTiB	B_M155 S037015 Z-FeTiB	B_M156 S037015 Z-FeTiB	B_M157 S037015 Z-FeTiB	B_M158 S037015 Z-FeTiB	C_M159 S037015 Z-FeTiB
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00	B_M152 S037015 Z-FeTiB 8.68 0.02 0.01	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00	B_M155 S037015 Z-FeTiB 0.17 0.17 0.05	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01	B_M152 S037015 Z-FeTiB 8.68 0.02 0.01 0.00	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 0.00	B_M155 S037015 Z-FeTiB 0.17 0.17 0.05 0.00	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 0.00	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30	B_M152 S037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 0.00 91.53	B_M155 S037015 Z-FeTiB 0.17 0.05 0.00 91.40	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 0.00 90.36	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01	B_M152 \$037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 0.00 91.53 -0.01	B_M155 S037015 Z-FeTiB 0.17 0.17 0.05 0.00 91.40 -0.01	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 0.00 90.36 -0.01	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.00	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01 0.00	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01 0.00	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01 0.00	B_M152 S037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00 0.34	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 0.00 91.53 -0.01 0.00	B_M155 S037015 Z-FeTiB 0.17 0.17 0.05 0.00 91.40 -0.01 0.04	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00 0.00	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 0.00 90.36 -0.01 0.01	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01
lta	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08 0.01	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.01 0.07	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.00 0.00 0.02	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01 0.00 0.13	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01 0.00 0.08	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01 0.00 0.01	B_M152 S037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00 0.02	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00 0.34 0.06	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 0.00 91.53 -0.01 0.00 0.00 0.01	B_M155 S037015 Z-FeTiB 0.17 0.17 0.05 0.00 91.40 -0.01 0.04 0.05	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00 0.00 0.00 0.06	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 0.00 90.36 -0.01 0.01 0.05	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 0.00
e data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% CaO wt% K ₂ O wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01	A_M145 \$037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08 0.01 0.09	A_M146 \$037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.07 0.01	A_M147 \$037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.00 0.02 0.02	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03 0.01	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01 0.00 0.13 0.01	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01 0.00 0.08 0.01	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01 0.00 0.01 0.01	B_M152 \$037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00 0.02 0.00	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00 0.34 0.06 0.02	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 91.53 -0.01 0.00 0.01 0.06	B_M155 S037015 Z-FeTiB 0.17 0.05 0.00 91.40 -0.01 0.04 0.05 0.04	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00 0.00 0.00 0.06 0.06	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 90.36 -0.01 0.01 0.05 0.03	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05 0.01	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 0.00 0.00
robe data	Sample Rocktype SiO ₂ wt% TiO ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% CaO wt% K ₂ O wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01	A_M145 \$037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08 0.01 0.09 0.02	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.01 0.07	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.00 0.02 0.02 -0.01	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03 0.01 0.03	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01 0.00 0.13 0.01 0.05	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 90.18 -0.01 0.00 0.08 0.01 0.02	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01 0.00 0.01 0.01 0.02	B_M152 \$037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00 0.02 0.00 0.00 0.00	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00 0.34 0.06 0.02 0.05	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 91.53 -0.01 0.00 0.01 0.06 0.04	B_M155 S037015 Z-FeTiB 0.17 0.05 0.00 91.40 -0.01 0.04 0.05 0.04 -0.02	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00 0.00 0.00 0.06 0.06 -0.02	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 90.36 -0.01 0.01 0.05 0.03 0.01	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05 0.01 0.03	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 0.00 0.00 0.00 0.04
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% CaO wt% K ₂ O wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02	A_M145 \$037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08 0.01 0.09	A_M146 \$037015 Z-FeTiB 0.09 0.16 0.01 91.38 0.01 0.01 0.07 0.01 0.02	A_M147 \$037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.00 0.02 0.02	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03 0.01	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01 0.00 0.13 0.01	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01 0.00 0.08 0.01	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01 0.00 0.01 0.01	B_M152 \$037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00 0.02 0.00	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00 0.34 0.06 0.02	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 91.53 -0.01 0.00 0.01 0.06	B_M155 S037015 Z-FeTiB 0.17 0.05 0.00 91.40 -0.01 0.04 0.05 0.04	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00 0.00 0.00 0.06 0.06	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 90.36 -0.01 0.01 0.05 0.03	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05 0.01	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 0.00 0.00
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₃ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt% Nb ₂ O ₈ wt% ZnO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08 0.01 0.09 0.02 0.02	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.01 0.07 0.01 0.02 -0.01	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.00 0.02 0.02 -0.01 0.01	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03 0.01 0.03 0.02	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01 0.00 0.13 0.01 0.05 0.00	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01 0.00 0.08 0.01 0.02 0.02	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01 0.00 0.01 0.00 0.01 0.01 0.02 0.00	B_M152 \$037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00 0.02 0.00 0.02 0.00 0.00 0.00 0.03	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00 0.34 0.06 0.02 0.05 -0.01	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 91.53 -0.01 0.00 0.01 0.06 0.04 0.01	B_M155 S037015 Z-FeTiB 0.17 0.17 0.05 0.00 91.40 -0.01 0.04 0.05 0.04 -0.02 0.01	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00 0.00 0.00 0.00 0.06 0.06 -0.02 0.03	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 0.00 90.36 -0.01 0.01 0.05 0.03 0.01 0.01	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05 0.01 0.03 -0.01	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 0.00 0.00 0.00 0.04 0.00
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% C ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% C ₂ O wt% ZnO wt% CuO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00 -0.01	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08 0.01 0.09 0.02 0.02 0.00	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.01 0.07 0.01 0.02 -0.01 0.00	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.00 0.02 0.02 -0.01 0.01 0.01 0.01 0.01	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03 0.01 0.03 0.02 -0.01	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01 0.00 0.13 0.01 0.05 0.00 0.00 0.00	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01 0.00 0.08 0.01 0.02 0.02 0.01	B_M151 S037015 Z-FeTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01 0.00 0.01 0.01 0.01 0.02 0.00 0.00 0.00 0.00	B_M152 \$037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00 0.02 0.00 0.02 0.00 0.00 0.03 0.00	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00 0.34 0.06 0.02 0.05 -0.01 0.00	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 91.53 -0.01 0.00 0.01 0.06 0.04 0.01 -0.02	B_M155 S037015 Z-FeTiB 0.17 0.05 0.00 91.40 -0.01 0.04 0.05 0.04 -0.02 0.01 -0.01 -0.01	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00 0.00 0.00 0.00 0.06 0.06 -0.02 0.03 0.01	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 0.00 90.36 -0.01 0.01 0.05 0.03 0.01 0.01 0.01 0.00	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05 0.01 0.03 -0.01 0.01	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 0.00 0.00 0.00 0.04 0.00 0.00
Probe data	Sample Rocktype SiO2 wt% TiO3 wt% Cr303 wt% Cr303 wt% ReO wt% Mn0 wt% CaO wt% K300 wt% ZnO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00 -0.01 0.00	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08 0.01 0.09 0.02 0.02 0.00 0.01	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 91.38 0.01 0.01 0.01 0.01 0.01 0.02 -0.01 0.00 0.00 0.00	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.02 0.02 0.02 0.02 -0.01 0.01 0.00 0.00 0.00	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03 0.01 0.03 0.02 -0.01 0.00	A_M149 S037015 Z-FeTiB 0.06 0.14 0.02 0.05 90.74 0.01 0.00 0.13 0.01 0.05 0.00 0.00 0.00 0.00	A_M150 S037015 Z-FcTiB 0.13 0.14 0.06 90.18 -0.01 0.00 0.08 0.01 0.02 0.02 0.01 0.00	B_M151 S037015 Z-FcTiB 0.24 -0.01 0.00 -0.01 90.30 -0.01 0.00 0.01 0.01 0.02 0.00 0.00 0.00 0.00 0.00 0.00	B_M152 S037015 Z-FcTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00 0.02 0.00 0.00 0.00 0.00 0.00	B_M153 S037015 Z-FeTiB 0.98 0.04 0.47 0.00 88.65 0.00 0.34 0.06 0.02 0.05 -0.01 0.00 -0.01	B_M154 S037015 Z-FeTiB 0.06 0.14 0.00 91.53 -0.01 0.00 0.01 0.06 0.04 0.01 -0.02 -0.01	B_M155 S037015 Z-FeTiB 0.17 0.05 0.00 91.40 -0.01 0.04 -0.02 0.01 -0.01 0.01	B_M156 S037015 Z-FeTiB 0.03 0.42 0.03 0.01 91.37 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.000 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 90.36 -0.01 0.05 0.03 0.01 0.01 0.00 -0.01	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05 0.01 0.03 -0.01 0.01 0.00	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.0
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MgO wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% ND ₀ O ₃ wt% CaO wt% SiO ₂ wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.12	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.08 0.01 0.09 0.02 0.02 0.00 0.01 0.14	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 0.01 0.01 0.07 0.01 0.07 0.01 0.00 0.00	A_M147 S037015 Z-FeTiB 0.04 0.18 0.01 0.04 91.84 0.00 0.00 0.02 0.02 -0.01 0.01 0.01 0.01 0.02 -0.01 0.01 0.01 0.02 -0.01 0.04 0.02 -0.02 -0.01 0.04 0.02 -0.02 -0.01 0.04 0.02 -0.02 -0.01 0.02 -0.02 -0.01 0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.01 -0.02 -0.02 -0.02 -0.02 -0.01 -0.02 -0.02 -0.02 -0.01 -0.01 -0.02 -0.02 -0.02 -0.01 -0.02 -0.02 -0.02 -0.01 -0.02 -0.02 -0.01 -0.01 -0.02 -0.02 -0.01 -0.01 -0.02 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Probe data	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr503 wt% FeO wt% ReO wt% CaO wt% CaO wt% CaO wt% CaO wt% SaO2 wt% SaO2 wt% P2O5 wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.01 0.01 0.01 0.00 0.01 0.00 0.12 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.12 -0.01 0.01 0.00 0.11 0.00 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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Probe data	Sample Rocktype SiO2 wt% TiO3 wt% Al2O3 wt% Cr5O3 wt% FeO wt% Mn0 wt% CaO wt% K3O wt% CaO wt% SaO3 wt% CaO wt% SaO3 wt% CaO wt% SaO3 wt% CaO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00 0.01 0.01 -0.02 0.00 0.12 -0.01 0.01 0.00 0.12 -0.01 0.00 0.44	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.09 0.02 0.00 0.01 0.09 0.02 0.00 0.01 0.14 -0.01 0.00 0.14 -0.01 0.00 0.38	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.07 0.01 0.07 0.01 0.02 -0.01 0.00 0.00 0.13 -0.27 0.07 0.02 0.40	A_M147 S037015 Z-FeTiB 0.04 0.10 0.04 91.84 0.00 0.02 0.02 0.02 -0.01 0.01 0.01 0.01 0.02 0.02 -0.01 0.01 0.01 0.04 91.84 0.00 0.02 0.02 -0.01 0.01 0.02 0.02 -0.01 0.01 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.02 0.00 0.01 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.00 0.01 0.00 0.03 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	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B_M155 S037015 Z-FeTiB 0.17 0.05 0.00 91.40 -0.01 0.04 -0.02 0.04 -0.02 0.04 -0.02 0.01 0.04 -0.01 0.05 0.04 -0.01 0.05 0.00 0.04 -0.01 0.15 0.05 0.00 0.04 -0.01 0.15 0.05 0.00 0.04 -0.01 0.05 0.04 -0.01 0.05 0.04 -0.01 0.05 0.04 -0.01 0.05 0.04 -0.01 0.05 0.04 -0.01 0.05 0.04 -0.01 0.05 0.00 0.04 -0.01 0.05 0.00 0.04 -0.01 0.05 0.00 0.04 -0.01 0.05 0.00 0.05 0.04 -0.01 0.05 0.00 0.01 0.05 0.00 0.04 -0.01 0.01 0.05 0.00 0.04 -0.01 0.01 0.05 0.00 0.04 -0.01 0.05 0.00 0.01 0.05 0.00 0.04 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.01 0.01 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	B_M156 S037015 Z-FeTiB 0.03 0.02 0.03 0.01 91.37 0.00 0.00 0.06 0.06 0.06 0.06 0.06 0.02 0.03 0.01 0.02 0.12 -0.01 -0.01 -0.01 0.36	B_M157 S037015 Z-FeTiB 0.09 0.88 0.00 90.36 -0.01 0.01 0.01 0.05 0.03 0.01 0.01 0.01 0.01 0.01 0.00 -0.01 0.11 -0.02 -0.02 -0.01 0.38	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05 0.01 0.03 -0.01 0.03 -0.01 0.03 -0.01 0.01 0.01 0.03 -0.01 0.03 -0.01 0.03 -0.01 0.03 -0.01 0.05 0.01 0.01 0.05 0.01 0.01 0.05 0.01 0.01 0.05 0.01 0.01 0.05 0.01 0.01 0.05 0.01 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.05 0.01 0.05 0.05 0.01 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.25 0.	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 0.00 0.00 0.04 0.00 0.00 0.00
Probe data	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr503 wt% FeO wt% ReO wt% CaO wt% CaO wt% CaO wt% CaO wt% SaO2 wt% SaO2 wt% P2O5 wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.01 0.01 0.01 0.00 0.01 0.00 0.12 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.12 -0.01 0.01 0.00 0.11 0.00 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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Probe data	Sample Rocktype SiO2 wt% TiO3 wt% Al2O3 wt% Cr5O3 wt% FeO wt% Mn0 wt% CaO wt% K3O wt% CaO wt% SaO3 wt% CaO wt% SaO3 wt% CaO wt% SaO3 wt% CaO wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00 0.01 0.01 -0.02 0.00 0.12 -0.01 0.01 0.00 0.12 -0.01 0.00 0.44	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.09 0.02 0.00 0.01 0.09 0.02 0.00 0.01 0.14 -0.01 0.00 0.14 -0.01 0.00 0.38	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.07 0.01 0.07 0.01 0.02 -0.01 0.00 0.00 0.13 -0.27 0.07 0.02 0.40	A_M147 S037015 Z-FeTiB 0.04 0.10 0.04 91.84 0.00 0.02 0.02 0.02 -0.01 0.01 0.01 0.01 0.01 0.02 0.02 -0.01 0.01 0.01 0.04 91.84 0.00 0.02 0.02 -0.01 0.01 0.02 0.02 -0.01 0.01 0.02 0.02 0.00 0.01 0.02 0.02 0.00 0.02 0.00 0.01 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	A_M148 S037015 Z-FeTiB 0.05 0.12 0.04 0.00 91.73 -0.01 0.00 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.00 0.03 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	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Probe data	Sample Rocktype SiO2 wt% TiO3 wt% Cr503 wt% Cr503 wt% ReO wt% Mn0 wt% CaO wt% XaO wt% XaO wt% CaO wt% SnO2 wt% CaO wt% SnO2 wt% CaO wt% SnO2 wt% P203 wt% P203 wt% Total wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 0.01 0.01 0.01	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.09 0.02 0.00 0.01 0.09 0.02 0.00 0.01 0.14 -0.01 0.00 0.38 92.45	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.07 0.01 0.07 0.01 0.02 -0.01 0.00 0.00 0.13 -0.27 0.07 0.07 0.07 0.07 0.07 0.07 0.02 0.40 92.12	A_M147 S037015 Z-FeTiB 0.04 0.08 0.01 0.04 91.84 0.00 0.00 0.02 0.02 0.02 0.02 0.02 0.01 0.01 0.01 0.01 0.01 0.04 91.84 0.00 0.02 0.02 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.01 0.01 0.02 0.02 0.00 0.01 0.01 0.01 0.02 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	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0.05	B_M156 S037015 Z-FeFTIB 0.03 0.42 0.03 0.042 0.03 0.01 91.37 0.00 0.006 0.006 0.006 0.006 0.006 0.001 0.001 0.011 0.011 0.02 0.011 0.011 0.02 0.03 0.012 0.031 0.02 0.03 0.02 0.03 0.02 0.03 0.03 0.03	B_M157 S037015 Z-FeTIB 0.09 0.88 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.03 0.00 0.00 0.05 0.03 0.01 0.05 0.00 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.00 0.00 0.05 0.05 0.00 0.05 0.05 0.05 0.05 0.00 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 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	Sample Rocktype SiO ₂ w1% TiO ₂ w1% Al ₂ O ₃ w1% Cr ₂ O ₃ w1% FeO w1% MgO w1% CaO w1% CaO w1% SnO ₂ w1% ZnO w1% CaO w1% SnO ₂ w1% ZrO ₂ w1% F ₂ O ₃ w1% Total w1%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00 -0.01 0.00 0.12 -0.01 0.00 0.12 -0.01 0.01 0.01 0.00 0.12 -0.01 0.01 0.01 0.00 0.12 -0.01 0.01 0.01 0.00 0.11 0.02 0.11 0.04 0.05 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 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92.45 66.93	A_M146 S037015 Z-FcTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.07 0.01 0.02 -0.01 0.00 0.00 0.13 -0.27 0.07 0.02 0.40 92.12 67.23	A_M147 S037015 Z-FeTiB 0.04 0.10 0.04 91.84 0.00 0.02 0.02 -0.01 0.01 0.00 0.02 -0.01 0.01 0.00 0.14 -0.01 0.01 0.01 0.04 91.84 -0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.04 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.00 0.02 -0.01 0.04 -0.01 0.02 -0.01 0.01 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.01 0.01 0.00 0.02 -0.01 0.01 0.01 0.01 0.01 0.00 0.02 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.02 -0.01 0.01 0.01 0.01 0.01 0.02 -0.01 0.02 -0.01 0.01 0.02 -0.01 0.02 -0.01 0.02 -0.02 -0.02 -0.02 -0.02 -0.01 0.02 -0.02 -0.01 -0.02 -0.02 -0.02 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A_M149 S037015 Z-FETIB 0.06 0.14 0.02 0.02 0.05 90.74 0.01 0.03 0.01 0.03 0.01 0.03 0.00 0.00	A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01 0.00 0.08 0.01 0.02 0.02 0.01 0.02 0.01 0.00 0.11 -0.10 -0.01 0.00 0.13 -0.01 0.00 0.13 -0.01 0.05 91.36 66.28	B_M151 S037015 Z-FETIB 0.24 -0.01 -0.01 90.30 -0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 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	Sample Rocktype SiO2 wt% TiO3 wt% Cr50, wt% FeO wt% Nn0 wt% CaO wt% K30 wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% Sn02, wt% P2O3 wt% P2O3 wt% FeO3, wt% FeO3	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.12 -0.01 0.00 0.12 -0.01 0.00 0.44 92.54 67.71 30.84 99.36 0.14	A_M145 S037015 Z-FeTiB 0.33 0.16 0.12 0.01 91.08 0.01 0.09 0.02 0.02 0.00 0.01 0.14 -0.01 0.14 -0.01 0.14 -0.01 0.00 0.00 0.38 92.45 66.93 30.86 99.17 0.20	A_M146 S037015 Z-FeTiB 0.09 0.16 0.01 0.01 91.38 0.01 0.01 0.07 0.01 0.07 0.01 0.02 -0.01 0.00 0.00 0.13 -0.27 0.07 0.02 0.40 92.12 67.23 30.89 99.13 0.21	A_M147 S037015 Z-FeTiB 0.04 0.04 0.04 91.84 0.00 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.01 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.00 0.00 0.02 0.02 0.02 0.01 0.01 0.00 0.02 0.02 0.02 0.02 0.01 0.01 0.00 0.02 0.02 0.00 0.00 0.00 0.02 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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A_M150 S037015 Z-FeTiB 0.13 0.14 0.06 0.06 90.18 -0.01 0.00 0.08 0.01 0.02 0.02 0.02 0.01 0.00 0.11 -0.01 0.00 0.65 91.36 66.28 30.54 98.11 0.18	B_M151 S037015 Z-FeTiB 0.24 -0.01 90.30 -0.01 90.30 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.	B_M152 \$037015 Z-FeTiB 8.68 0.02 0.01 0.00 84.21 -0.01 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.	B_M153 S037015 Z-FeTIB 0.98 0.04 0.04 0.04 0.04 0.00 888.65 0.00 0.02 0.05 0.01 0.11 0.11 0.04 0.00 0.01 0.11 0.11 0.04 0.00 0.05 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S03705 S037	B_M154 \$037015 Z-FeTiB 0.06 0.14 0.00 91.53 -0.01 0.00 0.01 0.06 0.04 0.01 0.06 0.04 0.01 0.00 0.01 0.02 -0.01 0.14 -0.01 0.14 -0.01 0.14 -0.01 0.00 0.00 0.35 92.30 67.59 30.70 99.12 0.18	B_M155 S037015 Z-FeT1B 0.17 0.17 0.17 0.17 0.17 0.05 0.00 91.40 -0.01 0.05 0.04 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.05 0.04 -0.01 0.01 0.01 0.05 0.04 0.01 0.01 0.05 0.04 0.01 0.01 0.05 0.04 0.01 0.01 0.05 0.04 0.01 0.01 0.05 0.00 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.01 0.01 0.05 0.00 0.05 0.00 0.00 0.00 0.00 0.05 0.00 0.05 0.00 0.00 0.05 0.00 0.05 0.00 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.5 0.	B_M156 S037015 Z-FeTIB 0.03 0.42 0.03 0.04 9.03 0.01 91,37 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	B_M157 S037015 Z-FeT1B 0.09 0.88 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02	B_M158 S037015 Z-FeTiB 0.49 2.74 0.01 0.01 89.17 0.03 0.00 0.05 0.01 0.03 -0.01 0.01 0.00 0.14 -0.20 0.05 0.29 93.51 60.87 34.40 99.82 3.44	C_M159 S037015 Z-FeTiB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 91.23 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.0
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₅ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% CaO wt% SnO wt% ZnO wt% CaO wt% SnO ₂ wt% P ₂ O ₅ wt% Fo ₂ O ₃ wt% Fo ₂ wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00 0.01 0.01 -0.02 0.00 0.01 0.01 -0.02 0.00 0.11 0.01 -0.02 0.01 0.01 -0.01 0.01 -0.01 0.01 -0.02 0.01 -0.01 0.01 -0.02 0.01 -0.01 -0.02 0.01 -0.02 0.01 -0.02 0.01 -0.02 0.01 -0.02 0.01 -0.02 0.00 0.00 -0.01 -0.02 0.00 -0.01 -0.02 -0.01 0.00 0.00 -0.01 -0.02 -0.01 0.00 0.00 -0.01 0.00 0.00 0.00 -0.01 0.00 0.00 0.00 -0.01 0.00 0.00 0.00 0.00 0.00 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₅ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% CaO wt% SnO wt% ZnO wt% CaO wt% SnO ₂ wt% P ₂ O ₅ wt% Fo ₂ O ₃ wt% Fo ₂ wt%	A_M144 S037015 Z-FeTiB 0.02 0.11 0.04 0.05 91.77 0.00 0.00 0.01 0.01 -0.02 0.00 0.01 0.01 -0.02 0.00 0.01 0.01 -0.02 0.00 0.11 0.01 -0.02 0.01 0.01 -0.01 0.01 -0.01 0.01 -0.02 0.01 -0.01 0.01 -0.02 0.01 -0.01 -0.02 0.01 -0.02 0.01 -0.02 0.01 -0.02 0.01 -0.02 0.01 -0.02 0.00 0.00 -0.01 -0.02 0.00 -0.01 -0.02 -0.01 0.00 0.00 -0.01 -0.02 -0.01 0.00 0.00 -0.01 0.00 0.00 0.00 -0.01 0.00 0.00 0.00 -0.01 0.00 0.00 0.00 0.00 0.00 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.02 -0.29 -0.35 -0.29 -0.35 -0.29 -0.35 -0.44 -0.20 -0.55 -0.29 -0.35 -0.44 -0.20 -0.55 -0.29 -0.35 -0.44 -0.20 -0.55 -0.29 -0.35 -0.44 -0.44 -0.20 -0.55 -0.44 -0.20 -0.55 -0.44 -0.44 -0.20 -0.55 -0.44 -0.44 -0.20 -0.55 -0.44 -0.44 -0.44 -0.44 -0.20 -0.55 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.55 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44 -0.44	C_M159 S037015 Z-FeTIB 0.16 0.03 0.02 0.01 91.23 0.00 0.01 91.23 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0

