AN EXPERIMENTAL APPROACH IN INUIT GROUND STONE TECHNOLOGY AT NACHVAK FIORD, LABRADOR

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An Experimental Approach to Inuit

Ground Stone Technology at Nachvak Fiord, Labrador

by

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Abstract

Although nephrite use has been studied from various perspectives in many parts of the world (Asia, Mesoamerica, and western Canada), discussion of its use amongst the precontact Inuit of Labrador is limited. Archaeologists have discussed possible nephrite sources in Labrador in the past, but have not dealt directly with its exploitation. Focusing mainly on the nephrite assemblage recovered from Nachvak Village (IgCx-3) in northern Labrador, the difficulties associated with nephrite procurement, manufacture and use are discussed. The fibrous crystalline structure that gives nephrite its strength and durability also makes it very difficult to work. Concepts of agency, chaîne opératoire and anthropology of technology are used to characterize the ground stone assemblage according to provisional function and stage in the production process. Based on the tools and implements available, the experimental production and use of drill bits are discussed in order to assess the costs and benefits of using nephrite as opposed to slate. Successes and failures associated with the experimental approach are also discussed to highlight the learning process, as well as the nuances of Inuit ground stone technology.

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Table of Contents

Abstract	i
Acknowledgements	ii
Table of Contents	v
List of Tables	ix
List of Figures	x
List of Appendices	xii
Chapter 1: Introduction	1
Chapter 2: Background	7
2.1 Thule Culture History	7
2.2 Labrador Inuit Culture History	9
2.3 Inuit Ground Stone Technology	11
2.3.1 Range of Materials Worked	12
2.3.2 Gaps in Present Knowledge	14
2.4 Nachvak Overview	16
2.4.1 Overview of Past and Present Research	16
2.4.2 Nachvak Overview	18
Chapter 3: Theoretical Framework	25
3.1 Chaîne Opératoire	25
3.2 Agency	28
3.3 Anthropology of Technology	31
3.4 Cognition and the Constellation of Knowledge	32
3.4.1 End Goal	34
3.4.2 Raw Material	34
3.4.3 Technique	36
3.6 Conclusion	41
Chapter 4: Ground Stone Tool Descriptions	43
4.1 Classification by Provisional Function	44

4.1.1 Blades 49
4.1.1.1 Weapon Blades 50
4.1.1.1.1 Harpoon Head End Blades 50
4.1.1.1.2 Lance End Blades 52
4.1.1.1.3 Arrowhead End Blades 56
4.1.1.1.4 Knives as Weapons 57
4.1.1.2 Knife Blades 58
4.1.1.2.1 Ulu Blades 58
4.1.1.2.2 Baleen Shave 66
4.1.1.2.3 Flensing Knives 68
4.1.1.2.4 Men's Knives 69
4.1.2 Drill Bit 74
4.1.3 Awls and Gravers 84
4.1.4 Adzes 85
4.1.5 Beads 91
4.1.6 Round Slate Disk 92
4.1.7 Conclusion 92
4.2 Classification by Role in Production Process 93
4.2.1 Manufacturing Implements 98
4.2.1.1 Hammerstones and Peckers 98
4.2.1.2 Sand as an Abrasive 100
4.2.1.3 Whetstones 101
4.2.1.3.1 Classifying Whetstones by Material 101
4.2.1.3.2 Distribution of Whetstones at Nachvak 105
4.2.2.1 Raw Material 112
4.2.2.2 Blanks 113
4.2.2.3 Preforms 113
4.2.2.3.1 Unfinished Drill Holes 114
4.2.3 By-Products 116
4.2.3.1 Sand 117

4.2.4 Finished tools 118
4.3 Conclusion 120
Chapter 5: Comparison of Slate and Nephrite 121
5.1 Working Nephrite 121
5.2 Hardness 124
5.3 Chemical Makeup 125
5.4 Raw Material Procurement 126
5.4.1 Finding Nephrite 126
5.4.1.1 Nephrite, Serpentine and Soapstone 126
5.4.1.2 Distance Decay 129
5.4.1.3 Nephrite Sourcing Problems 130
5.4.2 Slate 131
5.5 Evidence of Tool Production 133
5.5.1 Incised Lines 134
5.5.2 Coarse-Grained Whetstones 136
5.6 Material Distribution 137
5.7 Conclusion 139
Chapter 6: Experimental Replication and Use 140
6.1 Value 140
6.2 Problems 141
6.2.1 Learning Curve 141
6.2.2 Raw Material 142
6.3 Replica Production 143
6.4 Experimental Drill Bit Production 144
6.4.1 Experiment 1: Experimenting with Drill Technology 144
6.4.2 Experiment 2: Determining the Tang 145
6.4.3 Experiment 3: Creating a Nephrite Drill Bit 146
6.4.4 Experiment 4: Drill Bit Production Time Trials 148
6.4.4.1 Experiment 5: Preform Production 149
6.4.4.2 Experiment 6: Drill Bit Production without a Vice 150

6.4.4.3 Experiment 7: Drill Bit Production with Sand, Water and a Vice 151
6.4.4.4 Results 155
6.4.5 Nephrite Ulu Production 157
6.5 Experimental Use 159
6.5.1 Assessing Drill Bit Efficiency 159
6.5.1.1 Making of the Bow Drill. 160
6.5.1.2 Using the Bow Drill 162
6.5.1.3 Assessing Drill Bit Efficiency Based on Material 163
6.5.1.4 Problems with Experimental Drilling 166
6.6 Conclusion 167
Chapter 7: Discussion 169
7.1 Characterization by Ground Stone Assemblage 170
7.2 Comparison of Slate and Nephrite 174
7.3 Experimental Use 175
7.4 Experimental Replication of Inuit Drilling Technology 178
7.5 Future Research 180
Chapter 8: Conclusion 185
Bibliography 188
Appendix I 199
Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database 199

List of Tables

Table 1.1: Examples of the sorts of objects produced with ground stone tools. 13
Table 2.1: Breakdown of 2003-2006 excavations at Nachvak Village (IgCx-3). 23
Table 3.1: Relationship between technique and implements. 36
Table 4.1: Breakdown of artifacts according to tool and material type, provisional function totals in parentheses. 45
Table 4.2: Distribution of drill bits by house and material type. 80
Table 4.3: Distribution of drill bits by portion remaining and material type. 82
Table 4.4: Comparison of number of nephrite and slate awl/gravers according to feature. 85
Table 4.5: Distribution of adze blades by house, material and degree of completion. 88
Table 4.6: Division of artifacts according to role in the production process. 97
Table 4.7: Distribution of manufacturing implements. 98
Table 4.8: Categories used in the identification of whetstone material type and coarseness (Stow 2005). 102
Table 4.9: Distribution of whetstones by grain, rock type and percentage of total whetstones. 105
Table 4.10: Distribution of whetstones by number of facets polished. 106
Table 4.11: Using degree of chipping and grinding as a proxy for stage of preform production. 114
Table 5.1: Moh's scale of hardness (Chesterman 1979:27). 124
Table 5.2: Distribution of unfinished tool by material type. 134
Table 6.1: Dimensions of preforms before grinding. 152
Table 6.2: Manufacturing techniques for each nephrite bit used in timed experiment. 153
Table 6.3: Completion times and estimated strokes per tool. 154
Table 6.4: Dimensions of complete drill bit specimens. 154
Table 6.5: Weight comparison of preform and completed replicas. 155
Table 6.6: Experimental drilling times for various media. 165

List of Figures

Figure 1.1: Nachvak Village (IgCx-3) site location (Whitridge 2004). 2
Figure 2.1: View of inner Nachvak Fiord, Nachvak Village (IgCx-3). 19
Figure 2.2: View of Nachvak Village (IgCx-3). 19
Figure 2. 3: Nachvak Village site map. 22
Figure 3.1: Chaîne opératoire of ulu production. 27
Figure 3.2: Application of constellation of knowledge model to the production of an Inuit ground stone ulu (adapted from Sinclair 2000:201). 33
Figure 3.3: Differential ulu edge type as an indicator of how it was used. 34
Figure 3.4: Constellation of knowledge for the production of an ulu handle. 39
Figure 4.1: Comparison of ground stone assemblage according to provisional function. 48
Figure 4.2: Organizing ground stone blades by function. 49
Figure 4.3: Grouping harpoon head end blades by location of hafting hole. 52
Figure 4.4: Small harpoon head and lance end blades from IgCx-3. 53
Figure 4.5: Large harpoon head and lance end blades from IgCx-3. 55
Figure 4.6: Potential arrowhead end blades from IgCx-3. 57
Figure 4.7: Division of uluit according to blade size, as determined by length. 60
Figure 4.8: Uluit from IgCx-3. 61
Figure 4.9: Large uluit, baleen shaves and flensing knife from IgCx-3. 63
Figure 4.10: Comparison of uluit edge types. 64
Figure 4.11: Uluit blade edge categories. 65
Figure 4.12: Assessing ulu function based on edge type. 66
Figure 4.13: Ground stone blanks and performs from IgCx-3. 67
Figure 4.14: Comparison of complete knife blade hafting methods and edge type. 70
Figure 4.15: Stemmed arrowhead end blades from IgCx-3. 72
Figure 4.16: Side-slotted and end-slotted end blades from IgCx-3. 73
Figure 4.17: Parts of a bow drill with arrows indicating applied forces. 74
Figure 4.18: Organic tools from PaJs-2 and IgCx-3. 77
Figure 4.19: Mounting the spindle in the bow. 78
Figure 4.20: Chuck variation. 79
Figure 4.21: Anatomy of a drill bit. 80
Figure 4.22: Drill bits, awls and gravers from IgCx-3. 81
Figure 4.23: Comparison of drill bit shaft widths. 83
Figure 4.24: Comparing drill bit tip types. 83
Figure 4.25: Hafting for awl and graver. 84
Figure 4.26: Hafting of large and small bladed adzes. 86
Figure 4.27: Comparison of adze size versus material type. 86

Figure 4.28: Large adze blades from IgCx-3. 87
Figure 4.29: Alternative use of 'large adze blades' as dull scraper blades. 88
Figure 4.30: Small adze blades, beads, and slate disk from IgCx-3. 90
Figure 4.31: Relating ground stone tool production techniques, stages of production and artifact type. 94
Figure 4.32: Percussive techniques. 94
Figure 4.34: Comparative chart for estimating grain size. 102
Figure 4.35: Distribution of whetstones by degree of completeness. 106
Figure 4.36: Morphological distribution of whetstones. 107
Figure 4.37: Sample of whetstones from IgCx-3. 108
Figure 4.38: Large wedge-shaped labradorite whetstone. 109
Figure 4.39: Relative lengths of 90-100% complete whetstones. 110
Figure 4.40: Drilled blade fragments from IgCx-3. 116
Figure 4.41: Fragmented knife blade (IgCx-3:915) before refitting. 119
Figure 4.42: Fragmented knife blade (IgCx-3:915) after refitting. 119
Figure 5.1: Location of potential nephrite sources discussed in text. 127
Figure 5.2: Partially worked nephrite nodule (KeDq-2:719). 130
Figure 5.3: Slate outcrop at Ramah chert quarry (Higdon 2004). 132
Figure 5.4: IgCx-3 artifacts with incised lines. 135
Figure 5.5: Suggested chaîne opératoire of groove and snap technique. 136
Figure 5.6: Comparison of material type percentages by feature. 138
Figure 5.7: Percentage of metal (iron and copper) per feature. 139
Figure 6.1: Initial experimental nephrite drill bit with antler chuck. 147
Figure 6.2: Experimental nephrite drill preform. 150
Figure 6.3: Experimental nephrite drill bit without vice or sand. 150
Figure 6.4: Experimental drill bits without vice or sand. 151
Figure 6.5: Large slate drill bit production with water, sand and labradorite whetstone. 156
Figure 6.6: Large nephrite drill bit production with water, sand and labradorite whetstone. 156
Figure 6.7: Nephrite ulu production with end goal highlighted with dotted line. 158
Figure 6.8: Components of experimental bow drill. 160
Figure 6.9: Experimental use of the bow drill. 162

List of Appendices

Appendix I: Nachvak Village 2004-2006 Ground Stone Tool Database 199

Chapter 1: Introduction

The focus of this thesis is the development of an experimental approach to understanding the Late Precontact/Early Historic Inuit ground stone technology from the Nachvak Village site in Northern Labrador (Figure 1.1). For the purposes of this thesis, technology refers to "all activity that occurs during the life histories of artifacts" (Schiffer 2001:3). This involves the technical knowledge and practice associated with raw material procurement and artifact manufacture, use and discard. My research objectives include characterizing the ground stone production process at Nachvak and then using experimental archaeology to elaborate on how the tools would have been produced. The Nachvak Village site (IgCx-3) is a winter site consisting of fifteen semi-subterranean houses dating to the sixteenth through eighteenth centuries A.D. (Whitridge 2004). The ground stone tools from IgCx-3 were recovered from four house and two middens spanning the Late Precontact and Early Historic Inuit period.

Before discussing the merits of the experimental approach it is important to address the inherent problems associated with attempting to understand archaic technologies. The first problem is that technology is inexorably bound up with other forms of "cultural baggage" (Dobres 2001:53). The reasons for making a tool a certain way are based on years of tradition, which slowly change over time. Prehistoric tool makers had different sets of life experiences, social obligations, and social and cultural knowledge, which affected the tools they produced. Being totally engrossed in a culture

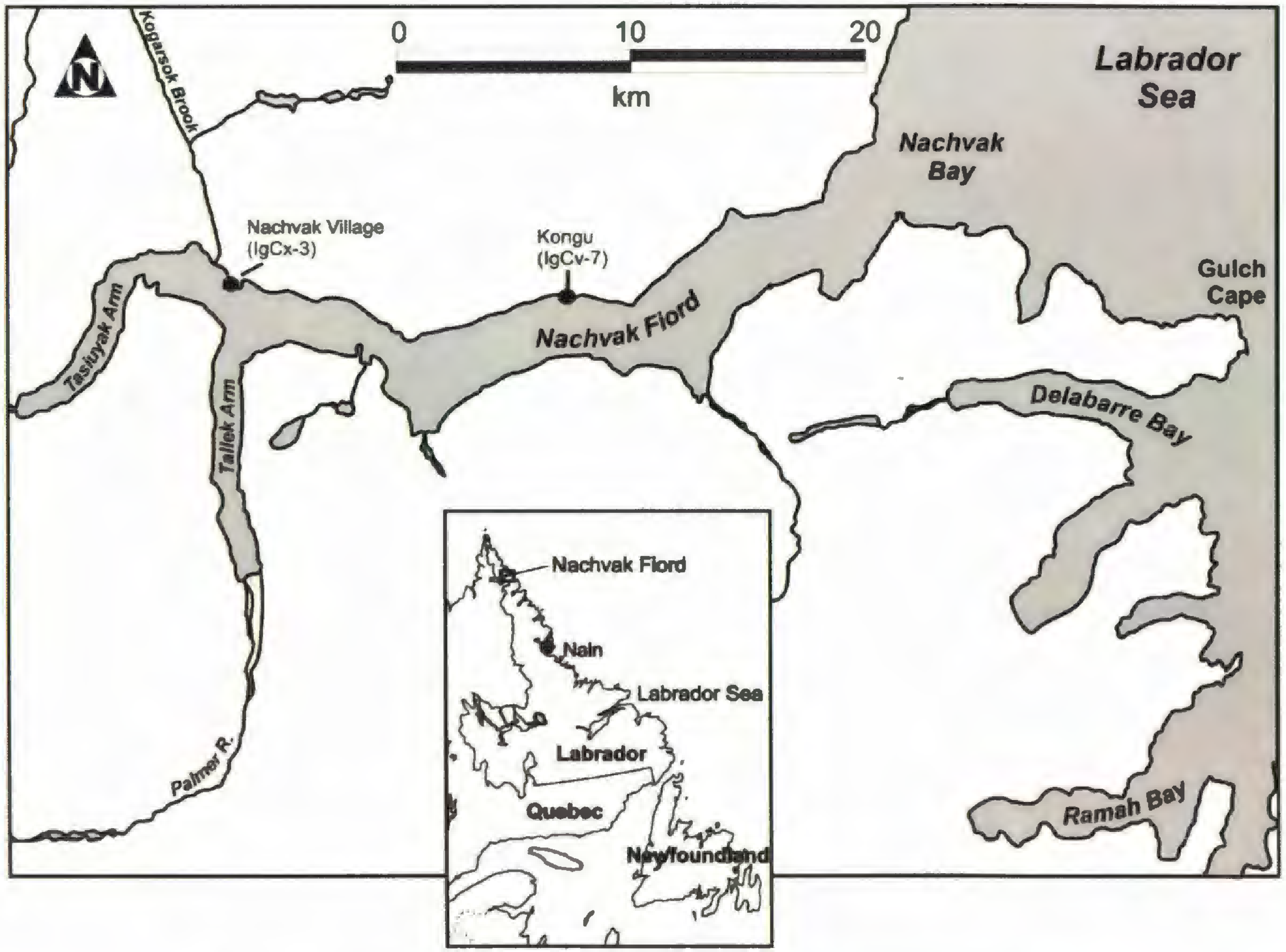


Figure 1.1: Nachvak Village (IgCx-3) site location (Whitridge 2004).

since birth, young tool makers would invariably pick up the nuances of technology from the people around them. This can range from raw material procurement strategies, to tool morphology, to how to successfully hunt a seal. As modern experimental archaeologists, we can begin to understand the intricacies of ground stone technology through the interpretation of the archaeological record, along with relevant ethnographic and experimental studies. It is through acknowledging our biases and being open to alternative methods and theories that an experimental approach can truly be successful.

The experimental archaeology approach involves the reproduction and use of specific artifact types in order to better understand the techniques, technological constraints and other process that may have affected past cultures (Banning 2000, Odell 2004). This is undertaken by employing techniques, implements, and technologies comparable to those that would have been available to the tool makers being studied. It is for this reason that the archaeological study collections need to be organized initially according to provisional function, based on ethnographic and comparative collections, and subsequently analyzed in terms of the reconstructed production process. By knowing more about the artifacts, their context, and their role in past ground stone technologies, we are better able to learn about the production process, and vice versa.

Applying an experimental approach to understanding an archaeological assemblage and/or a technology is valuable because it humanizes the artifacts. By working with the same type of materials, implements and tool forms as the prehistoric tool maker, it provides insight into the decision making process, while at the same time fostering an appreciation for the skill, time and resources required to make tools in the past. Such experimentation may also be used to test hypotheses concerning how certain tools may have been made or used, why one material type may have been preferred over another (i.e. slate versus nephrite), as well as the relationship between the tools and the debitage produced (Banning 2000:150-151). It can also highlight other issues that might not have been considered otherwise, such as how tools were hafted, how drill bits were produced (i.e. were they held in place with some kind of vice), and the nature of preferences for nephrite or slate. More questions than answers arise from doing experimental archaeology, thus allowing for increased discussion about cultural and technological processes, and moving the lithic analysis closer to understanding just how and why the tools were made the way they were.

The structure of the present thesis is as follows:

Chapter 2 provides a brief overview of Thule and Labrador Inuit culture history, an outline of the components of Inuit ground stone technology, and an overview of past and present research in the Nachvak Village area. Discussion of this and other relevant northern Labrador/Baffin Island assemblages puts the characterization and experimental replication of the artifacts in context and allows for a better discussion of Inuit ground stone technology as a whole.

Chapter 3 discusses the theoretical basis behind characterizing the tools by function and their role in the production process. This chapter also discusses how theories concerning chaîne opératoire, anthropology of technology and concepts of agency may be applied to experimental archaeology.

Chapter 4 involves the classifications of the ground stone assemblage from Nachvak Village according to provisional artifact function and place in the production process. Sorting the artifacts by provisional function helps to establish the diversity of the tool assemblage, while at the same time highlighting the prominent tool types. These are then characterized by their role in the production process, namely as manufacturing implements, unfinished tools, by-products, or finished tools. This is important, as it highlights the various stages of the production process and the fact that complete tools make up a relatively small proportion of the ground stone assemblage.

Chapter 5 provides a comparison of slate and nephrite, with respect to raw material procurement strategies, evidence of tool production, and relative tool type frequencies. This serves to emphasize how the toughness and durability of nephrite shaped how it was used and integrated into the assemblage.

Chapter 6 discusses the experimental replication and use of Thule/Inuit ground stone drill bits and uluit (sing. ulu) as proxies for understanding the techniques, manufacturing implements and debitage associated with ground stone production processes. Experiments address the production of ground stone drill bits, how they were used and time trials help determine the costs and benefit of using nephrite as opposed to slate. A sample of media, including slate, wood and antler, were also drilled to assess the respective efficiencies of slate versus nephrite drill bits. The lessons learned from making and using tools are also discussed.

Chapter 7 establishes a link between the experimental tools and the artifact assemblage from Nachvak Village (IgCx-3). The usefulness of the experimental approach for understanding Inuit ground stone technology is reiterated through the manufacture and use of tool replicas.

Chapter 8 offers concluding remarks about the characterizations and experimentations undertaken in this project. This includes the primary lessons learned from experimental studies and the effectiveness of this approach in helping us to better understand Inuit technology associated with the production of ground stone tools.

Appendix I provides provenience, measurements and other descriptive data for the discussed ground stone tools. Artifacts were divided into the following categories: anvil and hammerstones; beads; blades, blanks, preforms, and raw materials; awls, drill bits and gravers; and whetstones. This classification is based on the types of measurements and analysis conducted for each tool type.

Chapter 2: Background

Before discussing the ground stone tool assemblage and subsequent experiments, it is important to elaborate briefly on the cultural context of the tools being discussed. The following offers a brief overview of Thule culture history, Labrador Inuit culture history and Inuit ground stone technology. This is augmented by a brief synopsis of past and present archaeological research in northern Labrador, focusing mainly on the Nachvak Fiord region.

2.1 Thule Culture History

With ancestral ties to the peoples of northeastern Siberia, Bering Strait, and present-day Alaska, the Thule migrated eastward across the Arctic. First suggested by Mathiassen (1976 [1927]:7), it was generally accepted in the past that the migration took place in the eleventh century (Franklin *et al.* 1981:3, Kaplan 1980:45-46), as a response to climate change and reduction in sea ice associated with the "Medieval Warm Period" (McCartney 1977, McGhee 1972, 2000, Morrison 1983, Whitridge 2002, and others). McGhee (2000) and others contest this, maintaining that a thirteenth century date of migration is more likely. This is substantiated by reinterpretation of radiocarbon dates from a plethora of sites throughout the Arctic, dendrochronological dating of Thule sequences in northern Alaska, and the first historical account of Norse encountering Inuit in "northwest Greenland during the mid-thirteenth century" (McGhee 2000:3). Maybe the impetus for a later migration was not climate change, but the rather a quest for metal, from Cape York meteorites and Norse settlements in Greenland (McCartney & Mack 1973, McGhee 2000).

Practicing a "modified maritime adaptation" (Fitzhugh 1972:161), the Thule settled the resource-rich coasts of the Arctic and pursued various marine and terrestrial resources (Kaplan 1980). They actively sought out regions suitable for the hunting of pinnipeds (seals and walrus) as well as cetaceans (baleen and toothed whales). They hunted cooperatively in kayaks and umiaks (large skin boats), sometimes led by an umialik who would have shared the rewards of the hunt, keeping the largest portion for himself (Whitridge 1999:104-105).

Meat was allocated to those who needed it, bones were used in the manufacture of tools and shelters, and surpluses were either stockpiled (McCartney 1980) or used for trade, with any leftovers given to the dogs. Whale blubber was rendered to heat and light their dwellings, to preserve food and to keep boats skins from drying up and was stored in pouches of seal skin as a valuable trade commodity. Likewise, any baleen was used to its utmost potential. According to Whitridge, it was "bent into boat ribs, drum frames, cylindrical containers, cut into scrapers, snow beaters, bow backings, [etc.]" (Whitridge 1999:108). A shave made of whale bone or slate was also used to make strands of hide, baleen or sinew into varying lengths and thickness for use as whippings, fish lines, nets, snares for general cordage and for supporting the bone frame of a house (Whitridge 1999:108-109). In addition to being used as critical sources of food, fuel, shelter and other raw material, marine products were also prized as trade goods. Prehistoric Inuit groups either divided their time between the coast and interior regions or they focused on obtaining marine resources for trade with interior groups as a way to gain a steady supply of interior goods (Kaplan 1980).

Although the "nature and degree of whale use varied over time and space" (Whitridge 1999:104), coastal Inuit groups sometimes travelled seasonally to procure wood and caribou products. In other instances, the terrestrial resources were accessible from the coast, or were obtained through trade with interior Inuit groups. Marine products, such as whale and seal oil, bones, and baleen could be traded to aboriginal groups of the interior for caribou hides, antlers, and bone. It would have been problematic for the Inuit to survive on whale and seals alone, as caribou hide would have been required for clothing as it offered optimal durability and warmth in the often cold arctic environment (Maxwell 1985:51). Although fox and polar bear hides were used on occasion for clothing they were not available in sufficient abundance to warrant the abandonment of such trade with interior groups or seasonal trips to the interior (Whitridge 1999:104-105).

2.2 Labrador Inuit Culture History

The Thule arrived on the coast of Labrador between the fifteenth and sixteenth centuries A.D., either by traveling eastward from Nunavik (arctic Quebec) or by crossing southward from Baffin Island (Kaplan 1980, Fitzhugh 1994, Schledermann 1971, Whitridge 2004). McGhee's (2000) reinterpretation of radiocarbon dates in the Labrador/Nunavik area suggests a thirteenth century arrival. Whitridge (2004) goes on to suggest that once arriving in northern Labrador, it did not take long before they began to move into central and southern Labrador, making contact with "Europeans…by at least the mid-sixteenth century" (Whitridge 2004:4).

By the time the Inuit came to Labrador, parts of it had been inhabited for upwards of 8000 years. From the Maritime Archaic Indians to the Late Dorset and Point Revenge Indians, in order to be successful on the Labrador coast groups had to be well adapted to the "land, highly seasonal resources and one another" (Kaplan 1980:45).

Already highly adapted to marine environments and accustomed to dealing with other cultures in their progressive conquest of the Arctic, Thule peoples were well equipped to deal with the challenges of living on the rugged Labrador coast. They arrived with a diverse technology that offered a more efficient means of exploiting resources than that employed by the Late Dorset and Point Revenge Indians who previously inhabited the coast. The Thule were able to navigate the harsh terrain (mountains, snow, ice, and open water), with their dog drawn sleds, large skin boats (umiaks), and single person skin boats (kayaks). Such technology allowed them to transport people and heavy equipment both quickly and efficiently. Such effectiveness is paralleled by the way in which they used their toggling harpoons, bow and arrows, dogs, various spear types and diverse hunting strategies to make the most of the marine and terrestrial animals at their disposal (Kaplan 1980:48-49). By the end of the fifteenth century the Inuit dominated the northern coast of Labrador, displacing the Late Dorset from it and most of the eastern Arctic (Kaplan 1980:48), if indeed they had not already disappeared by then (Park 2000).

The Thule initially settled along the major fiord and island systems of the Labrador coast, so that they could take advantage of the best areas for both terrestrial and marine hunting (Whitridge 2004). The communal nature of the hunt and the sharing of readily available floral, faunal and lithic materials formed the basis of important social and economic networks amongst the Thule of the coast. Such networks allowed for the exchange of "slate, nephrite, soapstone, wood, ivory, feathers, and caribou skins" (Kaplan 1980:658) and potentially information about new technologies, peoples and/or resource availability on the coast.

Despite the occasional use of native copper and meteoritic iron, long before European contact (Whitridge 2002), Thule culture is largely characterized by its production and use of ground stone tools (Hawkes 1916, Schlederman 1971, 1975). From the sixteenth century onward, the use of ground stone technology decreased and was eventually replaced by a dependence on European iron and other goods. Probably originating with the increased availability of metals from Basques and other Europeans, this dependence was heightened with the establishment of Moravian missions and Hudson's Bay Company posts, which were established along the coast with the intent of converting and trading with resident Inuit populations.

Understanding the production and use of ground stone technology allows us to better understand a widely-used but little-studied component of Neoeskimo material culture. By understanding the technology, we are better able to understand the society that used it (Dobres 2001).

2.3 Inuit Ground Stone Technology

Unlike their Paleoeskimo counterparts, the Inuit relied almost entirely on ground stone as opposed to chipped stone technologies. The distinguishing factor between the two is that ground stone tools were modified largely through abrasive forces, while chipped stone tools were formed with percussive forces and pressure flaking (Odell 2004:74). While both technologies utilize hammerstones to shape a raw material into a blank, this is where the similarities end. Materials such as slate and nephrite are ground because they do not break as predictably as chert and other knappable rocks. A host of whetstones and abraders are needed to shape the ground stone blank into a functional tool.

When discussing Inuit ground stone technology it is important to address why ground stone was chosen instead of chipped stone, as well as the how the raw materials were procured. This is noteworthy as both have repercussions for the time and techniques needed to process and use ground stone tools. The utility of ground stone technology stems from the relatively small amount of raw material needed to conduct the same tasks as their chipped stone counterparts. Although the production of slate tools takes much longer than does the production of chipped stone tools, the former are more durable, holding their edge much longer. There is a notable trend among increasingly sedentary groups to invest more time in the formation of reliable tools which can effectively be reused and resharpened repeatedly, ultimately reducing the amount of waste material and maximizing productivity (Boydston 1989, Hayden 1989).

2.3.1 Range of Materials Worked

The Inuit used ground stone technology in almost every facet of daily life, from the harpoons, lances and arrows used to procure game, to the knives used to process the flora and fauna into food, clothing, shelter, and other tools (Table 1.1).

Table 1.1: Examples of the sorts of objects produced with ground stone tools.

Material Worked	Use	Ground Stone Tools Required
antler, bone, ivory	adze handles, adze sockets, bow drills, carvings, fish hooks, leisters, needles, scapula scrapers, sled shoes, snow knives, tool handles	adzes, drills, gravers, knives
hide, skin	summer tent shelters, bedding, clothing, containers	knives, uluit
baleen	lashing, pot suspension, disks for vessel bases	knives, baleen shaves
sinew	thread, lashing	knives, uluit
wood	bows, arrow and harpoon shafts, carvings, handles, wick trimmers, shelter supports, plug for seal float.	adzes, knives, drills
soapstone	lamps, pots, pendants	abraders, gravers, drills (for suspension and repair), picks, saws
slate, nephrite	blades, drill bits, beads, adze bits, graver bits, etc.	whetstones, hammerstones, drills

It should also be mentioned that the production of soapstone pots also involved the use of ground stone tools. These included picks, saws and abraders to shape them, engraving tools to incise lines for decoration and bow drills tipped with stone points to drill holes for suspension and repair (de Laguna 1940). Although the ground stone technology revolved around the production of tools out of slate, the harder semi-precious mineral nephrite (Demattè 2006) was also used for more specialized tools such as drill bits, adze bits, ulu blades and other blade fragments. Nephrite would have been chosen for its toughness and ability to resist fracturing, as compared with artifacts made of slate. This toughness and durability stems from the interlace of quartz crystals and other minerals within its physical structure (Nagle 1986). Tools made of nephrite are notably smaller than their slate counterparts, probably owing to its rarity, and the difficulty of working it.

The use of ground stone changed dramatically with the introduction of large quantities of European iron as contact between the Inuit and Europeans increased in the seventeenth century (Barr 1994). Although Thule groups had occasional access to metal before direct encounters with Europeans in Labrador, the increasing ease of obtaining iron tools eventually led to the abandonment of most ground stone technology, except for soapstone, which was still used in the construction of lamps and pots.

2.3.2 Gaps in Present Knowledge

Despite the importance of ground stone tools to Inuit lifeways, there are still a number of gaps in our present knowledge concerning their production and use. Most lithic discussions concern themselves with the more widely used chipped stone technology. These include the distribution of debitage and specific types of flakes, the different methods of percussive flaking, and the refitting of flakes onto cores (Banning 2000, Kooyman 2000, Odell 2004, Whittaker 1994). When ground stone tools are discussed, it is largely in terms of ground stone technology used for grinding other objects, such as metates to grind maize and grains, and mortar and pestles for grinding substances into fine powders (Adams 2002, Odell 2004). With few exceptions (i.e. Darwent 1998) ground stone technological studies do not discuss the production of finer blades, beads and drill bits.

Persistent gaps in knowledge concerning ground stone tool production include the specific types of stone needed for each task (i.e. coarse grained whetstones versus fine grained whetstones) and the effectiveness of different qualities of slate, nephrite and other raw materials. There also needs to be more discussion concerning such technical questions as: were tools ground and then hafted, or vice versa? Were some tools multi-purpose as ethnographic studies suggest, or were blade types task specific? How was nephrite ground? How were these tools hafted? These and other questions still need to be addressed.

Since Semenov's (1964) initial exploration of use wear focused on both ground and chipped stone industries, there has been a notable lack of use wear studies applied to ground stone assemblages, most dealing with chipped stone tools (Keeley 1980, Odell 2004) or organic tools (LeMoine 1997). Defined as "the damage or wear on the edge of a stone tool as a result of being used" (Kooyman 2000:117), use wear studies may be used to contradict or reaffirm traditional views of how a tool was used, or even whether or not the tool was used at all. If a tool lacks use wear it could indicate that it was ornamental, ceremonial, incomplete or simply unused. A lack of use wear may also be a result of extensive use, with the blade edge having been resharpened, removing remnants of previous use.

In addition, there still remains a cloud of mystery around the procurement of nephrite or jade in the Eastern Arctic. Given that there are many potential areas for a nephrite source, it will ultimately require a great deal of survey and lab work. By distinguishing between different types of nephrite through chemical and visual tests, it may be possible to eventually pinpoint a source. In a similar vein, if the Thule migration eastward across the Arctic was motivated by a quest for sources of natural, meteoritic and/or European sources of copper and iron (McCartney 1988, McGhee 2000), it leads to the additional question of how did this affect their possible dependence on nephrite?

In addition to trying the find the elusive nephrite sources, there are also large gaps concerning Inuit nephrite technologies in general. While there have been studies of nephrite use on the British Columbia Plateau (Darwent 1998), in China (Sax *et al.* 2004) and India (Kenover *et al.* 1991), there has been relatively little discussion concerning nephrite in the arctic and subarctic regions. Time trials, use wear studies and an efficient means of working the ground stone materials are but some of the avenues that could be explored in order to clarify nephrite's role in Inuit ground stone technology.

By addressing questions concerning ground stone tool production, use wear studies and the source and workability of nephrite, we can better understand the mindset of the Inuit tool makers. Such work would also aid in the interpretation of Inuit assemblages and highlight other questions that might not otherwise be considered.

2.4 Nachvak Overview

2.4.1 Overview of Past and Present Research

Due to the remoteness of northern Labrador, it was not until the 1930s that the first intermittent survey and excavations of the region were completed. Work conducted by Leechman (1943) and Plumet (Plumet & Gangloff 1991) eventually paved the way for future explorations (Fitzhugh 1980, Whitridge 2004). It was not until 1969 that Jim Tuck and other archaeologists from Memorial University began a three year project of survey and excavation of the Saglek region (Schlederman 1972, Tuck 1975). Schlederman's extensive excavation of Thule and Historic Inuit houses in the region amassed a large assemblage, which enabled him to sketch the outlines of Inuit culture history (Whitridge 2004).

Initial archaeological research began in Nachvak Fiord as part of the Smithsonian Institution's Torngat Archaeology Project (TAP) in 1977 and 1978 (Whitridge 2004). The aim of TAP was to conduct a comprehensive survey and test of the north coast, in an attempt to better understand subsistence and settlement patterns in the area. Laying a framework for future Thule and Inuit research, this project went on to highlight the social and economic changes that occurred due to increased European presence and goods along the coast (Fitzhugh 1980, Kaplan 1980). Test pits were dug at the Nachvak Village site (IgCx-3), indicating the presence of a late Thule occupation at the site.

It should be noted that survey and excavation of the Nachvak area also highlighted the presence of Paleoeskimo (Middle Dorset) and Maritime Archaic populations prior to the arrival of the Thule. While some sites were clearly visible, others were extensively intermingled within Thule structures. The reason behind this is twofold. First, the Thule actively sought out Dorset sites as places of great settlement potential (Whitridge 2004), and second the invasive construction of the semi-subterranean houses, both in removal of large amounts of earth and the transplanting of sod as roofing material, resulted in non-Inuit artifacts being placed above those of the Inuit.

Extensive excavations of the Nachvak region resumed at Nachvak Village (IgCx-3) in 2003 with the excavation of a Late Precontact Inuit (Late Thule) winter house by Dr.

Peter Whitridge from Memorial University. Between 2004 and 2006, three additional houses were excavated, as well as four test trenches at an eighteenth and nineteenth century Historic Inuit site closer to the mouth of the Fiord (IgCv-7) (Figure 1.1). Fodder for architectural, faunal, ceramic, and community oriented graduate research, excavations during the past four years have also yielded a large quantity of artifacts which may be used to better understand Inuit ground stone technology.

2.4.2 Nachvak Overview

Nachvak Village (IgCx-3) is located in Nachvak Fiord, approximately 240 km north of Nain (Figure 1.1). Located in the inner portion of the fiord, the site is found on a terrace at the opening of Tallek Arm (Figure 2.2 & 2.3) overlooking a polynia formed by the intermingling of the currents of Tallek Arm, Tasiuyak Arm and the main branch of Nachvak Fiord. The constant motion that keeps this area unfrozen stirs up bottom waters, thus "providing a nutrient-rich environment for sea mammals" (Schlederman 1996:35). The rewarding nature of the seal rich environment was augmented by the village's proximity to the Atlantic Ocean. Ideal for whale hunting, groups could have moved seasonally to the mouth of the fiord to harvest whales for food, construction materials and other resources.

The location of the site also allows for ample access to Korgarsok Brook, to the west (Figure 2.1). Not only is the brook a lucrative source of arctic char, a staple during the summer (Taylor 1977), but it also provides a route to reach inland caribou herds. While only a relatively small number were sighted during the four seasons of Whitridge's excavations, large bands numbering in the hundreds are reported to have frequented these

Figure 2.1: View of inner Nachvak Fiord, Nachvak Village (IgCx-3) at center, Korgarsok brook in foreground, facing southeast (Higdon 2005).

Figure 2.2: View of Nachvak Village (IgCx-3), located in the center atop grassy terrace, facing north (Higdon 2004).

areas in the past.

Other faunal resources, seen during the most recent excavations, that may have also been exploited by the Inuit include grumpus (pilot whales), ermine, arctic fox, polar bear, black bear, wolf, and various types of bird. In addition to its faunal resources, the area also has abundant floral resources such as driftwood scattered along the beaches, patches of gnarled willow along the base of the mountains to the north and abundant berries throughout.

Nachvak Village (IgCx-3) is also located "at the junction of major sled routes to the north, west and south" (Whitridge 2004:51). This would have been important in maintaining trade networks northward to Cape Chidley; west to George River and Ungava Bay; and southward to Ramah, Saglek and the rest of the Labrador Coast. In sum, Nachvak Village lies at the nexus of everything essential for survival on the Labrador coast. The combined presence of ample faunal and floral resources in conjunction with potential trade networks is likely the reason for the successful settlement of the Inuit at Nachvak.

The site consists of fifteen semi-subterranean houses dating to the sixteenth to eighteenth centuries (Figure 2.4). Test pits were dug at the site in 1977 and 1978 by Fitzhugh and crew as part the Smithsonian's Torngat Archaeology Project, thus identifying it as Late Thule. Excavations and survey resumed in 2003 with excavations led by Dr. Whitridge. Four houses and two middens were investigated between 2003 and

2006 (Table 2.1). The main goal of the greater project was to learn more about the site and Labrador Inuit prehistory as a whole (Whitridge 2004).

Each excavated house was gridded with 1m x 1m squares in line with the central axis of the entrance tunnel. Lying roughly north to south, as most tunnel entrances face southward to the water, this was done to ensure that the grid encompassed both the house and as much of the tunnel as possible. The houses were then excavated stratigraphically taking into account both natural and objective levels. This involved excavating in 10 cm increments until the color/texture of the level changed. All units were excavated uniformly to the same level for consistency. All excavated soil was subsequently screened with a ¼ inch mesh.

House 2 was the first house to be excavated by Whitridge and his crew in 2003, consisting of a bilobate structure with two identical paved lobes, each with its own lamp stand and semi-lunar sleeping platform (Whitridge 2004). This structure had a relatively high abundance of whale bone as compared to the houses excavated in subsequent seasons. Excavations in 2006 also exposed part of the House 2 midden, extending beyond the tunnel entrance. Four more units were excavated in 2006 partially excavated in 2006, House 4 consists of a single-lobed house. It is markedly different from the others because excavation of the potential tunnel area revealed a notable lack of tunnel architecture. The most southern portion of the excavations also revealed a possibly unrelated midden area, as well as the remnants of a test pit dug in the 1970s by the Torngat Archaeology Project.

Interpretation of House 4 is further hindered by the fact that it was not completely

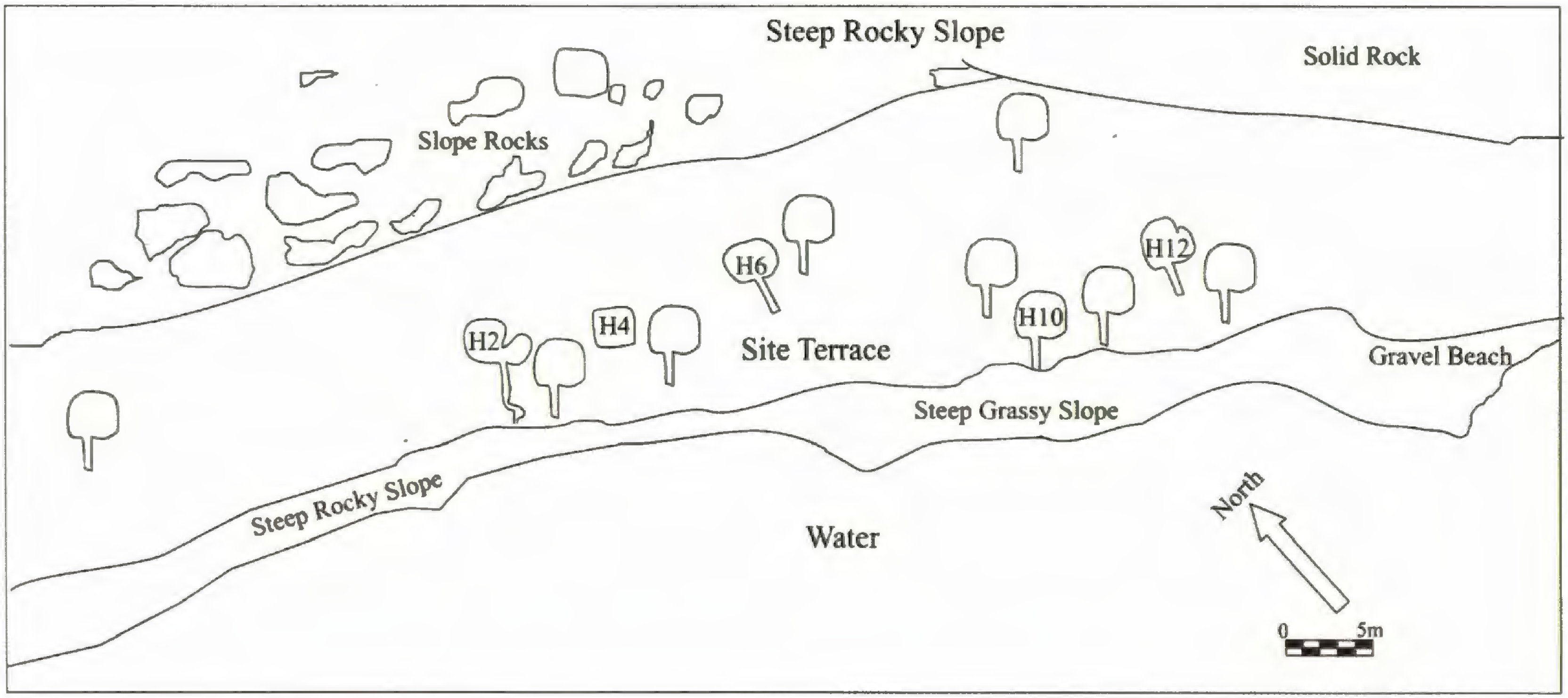


Figure 2.3: Nachvak Village site map (Courtesy of Lindsay Swinarton).

Table 2.1: Breakdown of 2003-2006 excavations at Nachvak Village (IgCx-3).

Feature Name	Nature of Feature	Excavation Area (Number of 1m x 1m Units)	Year Excavations Began	Year Excavations Ended
House 2 (H2)	Bilobate House	45	2003	2003
House 2 Midden (H2M)	Midden	4	2006	2006
House 4 (H4)	Single-lobed House	24	2006	2006
House 6 (H6)	Single-lobed House	30	2004	2005
House 10 Midden (H10M)	Midden	4	2006	2006
House 12 (H12)	Bilobate House	40	2004	2005

excavated in 2006. Weather and time constraints prevented excavation beneath the floor tiles and sleeping platforms. There is more to be learned about the hypothesized tunnel area as it was not excavated as deeply as the remainder of the house. Like other Inuit semi-subterranean houses, House 4 also appears to have been altered from its original configuration. Flag stones appeared to continue underneath the sleeping platform, possibly extending well into the rear of the house, suggesting that the house was reused and made smaller over time.

Fully excavated over the 2004 and 2005 field seasons, House 6 is a single-lobe house with a large intact lintel, sleeping platform and lamp stands. Unlike House 4 it also had a clear tunnel area that was repaved repeatedly during use. Deposition of roofing sod and artifacts indicate that House 6 may have been used as a midden for adjacent houses, sometime after it was abandoned.

Excavated at the same time as House 6, House 12 consisted of a large bilobate structure with two well defined living areas, each with their own sleeping platforms and lamps stands. It also had a distinct tunnel that extended beyond the excavation area. Some evidence of European goods was uncovered, such as iron, the occasional nail and copper tubing.

The House 10 midden was located just outside the entrance tunnel of House 10. Excavation involved a 3m by 1m trench, with an additional $1m^2$ placed off the southern wall of the middle unit.

Excavation of the Nachvak Village area revealed a number of semi-subterranean winter houses of various sizes and configurations, all first occupied in the precontact time period. The relative lack of European items at Nachvak Village reinforces the notion that the whole village would have been abandoned by about 1700 A.D. (Whitridge 2004).

Chapter 3: Theoretical Framework

The experimental archaeological approach to understanding ground stone tools explored here involves a theoretical framework encompassing chaîne opératoire, concepts of agency and the anthropology of technology. Each may be used to reconstruct the sequences of activities involved in the production of ground stone tools (Sellet 1993), while at the same time modeling the decision making process of the prehistoric tool maker (Sinclair 2000).

Although the physical utility, mechanics and efficiency of ground stone tools are all critical, it is also important to note that the study of a culture's technology should reflect how artifact production reproduces culture (Dobres 2001). Meaning should not be derived solely from the finished products that we uncover. The journey toward the desired end-product can be as or arguably more important than the artifact's final form. Although a knapper may sit and knap alone, he/she is not truly alone, in the sense that the production process and the resultant artifacts are saturated with inherent "cultural baggage" (Dobres 2001:53). The knapper is a product of his/her time, with societal knowledge enveloping every part of the artifact's conception, production and use.

3.1 Chaîne Opératoire

Chaîne opératoire, conceived by Leroi-Gourhan in the mid 1960s, deals with the operational sequences involved in taking a raw material and shaping it into a finished artifact. This sequence involves "a series of discrete steps, each linked to the preceding and following steps in a necessary, determined and non-frangible order" (Cresswell

1993:182). Not just a method to describe the stages of production, the chaîne opératoire approach serves to highlight the thoughts and decisions behind the steps that we observe (Cresswell 1993).

Also relevant for modeling the decision making process, chaîne opératoire may be defined as a "succession of mental operations and technical gestures, in order to satisfy a need (immediate or not), according to a pre-existing project" (Perles 1987: 231 in Sellet 1993:106). It serves to break down a technical process into steps, with raw material acquisition as the first stage and the discard of the object as the final stage (Sellet 1993). Each process can be unpacked to reveal numerous stages, with each stage unpacked to reveal a variety of activities (Schiffer 1976).

The steps required to make an Inuit slate ulu may be used to illustrate the application of the chaîne opératoire approach (Figure 3.1). The nature of the Inuit slate ulu requires two separate processes which ultimately come together in the end, namely the production of the slate blade and ulu handle and rivet. The chaîne opératoire for production of an ulu blade could be modeled as follows:

1a. Obtain piece of slate large enough for desired ulu.

1b. Rough out the shape of the ulu with a hammerstone.

1c. Further manipulate the edges of the piece to create an ulu preform.

1d. Create a blade edge with a coarse-grained whetstone.

1e. Form tang opposite the blade for hafting.

1f. Finish the blade edge with a fine-grained whetstone.

1g. Drill hole(s) in tang to facilitate hafting process.

The chaîne opératoire of the ulu handle could be modeled as follows: (Figure 3.1)

2a. Obtain piece of wood, bone, or antler for handle.

2b. Shape the handle to desired size.

2c. Create a hand hold.

2d. Drill hole(s) in handle, lining it up with those of the blade.

2e. Cut slit into the handle for hafting.

2f. For bone or antler, heat handle slot (Whitridge 2002a).

2g. Wedge blade into handle.

2h. Affix blade in place with wood/bone rivet or sinew.

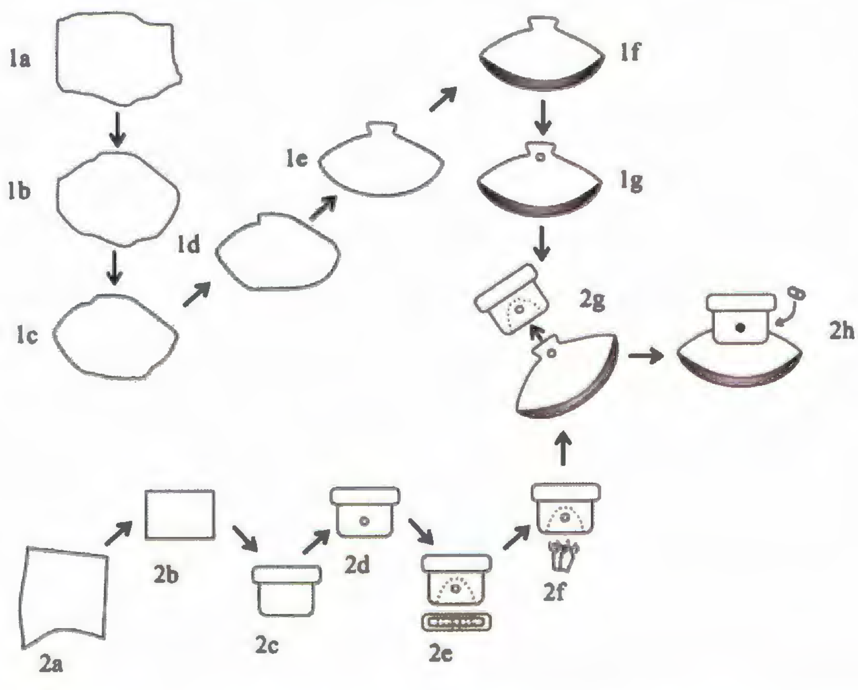


Figure 3.1: Chaîne opératoire of ulu production: 1a-1g) Blade production, 2a – 2f) Handle production, 2g-2h) hafting of the ulu blade in handle.

While following the described production steps will lead to the desired end goal, the order of some of the steps may be rearranged. For example, the tang could be finished before or after the blade edge. Likewise, it is unclear when the tool would have been drilled. One can further model the thought processes through the combination of chaîne opératoire with the concepts of agency and ideas from the anthropology of technology.

3.2 Agency

Agency is the core of technology (Dobres 2001:127). Cultural groups, and by extension agents, are measured and defined by the technology that they use. Concepts of agency can serve to highlight the physical and mental processes behind an artifact's conception, production and use.

The concept of agency was formed out of Marxist and contemporary practice theory with the main tenet that everything we do is culturally bound in the context of past experience and contemporary knowledge, all in hopes of achieving a goal in the future. Despite there being some debate over the precise meaning of agency, Dobres & Robb (2000) offer four guiding principles. They state that concepts of agency deal with,

> Material conditions of social life, the simultaneously constraining and enabling influence of social, symbolic, and material structures and institutions, habituations, and beliefs; the importance of the motivations and actions of agents; and the dialectic of structure and agency (Dobres & Robb 2000:8).

The underlying notion that every action is influenced or motivated by society is an important part of the study of agency (Dobres & Robb 2000). Every action has the capacity to implicitly or explicitly tell a story, based on form, function, historical context and what it is trying to represent.

Aside from the difficulties of pinpointing a workable definition of agency that can be accepted by all who study social action, there are many concerns about the application of the concept in archaeology. These anxieties about agency include: the problems of intention and social reproduction, scale, social change and the political context of its application.

A main issue is whether or not agency should stress the intentions of the agent, as opposed to the way in which their actions, intentional or circumstantial, reproduce the social contexts in which they were conceived (Dobres & Robb 2000). Working on either side of the issue may be beneficial when applied to experimental archaeology. On the one hand, looking at intention may give insight into why a change has occurred and why people chose do something a certain way. On the other hand, past cultures are identified based on the material they leave behind. If there were not some continuity in the social contexts, it would be virtually impossible to categorize and define culture.

Different scales of agency may also be useful depending on the situation. For example, when examining lithic tool production, it is possible to study the exact flakes that were removed from a core for the purpose of making a tool (Grimm 2000). By reconstructing the manufacturing processes, one is able to trace the actions and thoughts of the individual. An experienced flintknapper is able to pinpoint exactly why a tool broke the way it did, namely the error that resulted in the breaking of a tool during manufacture. While some stress the individual, others stress the way that agents may be assembled into like-minded groups who have similar thought processes and cultural experiences.

Another issue regarding agency is its role in social change: it may be used to explain individual changes by way of short term processes. As mentioned with the issue of intention, long term change may arguably be the result of a series of choices by individuals that were accepted eventually as the norm. Long term change might also result from the direct and indirect consequences of people's actions over time (Dobres & Robb 2000). It may be possible to trace innovation back to a particular area or group, but rarely back to an individual unless there is direct historical evidence.

As with any change, innovation is difficult to assess unless there is clear deviation from the norm (David 2004). David goes on to propose that "change implies innovation, innovation implies choice, choice between new ideas and what came before it" (David 2004:69). David makes such choice political by suggesting that the choice may be accepted by those at the top, oppressing those below, or by the subordinates in order to undermine an oppressor's authority. Rather than making it overtly political, change may simply be adopted as a new choice that makes something work more efficiently.

The political nature of agency does not end with how societies handled change. Everything we do is political. Politics thus governs the way in which agency is applied to archaeology. The past influences the present, just as it has played a factor in past cultural change and representation (Dobres & Robb 2000). Biases are inherent in everything we do and should be acknowledged and dealt with whenever possible. The problems associated with agency are both diverse and interconnected. It may be argued that studies of technology can also fall prey to many of these same problems.

3.3 Anthropology of Technology

People have been looking at the technologies of the past since the first antiquarians began collecting. Studies of culture since then have dealt with various aspects of technology, looking at manufacture, use, and change in these over time. Aside from the chaîne opératoire method developed in the 1960s, the most promising approach to understanding the technological process is the refinement of experimental archaeology. Both chaîne opératoire and experimental archaeology may be used together to get at the thought processes behind technology.

Like agency, technology has a social context dependent on an agent's particular past and present. Depending on the researcher, technology can also be defined in a number of ways. It could refer to the manufacturing process (artifact and raw material), both manufacture and use, or more extensively to "all activity that occurs during the life histories of artifacts" (Schiffer 2001:3). The latter definition seems to be most relevant to the study of agency and the development of an anthropology/archaeology of technology. Such a broad definition can deal with every aspect of an artifact's conception, use and deposition into the archaeological record. A good way of understanding the life history of an artifact is to understand the cognitive knowledge that stands behind its particular configuration.

3.4 Cognition and the Constellation of Knowledge

As socially bound constructs, the cognitive aspects of agency and technology are of utmost importance. The knowledge of an agent participating in some social act is analogous to the cognitive framework of an artisan working on a masterpiece. Like the artisan, all active agents make decisions that affect the future, based on the social practices of the past and present. Such decisions range from where pressure should be applied so a flaked tool is not broken, to which area should be farmed for maximum yield.

The cognitive framework inherent in technology may be further understood through a "constellation of knowledge" (Sinclair 2000:196) approach to the concept of agency. Sinclair develops the notion that technology is a "suite of technical gestures and knowledge that is learned and expressed by individuals in the course of social practice" (2000:196). From this he formulates the idea of constellations of knowledge that intersect everything we do (Figure 3.2). He argues that there is a discernible relationship between the raw material, implements, techniques and desired end point all technological endeavours. Each segment of the model is simultaneously governed by stylistic, aesthetic, procedural and functional considerations (Sinclair 2000).

Such a mapping out of knowledge may be useful in agency studies, to go beyond the production of concrete products. It could be applied to virtually any situation where one has to think before one acts. Some processes may be planned out for months or years

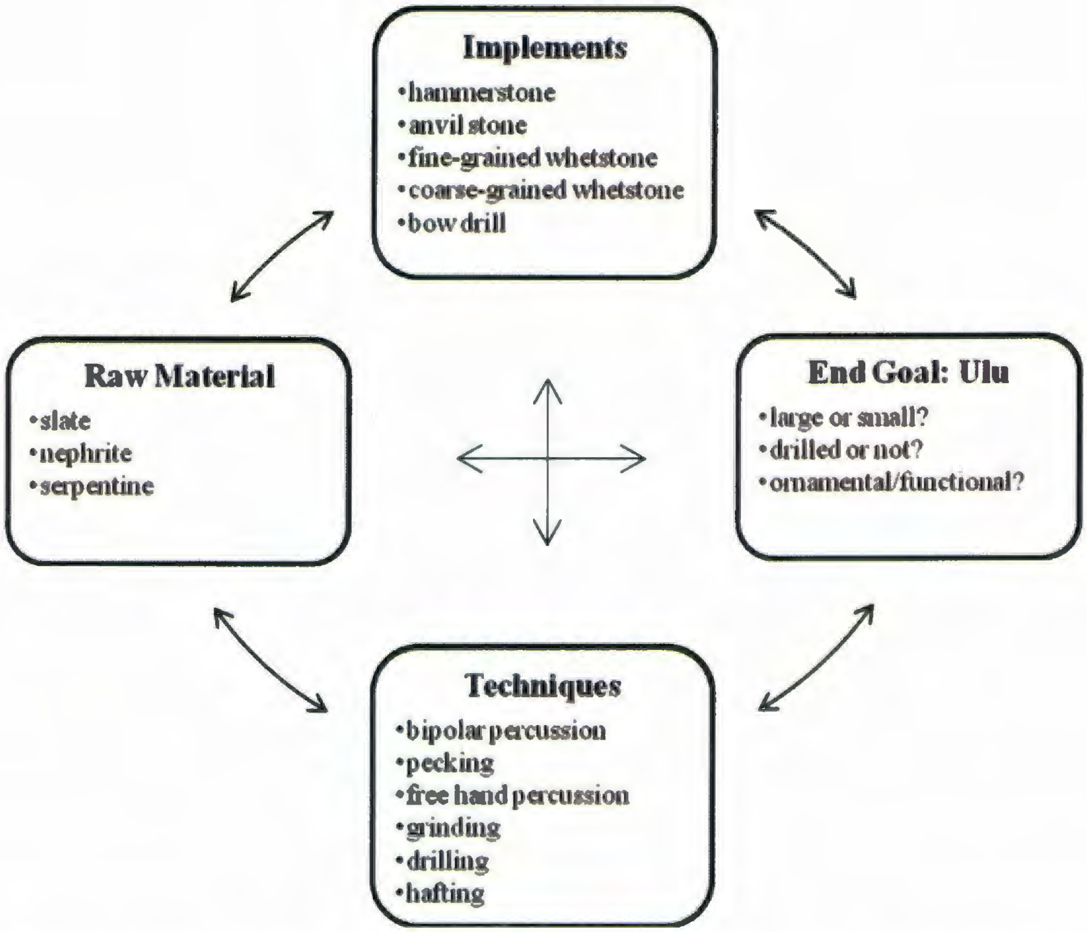


Figure 3.2: Application of constellation of knowledge model to the production of an Inuit ground stone ulu (adapted from Sinclair 2000:201).

before reaching fruition (i.e. space shuttle launch), while others happen instantaneously based on instinct and a wealth of past experience (i.e. a paramedic checking for a pulse). The constellation of knowledge model outlined by Sinclair (2000) may be applied by addressing the steps involved in the production of a ground stone ulu (Figure 3.1). While the chaîne opératoire approach focuses on the required production steps, Sinclair's model focuses on the interrelatedness of the engrained cultural knowledge and limitations set out by the raw materials, implements, and techniques that were available to the Inuk tool maker (Figure 3.2).

3.4.1 End Goal

The very decision to make an ulu is a culturally bound process; it is based on the maker's identification with an Inuit cultural tradition. By contrast, Paleoeskimo groups living in the same areas and hunting the same animals would have conducted comparable tasks with microblades and flaked knives. The choice of an ulu and not some other knife is also contingent on its desired function. The semi-circular natures of this type of knife makes it useful for a multitude of cutting tasks, such as food and hide preparation, as well as the intricate detailing of an object (Bennett & Rowley 2004:442). Its use also dictates the type of blade edge given to the ulu, namely a bifacial edge for cutting or a unifacial edge for scraping (Figure 3.3). Object size is also an issue as it is directly related to raw material availability, as well as the desired function. Small uluit would be made as ornaments, toys for little girls and for fine detail work; while larger uluit would be made for scraping, cutting and various other everyday tasks. This reiterates the interrelatedness of the implements and techniques. It cannot be overstated how the objects we make and use are directly related to the society in which we belong.

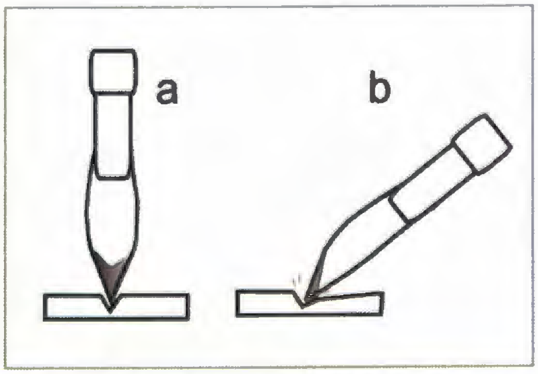


Figure 3.3: Differential ulu edge type as an indicator of how it was used i.e. a) cutting versus, b) scraping.