	Probe ID	S037015_ C_M160	S037015_ C_M161		S037015_ D_M163		S037015_ D_M165		S037015_ D_M167	S037015_ D_M168	S037015_ E_M169	S037015_ E_M170	S037015_ E_M171	S037015_ E_M172	S037015_ E_M173	S037015_ E_M174	S037015_ E_M175
	Sample	S037015	\$037015	8037015	8037015	8037015	8037015	8037015	8037015	\$037015	S037015	S037015	\$037015	\$037015	\$037015	S037015	8037015
	Rocktype	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB
	SiO2 wt%	0.17	0.16	0.22	0.08	0.18	0.06	3.26	0.10	0.06	2.10	0.45	0.68	0.15	0.05	0.02	0.01
	TiO2 wt%	0.03	0.00	0.01	0.29	0.16	0.26	0.19	0.19	0.41	0.00	0.03	1.11	1.46	1.86	0.04	0.05
	Al ₂ O ₃ wt%	0.02	0.01	0.03	0.03	0.04	0.04	0.04	0.03	0.00	1.16	0.02	0.06	0.02	0.00	0.03	0.01
	Cr ₂ O ₃ wt%	0.03	0.00	0.04	0.00	0.03	-0.01	0.04	0.00	0.01	0.00	0.00	0.02	-0.01	0.01	0.03	0.03
	FeO wt%	90.32	90.03	90.19	91.46	91.67	91.45	88.22	91.08	91.12	87.25	90.27	90.61	91.50	91.21	91.75	91.90
	MnO wt%	0.00	-0.01	0.01	-0.01	0.00	0.00	-0.02	0.00	0.01	0.03 0.94	0.00	0.02	0.00	0.02	0.00	0.01
	MgO wt% CaO wt%	0.00	0.00 0.01	0.01 0.01	0.00	0.04	0.00 0.06	0.00	0.00	0.00	0.94	0.00 0.01	0.18	0.01 0.04	0.00	-0.01 0.01	0.00 0.05
ıta	K ₂ O wt%	0.00	0.01	0.01	0.08	0.07	0.00	0.05	0.00	0.07	0.01	0.01	0.02	0.04	0.01	0.01	0.00
Probe data	Nb ₂ O ₅ wt%	0.05	0.03	0.02	0.02	0.01	0.02	0.01	0.02	0.02	0.03	0.03	0.05	0.00	0.05	0.01	0.02
rob	ZnO wt%	0.01	0.01	0.00	0.00	0.02	0.01	0.02	0.01	0.01	0.01	0.00	0.00	-0.01	0.00	-0.02	0.01
д	CuO wt%	-0.01	0.00	0.00	0.00	0.01	0.00	0.01	-0.01	0.01	0.00	0.00	0.01	0.00	0.00	-0.01	-0.01
	NiO wt%	-0.01	0.00	-0.01	0.01	0.00	-0.01	0.00	0.01	0.00	-0.01	0.00	0.00	0.01	0.01	0.01	0.00
	CoO wt%	0.13	0.13	0.13	0.11	0.15	0.13	0.14	0.08	0.11	0.11	0.14	0.13	0.11	0.14	0.11	0.14
	SnO2 wt%	-0.01	0.00	-0.04	-0.03	-0.15	-0.02	-0.07	0.00	-0.09	-0.11	-0.11	-0.02	-0.05	-0.05	-0.01	-0.16
	ZrO2 wt%	-0.01	-0.01	-0.01	0.06	0.01	0.00	0.01	0.00	0.01	-0.02	-0.01	-0.01	0.13	0.01	-0.01	0.00
	P_2O_5 wt%	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
	V ₂ O ₃ wt%	0.43	0.41	0.50	0.37	0.39	0.37	0.36	0.41	0.37	0.17	0.22	0.35	0.36	0.35	0.43	0.38
	Total wt%	91.14	90.79	91.11	92.52	92.68	92.40	92.30	92.02	92.13	91.69	91.05	93.22	93.76	93.67	92.40	92.46
	Fe ₂ O3_%	66.44	66.33	66.30	67.36	67.46	67.34	59.44	67.01	66.92	61.61	66.02	64.63	65.55	65.03	67.78	67.96
	FeO_%	30.54	30.34	30.52	30.84	30.97	30.86	34.73	30.78	30.90	31.82	30.86	32.45	32.51	32.70	30.76	30.75
eq	Total_%	97.84	97.46	97.81	99.32	99.59	99.19	98.34	98.75	98.92	98.00	97.80	99.73	100.39	100.25	99.25	99.44
Calculated	Ti mol %	0.03	0.00	0.02	0.37	0.20	0.32	0.23	0.24	0.52	0.00	0.03	1.39	1.83	2.32	0.05	0.07
alc	Fe ²⁺ mol %	42.51	42.23	42.49	42.93	43.10	42.96	48.34	42.85	43.01	44.29	42.96	45.17	45.26	45.52	42.81	42.80
0	Fe ³⁺ mol %	41.60	41.54	41.52	42.18	42.24	42.17	37.22	41.96	41.91	38.58	41.34	40.47	41.05	40.72	42.45	42.56
	Usp Mol% Ilm Mol%	0.08	0.01 0.00	0.04 0.00	0.86 0.00	0.48 0.00	0.76 0.00	0.62 0.00	0.57 0.00	1.22 0.00	0.01 0.00	0.08	3.29 0.00	4.26 0.00	5.40 0.00	0.11	0.16 0.00
	1111 14101 76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Probe ID	S037015_ F_M176	S037015_ F_M177	S037015_ F_M178	S037015_ F_M179	S037015_ F_M180	S037015_ G_M181	S037015_ G_M182	S037015_	S037015_ H_M184			S037015_ H_M188	S037015_ H_M189	S037015_ H_M190	S037015_ 1B_M25	S037015_ 1B_M26
	Probe ID Sample	\$037015_ F_M176 \$037015	S037015_ F_M177 S037015	S037015_ F_M178 S037015	S037015_ F_M179 S037015	S037015_ F_M180 S037015		S037015_ G_M182 S037015	S037015_ G_M183 S037015	S037015_ H_M184 S037015	S037015_ H_M185 S037015	S037015_ H_M186 S037015	S037015_ H_M188 S037015	S037015_ H_M189 S037015	S037015_ H_M190 S037015	\$037015_ _1B_M25 \$037015	S037015_ _1B_M26 S037015
		F_M176	F_M177	F_M178	F_M179	F_M180	G_M181	G_M182	G_M183	H_M184	H_M185	H_M186	H_M188	H_M189	H_M190	_1B_M25	_1B_M26
	Sample Rocktype	F_M176 S037015 Z-FeTiB	F_M177 S037015 Z-FeTiB	F_M178 S037015 Z-FeTiB	F_M179 S037015 Z-FeTiB	F_M180 S037015 Z-FeTiB	G_M181 S037015 Z-FeTiB	G_M182 S037015 Z-FeTiB	G_M183 S037015 Z-FeTiB	H_M184 S037015 Z-FeTiB	H_M185 S037015 Z-FeTiB	H_M186 S037015 Z-FeTiB	H_M188 S037015 Z-FeTiB	H_M189 S037015 Z-FeTiB	H_M190 S037015 Z-FeTiB	_1B_M25 S037015 Z-FeTiB	_1B_M26 S037015 Z-FeTiB
	Sample	F_M176 S037015	F_M177 S037015	F_M178 S037015	F_M179 S037015	F_M180 S037015	G_M181 S037015	G_M182 S037015	G_M183 S037015	H_M184 S037015	H_M185 S037015	H_M186 S037015	H_M188 S037015	H_M189 S037015	H_M190 S037015	_1B_M25 \$037015	_1B_M26 \$037015
	Sample Rocktype SiO ₂ wt%	F_M176 S037015 Z-FeTiB 0.20	F_M177 S037015 Z-FeTiB 0.21	F_M178 S037015 Z-FeTiB 0.05	F_M179 S037015 Z-FeTiB 0.39	F_M180 S037015 Z-FeTiB 0.07	G_M181 S037015 Z-FeTiB 0.05	G_M182 S037015 Z-FeTiB 0.03	G_M183 S037015 Z-FeTiB 0.10	H_M184 S037015 Z-FeTiB 0.14	H_M185 S037015 Z-FeTiB 0.34	H_M186 S037015 Z-FeTiB 0.09	H_M188 S037015 Z-FeTiB 0.44	H_M189 S037015 Z-FeTiB 0.01	H_M190 S037015 Z-FeTiB 0.60	_1B_M25 S037015 Z-FeTiB 0.09	_1B_M26 S037015 Z-FeTiB 2.65
	Sample Rocktype SiO2 wt% TiO2 wt%	F_M176 S037015 Z-FeTiB 0.20 0.00	F_M177 S037015 Z-FeTiB 0.21 -0.01	F_M178 S037015 Z-FeTiB 0.05 0.71	F_M179 S037015 Z-FeTiB 0.39 1.46	F_M180 S037015 Z-FeTiB 0.07 0.35	G_M181 S037015 Z-FeTiB 0.05 0.09	G_M182 S037015 Z-FeTiB 0.03 0.08	G_M183 S037015 Z-FeTiB 0.10 0.07	H_M184 S037015 Z-FeTiB 0.14 0.00	H_M185 S037015 Z-FeTiB 0.34 0.01	H_M186 S037015 Z-FeTiB 0.09 0.01	H_M188 S037015 Z-FeTiB 0.44 1.23	H_M189 S037015 Z-FeTiB 0.01 1.58	H_M190 S037015 Z-FeTiB 0.60 0.09	_1B_M25 S037015 Z-FeTiB 0.09 0.62	_1B_M26 \$037015 Z-FeTiB 2.65 1.96
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00
ta	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.02	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.00	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.00 0.03	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.06	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.01	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.00 0.02	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.07	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.06	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01
data	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt% K2O wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.02 0.01	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.00 0.07	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.00 0.03 0.01	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.06 0.02	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.01 0.00	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.00 0.02 0.01	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.07 0.01	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.06 0.02	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05	_1B_M25 \$037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02	_1B_M26 \$037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03
obe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MnO wt% CaO wt% K ₂ O wt% Nb ₂ O ₅ wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.00 0.00 0.02 0.01 0.02	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.00 0.07 -0.06	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.03 0.01 0.00	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.06 0.02 0.01	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02 0.02 0.04	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.01 0.00 0.03	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00 0.00	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.01	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.02 0.01 0.01	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04 0.01	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.07 0.01 0.01	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.06 0.02 0.02	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05 0.03	_1B_M25 \$037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02 0.02 0.04	_1B_M26 \$037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.03
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt% Nb ₂ O ₈ wt% ZnO wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.00 0.00 0.02 0.01 0.02 -0.01	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.00 0.07 -0.06 -0.02	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.03 0.01 0.00 0.01	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.06 0.02 0.01 0.02	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02 0.04 0.00	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.01 0.00 0.03 -0.01	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00 0.00 0.00 0.00	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.00 0.01 0.01	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.02 0.01 0.01 0.00	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04 0.01 0.00	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.07 0.01 0.01 -0.01	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.06 0.02 0.02 0.02 0.02 0	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01 0.02	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05 0.03 0.00	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02 0.02 0.04 0.00	_11B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.03 0.01
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% CaO wt% K ₂ O wt% ZnO wt% CuO wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.00 0.01 0.02 -0.01 0.00	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.00 0.07 -0.06 -0.02 0.01	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.00 0.03 0.01 0.00 0.01 0.00	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.02 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02 0.04 0.00 -0.01	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.01 0.00 0.03 -0.01 0.00	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00 0.00	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.00 0.01 0.01 0.00	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.00 0.00 0.01 0.01 0.00 0.04	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04 0.01 0.00 0.01	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.01 0.01 -0.01 0.00 0.00	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.02 0.00 0.02 0.02 0.02	H_M189 S037015 Z-FeTiB 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01 0.02 -0.01	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05 0.03 0.00 0.00 0.00 0.00	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02 0.02 0.04 0.00 -0.01	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.03 0.01 -0.01
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt% Nb ₂ O ₈ wt% ZnO wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.00 0.00 0.02 0.01 0.02 -0.01	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.00 0.07 -0.06 -0.02	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.03 0.01 0.00 0.01	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.06 0.02 0.01 0.02	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02 0.04 0.00	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.01 0.00 0.03 -0.01	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.0	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.00 0.01 0.01	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.02 0.01 0.01 0.00	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04 0.01 0.00	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.07 0.01 0.01 -0.01	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.06 0.02 0.02 0.02 0.02 0	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01 0.02	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05 0.03 0.00	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02 0.02 0.04 0.00	_11B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.03 0.01
Probe data	Sample Rocktype SiO ₂ wt% TiO ₃ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% CaO wt% Nb ₂ O ₈ wt% ZaO wt% Nb ₂ O ₈ wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.00 0.01 0.02 -0.01 0.00 0.00 0.00	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.00 0.07 -0.06 -0.02 0.01 0.01	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.00 0.03 0.01 0.00 0.01	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.06 0.02 0.01 0.02 0.01 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02 0.04 0.00 -0.01 0.02	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.00 0.03 -0.01 0.00 0.00 0.00 0.00	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92,19 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.0	G_M183 S037015 Z-FcTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.01 0.01 0.00 0.00 0.0	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.02 0.01 0.01 0.01 0.00 0.04 0.04	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04 0.01 0.00 0.01	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.00 0.02 0.02 0.02 0.02	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01 0.02 -0.01 -0.01	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05 0.03 0.00 0.00 0.00 0.00 0.00	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02 0.04 0.00 -0.01 0.01	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.03 0.03 0.01 -0.01 0.01
Probe data	Sample Rocktype SiO2 wt% TiO3 wt% Al2O3 wt% Cr2O3 wt% FeO wt% Mn0 wt% CaO wt% Nb2O8 wt% CaO wt% CaO wt% CaO wt%	F_M176 S037015 Z-FeTTB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.02 0.01 0.02 -0.01 0.02 -0.01 0.00 0.00 0.00 0.00	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.00 0.07 -0.06 -0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.00 0.03 0.01 0.00 0.01 0.01 0.01 0.01 0.11	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.00 0.00 0.01 0.02 0.00 0.01	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02 0.04 0.00 -0.01 0.02 0.15	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.00 0.03 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.0	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.0	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.01 0.01 0.01 0.00 0.01 0.01 0.00 0.01	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.0	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04 0.01 0.01 0.01 0.01 0.11	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.07 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.04 0.05 0.01 0.04 0.05 0.01 0.04 0.05 0.01 0.04 0.05 0.01 0.04 0.05 0.01 0.01 0.04 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.02 0.02 0.02 0.02 0.00 0.00	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.03 0.02 0.01 0.03 0.02 0.01 0.03 0.02 0.01 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.03 0.01 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.0	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.05 0.03 0.00 0.00 0.05 0.03 0.00 0.00 0.05 0.03 0.00 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.03 0.05 0.03 0.03 0.03 0.04 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.00 0.03 0.00 0.03 0.05 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.03 0.05 0.05 0.03 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.5 0.	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.02 0.02 0.02 0.04 0.00 0.02 0.04 0.00 0.01 0.01 0.13	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.03 0.03 0.03 0.01 -0.01 0.01 0.13
Probe data	Sample Rocktype SiO2 wt% TiO2 wt% Al2O, wt% Cr2O, wt% FeO wt% MnO wt% MgO wt% CaO wt% NiO wt% ZnO wt% CaO wt% NiO wt% Samption CaO wt% Samption CaO wt% Samption	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.0	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02 0.04 0.00 -0.01 0.02 0.15 -0.16	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.01 0.00 0.03 -0.01 0.00 0.03 -0.01 0.00 0.03 -0.01 0.00 0.03 -0.01 0.05	G_M182 S037015 Z-FeTTB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 5 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 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G_M183 S037015 Z-FeTTB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.01 0.01 0.01 0.01 0.0	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.00 0.02 0.01 0.01 0.00 0.04 0.04 0.04 0.01	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04 0.04 0.01 0.00 0.01 0.01 0.01	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.0	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.03 0.02 0.01 0.03 0.02 -0.01 0.01 0.01 0.03 -0.01 0.13 -0.03	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05 0.03 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.03 0.00 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.04 0.03 0.03 0.04 0.03 0.04 0.05 0.03 0.00 0.04 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.00 0.00 0.03 0.00 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02 0.02 0.04 0.00 -0.01 0.01 0.13 -0.18	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.01 0.03 0.01 0.01 0.01
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt% Nb ₂ O ₅ wt% Nb ₂ O ₄ wt% NiO wt% CaO wt% ZaO wt% ZaO wt% ZaO, wt% Z	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.00 0.00 0.01 0.02 -0.01 0.00 0.00 0.12 -0.01 0.00	F_M177 S037015 Z-FeTiB 0.21 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.00 0.07 -0.06 -0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 -0.02 0.01 0.01 0.01 0.00 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.03 -0.04 -0.04 -0.04 -0.04 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.05 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55 -0.55	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.05 0.01 0.05 0.04 91.49 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	F_M179 S037015 Z-FeTiB 0.39 1.46 0.04 0.01 90.50 0.02 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.5 0.	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.00 0.27 0.02 0.04 0.00 -0.01 0.02 0.04 0.00 -0.01 0.02 0.15 -0.16 0.00	G_M181 S037015 Z-FeTiB 0.05 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.00 0.00 0.03 -0.01 0.00 0.00 0.03 -0.01 0.00 0.00 0.03 -0.01 0.00 0.00 0.03 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 5 0.00 0.01	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.01 0.01 0.00 0.00 0.0	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 -0.01 -0.01	H_M185 S037015 Z-FeTiB 0.34 0.01 0.16 0.00 90.84 -0.01 0.02 0.04 0.04 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.04 0.01 0.01 0.01 0.02 0.04 0.01 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.01 0.02 0.04 0.01 0.01 0.02 0.04 0.01 0.01 0.02 0.04 0.01 0.01 0.01 0.02 0.04 0.01 0.01 0.01 0.02 0.04 0.01 0.01 0.01 0.02 0.04 0.01 0.01 0.00 0.01 0.01 0.02 0.04 0.01 0.01 0.00 0.01 0.01 0.02 0.04 0.01 0.01 0.01 0.01 0.00 0.01 0.01 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.00 0.02 0.02 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.000 0.00 0.000000	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01 0.02 -0.01 0.02 -0.01 0.13 -0.03 0.03 0.03	H_M190 S037015 Z-FeTiB 0.60 0.09 0.04 0.02 90.82 -0.03 0.00 0.12 0.05 0.03 0.00 0.02 0.00 0.02 0.10 -0.03 0.00 0.02 0.10 -0.03 0.00 0.02 0.02 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.03 0.00 0.03 0.00 0.03 0.03 0.00 0.03 0.00 0.03 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.04 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.02 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02 0.04 0.00 -0.01 0.13 -0.18 0.01	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.03 0.03 0.01 -0.01 0.13 -0.01 0.00
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MgO wt% CaO wt% K ₂ O wt% Nb ₂ O ₃ wt% CaO wt% SaO ₂ wt% P ₂ O ₃ wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.02 0.01 0.02 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.00 0.06 0.02 0.02 0.02 0.00 0.00	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01 0.02 0.01 0.02 -0.01 0.02 -0.01 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.00 0.04 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.5 0.	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Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% CaO	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.02 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.00 0.02 0.01 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.00 0.02 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 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G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.00 91.85 -0.02 -0.01 0.00 0.00 0.00 0.01 0.00 0.00 0.0	H_M184 S037015 Z-FeTiB 0.14 0.00 0.02 0.05 91.57 0.00 0.00 0.02 0.01 0.01 0.04 0.00 0.11 -0.01 -0.01 0.01 0.04	H_M185 S037015 Z-FeTiB 0.34 0.01 0.02 0.04 0.01 0.02 0.04 0.01 0.01 0.01 0.01 0.01 0.01 0.11 -0.17 -0.01 0.00 0.43	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.11 -0.06 -0.01 0.09 0.01 0.04 0.05 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 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Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% dr ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% SaO ₂ wt% ZrO ₂ wt% Y ₂ O ₃ wt% V ₂ O ₃ wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.00 0.12 -0.01 0.00 0.18 91.34	F_M177 S037015 Z.F.F.TIB 0.21 -0.01 0.00 59.14 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.0	F_M178 S037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.03 0.01 0.00 0.01 0.11 -0.22 -0.01 0.00 0.36 92.63	F_M179 S037015 Z.F.F.TIB 0.39 1.46 0.04 0.04 0.04 0.04 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.00 0.00	F_M180 S037015 Z-FeTiB 0.07 0.35 0.02 0.01 90.54 0.01 0.02 0.01 0.02 0.02 0.04 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.02 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.04 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.04 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.5 0.	G_M181 S037015 Z-FeTiB 0.09 0.09 0.07 -0.01 92.30 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.03 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	G_M182 S037015 Z-FeTiB 0.03 0.08 0.07 0.00 92.19 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.	G_M183 S037015 Z-FeTiB 0.10 0.07 0.04 0.04 0.04 0.04 0.04 0.04 0.0	H_M184 S037015 Z.F.F.TIB 0.14 0.00 0.02 0.02 0.01 0.00 0.00 0.00 0.01 0.01	H_M185 S037015 Z-FeTiB 0.34 0.01 0.06 0.00 90.84 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.0	H_M186 S037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.	H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.00 0.06 0.02 0.00 0.06 0.02 0.00 0.03 -0.01 0.00 0.00 0.03 -0.01 0.00 0.00 0.03 -0.01 0.00 0.00 0.03 -0.01 0.00 0.00 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.5 0.	H_M189 S037015 Z-FeTiB 0.01 1.58 0.01 0.00 91.39 0.01 0.00 0.03 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.03 0.02 0.01 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.02 0.01 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.03 0.32 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.3	H_M190 S037015 Z-FeTiB 0.60 0.09 90.82 -0.03 0.04 0.02 90.82 -0.03 0.04 0.02 90.82 -0.03 0.00 0.02 0.12 0.05 0.03 0.00 0.09 0.12 0.05 0.09 0.02 0.12 0.05 0.09 0.02 0.12 0.05 0.09 0.02 0.03 0.04 0.02 0.04 0.04 0.04 0.04 0.04 0.05 0.05 0.05 0.05 0.05 0.05 0.02 0.05 0.02 0.05 0.02 0.05 0.02 0.05 0.02 0.05 0.02 0.05 0.02 0.05 0.02 0.03 0.00 0.04 0.02 0.05 0.04 0.02 0.05 0.02 0.03 0.00 0.00 0.02 0.03 0.00 0.00 0.05 0.00 0.05 0.00 0.00 0.05 0.00 0.00 0.00 0.02 0.03 0.00 0.00 0.00 0.00 0.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.00 0.02 0.02 0.02 0.04 0.00 0.01 0.13 -0.18 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.03 92.60	_IB_M26 S037015 Z-FeTIB 2.65 1.96 0.02 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.01 0.03 0.01 0.01 0.01
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MBO wt% MBO wt% MBO wt% CaO wt% ZnO wt% SnO wt	F_M176 S037015 Z-FeTiB 0.20 0.00 90.77 0.00 0.00 90.77 0.00 0.02 0.01 0.02 -0.01 0.00 0.02 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.00 0.02 -0.01 0.00 -0.01 0.02 -0.01 0.00 0.02 -0.01 0.00 0.00 -0.01 0.00 0.02 -0.01 0.00 0.00 0.01 0.02 -0.01 0.00 0.00 0.01 0.00 0.02 -0.01 0.00 0.00 0.02 -0.01 0.00 0.00 0.02 -0.01 0.00 0.00 0.02 -0.01 0.00 0.00 0.02 -0.01 0.00 0.00 0.02 -0.01 0.00 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.18 -0.18 -0.24 -0.24 -0.24 -0.25 -0.18 -0.24 -0.24 -0.24 -0.24 -0.25 -0.24 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.25 -0.	F_M177 S037015 Z-FeTIB 0.21 -0.01 -0.01 -0.01 0.00 59,14 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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G_M181 S037015 Z-FeT1B 0.05 0.09 0.07 -0.01 92,30 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.03 0.00 0.01 0.01 0.01 0.02 0.02 0.02 0.03 0.00 0.03 0.00 0.01 0.01 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	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	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MnO wt% MnO wt% MnO wt% CaO wt% SnO wt% CaO wt% SnO ₂ wt% SnO ₂ wt% SnO ₂ wt% SnO ₂ wt% FeO_wt% FeO_%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.00 0.02 0.01 0.02 0.01 0.02 0.01 0.00 0.00 0.02 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.03 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.0	F_M177 S037015 2.FeTiB 0.21 -0.01 -0.01 -0.01 0.00 59.14 -0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.0	F_M178 \$037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.03 0.01 0.03 0.04 91.49 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.03 0.01 0.00 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.01 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.00 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	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	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt%	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.01 0.02 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.18 91.34 66.92 30.55 98.06	F_M177 S037015 2.FeTiB 0.21 -0.01 -0.01 0.00 0.01 0.01 0.01 0.01 0	F_M178 \$037015 Z-FeTiB 0.05 0.71 0.03 0.04 91.49 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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H_M184 S037015 2.FeTiB 0.14 0.002 0.02 0.02 0.01 0.00 0.00 0.00 0.0	H_MI85 S037015 Z-FeTiB 0.34 0.04 0.06 0.00 0.02 0.04 0.04 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02	H_M186 \$037015 Z-FeTiB 0.09 0.01 0.04 0.05 91.15 -0.01 0.01 0.01 0.07 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	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Calculated Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₄ wt% MgO wt% CaO wt% MgO wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% SiO ₂ wt% CaO wt% ZaO wt% CaO wt% SiO ₂ wt% CaO wt% SiO ₂ wt% FeO ₂ % FeO ₂ % FeO ₂ % Tiotal %	F_M176 S037015 Z-FeTiB 0.20 0.00 0.03 0.00 90.77 0.00 0.02 0.01 0.02 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.12 -0.01 0.00 0.00 0.00 0.12 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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H_M188 S037015 Z-FeTiB 0.44 1.23 0.15 0.00 91.20 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.02 0.00 0.00 0.02 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.05 0.00 0.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	_1B_M25 S037015 Z-FeTiB 0.09 0.62 0.05 0.00 91.43 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.04 0.00 0.01 0.13 -0.18 0.01 0.13 -0.18 0.01 0.13 -0.18 0.01 0.39 92.60 66.71 31.40 99.49 0.77 43.70	_1B_M26 S037015 Z-FeTiB 2.65 1.96 0.02 0.04 87.61 0.05 0.00 0.01 0.03 0.03 0.03 0.01 0.01 0.01