3.4.2 Raw Material

After choosing to make an ulu, one must decide on the material type. This is based on the techniques known to the individual, the implements available, the functionality of the ulu, and the availability of the raw material. Uluit were shaped out of slate, nephrite, iron and copper. Relatively common and easy to work, slate could be used in the production of an ulu of any size or function. The only limitations would be the skill of the craftsman and the size and quality of the initial raw material.

Nephrite, on the other hand, is arguably rare, and does not appear to form in large pieces. Due to the time, labour, and material invested in working nephrite, it appears only to have been used to a limited extent in Labrador assemblages, where strength and durability (specialized blades, drill bits, adzes) and/or the aesthetic appearance of the item (beads, ceremonial objects) was paramount.

Increasingly common as European contact increased, European iron (like meteoritic) could be worked much more easily than stone through cold hammering instead of bipolar percussion and pecking. It could also hold a better edge, required less material to produce an adequate blade, and could be reused more efficiently (MacLean 1989, McCartney & Mack 1973).

To a lesser degree than iron, copper was used to tip gravers, blades and small knives, when it was available (McCartney & Mack 1973); if it was actually used for the production of an ulu the malleability that makes it workable would also be its downfall. It is too soft for more intensive tasks, like cutting bone and hides, and would require repeated sharpening to maintain an adequate blade edge.

When it comes to material availability, it is also important to note the previous use of cherts, quartz, quartz crystal and other knappable stone in the region, as demonstrated by their occurrence in Paleoeskimo and Maritime Archaic assemblages (Nagle 1986, Fitzhugh 1980). The Inuit propensity to locate and actively seek out Paleoeskimo structures and sites as areas of great hunting potential (Park 1993) suggests that they knew what both chipped stone blades and flakes looked like. While Neoeskimo groups in Alaska made extensive use of both chipped stone and ground stone tools, such complementary use does not appear to extend into the eastern Arctic (aside from Southampton Island). Weighing the availability of time and materials, and the pros and cons of each material type, slate appears to have been the best option for the average blade, and consequently is the medium chosen for this example.

3.4.3 Technique

The two components of the model that are most interrelated are arguably the techniques and implements employed by the Inuk tool maker (Table 3.1). Bipolar percussion, pecking and free hand percussion require the use of a hammerstone to strike pieces off a core of slate or a preform. Bipolar percussion and pecking dictate that the

Table 3.1: Relationship between technique and implements (x implement used, - implement not used, ? implement may be used).

Technique Employed	Implement Required					
	Anvil Stone	Hammer-stone	Fine-Grained Whetstone	Coarse-Grained Whetstone	Bow Drill	Vice
Bipolar Percussion	x	x	-	-	-	-
Pecking	x	x	-	-	-	-
Free Hand Percussion	x	-	-	-	-	-
Grinding	-	-	x	x		?
Drilling	-	-	-	-	x	?

material being hammered should be placed against an anvil stone. Holding the medium firmly on the anvil allows for increased striking accuracy as well as additional force applied upward from the anvil as the material is struck. The energy from the strike reflects back into the object being hammered, allowing for more material to be removed.

The abrasive techniques that define ground stone technology are also inseparably linked to the implements and raw materials on hand. Coarse-grained whetstones are required to effectively shape the chipped edge into a functional blade. This involves working the blade edge, as well as flattened portions for hafting and a general polish for aesthetics. In the case of the ulu, this would include the tang and the area between the tang and the blade edge. Production times would soar if the right whetstone was not used for this initial process. A fine-grained whetstone would not have the capacity to effectively shape the preform. However, the Inuk tool maker likely used a fine-grained whetstone to put the finishing touches on the blade edge. A fine-grained whetstone and/or a slurry of fine-grained sand and water could also be used to polish every facet of the tool. This can be done to make the tool more aesthetically pleasing and to prevent any irregularities from interfering with use.

The raw material being worked also affects the implements in that harder and coarser stones are required as the hardness of the material increases. A coarse whetstone with a high percentage of quartz is necessary when working nephrite; this may be augmented by the use of coarse-grained sand and water as an abrasive agent. It would be impractical to work a piece of nephrite with a relatively soft whetstone made of sandstone.

The drilling technique required to create a hole for hafting requires a whole suite of implements and techniques (i.e. bow, drill bit, spindle and mouthpiece). As described in greater detail in the following chapter, one must also possess the technical knowledge associated with using bow drill technology and be aware of the right type of drill bit for the task at hand. For instance, one must understand that a slate drill bit is relatively useless for drilling nephrite, dried bone and ivory. This reaffirms the notion that each step is made up of a series of activities, all of which need to be performed and understood for the successful completion of the task (Schiffer 1976, Sinclair 2000).When it comes to physically hafting the tool, one must also appreciate the intensive process and 'culturally bound' knowledge associated with forming the haft. As demonstrated with the chaîne opératoire of an ulu handle (Figure 3.1), the hafting process also has its own associated 'constellation of knowledge' (Figure 3.4) or set of associated stages and activities.

While the interrelatedness of the steps, tools and techniques illustrated by chaîne opératoire, concepts of agency and anthropology of technology can provide a much needed theoretical background for experimental approaches to understanding ground stone tools, knowledge of how people learn to make tools is also important. This can be acquired through trial and error and watching others. By making the mistakes oneself, one is better able to gain an appreciation for the skill involved in tool production, as well as the associated learning curve.

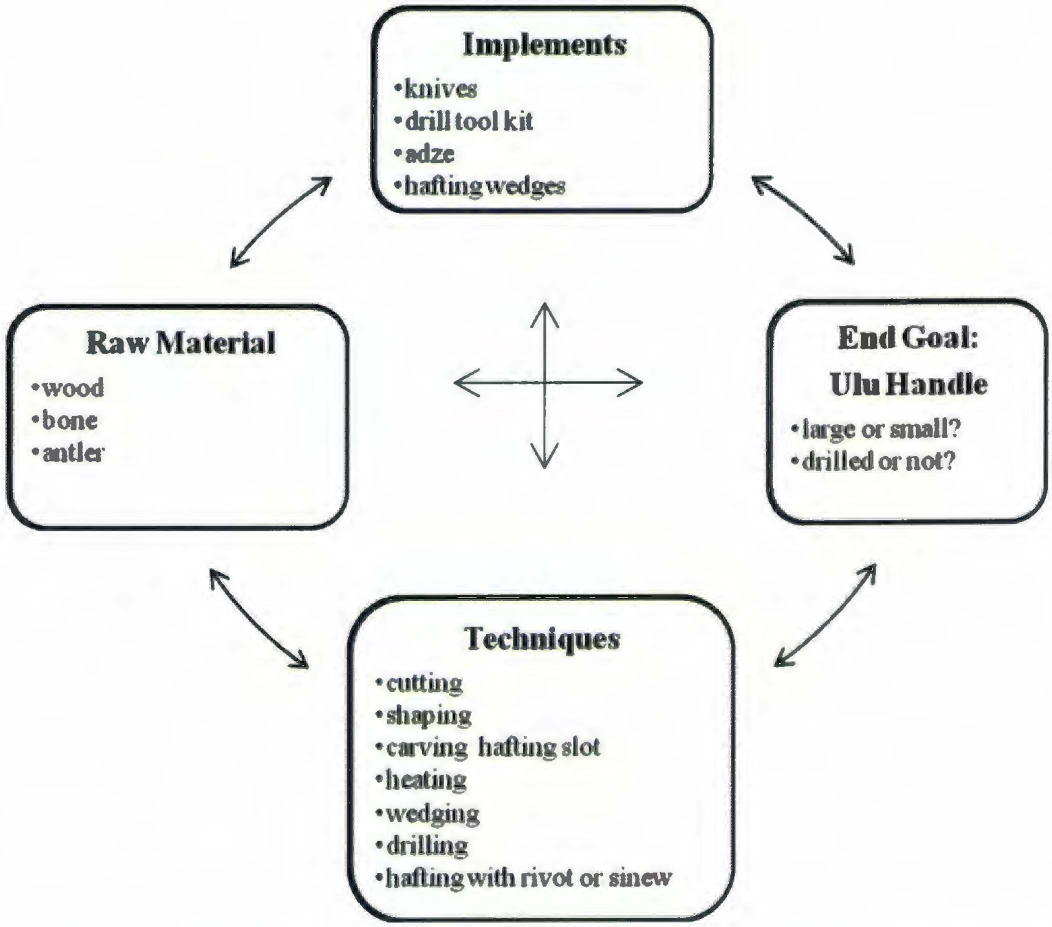


Figure 3.4: Constellation of knowledge for the production of an ulu handle (adapted from Sinclair 2000:201).

3.5 Choice and Learning

When learning how to reconstruct a culture's technology it is important to have an appreciation for the choices and skill associated with the technology. One cannot truly understand how they made the tools unless one is thrust into the culture at an early age. Delving into the technological process in this manner would give the tool maker an instinctual grasp of the technology, enabling him or her both to improvise, and unconsciously make tools according to the social norm. While getting close to authentic lithic tool makers is increasingly difficult, we can draw on analogous ethnographic and historical sources to provide insight into how the technologies were produced.

When examining the context of the production and use of ground stone technology, it is important to consider that men, women, children and the elderly all bring their own "situated understandings" to the task (Dobres 2001:53). Studies concerning gender and subaltern groups highlight how men were not the only people to make and use the tools (Gero 1991). Nevertheless, Rankin & Lebreche (1993) consider the ulu as for the most part a women's knife. Since slate tools often require extensive resharpening during use (Frink *et al.* 2002, Morin 2005), it is reasonable to hypothesize that most people would have had some knowledge of how to use a whetstone to sharpen a blade.

Continuing with this theme, observation of an experienced Inuk tool maker in action would make it seem that he works instinctively, with knowledge invisible to the outside observer. Dubbed "tacit knowledge" (Keller 2001:39), the tool maker knows from experience what to do and how to deal with a problem, either though improvisation or in consultation with a fellow knapper. Whether you are a commercial chef or a hunter-gatherer living on the tundra, adaptation and improvisation are vital for success.

As a practicing blacksmith and anthropologist, Charles Keller (2001) elaborates on the constellations of knowledge model by exploring the notion of the cognitive aspects of technology, with reference to the artisan. Rather than just discussing the raw materials, implements and tools used to get to a desired end point, he discusses at length the additional thought processes that must be considered when using and studying technology.

Like the ancient tool maker making an ulu, the artisan must have an image (physical or mental) of what he/she intends to create. Associated with this, he/she needs to have an image of the tools and materials necessary to carry out the task. The process also involves knowledge of the properties and performance characteristics of the tools and materials which are available. Based on this, the artisan must then choose the best tool for the job (Keller 2001:34). It is essential for the artisan to have a good grasp of the active processes involved, so that rational judgments can be applied throughout. Based on a memory of successes and failures, the artisan can then employ culturally elaborated "standards for diagnosing problems… and a repertoire of corrective measures" (Keller 2001:34). The improvisational skills necessary are built upon these standards and enhance the ability of the artisan to apply corrective methods in a timely manner. This knowledge comes with experience, and can be used to understand agency and the reproduction and evolution of technology in virtually any situation.

3.6 Conclusion

An anthropology of technology approach combining chaîne opératoire and concepts of agency can be used to gain a better understanding of the production and use of ground stone technology by the Thule. In characterizing the production process and uses of the various tools it is important to understand why they made the choices they did, as well as who made and used the tools.

It is important to reiterate that a tool is ground in a certain way, dependent on desired use, cultural tradition and the experience of the individual. This highlighting of the steps involved in conception, production and use of an artifact serves to deemphasize the importance of the finished product. A lot may be understood about a past technology by looking at the artifacts in terms of their life histories and the actors who used the technology. This is a critical aspect of the present research, as each artifact has its own history and background which should not be overlooked. By experimentally replicating and using artifacts, we are better equipped to understand their function and life histories.

Chapter 4: Ground Stone Tool Descriptions

In order to apply the chaîne opératoire and constellation of knowledge models to better understand the Nachvak ground stone assemblage, the artifacts must first be sorted according to provisional function. Sorting by traditional typologies also highlights the need to further organize those tools that do not fit into specific tool categories (i.e. polished stone), as well as those that fit into more than one category (i.e. blade preform). Those without an explicit function may be sorted according to their place in the production process, namely the implements, by-products, unfinished tools and finished tools.

While it is useful to sort artifacts by functional typologies, doing so ends up stressing the final product, as opposed to the stages and techniques that lead up to its eventual discard. Highlighting both provisional function and role in the production process allows for a better understanding of how each artifact makes up only part of the greater ground stone assemblage. Whether it is a polished flake or a finely crafted toggling harpoon head, each is infused with its own 'life history' (Schiffer 2001:3) that communicates something about the use of Inuit ground stone technology. Knowledge of the functional tool types and production processes can then be used to guide the experimental process, stressing the limits of the technology; providing examples of each stage in the production process; and ultimately generating an appreciation for the time and skill associated with tool production and use.

4.1 Classification by Provisional Function

The instant we see an object we immediately classify it according to provisional function. An object with legs at the corners of a flat rectangular surface, with more objects on top, must be a table. It works the same with an archaeological assemblage where provisional function is typically based on comparable ethnographic (Boas 1907, Hawkes 1916, Mathiassen 1979 [1927], Turner 1979 [1894]) and archaeological examples (Maxwell 1985, Schlederman 1971, 1975). For example, a crescent-shaped object sharpened on the round edge is an ulu.

While initial descriptions made in the field are adequate for the field catalogue, further examination of the ground stone assemblage reveals much more than the traditional blade, end blade, drill bit, whetstone and other categories. Tool categories can be further broken down into subgroups based on use, i.e. "blades" can be split into both knives and weapons (Table 4.1). Once divided into provisional function groups, they may then be divided by how they would be hafted and then used. This is largely based on fastening hole configuration and subtle differences in tool morphology and size. See Appendix I for additional provenience, measurement and descriptive data.

Identifications were made based on comparison with archaeological (LeMoine 1997, Maxwell 1985, McCartney 1977, Park & Stenton 1998, Rankin & Labreche 1991, Schlederman 1971, 1975, Stenton & Park 1998, Taylor 1979) and ethnographic sources (Boas 1907, Birket-Smith 1976 [1929]a, 1976 [1929]a, Mathiassen 1979 [1927], Mathiassen 1979 [1930], Hawkes 1916, Turner 1979 [1894]). While some tools can be clearly labelled according to provisional function, (i.e. adzes, beads, drill bits, uluit,

Table 4.1: Breakdown of artifacts according to tool and material type, provisional function totals in parentheses.

		Material								
Provisional Function	Artifact Type	Slate		Nephrite		Serpentine		Other		Total
		n	%	n	%	n	%	n	%	n
knife blade (n = 95)	ulu	24	88.9	3	11.1	0	0.0	0	0.0	27
	ulu/knife	4	100.0	0	0.0	0	0.0	0	0.0	4
	baleen shave	1	100.0	0	0.0	0	0.0	0	0.0	1
	flensing knife	1	100.0	0	0.0	0	0.0	0	0.0	1
	men's knife	39	83.0	8	17.0	0	0.0	0	0.0	47
	stemmed knife blade	14	93.3	1	6.7	0	0.0	0	0.0	15
weapon blade (n = 68)	end blade	27	96.4	1	3.6	0	0.0	0	0.0	28
	harpoon end blade	29	100.0	0	0.0	0	0.0	0	0.0	29
	lance/ knife end blade	1	100.0	0	0.0	0	0.0	0	0.0	1
	lance end blade	10	100.0	0	0.0	0	0.0	0	0.0	10
miscellaneous blade fragment (n = 80)		61	76.3	15	18.8	3	3.8	1	1.3	80
drill bit (n=18)	drill bit	5	27.8	13	72.2	0	0.0	0	0.0	18
awls & gravers (n = 13)	awl/graver tip	5	45.5	6	54.5	0	0.0	0	0.0	11
	awl tip	1	50.0	1	50.0	0	0.0	0	0.0	2
adzes (n = 10)	adze blade (small)	0	0.0	7	100.0	0	0.0	0	0.0	7
	adze blade (large)	2	66.7		0.0	1	33.3	0	0.0	3
ornament (n = 6)	Bead	3	60.0	2	40.0		0.0	0	0.0	5
	Amulet	1	100.0		0.0		0.0	0	0.0	1
round disk (n = 1)	round disk	1	100.0	0	0.0		0.0	0	0.0	1
polished fragments (n = 90)		68	75.6	21	23.3	1	1.1	0	0	90
production remains (n=139)	raw material	7	87.5	0	0.0	1	12.5	0	0.0	8
	blank	30	93.8	0	0.0	2	6.3	0	0.0	32
	perform	95	96.0	3	3.0	1	1.0	0	0.0	99

manufacturing implements (n=146) **not including drill bits*	anvil stone	0	0.0	0	0.0	0	0.0	2	100.0	2
	Hammers-tone	0	0.0	0	0.0	0	0.0	5	100.0	5
	Hammers-tone/ pecker	0	0.0	0	0.0	0	0.0	2	100.0	2
	modified stone	0	0.0	0	0.0	0	0.0	1	100.0	1
	utilized cobble	0	0.0	0	0.0	0	0.0	2	100.0	2
	whetstone	0	0.0	0	0.0	6	4.5	128	95.5	134
Grand Total		429	64.4	81	12.3	15	2.2	141	21.1	666

side-slotted knife blades, hammerstones and whetstones), the identification of some tools (i.e. awls, gravers and end blades) can be debatable. A tool's use may be discerned by taking into account relative size, hafting method and use wear. Many awls and gravers are grouped together because both are multifaceted tools with wear concentrated on one pointed edge. Additional use wear and experimental studies could be used to distinguish between the two tool types. Likewise, many of the end blades could have been used to tip a variety of tools.

Blades were sorted by provisional function according to relative size, hafting method and use wear along sharpened blade edges. Those that could not be identified were labelled as end blades. These examples were either too fragmented to be identified or could not be assigned to a particular end blade category. Also, some ground stone objects, such as the round slate disc, are not commonly discussed in the archaeological and ethnographic literature and await future identification.

For the purposes of this thesis, definite identifications are not crucial for every ground stone artifact. While some identifications may be contested, it is important to note that the tools are categorized by provisional function and may be reclassified in the future based on increased work with the collection or additional experimental and use wear analysis. The classifications presented are meant to highlight the diversity of the Inuit ground stone assemblage, taking into account tools in varying stages of production.

Six hundred and sixty-six artifacts from Nachvak Village (IgCx-3) may be categorized as elements of ground stone technology. The tools are either made of ground stone, or may be characterized as implements used to work the stone or pieces associated with their manufacture (i.e. blanks, preforms and debitage). It is worth noting that only artifact types that directly relate to the production and use of ground slate and nephrite tools were chosen as part of this study. While much of the debitage exists as flakes, they were not included as part of my analysis in an effort to reduce sample size. Similarly, while soapstone tool production employed ground stone technology techniques, they were also exempt from the sampled assemblage because they are not used in the production of slate and nephrite tools.

The assemblage is made up of 64.4% slate, 12.3% nephrite, 2.2% serpentine and 21.1 % 'other' stone, namely sandstone, mudstone, and beach cobbles used in the manufacture of the stone tools. The low percentage of nephrite may be attributed to the relative rarity of the material, as well as the difficulty associated with working it as compared to slate.

When sorted by provisional function, blades make up nearly 36.7 % of the total ground stone assemblage, of which 24.7% are diagnostic, while the other 11.9% are so fragmentary that they may only be classified as miscellaneous blade fragments. This includes those with an identifiable blade edge, but without enough to ascribe them to a particular blade class (Figure 4.1). Similarly, 13.4% of the assemblage is made up of polished stone. Unlike the miscellaneous blades, they lack a formal blade edge and may belong to virtually any tool type except for the production implements.

The high percentage of blades overshadow the 7.3% or the remaining finished tools, comprised mainly of drill bits, adzes, awls, gravers and objects of uncertain function. It is also important to note that the majority of the collection is made up of artifacts associated with production, namely production remains and manufacturing implements, rounding out the assemblage at 20.7% and 21.8% respectively. This serves to emphasize how the ground stone assemblage is made up of much more than just the

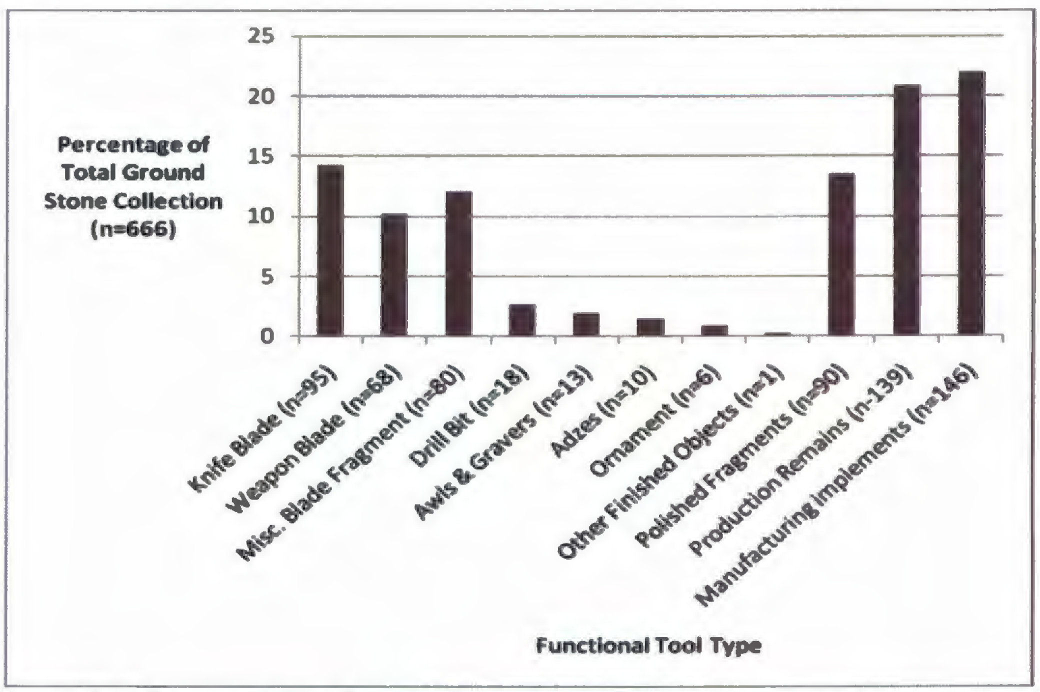


Figure 4.1: Comparison of ground stone assemblage according to provisional function

finished tools.

4.1.1 Blades

Inuit ground stone blades may be further subdivided according to whether or not the blade was used as a weapon, for hunting or warfare/defence, or as a knife, used for processing of food, skins and other raw materials (Figure 4.2). While most blades and blade fragments can be assigned to these categories, the use of a "miscellaneous" blade category is required to include fragmented pieces which clearly have a blade edge, but

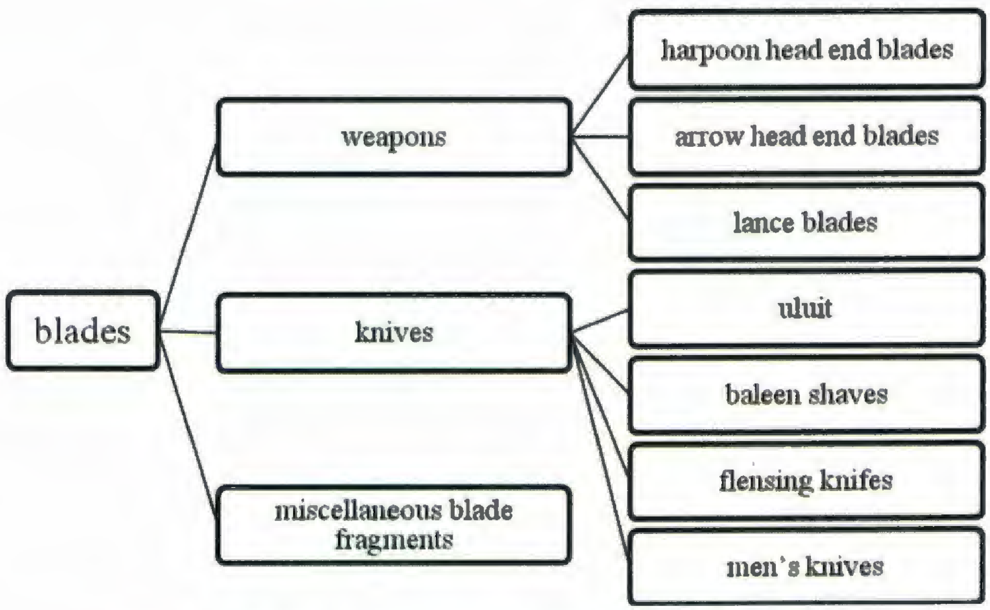


Figure 4.2: Organizing ground stone blades by function.

cannot be assigned to a particular blade category. This also serves to separate the specimens from the extraneous polished ground slate which could belong to virtually any tool category, aside from the manufacturing implements.

4.1.1.1 Weapon Blades

Weapon blades are defined here as any blade that was clearly designed for hunting or warfare. This includes end blades for harpoons and lances, as well as the stemmed end blades used to tip arrowheads. Ethnographic sources also note that knives were used by Inuit people as weapons against wolves (Bilby 1927) and other people (Woodman 1991). As with many aspects of Inuit ground stone technology, the design and morphology of each blade is largely dependent on function.

4.1.1.1.1 Harpoon Head End Blades

Before discussing the types of harpoon head end blades, it is important to understand the various aspects of the Inuit toggling harpoon as well as its use. While there were many varieties of harpoons, they were either thrown or thrust into the prey. Harpoons were used for harpooning seals at the breathing holes and for hunting in open water. Larger varieties would have been used depending on the size of the game. The open water harpoons consisted of a main shaft affixed to a smaller foreshaft, which in turn was affixed to the harpoon head. This setup increased flexibility, preventing the harpoon from breaking if it was unable to penetrate the skin of the larger animals (Bennett & Rowley 2004:268). While "throwing harpoons had a loose or movable shaft…designed to come apart from the socket piece as soon as the animal was struck" (Park & Stenton 1998:4), those intended for thrusting had a "fixed" foreshaft that released with "a backward tug on the harpoon shaft as the animal is struck" (Park & Stenton 1998:4).The main shaft of each would have also had a finger rest just ahead of the balance point for optimal grip, thrust and control.

Each toggling harpoon head would have been attached to a sealskin float via a skin line (Bennett & Rowley 2004). When the toggling harpoon head enters the animal, it detaches from the shaft and rotates so that it cannot fall out of the entry wound. Bennett and Rowley note that antler was preferred over ivory in the manufacture of harpoon heads because ivory is more sensitive to the cold and could shatter if it struck the hard ice (2004:268).

The float was connected to the harpoon with a skin line attached to a hole in the harpoon head, or a hole in the side of the harpoon end blade itself. These floats were made from a skinned seal, taking care to remove the carcass and blubber without damaging the skin. All extraneous holes were then sewn with baleen or skin twine, and/or patched with wooden disks. Both the line and the float were carefully maintained as they are the last means of preventing the animal from getting away (Bennett & Rowley 2004). Finally, an inflation tube with a mouth piece was used to inflate the float, which was then plugged with a small plug made of bone or ivory (Turner 1979 [1894]:84).

The aim of the float was to allow the user to track the animal, and to act as a drag, tiring the animal as it tried to get away. It could also serve as a buoy, indicating the place where the animal sank, if that transpired. While not as relevant for breathing hole sealing, this is worth noting, as seals struck in open water may sink after death due to the struggle and exhaustion associated with being struck with the harpoon (Bennett & Rowley 2004, Turner 1979 [1894]:84).

All more or less triangular in shape, the harpoon end blades at Nachvak Village may be assigned to three main groups: those with one or more centralized holes for hafting (Figure 4.3 a,b,c), those with holes in the side or corner of the blade (Figure 4.3 d,e) and those without a hole. While each would have been hafted into the blade slot at the end of the toggling harpoon head, the variation in hole location reflects their different uses (Figure 4.3, 4.4). The end blade with the centralized hole would have been the sturdiest and most durable, held in place with a rivet of bone, ivory or copper. The end blades with the hole in the bottom corner or the side corner may have allowed for an additional toggling line (Boas 1974). And lastly, the blades without holes may have had a different function or merely been unfinished. Although many of the end blades without holes have evidence of use wear, from being hafted and/or used, they may also be examples of blade that had not yet been drilled. Of the twenty six finished harpoon end blades, eighteen were drilled with one or more holes, in a variety of configurations (Figure 4.3).

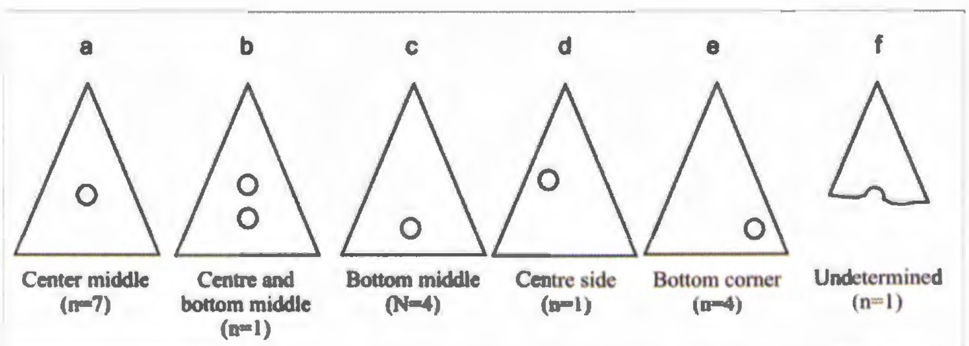


Figure 4.3: Grouping harpoon head end blades by location of hafting hole, including total number of specimens (n).

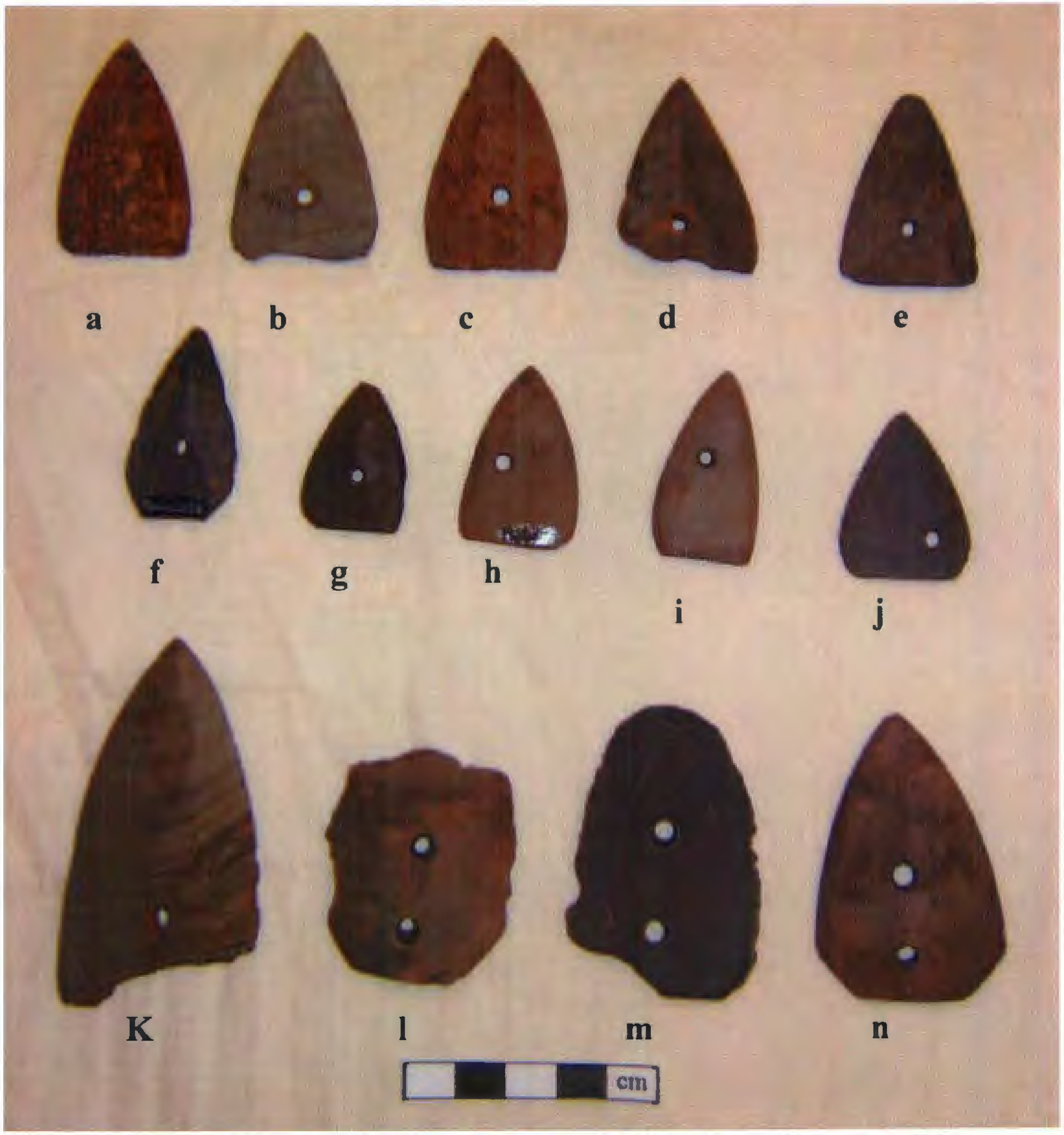


Figure 4.4: Small harpoon head and lance end blades from IgCx-3: a-j) harpoon head end blades (2095, 2507, 3109, 4623, 6928, 1725, 3758, 4459, 3867, 5160), k-n) small lance blades (6878, 6144, 1570, 3680).

4.1.1.1.2 Lance End Blades

Much larger and more elongated than the harpoon head end blades, lance blades were fixed to shafts and used to kill both sea and land mammals. Sea mammals would first be impaled with the harpoon and then struck repeatedly with the lance once it was within range (Bennett & Rowley 2004:271). The size of the lance blade increased with the size of the game. Using a small lance would be futile for whale hunting as it would require repeated strikes to equal the damage of a larger blade. In addition to this, a small blade might not be large enough to penetrate the thick skin and blubber of such a large animal. Likewise, using a large blade on a seal would create unnecessarily large holes in the prized pelt.

Lances were also used from a kayak to hunt caribou while they swam. The hunters would be stationed near a known caribou river crossing. Once the caribou were spotted crossing the river kayaks were deployed up river. Meanwhile others would scare the caribou back into the water where they were most vulnerable (Boas 1907, Bennett & Rowley 2004). Females were harvested for their light skins for use in making clothing, and males for their greater proportion of meat and heavier skin used for other purposes (Turner 1979 [1894]:85).

Ten finished lance blades were recovered, as well as one large blank that could have been made into a lance blade or a knife, four lance blade preforms, and one preform that could be made into a harpoon head end blade or lance end blade. Of the finished lance blades, half were large and wide, probably for whaling and the other half were long and narrow, probably used for lancing smaller game.

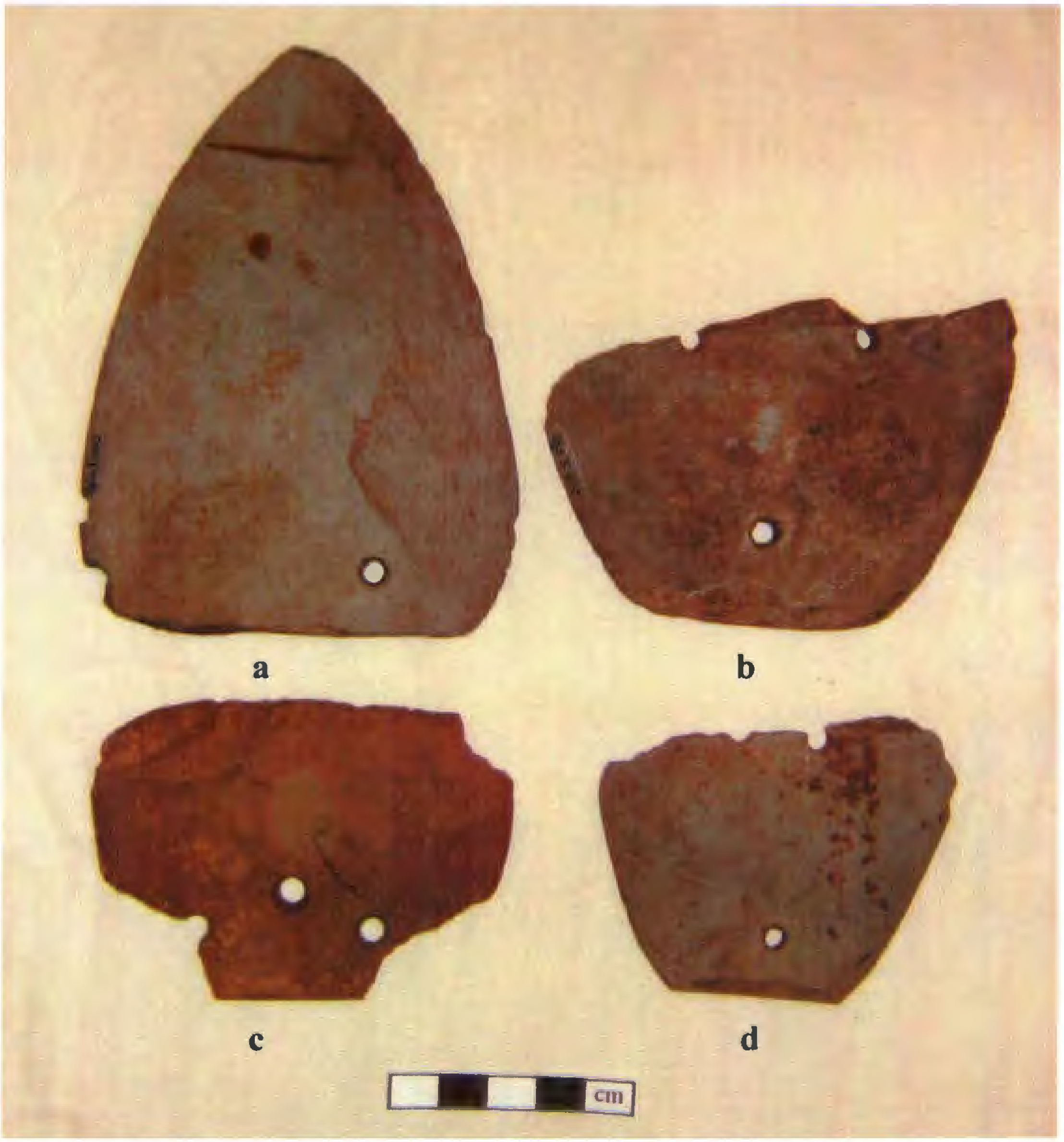


Figure 4.5: Large harpoon head and lance end blades from IgCx-3: a-b) Whaling harpoon head end blade or large lance blade (602), Lance or flensing knife end blade (1207), c) reworked slate lance blade or whaling harpoon end blade (6659), d) large slate lance blades (6659, 3465).

There are many reasons for the lack of large lance blades. First of all, broken blades may have been reused (i.e. compare IgCx-3:602 and IgCx-3:6659; Figure 4.5). Not only are the bases of the latter specimens equal in length, but the hole in the bottom corner of each lines up as well. The remaining distal edge of IgCx-3:6659 appears to be intentionally chipped, possibly in preparation for grinding. Once ground, this object could function as an ulu or scraper. The higher proportion of harpoon head end blades than lance blades may thus be attributed to the reworking of broken lance blades.

4.1.1.1.3 Arrowhead End Blades

Bow and arrow technology was also an important part of the Thule hunting repertoire. It was used for the short range hunting of large land mammals and small game such as ptarmigan and hare (Turner 1979 [1894]). At times, bows were also used in self defence, as was the case during a failed Inuit abduction on Baffin Island in 1577, in which Frobisher was shot in the buttocks as the prospective Inuit captives tried to escape (Vaughan 2004:4).

There were two main types of bows: long bows and curved bows. They were largely composite items, made of available wood and/or baleen, bound and spliced together with braided baleen and sinew for added strength and flexibility (Birket-Smith 1976 [1929]a, Turner 1979 [1894]). In some areas, like Labrador, where wood is more plentiful, bows may have been shaped out of a single piece of wood.

Archaeological examples from LiDj-1 indicate that arrowheads were made of bone, antler, and slate. Ground stone arrowheads have been classified as triangular end blades with a hole in the center (Figure 4.6) (Schlederman 1975). They are provisionally distinguished from the harpoon head end blades according to size, with smaller end blades used to tip arrows, and larger end blades used to tip lances and harpoon heads. Like their knife and harpoon head end blade counterparts, the triangular blade would be inserted into an arrow slot and then secured with a rivet, and or glue. Additional lashing could also be used to hold the blade in place.

Figure 4.6: Potential arrowhead end blades from IgCx-3: a-g) (2379 5966, 528, 4664, 1335, 1835, 3681).

4.1.1.1.4 Knives as Weapons

In addition to being used to eat and process raw materials, knives were used for hunting and self-defence. There are various accounts of Inuit using knives as weapons, from pretending to stab one another in shamanic performances (Boas 1887), to self-defence against Europeans intent on trading with and/or capturing them. They were also used as a weapon against wolves. Ethnographic accounts describe coating a sharp knife with blood and leaving it in the snow. A wolf would proceed to lick the blood, cut its tongue and leave a blood trail for the hunters to follow (Bennett & Rowley 2004:69, Mathiassen 1976 [1927]:63).

Weaponry makes up a large portion of the Inuit ground stone tool kit, highlighting the Inuit dependence on the hunting of animals to survive. It is for this reason that they needed situation-specific weaponry to effectively hunt game that came (or was stalked) within range.

4.1.1.2 Knife Blades

Knife blades were, and still are, vital in the processing of the flora and fauna collected by the Inuit. As with other aspects of Inuit technology, some knives were decorative and decorated, while others were designed with specific functions in mind. Baikci (1970) suggests that they were made because "they were indispensible, not because [they] were pleasing to the senses" (Balikci 1970:4). Inuit ground stone knife blades may be divided into four categories, based on function and morphology. These include: uluit, baleen shaves, flensing knives, and "men's knives." Uluit and men's knives can be broken down further based on subtle differences in morphology, hafting method and use.

4.1.1.2.1 Ulu Blades

Not unique to the Inuit, the ulu blade category incorporates all crescent- shaped or semi-lunar blades (Rankin & Lebreche 1991, Steiner 1941). Mainly used by women (Rankin & Lebreche 1991, Turner 1979 [1894]), the size of the ulu and the edge shape depend largely on style and the desired function. "Each woman had a series of uluit of different sizes and styles for different tasks. The working edges of uluit were also sharpened differently, depending on their use" (Bennett & Rowley 2004:305). Bennett and Rowley give the example of a woman with three uluit: one to scrape caribou skin; another to cut it; and a third for more general tasks like cutting meat, preparing it to be dried, and eating. The first two uluit would be used only by the owner for those specific tasks, thus ensuring that they would not be dulled by improper use (Bennett & Rowley 2004:305).

In some instances, specific names were given to certain types of uluit, like the *Kimaliq*, "a small ulu used for cutting skin patterns." (Bennett & Rowley 2004:305). Oral histories also indicate that uluit may have been very personal in nature, with girls receiving small uluit at a young age (Bennett & Rowley 2004:305). There are also accounts of women being buried with uluit after death, and the women taking her working tools if she divorced, reiterating how their ability to make and mend clothes was essential to their survival (Bennett & Rowley 2004:299). In addition to the uluit of varying sizes, the women's sewing kit would have also included whetstones, stretchers, scrapers, needles, thimbles, thimble holders, boot creasers and awls. All of these were kept in a special bag, sometimes made of skin (Bennett & Rowley 2004:304). The ulu was also integral for skin processing, with each stage requiring a different type of ulu, including blunt uluit for the removal of fat and blubber, and sharper uluit for removing hair, cleaning flesh, and cutting skins into manageable strips for use as boot soles, thongs, drying racks, and other products (Balikci 1970: 8-12).

The assemblage from Nachvak produced a range of uluit which vary in size, morphology, edge type, and drill hole configuration. Each is indicative of the artifact's individual life history, namely how it was shaped, hafted and used. Three sizes of uluit were recovered from Nachvak Village: large, small and miniature (Figure 4.7, 4.8, 4.9). In accordance with Taylor (1979), uluit with lengths greater than 85.0mm were

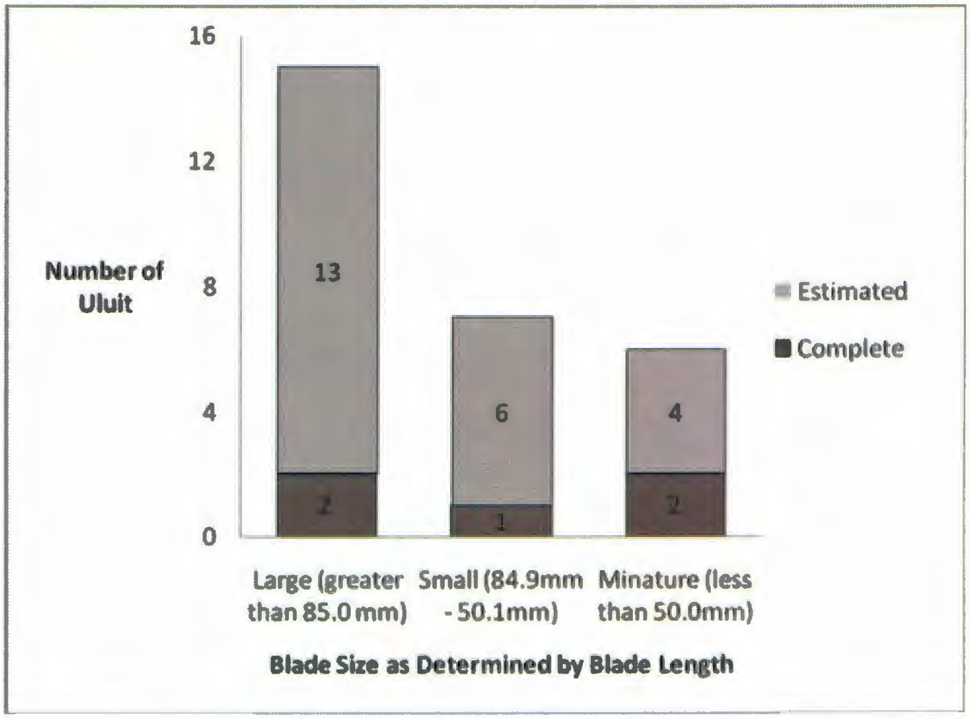


Figure 4.7: Division of uluit according to blade size, as determined by length.

classified as large and those less than that as small. It was also necessary to create a miniature category (less than 50mm) to highlight the presence of smaller uluit. The six miniature examples are much thinner than the others, and seemingly more brittle, indicating that they may have served as toys or ornaments, rather than functional tools used by adults (Whitridge 2007). Having said that, initial blade edge analysis of the

Figure 4.8: Uluit from IgCx-3: a-d) miniature uluit (3459, 2753, 4345, 2170); e) miniature ulu preform (4761); f-g) small uluit (6469, 4276); i – m) large uluit with tang (5801, 954, 3710, 1193, 2110, 6216).

miniature uluit reveals that IgCx-3:2170 (Figure 4.8 d) may have been used. This is due to the extensive striations along its blade surface, and the appearance of striations at a forty five degree angle from the blade edge. The other examples either lack a blade edge, are finely polished, or have striations made during manufacture and not use. Use striations would be primarily concentrated along the blade edge, while manufacture striations would be largely removed during the polishing stage of manufacture.

Estimates of total length (one tip to the other) and size take into account the portion of the remaining blade as well as its thickness and weight. For example, IgCx-3:3723 is the tang to blade portion of an ulu, representing approximately 25% of a complete specimen. With a weight of 13.6g, the complete ulu should be around 55.4g, well within the range of the larger ulu category, and significantly heavier than their small and miniature counterparts.

There are also variations in the size of the ulu tang, whether or not it is present, and the placement of hafting holes. This variation may depend on personal preference, and/or the intended end function of the ulu. Of the fourteen uluit with identifiable tangs, eight were drilled and six were not (Figure 4.8). Of the drilled specimens, four were drilled below the tang (Figure 4.8 f, j, k), and four in the middle of the tang (Figure 4.8 i, m). Due to the fragmentary nature of twelve of the uluit, it was unclear whether or not they had a tang. In these instances, two fragments were drilled, while the other ten were not. These variations in hole placement would ultimately affect the sturdiness of the haft, and the depth of the handle's tang slot.

Figure 4.9: Large uluit, baleen shaves and flensing knife from IgCx-3: a-b) Large uluit without tang 2312, 6812), c) baleen shave preform (5122), d) baleen shave (3867), e) large flensing knife (4100), f-h) baleen shave preforms (6581, 4978, 1610).

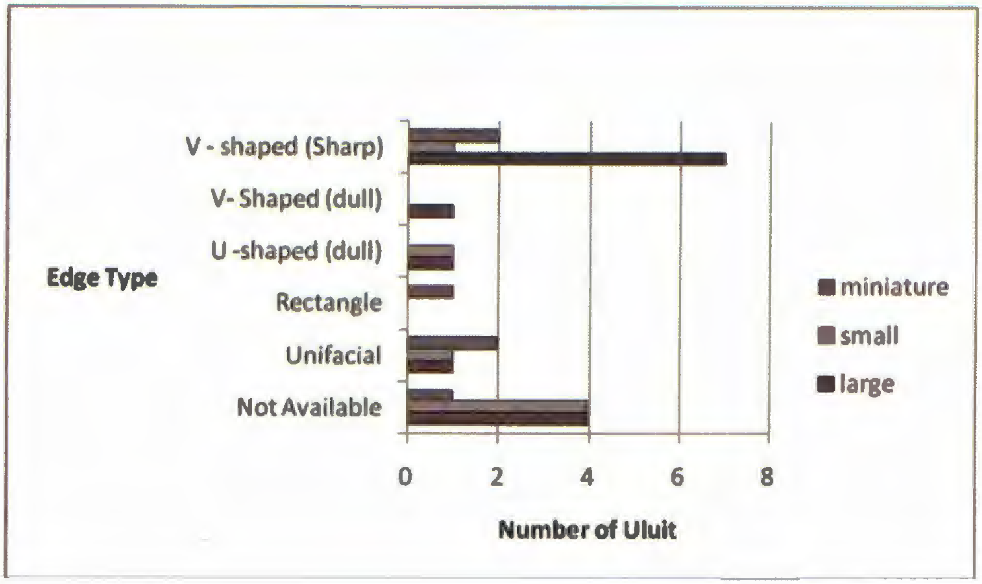


Figure 4.10: Comparison of uluit edge types.

Only two complete uluit lacked pronounced tangs. Both were drilled with multiple holes for hafting, and most of the use wear was concentrated along the blade edge and below the inferred extent of the handle. IgCx-3:2312 (Figure 4.9 a) looks like a conventional ulu with a crescent-shaped blade. Its shape and the orientation of the holes are not unlike later examples of metal ulu blades with added bone or wood tangs that were hafted to a handle (Boas 1927). IgCx-3: 6812 (Figure 4.9 b), on the other hand, would not have needed the additional tang, as the holes were spread far enough apart to fit into a larger handle.

There is also a relationship between blade edge and function, with dull blades being used for scraping and sharper blades being used for cutting (Balikci 1970). Most of the discernable blades appear to be sharpened to a 'V' or were otherwise unidentifiable (Figure 4.10). Sharp blades used for cutting include edges that were bifacially worked into a sharp 'V' (Figure 4.11 a). Dull blades used for scraping include bifacially worked edges that form either a rounded 'V' (Figure 4.11 b) blades that are or a U-shape in cross section (Figure 4.11 c), as well as unifacially worked examples that are ground at an angle on just on one side (Figure 4.11 e).There was also a lone miniature ulu (Figure 4.8 a) with an edge that was rectangular in cross section (Figure 4.11d). Its size and the hafting hole in the tang suggest that it was not functional and may have been ornamental in nature. In addition to these, nine uluit were missing the blade, and could not be further classified.

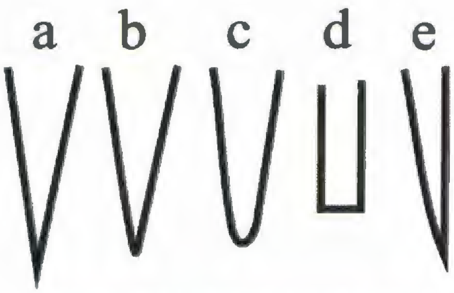


Figure 4.11: Uluit blade edge categories: a) V-shaped (sharp), b)V-shaped (dull), c) U shaped (dull), d) rectangular, e) unifacial

The dull V-shaped category may represent wear related to use. Beginning with a sharp edge (Figure 4.11 a), a blade gradually became dull (Figure 4.11 b), until it was eventually rounded (Figure 4.11 c). This edge could then be resharpened enabling the cycle to be repeated. In a similar vein, the rectangular edged ulu may represent a blade edge that was not finished, or was intentionally shaped as an ornament.

When uluit with observable edges are divided based on functional edge types (Figure 4.12), there is a notable descrepancy in the number of large uluit used for cutting as opposed to scraping. While minatures are regularly identified as toys, their blade edge indicates that they may have served practical purposes.Having said that, the use wear on the miniatures may be attributed to their use as toys by children. Like the miniature stemmed knife blades, some of the minature uluit do not appear sturdy enough to have

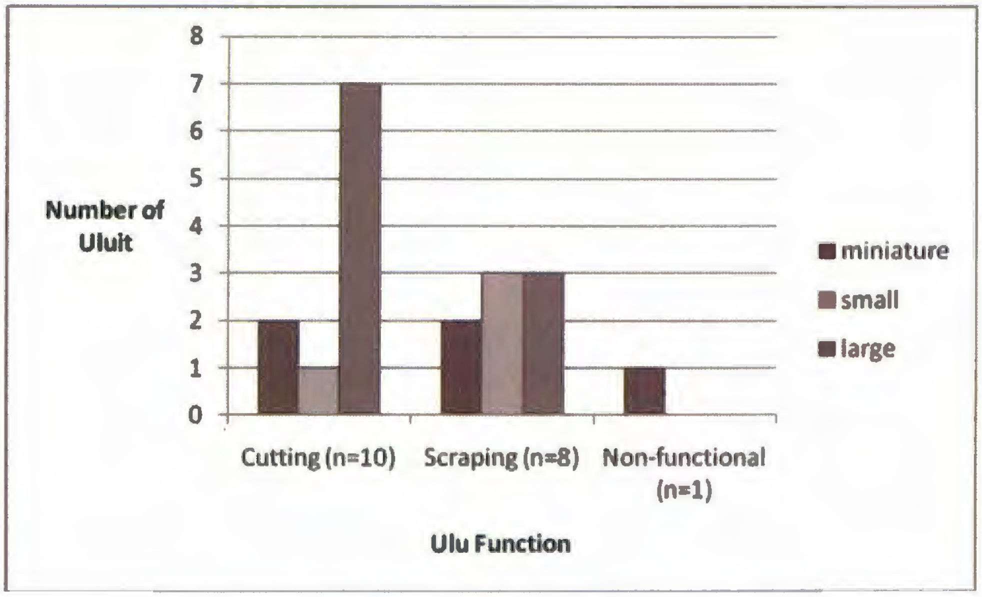


Figure 4.12: Assessing ulu function based on edge type.

been functional. It is also worth noting that most of the scraping tools are unifacial in nature, decreasing the likelihood that they will cut the skin while at the same time remaining sharp enough to remove fat and hair through scraping.

Excavations at Nachvak also yielded five ulu preforms. This total includes one that could have been made into a large end blade or ulu (IgCx-3:6024) (Figure 4.13 d), and another that could have been crafted into a knife. IgCx-3:4761 (Figure 4.8 e) is a miniature ulu preform reworked from the broken tip of a blade intended for an end-slotted knife. The blade is a carryover from its former status as knife blade, with only half of the tang having been finished.

Uluit were a very important component of Inuit ground stone technology, as they were used to cut, scrape and process faunal resources for food and clothing. Specific uses are highlighted by the variations in size and blade edge.

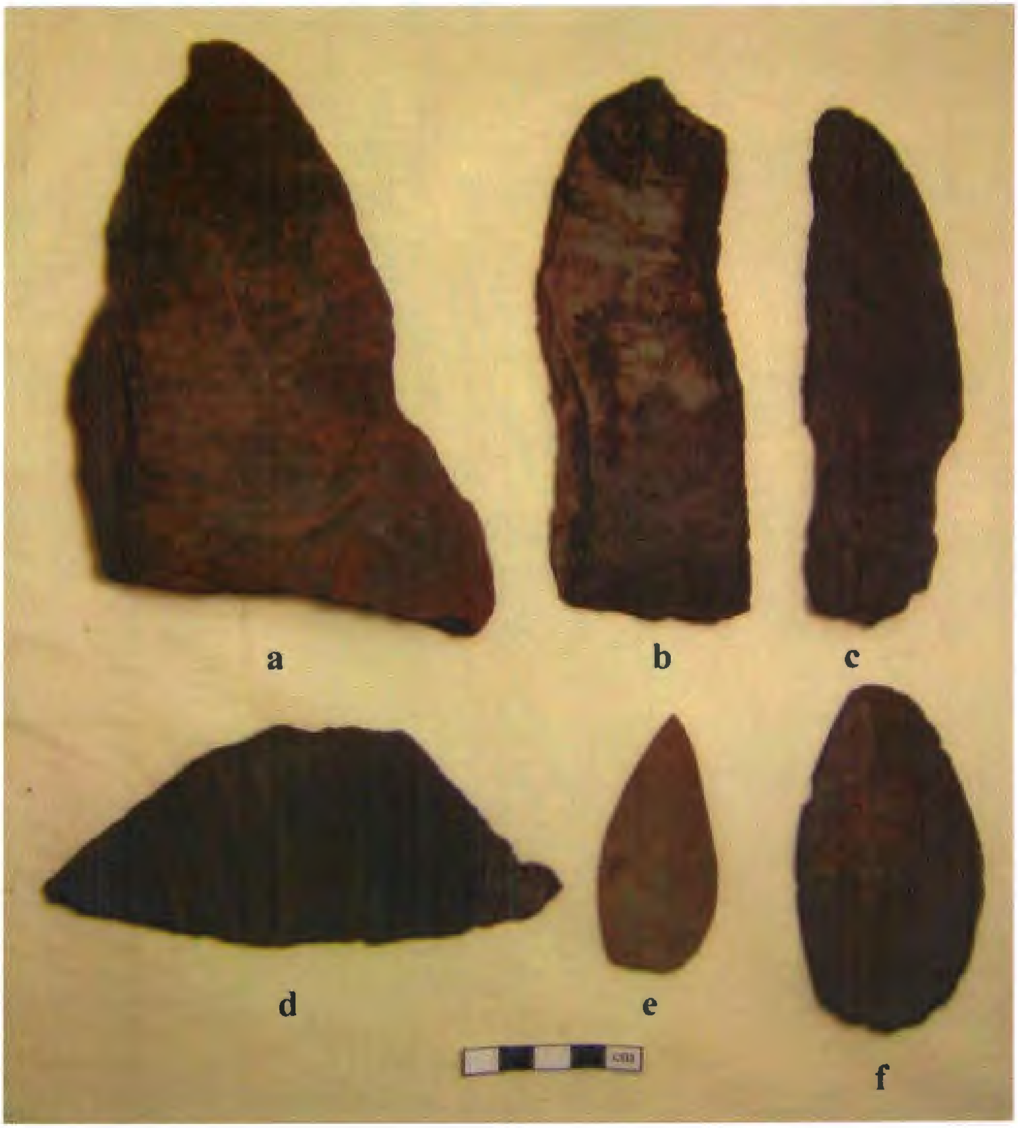


Figure 4.13: Ground stone blanks and performs from IgCx-3: a) Slate blank (6399); b) chipped knife preform (2013); c) chipped and shaped knife preform (4828); d) lance/ulu/knife preform (6024); e) lance/knife blade preform (6753); f) lance/knife blade preform (6029).

4.1.1.2.2 Baleen Shave

A baleen shave is an oval shaped variety of knife used primarily to process baleen into manageable strips. They would have been hafted with small handles, not unlike their uluit counterparts. Used in almost every facet of Inuit life, baleen was employed for such tasks as suspending pots over lamps for cooking, lashing structural supports, repairing broken vessels, and in the manufacture of composite tools, bowls, kayaks, and cordage.

Five artifacts resembling baleen shaves were found (Figure 4.9 c, d, f, g, h). All were made of slate. Only one of the baleen shaves is complete. The other four are oval baleen shave preforms. The complete example, IgCx-3:3867 (Figure 4.9 d) is convex in cross section with one side sharpened more extensively than the others. Wear marks perpendicular to the blade edge suggest that it may have also functioned as a scraper. Preforms IgCx-3:6581 (Figure 4.9 f) and IgCx-3:4978 (Figure 4.9 g) also have polish on some edges, suggesting that they were abandoned during the final stages of the production process.

Initial comparison of baleen shaves to the frequency of baleen samples in a given feature indicates that there is not a correlation between the two (Table 4.4). In fact, House 6, with only 23% of the baleen, had three out of five (60%) of all the baleen shaves.

4.1.1.2.3 Flensing Knives

Flensing knives are large long-bladed knives used to cut the flesh and blubber from whales. Undertaken in relatively deep water, the flensing knife was used in association with a buoyant seal skin suit that covered all but the face. Worn only after the whale was killed, it allowed the wearer to navigate around the whale, enabling him to stay dry while cutting the whale and hauling the pieces to shore (Taylor 1971:297). Waterproof seal skin wading pants and mittens were also used to retrieve the pieces of the whale as it was brought ashore.

A fist sized bladder was added to the knives' handles to enable them to float if they were accidentally dropped in the water (Taylor 1971:298). The buoyancy of the knife was compounded by handles, often 4ft in length, which would ultimately compensate for the weight of the large slate blade. Missionaries in Okak also noted that the large blade at times functioned as a temporary oar when paddling the umiak back to shore (Taylor 1971:298). Such technology gradually disappeared with the adoption of European whaling techniques and implements and the disappearance of whales.

The only possible flensing knife blade recovered from Nachvak Village came from House 12 (Figure 4.9 e). IgCx-3:4100 measures 174.2mm by 67.6mm, with one side sharpened to form a blade edge and a hole in the top middle portion of the blade for hafting. While brown residues obscure much of the microwear on the blade edge, extensive micro-flaking is indicative of heavy use. In accordance with Okak missionary accounts, a flensing knife of that size would have required a lengthy handle to compensate for the 148.9g weight of the blade.