	Probe ID	S037015_ 2_M27	S037015_ 2_M28	S037015_ 2_M29	S037015_ 2_M30	S037015_ 2_M31	S037015_ 2_M32	S037015_ 2_M33	S037015_ 2_M34	S037015_ 2_M35	S037015_ 2_M36	S037015_ 2_M37	S037015_ 2_M38	S037015_ 2_M39	S037015_ 4_M40	S037015_ 4_M41	S037015_ 5_M44
	Sample	S037015	\$037015	8037015	\$037015	\$037015	\$037015	\$037015	8037015	\$037015	\$037015	\$037015	\$037015	\$037015	\$037015	\$037015	\$037015
	Rocktype	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB
	SiO2 wt%	0.17	0.28	26.21	29.58	0.27	1.18	0.21	0.16	0.05	0.10	0.08	0.04	0.07	0.07	0.06	0.12
	TiO2 wt%	0.04	0.07	0.00	0.00	0.04	0.02	0.00	0.01	0.25	0.24	0.23	0.09	0.19	0.06	0.10	0.03
	Al_2O_3 wt%	0.05	0.10	9.20	11.52	0.09	0.04	0.05	0.04	0.03	0.05	0.03	0.03	0.02	0.04	0.09	0.04
	Cr2O3 wt%	0.04	0.00	0.02	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.06	0.01	-0.01	-0.01	0.00	0.04
	FeO wt%	90.53	90.14	52.29	51.96	89.75	89.34	90.21	90.20	91.43	91.08	91.41	91.34	90.49	92.08	91.76	92.41
	MnO wt% MgO wt%	-0.01 0.00	0.01 0.00	-0.01 0.00	0.00	0.00	0.00	-0.01 0.02	0.00	-0.01 0.00	0.00	-0.01 -0.01	0.00	-0.01 0.00	0.00 0.01	0.00 0.01	-0.01 0.00
	CaO wt%	0.00	0.00	2.41	2.23	0.01	0.01	0.02	0.00	0.06	0.00	0.03	0.00	0.00	0.01	0.01	0.00
ata	K ₂ O wt%	0.00	0.00	0.07	0.02	0.01	0.00	0.01	0.00	0.03	0.01	0.02	0.02	0.04	0.00	0.00	0.00
Probe data	Nb2O5 wt%	0.00	0.05	0.05	0.03	0.03	-0.02	0.00	0.02	0.00	-0.03	0.04	0.04	0.03	0.02	0.03	0.00
lot	ZnO wt%	0.01	0.04	0.00	0.01	0.00	-0.01	-0.02	-0.01	0.00	0.00	0.02	0.02	-0.02	-0.01	0.00	0.00
_	CuO wt%	0.01	0.00	-0.01	-0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00
	NiO wt%	0.01	0.00	0.00	-0.01	0.00	0.00	-0.01	0.01	0.00	-0.01	0.00	0.01	0.01	-0.01	0.00	0.00
	CoO wt%	0.13	0.11	0.07	0.08	0.12	0.12	0.11	0.13	0.13	0.14	0.12	0.14	0.12	0.13	0.12	0.13
	SnO ₂ wt%	-0.01	-0.17	-0.03	-0.01	-0.12	-0.02	-0.19	-0.02	-0.20	-0.02	-0.13	-0.02	0.00	-0.01	0.00	-0.02
	ZrO2 wt% P2O5 wt%	-0.01 -0.01	-0.01 0.00	0.01 0.01	0.00	-0.01 0.00	0.01	-0.01 0.00	0.00	0.00	-0.01 0.00	0.04 0.00	0.00	0.01	0.00	0.00	0.00
	V_2O_3 wt%	0.39	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Total wt%	91.37	90.89	90.47	95.62	90.50	91.02	90.71	90.92	92.15	92.09	92.37	92.16	91.39	92.72	92.43	93.14
	Fe ₂ O3_%	66.66	66.14	0.00	0.00	65.93	64.08	66.46	66.50	67.39	67.03	67.17	67.46	66.74	67.98	67.69	68.13
	FeO_%	30.54	30.62	52.29	51.96	30.42	31.68	30.41	30.36	30.79	30.77	30.97	30.64	30.43	30.91	30.85	31.11
٥	Total_%	98.07	97.70	90.52	95.65	97.24	97.50	97.61	97.61	99.13	98.86	99.25	98.94	98.11	99.57	99.22	100.01
ala	Ti mol %	0.05	0.09	0.00	0.00	0.05	0.02	0.00	0.01	0.31	0.30	0.29	0.12	0.23	0.07	0.12	0.03
Calculated	Fe ²⁺ mol %	42.51	42.62	72.78	72.33	42.34	44.10	42.32	42.26	42.86	42.83	43.11	42.65	42.36	43.03	42.95	43.30
Ĵ	Fe ³⁺ mol %	41.74	41.42	0.00	0.00	41.29	40.13	41.62	41.64	42.20	41.97	42.06	42.24	41.80	42.57	42.38	42.66
	Usp Mol%	0.12	0.21	0.00	0.00	0.12	0.05	0.00	0.03	0.73	0.71	0.68	0.28	0.56	0.17	0.29	0.07
	Ilm Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Probe ID	\$037015_ 5_M45foc	S037015_ 6_M47	S037015_ 7_M48	S037015_ 7_M49	S037015_ 7_M50	S037015_ 5_M45	\$039313_ 1_I20	\$039313_ 4_124	\$039313_ 4_125	\$039313_ 4_126	S039313_ 1_M51	S039313_ 1_M52	S039313_ 1_M53	S039313_ 1_M54	8039313_ 1_M55	S039313 3_M56
	Probe ID Sample																
		5_M45foc us	6_M47	7_M48	7_M49	7_M50	5_M45 \$037015_	1_I20	4_124	4_125	4_126	1_M51	1_M52	1_M53	1_M54	1_M55	3_M56
	Sample	5_M45foc us S037015	6_M47 S037015	7_M48 S037015	7_M49 8037015	7_M50 S037015	5_M45 S037015_ nonfocus	1_120 S039313 HW-	4_124 \$039313 HW-	4_125 \$039313 HW-	4_126 \$039313 HW-	1_M51 \$039313 HW-	1_M52 \$039313 HW-	1_M53 S039313 HW-	1_M54 S039313 HW-	1_M55 8039313 HW-	3_M56 S039313 HW-
	Sample Rocktype	5_M45foc us S037015 Z-FeTiB	6_M47 S037015 Z-FeTiB	7_M48 S037015 Z-FeTiB	7_M49 S037015 Z-FeTiB	7_M50 S037015 Z-FeTiB	5_M45 S037015_ nonfocus Z-FeTiB	1_120 \$039313 HW- FeTiB	4_124 \$039313 HW- FeTiB	4_125 \$039313 HW- FeTiB	4_126 \$039313 HW- FeTiB	1_M51 \$039313 HW- FeTiB	1_M52 S039313 HW- FeTiB	1_M53 \$039313 HW- FeTiB	1_M54 S039313 HW- FeTiB	1_M55 8039313 HW- FeTiB	3_M56 8039313 HW- FeTiB
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10	6_M47 \$037015 Z-FeTiB 0.06 0.34 0.04	7_M48 \$037015 Z-FeTiB 0.09 0.06 0.02	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04	7_M50 \$037015 Z-FeTiB 0.11 0.67 0.02	5_M45 \$037015_ nonfocus Z-FeTiB 0.33 0.04 0.09	1_120 \$039313 HW- FeTiB 7.41 7.39 0.02	4_124 \$039313 HW- FeTiB 1.14 8.30 0.60	4_125 \$039313 HW- FeTiB 0.37 8.94 0.06	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01	1_M51 \$039313 HW- FeTiB 0.02 0.02 0.01	1_M52 \$039313 HW- FeTiB 0.02 0.02 0.02	1_M53 \$039313 HW- FeTiB 1.40 0.42 0.02	1_M54 S039313 HW- FeTiB 0.00 0.10 0.03	1_M55 \$039313 HW- FeTiB 0.02 0.03 0.03	3_M56 S039313 HW- FeTiB 0.02 0.02 0.02
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 0.04	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01	7_M50 \$037015 Z-FeTiB 0.11 0.67 0.02 0.04	5_M45 \$037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00	1_120 \$039313 HW- FeTiB 7.41 7.39 0.02 0.00	4_124 \$039313 HW- FeTiB 1.14 8.30 0.60 0.00	4_125 \$039313 HW- FeTiB 0.37 8.94 0.06 0.01	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02	1_M51 S039313 HW- FeTiB 0.02 0.02 0.02 0.01 -0.01	1_M52 S039313 HW- FeTiB 0.02 0.02 0.02 0.02 0.00	1_M53 \$039313 HW- FeTiB 1.40 0.42 0.02 0.00	1_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00	1_M55 \$039313 HW- FeTiB 0.02 0.03 0.03 0.01	3_M56 \$03931: HW- FeTiB 0.02 0.02 0.02 0.01
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 91.62	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 0.04 91.95	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62	1_120 S039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98	4_124 \$039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24	4_125 \$039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24	1_M51 S039313 HW- FeTiB 0.02 0.02 0.01 -0.01 91.69	1_M52 S039313 HW- FeTiB 0.02 0.02 0.02 0.02 0.02 0.00 91.79	1_M53 S039313 HW- FeTiB 1.40 0.42 0.02 0.00 35.82	1_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44	1_M55 S039313 HW- FeTiB 0.02 0.03 0.03 0.01 89.42	3_M56 \$039313 HW- FeTiB 0.02 0.02 0.02 0.01 92.53
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 91.62 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 91.95 -0.01	7_M48 \$037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00	1_120 \$039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98 0.01	4_124 \$039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24 0.00	4_125 \$039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68 0.00	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24 0.00	1_M51 \$039313 HW- FeTiB 0.02 0.02 0.01 -0.01 91.69 -0.01	1_M52 \$039313 HW- FeTiB 0.02 0.02 0.02 0.00 91.79 0.01	1_M53 \$039313 HW- FeTiB 1.40 0.42 0.02 0.00 35.82 0.22	1_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44 0.00	1_M55 \$039313 HW- FeTiB 0.02 0.03 0.03 0.01 89.42 0.00	3_M56 \$039313 HW- FeTiB 0.02 0.02 0.02 0.02 0.01 92.53 -0.02
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 91.62	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 0.04 91.95	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62	1_120 S039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98	4_124 \$039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24	4_125 \$039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24	1_M51 S039313 HW- FeTiB 0.02 0.02 0.01 -0.01 91.69	1_M52 S039313 HW- FeTiB 0.02 0.02 0.02 0.02 0.00 91.79	1_M53 S039313 HW- FeTiB 1.40 0.42 0.02 0.00 35.82	1_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44	1_M55 S039313 HW- FeTiB 0.02 0.03 0.03 0.01 89.42	3_M56 \$039313 HW- FeTiB 0.02 0.02 0.02 0.01 92.53
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 91.62 0.01 0.03	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 0.04 91.95 -0.01 -0.01	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.00	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00 0.00	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01 0.00	5_M45 \$037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00 0.03	1_120 \$039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98 0.01 0.00	4_124 \$039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24 0.00 0.01	4_125 S039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68 0.00 0.01	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24 0.00 0.00	1_M51 S039313 HW- FeTiB 0.02 0.01 -0.01 91.69 -0.01 0.00	1_M52 S039313 HW- FeTiB 0.02 0.02 0.02 0.00 91.79 0.01 0.00	1_M53 S039313 HW- FeTiB 1.40 0.42 0.02 0.00 35.82 0.22 0.38	1_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44 0.00 0.00	1_M55 \$039313 HW- FeTiB 0.02 0.03 0.03 0.01 89.42 0.00 0.00	3_M56 S039313 HW- FeTiB 0.02 0.02 0.02 0.02 0.01 92.53 -0.02 -0.01
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 91.62 0.01 0.03 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 0.04 91.95 -0.01 -0.01 0.06	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.00 0.00 0.13	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00 0.00 0.00 0.07	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01 0.00 0.05	5_M45 \$037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00 0.03 0.01	1_120 S039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98 0.01 0.00 0.00 0.02	4_124 S039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24 0.00 0.01 0.01	4_125 S039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68 0.00 0.01 0.02	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24 0.00 0.00 0.00 0.02	1_M51 S039313 HW- FeTiB 0.02 0.01 -0.01 91.69 -0.01 0.00 0.19	1_M52 \$039313 HW- FeTiB 0.02 0.02 0.00 91.79 0.01 0.00 0.25	1_M53 S039313 HW- FeTiB 1.40 0.42 0.02 0.00 35.82 0.22 0.38 26.52	1_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44 0.00 0.00 0.00 0.00	1_M55 S039313 HW- FeTiB 0.02 0.03 0.03 0.01 89.42 0.00 0.00 0.00	3_M56 \$039313 HW- FeTiB 0.02 0.02 0.02 0.02 0.01 92.53 -0.02 -0.01 0.00
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt% K2O wt% Nb2O3 wt% ZBO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 91.62 0.01 0.03 0.01 0.03 0.01 0.03	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 91.95 -0.01 -0.01 0.06 0.02 -0.01 0.01	7_M48 \$037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.00 0.13 0.05 0.03 -0.02	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00 0.00 0.00 0.07 0.03 0.02 0.02	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01 0.00 0.05 0.04 0.00 -0.01	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00 0.03 0.01 0.03 0.01 0.00	1_120 S039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98 0.01 0.00 0.02 0.00 0.02 0.00 -0.02 0.00	4_124 \$039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24 0.00 0.01 0.01 0.22 0.00 0.02	4_125 \$039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68 0.00 0.01 0.02 0.02 0.02 0.01	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24 0.00 0.00 0.00 0.02 0.01	1_M51 \$039313 HW- FeTiB 0.02 0.02 0.01 -0.01 91.69 -0.01 0.00 0.19 0.02 0.02 0.02 0.00	1_M52 S039313 HW- FeTiB 0.02 0.02 0.02 0.00 91.79 0.01 0.00 0.25 0.01 -0.01 -0.01	1_M53 ⁻ S039313 HW- FeTiB 1.40 0.42 0.02 0.00 35.82 0.22 0.38 26.52 0.09 -0.02 -0.01	L_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	1_M55 \$039313 HW- FeTiB 0.02 0.03 0.03 0.01 89.42 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 -0.01	3_M56 S039313 HW- FeTiB 0.02 0.02 0.02 0.01 92.53 -0.02 -0.01 0.00 0.00 0.03 0.00
	Sample Rocktype SiO2 wt% TiO2 wt% AC204 AC204 MBO wt% CaO wt% K20 wt% ZnO wt% ZnO wt% ZnO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 91.62 0.01 0.03 0.01 0.03 0.01 0.01 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 91.95 -0.01 -0.01 0.06 0.02 -0.01 0.01 0.01 0.00	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.00 0.13 0.05 0.03 -0.02 0.00	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00 0.00 0.00 0.07 0.03 0.02 0.02 0.00	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01 0.00 0.05 0.04 0.00 -0.01 -0.01	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00 0.03 0.01 0.03 0.01 0.03 0.01 0.00 0.00 0.00	1_120 S039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98 0.01 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	4_124 \$039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24 0.00 0.01 0.01 0.22 0.00 0.02 0.01	4_125 \$039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68 0.00 0.01 0.02 0.02 0.02 0.01 -0.02	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24 0.00 0.00 0.00 0.02 0.01 0.06 0.01 0.01	1_M51 S039313 HW- FeTiB 0.02 0.02 0.01 -0.01 91.69 -0.01 0.00 0.19 0.02 0.02 0.02 0.02 0.00 0.00 0.00	1_M52 S039313 HW- FeTiB 0.02 0.02 0.02 0.00 91.79 0.01 0.00 0.25 0.01 -0.01 -0.01 0.01	1_M53 ⁻ S039313 HW- FeTiB 1.40 0.42 0.00 35.82 0.22 0.38 26.52 0.09 -0.02 -0.01 -0.01	L_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.000 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1_M55 \$039313 HW- FeTiB 0.02 0.03 0.01 89.42 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 -0.01 0.01	3_M56 S039313 HW- FeTiB 0.02 0.02 0.02 0.01 92.53 -0.02 -0.01 0.00 0.00 0.03 0.00 -0.01
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% C ₂ O ₃ wt% CaO wt% K ₂ O wt% Nb ₂ O ₃ wt% CuO wt% NiO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.03 0.03 0.01 0.03 0.01 0.03 0.01 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 91.95 -0.01 -0.01 0.06 0.02 -0.01 0.01 0.00 0.02	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.00 0.13 0.05 0.03 -0.02 0.00 0.00 0.00	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00 0.07 0.03 0.02 0.02 0.00 0.00 0.00	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01 0.00 0.05 0.04 0.00 -0.01 -0.01 0.01	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00 0.03 0.01 0.03 0.01 0.00 0.00 0.00 0.01	1_120 S039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	4_124 S039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24 0.00 0.01 0.01 0.22 0.00 0.02 0.01 0.01	4_125 S039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68 0.00 0.01 0.02 0.02 0.01 -0.02 0.00	4_126 \$039313 HW-FeTiB 2.31 7.31 0.01 0.02 80.24 0.00 0.00 0.00 0.00 0.01 0.01	1_M51 S039313 HW- FeTiB 0.02 0.01 -0.01 91.69 -0.01 0.00 0.19 0.02 0.02 0.00 0.02 0.02 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.00 0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.02 -0.02 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.02 -0.02 -0.01 -0.01 -0.01 -0.02 -0.02 -0.01 -0.01 -0.01 -0.02 -0.01 -0.00 -0.01 -0.00 -0.00 -0.01 -0.00 -0.01 -0.00 -0.00 -0.01 -0.00 -0.01 -0.00 -0.01 -0.00 -0.01 -0.00 -0.01 -0.00 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.02 -0.00 -0.02 -0.02 -0.00 -0.02 -0.00 -0.00 -0.02 -0.00 -0.00 -0.01 -0.00 -0.02 -0.00 -0.00 -0.00 -0.00 -0.00 -0.02 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -0.00 -	1_M52 S039313 HW- FeTiB 0.02 0.02 0.00 91.79 0.01 0.00 0.25 0.01 -0.01 -0.01 0.01 0.01	1_M53 ⁻ S039313 HW- FeTiB 1.40 0.42 0.02 0.00 35.82 0.22 0.38 26.52 0.09 -0.02 -0.01 -0.01 0.00	I_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.000 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1_M55 S039313 HW- FeTiB 0.02 0.03 0.01 89.42 0.00 0.00 0.00 0.00 0.00 0.01 -0.01 0.01	3_M56 S03931: HW- FeTiB 0.02 0.02 0.02 0.01 92.53 -0.02 -0.01 0.00 0.00 0.03 0.00 -0.01 0.00
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% Mn0 wt% CaO wt% Nb ₂ O ₈ wt% CaO wt% CaO wt% CaO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 0.01 0.03 0.01 0.03 0.01 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 91.95 -0.01 -0.01 0.06 0.02 -0.01 0.01 0.00 0.02 0.14	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.13 0.05 0.03 -0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.0	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00 0.00 0.00 0.07 0.03 0.02 0.02 0.02 0.00 0.00 0.01	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01 0.00 0.05 0.04 0.00 -0.01 -0.01 0.01 0.12	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00 0.03 0.01 0.03 0.01 0.00 0.00 0.01 0.01 0.11	1_120 \$039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.00 0.00 0.00 0.	4_124 S039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24 0.00 0.01 0.01 0.02 0.00 0.02 0.01 0.01 0.01 0.08	4_125 S039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68 0.00 0.01 0.02 0.02 0.02 0.01 -0.02 0.00 0.12	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.11	1_M51 S039313 HW- FeTiB 0.02 0.02 0.01 -0.01 0.00 0.19 0.02 0.00 0.19 0.02 0.00 0.01 0.01 0.01 0.01 0.01 0.02 0.02 0.02 0.01 0.01 0.01 0.02 0.02 0.01 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.02 0.01 0.02 0.02 0.02 0.02 0.01 0.00 0.02 0.02 0.01 0.00 0.02 0.02 0.02 0.01 0.02 0.02 0.02 0.01 0.00 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 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	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr203 wt% FeO wt% MBO wt% CaO wt% NNO wt% ZaO wt% ZaO wt% CuO wt% SiO4 wt% CuO wt% SnO2 wt%	5_M45foc us \$037015 Z-FeTiB 0.34 0.03 0.01 0.03 0.01 0.03 0.01 0.01 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 0.04 91.95 -0.01 -0.01 0.06 0.02 -0.01 0.01 0.01 0.00 0.02 0.14 -0.01	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.13 0.05 0.03 -0.02 0.00 0.13 0.05 0.03 -0.02 0.00 0.13 0.05 0.03 -0.02 0.00 0.13 0.05 0.03 -0.02 0.00 0.13 0.05 0.03 -0.02 0.00 0.13 0.05 0.03 -0.02 0.00 0.13 0.05 0.03 -0.02 0.00 0.13 0.05 0.03 -0.02 0.03 -0.02 0.00 0.13 0.05 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.03 -0.02 0.00 0.03 -0.02 0.00 0.03 -0.02 0.00 0.03 -0.02 0.00 0.03 -0.02 0.00 0.03 -0.02 0.00 0.03 -0.02 0.00 0.00 0.03 -0.02 0.00 0.00 0.00 0.03 -0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.00 0.00 0.00 0.00 0.00 0.00	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00 0.00 0.00 0.07 0.03 0.02 0.02 0.00 0.00 0.00 0.11 -0.09	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01 0.00 0.05 0.04 0.00 0.05 0.04 0.00 -0.01 0.01 0.12 -0.03	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00 0.03 0.01 0.03 0.01 0.03 0.01 0.00 0.00 0.01 0.01 0.00 0.01 0.01 0.01 0.01 0.02 0.01 0.02 0.02 0.02 0.02 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.02 0.01 0.03 0.01 0.03 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 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	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% Mn0 wt% CaO wt% Nb ₂ O ₈ wt% CaO wt% CaO wt% CaO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 0.01 0.03 0.01 0.03 0.01 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 91.95 -0.01 -0.01 0.06 0.02 -0.01 0.01 0.00 0.02 0.14	7_M48 S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.00 0.13 0.05 0.03 -0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.0	7_M49 S037015 Z-FeTiB 0.08 0.09 0.04 0.01 91.41 0.00 0.00 0.00 0.00 0.07 0.03 0.02 0.02 0.00 0.00 0.00 0.01	7_M50 S037015 Z-FeTiB 0.11 0.67 0.02 0.04 91.59 0.01 0.00 0.05 0.04 0.00 -0.01 -0.01 0.01 0.12	5_M45 S037015_ nonfocus Z-FeTiB 0.33 0.04 0.09 0.00 91.62 0.00 0.03 0.01 0.03 0.01 0.00 0.00 0.01 0.01 0.11	1_120 \$039313 HW- FeTiB 7.41 7.39 0.02 0.00 76.98 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.00 0.00 0.00 0.00 0.	4_124 S039313 HW- FeTiB 1.14 8.30 0.60 0.00 80.24 0.00 0.01 0.01 0.02 0.00 0.02 0.01 0.01 0.01 0.08	4_125 S039313 HW- FeTiB 0.37 8.94 0.06 0.01 79.68 0.00 0.01 0.02 0.02 0.02 0.01 -0.02 0.00 0.12	4_126 \$039313 HW- FeTiB 2.31 7.31 0.01 0.02 80.24 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.11	1_M51 S039313 HW- FeTiB 0.02 0.02 0.01 -0.01 0.00 0.19 0.02 0.00 0.19 0.02 0.00 0.01 0.01 0.01 0.01 0.01 0.02 0.02 0.02 0.01 0.01 0.01 0.02 0.02 0.01 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.01 0.02 0.02 0.02 0.01 0.02 0.02 0.02 0.02 0.01 0.00 0.02 0.02 0.01 0.00 0.02 0.02 0.02 0.02 0.01 0.00 0.02 0.02 0.02 0.02 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 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0.01 0.01 0.01 0.01 0	1_M52 S039313 HW- FeTiB 0.02 0.02 0.00 91.79 0.01 0.00 0.25 0.01 -0.01 -0.01 -0.01 0.01 0.01 0.01 0.12	1_M53 S039313 HW- FeTiB 1.40 0.42 0.02 0.00 35.82 0.22 0.38 26.52 0.09 -0.02 -0.01 -0.01 0.00 0.04	I_M54 S039313 HW- FeTiB 0.00 0.10 0.03 0.00 92.44 0.00 0.00 0.00 0.00 0.00 0.00 0.00	1_M55 S039313 HW- FeTiB 0.02 0.03 0.03 0.01 89.42 0.00 0.00 0.00 0.00 0.00 0.01 -0.01 0.01 0.12	3_M56 S039313 HW- FeTiB 0.02 0.02 0.02 0.02 0.02 0.02 -0.01 0.00 0.00 0.03 0.00 -0.01 0.00 0.01 0.00 0.13
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O, wt% FeO wt% Ma0 wt% CaO wt% K2O wt% Nb2O wt% CaO wt% Nb2 owt% NiO wt% CaO wt% SiO wt% SiO wt% ZnO wt% SiO wt% SiO wt% ZrO wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 0.10 0.03 0.01 0.01 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 91.95 -0.01 -0.01 0.06 0.02 -0.01 0.01 0.00 0.02 -0.01 0.01 0.00 0.02 -0.01 0.01 0.00 0.02 -0.01 0.01 0.00 0.02 -0.01 0.01 0.01 0.02 -0.01 0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 -0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.01 0.00 0.02 0.01 0.01 0.00 0.02 0.01 0.01 0.00 0.02 0.01 0.01 0.00 0.02 0.01 0.01 0.02 0.01 0.02 0.14 -0.01 0.01 0.02 0.14 -0.01 0.01 0.01 0.02 0.14 -0.01 -0.01 0.01 0.02 0.14 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 -0.01 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S037015 Z-FeTiB 0.09 0.06 0.02 0.00 91.07 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MnO wt% CaO wt% Nb ₂ O ₃ wt% CaO wt% Nb ₂ O ₃ wt% CaO wt% SaO ₂ wt% P ₂ O ₅ wt%	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.10 0.03 91.62 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.01	6_M47 S037015 Z-FeTiB 0.06 0.34 0.04 91.95 -0.01 -0.01 0.06 0.02 -0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.02 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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Calculated Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% Cr ₂ O ₄ wt% MnO wt% MnO wt% MgO wt% CaO wt% K ₂ O wt% ZnO wt% CuO wt% C	5_M45foc us S037015 Z-FeTiB 0.34 0.03 0.03 91.62 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.03	6_M47 S037015 Z-FCFIB 0.06 0.34 0.04 9.04 0.04 9.04 9.05 -0.01 -0.01 0.06 0.02 -0.01 0.06 0.02 0.01 0.06 0.02 0.01 0.06 0.02 0.01 0.06 0.02 0.06 0.02 0.06 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.06 0.06 0.02 0.01 0.06 0.02 0.01 0.01 0.01 0.01 0.01 0.02 0.01 0.02 0.01 0.01 0.02 0.02 0.01 0.02 0.02 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 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	Probe ID	S039313_ 3_M57	S039313_ 3_M58	\$039313_ 4_M59	S039313_ 5_M60	S039313_ 5_M61	W605013 _4_C	W605013 _4_R	W605013 _2_M10	W605013 _3_M13	W605013 _1_M15fo cus	W605013 _1_M15	W605013 _1_M16fo cus	W605013 _1_M16	W605013 _1_M17	W605013 _1_M22	W605013 _1_M23
	Sample	S039313	S039313	S039313	S039313	8039313	W605013	W605013	W605013	W605013	W605013	W605013	W605013	W605013	W605013	W605013	W605013
	Rocktype	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	Iron formation	Iron formation	Iron formation	Iron formation	Iron formation	Iron formation	Iron formation	Iron formation	Iron formation	Iron formation	Iron formation
	SiO2 wt%	0.03	0.34	0.15	0.07	0.04	0.27	0.14	0.05	0.15	0.20	0.15	0.03	0.03	0.41	0.30	0.50
	TiO2 wt%	0.04	0.05	0.05	0.14	0.26	0.01	0.00	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.00	0.00
	Al ₂ O ₃ wt%	0.03	0.21	0.08	0.01	0.00	0.07	0.05	0.01	0.01	0.01	0.01	-0.01	0.00	0.03	0.01	0.01
	Cr2O3 wt%	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	-0.01	0.01	0.00	0.00	0.01
	FeO wt%	92.29	91.68	91.67	91.73	91.84	91.45	91.49	90.95	91.72	91.77	91.61	91.17	91.30	91.36	91.83	91.42
	MnO wt%	0.00	-0.02	-0.01	0.01	-0.01	0.03	0.03	0.04	0.04	0.04	0.04	0.03	0.01	0.04	0.06	0.06
	MgO wt% CaO wt%	0.00	0.00	0.02	0.00	0.00	0.00	0.03	0.00 0.01	0.01	0.03	0.04	0.01 0.01	0.00	0.09 0.01	0.00	0.01 0.01
ta	CaO wt% K ₂ O wt%	0.00	0.00	0.01	0.00	0.05	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	-0.01	-0.01	0.01
Probe data	Nb ₂ O ₅ wt%	0.03	0.00	0.03	-0.01	0.04	0.01	-0.02	0.03	0.00	0.00	0.00	-0.01	-0.02	0.04	0.03	0.00
rob	ZnO wt%	0.02	0.01	0.02	0.01	0.02	0.01	0.00	0.01	0.02	0.00	0.01	0.01	0.01	0.02	0.00	0.02
Р	CuO wt%	0.00	0.00	-0.01	0.00	-0.01	0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	NiO wt%	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.03	0.01	0.00	0.00	0.00	-0.02	0.00	-0.01
	CoO wt%	0.11	0.12	0.13	0.12	0.13	0.11	0.12	0.14	0.12	0.13	0.13	0.09	0.13	0.14	0.12	0.14
	SnO2 wt%	-0.02	-0.15	-0.12	-0.09	-0.04	-0.01	-0.06	0.00	-0.02	-0.01	-0.16	0.00	-0.14	-0.14	-0.17	0.00
	ZrO2 wt%	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.01	0.00	0.00
	P_2O_5 wt%	-0.01	0.00	-0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	V ₂ O ₃ wt%	0.14	0.14	0.13	0.10	0.12	0.07	0.06	0.20	0.05	0.04	0.05	0.03	0.06	0.05	0.05	0.04
	Total wt%	92.67	92.51	92.15	92.13	92.48	92.04	91.88	91.44	92.15	92.23	91.91	91.38	91.43	92.05	92.19	92.22
	Fe ₂ O3_%	68.29	67.54	67.59	67.80	67.66	67.31	67.78	67.31	67.78	67.75	67.73	67.59	67.64	67.12	67.57	66.98
	FeO_%	30.85	30.90	30.85	30.72	30.96	30.88	30.50	30.38	30.73	30.81	30.67	30.35	30.44	30.96	31.02	31.15
ed	Total_%	99.55	99.46	99.07	99.03	99.31	98.80	98.77	98.21	98.97	99.05	98.86	98.18	98.37	98.94	99.17	98.95
Calculated	Ti mol %	0.04	0.07	0.07	0.17	0.33	0.01	0.00	0.02	0.02	0.02	0.01	0.01	0.03	0.02	0.00	0.01
alc	Fe ²⁺ mol %	42.94	43.02	42.95	42.76	43.09	42.98	42.46	42.28	42.77	42.88	42.69	42.25	42.37	43.10	43.18	43.36
0	Fe ³⁺ mol %	42.76	42.29	42.32	42.46	42.37	42.15	42.44	42.15	42.44	42.42	42.41	42.32	42.36	42.03	42.32	41.94
	Usp Mol% Ilm Mol%	0.10	0.16 0.00	0.16 0.00	0.40 0.00	0.77 0.00	0.03	0.00	0.05 0.00	0.04 0.00	0.04	0.02	0.03	0.07 0.00	0.04 0.00	0.00	0.01
	HIII N10170	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Probe ID	W605013 _4_M4	W605013 _4_M5	W605013 _4_M7	W605013 _2_M8	W605013 _2_M9	W605041 _1_M62	W605041 _1_M63	W605041 _1_M64	W605041 _1_M65	W605041 _1_M66	W605041 _1_M67	W605041 _1_M68	W605041 _1_M69	W605041 _1_M70	W605041 _1_M71	W605041 _1_M72
	Probe ID Sample				_2_M8	_2_M9			_1_M64								
		_4_M4	_4_M5	_4_M7	_2_M8	_2_M9	_1_M62	_1_M63	_1_M64	_1_M65	_1_M66	_1_M67	_1_M68	_1_M69	_1_M70	_1_M71	_1_M72
	Sample	_4_M4 W605013 Iron	_4_M5 W605013 Iron	_4_M7 W605013 Iron	_2_M8 W605013 Iron	_2_M9 W605013 Iron	_1_M62 W605041	_1_M63 W605041	_1_M64 W605041	_1_M65 W605041	_1_M66 W605041	_1_M67 W605041	_1_M68 W605041	_1_M69 W605041	_1_M70 W605041	_1_M71 W605041	_1_M72 W605041
	Sample Rocktype	_4_M4 W605013 Iron formation	_4_M5 W605013 Iron formation	_4_M7 W605013 Iron formation	_2_M8 W605013 Iron formation	_2_M9 W605013 Iron formation	_1_M62 W605041 HSR	_1_M63 W605041 HSR	_1_M64 W605041 HSR	_1_M65 W605041 HSR	_1_M66 W605041 HSR	_1_M67 W605041 HSR	_1_M68 W605041 HSR	_1_M69 W605041 HSR	_1_M70 W605041 HSR	_1_M71 W605041 HSR	_1_M72 W605041 HSR
	Sample Rocktype SiO ₂ wt%	_4_M4 W605013 Iron formation 0.01	_4_M5 W605013 Iron formation 0.07	_4_M7 W605013 Iron formation 0.27	_2_M8 W605013 Iron formation 0.05	_2_M9 W605013 Iron formation 0.10	_1_M62 W605041 HSR 0.20	_1_M63 W605041 HSR 0.23	_1_M64 W605041 HSR 2.55	_1_M65 W605041 HSR 0.60	_1_M66 W605041 HSR 0.10	_1_M67 W605041 HSR 0.07	_1_M68 W605041 HSR 0.43	_1_M69 W605041 HSR 0.05	_1_M70 W605041 HSR 0.09	_1_M71 W605041 HSR 3.04	_1_M72 W605041 HSR 0.22
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00	_2_M9 W605013 Iron formation 0.10 0.01 0.00 0.00	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00	_1_M65 W605041 HSR 0.60 0.04 0.20 0.00	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01	_1_M67 W605041 HSR 0.07 0.01 0.00 0.00	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00	_1_M69 W605041 HSR 0.05 0.01 0.01 -0.01	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34	_2_M9 W605013 Iron formation 0.10 0.01 0.00 0.00 91.02	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72	_1_M65 W605041 HSR 0.60 0.04 0.20 0.00 90.46	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31	_1_M67 W605041 HSR 0.07 0.01 0.00 0.00 91.58	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89	_1_M69 W605041 HSR 0.05 0.01 0.01 -0.01 91.25	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03	_2_M9 W605013 Iron formation 0.10 0.01 0.00 0.00 91.02 0.03	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25 -0.01	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00	_1_M65 W605041 HSR 0.60 0.04 0.20 0.00 90.46 -0.01	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01	_1_M67 W605041 HSR 0.07 0.01 0.00 0.00 91.58 0.00	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00	_1_M69 W605041 HSR 0.05 0.01 0.01 -0.01 91.25 0.01	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00	_2_M9 W605013 Iron formation 0.01 0.00 0.00 91.02 0.03 0.00	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25 -0.01 0.00	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00 0.00	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53	_1_M65 W605041 HSR 0.60 0.04 0.00 90.46 -0.01 0.05	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.00	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00 0.06	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01 0.00	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00
ata	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00 0.00 0.00	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00 0.00	_2_M9 W605013 Iron formation 0.01 0.00 0.00 91.02 0.03 0.00 0.00 0.00	_1_M62 W605041 HSR 0.20 0.01 -0.01 91.25 -0.01 0.00 0.01	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00 0.00 0.01	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08	_1_M65 W605041 HSR 0.60 0.04 0.00 90.46 -0.01 0.05 0.01	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.00 0.01	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.00 0.00	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00 0.06 0.02	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.01 0.11	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01 0.00 0.01	_1_M71 W605041 HSR 0.04 2.15 0.00 85.93 0.00 0.26 0.06	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.00
e data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% CaO wt% K ₂ O wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01 0.03	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00	_2_M9 W605013 Iron formation 0.01 0.00 0.00 91.02 0.03 0.00	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25 -0.01 0.00	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00 0.00	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53	_1_M65 W605041 HSR 0.60 0.04 0.00 90.46 -0.01 0.05	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.00	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00 0.06 0.02 0.10	_1_M69 W605041 HSR 0.05 0.01 0.01 91.25 0.01 0.01 0.11 0.00	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01 0.00	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.00 0.00 0.01
brobe data	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00 0.00 0.01	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00 0.00 0.00	_2_M9 W605013 Iron formation 0.10 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25 -0.01 0.00 0.01 0.03	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00 0.00 0.01 0.03	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08 0.42	_1_M65 W605041 HSR 0.60 0.04 0.20 0.00 90.46 -0.01 0.05 0.01 0.14	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.00 0.01 0.01	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.01 0.02	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00 0.06 0.02	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.01 0.11	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01 0.00 0.01 0.01	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.00
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MnO wt% CaO wt% K ₂ O wt% Nb ₂ O ₅ wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01 0.03 0.02	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00 0.00 0.01 0.02	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00 0.00 0.00 0.00 0.04	_2_M9 W605013 Iron formation 0.10 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25 -0.01 0.00 0.01 0.03 0.02	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00 0.00 0.00 0.01 0.03 0.02	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08 0.42 0.00	_1_M65 W605041 HSR 0.60 0.04 0.20 0.00 90.46 -0.01 0.05 0.01 0.14 0.01	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.00 0.01 0.01 0.05	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.01 0.02 0.01	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00 0.06 0.02 0.10 0.01	_1_M69 W605041 HSR 0.05 0.01 0.01 91.25 0.01 0.01 0.11 0.00 -0.01	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01 0.00 0.01 0.01 0.00	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.00 0.01 0.00
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt% Nb ₂ O ₅ wt% ZnO wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01 0.03 0.02 -0.01	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00 0.00 0.00 0.01 0.02 0.01	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_2_M9 W605013 Iron formation 0.10 0.01 0.00 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25 -0.01 0.00 0.01 0.03 0.02 -0.01	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00 0.00 0.00 0.01 0.03 0.02 0.01	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08 0.42 0.00 0.05	_1_M65 W605041 HSR 0.60 0.04 0.20 0.00 90.46 -0.01 0.05 0.01 0.14 0.01 0.00	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.00 0.01 0.01 0.05 -0.02	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 9.00 0.01 0.02 0.01 0.00	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00 0.06 0.02 0.10 0.01 0.01 0.00	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.11 0.00 -0.01 0.00	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01 0.00 0.01 0.01 0.00 0.01	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.00 0.01 0.00 0.02
Probe data	Sample Rocktype SiO2 wt% TiO2 wt% ACp30 wt% FeO wt% MnO wt% MgO wt% CaO wt% K20 wt% ZnO wt% CaO wt% ZnO wt% Cuo wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.04 0.03 -0.01	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01 0.03 0.02 -0.01 0.00	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00 0.00 0.00 0.01 0.02 0.01 0.02	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_2_M9 W605013 Iron formation 0.10 0.01 0.00 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25 -0.01 0.00 0.01 0.03 0.02 -0.01 0.00	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00 0.00 0.00 0.01 0.03 0.02 0.01 0.00	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08 0.42 0.00 0.05 0.00	_1_M65 W605041 HSR 0.60 0.04 0.00 90.46 -0.01 0.05 0.01 0.14 0.01 0.00 0.00 0.00	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.00 0.01 0.01 0.05 -0.02 0.00	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.00 0.01 0.02 0.01 0.00 0.00	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00 0.06 0.02 0.10 0.01 0.01 0.00 -0.01	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.11 0.01 0.01 0.00 -0.01 0.00 0.00	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01 0.00 0.01 0.00 0.01 0.00 0.01 -0.01	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00 0.00 0.00	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.00 0.01 0.00 0.01 0.00 0.02 0.00
Probe data	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt% NiO wt% CaO wt% NiO wt% Samptified CaO wt% Samptified CaO wt% Samptified	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.0	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 0.04 0.01 0.03 0.02 -0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.0	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 0.00 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.02	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_2_M9 W605013 Iron formation 0.01 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.01 0.01 0.01	_1_M62 W605041 HSR 0.20 0.02 0.01 -0.01 91.25 -0.01 0.00 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.00 0.00 0.00 0.10 -0.28	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 0.01 0.00 0.00 0.01 0.03 0.02 0.01 0.00 0.01 0.01 0.01 0.01 0.01	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08 0.42 0.00 0.05 0.00 0.05 0.00 -0.01 0.11 -0.01	_1_M65 W605041 HSR 0.60 0.04 0.04 0.00 90.46 -0.01 0.05 0.01 0.14 0.00 0.00 0.00 0.00 0.00 0.14 -0.02	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.01 0.01 0.01 0.01 0.05 -0.02 0.00 0.00 0.00 0.15 -0.04	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.00 0.01 0.02 0.01 0.00 0.00	_1_M68 W605041 HSR 0.04 0.15 0.00 89.89 0.00 0.06 0.02 0.10 0.01 0.01 -0.01 -0.01 -0.01 -0.01 -0.04	_1_M69 W605041 HSR 0.05 0.01 0.01 91.25 0.01 0.01 0.01 0.00 -0.01 0.00 0.00 -0.01 0.15 -0.07	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 0.01 0.01 0.01 0.01	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00 0.00 0.001 0.00 0.01 0.10 -0.05	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.00 0.01 0.00 0.00 0.00 0.0
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt% Nb ₂ O ₈ wt% Nb ₂ O ₈ wt% NiO wt% CaO wt% ZnO wt% ZnO wt% ZnO wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.04 0.03 -0.01 -0.01 0.14 -0.01 -0.01	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.01 0.03 0.02 -0.01 0.00 0.01 0.00 0.01 0.01 0.01 0.0	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00 0.00 0.01 0.02 0.01 0.02 0.01 0.05 -0.23 -0.01	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00 0.00 0.00 0.00 0.00 0.04 0.01 0.00 0.01 0.00 0.11 -0.02 0.00	_2_M9 W605013 Iron formation 0.01 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_1_M62 W605041 HSR 0.20 0.01 91.25 -0.01 0.00 0.01 0.03 0.02 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.10 -0.28 -0.01	_1_M63 W605041 HSR 0.23 0.01 -0.01 90.86 0.00 0.01 0.03 0.02 0.01 0.03 0.02 0.01 0.00 0.01 0.00 0.01 0.10 -0.02 -0.01	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08 0.42 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.11 -0.01 0.00	_1_M65 W605041 HSR 0.60 0.04 0.00 90.46 -0.01 0.05 0.01 0.01 0.01 0.00 0.00 0.00	_1_M66 W605041 HSR 0.10 0.01 0.01 91.31 0.01 0.01 0.01 0.01 0.05 -0.02 0.00 0.00 0.05 -0.02 0.00 0.05 -0.04 -0.01	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.01 0.02 0.01 0.02 0.01 0.00 0.00	_1_M68 W605041 HSR 0.43 0.04 0.05 89.89 0.00 89.89 0.00 0.06 0.02 0.10 0.01 0.01 0.01 0.01 -0.01 0.14 -0.04 0.01	_1_M69 W605041 HSR 0.05 0.01 0.01 91.25 0.01 0.01 0.01 0.00 -0.01 0.00 0.00 0.0	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 0.01 0.01 0.01 0.01	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00 0.00 0.00 0.00 0.01 0.10 -0.05 0.00	_1_M72 W605041 HSR 0.22 0.04 0.02 91.38 -0.01 0.00 0.01 0.00 0.01 0.00 0.02 0.00 0.02 0.00 0.13 0.00 0.13 0.00 -0.01
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MmO wt% CaO wt% Nb ₂ O ₃ wt% CaO wt% SaO ₂ wt% NiO wt% CaO wt% SaO ₂ wt% P ₂ O ₃ wt%	_4_M4 W605013 Iron formation 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01 0.01 0.01 0.02 -0.01 0.00 0.00 0.01 0.13 0.02 0.01 0.00 0.00 0.01	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 90.17 0.02 0.00 0.01 0.02 0.01 0.02 0.01 0.00 0.01 0.01	_2_M8 W605013 Iron formation 0.05 0.01 -0.01 0.00 91.34 0.03 0.00 0.00 0.00 0.00 0.04 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.05 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.000 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	_2_M9 W605013 Iron formation 0.10 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_1_M62 W605041 HSR 0.20 0.02 0.01 91.25 -0.01 0.00 0.01 0.03 0.02 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.0	_1_M63 W605041 HSR 0.23 0.01 -0.01 90.86 0.00 0.01 0.03 0.02 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.01 0.02 -0.01 0.01	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08 0.42 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.01 0.11 -0.01 0.00 0.00	_1_M65 W605041 HSR 0.60 0.04 0.00 90.46 -0.01 0.05 0.01 0.14 0.01 0.00 0.00 0.00 0.00 0.00	_1_M66 W605041 HSR 0.10 0.01 0.01 0.01 0.01 0.01 0.01 0.0	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.01 0.02 0.01 0.00 0.00 0.00	_1_M68 W605041 HSR 0.43 0.04 0.05 89.89 0.00 89.89 0.00 0.06 0.02 0.10 0.01 0.01 0.01 0.01 0.04 0.01 0.00	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.01 0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.00 0.00	_1_M70 W605041 HSR 0.09 0.01 0.00 0.01 91.64 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.0	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00 0.00 0.00 0.00 0.01 0.10 0.05 0.00 0.00	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.00 0.00 0.01 0.00 0.02 0.00 0.02 0.00 0.00
Probe data	Sample Rocktype SiO ₂ wt% TiO ₃ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% CaO wt% Nb ₂ O ₈ wt% Nb ₂ O ₈ wt% Nb ₂ O ₈ wt% CaO wt% SiO ₂ wt% CoO wt% SiO ₂ wt% V ₂ O ₃ wt% V ₂ O ₃ wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.00 0.01 0.13 -0.19 0.00 0.01 0.13 -0.19 0.00 0.01	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.01	_2_M8 W605013 Iron formation 0.05 0.01 0.00 91.34 0.00 91.34 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	_2_M9 W605013 Iron formation 0.10 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.01 0.01	_1_M62 W605041 HSR 0.20 0.01 -0.01 91.25 -0.01 0.00 0.01 0.03 0.02 -0.01 0.00 0.00 0.10 -0.28 -0.01 0.00 0.00 0.00 0.01	_1_M63 W605041 HSR 0.23 0.01 -0.01 0.01 90.86 0.00 0.00 0.01 0.03 0.02 0.01 0.00 0.01 0.00 0.01 0.10 -0.02 -0.01 0.01 0.01	_1_M64 W605041 HSR 2.55 0.06 1.47 0.00 85.72 0.00 0.53 0.08 0.42 0.00 0.42 0.00 0.05 0.00 -0.01 0.11 -0.01 0.00 0.00 0.00	_1_M65 W605041 HSR 0.60 0.04 0.20 0.00 90.46 -0.01 0.05 0.01 0.14 0.00 0.00 0.00 0.00 0.00 0.14 -0.02 0.00 0.01 -0.01	_1_M66 W605041 HSR 0.10 0.01 91.31 0.01 0.01 0.01 0.01 0.01 0.05 -0.02 0.00 0.00 0.15 -0.04 -0.04 -0.04 0.00 0.00	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.01 0.02 0.01 0.00 0.01 0.00 0.01 0.14 -0.04 0.00 0.00 0.00 0.00	_1_M68 W605041 HSR 0.43 0.04 0.15 0.00 89.89 0.00 0.06 0.02 0.10 0.01 0.01 0.01 0.01 0.14 -0.04 0.01 0.00 0.00 0.01	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.15 -0.07 0.00 0.00 0.00	_1_M70 W605041 HSR 0.09 0.01 91.64 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.0	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.06 0.84 -0.01 0.00 0.00 0.01 0.10 -0.05 0.00 -0.01	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.0
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% dr ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% CaO wt% SaO ₂ wt% ZrO ₂ wt% V ₂ O ₃ wt% V ₂ O ₃ wt%	_4_M4 W605013 Iron formation 0.01 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.03 0.03 0.04 0.01 0.03 0.04 0.01 0.01 0.03 0.04 0.01 0.01 0.03 0.04 0.01 0.03 0.01 0.01 0.01 0.01 0.01 0.01	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 0.01 0.02 0.00 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.15 -0.23 -0.01 0.00 0.03 90.45	M8 W605013 0.01 0.05 0.01 0.00 0.00 0.00 0.00 0.00	_2_M9 W605013 Iron formation 0.10 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.01 0.01	_1_M62 W605041 HSR 0.02 0.02 0.01 -0.01 91.25 -0.01 0.00 0.00 0.01 0.03 0.02 -0.01 0.01 0.03 0.02 -0.01 0.01 0.02 8 -0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.02	_1_M63 W605041 HSR 0.23 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.0	_1_M64 W605041 HSR 2.55 0.06 8.572 0.00 8.572 0.00 8.572 0.00 0.03 0.03 0.03 0.03 0.03 0.03 0.0	_I_M65 W605041 HSR 0.60 0.04 0.00 0.00 0.00 0.01 0.14 0.01 0.00 0.00	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.01 0.01 0.01 0.01 0.01 0.01	_1_M67 W605041 HSR 0.07 0.01 0.00 0.00 0.00 0.00 0.01 0.02 0.01 0.00 0.00	_I_M68 W605041 HSR 0.04 0.04 0.05 0.00 88.89 0.00 0.06 0.02 0.10 0.01 0.01 0.01 0.01 0.01 0.01	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.01 0.01 0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.15 -0.07 0.00 0.00 0.00 0.00 0.00 0.00 0.0	_I_M70 W605041 HSR 0.09 0.01 91.64 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.0	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00 0.00 0.01 0.10 -0.05 0.00 0.00 0.00 -0.01 92.37	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.01 0.00 0.01 0.00 0.13 0.00 0.13 0.00 0.13 0.00 0.13 0.00 0.01 91.83
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MnO wt% MgO wt% CaO wt% CaO wt% SaO ₂ wt% ZrO ₃ wt% ZrO ₃ wt% ZrO ₃ wt% Total wt% Fe ₂ O ₃ %	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.	_4_M5 W605013 Iron formation 0.07 0.00 0.01 0.00 90.98 0.04 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.01 0.03 0.02 -0.01 0.03 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.01 0.03 0.02 -0.01 0.01 0.03 0.01 0.03 0.01 0.01 0.01	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 0.01 0.02 0.00 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.01	_2_M8 W605013 0.05 0.01 0.00 0.00 0.00 0.00 0.00 0.00	_2_M9 W605013 Iron formation 0.10 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0	_1_M62 W605041 HSR 0.02 0.02 0.01 -0.01 91.25 -0.01 0.00 0.01 0.01 0.03 0.02 -0.01 0.00 0.01 0.00 0.00 0.01 0.02 8 -0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02	_1_M63 W605041 HSR 0.23 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.0	_1_M64 W605041 HSR 2.55 0.06 0.07 85.72 0.00 0.53 0.08 0.08 0.08 0.08 0.03 0.08 0.03 0.00 0.01 0.11 0.00 0.00 0.01 0.00 0.01 90.97 6.018	_I_M65 W605041 HSR 0.04 0.04 0.02 0.00 0.02 0.00 0.04 0.05 0.01 0.01 0.01 0.01 0.01 0.01 0.01	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.01 0.01 0.01 0.01 0.01 0.01	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.00 0.00	_I_M68 W605041 HSR 0.43 0.04 0.05 0.00 0.06 89.89 0.00 0.00 0.02 0.02 0.02 0.02 0.02 0.0	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.01 0.00 -0.01 0.00 0.00 0.0	_1_M70 W605041 HSR 0.09 0.01 91.64 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.0	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.84 -0.01 0.00 0.00 0.01 0.10 -0.05 0.00 0.00 -0.01 92.37 59.97	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.0
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MnO wt% MgO wt% CaO wt% NiO wt% CaO wt% SnO ₂ wt% SnO ₂ wt% SnO ₂ wt% SnO ₂ wt% Fc ₂ O ₃ wt%	_4_M4 W605013 Iron formation 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	_4_MS W605013 Iron formation 0.07 0.00 0.01 0.00 0.04 0.01 0.03 0.02 -0.01 0.00 0.01 0.03 0.02 -0.01 0.00 0.01 0.03 0.02 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.01 0.01 0.00 -0.01 0.00 0.00	_I_M70 W605041 HSR 0.09 0.01 0.01 0.01 0.01 0.01 0.01 0.01	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₄ wt% MgO wt% CaO wt% K ₂ O wt% CaO wt% CaO wt% SaO ₂ wt% CaO wt% SaO ₂ wt% P ₂ O ₃ wt% P ₂ O ₃ wt% Total wt% FeO_% Total_% Timel%	_4_M4 W605013 Iron formation 0.01 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.01 0.01 0.00 0.00 0.00 0.00 0.01 0.01 0.00 0.00 0.00 0.01 0.01 0.07 91.86 67.88 39.8.71 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 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Calculated Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MBO wt% MBO wt% MBO wt% CaO wt% NO wt% ZnO wt% CaO wt% SnO ₂ wt% ZnO ₂ wt% Total wt% Fe ₂ O ₃ % Fe ₂ C [*] mol %	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.	_4_MS W605013 Iron formation 0.07 0.00 90.98 0.04 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.13 -0.19 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.01 0.01 0.01 0.01	_1_M711 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MBO wt% MBO wt% MBO wt% CaO wt% NO wt% ZnO wt% CaO wt% SnO ₂ wt% ZnO ₂ wt% Total wt% Fe ₂ O ₃ % Fe ₂ C [*] mol %	_4_M4 W605013 Iron formation 0.01 0.00 0.00 0.01 91.61 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.	_4_MS W605013 Iron formation 0.07 0.00 90.98 0.04 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.01 0.03 0.02 -0.13 -0.19 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	_4_M7 W605013 Iron formation 0.27 0.00 0.01 0.00 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.15 -0.23 -0.03 0.00 0.03 90.45 66.44 30.38 97.36 0.01 42.29	_2_M8 W605013 Iron formation 0.05 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.02 0.00 0.01 91.76 67.55 98.57 98.57	_2_M9 W605013 Iron formation 0.10 0.01 0.00 91.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.00 0.11 0.00 0.01 0.01 0.00 0.12 0.03 0.00 0.01 0.00 0.14 -0.13 -0.01 0.00 0.19 91.33 67.32 30.425 0.01 0.02 0.01 0.00 0.00 0.19 91.33 67.32 30.425 0.01 0.01 0.02 0.01 0.00 0.00 0.19 91.33 67.32 30.425 0.01 0.01 0.02 0.01 0.00 0.00 0.19 91.33 67.32 30.425 0.01 0.01 0.02 0.01 0.00 0.19 91.33 0.01 0.25 0.01 0.02 0.01 0.00 0.19 91.33 0.01 0.02 0.01 0.00 0.19 91.33 0.01 0.02 0.01 0.02 0.01 0.00 0.19 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.02 0.01 0.00 0.14 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.05 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55 0.55	_1_M62 W605041 HSR 0.02 0.02 0.01 -0.01 91,25 -0.01 0.00 0.01 0.01 0.03 0.02 -0.01 0.01 0.01 0.01 0.01 0.01 0.02 -0.01 0.01 0.01 0.02 0.01 0.01 0.02 0.01 0.01	_1_M63 W605041 HSR 0.23 0.01 0.01 0.01 0.01 0.00 0.00 0.01 0.01 0.01 0.01 0.00 0.00 0.01 0.01 0.01 0.01 0.01 9.26 6.7.00 30.57 9.8.01 42.55	_1_M64 W605041 HSR 2.55 0.06 0.02 0.00 0.53 0.08 0.08 0.08 0.08 0.08 0.00 0.00 0.0	_I_M65 W605041 HSR 0.60 0.04 0.02 0.00 0.02 0.00 0.00 0.01 0.14 0.01 0.01 0.01 0.01	_1_M66 W605041 HSR 0.10 0.01 0.02 -0.01 91.31 0.01 0.01 0.01 0.01 0.01 0.01 0.01	_1_M67 W605041 HSR 0.07 0.01 0.00 91.58 0.00 0.00 0.01 0.02 0.01 0.02 0.01 0.00 0.01 0.14 -0.04 0.00 0.01 91.82 67.86 30.51 98.66 0.01 42.47	_I_M68 W605041 HSR 0.43 0.04 0.05 0.00 89.89 0.00 0.06 0.02 0.10 0.01 0.01 0.01 0.01 0.01 0.01	_1_M69 W605041 HSR 0.05 0.01 -0.01 91.25 0.01 0.01 0.01 0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.15 -0.07 0.00 0.00 91.52 67.73 30.30 98.40 0.02 42.18	_1_M70 W605041 HSR 0.09 0.01 91.64 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.0	_1_M71 W605041 HSR 3.04 0.04 2.15 0.00 85.93 0.00 0.26 0.06 0.84 -0.01 0.00 0.00 0.01 0.10 -0.05 0.00 0.00 -0.01 92.37 59.97 31.96 98.45 0.05 44.49	_1_M72 W605041 HSR 0.22 0.04 0.02 0.00 91.38 -0.01 0.00 0.01 0.00 0.01 0.00 0.00 0.13 0.00 0.13 0.00 0.13 0.00 0.13 0.00 0.13 0.00 0.13 0.00 0.13 0.00 0.01 91.83 67.37 30.76 98.60 0.05 42.82