4.1.1.2.4 Men's Knives

Mathiassen (1979 [1927]) divides men's knife handles into four main categories. Division in this manner may be used to determine how the blades would have been hafted and subsequently used. The men's knives include: the aforementioned flensing knives, with large blades and long handles for use with two hands; small knives with blades hafted at the end of the handle, small knives with side blades, and whittling knives that are set into a handle by splitting the handle in half and lashing the entire handle together to secure the blade in place (Mathiassen 1979 [1927]:49-52). Helpful in identifying how a blade was hafted, and whether or not it was a side blade, Mathiassen (1979[1927]) goes on to mention that the blades vary between those with a double blade edge and those with a single blade edge (Mathiassen 1979 [1927]:53).

For the purposes of this thesis, blades are first divided between those with one blade edge, and those with two. They are subsequently divided by how they were hafted, namely in end-slots or side-slots (Figure 4.14). In some instances, the type of haft is indeterminate, due to the fragmentary nature of the specimen.

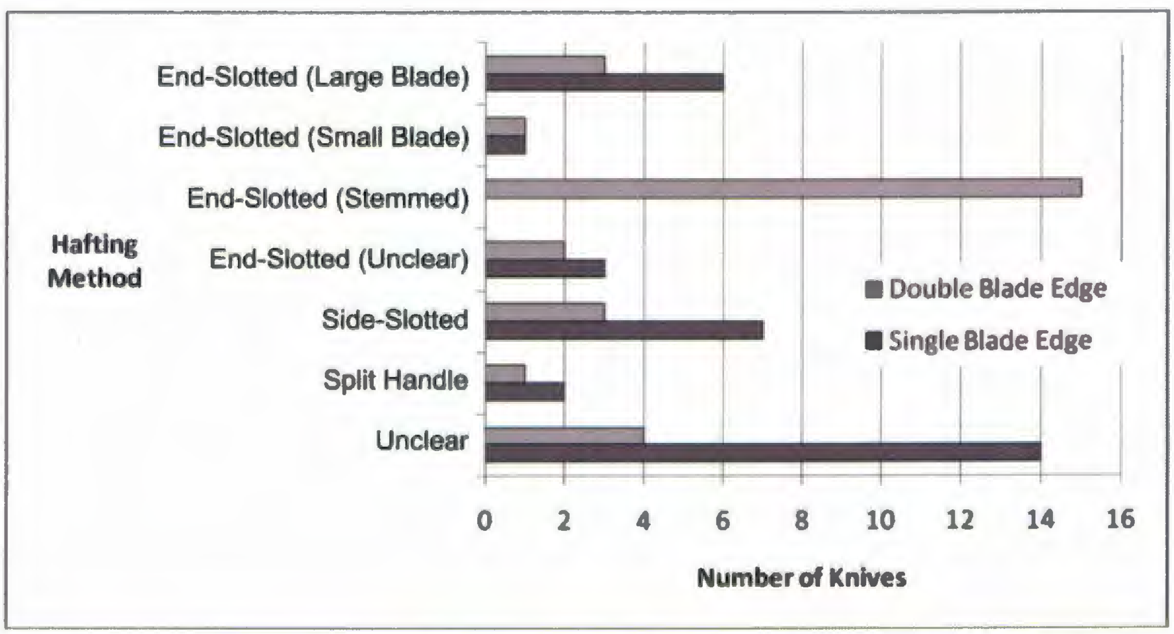


Figure 4.14: Comparison of complete knife blade hafting methods and edge type.

Sixty-five knife blades were recovered from IgCx-3, including sixteen end-slotted, fifteen end-slotted stemmed, ten side-slotted, three hafted in a split handle, and eighteen others which may be distinguished from other end blades, but it is unknown how they were hafted. The number of double-edged end-slotted end blades may be a conservative estimate as it does not include end blades that could alternatively be used to tip lances, harpoon heads and arrowheads.

While the stemmed end blades would have been hafted into the end slot of a handle, they are distinguished from their end-slotted counterparts, because of how they would have been hafted. Stemmed end blades would have been inserted into a bored or cut slot in the end of the knife handle and potentially secured with sinew binding and animal glue. The hafting method for the stemmed end blades is more like that of the undrilled uluit and the drill bits.

A total of seventeen stemmed end blades were recovered, sixteen made of slate and one made of nephrite (Figure 4.15). Nine of the stemmed end blades were complete, with six broken and two at the preform stage of manufacture (Table 4.3). IgCx-3:3097 (Figure 4.15 l) is an anomaly because holes were drilled in the middle and bottom corner of the blade, possibly to augment hafting. Cracked along the holes and part of the stem, the fracture of this piece may be attributed to the holes not being lined up properly during the drilling stage of production or it having been made from a portion of a recycled blade. Three of the stemmed blades (IgCx-3: 4612, IgCx-3:946 and IgCx-3:4945) were miniatures. While microscopic wear on each suggest that they may have been hafted, they appear too thin and brittle to have functioned as practical knife blades. They may instead have been crafted as children's toys.

Three of the double-edge knife blades were classified as side-slotted blades because the edges were differentially worked. The 'main' cutting edge was shaped from use and resharpening. Each also had striations perpendicular to the 'main' cutting edge,

Figure 4.15: Stemmed arrowhead end blades from IgCx-3: a – l) (4612, 946, 4945, 5626, 1788, 1215, 2968, 1194, 5644, 1457, 6457, 3097)

which stopped abruptly where the blade would have been hafted. This other side of the blade was also heavily polished and rounded from hafting.

Six of the side-slotted blades were drilled to facilitate the hafting process, while the other four were not. In addition to jamming the blade into the blade slot, natural adhesives, such as blood glue, were also used to keep the blade in place (Balikci

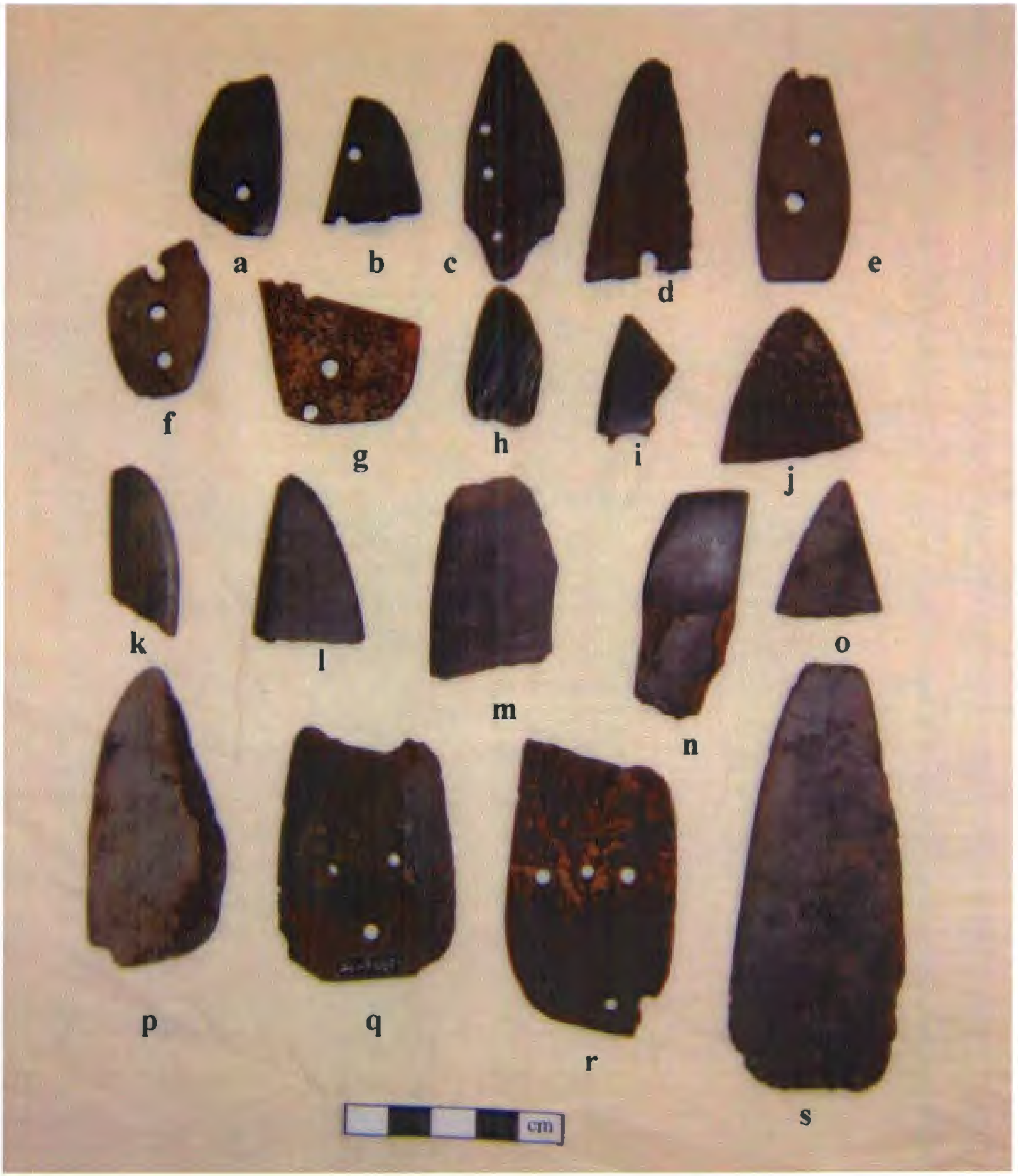


Figure 4.16: Side-slotted and end-slotted end blades from IgCx-3: a – h) side-slotted knife blades (6023, 411, 5171, 4603, 1911, 1911, 1744, 1145), i – s) end-slotted knife blades (4638, 1790, 5714, 2202, 2928, 704, 6813, 1961, 4475, 2099, 4993)

1970). IgCx-3:411 illustrates this with distinct residues present only on the hafted portion of the blade (Figure 4.16 b). The three split-handled knives were too large to fit into a slot at the end of a knife handle. Instead the handle would have been split in half, the blade inserted, and then the whole lashed together, not unlike some European-style knife handles.

The variation in hafting strategies for knife blades reflects the differential uses of men's knives. While specific uses may be determined through use wear and residue analysis, it can be assumed that they were used to process animal carcasses. Smaller blades may have been used for the intricate carving of handles, amulets, and other items out of bone, ivory and wood (Balikci 1970).

4.1.2 Drill Bit

Ground stone drill bits are an important part of the ground stone assemblage as they tip most drills and act as an efficient means of boring holes in various media. Such holes are important for hafting blades, repairing and suspending soapstone and ceramic vessels, drilling holes in sled runners and for the fabrication of a host of other implements. Not only was drilling more efficient the gouging, as was practiced by Dorset groups (McGhee

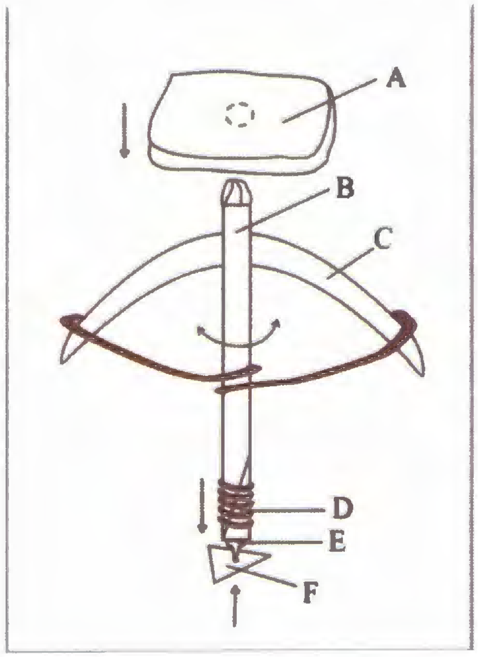


Figure 4.17: Parts of a bow drill with arrows indicating applied forces. a) handhold/mouthpiece, b) spindle, c) bow and string, d) chuck, e) drill bit, f) drilled medium.

2001:142), it also enabled the Inuit tool makers to drill holes in stone, so that blades could be more securely hafted using rivets as well as baleen or skin lashing. Before discussing the ground stone drill bits, it is important to briefly outline the forces, implements and actions involved in the drilling process. Understanding of the drill bit technology is also important as it is a component of the experimental research to follow. Bow drill technology requires the melding of number of individual culturally modified objects, namely the mouthpiece/handhold, spindle, bow, chuck, and drill bit (Figure 4.17). Each component is outlined below.

A handhold/mouthpiece (Figure 4.17 a) is used to hold the spindle in place while at the same time applying a downward pressure (Moc 2006). Too much downward pressure and the drill will not spin, not enough and the spindle will move erratically, resulting in the spindle slipping out from beneath the handhold. Ethnographic and archaeological evidence reveals that this piece is often held in the mouth (Bennett & Rowley 2004, Birket-Smith 1976b, Boas 1974, Hall 1971), allowing the user to use one hand on the bow and the other to hold the item being drilled (Figure 4.17 f). This works for those items that are too small or too large to be stepped on for stabilization, namely beads, small end blades, and fragile pieces of bone or wood, as well as kayak and sled runners. This stability also stems from the observation that it is harder to hold a large spindle in place with a small handhold. Therefore, larger spindles require larger handholds/mouthpieces.

Caribou astragali (lower ankle bones) were often used as mouthpieces, taking advantage of their natural curvature. They are small enough to fit in the mouth, while at

Figure 4.18: Organic tools from PaJs-2 and IgCx-3: a) caribou rib drill bow (PaJs-2:1981), b) caribou astragalus mouthpiece (PaJs-2:5660), c) antler awl handle (IgCx-3:2420) (Whitridge 1999).

the same time providing a natural indent useful for bracing the tapered end of the spindle (Koerper & Whitney-Desautels 1999) (Figure 4.18 b). Repeated wear from the pressure, abrasion and heat associated with the spinning spindle creates a globular facet in the curved portion of the mouthpiece (ibid). Mathiassen (1976 [1927]:107) also notes that when astragali were not available, mouthpieces were made of antler, wood, and even vertebrae because of their natural holes.

In order to facilitate the spinning process, Moc (2006) states that a hole should be gouged in the middle of the mouthpiece at a forty-five degree angle, forming a cone-shaped depression. This decreases the likelihood of the spindle falling out, while at the same time allowing it to spin freely. The depression may either be made by this deliberate process or as an individual result of extensive use. The spinning produces friction in the hole, in essence boring and smoothing it until the mouthpiece becomes unusable. This occurs when the hole extends too far into the mouthpiece, increasing the likelihood that the spindle may get stuck, when the hole becomes too wide, allowing the spindle to whirl uncontrollably, or when the hole threatens to break through the mouthpiece, as it does on some archaeological specimens.

Made of wood or bone, the end of the spindle adjoining the mouthpiece is tapered to facilitate spinning (Figure 4.17 b). When using the bow drill, it is important that the spindle is mounted outside the arc of the bow (Figure 4.19 a), so that it does not hit the edges of the bow during use (Moc 2006). Moc notes that, the fatter the spindle, the longer the bow has to be to equal the rotation of a thin spindle. Thinner girth spindles require a smaller bow, but produce more wear on the string. The size of the spindle and rotations

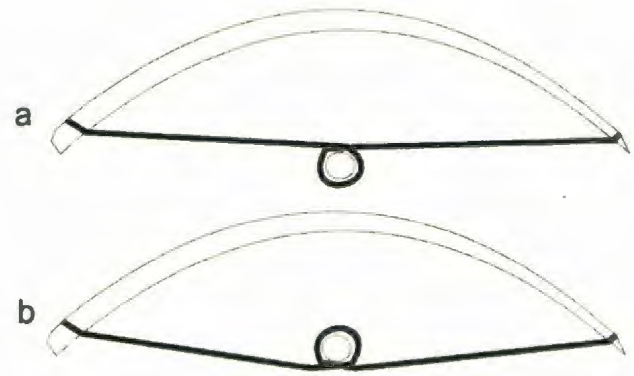


Figure 4. 19: Mounting the spindle in the bow: a) spindle outside the bow arc (right), b) spindle inside the bow arc (wrong).

work the same way as "gearing on a bicycle" (Moc 2006). A compromise can be reached by hafting the spindle into a larger chuck, allowing for a larger drill bit.

While there are examples of the Inuit using hand drills in the archaeological record (Mathiassen 1976 [1927]:82, 1976 [1930]:31), using a bow (Figure 4.17 c) made the drilling process much more efficient and easier to control. Caribou ribs made ideal bows as they are hard, somewhat flexible and naturally curved (Figure 4.18 a). Skin thong or sinew cordage could then be affixed to either end with or without a drilled hole. The coarser the line, the better it grips the shaft, allowing for more intensive strokes and efficient drilling.

An alternative means of hafting a drill bit at the base of a spindle is through the use of a chuck (Figure 4.17 d). The chuck fits onto the base of the spindle, allowing for a single spindle to be used with multiple drill bits, as well as the use of larger drill bits with narrow shafts. A drill bit may be hafted into a chuck in a number of ways: by gouging or

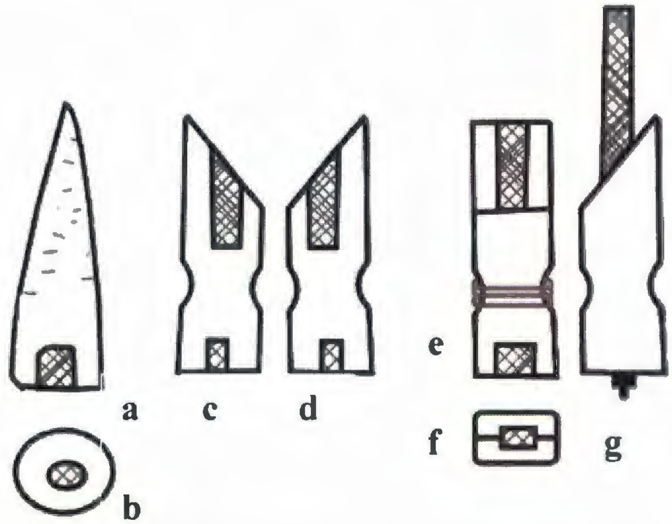


Figure 4.20: Chuck variation: a) chuck with carved slot; b) cross section of chuck with carved slot c) split chuck right segment, d) split chuck left segment, e) lashing of two sections; f) cross section of split chuck g) hafted split chuck with drill bit and spindle.

drilling a hole in the chuck and jamming in the drill bit (Figure 4.20 a-b), or by splitting the chuck in half, or partially in half, and then carving out a rectangular place for the drill bit (Figure 4.20 c-g). While the first example is not as time or labour intensive, it may be difficult to reuse if the bit breaks. The broken/exhausted bit must be extracted without damaging the hafting slot, and then replaced with a bit of equal size. In the latter example, the splitting and then relashing allows for easy replacement of broken or exhausted drill bits.

The media (Figure 4.17 f) being drilled also affects the type of drill bit that is suitable. While soft drill bits may be used on materials that are treated (i.e. antler soaked in water three days; LeMoine 1997), other drill bits are simply useless when it comes to working specific materials (i.e. using slate to drill nephrite). LeMoine (1997) demonstrates that drill bits made of chert, copper, iron and slate could all be used to drill antler, as long as it was properly soaked in advance. In contrast, only the iron bit was able to drill dry antler, while the slate bit broke, the chert bit threatened to break, and the copper bit failed to remove any material at all (LeMoine 1997:28).

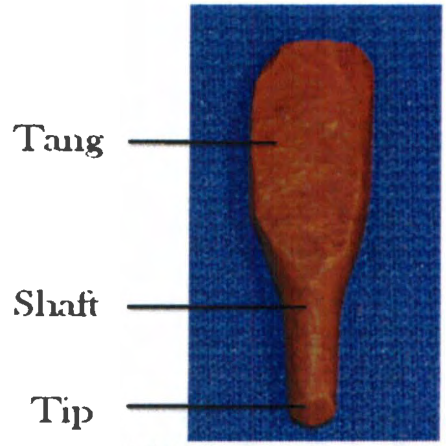


Figure 4.21: Anatomy of a drill bit (IgCx-3:3396).

The drill bit (Figure 4.17 c) typically consists of three parts (Figure 4.21): the tang, the shaft and the tip. The tang is often rectangular, or flat on t

wo or more sides to facilitate hafting. The oval shaft of the bit determines the depth and diameter of the drilled hole. When drilling media thicker than the length of the drill bit shaft, the object would be turned over and drilled from the opposite side. If not done carefully, the holes may not line up, making it difficult to insert a rivet or peg. The tip of each bit may also be sharpened in different ways depending on the media being drilled.

Feature	Nephrite	Slate	Total
House 2	-	1	1
House 2 Midden	1	-	1
House 4	4	1	5
House 6	3	3	6
House 10 Midden	1	-	1
House 12	4	1	5
Total	13	6	19

Table 4.2: Distribution of drill bits by house and material type.

Figure 4.22: Drill bits, awls and gravers from IgCx-3: a-m) nephrite drill bits (2087, 1542, 3437, 3655, 5401, 1905, 5252, 6481,1889, 6518, 5431,5852, 6635), n – r) slate drill bits (3396, 4585, 4435, 5242, 793), s – cc) awls/gravers (1394, 1950, 5697, 6205, 750, 250, 5081, 3868, 2894, 3481, 6282).

Of the nineteen drill bits from Nachvak Village (Figure 4.22), fourteen were made of nephrite and six of slate (Table 4.2). They were distributed evenly among the features, with the exception of House 2 and the two middens, which each only produced one stone drill bit (Table 4.2). Given that only five of the nineteen drill bits were complete it appears that the bits were normally abandoned when broken or exhausted (Table 4.3). Exhausted shafts result from the repeated use and resharpening of the tip and shaft until it encroaches too close to the tang to be functional.

Table 4.3: Distribution of drill bits by portion remaining and material type.

	Nephrite	Slate	Total
Complete (tang, shaft, tip)	2	2	4
Only tang-shaft remaining	4	1	5
Only shaft remaining	7	2	9
Only tip remaining	0	0	0
Preform	0	1	1
Total	13	6	19

Differences in drill bit size can be accessed through the comparison of respective shaft widths, as it is the only consistent measurement that can be taken for most of the drill bits recovered. The only exception to this is the drill bit preform (IgCx-3:5631) which did not have a finished shaft. This comparison reveals two distinct sizes of drill bits: those with shaft widths between 7.9mm and 8.3mm, and those between 2.2mm and 5.9mm. While the five slate drill bits have an average width of 4.4mm, nephrite was used to make drill bits of every size (Figure 4.23).

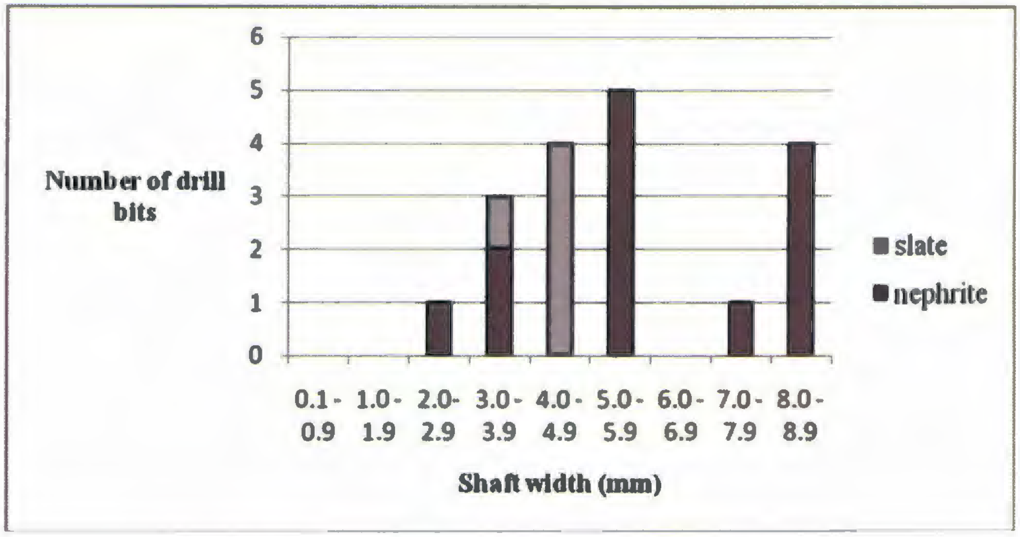


Figure 4.23: Comparison of drill bit shaft widths.

There is also variation in the shape of the drill bit tip, potentially affecting the efficiency of the drill. The tips were unbroken on thirteen out of the nineteen recovered. Nine were V-shaped with two facets, not unlike a chisel (Figure 4.24 a), while two others were pyramidal with four facets (Figure 4.22 d, 4.22 m, 4.24 b).

More work is necessary to fully understand the relationship between drill bit material, tip style and the extraneous techniques associated with drilling that may not be readily documented in the archaeological record, i.e. using a slate drill bit to drill antler (LeMoine 1997). Such studies need to be augmented by experimental and use wear studies to better understand which drill bits were used on which types of materials.

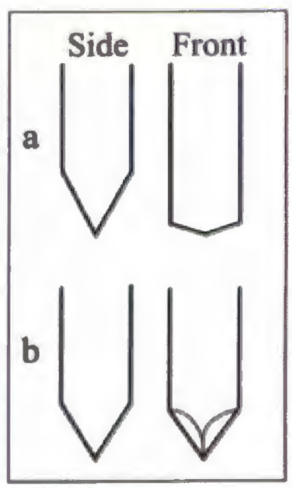


Figure 4.24: Comparing drill bit tip types: a) V-tip (2 facet), b) V-tip (4 facet).

4.1.3 Awls and Gravers

Both awls and gravers may be characterized as having a rectangular proximal end converging into a sharp V-shaped multifacial ground point at the distal end (Hall 1971:41). Both are very similar in morphology, but different in the way that they were hafted and used. Awls are often hafted at the base of a Y-shaped handle, made of antler or bone (Figure 4.18 c, 4.25 a) (Turner1979 [1984]), while gravers are often hafted into a two-part knife handle (Figure 4.25 b) (LeMoine 1997).

Awls would have been used to pierce holes in skins, creating a hole for a needle (LeMoine 1997), or for gouging holes in wood (Turner 1979 [1894]). LeMoine (1997) maintains that awls are a residual category, encompassing any pointed objects that could potentially pierce a hide. While bone awls exhibit crushing due to the pressure of pressing the awl through the hide (LeMoine 1997), additional use wear studies on the tips of prospective ground stone awls may be needed to adequately decide whether or not they were indeed used in this fashion.

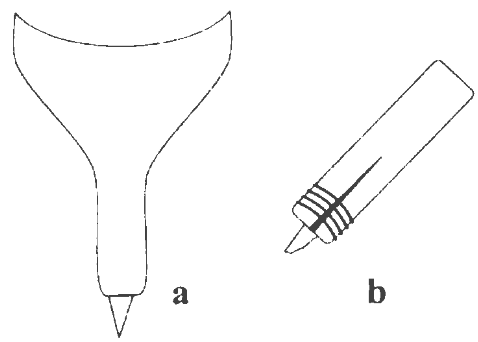


Figure 4.25: Hafting for awl and graver: a) awl (adapted from Turner 1979 [1894]: 114) b) graver (adapted from LeMoine 1997:25).

Tipped with ground stone as well as bone, metal or tooth, gravers would have been used to incise lines and other details into antler, bone, ivory (Hall 1971), and presumably wood and soapstone. LeMoine notes that they are also commonly referred to as splitting knives, used to "split bone and antler using the 'groove and splinter' technique" (LeMoine 1997:25). This entails scraping the graver bit back and forth along the bone to make a groove. The groove is eventually made deep enough to break the piece in half. Another use of the graver was to trace out the desired piece, and then incise the outline repeatedly until the piece could be pried out.

Twelve ground stone specimens may be identified as awl or graver tips (Figure 4.22 s-cc) including seven of nephrite and five of slate. They were distributed throughout the houses, with the notable exception of House 12 (Table 4.4). The awls may be further classified into four observable types, namely: triangular tips ground on two facets, rectangular in cross section (Figure 4.22 v, w, x); multifaceted tips, ground on four sides (Figure 4.22 y, z, aa, bb); and those with conical tips not unlike the tip of a pencil that have been ground so intensively that they are no longer multifaceted (Figure 4.22 s, t, u). IgCx-3:6282 (Figure 4.22 cc) is the anomalous awl as it is much larger than the rest, with a larger tang for hafting and a wider angled tip. It was classified as an awl/graver bit as its tip is polished and rounded not unlike those with conical tips (Figure 4.22 s, t, u). This later example may have also been an expediently reused fragment of something else.

Table 4.4: Comparison of number of nephrite and slate awl/gravers according to feature.

Feature	Awls/Gravers	
	Nephrite	Slate
H2	1	2
H2 M	-	-
H4	3	-
H6	2	3
H10M	-	-
H12	-	-
Total	6	5

4.1.4 Adzes

Adzes are composite tools used to thin down and round out pieces of antler, whale bone and wood. There are two types of adzes: those with the blade attached directly to a handle (Figure 4.26 a), and those with a smaller blade hafted into the slot of an adze head, which is in turn hafted into a handle (Figure 4.26 b).

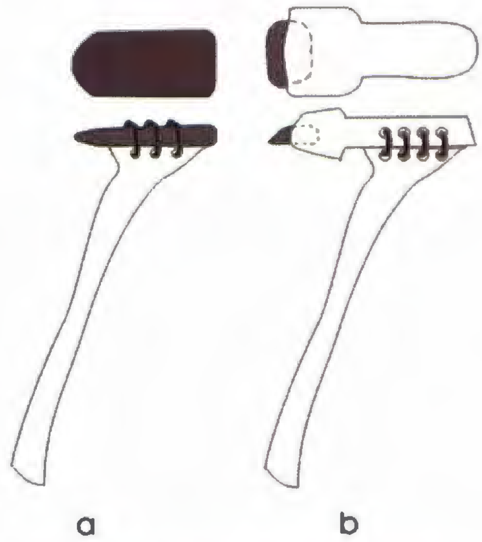


Figure 4.26: Hafting of large and small bladed adzes: a) large bladed adze and b) small bladed adze. (Model after Birket-Smith 1976 [1929]a:206, Boas 1907: 381, LeMoine 1997:26-27).

When looking at the distribution of nephrite and slate adze blades, there appears to be a correlation between the size of the blade and the material type (Figure 4.27). Small blades are almost exclusively crafted out of nephrite, while the larger blades are virtually all made out slate, except for one specimen crafted out of serpentine (Figure 4.27, 4.28 a).

Experiments conducted by LeMoine (1997) show that slate adzes were too brittle for working antler and bone, while those made of iron and copper barely impacted the surface of the dry antler being worked. Nephrite adzes were not tested, potentially due to

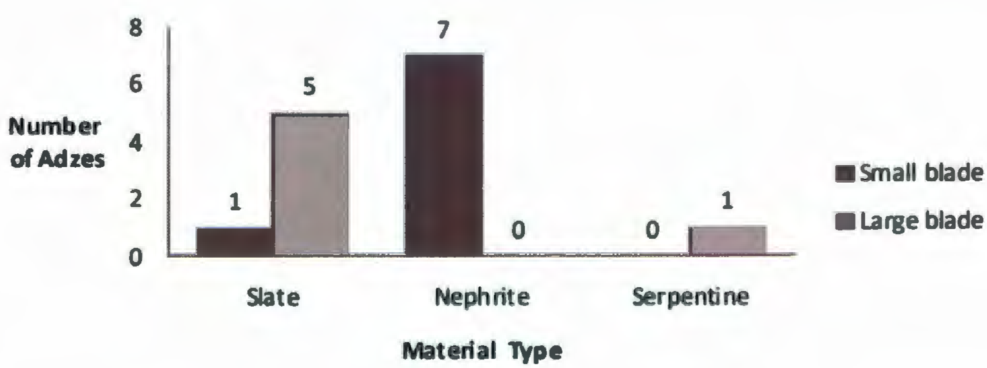


Figure 4.27: Comparison of adze size versus material type.