	Probe ID	W605041 _1_M73	W605041 _1_M74	W605041 _1_M75	W605041 _1_M76	W605041 _1_M77	W605041 _1_M78	W605041 _1_R23		W605282 _1_M101	W605282 _1_M102	W605282 _1_M103	W605282 _4_M104	W605282 _4_M105	W605282 _4_M106	W605282 _4_M107	W605282 _5_M108
	Sample	W605041	W605041	W605041	W605041	W605041	W605041	W605041	W605282	W605282	W605282	W605282	W605282	W605282	W605282	W605282	W605282
	Rocktype	HSR	HSR	HSR	HSR	HSR	HSR	HSR	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB
	SiO2 wt%	0.31	0.08	0.16	0.11	0.17	0.23	13.28	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.02	0.05
	TiO ₂ wt%	0.02	-0.01	0.00	0.01	0.04	0.02	0.00	0.05	0.03	0.04	0.01	0.05	0.05	0.04	0.04	0.04
	Al ₂ O ₃ wt%	-0.01	0.00	0.00	0.01	0.02	0.02	0.06	0.04	0.03	0.01	0.00	0.06	0.05	0.04	0.03	0.03
	Cr ₂ O ₃ wt%	0.02	0.00	-0.01	0.00	0.00	-0.01	0.00	0.07	0.00	0.04	0.04	0.06	0.04	0.03	0.06	0.04
	FeO wt%	90.81	91.04	91.37	91.33	91.31	91.18	81.48	91.68	91.61	90.90	85.79	91.81	91.60	91.81	91.78	92.07
	MnO wt%	-0.01 0.00	-0.01 0.00	0.01	0.02	0.01	0.00	0.00 -0.01	-0.01 0.00	0.02	0.06	0.21	0.00	0.02	0.02 0.00	0.01 -0.01	0.01 0.01
	MgO wt% CaO wt%	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.52	0.85	4.22	0.00	0.00	0.37	-0.01	0.03
ata	CaO wt%	0.04	0.05	0.04	0.02	0.00	0.01	0.05	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
Probe data	Nb2O5 wt%	-0.02	-0.01	0.03	0.01	0.04	0.03	0.00	-0.02	-0.01	0.02	0.03	0.00	0.02	0.05	0.03	-0.03
rob	ZnO wt%	0.00	0.00	-0.02	0.00	0.01	0.00	0.01	0.01	0.01	0.01	-0.01	0.00	-0.01	0.01	0.00	-0.01
Ч	CuO wt%	-0.01	-0.02	0.00	0.00	0.01	0.00	0.00	-0.02	0.00	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00
	NiO wt%	-0.01	0.00	0.01	0.00	0.02	0.00	0.00	-0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	CoO wt%	0.16	0.13	0.11	0.14	0.12	0.14	0.12	0.13	0.11	0.14	0.09	0.11	0.11	0.14	0.11	0.13
	SnO2 wt%	-0.11	-0.04	0.00	-0.08	-0.01	-0.03	-0.03	-0.16	-0.10	-0.03	-0.01	-0.18	-0.19	0.00	-0.02	0.00
	ZrO2wt%	-0.01	0.00	0.00	0.00	0.00	0.04	0.01	-0.01	0.00	-0.01	0.00	-0.01	-0.01	0.01	0.00	-0.01
	P_2O_5 wt%	0.00	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	V_2O_3 wt%	0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.62	0.52	0.49	0.46	0.67	0.64	0.62	0.64	0.35
	Total wt%	91.22	91.21	91.69	91.58	91.72	91.66	95.01	92.44	92.73	92.51	90.87	92.72	92.46	93.14	93.02	92.69
	Fe ₂ O3_%	66.92	67.53	67.57	67.62	67.35	67.21	37.03	67.76	68.21	67.99	67.63	67.89	67.70	68.11	68.02	68.04
	FeO_%	30.60	30.27	30.56	30.48	30.70	30.70	48.15	30.71	30.23	29.72	24.93	30.72	30.68	30.52	30.57	30.84
pa	Total_%	98.09	98.08	98.51	98.44	98.49	98.44	98.76	99.46	99.69	99.38	97.68	99.71	99.45	99.97	99.87	99.56
Calculated	Ti mol %	0.03	0.00	0.00	0.01	0.04	0.02	0.00	0.06	0.03	0.05	0.01	0.06	0.06	0.05	0.05	0.05
alcı	Fe ²⁺ mol %	42.59	42.14	42.55	42.43	42.74	42.74	67.03	42.74	42.09	41.37	34.71	42.76	42.70	42.48	42.55	42.93
0	Fe ³⁺ mol %	41.90	42.29	42.31	42.35	42.18	42.08	23.19	42.43	42.71	42.58	42.35	42.51	42.39	42.65	42.59	42.61
	Usp Mol%	0.06	0.00	0.01	0.02	0.10	0.06	0.00	0.13	0.07	0.11	0.01	0.15	0.14	0.10	0.11	0.11
	Ilm Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Probe ID						W605282					W605282	W605282	W605282	W605282	W605282	W605282
		_5_M109	_5_M110	_5_M111	_5_M112	_1_M79	_1_M80	_1_M81	_1_M82	_1_M83	_1_M84	_1_M85	_1_M86	_1_M88	_1_M89	_1_M90	_1_M91
	Sample	_5_M109 W605282	_5_M110 W605282	_5_M111 W605282	_5_M112 W605282	_1_M79 W605282	_1_M80 W605282	_1_M81 W605282	_1_M82 W605282	_1_M83 W605282	_1_M84 W605282	_1_M85 W605282	_1_M86 W605282	_1_M88 W605282	_1_M89 W605282	_1_M90 W605282	_1_M91 W605282
_	Sample Rocktype	_5_M109 W605282 Z-FeTiB	_5_M110 W605282 Z-FeTiB	_5_M111 W605282 Z-FeTiB	_5_M112 W605282 Z-FeTiB	_1_M79 W605282 Z-FeTiB	_1_M80 W605282 Z-FeTiB	_1_M81 W605282 Z-FeTiB	_1_M82 W605282 Z-FeTiB	_1_M83 W605282 Z-FeTiB	_1_M84 W605282 Z-FeTiB	_1_M85 W605282 Z-FeTiB	_1_M86 W605282 Z-FeTiB	_1_M88 W605282 Z-FeTiB	_1_M89 W605282 Z-FeTiB	_1_M90 W605282 Z-FeTiB	_1_M91 W605282 Z-FeTiB
	Sample Rocktype SiO ₂ wt%	_5_M109 W605282 Z-FeTiB 0.01	_5_M110 W605282 Z-FeTiB 0.04	_5_M111 W605282 Z-FeTiB 0.03	_5_M112 W605282 Z-FeTiB 0.05	_1_M79 W605282 Z-FeTiB 0.00	_1_M80 W605282 Z-FeTiB 0.03	_1_M81 W605282 Z-FeTiB -1.63	_1_M82 W605282 Z-FeTiB 0.04	_1_M83 W605282 Z-FeTiB 0.03	_1_M84 W605282 Z-FeTiB 0.00	_1_M85 W605282 Z-FeTiB	_1_M86 W605282 Z-FeTiB 0.00	_1_M88 W605282 Z-FeTiB 0.62	_1_M89 W605282 Z-FeTiB 0.01	_1_M90 W605282 Z-FeTiB	_1_M91 W605282 Z-FeTiB 0.89
	Sample Rocktype SiO2 wt% TiO2 wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04	_5_M110 W605282 Z-FeTiB 0.04 0.04	_5_M111 W605282 Z-FeTiB 0.03 0.05	_5_M112 W605282 Z-FeTiB 0.05 0.04	_1_M79 W605282 Z-FeTiB 0.00 0.03	_1_M80 W605282 Z-FeTiB 0.03 0.07	_1_M81 W605282 Z-FeTiB -1.63 0.06	_1_M82 W605282 Z-FeTiB 0.04 0.00	_1_M83 W605282 Z-FeTiB 0.03 0.03	_1_M84 W605282 Z-FeTiB 0.00 0.05	_1_M85 W605282 Z-FeTiB 0.00 0.02	_1_M86 W605282 Z-FeTiB 0.00 0.02	_1_M88 W605282 Z-FeTiB 0.62 0.06	_1_M89 W605282 Z-FeTiB 0.01 0.04	_1_M90 W605282 Z-FeTiB 0.05 0.04	_1_M91 W605282 Z-FeTiB 0.89 -0.02
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.05	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00	_1_M83 W605282 Z-FeTiB 0.03 0.03 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01	_1_M88 W605282 Z-FeTiB 0.62 0.06 0.27	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04	_5_M110 W605282 Z-FeTiB 0.04 0.04	_5_M111 W605282 Z-FeTiB 0.03 0.05	_5_M112 W605282 Z-FeTiB 0.05 0.04	_1_M79 W605282 Z-FeTiB 0.00 0.03	_1_M80 W605282 Z-FeTiB 0.03 0.07	_1_M81 W605282 Z-FeTiB -1.63 0.06	_1_M82 W605282 Z-FeTiB 0.04 0.00	_1_M83 W605282 Z-FeTiB 0.03 0.03 0.00 -0.01	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05 0.01	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02 0.02 0.06	_1_M86 W605282 Z-FeTiB 0.00 0.02	_1_M88 W605282 Z-FeTiB 0.62 0.06	_1_M89 W605282 Z-FeTiB 0.01 0.04	_1_M90 W605282 Z-FeTiB 0.05 0.04	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.05 0.01	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.03	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 0.00	_1_M83 W605282 Z-FeTiB 0.03 0.03 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06	_1_M88 W605282 Z-FeTiB 0.62 0.06 0.27 0.05	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 -0.01	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 0.04	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20
	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.05 0.01 92.06	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.03 92.01	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 0.00 62.33	_1_M83 W605282 Z-FeTiB 0.03 0.03 0.00 -0.01 89.73	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05 0.01 91.36	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02 0.06 90.72	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01	_1_M88 W605282 Z-FeTiB 0.62 0.06 0.27 0.05 87.97	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 -0.01 91.52	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 0.04 91.38	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28
_	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.05 0.01 92.06 0.01	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.03 92.01 -0.01	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07	_1_M83 W605282 Z-FeTiB 0.03 0.03 0.00 -0.01 89.73 0.07	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05 0.01 91.36 0.02	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02 0.06 90.72 0.06	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11	_1_M88 W605282 Z-FeTiB 0.62 0.06 0.27 0.05 87.97 0.04	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 -0.01 91.52 0.05	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 0.04 91.38 0.02	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01
data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.05 0.01 92.06 0.01 0.00	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.03 92.01 -0.01 0.01	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.00	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36 0.01	_1_M22 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00	_1_M83 W605282 Z-FeTiB 0.03 0.00 -0.01 89.73 0.07 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.01 91.36 0.02 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02 0.06 90.72 0.06 0.00 1.14 0.00	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11 0.00	_1_M88 W605282 Z-FeTiB 0.62 0.06 0.27 0.05 87.97 0.04 0.04	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 91.52 0.05 0.00	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 0.04 91.38 0.02 0.00	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01 0.16
be data	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% MnO wt% MgO wt% CaO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.05 0.01 92.06 0.01 0.00 0.00	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.03 92.01 -0.01 0.01 0.02	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.00 0.01	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84	_1_M83 W605282 Z-FeTiB 0.03 0.00 -0.01 89.73 0.07 0.00 1.30	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.01 91.36 0.02 0.00 0.21	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02 0.06 90.72 0.06 0.00 1.14	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11 0.00 2.17	_1_M88 W605282 Z-FeTiB 0.62 0.06 0.27 0.05 87.97 0.04 0.04 0.67 0.11 0.00	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 91.52 0.05 0.00 0.75	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 0.04 91.38 0.02 0.00 0.00 0.04	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01 0.16 0.15
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% MgO wt% Nb ₂ O ₃ wt% ZnO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.04 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.05 0.01 92.06 0.01 0.00 0.00 0.00 0.00 0.02 0.02	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.05 0.03 92.01 -0.01 0.01 0.02 0.00 0.01 0.04	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.00 0.01 0.01 0.03 0.00	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23 0.00 -0.01 0.00	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36 0.01 -0.47 -0.09	_1_M22 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02	_1_M33 W605282 Z-FeTiB 0.03 0.00 -0.01 89.73 0.07 0.00 1.30 0.01 0.00 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05 0.05 0.01 91.36 0.02 0.00 0.21 0.00 0.00 0.00 0.02	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02 0.02 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00	_1_M86 W605282 Z-FeTiB 0.00 -0.01 0.02 -0.01 0.04 89.01 0.11 0.00 2.17 0.00 0.03 0.02	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.04 0.67 0.11 0.00 0.01	_1_M89 W605282 Z-FeTiB 0.01 -0.01 -0.01 91.52 0.05 0.00 0.75 0.00 0.01 0.00	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 0.04 91.38 0.02 0.00 0.47 0.00 0.01 0.00	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.00 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07
Probe data	Sample Rocktype SiO2 wt% TiO2 wt% AC703 wt% FeO wt% MnO wt% MgO wt% CaO wt% K2O wt% ZnO wt% CuO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.05 0.01 92.06 0.01 0.00 0.00 0.00 0.00 0.00 0.02 0.02	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.03 92.01 -0.01 0.02 0.00 0.01 0.04 0.01	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.00 0.01 0.01 0.03 0.00 0.00 0	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23 0.00 -0.01 0.00 -0.01 0.00 -0.02	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36 0.01 -0.47 -0.09 -0.02	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01	_1_M33 W605282 Z-FeTiB 0.03 0.03 0.00 -0.01 89.73 0.07 0.00 1.30 0.01 0.00 0.00 0.00 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05 0.01 91.36 0.02 0.00 0.21 0.00 0.00 0.00 0.02 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00 -0.01	_1_M86 W605282 Z-FeTiB 0.00 -0.01 0.06 89.01 0.11 0.00 2.17 0.00 0.03 0.02 -0.01	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.04 0.67 0.11 0.00 0.01 0.00	_1_M89 W605282 Z-FeTiB 0.01 -0.01 -0.01 91.52 0.05 0.00 0.75 0.00 0.01 0.00 -0.01	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 0.04 91.38 0.02 0.00 0.47 0.00 0.47 0.00 0.01 0.00 0.00	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07 19.51
Probe data	Sample Rocktype SiO ₂ wt% TiO ₃ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MnO wt% CaO wt% Nb ₂ O ₈ wt% ZnO wt% NiO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.05 0.01 92.06 0.01 0.00 0.00 0.00 0.00 0.02 0.02 0.02	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.03 92.01 -0.01 0.01 0.02 0.00 0.01 0.04 0.01 0.00	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.01 0.01 0.01 0.03 0.00 0.00 0	_1_M79 W605282 Z-FcTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23 0.00 -0.01 0.00 -0.01 0.00 -0.02 -0.01	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00 0.00 0.01	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36 0.01 -0.47 -0.09 -0.02 -0.11	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01 0.00	_1_M83 W605282 Z-FeTiB 0.03 0.00 -0.01 89.73 0.07 0.00 1.30 0.01 0.00 0.00 0.00 0.00 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.01 91.36 0.02 0.00 0.21 0.00 0.00 0.00 0.02 0.00 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00 -0.01 0.00	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11 0.00 2.17 0.00 0.03 0.02 -0.01 -0.01	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.04 0.67 0.11 0.00 0.01 0.00 0.01	_1_M89 W605282 Z-FeTiB 0.01 -0.01 -0.01 91.52 0.05 0.00 0.75 0.00 0.01 0.00 -0.01 -0.01 -0.01	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 91.38 0.02 0.00 0.47 0.00 0.47 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.0	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07 19.51 0.18
Probe data	Sample Rocktype SiO2 wt% TiO2 wt% Al2O3 wt% Cr2O3 wt% FeO wt% Mn0 wt% CaO wt% Nb2O4 wt% Nb2O4 wt% CaO wt% CaO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.05 0.01 92.06 0.01 0.00 0.00 0.00 0.00 0.02 0.02 0.02	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.05 0.05 0.05 0.05 0.01 0.01	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.00 0.01 0.01 0.03 0.00 0.00 0	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 -0.01 0.00 -0.01 0.00 -0.02 -0.01 0.10	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00 0.01 0.11	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36 0.01 -0.47 -0.09 -0.02 -0.11 2.43	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01 0.00 0.08	_1_M83 W605282 Z-FeTiB 0.03 0.00 -0.01 89.73 0.07 0.00 1.30 0.01 0.00 0.00 0.00 0.00 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05 0.01 91.36 0.02 0.00 0.21 0.00 0.00 0.00 0.02 0.00 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 0.00 1.14 0.00 0.01 0.00 -0.01 0.00 0.01	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11 0.00 2.17 0.00 0.03 0.02 -0.01 -0.01 0.10	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.04 0.04 0.67 0.11 0.00 0.01 0.00 -0.01 0.13	_1_M89 W605282 Z-FeTiB 0.01 -0.01 -0.01 91.52 0.05 0.00 0.75 0.00 0.01 0.00 -0.01 -0.01 -0.01 0.13	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.04 91.38 0.02 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.01 0.00 -0.01 0.12	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07 19.51 0.18 0.32
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% FeO wt% MnO wt% MnO wt% MnO wt% CaO wt% ZnO wt% CuO wt% SnO wt% SnO ₂ wt%	_5_M109 W605282 Z-FeTiB 0.01 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.05 0.01 92.06 0.01 0.00 0.00 0.02 0.02 0.02 0.02 0.00 0.00 0.00 0.01 1 -0.01	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.05 0.05 0.05 0.01 0.01 0.01	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.00 0.01 0.03 0.00 0.00 0.00 0	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23 0.00 -0.01 0.00 -0.02 -0.01 0.10 -0.07	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00 0.01 0.11 -0.01	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36 0.01 -0.47 -0.09 -0.02 -0.11 2.43 0.00	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 0.00 0.03 0.01 1.84 0.00 0.03 0.02 -0.01 0.00 0.08 -0.06	_1_M33 W605282 Z-FeTiB 0.03 0.03 0.00 -0.01 89.73 0.07 0.00 1.30 0.01 0.00 0.00 0.00 -0.01 0.13 -0.01	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.01 91.36 0.02 0.00 0.21 0.00 0.02 0.00 0.00 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00 -0.01 0.00 0.10 -0.01	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11 0.00 2.17 0.00 2.17 0.00 0.03 0.02 -0.01 -0.01 0.10 -0.01	_1_M88 W605282 Z-FeTiB 0.62 0.06 0.27 0.05 87.97 0.04 0.04 0.04 0.04 0.67 0.11 0.00 0.01 0.00 0.00 0.00 0.001 0.13 0.15	_1_M89 W605282 Z-FeTiB 0.01 -0.01 -0.01 91.52 0.05 0.00 0.75 0.00 0.01 0.00 -0.01 -0.01 0.13 -0.18	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.04 0.04 91.38 0.02 0.00 0.47 0.00 0.47 0.00 0.01 0.00 0.00 -0.01 0.12 -0.13	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07 19.51 0.18 0.32 -0.04
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% MgO wt% MgO wt% CaO wt% Nb ₂ O ₅ wt% Nb ₂ O ₅ wt% NiO wt% CaO wt% ZnO wt% ZnO wt% ZnO wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.04 0.01 92.06 0.01 0.00 0.00 0.00 0.00 0.02 0.02 0.02	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.03 92.01 -0.01 0.01 0.01 0.00 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.05	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.00 0.01 0.03 0.00 0.00 0.00 0	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.00 -0.01 0.00	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00 0.01 0.11 -0.01 -0.01	_1_M81 W605282 Z-FeTiB -0.163 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36 0.01 -0.47 -0.09 -0.02 -0.11 2.43 0.00 0.08	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01 0.00 0.08 -0.06 -0.01	_1_M33 W605282 Z-FeTiB 0.03 0.03 0.00 0.00 1.30 0.00 0.00 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.01 91.36 0.02 0.00 0.21 0.00 0.00 0.00 0.00 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.02 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00 -0.01 0.00 0.10 -0.01 0.00	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11 0.00 0.03 0.02 -0.01 -0.01 0.10 0.01 -0.01	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.04 0.04 0.04 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.13 0.15 0.01	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 91.52 0.05 0.00 0.75 0.00 0.01 0.00 0.01 0.00 -0.01 0.01 -0.01 -0.13 -0.18 -0.01	_1_M90 W605282 Z-FeTiB 0.05 0.04 0.00 0.04 91.38 0.02 0.00 0.47 0.00 0.01 0.00 0.01 0.00 0.00 0.01 0.00 0.00 1.00 0.00 0.00 0.01 0.00 0.00 0.01 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.04 0.05 0.05	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07 19.51 0.18 0.32 -0.04 0.01
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MO wt% CaO wt% SaO ₂ wt% SaO ₂ wt% P ₂ O ₃ wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.04 0.04 0.04 0.04 0.01 92.06 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.05 0.03 92.01 -0.01 0.01 0.01 0.00 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.00 0.11 -0.07 0.00 0.00 0.00	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.01 0.01 0.01 0.03 0.00 0.00 0	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23 0.00 0.23 0.00 0.23 0.00 0.23 0.00 0.23 0.00 0.00	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.01 0.03 -0.02 0.00 0.01 0.01 0.01 0.01 0.00 1.001 0.00	_1_M81 W605282 Z-FeTiB -1.63 0.06 -0.16 0.00 1.24 0.02 -0.13 0.36 0.01 -0.47 -0.09 -0.02 -0.11 2.43 0.00 0.08 3.4.54	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01 0.00 0.03 0.02 -0.01 0.00 0.06 -0.01 0.00	_1_M33 W605282 Z-FeTiB 0.03 0.03 0.00 -0.01 89.73 0.07 0.00 1.30 0.01 0.00 0.00 0.00 0.00 0.00	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.05 0.01 91.36 0.02 0.00 0.21 0.00 0.21 0.00 0.00 0.02 0.00 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 90.72 0.06 90.72 0.06 0.00 1.14 0.00 0.00 -0.01 0.00 0.00 0.10 -0.01 0.00 0.00	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11 0.00 0.03 0.02 -0.01 0.00 0.03 0.02 -0.01 0.01 0.00 0.00 0.00 0.01 0.00	_1_M88 W605282 Z-FeTiB 0.62 0.06 0.27 0.05 87.97 0.04 0.04 0.04 0.04 0.07 0.11 0.00 0.01 0.00 -0.01 0.15 0.01 0.03	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 91.52 0.05 0.00 0.75 0.00 0.01 0.00 -0.01 0.00 -0.01 0.18 -0.01 0.00	_1_M90 W605282 Z-FeTiB 0.04 91.38 0.02 0.00 0.04 91.38 0.02 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.01 0.00 0.00 -0.01 0.12 -0.13 0.00 -0.01	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.20 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07 19.51 0.18 0.32 -0.04 0.01 0.03
Probe data	Sample Rocktype SiO2 wt% TiO3 wt% Al2O3 wt% Cr50, wt% FeO wt% Mn0 wt% CaO wt% Nb208 wt% Nb208 wt% Nb208 wt% CaO wt% Sn02 wt% Sn02 wt% V203 wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	_5_M110 W605282 Z-FeTiB 0.04 0.05 0.01 92.06 0.01 92.06 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.03 92.01 -0.01 0.01 0.02 0.00 0.01 0.01 0.01 0.01	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.01 0.01 0.01 0.01 0.03 0.00 0.00	_1_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23 0.00 -0.01 0.00 -0.02 -0.01 0.10 -0.07 0.00 0.00 0.00 0.05	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00 0.01 0.11 -0.01 0.00 0.54	_1_M81 W605282 Z-FeTiB -0.16 0.00 1.24 0.02 -0.13 0.36 0.01 -0.47 -0.09 -0.02 -0.11 2.43 0.00 0.00 0.00 0.00 3.4.54 -0.01	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01 0.00 0.08 -0.06 -0.01 0.00 0.03 7	_1_M33 W605282 Z-FeTiB 0.03 0.00 -0.01 89.73 0.07 0.00 1.30 0.01 0.00 0.00 -0.01 0.13 -0.01 0.13 -0.01 0.00 0.00 0.51	_1_M84 W605282 Z-FeTiB 0.00 0.05 0.01 91.36 0.02 0.00 0.21 0.00 0.02 0.00 0.00 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00 0.01 0.00 0.10 -0.01 0.00 0.10 -0.01 0.00 0.00	_1_M86 W605282 Z-FeTiB 0.00 0.02 -0.01 0.06 89.01 0.11 0.00 2.17 0.00 0.03 0.02 2.17 0.00 0.03 0.02 -0.01 -0.01 0.10 -0.01 0.00 0.00 0.00 0	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.04 0.67 0.11 0.00 0.01 0.00 -0.01 0.13 -0.15 0.01 0.03 0.52	_1_M89 W605282 Z-FeTiB 0.01 -0.01 -0.01 91.52 0.05 0.00 0.75 0.00 0.75 0.00 0.01 0.00 -0.01 -0.01 0.13 -0.18 -0.01 0.03 0.03 0.03 0.03 0.03 0.03 0.03	_1_M90 W605282 Z-FeTiB 0.05 0.04 91.38 0.02 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.01 0.00 -0.01 0.12 -0.13 0.05 7.01 0.57	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.01 47.28 0.01 47.28 0.01 6.15 0.13 -0.02 1.07 19.51 0.18 0.32 -0.04 0.03 -0.01
Probe data	Sample Rocktype SiO ₂ wt% TiO ₃ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% Mn0 wt% CaO wt% Nb ₂ O ₈ wt% ZnO wt% NiO wt% CaO wt% NiO wt% CaO wt% NiO wt% CaO wt% P ₂ O ₄ wt% P ₂ O ₅ wt% P ₂ O ₅ wt% Total wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	M110 W605282 Z.FeTiB 0.04 0.04 0.04 92.06 0.01 92.06 0.01 92.06 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.03 92.01 -0.01 0.01 0.02 0.00 0.01 0.01 0.00 0.01 0.00 0.11 -0.07 0.00 0.38 92.66	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.01 0.01 0.01 0.03 0.00 0.00 0	_I_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23 0.00 0.23 0.00 0.02 0.00 0.02 0.00 0.02 0.00 0.03 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.00 0.05 0.00 0.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00 0.01 0.11 -0.01 0.00 0.54 92.64	_I_M81 W605282 Z.FeTiB -1.63 0.06 0.01 1.24 0.02 0.01 0.01 0.036 0.01 -0.47 -0.09 0.02 -0.11 2.43 0.00 8.454 -0.01 3.6.2	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01 0.00 0.08 -0.06 -0.01 0.00 0.08 -0.06 -0.01 0.00 0.037 64.72	_L_M83 W605282 Z-FeTiB 0.03 0.03 0.00 -0.01 889.73 0.07 1.30 0.00 0.00 0.00 0.00 0.00 0.00 0.00	_I_M84 W605282 Z-FeTiB 0.00 0.05 0.01 91.36 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.0	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00 0.10 -0.01 0.00 0.10 -0.01 0.00 0.53 92.63	_1_M86 W605282 Z-FeTiB 0.00 0.02 0.01 0.06 89.01 0.01 0.01 0.00 2.17 0.00 0.03 0.02 2.17 0.00 0.03 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.01 0.02 0.02	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.67 0.11 0.00 0.01 0.00 -0.01 0.13 -0.15 0.01 0.03 0.52 90.35	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 91.52 0.05 0.05 0.05 0.00 0.01 0.01 0.00 0.01 0.00 0.01 0.01 0.00 0.01 0.01 0.00 0.01 0.03 0.00 0.01 0.04 0.04 0.04 0.04 0.04 0.04	_1_M90 W605282 Z-FeTiB 0.05 0.04 91.38 0.02 0.00 0.04 91.38 0.02 0.00 0.01 0.00 0.01 0.00 -0.01 0.12 -0.13 0.00 0.01 0.57 92.55	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07 19.51 0.18 0.32 -0.04 0.01 0.03 -0.01 69.88
Probe data	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% CaO wt% ND ₂ O ₈ wt% ZnO wt% SnO ₂ wt% SnO ₂ wt% ZrO ₃ wt% Total wt% Fe ₂ O ₃ wt%	_5_M109 W605282 Z-FeTiB 0.01 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	M110 W605282 Z-FeTiB 0.04 0.04 0.04 0.05 0.05 0.01 92.06 0.00 0.00 0.00 0.00 0.00 0.00 0.00	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.03 92.01 -0.01 0.01 0.01 0.02 0.00 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.03 0.05 0.03 92.01 0.03 0.05 0.03 92.01 0.03 0.05 0.03 92.01 0.03 0.05 0.03 92.01 0.03 0.05 0.03 92.01 0.03 0.05 0.05 0.05 0.05 0.05 0.05 0.05	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.05 0.05	_I_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 0.03 0.00 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	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Cr ₂ O ₃ wt% FeO wt% MgO wt% MgO wt% CaO wt% ZnO wt% ZnO wt% CaO wt% SnO ₂ wt% SnO ₂ wt% SnO ₂ wt% SnO ₂ wt% Fe ₂ O ₃ wt%	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	<u>5</u> _M110 W605282 Z-FeTiB 0.04 0.04 0.04 0.00 0.00 0.00 0.00 0.0	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.05 0.03 92.01 -0.01 0.01 0.02 0.00 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.00 0.01 0.00 0.01 0.00 0.01 0.05 0.03 0.05 0.05 0.05 0.05 0.05 0.05	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.00 0.01 0.01 0.00 0.00 0.00 0	_L_M79 W605282 Z-FeTiB 0.00 0.03 0.03 0.03 0.00 91.62 0.00 0.23 0.00 0.02 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 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0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.05 5.55 5.55 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00 0.01 0.11 -0.01 0.01 0.01 0.01 0.0	_I_W81 W605282 Z.FeTiB -1.63 0.06 0.01 0.01 0.02 0.01 0.03 0.01 -0.47 -0.09 0.02 -0.11 2.43 0.00 0.02 -0.11 2.43 0.00 3.454 -0.01 3.6.12 0.00 1.24 3.8.75 0.01 3.8.75 0.01 3.8.75 0.01 3.8.75 0.01 0.01 0.01 0.02 0.02 0.01 0.01 0.01	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01 0.00 0.08 -0.06 -0.01 0.00 0.03 7 64.72 47.82 19.30 69.59 0.01 26.86	_I_M83 W605282 Z-FeTiB 0.03 0.03 0.03 0.00 -0.01 88.73 0.07 0.00 0.00 0.00 0.00 0.00 0.00 0	_I_M84 W605282 Z-FeTiB 0.00 0.05 0.05 0.01 91.36 0.02 0.00 0.00 0.02 0.00 0.00 0.00 0.0	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00 0.10 -0.01 0.00 0.10 -0.01 0.00 0.10 -0.01 0.00 0.10 -0.01 0.00 0.53 92.63 68.15 29.40 99.50 0.02 40.92	_1_M86 W605282 Z-FeTiB 0.00 0.02 0.01 0.01 0.01 0.00 0.03 0.02 1.7 0.00 0.03 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.04 0.04 0.07 0.11 0.00 0.01 0.00 -0.01 0.13 -0.15 0.01 0.13 -0.15 0.01 0.03 0.52 90.35 64.70 29.75 96.99 0.08 41.41	_1_M89 W605282 Z-FcTiB 0.01 0.04 -0.01 91.52 0.05 0.00 0.01 0.05 0.00 0.01 0.01 0.01	_1_M90 W605282 Z-FeTiB 0.05 0.04 91.38 0.02 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.05 0.41 0.57 92.55 67.87 30.31 99.51 0.05 0.35 0.35 0.35 0.35 0.35 0.35 0.35	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.01 47.28 0.01 47.28 0.01 6.15 0.13 -0.02 1.07 19.51 0.18 0.32 -0.04 0.01 69.88 48.12 3.98 74.78 0.00 5.54
	Sample Rocktype SiO ₂ wt% TiO ₂ wt% Al ₂ O ₃ wt% Cr ₅ O ₃ wt% Cr ₅ O ₃ wt% GaO wt% MaO wt% CaO wt% Nb ₂ O ₃ wt% CaO wt% Nb ₂ O ₃ wt% CaO wt% SnO ₂ wt% ZrO ₃ wt% Total wt% FeO ₂ % Total ₂ % Ti mol %	_5_M109 W605282 Z-FeTiB 0.01 0.04 0.03 0.03 92.21 0.01 0.00 0.00 0.00 0.00 0.00 0.00	M110 W605282 Z.FeTiB 0.04 0.04 0.04 0.05 0.05 0.01 92.06 0.00 0.00 0.00 0.00 0.00 0.00 0.00	_5_M111 W605282 Z-FeTiB 0.03 0.05 0.03 92.01 -0.01 0.01 0.02 0.00 0.01 0.04 0.01 0.04 0.01 0.04 0.01 0.00 0.11 -0.01 0.00 0.11 -0.01 0.00 0.03 8 92.66 6 8.01 30.82 99.56 0.06	_5_M112 W605282 Z-FeTiB 0.05 0.04 0.02 0.03 92.31 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0	_I_M79 W605282 Z-FeTiB 0.00 0.03 0.05 0.00 91.62 0.01 0.00 0.23 0.00 0.02 0.00 0.02 0.01 0.01 0.00 0.00 0.00 0.02 0.01 0.00 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.05 0.00 0.00 0.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	_1_M80 W605282 Z-FeTiB 0.03 0.07 0.02 0.05 90.83 0.06 0.00 0.92 0.01 0.03 -0.02 0.00 0.01 0.11 -0.01 0.00 0.54 92.64 67.91 29.71 29.71 29.74 80,08	_I_M81 W605282 Z.FeTiB -1.63 0.06 0.00 1.24 0.02 0.01 0.03 0.03 0.03 0.01 -0.47 0.02 -0.11 2.43 0.00 0.08 34.54 -0.01 36.12 0.00 34.54 0.01 36.12	_1_M82 W605282 Z-FeTiB 0.04 0.00 0.00 62.33 0.07 0.01 1.84 0.00 0.03 0.02 -0.01 0.00 0.08 -0.06 0.08 -0.01 0.00 0.37 64.72 47.82 19.30 69.59 0.01	_I_M83 W605282 Z-FeTiB 0.03 0.03 0.00 -0.01 889.73 0.07 1.30 0.00 0.00 0.00 0.00 0.00 0.00 0.00	_I_M84 W605282 Z-FeTiB 0.00 0.05 0.01 91.36 0.02 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.02 0.00 0.00 0.00 0.01 0.02 0.00 0.00	_1_M85 W605282 Z-FeTiB 0.00 0.02 0.06 90.72 0.06 90.72 0.06 0.00 1.14 0.00 0.01 0.00 0.01 0.00 0.10 -0.01 0.00 0.10 -0.01 0.00 0.53 92.63 68.15 29.40 99.50 0.02	_1_M86 W605282 Z-FeTiB 0.00 0.02 0.01 0.00 0.00 2.17 0.00 0.03 0.01 0.01 0.01 0.01 0.01 0.01	_1_M88 W605282 Z-FeTiB 0.62 0.05 87.97 0.04 0.04 0.67 0.11 0.00 0.01 0.00 0.01 0.00 0.01 0.03 0.52 90.35 64.70 29.75 96.99 0.08	_1_M89 W605282 Z-FeTiB 0.01 0.04 -0.01 91.52 0.05 0.000 0.075 0.000 0.01 0.01 0.01 0.01 0.01 0.01 0.	_1_M90 W605282 Z-FeTiB 0.05 0.04 91.38 0.02 0.00 0.04 91.38 0.02 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.47 0.00 0.01 0.12 -0.13 0.00 -0.01 0.57 92.55 67.87 30.31 99.51 0.05	_1_M91 W605282 Z-FeTiB 0.89 -0.02 0.01 47.28 0.01 0.16 0.15 0.13 -0.02 1.07 19.51 0.18 0.32 -0.04 0.01 0.03 -0.01 0.03 -0.01 69.88 48.12 3.98 48.12 3.98 48.78 0.00

	Probe ID	W605282							
	TTODE ID	_1_M92	_1_M93	_1_M94	_1_M95	_1_M96	_1_M97	_1_M98	_1_M99
	Sample	W605282							
	Rocktype	Z-FeTiB							
	SiO2 wt%	0.01	0.00	0.02	0.01	0.02	0.00	0.02	0.04
	TiO2 wt%	0.03	0.01	0.03	0.10	0.03	0.05	0.03	0.04
	Al ₂ O ₃ wt%	0.02	0.01	0.02	0.09	0.04	0.06	0.05	0.03
	Cr2O3 wt%	0.01	0.06	0.03	0.01	0.01	0.05	0.00	0.00
	FeO wt%	91.22	91.17	91.60	91.71	91.24	91.76	91.57	91.28
	MnO wt%	0.04	0.03	0.02	0.00	0.00	0.02	0.02	0.00
	MgO wt%	0.00	0.00	-0.01	-0.01	0.00	-0.01	0.00	0.00
	CaO wt%	0.36	0.57	0.26	0.05	0.31	0.11	0.16	0.05
lata	K2O wt%	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
e d	Nb2O5 wt%	0.02	0.01	0.04	0.01	0.00	-0.01	0.03	0.00
Probe data	ZnO wt%	0.01	-0.01	0.00	0.00	0.00	-0.03	0.01	0.00
-	CuO wt%	-0.01	-0.01	0.00	0.01	-0.01	-0.01	0.00	0.00
	NiO wt%	0.01	0.00	-0.02	0.00	0.00	-0.01	0.00	0.00
	CoO wt%	0.12	0.14	0.12	0.13	0.13	0.14	0.11	0.13
	SnO2 wt%	-0.14	-0.15	-0.02	-0.02	-0.28	-0.08	-0.27	-0.09
	ZrO2 wt%	0.00	-0.01	0.01	0.00	-0.01	0.00	0.00	0.00
	P2O5 wt%	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00
	V2O3 wt%	0.57	0.55	0.61	0.63	0.59	0.61	0.65	0.62
	Total wt%	92.27	92.39	92.71	92.72	92.08	92.66	92.37	92.09
	Fe ₂ O3_%	67.73	67.97	67.83	67.65	67.67	67.86	67.72	67.42
	FeO_%	30.27	30.01	30.56	30.83	30.34	30.70	30.63	30.62
ğ	Total_%	99.21	99.38	99.56	99.53	99.16	99.59	99.43	98.95
laté	Ti mol %	0.04	0.02	0.04	0.12	0.04	0.06	0.04	0.05
Calculated	Fe ²⁺ mol %	42.13	41.77	42.54	42.91	42.24	42.73	42.63	42.62
õ	Fe ³⁺ mol %	42.42	42.56	42.48	42.37	42.38	42.49	42.41	42.22
	Usp Mol%	0.10	0.03	0.09	0.29	0.09	0.13	0.08	0.12
	Ilm Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A6. 8 Electron microprobe results for magnetite mineral chemistry and calculated mineral formulae based on six oxygens.