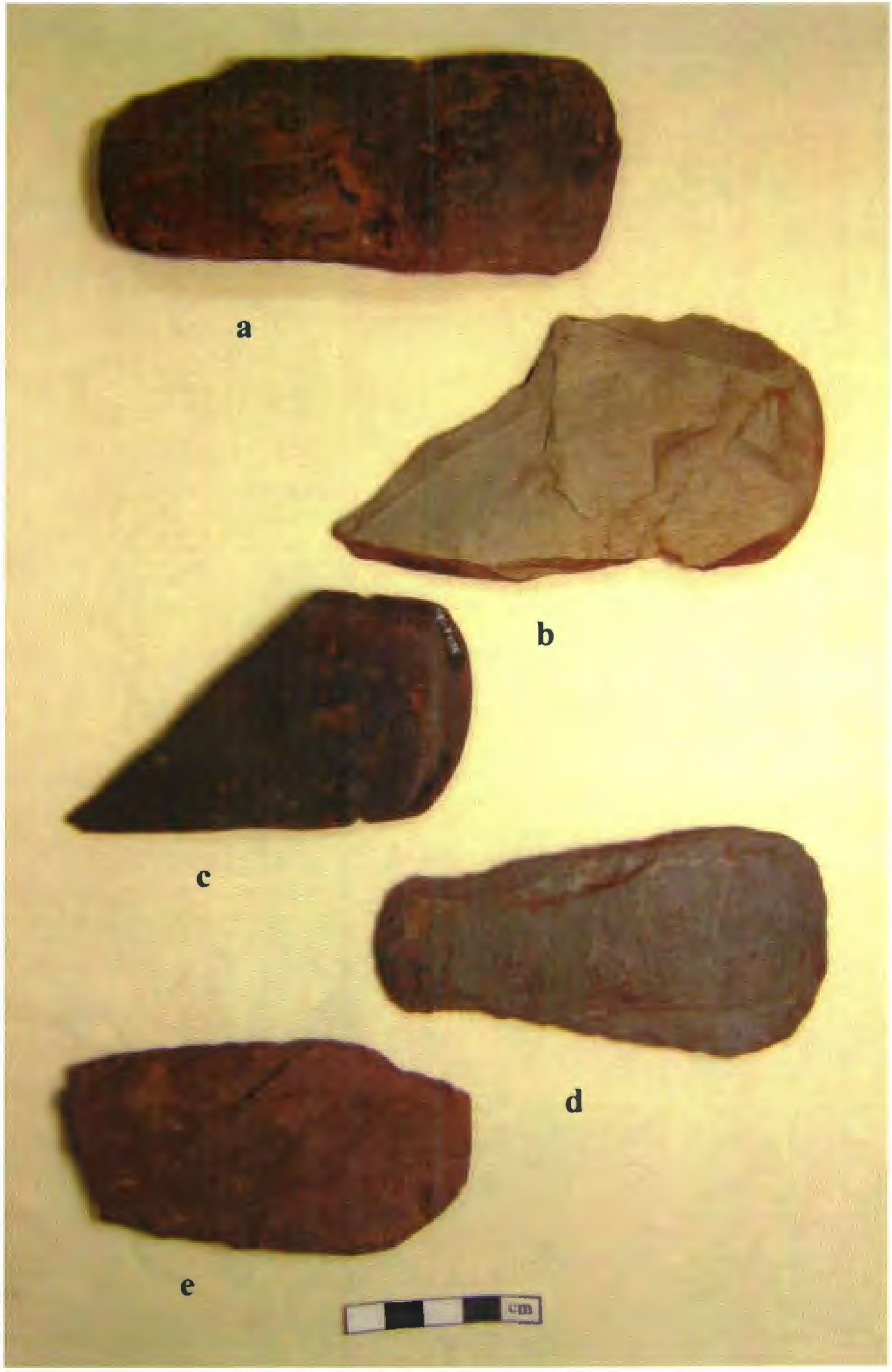


Figure 4.28: Large adze blades from IgCx-3: a) Serpentine adze/whetstone (6796), b, c) Slate large adze/dull scraper blades (5429, 1189), d, e) Slate adze/dull scraper blade preforms (6699, 4119).

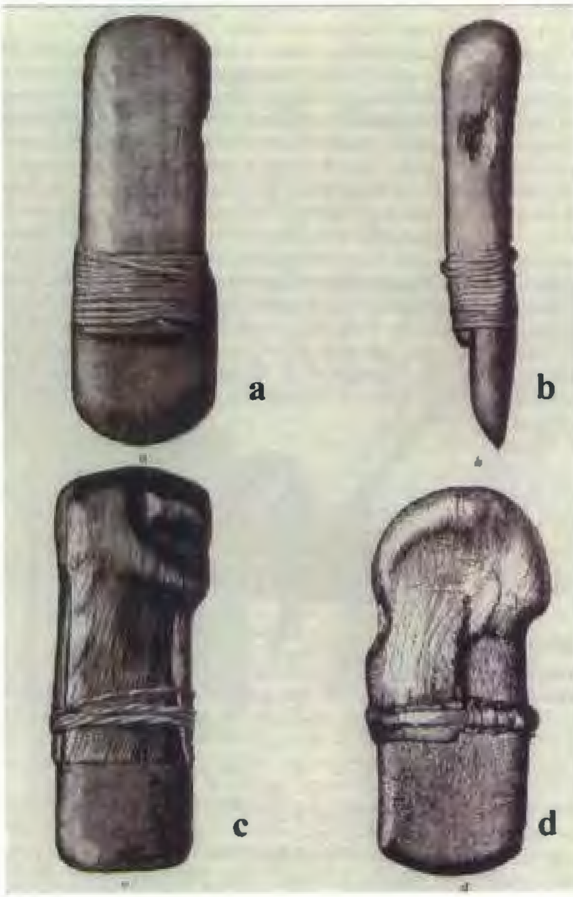


Figure 4.29: Alternative use of 'large adze blades' as dull scraper blades (Boas 1974:521).

Table 4.5: Distribution of adze blades by house, material and degree of completion.

Feature	Slate adze blade		Nephrite adze blade		Serpentine adze blade		Total
	Preform	Finished	Preform	Finished	Preform	Finished	
H2	1	1	-	1	-	-	3
H2 M	-	-	-	-	-	-	0
H4	1	-	-	3	-	1	5
H6	1	-	-	1	-	-	2
H10M	-	1	-	-	-	-	1
H12	1	-	-	2	-	-	3
Total	4	2	0	5	0	1	14

the amount of time required to make adequate nephrite adze blades. Due to the variable strength of slate samples, harder varieties of slate, nephrites, and metamorphic rock, such as serpentine, are prime candidates for adze production. Additional studies are needed to explore the production and use of adzes, including how the use of smaller adzes differs from the use of larger examples.

The large rectangular ground stone objects categorized as large adzes blades may have alternatively functioned as dull-bladed scrapers, "probably used for cleaning skins" (Boas 1974:521), and potentially not large bladed adzes at all (Figure 4.29). Boas (1974) illustrates four similar examples hafted into handles and held in place with baleen straps or thongs. There are more preforms made out of slate than nephrite (Table 4.5). This may be attributed to the curation of nephrite, and the workability of slate compared to nephrite.

Four adzes are highlighted here, as they each tell something different about the production and use life of Inuit ground stone adzes. IgCx-3:6796 is unique because it is one of the few artifacts in the Nachvak assemblage made out of serpentine (Figure 4.28 a). In addition to this, intensive polish on one surface indicates that it functioned as a whetstone sometime during its life history. The use of serpentine in this manner may also hint at awareness of the material and the merits of its use as compared to that of slate. It is also possible to learn about the hafting of the large dull blades through the examination of the notches of IgCx-3:1189 (Figure 4.28 c). This specimen was probably lashed into a handle, perpendicular to the flat portion of the blade, not unlike the dull scrapers discussed by Boas (1974) (Figure 4.29). The notches would aid in the lashing of the blade

Figure 4.30: Small adze blades, beads, and slate disk from IgCx-3:a, b) nephrite adze blade fragments (6130, 4052), c) nephrite adze blade (2309), d,e,f) slate beads (245, 5173, 1651), g) nephrite bead (1729), h) nephrite bead preform (2264), i) slate bead preform (4181), j) triangular bead preform (2284), k) round slate disk (4187).

to the handle. Not unlike a miniature axe, IgCx-3:2309 is an adze blade with a bifacially worked edge, heavily polished by extended use and sharpening (Figure 4.30 c). Hafted as a small adze blade, IgCx-3:4052 (Figure 4.30 b), on the other hand offers a unifacial edge with a multifaceted dorsal side. Both of these differ from the more typical Inuit adze blade (Figure 4.28 b) which is relatively flat on both sides, with one unifacially tapered edge. The variation in size and blade angle most likely indicates differential uses.

4.1.5 Beads

Beads were used to decorate women's hair and clothing so that they would make a sound while walking (Bilby 1923:110, Turner 1979:148), among other things. While initially made of ground stone, ivory, amber, etc. the Inuit also traded for beads made out of iron, copper, glass, and other foreign materials.

Eight ground stone beads were recovered from IgCx-3, five of which are complete and three of which are preforms (Figure 4.30). Four out of five of the complete specimens were circular, with a hole drilled in the center. IgCx-3:2284 (Figure 4.30 j) varies slightly as it appears to be a triangular bead with a partial drill hole in the center. Of the three bead preforms, two were made of nephrite and the other made of slate, all in varying stages of production. Triangular in shape, IgCx-3:2284 (Figure 4.30 j), is partially drilled, showing that drilling could occur at anytime during the bead production sequence. IgCx-3:1729 (Figure 4.30 g) and IgCx-3:4181 (Figure 4.30 i) are further along in the production process, with right angles requiring some additional polishing before they are complete.

On average, the nephrite beads are thicker than their slate counterparts. This may be attributed to the difficulty associated with working the material, and the makers not wanting to waste whatever nephrite was available to them. The colours chosen for the beads are also noteworthy in that the more common blue-grey slate was not used in the production of the slate beads; two are a dusky red, while the other two are a weak red. All of the nephrite beads however are the same dark greenish grey, with the exception of a pale light green IgCx-3:2284 (Figure 4.30 j). Additional testing will need to be conducted to determine whether or not they came from the same source.

In addition to the beads, a possible small amulet was also made of ground stone. IgCx-3:5578 is a weak red triangular piece of slate with a hole drilled in one corner. It measures 12.4mm x 10.6mm. Its weak red color differs from most other slates, potentially increasing the rarity and/or value of this piece. It was classified as an amulet because of its suspension hole and its similarity to the beads found in the assemblage.

4.1.6 Round Slate Disk

In addition to the beads and baleen shaves, a round slate disk (IgCx-3:4187) was also recovered from the site. IgCx-3:4187 is a light brownish grey disk measuring 18.5m mm by 17.7mm (Figure 4.30 l). It is not a baleen shave because of its small size and flattened edges. Quimby describes such flat, thin, ground slate discs as being a form of game counter (1940:159).

4.1.7 Conclusion

Sorting by provisional function serves to highlight the different types of tools, as well as the variations that exist between classes. Gaining an appreciation for the breadth of Inuit ground stone technology also allows an experimental tool maker to better understand the tools and implements available to Inuk tool makers of the past. Knowledge of ground stone technology may be amplified by sorting the ground stone artifacts by their role in the production process, as well as by experimenting with the production and use of analogous artifacts.

4.2 Classification by Role in Production Process

Working on ground stone requires knowledge of the properties of the material, the techniques needed for working it, and the ability to improvise and troubleshoot any unforeseen problems that may be encountered during the production process. These are best understood in the chaîne opératoire context, where one step needs to be finished before the next can commence. Before dividing the artifacts by role in the production process, it is important to outline the stages of production in relation to the production techniques and diagnostic artifacts found in the archaeological record (Figure 4.31).

Once the raw materials have been collected, the tool maker selects pieces of slate or nephrite that closely resemble the size and thickness of the desired end product, increasing time and energy efficiency in the end. Manageable pieces are otherwise broken from an outcrop using an available stone or manipulated through bipolar percussion, namely by placing a slab of raw material upon a larger, often flat rock (anvil stone) and hitting it from above with a hammerstone (Figure 4.32) (Jeske 1992). From this stage, either the blanks are made or manageable pieces are brought back to the main settlement for further processing (Stout 2002).

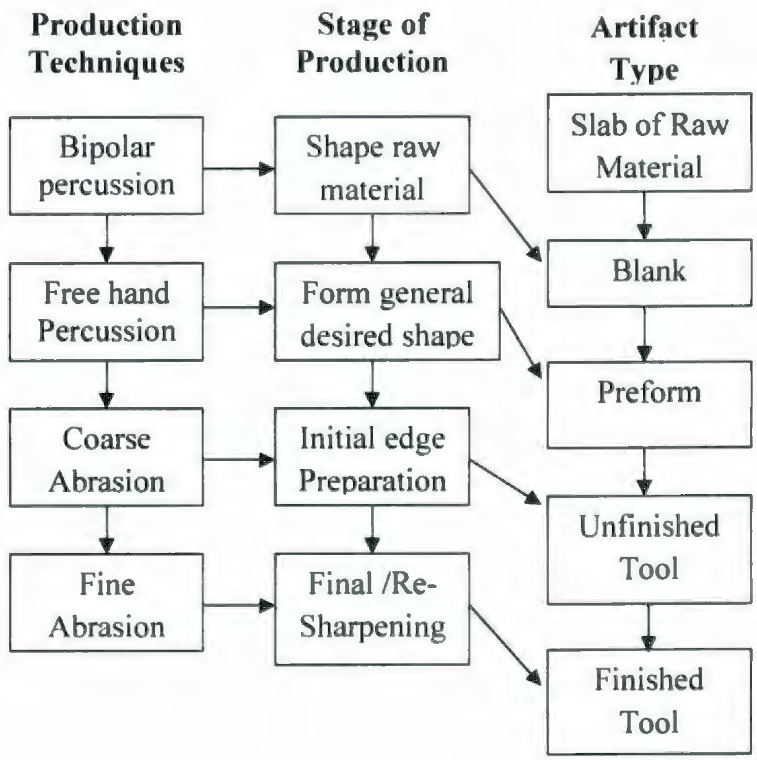


Figure 4.31: Relating ground stone tool production techniques, stages of production and artifact type.

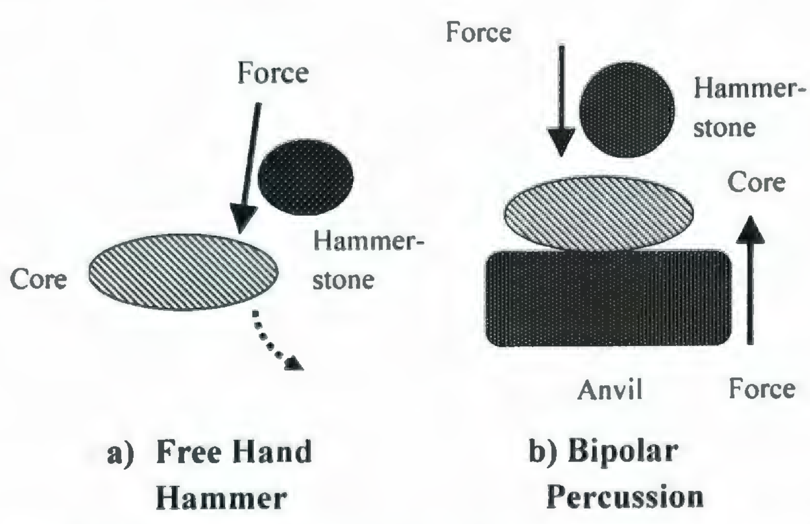


Figure 4.32: Percussive techniques: a) free hand hammer and b) bipolar percussion (Adapted from Jeske 1992:471).

Once a portion of slate is deemed suitable for use, the knapper then uses freehand percussion to reduce the size of the piece even further, forming it into a blank and then a preform of the desired tool. As with flintknapping, freehand and bipolar percussion would create a scatter of flakes and grit from both the tool being worked and the hammerstone.

The preform is then ground with a coarse-grained whetstone, such as quartzite or granite, to smooth the edge and remove the flake scars. The coarser the grain, the more material is removed. This process would take much longer if attempted with a fine-grained whetstone. Removal of the flake scars is necessary as it reduces the friction along the blade's edge during use (Boydson 1989). Finishing touches on the blade require the use of a fine-grained whetstone, such as sandstone. In addition to being used to reduce the friction of the blade, the grinding techniques also serve to enhance the aesthetics of the worked pieces.

It should be mentioned that that bipolar and free-hand percussion techniques are not the only means of preparing a piece of slate for sharpening and use. Inuit cultures in Western Alaska provide evidence of chipped stone use, while some cultures, such as the Aleut at Fort Ross, show evidence of having used the alternative saw and snap method (Mills 1997). Achieving a similar goal, this involves partially sawing through part of the slab and then snapping it. Once this is done, the grinding process follows the same procedure as mentioned above.

Although there have been some criticisims of treating the production process as a linear series of steps, it is useful for explaining the relationship between the techniques used, the stages of production, and the corresponding artifact types that make up the archaeological record (Hiscock 2004) (Figure 4.31). Hiscock (2004) argues that knappers of the past might not have necesarily though about and compartmentalized the production process in the same way that archaeologists and experimental knappers often do. He goes on to argue that tool production is fluid, employing both functional/technological and social/stylistic criteria in making decisions; tools are made and used in a social context and cannot be separated from one another (Hiscock 2004).

Artifacts can be further classified by their role in the production process, in accordance with Sinclair's 'constellation of knowledge' concept of agency (Figure 3.2). These include manufacturing implements, unfinished tools, by-products, and finished tools. Not only are the ground stone artifacts associated with specific stages of production, but they are shaped and worn differentially depending on how they were used. Use wear was concentrated on the particular portion of the tool that was used the most (Rots 2004). This can also be helpful in determining whether a tool was finished, in the later stages of the formative process, and whether or not it was used at all.

Out of the six hundred and sixty six ground stone artifacts examined, only 48% can be clearly classified as finished tools. A total of 22% are implements used in the manufacture of ground stone tools, and an additional 20% are unfinished tools in varying stages of repair (blanks and preforms). A further 9% of the ground stone artifacts can only be classified as 'miscellaneous' as they are too fragmented to be clearly assigned to a specific category. This division of the artifacts according to role in the production process clearly highlights how finished tools make up almost half of the total ground stone tool

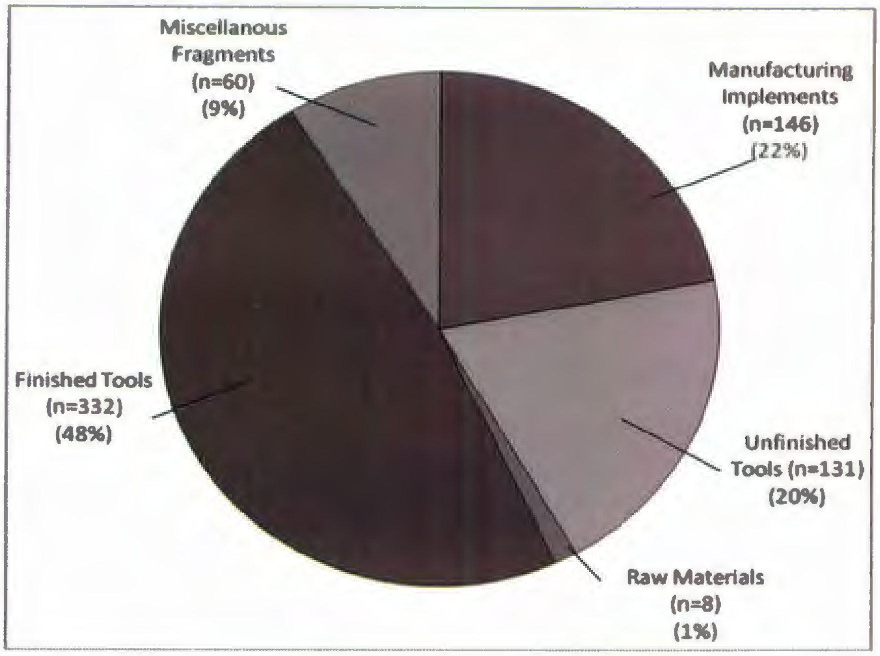


Figure 4.33: Distribution of artifacts according to their role in the production process (n=666).

Table 4.6: Division of artifacts according to role in the production process.

Role in the Production Process

Manufacturing Implements	*Raw Materials*	*Unfinished Tools*	*By-Products*	*Finished Tools*
• Hammer-stones • Peckers • Anvil Stones • Whetstones • Drills	• Slate Slab • Serpentine Slab • Nephrite Nodule	• Blank • Preform • Incomplete	• Flakes • Sand	• Blades • Drills • Whetstones • Gravers • Beads • Amulets • Other Finished Tools

assemblage (Figure 4.33 & Table 4.6). By looking individually at the other classes of artifacts, we can further elaborate on how the tools were made and

4.2.1 Manufacturing Implements

Manufacturing implements make up 22% of the ground stone assemblage. In accordance with Sinclair's 'constellations of knowledge' concept of agency, manufacturing implements include hammerstones, anvil stones, peckers and drills - essentially anything used to work towards achieving the end goal (Table 4.7).

Table 4.7: Distribution of manufacturing implements.

Anvil Stone	2
Hammerstone	5
Hammerstone/Pecker	2
Pecker	2
Utilized Cobble	2
Whetstones	
Coarse-Grained	18
Medium-Grained	26
Fine-Grained	91
Total	146

4.2.1.1 Hammerstones and Peckers

Five hammerstones and two peckers were recovered. Originally beach cobble, they may be distinguished from non-worked beach cobble by the presence of wear marks on one or more surface. Sometimes these marks occur when the hammerstone is used for removing smaller flakes from raw materials, blanks and preforms. These marks are otherwise cause by the repeated striking of the hammerstone against the medium being worked. To a moderately experienced knapper, most of these stones also fit comfortably in the hand, with the wear concentrated largely in one area. If the wear is more random, it may be attributed to less intensive use or alteration due to trampling or excavation processes (Shea & Klenck 1993).

As with flintknapping of cherts and other chipped stone, organic hammers and/or billets can also be used to form and manipulate a piece of raw material into a blank. The difference between a hammerstone and a pecker depends largely on how they were used. While both are used to remove flakes, hammerstones have wear concentrated on one or more surfaces, reflecting a downward sweeping motion and exemplified by the free hand percussion technique. Peckers, on the other hand, have wear concentrated on one edge of the tool, as it would have been exclusively used in a downward motion perpendicular to the anvil stone, as with bipolar percussion (Figure 4.32 b). Having said that, there are also instances where hammerstones could also be used as peckers, to remove flakes from a raw material or blank using bipolar percussion.

IgCx-3:583 and IgCx-3:2920 were used as anvil stones, as they do not have concentrated wear patterns on either edge, but instead across much of their flat surfaces. IgCx-3:4182 and IgCx-3:5984 had clear striations and wear marks on one or more facets. Two were clearly used as peckers (IgCx-3:2068, 2822), as they are too long to be used comfortably as hammerstones and have wear concentrated at one end. Four other examples exhibit ambiguous wear patterns and could have been used as both hammerstones and peckers. One of the remaining two beach cobbles, appears to have been utilized in some fashion, but not as intensively as the others.

The scarcity of anvil stones, hammerstones and peckers may be attributed to them not being consistently collected, as they may easily be mistaken for beach cobble, if use wear is not highly visible, especially if the stones are dirty when uncovered. Personal experience has taught me that knappers are very protective of their hammerstones. They will often show you how to knap using their hammerstone, but you will often not be allowed to touch it. Instead, it is expected that you try with your own stone. The personal nature of the hammerstone may stem from the time associated with finding one with the desired weight, shape and durability. It would be very inconvenient to look for a hammerstone each time you wanted to shape and/or rework a tool. If they are personal artifacts, they may be curated and subsequently not as visible in the archaeological record.

4.2.1.2 Sand as an Abrasive

While not collected during excavation, the potential use of sand in conjunction with water as an abrasive agent should also be discussed. First of all, quantification of the amount of sand used would require intensive screening of sand particles through multiple screens, as well as the separations of sand particles with a microscope, similar to the separation of seeds in paleoethnobotany exercises. Some of the sand is so small it would fall though the screen and would remain relatively indistinguishable without the aid of a high powered microscope. Distinguishing between abrasive agent sand, sand from the production process, and the sand that occurs naturally in the soil matrix would be a time intensive process, if not impossible. Experimentation is needed to discern whether or not this is even possible. Relative amounts of sand and grit could be measured in a controlled experiment where the whetstone is of a particular color and material type, and the media being worked is of a markedly different color and material. The study of sand as an abrasive would also be an important experiment, as grinding makes the process of working stone much more efficient (Darwent 1998).

4.2.1.3 Whetstones

The Concise Oxford Dictionary of Archaeology defines a whetstone as "An abrasive stone, usually sandstone or siltstone of some kind, with one or more shaped faces that can be used for sharpening the blades of metal edged tools such as axes, swords, knives, awls, sickles, or chisels" (Darvill 2002). Given this, whetstones can be readily identified as any stone that has at least one side that has been polished due to wear against another stone. Heavily used examples are often prismatic, with many polished facets, and fit comfortably in the hand.

Whetstones can be further classified by the coarseness of the grain and the material type being used. The coarseness of the grain dictates the stage in which the whetstone was most likely used. Coarse-grained stones are used for the initial edge grinding, once the preform has been prepared. The coarse nature of some sandstones and conglomerates removes greater numbers of particles from the blade surface. Those with a rating higher on the Moh's hardness scale also increase the efficiency of the grinding process, as is evident with the experimental studies comparing the grinding of slate with that of nephrite. The degree of polish and deformity from its original shape reflects the intensity of whetstone use. The degree of polish is also directly dependent on the grain size of the material in question.

4.2.1.3.1 Classifying Whetstones by Material

Whetstones can be classified through the examination of particle size and grain size. Particle size may be used to determine the grain size and material type, this includes:

fine-grained mudrock, medium-grained sandstone and serpentine and coarse-grained varieties of sandstone, breccias and conglomerate rock. Other coarse grained materials that cannot be defined by particle size include granite, dolomite and labradorite. Identifications were made based on the criteria outlined in Table 4.8. With this, grain size was determined by comparing the materials with the particles sizes highlighted in Figure 4.34.

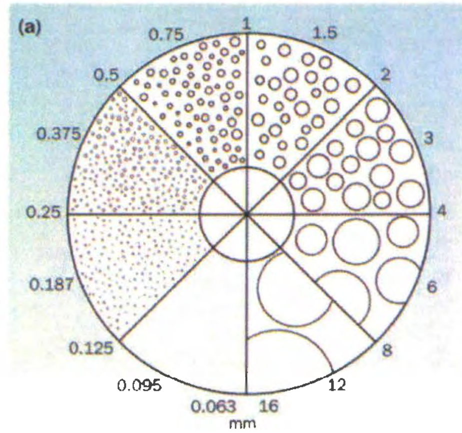


Figure 4.33: Comparative chart for estimating grain size (Stow 2005:110 - Figure 3.28).

Table 4.8: Categories used in the identification of whetstone material type and coarseness (Stow 2005).

Rock Type	Material	Grain Size	Particle Size (mm)	Particles visible to the naked eye?	Horiz -ontal layers	Other Information Useful for Identification
Sedimentary	Mudrock (Siltstone/ Mudstone/ Shale)	Fine	< 0.063	No	Yes	
	Sandstone	Medium	0.063-0.50	Yes	Yes	
	Sandstone	Coarse	0.5-2.00	Yes	Yes	
	Beccias Conglomer-ate	Coarse	< 2.00	Yes	Yes	
Igneous	Granite	Coarse	n/a	Yes	No	
Metamorp-hic	Serpentine	Medium	n/a	No	Yes	Platy/fibrous, scaly
Tectosilicate	Labradorite (Plagioclase Feldspar)	Coarse	n/a	Yes	No	Shiny blue flecks when held at angle to light.

High numbers of fine grained whetstones may be attributed to the brittleness of the stone and the abundance of particles removed during use. Harder, coarser stones tend to degrade more slowly than finer varieties of stone, except for dolomite and other fragile coarse-grained stones in which their outer, more weathered edges crumble away until the solid interior is revealed. Known for its fine grain size "mudrock is a general term for sediments composed chiefly of silt (4μm to 62μm) and clay (<4μm) sized particles" (Tucker 2003: 39). These fine grains remove small amounts of material from the blade's surface to form the optimal cutting edges. Not only do these types of stones occur more frequently in the archaeological record but they also are among the most common among all lithic types (Tucker 2003).

Sandstone whetstones are coarser than mudrock, but not as coarse as their breccia and conglomerate counterparts. Matrices of silt and clay are intertwined with coarse grains like quartz, feldspar, and other rock. The relative concentrations of these ingredients depend on the environment in which they were formed. This subsequently results in a somewhat arbitrary division between medium (0.063-0.5mm) and coarse-grained (0.5-2.0mm) varieties of sandstone. The primary difference between sandstones and mudrocks is that sandstone feels slightly rougher than mudrock with inclusions visible to the naked eye. The glassy nature of quartz particles shimmer when held at an angle to the light.

Breccias and conglomerates are the coarsest variety of sedimentary rock. The majority of particles are 2mm in diameter or more, due to the larger fragments of quartz crystals present during formation. Any less and they may be classified as pebbly sandstones or pebbly mudstones. Due to the nature of sedimentary rock, some of these whetstones may be banded with finer grained mudstone and/or sandstone layers cementing the larger particles of quartz or other minerals in place (Stow 2005).

Aside from sedimentary rocks being used as whetstones, other rock types were also used. They include: medium grained serpentine, coarse grained igneous granite, and coarse varieties of feldspar, like labradorite. According to Chesterman (1979), serpentine ranges between three and five on the Moh's scale of hardness. This platy fibrous mineral is described as greasy or waxy to the touch and does not appear to be widely used a whetstone. The formation of serpentine is discussed below in relation to nephrite (Chesterman 1979:527).

Despite having the same rating as slate on the Moh's scale of hardness (Table 5.1), granite's usefulness as a whetstone comes from its resistance to crushing and weathering, as well as the coarseness of its rough and pitted veneer. High in silica, potassium, sodium, and quartz, granite also has the ability to take on a high polish (Chesterman 1979: 695). Plagioclase feldspar whetstones, such as labradorite, are useful for the grinding of nephrite because they have a rating of 6.0 or more on the Moh's scale of hardness. It is important to note that labradorite is only one type of plagioclase feldspar. As an "important rock-forming mineral" (Chesterman 1979: 510) examples can be found throughout the world. The labradorite version is worth noting, because examples were found in the whetstone collection. It is commonly collected in eastern Labrador. These are just some of the rocks and minerals used as whetstones; in-depth discussion of each and every whetstone is outside the scope of this project.