	Probe ID	99362_2_I		99362_2_I	99362_2_I	99362_2_I	99362_2_I	S037015_	S037015								
	rrobe ID	34	42	47	51	54	57	1B_I1	6_I10	E_I200	E_I201	F_I202	F_1203	F_I204	F_1205	F_1206	6_I11
	Sample	99-362	99-362	99-362	99-362	99-362	99-362	S037015	S037015								
I	Rocktype	FW-FeB	FW-FeB	FW-FeB	FW-FeB	FW-FeB	FW-FeB	Z-FeTiB	Z-FeTiB								
5	SiO2 wt%	0.05	0.07	0.58	0.06	0.25	62.32	0.05	23.56	0.05	0.05	0.93	0.16	0.09	0.14	0.62	0.30
1	TiO2 wt%	49.75	51.42	49.74	51.09	49.68	0.05	52.15	6.43	52.37	50.87	51.97	52.01	52.51	52.07	50.99	52.23
A	Al ₂ O ₃ wt%	0.01	0.00	0.00	0.00	0.23	23.03	0.01	8.63	0.00	0.02	0.11	0.01	0.00	0.01	0.26	0.00
С	Cr2O3 wt%	-0.01	0.00	-0.01	0.01	0.00	0.01	0.01	-0.01	0.00	0.01	0.01	0.01	-0.01	0.00	0.00	0.00
1	FeO wt%	46.19	44.90	44.73	45.38	45.35	3.89	46.23	55.26	46.83	47.28	44.82	45.80	46.27	46.15	45.70	45.49
N	MnO wt%	2.50	2.81	2.54	2.66	2.91	0.01	1.44	0.16	1.53	1.50	1.44	1.43	1.49	1.44	1.43	1.49
N	MgO wt%	0.01	0.01	0.01	0.01	0.14	0.53	0.03	0.17	0.03	0.03	0.03	0.02	0.02	0.04	0.26	0.02
	CaO wt%	0.05	0.03	0.16	0.03	0.23	3.71	0.03	1.37	0.04	0.01	0.83	0.08	0.08	0.21	0.10	0.04
I N 2	K ₂ O wt%	0.00	0.00	0.01	0.00	0.00	0.90	0.02	0.25	0.03	0.00	0.01	0.02	0.02	0.05	0.01	0.02
N	b2O5 wt%	0.05	0.06	0.07	0.08	0.01	-0.05	0.04	0.06	0.05	0.08	0.05	0.01	0.06	0.06	0.05	0.03
2	ZnO wt%	0.05	0.06	0.02	0.03	0.01	0.00	0.04	0.00	0.07	0.00	0.04	0.05	0.01	-0.01	0.04	0.02
	CuO wt%	0.01	-0.01	0.00	0.00	0.02	0.00	0.00	-0.01	-0.01	-0.01	0.02	0.00	0.01	-0.01	0.02	0.00
ľ	NiO wt%	0.01	0.01	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.01	0.00	0.00	0.00	0.01
0	CoO wt%	0.06	0.05	0.06	0.07	0.07	0.01	0.06	0.08	0.05	0.07	0.06	0.07	0.06	0.05	0.06	0.05
s	SnO2 wt%	-0.02	-0.11	-0.01	-0.02	-0.01	0.01	-0.07	-0.10	-0.09	-0.04	0.00	-0.01	-0.03	-0.01	-0.01	-0.09
2	ZrO2 wt%	-0.01	0.00	0.00	0.00	0.00	0.05	-0.01	0.00	0.07	0.00	0.04	0.19	0.07	0.09	0.10	0.41
I	P2O5 wt%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.03	0.02	0.17	0.01	0.02
١	V ₂ O ₃ wt%	0.54	0.49	0.46	0.47	0.50	0.01	0.49	0.34	0.45	0.47	0.49	0.47	0.46	0.45	0.43	0.44
Т	Fotal wt%	99.25	99.80	98.38	99.85	99.37	94.49	100.52	96.20	101.48	100.33	100.85	100.37	101.11	100.92	100.06	100.49
1	Fe ₂ O ₃ %	4.54	1.70	2.38	2.33	4.39	0.00	1.03	26.97	1.54	3.37	0.00	0.47	0.66	0.76	1.30	0.00
	FeO %	42.10	43.37	42.59	43.28	41.40	3.89	45.30	30.99	45.45	44.25	44.82	45.37	45.67	45.46	44.53	45.49
	Total_%	99.75	100.10	98.63	100.12	99.83	94.54	100.71	99.02	101.73	100.72	100.85	100.43	101.22	101.02	100.20	100.59
F	Ti mol %	62.29	64.39	62.27	63.96	62.20	0.07	65.29	8.05	65.56	63.69	65.07	65.12	65.74	65.20	63.84	65.39
F	e ²⁺ mol %	58.61	60.37	59.29	60.24	57.63	5.42	63.05	43.14	63.26	61.59	62.39	63.16	63.58	63.28	61.98	63.32
F	e ³⁺ mol %	2.84	1.07	1.49	1.46	2.75	0.00	0.65	16.89	0.97	2.11	0.00	0.30	0.41	0.48	0.81	0.00
τ	Usp Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
т	llm Mol%	95.55	98.32	97.64	97.68	95.71	-5.97	99.09	53.53	98.54	96.72	100.46	99.51	99.37	98.99	98.72	100.25

		S037015															
	Probe ID	7_112	7_113	7_114	7_115	7_116	1B_I2	1B_I3	2_14	2_15	2_16	2_17	2_18	A_184	A_185	A_186	A_187
	Sample	S037015	\$037015														
	Rocktype	Z-FeTiB															
	SiO2 wt%	0.11	3.33	0.10	11.75	0.11	0.05	0.50	1.64	33.86	3.57	12.33	9.56	0.06	0.11	0.73	0.08
	TiO2 wt%	51.75	47.92	51.38	30.13	52.53	51.92	51.22	47.24	22.47	44.24	33.29	41.26	49.83	50.44	49.74	52.03
	Al ₂ O ₃ wt%	0.01	1.63	0.02	7.92	0.01	0.01	0.00	1.17	11.84	2.34	5.73	3.67	0.01	0.00	0.04	0.00
	Cr2O3 wt%	0.01	0.01	-0.01	-0.01	-0.01	0.00	0.01	0.01	0.00	-0.01	0.01	-0.01	0.00	0.00	-0.01	0.01
	FeO wt%	46.11	42.26	44.01	34.25	44.84	45.89	45.55	45.05	20.13	43.74	35.73	35.78	46.81	47.09	46.49	46.39
	MnO wt%	1.40	1.29	1.49	0.84	1.41	1.43	1.44	1.40	0.63	1.28	0.98	1.25	1.44	1.39	1.54	1.52
	MgO wt%	0.02	1.05	0.02	5.73	0.02	0.02	0.03	0.81	0.01	1.55	3.64	0.71	0.02	0.03	0.03	0.02
_	CaO wt%	0.04	0.44	0.69	0.28	0.03	0.18	0.07	0.07	2.81	0.11	0.11	1.90	0.08	0.00	0.03	0.04
Probe data	K2O wt%	0.06	1.10	0.09	1.24	0.08	0.05	0.01	0.05	0.06	0.58	4.31	0.05	0.00	0.00	0.00	0.00
e e	Nb ₂ O ₅ wt%	0.06	0.05	0.06	0.03	0.02	0.03	0.06	0.07	0.06	0.03	0.05	0.03	0.04	0.04	0.05	0.02
Prol	ZnO wt%	0.02	0.04	0.03	0.02	0.02	0.01	0.02	0.04	-0.02	0.02	0.04	0.04	0.04	0.03	0.01	0.04
_	CuO wt%	-0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.02	-0.01	0.01	-0.02	0.00	0.00	-0.01	0.00	-0.01
	NiO wt%	-0.02	-0.01	0.00	0.00	-0.01	-0.01	0.00	0.01	-0.02	-0.01	0.01	0.00	0.00	0.00	-0.01	0.00
	CoO wt%	0.06	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.03	0.04	0.05	0.04	0.05	0.06	0.06	0.07
	SnO2 wt%	-0.08	0.00	0.01	0.00	0.00	0.00	0.00	0.00	-0.04	0.00	-0.01	-0.04	0.00	-0.01	-0.01	-0.04
	ZrO2 wt%	0.13	0.00	0.00	0.15	0.13	0.02	0.73	0.09	0.05	0.00	0.06	0.57	0.00	0.00	-0.01	0.05
	P2O5wt%	0.01	0.22	0.49	0.09	0.01	0.00	0.04	0.00	0.01	0.00	0.01	1.20	0.36	0.00	0.00	0.01
	V_2O_3 wt%	0.43	2.92	0.47	0.26	0.46	0.48	0.49	0.44	0.20	0.41	0.31	0.34	0.49	0.44	0.49	0.47
	Total wt%	100.10	102.32	98.89	92.73	99.69	100.14	100.21	98.16	92.07	97.91	96.63	96.33	99.23	99.60	99.17	100.70
	Fe ₂ O ₃ %	1.13	2.10	0.00	8.99	0.00	1.16	0.03	4.07	0.00	6.31	13.12	0.00	3.14	3.47	2.82	1.30
	FeO %	45.09	40.37	44.01	26.16	44.84	44.85	45.52	41.39	20.13	38.06	23.93	35.78	43.98	43.97	43.95	45.22
ę	Total_%	100.32	102.55	98.90	93.64	99.71	100.28	100.22	98.57	92.16	98.56	97.98	96.38	99.56	99.98	99.49	100.88
ılat	Ti mol %	64.80	60.00	64.33	37.72	65.77	65.00	64.12	59.15	28.13	55.39	41.68	51.66	62.39	63.15	62.27	65.14
Calculated	Fe ²⁺ mol %	62.76	56.20	61.26	36.41	62.42	62.42	63.36	57.61	28.02	52.98	33.31	49.80	61.22	61.20	61.18	62.94
ű	Fe ³⁺ mol %	0.71	1.31	0.00	5.63	0.00	0.72	0.02	2.55	0.00	3.95	8.21	0.00	1.97	2.17	1.77	0.82
	Usp Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Ilm Mol%	98.98	101.22	99.86	92.59	101.10	99.08	99.45	95.92	216.26	95.34	101.99	110.71	96.12	96.66	97.23	98.76