4.2.1.3.2 Distribution of Whetstones at Nachvak

One hundred and thirty-five whetstones were recovered from IgCx-3. They were classified by material type and grain size (Table 4.9). Of all the whetstones, 65.9 % were fine-grained. This can be attributed to mudrocks being the most common form of sedimentary rock, and the importance of using a fine-grained whetstone for finishing and

Table 4.9: Distribution of whetstones by grain, rock type and percentage of total whetstones.

Grain	Rock Type	Number of Whetstones	Percentage of Total Whetstones
Fine	Mudrock	83	
	Unclear	6	
	Fine Total	89	65.9
Medium	Sandstone	20	
	Serpentine	6	
	Unclear	2	
	Medium Total	28	20.7
Coarse	Basalt	1	
	Beach Cobble	1	
	Breccias	1	
	Dolomite	1	
	Granite	5	
	Granite/Diorite	1	
	Labradorite	1	
	Sandstone	6	
	Coarse Total	18	13.3
	Grand Total	135	

maintaining the ground stone tools. Sixty-seven out of these eighty-nine whetstones were fractured, indicating both intensive use and friability of the material. The high proportion of fine-grained whetstones may also indicate that coarse stones were not needed to work softer types of slate. Working the slate preforms with only fine-grained whetstones would mean an increase in the time associated with shaping and polishing the tool. The intensive use of the whetstones is highlighted by the high percentage of broken whetstones (Figure 4.35), multifaceted polishing of numerous samples and the markedly thinned areas on

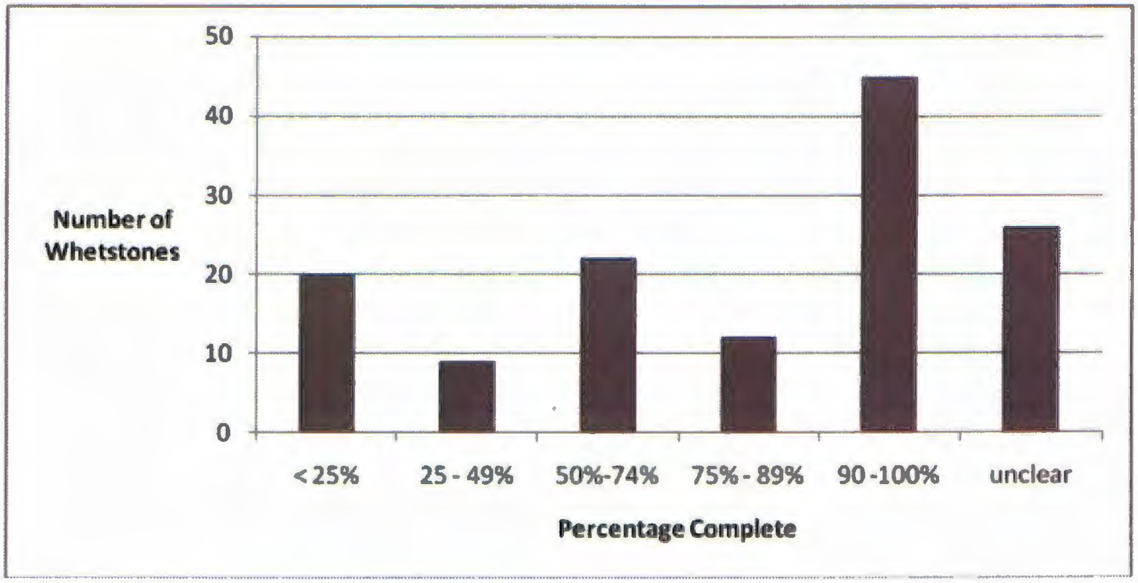


Figure 4.34: Distribution of whetstones by degree of completeness.

many of them. Multifaceted polishing took place on 55.6% of the whetstones (Table 4.10). This serves to maximize surface area for grinding. There is also variation in the morphology of whetstones in addition to of having been ground on one or more facets. Whetstones occur in five distinct shapes, with unidentifiable fragmented pieces classified as other (Figure 4.36). Rectangular whetstones (Figure 4.37 c) are different from prismatic whetstones (Figure 4.37 h) as the latter tend to be ground at right angles, without creating

Table 4.10: Distribution of whetstones by number of facets polished.

Facets Polished	Number
Single	57
Multiple	75
2 Facets	49
3 Facets	10
4 Facets	10
6 Facets (all sides plus 2 ends)	6
Unclear	2
Total	134

a uniform rectangular shape. Oblong pieces (Figure 4.37 g) are longer than they are wide, without the symmetry of an oval whetstone (Figure 4.37 e). With the exception of IgCx-3:3362 (Figure 4.38), the wedge-shaped whetstones appear to have been rectangular at one time, but ground into a wedge shape due to extensive use. The sloped portion of IgCX-3:3362, appears to have been harvested as a wedge shape, rather than having been shaped into a wedge through abrasion. Its size also serves to highlight the use of 'mega' whetstones, too lengthy and weighty to be handheld. They would instead be placed on the floor, or in one's lap, with the blade ground against it.

Another whetstone worth noting is IgCx-3:1440 (Figure 4.37 a). It is a small rectangular whetstone with a partial drill hole in one end. Rankin & Labreche (1991) note that whetstones were often attached to uluit via sinew or leather cordage for easy resharpening of the blade. Since uluit are considered to be primarily women's tools, the

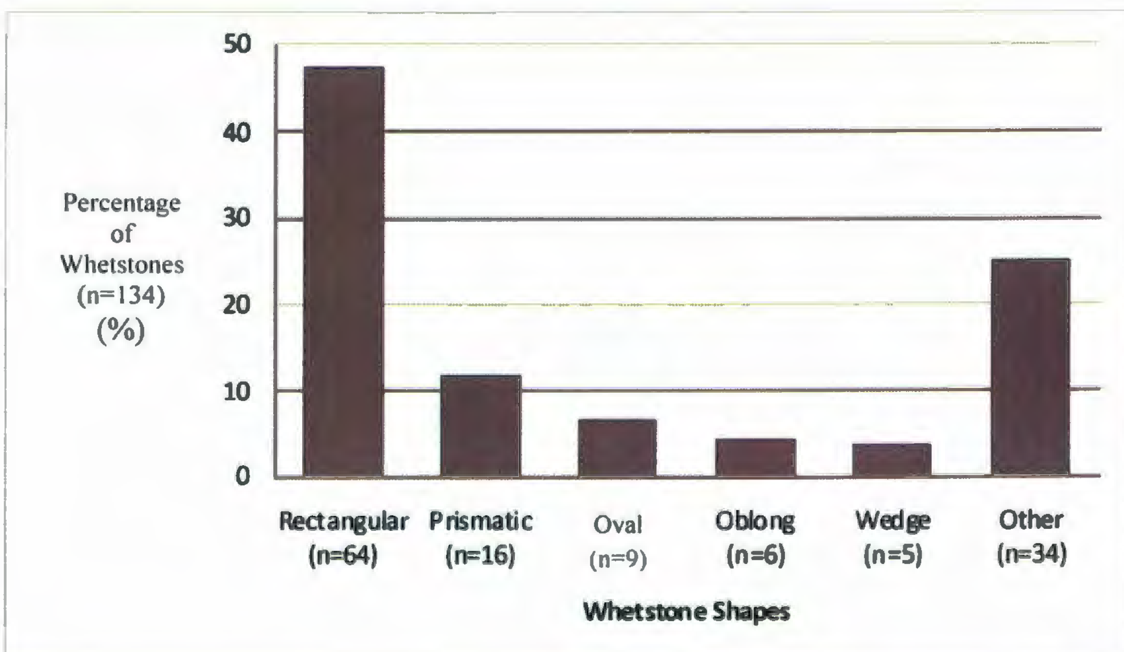


Figure 4.35: Morphological distribution of whetstones.

Figure 4.36: Sample of whetstones from IgCx-3: a) fine-grained mudrock with partial drill holes (1440); b, c) fine-grained unclear (2793, 5112) d) fine-grained serpentine (3525); e) fine-grained mudrock (4460); f) fine-grained sandstone (4182); g) fine-grained uncle (1184) h) coarse-grained conglomerate (1389), i) coarse-grained sand stone (721).

Figure 4.37: Large wedge-shaped labradorite whetstone (IgCx-3:3362).

use of a whetstone in this way would suggest that women took an active role in the maintenance of Inuit ground stone technology.

IgCx-3:4739 was located in the middle of the second lobe of House 12, between the sleeping platform and lamp stand. It is polished primarily on the surface that was facing up. It may have been used while sitting at the edge of the sleeping platform, as either a large whetstone, or an anvil stone.

IgCx-3:4088 was recovered in House 6, beneath the sleeping platform. It measures 193.1mm long, 190.0mm wide and 19.4mm thick. It weighs 1.7kg. While both sides are polished to varying degrees, it may have also been at one time placed vertically against the front ledge, acting as a door, essentially concealing the contents of the compartment.

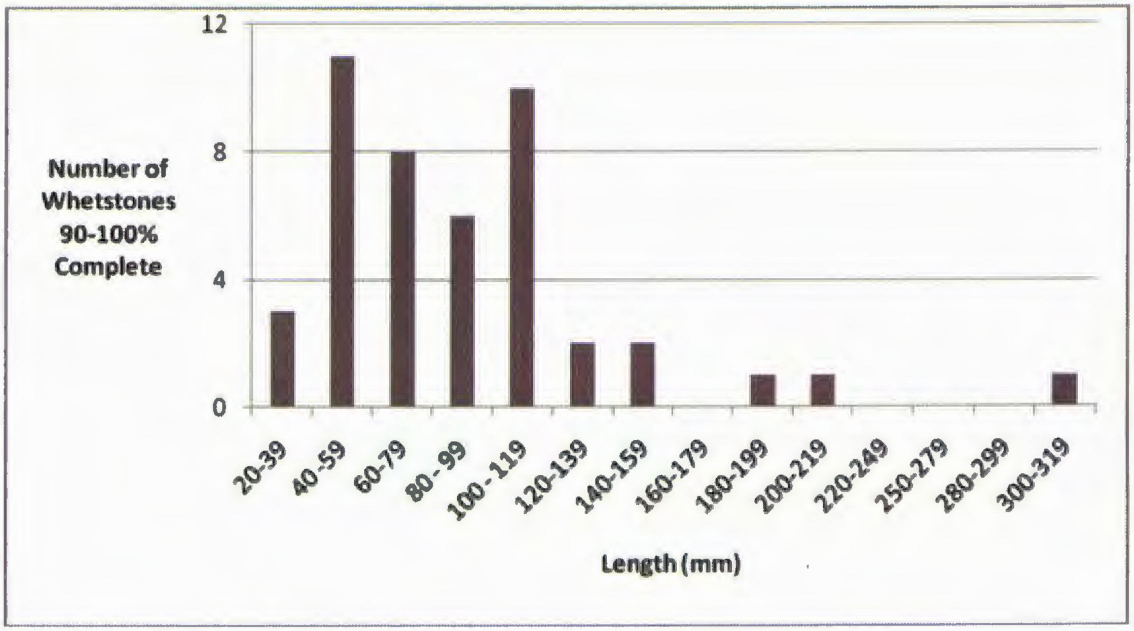


Figure 4.38: Relative lengths of 90-100% complete whetstones.

Whetstones were separated by estimated degree of completeness (Figure 4.36). Only the complete (90-100%) category was used to determine size variation amongst the whetstones (Figure 4.39). Forty-five whetstones were 90-100% complete, meaning that only minimal amounts of flakes had been removed, without compromising measurements of total length, width and thickness. The three largest whetstones, as determined by dimensions and weight, were not included in the analysis of whetstone size because they were substantially larger than the others. Some whetstones are small, some fit comfortably in the hand, and others are somewhat larger, but all are small when compared to the larger whetstones, like IgCx-3:3362 (Figure 4.38). Most complete whetstones are between 40mm and 219mm in length (Figure 4.39). Only three are between 20-39mm, and an additional four between 120mm and 155mm. Variations in length and size can reflect the original stone, grain size of the whetstone, and grain size of the medium that was ground, as well as the intensity of use.

4.2.2 Unfinished Tools

Just as the by-products and implements provide information on how a tool was made, so can the analysis of unfinished tools. Unfinished tools reflect a break in the chain of production. The tool was abandoned either because it broke, or was lost unintentionally within the house. When discussing the Inuit Houses at Eskimo Hutte (IkDb-2), Loring (1998) notes that Europeans entering Inuit houses often found them notably dark. Slabs of raw materials, blanks, and preforms clearly illustrate breakage from being used, while at the same time illustrating the variety of stages inherent in the production process.

4.2.2.1 Raw Material

Samples of raw materials, like slabs of slate or nodules of nephrite, may be used to assess the sizes of raw materials intentionally brought to the camp, either gathered directly from the source, or acquired through trade. Inuit throughout the arctic actively engaged in long range trading to obtain materials necessary for tool production (Whitridge 2002). All raw material samples would have been initially selected at a quarry site and transported back to the settlement to be worked.

Identification of slate slabs as raw materials may be problematic as excavations at Nachvak Village revealed that they are important structural components of the excavated houses. They are actively used to prop up sleeping platforms, form walls, and most notably pave floors. One must take into account the slab's provenience in relation to these structural components, as well as any intentional flaking created by removal of the slab from the quarry site, or the removal of blanks from the slab.

Identification of serpentine raw material and blanks are also problematic as they too were used as floor tiles in some instances. Examples of this include the paving stones found in House 4 as well as in the Centre Trench at IgCv-7. The Centre Trench was identified as a potential qargi, or ceremonial men's house, in part due to the carefully paved floor and possible bench (Whitridge 2006). It should also be noted that serpentine was not collected/recognized uniformly as its potential as a raw material is not often considered. Darwent (1998), however, experimented with the production of celts out of serpentine as an alternative to working with nephrite.

While seven slabs of unworked slate were recovered, there was no nephrite on site that was not worked in some fashion. This could be attributed to the rarity and consequent heavy curation of the material. The slate slabs range in size from 71mm to 190mm in length. Three were flaked during reduction from a larger piece of raw material (IgCx-3:2128, 6313, 714), while the other four were not (IgCx-3: 2280, 4576, 2823, 4088). A large soapstone blank was also recovered from House 2.

4.2.2.2 Blanks

Blanks fall between raw material and preforms in the production process (Figure 4.31). They have the potential to be crafted into virtually any ground stone tool, only limited by blank size and the cultural and practical experiences of the tool maker. It is beneficial to have a blank as close as possible to the desired end product, as it minimizes the amount of flaking and grinding required to finish the task. For example, IgCx-3:6024 (Figure 4:13 d) may be crafted into an ulu, large knife, end blade or any of the other smaller ground stone tools. Thirty-one blanks were recovered. Twenty-nine blanks were made of slate and two of serpentine (IgCx-3:4511, 4975). They all appear to have been shaped from a larger slab of raw material.

4.2.2.3 Preforms

Preforms are modified blanks that have gone through a phase of production designed to form them into an identifiable end product. Ascribing preforms to a particular end goal may however be problematic, as many preforms have the potential to be crafted into a variety of ground stone tools (Kooyman 2000:47). Comparisons of blanks and preforms allows for a better understanding of the various parts of the production process.

For example, slate blank, IgCx-3:6399 (Figure 4.13 a) could have been shaped into a preform resembling IgCx-3:2013 (Figure 4.13 b), and then into one like IgCx-3:4828 (Figure 4.13 c) and then ground smooth into a complete ground stone knife.

The more a preform is worked, the more it resembles the desired end product. The completeness of a preform may be assessed by looking at the degree to which it was chipped and/or ground (Table 4.11). Those early in the sequence have the greatest potential, while later stage preforms are more clearly identifiable. Preforms that were primarily shaped through flaking and not grinding document the transition from a blank to a preform, while those that have clear form (ground and relatively free of flakes) reflect the stage just before the tool is finished. Most preforms were either worked with minimal grinding or have a clear form with grinding covering up much of the initial flaking used to shape the object.

Table 4.11: Using degree of chipping and grinding as a proxy for stage of preform production.

Stage of Preform Production	Shaped	Clear Form	Total
No Grinding	21	14	35
Chip > Ground	17	7	24
Chip = Ground	8	9	17
Chip < Ground	1	21	22
Total	47	51	98

4.2.2.3.1 Unfinished Drill Holes

Depending on the tool, assessing the completion of a preform may also include noting whether or not it was drilled. The presence of complete and partially drilled holes can reveal much about the manufacturing process, namely, at what stage holes were usually drilled, and why a particular hole may not have been completed. Looking at partial holes also reflects the two-part process of drilling holes. The hole would be started on one side, drilled as far the length of the shaft permits, and then turned over to finish the hole from the other side. At times this was not always done successfully, as the holes did not perfectly line up. These examples could reflect inexperience, or just a simple mistake made by an experienced tool maker.

It is reasonable to assume that holes were drilled at a late stage in the production process, at least after the preform was adequately shaped and before the grinding process began. Holes affect the structural integrity of the blade. Further manipulation, through pecking and hammering, may produce unwanted fissures in the blade, making it more susceptible to breakage during manufacture or use. This assumption is supported by the lack of drilled blanks and the four blade preforms that were drilled in the later stages of production. IgCx-3:4262 was flaked into a yet unrecognizable blade form (Figure 4.40 a, b). End blade preform IgCx-3:5802 and knife blade preform IgCx-3:2433 (Figure 4.40 c) were more chipped than ground; both were broken along the holes. IgCx-3:1478 was ground more than it was chipped into a harpoon head end blade preform. This hypothesis may also be verified with the experimental production of slate blanks and preforms, with holes attempted at varying stages. In essence, the aim would be to emulate the same techniques and forces to better understand the mechanics of breakage associated with tool production.

Figure 4.39: Drilled blade fragments from IgCx-3: a) 4262a, b) 4262b c) 2433.

4.2.3 By-Products

The by-products of Inuit ground stone tool production are flakes from freehand and bipolar percussion, and sand/dust residues from both flaking and grinding. Depending on whether or not a tool was recycled, some flakes may be polished, drilled, or even consist of a portion of a broken blade, as a smaller tool may have been formed out of the remains of a larger broken specimen. The most notable by-products of the ground stone tool production process are the flakes produced by the reduction of the raw materials into blanks and preforms. Just as in flintknapping, these flakes occur in three stages, namely primary, secondary and tertiary. Primary flakes are the largest, with the greatest percentage of cortex; secondary flakes are smaller in size with some of the cortex from shaping the raw material into blanks. They are followed by tertiary flakes, which are the smallest, most abundant type of flakes, with relatively little cortex because they are formed during the final shaping of the preform (Kooyman 2000).

Large primary flakes may be absent from the assemblage as they are prime candidates for production into smaller tools, such as end blades, drill bits and gravers. Alternatively, the absence of primary flakes with a high percentage of cortex may be attributed to the production of blanks at the raw material source, with only smaller pieces and blanks brought back to camp. While there is an abundance of slate flakes in the collection, there is little evidence of flaking from nephrite blanks, as nephrite does not flake as reliably as slate (Darwent 1998). Any fragments of nephrite would likely have been used due to the rarity of the material.

4.2.3.1 Sand

Sand is produced during both flaking and grinding processes. Small flakes and sand are produced when the hammerstone and/or peckers are used to reduce the slate or nephrite core. They may be likened to the smallest of tertiary flakes. Since the whole act of grinding/abrasion is the rubbing of a hard material against a softer material (Banning 2000), sand is invariably produced during this stage of the production process. Sand comes from both the preform and tool being ground, and from the whetstone, as both are worn differentially through the grinding process. The effect of abrasion on a whetstone is clear because they are classified by virtue of having at least one of their sides polished through abrasion (Darvill 2002).

Soil samples were not collected for the separation of different types of sand because sand in the burial environment would come from a variety of sources. In addition to sand produced from the grinding of the whetstone and the media being ground, there would also be naturally occurring sand tracked in from people living in the house. The sand may have also been used as grit to aid in the grinding process. The separation of the sand would be too labour and time intensive, and would be better assessed using controlled experiments. If actually feasible, such an experiment would compare the sand residues from distinguishable whetstones and slate preforms that are ground above a tarp that would collect all the sand particles. One could weigh the whetstone and preforms before and after grinding and estimate how much material was lost through grinding.

4.2.4 Finished tools

While they are the most valued and aesthetically pleasing, finished tools make up only 48% of the total ground stone assemblage (Figure 4.33). These finished tools are used by archaeologists to define cultural groups and provide information about a variety of topics, such as seasonality, economic strategies, raw material usage, assemblage variability, and division of labour (Banning 2000, Odell 2004).

Not all the finished tools are complete. A total of 34.6% are complete and 65.4% were fragmented. This high percentage of broken tools reflects the fact that most tools eventually break during use. While larger tools have a greater likelihood of being recycled into smaller tools, only 2.4% or sixteen of the six hundred and sixty-six ground stone tools appear to be clearly reworked. Reuse of other tools is debatable as they may have been reworked to such a degree that the original tool is not longer recognizable.

Sixty-one percent (n=263) of the tool fragments were identifiable and could be classified based on provisional function. Eighteen percent (n=76) have a clear blade edge, but are fragmented to the degree that the blade type could not be determined. An additional twenty-one percent (n=90) could be distinguished from regular flakes due to varying degrees of polish on one or more surfaces. The fragmentary nature of the polished pieces prevents them from being identified as portions of blades or blades in various stages of repair.

Figure 4.40: Fragmented knife blade (IgCx-3:915) before refitting, highlighting identifiable, polished and miscellaneous blade fragments

Figure 4.41: Fragmented knife blade (IgCx-3:915) after refitting.

The high percentages of polished and miscellaneous blade fragments highlight the usefulness of refitting to aid in the identification of smaller fragments. For example, IgCx-3:915 (Figure 4.41) consists of ten pieces that fit together to form a knife or lance blade. If found individually, scattered throughout the house, they might otherwise be classified as three identifiable fragments, four polished fragments, and three miscellaneous blade fragments. Assembled together (Figure 4.42) they reduce the number of polished and miscellaneous blade fragments, while at the same time shedding light on how these artifacts were formed.

4.3 Conclusion

Classifying tools by their role in the production process reinforces the notion that ground stone technology consists of much more than the finished tools that we observe in the archaeological record. Analysis of manufacturing implements, unfinished tools, and by-products completes the life histories of the artifacts recovered. It also aids in understanding ground stone technology and production of experimental replicas by providing tangible examples of the implements used in manufacture, and what tools look like when they are only partially finished. Looking at tool manufacture in this way also provides practical examples of how things can go wrong, such as accidental fractures, holes not lining up and other unforeseen problems. The production of tools can be further understood through a comparison of the two main material types being worked, namely slate and nephrite.

Chapter 5: Comparison of Slate and Nephrite

Before discussing the experimental replication of Inuit ground stone technology, it is important to discuss how nephrite is worked, as well as the similarities and differences between nephrite and slate. These include hardness, sourcing, raw material procurement strategies, evidence of tool production and the distribution of nephrite and slate artifacts, based on house and function. Such a comparison ultimately highlights the pros and cons associated with working and using each material.

5.1 Working Nephrite

Chosen for its toughness and ability to resist fracturing as compared to slate and chert, this strength comes as a mixed blessing. The very structure that gives it its strength also ensures that it breaks unreliably. It cannot be flaked like chert, obsidian, or other knappable stones, nor can it be reliably chipped as is done with slate. Despite this Inuit, Chinese, prehistoric British Columbia Plateau dwellers and other jade and nephrite working groups have demonstrated that it can be worked (Darwent 1998).

The primary way of working nephrite is through controlled tedious abrasion. Investing a lot of time and energy into each nephrite object, such attrition may be used in the initial stages of production in association with the groove and snap technique, eventually leading to the laborious task of grinding an edge to form a blade. The archaeological record reveals that Inuit made beads, drill bits, gravers and other tools out of nephrite, likely requiring an array of manufacturing implements and techniques.

Looking at analogous examples of nephrite production and use can provide insight into the unrecorded methods used by the Inuit of Labrador. Such methods were not recorded by the early missionaries, ethnographers, and explorers who first began to write about their encounters with the Inuit (Boas 1907, Hawkes 1916, Birket-Smith 1976 [1929] a, b). This is because there was little interest in the production of stone artifacts, and by that time iron had replaced all of the tools that would have previously been made of nephrite (Kaplan 1980). It once again comes back to the costs and benefits of using nephrite and slate. Depending on the cost of trade goods and the qualities of the materials, it may be more not be worth it to spend time and energy crafting tools out of nephrite, when you can trade for a tool made of iron (i.e. iron tipped awls, knives, and drill bits). In a similar vein, it is also easier to cold-hammer a piece of iron or haft a nail into a handle, than to spend hours and hours working with the nephrite. This argument is reinforced if one accepts McGhee's (2000) and McCartney & Mack's (1973) argument that the Thule migrated across the Arctic in search of meteoritic and Norse smelted metals.

Darwent (1998) discusses the costs and benefits of making celts out of nephrite, when 'lesser' materials such as slate and serpentine were also available. He notes that while it was worthwhile to invest the time and energy to make nephrite celts, its choice as a raw material was also influenced by its role as a status symbol among the prehistoric peoples of the British Columbia Plateau. Unlike in the eastern Arctic, there is an abundance of well known nephrite sources throughout the British Columbia Plateau. In this instance, time is the governing factor for nephrite use, not necessarily material procurement or curation. Darwent (1998) notes that ethnographic sources reveal that people devised strategies for nephrite working when time for subsistence was not at a premium. It was by efficiently gathering massive amounts of food and resources that they were able to devote so much time to nephrite celt production (Darwent 1998: 90-93). The bulk of his experiments revolve around the reproduction of nephrite celts by sawing blanks from large nephrite boulders, via a sandstone saw lubricated with water and gritty sand particles.

Darwent (1998) discusses three methods of forming a celt blank, namely pebble modification, flake blank modification and sawing a blank out of a larger piece of rock. Pebble modification involves a pebble roughly the size of the desired piece being pecked and ground into the desired shape. The efficiency of this method depends largely on the size of the original pebble, and its closeness to the desired shape. Flake blank modification manipulates the shape of the blank using flaking reduction. Darwent states that this process is particularly problematic when working nephrite as it tends to break unpredictably, wasting large amounts of material (ibid: 33). The third and most time intensive method involves sawing blanks out of a larger piece of rock using the groove and snap technique. While this may take longer to form the preform, the blade edge may be formed during creation, thus reducing the overall grinding time.

The primary means of sawing include the use of a stone saw, a thong or a tapered piece of wood. The saw would be made of a durable material, such as a "sharp silicate sandstone," (Darwent 1998:14) chert, or something that ranks higher on the Moh's scale of hardness. These would be used in conjunction with copious amounts of water and gritty sand with the aim of increasing sawing efficiency. The potential of oil or grease performing the same function as water (Darwent 1998:16) is worth noting, as oil may be found throughout the prehistoric Inuit household as a result of their reliance on sea mammal products.

5.2 Hardness

In addition to its lustrous green appearance, nephrite is best known for its hardness and durability as compared to slate. Harder than steel or glass, nephrite rates 6.0 to 6.5 on the Moh's hardness scale (Table 5.1), ten being the hardest and one the softest. It derives its strength from the interlacing of quartz crystals and other minerals present during metamorphosis. In contrast to nephrite, slate is ranked 5.5 or lower on the scale, depending on its formative environment (Chesterman 1979).

Table 5.1: Moh's scale of hardness (Chesterman 1979:27).

Hardness	Mineral/Material
10	Diamond
9	Corundum
8	Topaz
7 7.0	Quartz Chert
6 6.0 - 6.5	Feldspar Nephrite
5 5.5 < 5.5	Apatite Glass, Steel, Granite Slate, Serpentine
4	Fluorite
3	Calcite
2 2.2	Gypsum Fingernail
1	Talc

Hardness of the material being worked directly impacts the effectiveness of the implements used to manipulate the stone. Relatively soft hammerstones and peckers (below six) would shatter with repeated impact against a piece of nephrite. Likewise, working nephrite with a soft whetstone would be futile, as the whetstone would disintegrate with extensive use. A whetstone made of quartz, or high concentrations of quartz or a harder material, would be necessary. Early groups in China worked nephrite with diamond-tipped drills, or diamond or corundum dust fed through a hollow tube onto concentrated portions of the nephrite specimen (Sax *et al.* 2004).

5.3 Chemical makeup

Belonging to the inosilicate (chain silicate) group and the jade family, nephrite is characterized by the affixation of silica tetrahedrons into "linked single or double chains" (Chesterman 1979:537). These "linked chains" are created with the interlace of tremolite and actinolite, forming a dense compact mineral of "unusual toughness" (Chesterman 1979:537). They are metamorphosed in liquid form in conjunction with the crystallization and fracture of serpentine beneath the earth's crust. It is believed that nephrite forms initially as a liquid flowing amongst the bordering cracks of serpentine, during heating, cooling and pressurization (Harlow & Sorensen 2005, Pearse 1975:3). The medley of tremolite and actinolite then hardens to form veins of nephrite that vary in colour based on concentrations of iron accumulated during conception. The color changes from grey to dark green as the iron increases (Nagle 1984:157). While nephrite is not as hard as chert, the presence of minor amounts of quartz and other materials, the "intergrowth of crystals in its structures and the lack of distinct boundaries" (Nagle 1984:157), allows for its incredible toughness and ability to withstand fractures far better than chert and most other minerals of comparable hardness (Nagle 1984:157).

5.4 Raw Material Procurement

5.4.1 Finding Nephrite

A source of nephrite in the eastern Arctic has remained elusive ever since nephrite artifacts in the area were first discovered. While it was first heralded as a testament to the expansiveness of Inuit trade networks with the west, it was later reasoned that local sources were yet to be discovered (Pearse 1975). Potential sources of nephrite in the eastern Arctic may be ascertained by using a combination of approaches. First, researchers need to look at areas that are rich in rock types that form in association with nephrite (namely serpentine and soapstone). Then, using trace element analysis to determine the relationship between nephrite assemblages and source areas, those data could be examined with a distance decay model.