Probe ID A_188 A_189 2_19 A_190 A_191 A_192 D_193 D_194 D_195 D_196 D_197 E_1198 E_1199 1_117 1_119 1_222																		
SampleS03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S03701S0370		Probe ID	S037015_													S039313_	S039313_	S039313_
BethyZ+ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETBZ-ETB <thz-etb< th="">Z</thz-etb<>		Sample	_	-	-	_	_	-	-	_	-	-	-	-	-	-	-	5039313
Tho. wt% 51.07 51.11 40.14 51.57 50.78 51.65 52.01 51.87 51.95 51.64 52.25 52.19 1.62 3.58 50.00 M1.0 wt% 0.00 0.00 4.35 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.			Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB			Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB	Z-FeTiB			
N-D N-D 0.00 4.35 0.00 0.02 0.00 0.00 0.03 0.00 0.02 0.01 -0.01 14.47 0.22 0.02 Cr_O, wt% 0.01 -0.01 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		SiO2 wt%	0.21	0.31	9.06	0.15	0.17	0.16	0.05	0.16	0.35	0.16	0.23	0.07	0.06	79.01	75.91	34.28
Gr ₂ O, wh% 0.01 -0.01 -0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01		TiO2 wt%	51.07	51.11	40.14	51.57	50.78	51.65	52.01	51.87	51.73	51.95	51.64	52.25	52.19	1.62	3.58	5.60
Few tr% 46.44 46.22 38.74 46.67 46.11 46.76 46.21 45.39 45.41 45.89 45.80 46.46 46.74 3.93 19.34 53.31 Mn0 wt% 1.53 1.45 1.16 1.46 1.42 1.41 1.48 1.42 1.45 1.54 1.56 1.47 0.01 0.00 -0.01 Mg0 wt% 0.07 0.03 2.60 0.03 0.03 0.02 0.01 0.02 0.02 0.02 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.		Al ₂ O ₃ wt%	0.10	0.00	4.35	0.00	0.02	0.00	0.00	0.00	0.03	0.00	0.02	0.01	-0.01	14.47	0.22	0.02
MRO wt% 1.53 1.45 1.16 1.46 1.42 1.41 1.48 1.42 1.45 1.45 1.54 1.56 1.47 0.01 0.00 0.00 Mg0 wt% 0.07 0.03 2.60 0.03 0.03 0.02 0.01 0.02 0.02 0.02 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01		Cr2O3 wt%	0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
MgO wt% 0.07 0.03 2.60 0.03 0.03 0.03 0.02 0.01 0.02 0.02 0.02 0.02 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01		FeO wt%	46.44	46.22	38.74	46.67	46.11	46.76	46.21	45.39	45.41	45.89	45.80	46.46	46.74	3.93	19.34	53.31
CAO with 0.09 0.06 0.15 0.08 0.25 0.06 0.01 0.33 0.05 0.15 0.04 0.01 0.01 0.01 K,O with 0.02 0.05 3.37 0.02 0.05 0.03 0.04 0.05 0.06 0.04 0.04 0.04 0.04 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01		MnO wt%	1.53	1.45	1.16	1.46	1.42	1.41	1.48	1.48	1.42	1.45	1.54	1.56	1.47	0.01	0.00	-0.01
Ky Ort% 0.02 0.05 3.37 0.02 0.05 0.02 0.03 0.03 0.04 0.05 0.06 0.04 0.04 0.05 0.06 0.04 0.01 0.01 Nb ₂ O ₃ vi% 0.03 0.03 0.04 0.05 0.03 0.04 0.05 0.05 0.04 0.06 -0.04 -0.03 0.01 ZO vi% 0.03 0.03 0.02 0.02 0.04 0.02 0.02 0.04 0.04 0.04 0.04 0.05 0.05 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		MgO wt%	0.07	0.03	2.60	0.03	0.03	0.03	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.51	0.02	0.00
Nb,0, w1% 0.05 0.08 0.03 0.06 0.05 0.04 0.05 0.03 0.05 0.04 0.05 0.04 0.05 0.05 0.04 0.06 -0.04 0.01 Zn0 w1% 0.03 0.03 0.02 0.02 0.00 0.00 0.00 0.04 0.02 0.04 0.04 0.04 0.04 0.05 0.05 0.01 0.00 0.00 N0 w1% 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.00 0.02 0.00 0.01 0.00 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	-	CaO wt%	0.09	0.06	0.15	0.08	0.25	0.06	0.06	0.11	0.33	0.05	0.15	0.04	0.01	0.01	0.01	0.01
ZD wt% 0.03 0.03 0.02 0.02 0.00 0.04 0.02 0.02 0.04 0.02 0.04 0.04 0.04 0.04 0.04 0.04 0.05 0.05 0.01 0.01 0.00 C0 wt% 0.00 0.02 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 <t< td=""><th>data</th><th>K2O wt%</th><td>0.02</td><td>0.05</td><td>3.37</td><td>0.02</td><td>0.05</td><td>0.02</td><td>0.03</td><td>0.03</td><td>0.04</td><td>0.05</td><td>0.06</td><td>0.04</td><td>0.04</td><td>5.48</td><td>0.11</td><td>0.01</td></t<>	data	K2O wt%	0.02	0.05	3.37	0.02	0.05	0.02	0.03	0.03	0.04	0.05	0.06	0.04	0.04	5.48	0.11	0.01
CaO wt% 0.00 0.02 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 NO wt% 0.05 0.07 0.04 0.06 0.06 0.05 0.05 0.06 0.05 0.06 0.00 0.00 0.00 Co wt% 0.05 0.06 0.02 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 <	ě	Nb ₂ O ₅ wt%	0.05	0.08	0.03	0.06	0.05	0.04	0.05	0.03	0.04	0.05	0.05	0.04	0.06	-0.04	-0.03	0.01
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Probe	ZnO wt%	0.03	0.03	0.02	0.02	0.00	0.04	0.02	0.02	0.04	0.04	0.04	0.05	0.05	0.01	0.01	0.00
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		CuO wt%	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.01	0.01	0.00	0.00	0.00
		NiO wt%	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.01	0.00	-0.01	0.01	0.00	0.00
Zroy wt% 0.00 0.35 -0.01 0.15 0.11 0.19 0.04 0.20 0.06 0.04 0.27 0.04 0.06 -0.01 0.00 0.00 P_Os wt% 0.00 0.01 0.01 0.01 0.03 0.01 0.03 0.01 0.00 0.02 0.00 0.00 0.00 0.01 0.01 V_O, wt% 0.46 0.46 0.39 0.47 0.45 0.48 0.41 0.48 0.43 0.42 0.45 0.48 0.40 0.48 0.42 0.45 0.48 0.49 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		CoO wt%	0.05	0.07	0.04	0.06	0.06	0.08	0.06	0.05	0.05	0.06	0.05	0.05	0.06	0.00	0.03	0.07
P20, wt% 0.00 0.01 0.01 0.01 0.01 0.03 0.01 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.03 0.01 0.02 0.00 0.00 0.00 0.01 0.01 V20, wt% 0.46 0.46 0.39 0.47 0.45 0.48 0.43 0.42 0.45 0.45 0.48 0.05 0.10 0.48 Total wt% 100.05 100.20 99.92 100.75 99.40 100.36 99.85 99.93 100.13 100.28 101.05 101.05 105.04 99.25 93.76 Fe(0% 44.34 44.80 30.64 44.97 44.05 45.17 45.23 44.93 45.18 44.95 45.27 45.34 3.93 19.34 45.96 Total wt% 100.35		SnO2 wt%	-0.06	-0.02	-0.12	0.00	-0.13	-0.09	-0.06	-0.02	-0.02	-0.03	-0.07	-0.04	-0.09	-0.01	-0.03	-0.02
V-20, wt% 0.46 0.46 0.39 0.47 0.45 0.48 0.41 0.48 0.43 0.42 0.45 0.45 0.48 0.05 0.10 0.48 Total wt% 100.05 100.20 99.92 100.75 99.40 100.84 100.36 99.85 99.93 100.13 100.28 10.15 105.04 99.25 93.76 Fe(0,% 2.33 1.57 9.00 1.89 2.29 1.85 1.16 0.18 0.53 0.79 0.95 1.32 1.56 0.00 0.00 8.17 FeO % 44.34 44.80 30.64 44.97 44.05 45.17 45.23 44.93 45.18 44.95 45.27 45.34 3.93 19.34 45.96 Total wt% 100.35 100.96 100.95 99.76 10.12 10.05 99.90 100.02 100.26 100.45 101.22 10.42 105.11 99.33 94.62 Timel% 63.94 <td< td=""><th></th><th>ZrO2 wt%</th><td>0.00</td><td>0.35</td><td>-0.01</td><td>0.15</td><td>0.11</td><td>0.19</td><td>0.04</td><td>0.20</td><td>0.06</td><td>0.04</td><td>0.27</td><td>0.04</td><td>0.06</td><td>-0.01</td><td>0.00</td><td>0.00</td></td<>		ZrO2 wt%	0.00	0.35	-0.01	0.15	0.11	0.19	0.04	0.20	0.06	0.04	0.27	0.04	0.06	-0.01	0.00	0.00
Total wt% 100.05 100.20 99.92 100.75 99.40 100.84 100.36 99.85 99.93 100.13 100.28 101.05 101.15 105.04 99.25 93.76 FcO5% 2.33 1.57 9.00 1.89 2.29 1.85 1.16 0.18 0.53 0.79 0.95 1.32 1.56 0.00 0.00 8.17 FcO% 44.34 44.80 30.64 44.97 44.05 45.10 45.17 45.23 44.93 45.18 44.95 45.27 45.34 3.93 19.34 45.96 Total wt 63.94 63.99 100.95 64.67 65.11 64.94 64.77 65.04 64.66 65.32 2.03 4.48 7.02 Fe ¹ m0% 61.72 62.73 42.55 61.31 62.77 62.87 62.88 62.57 63.02 63.12 5.47 2.68 63.02 63.12 5.47 2.68 63.92 63.02 63.12		P2O5 wt%	0.00	0.01	0.01	0.01	0.03	0.01	0.01	0.03	0.01	0.00	0.02	0.00	0.00	0.00	-0.01	0.01
Fe ₂ O ₃ % 2.33 1.57 9.00 1.89 2.29 1.85 1.16 0.18 0.53 0.79 0.95 1.32 1.56 0.00 0.00 8.17 FeO % 44.34 44.80 30.64 44.97 44.05 45.10 45.17 45.23 44.93 45.18 44.95 45.27 45.34 3.93 19.34 45.96 Total_% 100.35 100.39 100.96 100.95 9.76 101.12 100.56 9.90 100.02 100.26 10.42 10.12 10.35 46.37 65.04 64.66 64.26 65.35 2.03 4.48 7.02 Fe ^{2*} mol% 61.72 62.37 62.37 62.37 62.37 63.04 64.66 64.26 63.32 2.03 4.48 7.02 Fe ^{2*} mol% 61.72 62.37 62.37 62.37 62.37 63.04 64.66 64.26 63.32 2.03 4.48 7.02 Fe ^{2*} mol% 1.46		V2O3 wt%	0.46	0.46	0.39	0.47	0.45	0.48	0.41	0.48	0.43	0.42	0.45	0.45	0.48	0.05	0.10	0.48
Fe0 % 44.34 44.80 30.64 44.97 44.05 45.10 45.17 45.23 44.93 45.18 44.95 45.27 45.34 3.93 19.34 45.96 Total % 100.35 100.39 100.96 100.95 99.76 101.12 100.56 99.90 100.02 100.26 101.42 101.22 101.42 105.11 99.33 46.27 Timol % 63.94 63.99 50.25 64.57 63.88 64.67 65.11 64.64 64.66 65.42 65.35 2.03 44.88 7.02 Fe ³ mol % 1.46 0.98 5.42 61.28 61.07 62.37 62.37 62.37 63.02 63.12 5.47 63.28 63.02 63.12 5.47 62.87 63.94 63.99 63.02 63.12 5.47 63.28 63.02 63.12 5.47 63.02 63.12 5.47 63.02 63.12 5.47 63.02 63.12 5.47 63.02 63		Total wt%	100.05	100.20	99.92	100.75	99.40	100.84	100.36	99.85	99.93	100.13	100.28	101.05	101.15	105.04	99.25	93.76
Total_% 100.35 100.39 100.96 100.95 99.76 101.12 100.65 99.90 100.02 100.45 101.22 101.42 101.11 99.33 94.62 Ti mol % 63.94 63.99 50.25 64.57 63.58 64.67 65.11 64.94 64.77 65.04 64.66 65.42 65.35 2.03 44.48 7.02 Fe ³ mol % 61.72 62.37 42.65 62.59 61.31 62.77 62.87 62.54 63.02 63.12 5.47 26.92 63.97 Fe ³ mol % 1.46 0.98 5.64 1.18 1.43 1.16 0.72 0.11 0.33 0.49 0.59 0.82 0.97 0.00 0.00 5.12 Usp Mol % 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 <td< td=""><th></th><th>Fe₂O₃ %</th><td>2.33</td><td>1.57</td><td>9.00</td><td>1.89</td><td>2.29</td><td>1.85</td><td>1.16</td><td>0.18</td><td>0.53</td><td>0.79</td><td>0.95</td><td>1.32</td><td>1.56</td><td>0.00</td><td>0.00</td><td>8.17</td></td<>		Fe ₂ O ₃ %	2.33	1.57	9.00	1.89	2.29	1.85	1.16	0.18	0.53	0.79	0.95	1.32	1.56	0.00	0.00	8.17
Time 63.94 63.99 50.25 64.57 63.88 64.67 65.11 64.94 64.77 65.04 64.66 65.42 65.35 2.03 4.48 7.02 Fe ³⁺ mol % 61.72 62.37 42.65 62.59 61.31 62.77 62.87 62.97 62.54 62.88 62.57 63.02 63.12 5.47 26.92 63.97 Fe ³⁺ mol % 1.46 0.98 5.64 1.18 1.43 1.16 0.72 0.11 0.33 0.49 0.59 0.82 0.97 0.00 0.00 5.12 Usp Mol% 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		FeO %	44.34	44.80	30.64	44.97	44.05	45.10	45.17	45.23	44.93	45.18	44.95	45.27	45.34	3.93	19.34	45.96
Fe ^{3*} mol % 61.72 62.37 42.65 62.59 61.31 62.77 62.87 62.97 62.54 62.88 62.57 63.02 63.12 5.47 26.92 63.97 Fe ^{3*} mol % 1.46 0.98 5.64 1.18 1.43 1.16 0.72 0.11 0.33 0.49 0.59 0.82 0.97 0.00 0.00 5.12 Usp Mol% 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	g	Total_%	100.35	100.39	100.96	100.95	99.76	101.12	100.56	99.90	100.02	100.26	100.45	101.22	101.42	105.11	99.33	94.62
Fe ^{1*} mol % 1.46 0.98 5.64 1.18 1.43 1.16 0.72 0.11 0.33 0.49 0.59 0.82 0.97 0.00 0.00 5.12 Usp Mol% 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	Calculated	Ti mol %	63.94	63.99	50.25	64.57	63.58	64.67	65.11	64.94	64.77	65.04	64.66	65.42	65.35	2.03	4.48	7.02
Usp Mol% 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	alcu	Fe ²⁺ mol %	61.72	62.37	42.65	62.59	61.31	62.77	62.87	62.97	62.54	62.88	62.57	63.02	63.12	5.47	26.92	63.97
	ű	Fe ³⁺ mol %	1.46	0.98	5.64	1.18	1.43	1.16	0.72	0.11	0.33	0.49	0.59	0.82	0.97	0.00	0.00	5.12
Ilm Mol% 97.78 98.39 102.94 98.12 97.79 98.17 98.95 99.76 99.56 99.39 99.05 98.85 98.62 -34.87 -87.38 80.68		Usp Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Ilm Mol%	97.78	98.39	102.94	98.12	97.79	98.17	98.95	99.76	99.56	99.39	99.05	98.85	98.62	-34.87	-87.38	80.68

	Probe ID	S039313_	S039313_	S039313_	S039313_	S039313_	W605282										
		5_128	5_129	5_130	5_131	5_132	_1_162	_1_I63	_1_164	_1_165	_1_166	_1_167	_1_168	_1_169	_1_170	_1_171	_1_172
	Sample	S039313	S039313	S039313	S039313	S039313	W605282										
_	Rocktype	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	Z-FeTiB										
	SiO2 wt%	16.36	18.81	37.95	32.85	29.54	0.06	0.18	0.01	0.25	0.06	1.19	0.45	2.75	0.05	0.03	0.01
	TiO2 wt%	7.48	5.07	6.29	4.03	4.86	51.65	51.81	51.59	51.79	50.75	49.59	51.24	47.24	51.77	51.79	52.09
	Al ₂ O ₃ wt%	1.65	0.03	5.01	9.61	7.25	0.03	0.09	0.00	0.18	0.02	1.00	0.01	2.04	0.04	0.01	0.00
	Cr ₂ O ₃ wt%	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	-0.01	0.00	0.00	0.01
	FeO wt%	68.66	63.35	45.74	44.46	16.92	44.79	45.28	45.78	45.73	45.55	44.70	45.56	42.27	45.52	45.48	45.87
	MnO wt%	-0.01	0.00	0.00	0.00	0.00	2.77	2.65	2.68	2.71	2.61	2.52	2.54	2.42	2.65	2.72	2.69
	MgO wt%	0.00	-0.01	0.00	0.01	0.02	0.01	0.03	0.01	0.03	0.01	0.09	0.02	0.06	0.01	0.01	0.02
_	CaO wt%	0.10	0.05	0.47	0.69	0.55	1.02	0.09	0.45	0.04	0.30	0.20	0.34	0.92	0.21	0.06	0.09
Probe data	K2O wt%	0.00	0.01	0.04	0.21	0.08	0.00	0.05	0.00	0.04	0.02	0.26	0.01	0.77	0.01	0.03	0.02
ě	Nb ₂ O ₅ wt%	0.01	-0.02	0.02	0.00	0.01	0.06	0.04	0.07	0.06	0.09	0.05	0.08	0.04	0.06	0.06	0.04
Pro	ZnO wt%	0.01	0.02	0.01	0.01	0.02	0.05	0.04	0.03	0.03	0.02	0.04	0.00	0.04	0.00	0.03	0.02
	CuO wt%	0.01	0.00	0.00	0.01	0.01	-0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	-0.01
	NiO wt%	-0.01	-0.02	0.01	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.01	-0.02
	CoO wt%	0.10	0.10	0.06	0.06	0.02	0.07	0.05	0.07	0.08	0.06	0.06	0.05	0.05	0.05	0.05	0.07
	SnO2 wt%	-0.01	-0.07	-0.03	-0.07	-0.02	0.00	-0.01	-0.03	0.00	-0.08	-0.01	-0.09	-0.01	-0.07	-0.11	0.00
	ZrO2 wt%	0.00	0.01	0.00	-0.02	-0.02	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
	P2O5 wt%	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.01
	V2O3 wt%	0.70	0.70	0.42	0.34	0.17	0.47	0.51	0.51	0.52	0.50	0.50	0.48	0.47	0.49	0.45	0.49
	Total wt%	95.07	88.04	96.01	92.22	59.42	100.96	100.82	101.15	101.46	99.92	100.23	100.70	99.07	100.78	100.61	101.39
	Fe ₂ O ₃ %	47.35	40.54	0.00	3.51	0.00	2.73	1.67	3.00	2.06	3.25	2.77	2.20	2.94	2.08	2.00	2.19
	FeO %	26.05	26.87	45.74	41.30	16.92	42.33	43.78	43.08	43.88	42.62	42.21	43.58	39.63	43.65	43.67	43.89
p	Total_%	99.84	92.22	96.04	92.66	59.46	101.25	101.01	101.50	101.69	100.33	100.52	101.03	99.38	101.07	100.93	101.65
llate	Ti mol %	9.37	6.35	7.88	5.05	6.08	64.66	64.87	64.59	64.84	63.55	62.09	64.15	59.14	64.82	64.84	65.22
Calculated	Fe ²⁺ mol %	36.27	37.40	63.68	57.50	23.55	58.92	60.94	59.97	61.07	59.33	58.75	60.66	55.16	60.76	60.79	61.10
õ	Fe ³⁺ mol %	29.65	25.39	0.00	2.20	0.00	1.71	1.04	1.88	1.29	2.04	1.74	1.38	1.84	1.30	1.26	1.37
	Usp Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Ilm Mol%	38.42	37.88	116.09	90.92	639.84	97.33	98.56	97.08	98.14	96.83	98.13	97.84	99.68	97.99	98.13	97.96

	Probe ID	W605282							
	Sample	_1_I73 W605282	_1_174 W605282	_4_175 W605282	_4_176 W605282	_4_177 W605282	_4_178 W605282	_4_179 W605282	_5_I80 W605282
	Sample	W005282	W605282	W005282	W005282	W005282	w605282	w605282	W005282
	Rocktype	Z-FeTiB							
	SiO2 wt%	0.05	0.22	0.14	0.07	0.30	0.02	0.39	0.28
	TiO2 wt%	51.25	51.88	51.85	51.37	51.75	52.34	50.80	50.56
	Al ₂ O ₃ wt%	0.01	0.13	0.10	0.02	0.23	0.00	0.21	0.21
	Cr2O3 wt%	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	0.02
	FeO wt%	44.98	45.32	45.54	45.67	45.58	44.79	45.78	46.11
	MnO wt%	2.79	2.71	2.73	2.51	2.62	2.80	2.63	2.16
	MgO wt%	0.07	0.01	0.02	0.04	0.01	0.01	0.02	0.11
_	CaO wt%	0.33	0.19	0.45	0.32	0.25	0.50	0.22	0.03
Probe data	K2O wt%	0.04	0.08	0.07	0.08	0.09	0.01	0.14	0.00
ě	Nb ₂ O ₅ wt%	0.04	0.06	0.09	0.07	0.04	0.04	0.01	0.03
LO LO	ZnO wt%	0.01	0.05	0.04	0.04	0.01	0.03	0.04	0.00
	CuO wt%	0.00	-0.01	0.00	-0.01	-0.01	0.00	-0.01	0.00
	NiO wt%	0.00	0.00	0.00	-0.01	0.00	0.00	-0.02	0.00
	CoO wt%	0.07	0.06	0.05	0.08	0.07	0.07	0.05	0.05
	SnO2 wt%	-0.05	-0.03	0.00	-0.03	0.00	-0.05	0.00	-0.01
	ZrO2 wt%	0.00	-0.02	0.01	0.01	0.01	0.01	0.01	0.00
	P2O5 wt%	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	V2O3 wt%	0.46	0.48	0.50	3.13	0.51	0.47	0.47	0.47
	Total wt%	100.04	101.13	101.60	103.34	101.47	101.07	100.75	100.01
	Fe ₂ O ₃ %	2.61	1.87	2.56	2.98	2.20	1.41	3.45	3.04
	FeO %	42.62	43.64	43.24	42.98	43.60	43.52	42.68	43.37
2	Total_%	100.36	101.37	101.86	103.70	101.71	101.26	101.13	100.33
llat	Ti mol %	64.17	64.95	64.91	64.32	64.79	65.53	63.60	63.30
Calculated	Fe ²⁺ mol %	59.33	60.75	60.18	59.83	60.70	60.58	59.41	60.38
Ű	Fe ³⁺ mol %	1.64	1.17	1.60	1.87	1.38	0.88	2.16	1.90
	Usp Mol%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Ilm Mol%	97.59	98.43	97.68	97.34	98.16	98.69	97.11	97.04

Table A6. 9 Electron microprobe results for rutile mineral chemistry and calculated mineral formulae based on two oxygens.

	Probe ID	9431_1_18 1	9431_1_18 2	9431_1_18 3	3 9431_1_M 116	9431_1_R 71	9431_1_R 72	9431_1_R 73	9431_1_R 74	9431_1_R 75	9431_1_R 76	9431_1_R 77	9431_1_R 78	9431_1_R 79	9431_2_R 80	9431_2_R 81	9431_2_ 82
	Sample	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31
	Rocktype	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB
	SiO2 wt%	0.01	4.00	1.61	0.03	52.35	7.42	3.53	6.30	8.65	22.60	0.09	1.58	7.12	3.30	0.24	3.23
	TiO2 wt%	96.85	94.68	94.61	96.21	2.41	82.78	90.71	21.35	69.77	16.43	99.89	93.62	83.46	93.00	97.72	88.45
	Al ₂ O ₃ wt%	0.00	0.10	0.30	0.03	7.93	1.10	1.06	2.37	4.82	17.96	0.01	1.10	3.68	2.29	0.06	2.55
	Cr ₂ O ₃ wt%	-0.01	0.01	0.00	0.00	-0.03	-0.01	-0.01	0.00	0.00	-0.01	0.01	0.00	-0.01	0.01	0.00	0.00
	FeO wt%	0.86	0.82	0.77	1.44	2.22	1.25	1.63	3.60	2.05	17.85	0.71	2.43	1.89	1.53	2.11	3.43
	MnO wt%	-0.01	0.00	0.00	0.01	0.25	0.02	0.02	0.59	0.10	0.11	0.00	0.03	0.00	0.00	0.00	0.03
	MgO wt%	0.00	0.03	0.07	0.07	0.76	0.23	0.40	1.60	1.19	14.43	0.00	0.82	0.63	0.16	0.03	2.16
	CaO wt%	0.00	0.50	0.63	1.64	21.91	0.80	0.25	38.58	5.36	0.10	0.68	0.15	0.12	0.02	0.05	0.58
riouc uala	K2O wt%	0.00	0.10	0.18	0.25	1.89	0.72	0.51	2.05	2.26	0.56	0.04	0.04	1.70	0.95	0.06	0.23
e E	Nb ₂ O ₅ wt%	0.07	0.09	0.05	0.08	0.00	0.05	0.05	0.00	0.06	0.05	0.07	0.05	0.06	0.49	0.12	0.01
5	ZnO wt%	0.00	0.03	0.00	0.01	0.01	0.01	0.02	0.01	0.02	0.07	0.01	0.01	0.02	0.00	0.04	0.00
-	CuO wt%	0.00	0.00	0.03	0.00	0.00	0.04	0.00	0.02	0.02	0.00	0.00	0.02	0.00	0.01	0.11	0.00
	NiO wt%	0.00	-0.01	0.01	-0.01	0.01	0.01	0.01	-0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00
	CoO wt%	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00	0.03	0.00	0.01	0.00	-0.01	0.00	0.00
	SnO2 wt%	0.00	0.00	0.01	0.00	-0.01	0.00	0.00	-0.01	0.00	-0.04	0.00	0.01	0.00	0.00	0.00	0.00
	ZrO2 wt%	0.00	0.01	0.00	0.01	0.36	0.00	0.06	0.00	0.00	-0.01	0.05	0.03	0.00	-0.01	-0.01	0.01
	P2O5wt%	0.00	0.00	0.01	0.00	4.78	0.02	0.02	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	V2O3 wt%	0.95	0.98	0.94	0.95	0.07	0.83	0.90	0.26	0.75	0.20	1.04	0.94	0.92	1.01	1.07	0.93
	Total wt%	98.72	101.35	99.24	100.71	94.87	95.27	99.15	76.75	95.08	90.35	102.60	100.83	99.60	102.73	101.60	101.6
	Fe ₂ O ₃ %	0.86	0.82	0.77	1.44	2.22	1.25	1.63	3.60	2.05	17.85	0.71	2.43	1.89	1.53	2.11	3.43
3	FeO %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calculated	Total_%	98.75	101.36	99.24	100.73	94.92	95.28	99.17	76.78	95.08	90.41	102.61	100.83	99.62	102.76	101.62	101.6
	Ti mol %	121.26	118.54	118.46	120.45	3.01	103.65	113.57	26.73	87.36	20.57	125.06	117.21	104.49	116.43	122.35	110.7
5	Fe ²⁺ mol %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fe ³⁺ mol %	0.54	0.51	0.49	0.90	1.39	0.78	1.02	2.25	1.29	11.18	0.44	1.52	1.18	0.96	1.32	2.15
		0421.2.0	0421.2.0	0421.2.0	: 9431 3 R	0421.2.0	0421.2.0	0421.2.0	0421.2.0		0421 4 0	0421 4 8	0421 4 0	0020212	0020212	6020212	60202
	Probe ID	9431_2_R 83	9431_2_R 84	9431_3_K 85	86 86	9431_3_R 87	9431_3_K 88	9431_3_K 89	9431_3_K 90	9431_3_K 91	9431_4_R 92	9431_4_R 93	9431_4_K 94	1_R1	3_R10	\$039313_ 3_R11	4_R
	Sample	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	S039313	S039313	\$039313	S0393
	Rocktype	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW FeTi
	SiO2 wt%	0.11	0.60	28.47	0.06	0.04	0.11	0.13	0.07	0.46	71.18	0.09	0.19	45.27	58.51	41.91	0.1
	TiO ₂ wt%	99.73	97.84	73.95	99.52	99.37	98.95	82.64	99.97	98.64	30.38	99.79	99.05	48.40	43.10	54.95	93.7

	Sample	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	94-31	S039313	S039313	S039313	S039313
	Rocktype	HW- FeTiB															
	SiO2 wt%	0.11	0.60	28.47	0.06	0.04	0.11	0.13	0.07	0.46	71.18	0.09	0.19	45.27	58.51	41.91	0.17
	TiO2 wt%	99.73	97.84	73.95	99.52	99.37	98.95	82.64	99.97	98.64	30.38	99.79	99.05	48.40	43.10	54.95	93.70
	Al ₂ O ₃ wt%	0.02	0.47	0.03	0.03	0.02	0.02	0.04	0.01	0.19	1.16	0.03	0.08	2.19	0.03	0.06	0.00
	Cr2O3 wt%	0.01	0.00	0.00	0.00	0.01	0.01	-0.01	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.01
	FeO wt%	0.92	1.11	0.48	0.80	0.81	0.68	0.54	0.71	1.04	0.66	0.81	0.94	2.52	0.76	3.48	5.79
	MnO wt%	0.02	0.01	0.01	0.00	0.01	-0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.06	0.02
	MgO wt%	0.00	0.32	0.01	0.02	0.00	0.00	0.01	0.00	0.12	0.15	0.01	0.03	1.87	0.01	0.01	0.01
-	CaO wt%	0.01	0.19	0.30	0.28	0.06	0.03	9.31	0.67	0.08	0.04	0.01	0.01	0.08	0.16	0.06	0.01
Probe data	K2O wt%	0.13	0.10	0.08	0.09	0.18	0.16	0.17	0.08	0.12	0.50	0.15	0.15	0.03	0.05	0.03	0.02
pe	Nb2O5 wt%	0.09	0.03	-0.01	0.08	0.05	0.03	0.05	0.03	0.04	0.05	0.01	0.03	0.03	0.05	0.03	0.02
Pro	ZnO wt%	0.01	0.00	-0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.00	0.02	0.02	0.00	0.01	0.02
	CuO wt%	0.01	0.00	0.01	-0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.02	0.00	0.00
	NiO wt%	0.01	0.00	0.00	0.01	0.01	-0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.00
	CoO wt%	0.00	0.01	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	SnO2 wt%	0.00	0.00	0.01	0.01	0.00	-0.01	0.00	0.00	0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.00
	ZrO2 wt%	0.02	-0.01	-0.01	0.00	0.00	0.00	0.04	-0.02	0.00	0.05	0.00	0.00	0.04	0.04	0.02	-0.01
	P2O5wt%	0.00	0.00	0.00	0.00	-0.01	0.00	8.07	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.00
	V2O3 wt%	1.01	1.02	0.76	1.07	1.01	1.00	0.84	1.07	1.08	0.33	0.99	1.10	0.46	0.38	0.48	0.80
	Total wt%	102.11	101.70	104.07	101.95	101.59	100.99	101.83	102.60	101.81	104.53	101.93	101.62	100.95	103.15	101.13	100.55
	Fe ₂ O ₃ %	0.92	1.11	0.48	0.80	0.81	0.68	0.54	0.71	1.04	0.66	0.81	0.94	2.52	0.76	3.48	5.79
pa	FeO %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
llato	Total_%	102.11	101.71	104.11	101.98	101.60	101.02	101.85	102.63	101.82	104.55	101.95	101.63	100.96	103.16	101.14	100.57
Calculated	Ti mol %	124.86	122.50	92.59	124.61	124.42	123.89	103.47	125.16	123.51	38.04	124.93	124.02	60.60	53.97	68.80	117.31
ű	Fe ²⁺ mol %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fe ³⁺ mol %	0.57	0.70	0.30	0.50	0.51	0.43	0.34	0.45	0.65	0.41	0.51	0.59	1.58	0.48	2.18	3.62

Probe ID	S039313_ 4_R13	S039313_ 4_R14	\$039313_ 4_R15	\$039313_ 5_R16	S039313_ 5_R17	S039313_ 1_R2	S039313_ 1_R3	S039313_ 1_R4	\$039313_ 1_R5	S039313_ 1_R6	S039313_ 1_R7	S039313_ 1_R8	\$039313_ 3_R9	W605041 _1_R18	W605041 _1_R19	W605041 _1_R20
Sample	S039313	S039313	S039313	S039313	S039313	S039313	S039313	S039313	S039313	S039313	S039313	S039313	S039313	W605041	W605041	W605041
Rocktype	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HW- FeTiB	HSR	HSR	HSR
SiO2 wt%	51.22	56.57	55.64	32.77	32.92	26.86	7.22	41.58	27.36	72.19	54.10	57.02	26.59	50.94	19.70	46.44
TiO2 wt%	49.15	43.04	27.32	37.69	15.64	66.06	0.00	26.48	73.81	27.01	45.49	48.31	73.06	0.62	58.29	0.91
Al ₂ O ₃ wt%	0.35	0.04	14.54	18.53	10.07	6.68	0.10	20.70	0.12	0.00	0.01	0.01	0.00	28.89	9.12	26.62
Cr2O3 wt%	-0.01	0.01	0.00	0.00	0.02	0.00	0.00	-0.01	0.01	0.00	0.00	0.00	0.01	-0.01	0.00	0.00
FeO wt%	0.95	0.82	0.30	2.57	35.36	1.07	53.28	3.16	0.39	1.93	2.21	0.24	0.80	5.36	4.01	6.79
MnO wt%	0.01	0.00	0.00	0.00	-0.01	-0.01	0.73	0.02	0.02	0.00	0.00	-0.01	0.01	0.19	0.00	0.27
MgO wt%	0.00	0.00	0.01	0.69	0.00	0.29	0.56	0.96	0.08	0.00	-0.01	0.00	0.00	1.82	0.71	1.50
CaO wt%	0.01	0.13	0.61	0.53	0.75	0.06	22.54	0.04	0.06	0.01	0.01	0.18	0.06	0.05	0.16	0.09
K2O wt%	0.20	0.02	0.16	5.43	0.06	2.68	0.06	6.47	0.08	0.01	0.01	0.01	0.02	6.16	4.13	5.50
Nb2O5 wt%	0.06	0.05	-0.01	0.03	-0.02	0.27	0.02	0.01	0.02	0.00	0.03	0.01	0.09	7.31	5.06	12.76
K2O wt% Nb2O5 wt% ZnO wt%	0.01	0.00	0.01	0.01	0.00	0.00	0.06	0.00	0.03	-0.01	0.00	-0.01	0.00	0.01	0.01	-0.01
CuO wt%	0.00	0.00	0.00	0.02	0.00	-0.01	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
NiO wt%	0.00	-0.01	0.01	0.00	0.00	0.01	-0.01	0.01	0.00	0.00	0.01	0.00	0.00	-0.01	-0.01	0.00
CoO wt%	0.00	0.00	-0.01	0.00	0.05	0.00	0.07	0.00	0.00	-0.01	0.00	0.00	-0.01	0.01	0.01	0.01
SnO2 wt%	0.00	0.00	-0.01	0.00	-0.01	-0.01	-0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.00
ZrO2 wt%	0.00	0.11	-0.01	0.03	0.00	0.01	0.00	0.00	0.02	0.00	-0.01	0.00	0.19	0.00	0.00	1.95
P2O5wt%	0.00	0.09	0.01	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.03
V2O3 wt%	0.45	0.36	0.28	0.46	0.45	0.64	0.00	0.26	0.66	0.29	0.46	0.50	0.63	0.00	0.46	0.02
Total wt%	102.41	101.23	98.86	99.12	95.27	104.60	84.64	99.68	102.66	101.43	102.34	106.28	101.50	101.35	101.67	102.87
Fe ₂ O ₃ %	0.95	0.82	0.30	2.57	35.36	1.07	53.28	3.16	0.39	1.93	2.21	0.24	0.80	5.36	4.01	6.79
FeO %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FeO % Total_% Ti mol %	102.42	101.25	98.90	99.12	95.33	104.64	84.66	99.69	102.66	101.47	102.36	106.30	101.52	101.37	101.69	102.89
Ti mol %	61.53	53.89	34.21	47.19	19.58	82.71	0.01	33.15	92.41	33.81	56.96	60.49	91.48	0.77	72.98	1.14
Fe ²⁺ mol %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe ³⁺ mol %	0.60	0.52	0.19	1.61	22.14	0.67	33.36	1.98	0.25	1.21	1.39	0.15	0.50	3.36	2.51	4.25

	Probe ID	W605041 _1_R21	W605041 _1_R22	W605041 _1_R25	W605041 _1_R26	W605041 _1_R27	W605041 _1_R30	W605041 _1_R32	W605041 _1_R33	W605041 _1_R34	W605041 _1_R35	W605041 _1_R36	W605318 _9_R37	W605318 _9_R38	W605318 _9_R39	W605318 _9_R40	W605318 _9_R41
	Sample	W605041	W605318	W605318	W605318	W605318	W605318										
	Rocktype	HSR	FeR	FeR	FeR	FeR	FeR										
	SiO2 wt%	42.05	17.01	45.74	41.54	75.43	31.76	18.58	45.73	18.68	53.37	38.66	4.97	40.43	9.18	23.95	1.68
	TiO2 wt%	17.93	49.07	1.13	0.13	4.53	4.55	3.17	0.99	2.46	36.39	0.17	84.21	8.56	55.71	43.94	87.95
	Al ₂ O ₃ wt%	16.55	11.60	21.74	25.34	4.62	16.44	11.96	27.26	11.06	2.75	25.54	3.73	24.18	0.63	11.02	0.29
	Cr ₂ O ₃ wt%	0.00	-0.01	-0.01	-0.01	0.01	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	-0.05	-0.01	-0.02	0.00
	FeO wt%	2.47	9.87	7.69	9.26	0.79	11.28	12.81	7.35	12.47	2.45	9.39	1.16	0.66	0.69	1.82	1.01
	MnO wt%	0.03	0.07	0.27	0.17	0.01	0.51	1.34	0.31	1.20	0.01	0.19	0.00	0.03	0.00	0.10	0.00
	MgO wt%	0.94	3.46	1.08	0.35	0.21	0.12	1.22	2.04	1.01	0.40	0.09	0.35	2.30	0.05	8.68	0.01
_	CaO wt%	14.57	0.14	5.17	16.79	0.25	15.70	0.05	0.04	0.11	0.47	21.75	0.21	0.10	0.04	0.01	0.05
Probe data	K2O wt%	4.37	2.57	4.24	2.41	1.88	0.05	4.46	6.15	4.44	0.97	0.07	1.40	6.69	0.32	6.98	0.36
þe	Nb ₂ O ₅ wt%	1.26	4.49	9.41	1.81	7.36	15.96	46.33	11.37	46.70	2.40	0.13	1.95	0.23	1.12	0.64	1.69
Pro	ZnO wt%	0.01	0.05	0.00	-0.01	0.01	0.01	0.02	0.03	0.02	0.01	0.00	0.02	0.07	-0.01	0.08	0.00
_	CuO wt%	0.01	0.00	0.00	0.01	-0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	-0.01	0.00	0.00
	NiO wt%	0.00	0.00	0.01	0.00	-0.02	0.00	0.01	-0.01	0.01	-0.01	0.00	-0.01	0.01	-0.01	0.00	-0.01
	CoO wt%	0.01	0.02	0.04	0.02	0.18	0.04	0.07	0.01	0.01	0.00	0.04	0.00	0.00	0.03	0.00	0.04
	SnO2 wt%	-0.02	0.00	0.00	-0.01	-0.02	0.00	-0.02	-0.01	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
	ZrO2 wt%	-0.01	-0.02	0.01	0.03	0.00	0.02	0.13	0.55	0.03	0.50	0.00	0.03	0.99	5.89	0.00	2.34
	P2O5 wt%	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.00	0.06	0.03	0.20	0.72	0.01	0.76
	V2O3 wt%	0.14	0.36	0.01	0.01	0.03	0.01	0.02	0.01	0.01	0.29	0.01	0.79	0.10	0.51	0.40	0.77
	Total wt%	100.29	98.67	96.55	97.83	95.27	96.49	100.16	101.85	98.19	100.02	96.12	98.85	84.49	74.86	97.62	96.97
	Fe ₂ O ₃ %	2.47	9.87	7.69	9.26	0.79	11.28	12.81	7.35	12.47	2.45	9.39	1.16	0.66	0.69	1.82	1.01
eq	FeO %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calculated	Total_%	100.33	98.70	96.56	97.86	95.34	96.49	100.17	101.87	98.21	100.04	96.12	98.86	84.54	74.89	97.65	96.99
alcu	Ti mol %	22.44	61.44	1.41	0.16	5.67	5.70	3.97	1.24	3.08	45.57	0.21	105.43	10.72	69.75	55.02	110.11
ő	Fe ²⁺ mol %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fe ³⁺ mol %	1.54	6.18	4.81	5.80	0.50	7.07	8.02	4.60	7.81	1.53	5.88	0.73	0.42	0.43	1.14	0.63

	Probe ID	W605318 _3_R42	W605318 _3_R43	W605318 _3_R44	W605318 _3_R45	W605318 _3_R47	W605318 _3_R48	W605318 _3_R49	W605318 _3_R50	W605318 _3_R51	W605318 _3_R52	W605318 _3_R53	W605318 _3_R54	W605318 _3_R55	W605318 _3_R56	W605318 _3_R57	W605318 _3_R58
	Sample	W605318															
	Rocktype	FeR															
	SiO2 wt%	4.07	41.63	58.68	27.41	16.00	28.28	62.08	27.95	0.80	0.96	2.27	0.64	2.05	2.03	0.55	3.54
	TiO2 wt%	76.51	59.21	31.00	64.65	76.98	60.13	32.47	66.66	92.51	92.87	91.06	94.87	90.51	89.05	95.54	84.28
	Al ₂ O ₃ wt%	0.09	0.24	0.35	0.06	0.36	6.98	1.42	0.12	0.17	0.05	1.27	0.10	1.02	0.82	0.35	0.92
	Cr ₂ O ₃ wt%	-0.02	0.01	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	-0.01	0.01	0.00	0.01	0.01	0.00	0.00
	FeO wt%	0.88	0.74	8.06	0.75	1.02	1.01	0.57	0.87	1.18	1.19	1.23	1.20	1.27	1.55	1.19	1.29
	MnO wt%	0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.01	0.01	0.00	0.00	0.01	0.00
	MgO wt%	0.00	0.01	0.00	0.00	0.01	0.54	0.08	0.00	0.02	0.00	0.08	-0.01	0.06	0.09	0.02	0.14
_	CaO wt%	0.12	0.02	0.00	0.13	0.05	0.01	0.00	0.05	0.03	0.04	0.01	0.03	0.05	0.04	0.01	0.05
Probe data	K2O wt%	0.09	0.12	0.19	0.05	0.14	2.39	0.55	0.14	0.15	0.07	0.80	0.13	0.49	0.46	0.24	0.54
ě	Nb ₂ O ₅ wt%	1.49	1.24	0.55	1.53	1.49	1.37	1.06	1.23	1.96	1.79	2.49	2.38	2.45	3.03	2.44	2.52
Pro	ZnO wt%	0.03	0.03	0.01	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.02	0.01	0.01	0.00	0.02	0.01
	CuO wt%	0.01	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.02	0.00	0.00	0.01	0.00	0.00	-0.02	0.00	0.00
	NiO wt%	-0.01	0.00	-0.01	0.00	0.00	0.00	-0.01	-0.01	-0.02	0.00	0.01	-0.01	-0.01	0.00	-0.01	-0.01
	CoO wt%	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	-0.01	-0.01	-0.01	0.01	0.02	0.00	0.05
	SnO2 wt%	0.02	0.00	0.00	0.01	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.03	0.02	0.02	0.03	0.02
	ZrO2 wt%	7.61	0.96	0.04	3.39	1.83	0.77	0.82	4.18	0.90	1.47	0.18	0.66	1.24	1.28	0.09	3.91
	$P_2O_5wt\%$	1.66	0.22	0.00	0.71	0.31	0.08	0.07	0.68	0.17	0.24	0.04	0.17	0.33	0.35	0.01	1.00
	V2O3 wt%	0.66	0.53	0.29	0.63	0.70	0.58	0.30	0.56	0.82	0.85	0.94	0.92	0.87	0.92	0.88	0.80
	Total wt%	93.24	104.95	99.15	99.34	98.92	102.17	99.44	102.46	98.69	99.54	100.42	101.12	100.38	99.65	101.38	99.05
	Fe ₂ O ₃ %	0.97	0.74	8.06	0.75	1.02	1.01	0.57	0.87	1.18	1.19	1.23	1.20	1.27	1.55	1.19	1.29
g	FeO %	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
late	Total_%	93.37	104.96	99.17	99.35	98.93	102.18	99.45	102.51	98.72	99.56	100.43	101.15	100.39	99.67	101.39	99.08
Calculated	Ti mol %	95.80	74.13	38.81	80.94	96.38	75.29	40.65	83.46	115.82	116.28	114.01	118.78	113.32	111.50	119.62	105.52
ũ	Fe ²⁺ mol %	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fe ³⁺ mol %	0.61	0.46	5.05	0.47	0.64	0.63	0.36	0.54	0.74	0.74	0.77	0.75	0.79	0.97	0.75	0.81

	Probe ID	W605318 _3_R59	W605318 _5_R60		
	Sample	W605318	W605318		
	Rocktype	FeR	FeR		
	SiO2 wt%	9.41	1.86		
	TiO2 wt%	86.09	90.33		
	Al ₂ O ₃ wt%	0.43	0.06		
	Cr2O3 wt%	0.01	0.00		
	FeO wt%	1.03	1.19		
	MnO wt%	0.00	0.02		
	MgO wt%	0.02	0.00		
	CaO wt%	0.01	0.14		
lata	K2O wt%	0.39	0.22		
pe o	Nb2O5 wt%	2.09	1.96		
Probe data	ZnO wt%	0.01	0.01		
_	CuO wt%	0.01	-0.02		
	NiO wt%	0.00	0.01		
	CoO wt%	0.00	0.02		
	SnO2 wt%	0.02	0.00		
	ZrO2 wt%	0.16	3.97		
	$P_2O_5wt\%$	0.04	0.23		
	V_2O_3 wt%	0.80	0.80		
	Total wt%	100.50	100.82		
	Fe ₂ O ₃ %	1.03	1.19		
pa	FeO %	0.00	0.00		
ılat	Total_%	100.51	100.84		
Calculated	Ti mol %	107.79	113.10		
Ü	Fe ²⁺ mol %	0.00	0.00		
	Fe ³⁺ mol %	0.65	0.75		

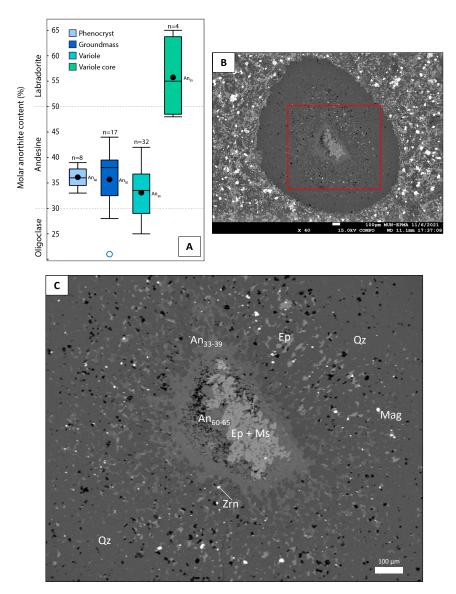


Fig. A6. 1 (A) A box plot showing the molar anorthite content (%) of the different plagioclase phases in sample S037015 of the Z-FeTiB. The most Ca-rich plagioclase phases were probed within the very core of a few varioles. Plagioclase in the outer cores have average andesine compositions, like the plagioclase microlites in the groundmass and larger plagioclase phenocrysts. (B) Backscattered electron (BSE) image of a variole with well-defined zoning from the core. The area within the red box is shown in (C). (C) The Ca-rich plagioclase core (labradorite composition) is partially replaced by muscovite and epidote. It has a relic lath shape with less Ca-rich fibrous blebs of plagioclase (andesine composition) radiating from the core like bicycle spokes. Interstices between the plagioclase fibers comprise quartz and Fe-, Mg-, and Ti-bearing minerals such as chlorite, amphibole, magnetite, and dark, glassy bits. The recrystallization and greenschist facies metamorphism obscure primary textures. Still, these interstitial Fe-Mg-Ti minerals could have been primarily glassy components between the plagioclase fibers formed by spherulitic growth and nucleated on a plagioclase phenocryst. Note the rare sub-micrometer zircon crystal identified during SEM/EPMA work.

Appendix 6 References

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