5.4.1.1 Nephrite, Serpentine and Soapstone

Nephrite forms in association with serpentine. Serpentine is so-named because it is green and scaly in appearance, not unlike a serpent (Chesterman 1979:528). Commercial variants of serpentine are also known as asbestos (Chesterman 1979, Pearse 1975). By extension, mapping of asbestos sources may help pinpoint potential sources of nephrite. Pearse (1975) highlights five known areas with extensive asbestos deposits (Figure 5.1). The Cape Smith-Wakeham Bay Sills (Figure 5.1 P1) and the Labrador Trough (Figure 5.1 P2) offer the greatest potential for nephrite procurement by arctic peoples as they lie in areas occupied by Inuit and Paleoeskimo (Matthews

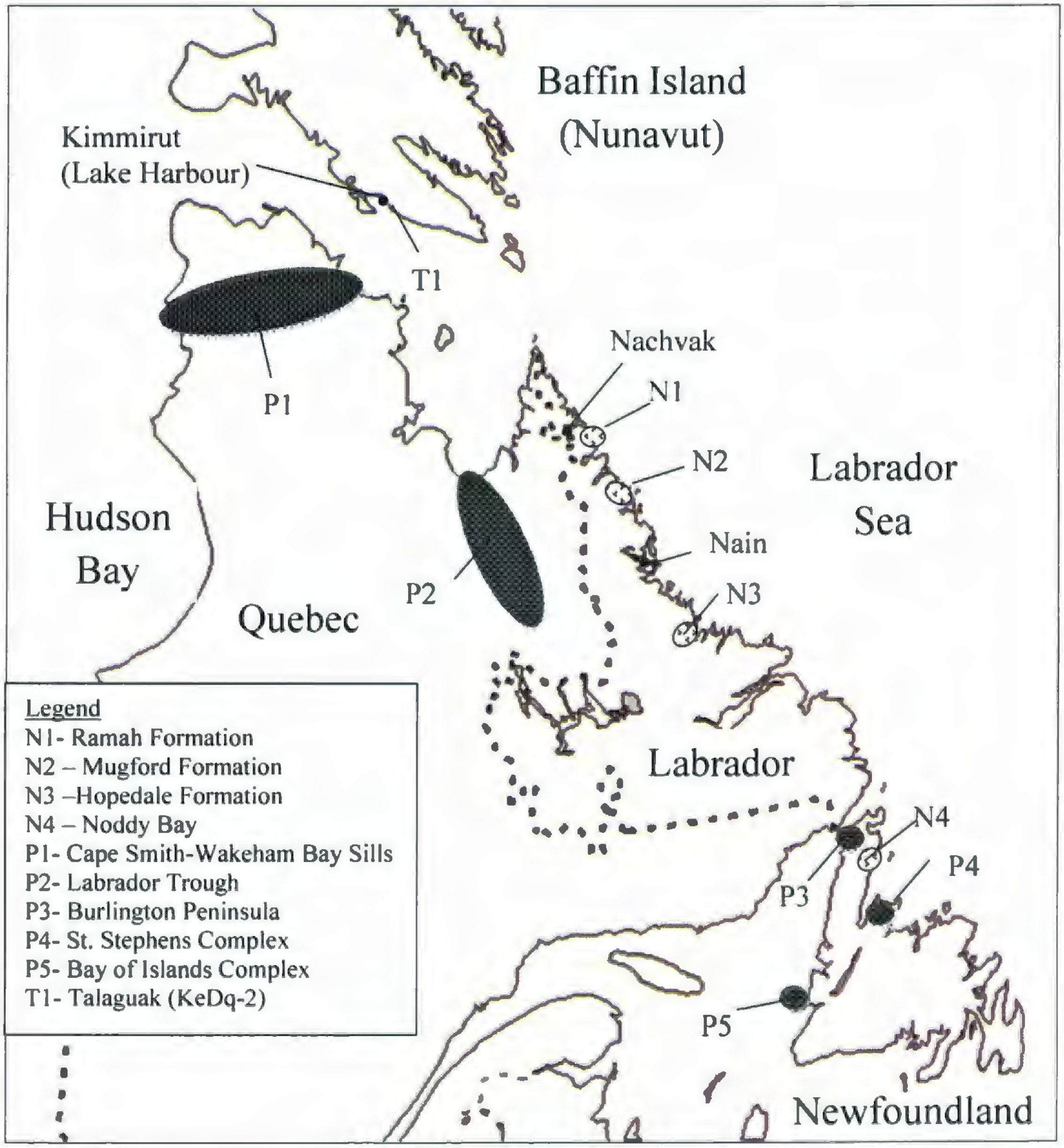


Figure 5.1: Location of potential nephrite sources discussed in text. (Adapted from Nagle 1984, and Pearse 1975).

1975). Three areas on the island of Newfoundland are more localized and were potentially accessed by Dorset Paleoeskimo groups in the area.

Blackman and Nagle (1982) initially searched for potential nephrite sources using trace element analysis of Dorset Paleoeskimo nephritic jade artifacts from central Labrador. This study tested Dorset samples from the Okak and Nain areas to determine the chemical variations that occur between nephrite artifacts. Samples were compared with one another, and with nodules of nephrite collected from a beach in Saglek Fiord and the only confirmed source of nephrite in eastern Canada, Noddy Bay (Figure 5.1 N4). Nagle (1984) goes on to highlight three rock formations that have the greatest potential of yielding a nephrite source, namely the Ramah, Saglek, and Hopedale Formations (Figure 5.1 N1, N2, N3 respectively). Each is located along the super crust where metamorphosed green-schist may accumulate. These areas are well within the range of Inuit as well, as they too lived, traveled and traded along the coast since their arrival in the area.

The geological context of the nephrite at Noddy Bay is also worth noting because it is found within a soapstone matrix (Nagle 1984), illustrating how the components of nephrite can also form in talc, in addition to serpentine (Chesterman 1979:537). By extension, the location of soapstone quarries should also be factored into the search for a potential nephrite source.

Relying on soapstone for the fabrication of pots and lamps, it is reasonable to assume that Inuit groups would have had extensive knowledge of soapstone sources as well as of any nephrite that might have been found. More work is needed to determine whether or not nephrite in a soapstone matrix is a regular occurrence and whether or not it occurs as such in Noddy Bay by happenstance. If it appears to be commonplace, the number of potential sources would dramatically increase as soapstone quarries can be found throughout the Arctic.

5.4.1.2 Distance Decay

A source of nephrite may also be deduced through a model of distance decay, since lithic procurement is largely dependent on the distances between sites and sources. The basic assumption is that the mass of artifacts would decrease at sites farther away from the source. This decrease is largely associated with the travel and transportation costs associated with accessing the raw material (Nagle 1986). The model is also influenced by the curation of raw materials through reuse and resharpening, and through alterations in production techniques, i.e. making thinner yet still functional blades. It should also be noted that the distance decay model would have to account for multiple sources, if such were identified (Nagle 1984, 1986).

The inverse would also be true for the distance decay model; sites closer to a nephrite source should have larger nephrite artifacts and comparatively larger nephrite assemblages increasingly made up of unfinished tools and debitage. This is demonstrated by Fitzhugh's signalling of a potential nephrite source near Okak, based on a "considerable amount of nephrite debitage at Moores Island 1" (Fitzhugh 1980 b:44). When considered in terms of the distance decay model, the size of a partially worked nephrite nodule (Figure 5.2) from the Thule/Inuit site of Talaguak (KeDq-2) (Figure 5.1 T1), may also point to a potential source near Kimmirut on southern Baffin Island.

Figure 5.2: Partially worked nephrite nodule (KeDq-2:719) (Courtesy of the Canadian Museum of Civilization).

5.4.1.3 Nephrite Sourcing Problems

The elusiveness of the nephrite source is augmented by a number of factors. Researchers have not been searching long, nor have they been looking in the right places. In addition to this, nephrite is rare, and is not as widely found throughout the Arctic as chert, quartzite, soapstone and other resources used by Paleoeskimo and Neoeskimo peoples.

Identifying nephrite on the landscape may also be problematic. While we think of nephrite as rich green in colour, this is only true for pieces that have been worked or water worn. Pearse (1975) notes that outcrops are "often camouflaged by a creamy-to-brownish veneer" caused largely by weathering. In addition to this, if the nephrite occurs in association with large amounts of asbestos, it often takes the color of the surrounding rock. Identification would be complicated by the fact that nephrite makes up a tiny portion of a serpentine deposit's total mass. Forming in the cracks and fissures, if at all, nephrite pieces could be very small in size and not be widespread and readily visible like veins of chert or other clearly identifiable minerals.

The finding of a single nodule does not necessarily mean that a nephrite source is nearby. Pieces of nephrite may have been deposited on the landscape as the glaciers retreated from the Labrador coast. Paryk-Kara (2002) notes that nephrite placers are often found in the eastern Sayan region in southern Russia, as well as in British Columbia, associated with areas of mountain–valley glaciations. He suggests that "under such conditions, large nephrite blocks are easily removed from the loose serpentite, accumulated in the moraine, and subsequently distributed as fluvioglacial boulder placers" (Paryk-Kara 2002:437). The problem of finding a nephrite source may be tackled through the correlation of soapstone and serpentine rich areas, mountain–valley glaciation areas, trace element analysis of a variety of nephrite samples (Blackman & Nagle 1982); and the use of a distance decay model to extrapolate where potential sources may occur (Nagle 1986).

5.4.2 Slate

Slate is much more common than nephrite. It is essentially formed through the metamorphosis and compression of mudrock, specifically shale. It may be formed in any environment where mudrock is present. It easily splits into thin sheets along the alignment of mica flakes in parallel beds. It commonly occurs as "steeply tilted outcrops with jagged or irregular outlines due to weathering" (Chesterman 1975:732) (Figure 5.3). The color and strength of slate samples depends on their chemical composition. Gray to black specimens result from carbonaceous matter and graphite inclusions, green from chlorite, and red, purple, brown or yellow from varying levels of iron oxide (Chesterman 1975). As with other rocks, the specific chemical markers in slate could be used to create a map of potential slate sources in the study area.

Figure 5.3: Slate outcrop at Ramah chert quarry (Higdon 2004).

In addition to being formed in almost any environment, the abundance of slate in the Nachvak assemblage may also be attributed to the workability of this material. Unlike nephrite, it is soft enough to be scratched with a knife, and subsequently ground with any whetstone. While flakes may not be as easily controlled as knappable stones such as chert, the relatively brittle nature of slate edges ensures that it can be flaked with some degree of control. While it does take considerable energy to remove sizable slate flakes, one does not have to pound incessantly as is required with nephrite. The banding of slate is also an asset for the production of slate tools as sheets are jagged and almost blade-like when they are broken from a larger core. When considered in terms of the distance decay model, large quantities of slate tools of varying sizes and massive amounts of debitage indicate that sources occur nearby. In addition to this, slate tools do not appear to be as heavily curated as their nephrite equivalents.

5.5 Evidence of Tool Production

When it comes to evidence of tool production, there are considerably more examples of slate than nephrite. Excavations at IgCx-3 yielded and evidence of every stage of the slate tool production process, but only minimal evidence of the processing of nephrite. It is also interesting to note that there were more serpentine pieces at various reduction stages than nephrite.

Every part of the slate production process was recovered, including large slabs of raw material, blanks, and preforms in various stages of reduction. Slate preforms range from those crudely shaped through flaking to those that exhibit both flaking and chipping on the same specimen. Ninety-five percent of the unfinished tools collected were slate, with 2.2 % serpentine and 2.8% nephrite (Table 5.2).

Of the eighty-one nephrite artifacts recovered from IgCx-3, only three can be readily classified as preforms, namely the two bead preforms and the one potential knife blade preform (IgCx-3:5762). None are chipped like slate, but instead have varying degrees of polish on all surfaces.

Table 5.2: Distribution of unfinished tool by material type.

Material	Raw Material	Blank	Preform	Grand Total	Percentage of Total
	Artifact Status				
Nephrite	0	0	3	3	2.8%
Serpentine	1	2	1	4	2.2%
Slate	7	31	94	132	95.0%
Grand Total	8	33	98	139	100.0%

5.5.1 Incised Lines

Eight artifacts were clearly incised to aid in the production process, including six of nephrite and two of slate (Figure 5.4). Employing the groove and snap technique, it is debatable whether or not these incisions were made using a much harder stone or metal saw, or if they were incised using a piece of hard wood and/or sinew or leather lashing with coarse grit or sand as an abrasive agent (Darwent 1998, Mills 1997, Sax *et al.* 2004). Each of the eight pieces may be assigned to a chaîne opératoire for the groove and snap technique of manipulating ground stone (Figure 5.5).

First an initial line is made (Figure 5.5 a). A 'v' is then scored on one or both sides of the fragment being worked, to weaken it for a controlled break (Figure 5.4 a, 5.5 b, c). A hammerstone can then be used to break off the desired piece (Figure 5.4 b, c, e, h, 5.5 d). All traces of production would then be removed by the grinding methods described below. While complete and functional, IgCx-3:5714 (Figure 5.4 f) illustrates a break at the end of the chain, as a complete and functional end-slotted knife blade, with traces of the groove and snap technique on one edge of the blade. This is also the case with a complete drill bit (IgCx-3:3655) (Figure 5.4 g) with remains of an incised line on one

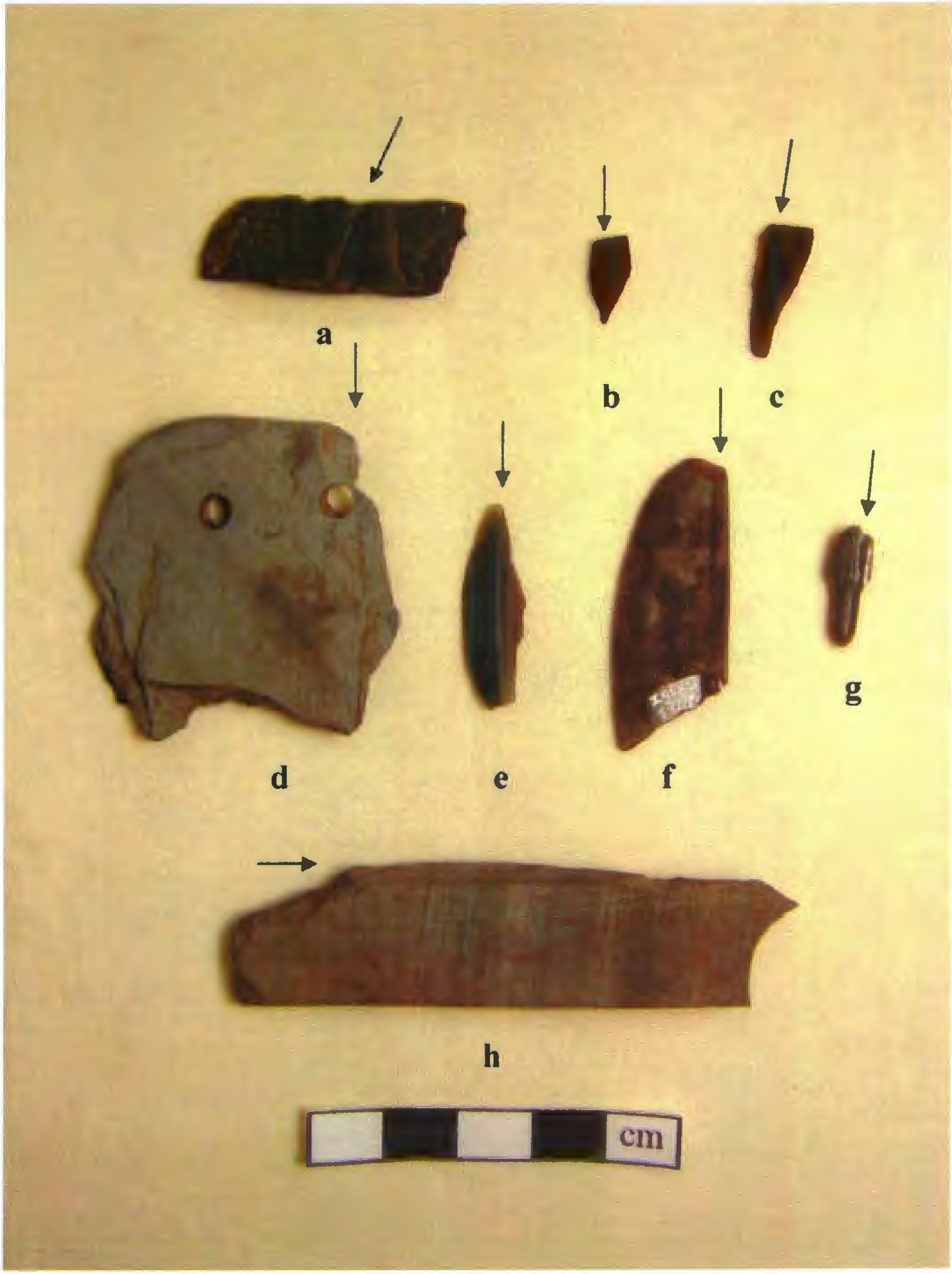


Figure 5.4: IgCx-3 artifacts with incised lines, with arrows indicating location of incision: a-c) polished nephrite fragments (3491, 523, 5500), d) miscellaneous drilled slate fragment (5357), e) miscellaneous nephrite blade fragment (5150), f) nephrite knife Blade (5714), g) nephrite drill bit (3655), h) miscellaneous slate fragment (5893).

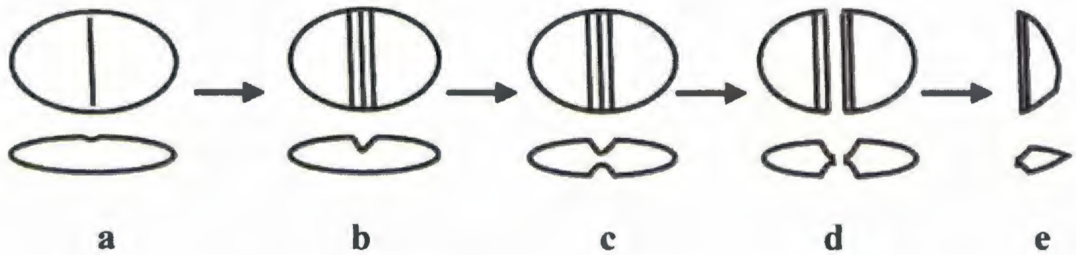


Figure 5.5: Suggested chaîne opératoire of groove and snap technique, showing both top and cross sectional view of each piece.

portion of the tang.

All of the incised pieces show evidence of reworking a piece that has broken during use, and all are polished to some extent. Five out of seven of them were made of nephrite. IgCx-3:5357 (Figure 5.4 d) is one of the larger pieces exhibiting two drill holes, from its life as another tool. IgCx-3:5893 (Figure 5.4 h) highlights the use of the groove and snap method to predictably shape a thick piece of slate. This piece was also previously used as part of another tool, as it is ground flat on numerous sides, with a circular indentation along one edge.

5.5.2 Coarse-Grained Whetstones

Coarse-grained whetstones make up only 13.3% of all the whetstones recovered (Table 4.9). The relative softness of slate and the abundance of sandstone whetstones indicate that the coarse-grained whetstones may not have been necessary for the grinding of slate tools. Their use would merely expedite the tool making process. Coarse-grained whetstones are required for working nephrite because softer whetstones made of mudrock and sandstone would disintegrate after minimal use. All of the coarse-grained whetstones show extensive polish on at least one facet, indicating that they were used to grind something much harder than themselves.

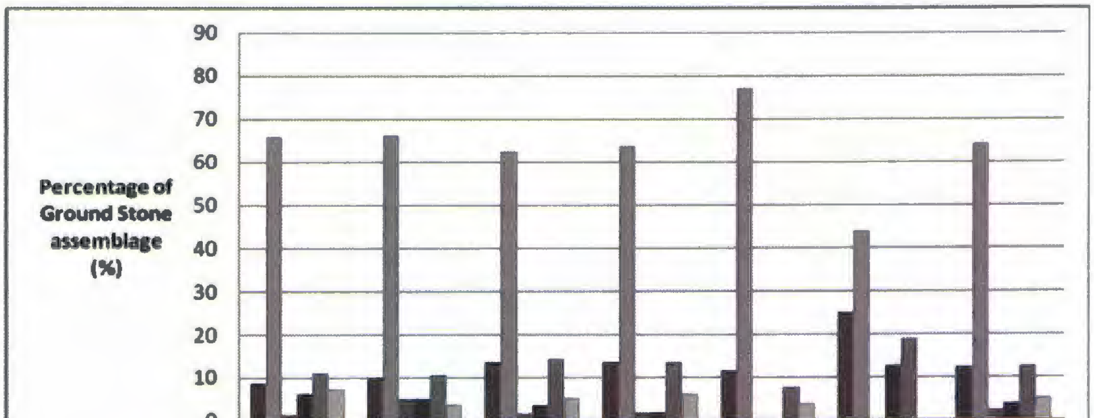
Conglomerates and breccias as well as granite, dolomite, labradorite and beach cobble artifacts that show evidence of being used as whetstones all rate around 6.0 on the Moh's scale of hardness, equivalent to nephrite. While I could not conduct the standard geology scratch to test variations in hardness, it is reasonable to assume that those with higher percentages of quartz would rank higher on the hardness scale, and consequently be more suitable for working nephrite.

The lack of whetstones higher than 6.5 on the Moh's hardness scale also highlights the need for additional methods for working nephrite, such as the groove and snap technique, vices to hold the piece in place, and/or the use of liquid and grit as abrasive agents. The abundance of nephrite in ground stone assemblages throughout the Arctic indicates that it was not impossible to work. It would have just taken additional time, thought and energy. Such a sacrifice would have been worthwhile, for the production of a durable tool that would not fracture easily and required relatively little sharpening over time.

5.6 Material Distribution

The distribution of slate and nephrite tools is also worth noting as it highlights the pros and cons of using each material. While slate is used for virtually all tool categories, except for manufacturing implements (excluding drill bits), there is a notable trend toward the selective use of nephrite. Nephrite is used mainly for small items where durability is key, especially drill bits, awls, gravers, and small adze blades. These tool types require extensive force and repeated wear along their edges to work efficiently. Any blades made out of nephrite tend to be smaller than their slate counterparts, most likely due to the preciousness of nephrite, the size of the nodules available and the difficulty associated with working it.

Figure 5.6 illustrates that the percentages of different materials employed in ground stone technology remains more or less constant for each feature. House percentages of slate and nephrite are consistently within two percent of the overall



	House 2 (n=84)	House 4 (n=26)	House 6 (n=199)	House 12 (n=179)	House 2 Midden (n-26)	House 10 Midden (n=16)	All Houses (n=666)
■ Nephrite	9	10	14	13	12	25	12
■ Slate	66	66	62	64	77	44	64
■ Serpentine	1	5	2	2	0	0	2
■ Sandstone	6	5	4	2	0	13	4
■ Mudrock	11	10	14	13	8	19	13
■ Other	7	4	5	6	4	0	5

Figure 5.6: Comparison of material type percentages by feature.

average of 12.2% and 64.2 % respectively. The middens differ slightly because they represent tools that were intentionally discarded. They are also anomalous because percentages were calculated from a smaller sample size than that of the houses. Interestingly, House 2 has proportionally less nephrite than all of the other features. This may be attributed to a later reoccupation of the site as suggested by the relative abundance of European metal within the house, as compared to the others (Whitridge 2004) (Figure 5.7). This suggests that if a house dates to the contact period, much less nephrite than iron should be used.

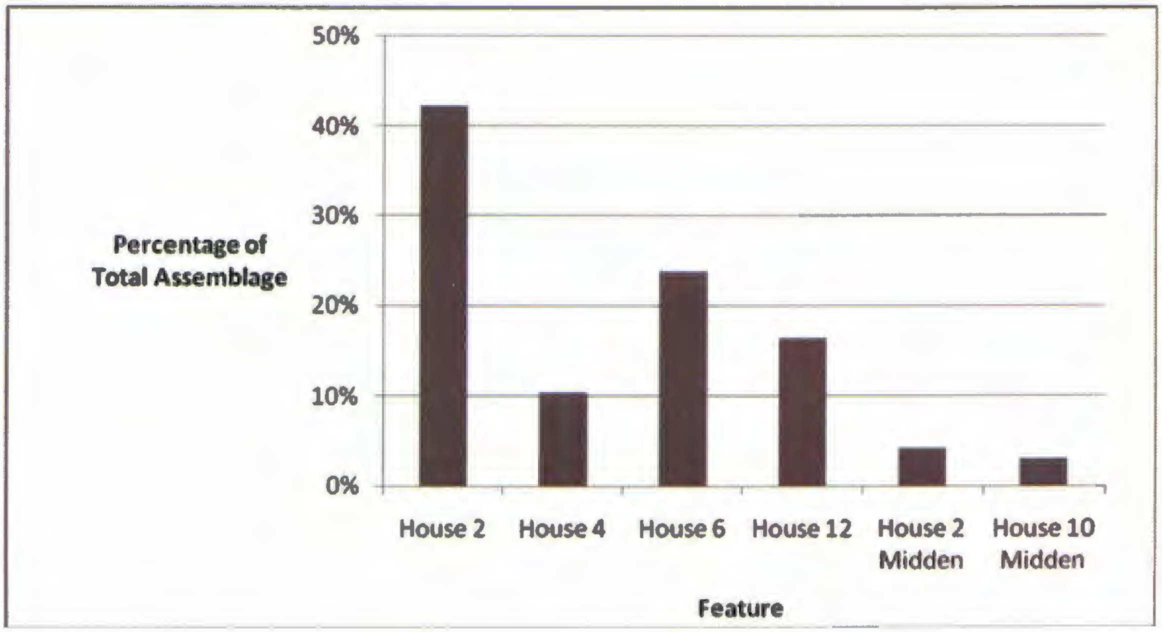


Figure 5.7: Percentage of metal (iron and copper) per feature.

5.7 Conclusion

Comparison of the production and use of slate and nephrite allows for a greater appreciation of how and why each material was used. The sample size and dimensions of the artifacts are directly related to differences in raw material procurement strategies, the amount of material available, intended tool use, extent of the excavation area and the date of the house. Understanding why specific materials were used ultimately allows a better understanding of the ground stone assemblage and the experimental production and use of there facsimiles.

Chapter 6: Experimental Replication and Use

The physical and mental components of Inuit ground stone tool technology can be best understood through an experimental approach. This chapter will discuss the value and problems associated with using an experimental approach to interpreting the archaeological record. The successes and failures associated with tool replication and use is just as important as timing the production or use of a particular type of tool. Making the mistakes oneself enables the tool maker to get one step closer to understanding the gestures and decision-making processes inherent in the replication of Inuit ground stone technology.

6.1 Value

An experimental approach to understanding technology is useful as it puts the researcher in the place of the tool maker. Doing so can provide insight into the decision-making process, aid in the identification of artifacts, and also bring to light additional technology-related problems that might not otherwise have been considered. These include: How did the Inuk tool maker successfully grind nephrite? How were the skins physically scraped? Were there specific people who mainly made tools? How did people learn these skills?

This approach also reinforces the interrelatedness of the raw materials, implements, and techniques used to achieve a desired goal. By making the tools oneself, it is easier to appreciate how the desired end goal varies with the techniques and materials available to the tool maker. Recognizing what tools are needed to work ground stone tools allows us to begin to learn the gestures and techniques associated with their use.

6.2 Problems

Before discussing the experimental replication and use of ground stone tools, it is important to note some of the problems associated with using experimental archaeology to understand the past. These include: learning to overcome the general lack of skill of the experimenter, obtaining materials comparable to those represented in the archaeological record, and overcoming any inherent biases that may affect the decision- making process (i.e. assumptions about how a tool should be shaped, ground and used).

6.2.1 Learning Curve

The first obstacle in conducting experimental studies is one of proficiency. For example, while I started my experimental studies just two years ago, prehistoric Inuk tool makers would have been exposed to ground stone technology from an early age. They probably dealt with ground stone tool production on a daily basis, and would have been aware of the skills and knowledge needed to process the slate into a useable form. While not necessarily breaking it up into steps as we would today, they would have been aware of the chaîne opératoire behind the tool-making process. The following experiments will serve as analogies for how the materials were worked, in order to better understand the tool making process and the qualities of the materials.

The learning curve associated with adjusting to a different technology can be lengthy and arduous. One must be able to replicate the process as closely as possible, using comparable materials and techniques. As with learning anything, the quality of craftsmanship can only increase over time as experience with a particular task increases. One gradually becomes more efficient at tool replication, picking up on the nuances and intricacies of tool production and use. Learning how to make the tools is also important, as it highlights stages of production that might not have otherwise been addressed. Such issues may include: how to form the transition between the shaft and tang of a drill bit and the best angle at which to hold a blade to sharpen it effectively.

6.2.2 Raw Material

There is also an issue concerning the source and form of the raw materials used for this study. Nephrite from the eastern Arctic was not available for this study, as a commercial source has yet to be identified. Instead, nephrite used in the experiments comes from a jade mine in northern British Columbia. In this area, nephrite forms in large car-sized boulders (Jade West 2005).

Since the quality of a mineral may depend on the formative environments, and even its particular placement within a source quarry (Taboada *et al.* 1998), it is logical to assume that the British Columbia nephrite may not be of the same quality as nephrite used by the Thule/Prehistoric Inuit in northern Labrador. When the experiments were conducted, some of the work had in effect already been performed, and it is for this reason that the time needed to take a piece of nephrite from raw material to preform is not dealt with directly.

One of the problems that plague experimental replication is obtaining raw materials from the same source, and in the same form as used by the prehistoric tool makers. By opting for slabbed nephrite from British Columbia, two additional problems are created. First, the source of the nephrite may affect its workability and secondly, working from a slab instead of a cobble would undoubtedly affect the production process. With this in mind, starting out with a slab of a specific length, width and shape puts the researcher at an instant disadvantage.

There is also the problem of slate procurement. Not all slate is created equal; the strength and workability of slate depends on "three geographic factors: stratigraphic, structural and metamorphic" (Taboada *et al.* 1998:203). Each influences the thickness, quality and structural integrity of the layers found in sources of slate. Weathering may also affect the durability of slate as a raw material. The usefulness of slate located next to the ocean is also debatable, since continuous bombardment of waves and the salt from the ocean would serve to weaken the rocks. One way to get around this would be to select slate not directly exposed to the elements.

6.3 Replica Production

Artifact replication is the first step in an experimental approach to understanding Inuit ground stone technology. In addition to knowing the context of the tools, and ethnographic and experimental examples of how the tools have been made, this process includes an evaluation of the successes and failures associated with tool production and use. The usefulness of the experimental process will be explained within the context of the production and use of slate and nephrite drill bits, as well as the unsuccessful reproduction of a nephrite ulu blade. Time and resources did not permit the replication of all tool types. Instead these examples will be used as a proxy for understanding the methodology of drill bit production and how slate and nephrite react differently to the production process.

Drill bits were chosen for replication for a number of reasons. They are small, used in the production of most tool types and are arguably the easiest to make and test, as compared to testing the efficiency of other tools such as knives, scrapers, and harpoon head end blades. It is much easier to replicate the drilling of a number of media than to simulate the motion of stabbing a seal with a harpoon. The implements associated with drill bit production are also much more compact and the process does not produce as much refuse as other forms of ground stone technology. They may be used to address a number of production related questions, such as: what is the chaîne opératoire for the drill bit production process? How does the greater toughness of nephrite as opposed to slate affect tool production? Are additional steps required for the grinding of nephrite? I will first discuss how learning to make drill bits can shed light on the relative difficulty of working nephrite and slate. This difference will then be quantified by time experiments detailing the production of the same sized drill bits out of each material.

6.4 Experimental Drill Bit Production

6.4.1 Experiment 1: Experimenting with Drill Technology

Before delving too deeply into drill bit replication, it was decided to test whether or not it was feasible to invest time and energy in the production of functional drill bit replicas. It was first necessary to know if they could be made, along with associated implements. For this initial foray into drill bit production a piece of slate was worked with a commercially available dual-sided whetstone that was coarse-grained on one side and fine-grained on the other.

After producing a crude drill bit, it was then hafted onto a broken fibreglass tent pole with masking tape. Rather than investing the time to make a functional bow and mouth piece, the spindle was then spun between the hands until it successfully bored a hole into a wooden door stop. The successful creation of a hole with a homemade drill bit allowed for the refinement of the replica drill bits and the techniques needed to produce them accurately and efficiently.

This experiment showed that while it was relatively easy to make and use a functional slate drill bit, making and using accurate replicas using the same materials, implements, and techniques as the Inuk tool maker would be a more onerous task. Spinning the spindle proved to be hard on the hands and would ultimately take much longer than using a bow. In addition to this, the spindle was relatively unstable, probably due to the lack of pressure that resulted from not using a mouth piece or hand hold. While spinning the tent pole by hand demonstrated that it was possible to operate a drill bit in this way, it also highlights the need for a bow drill and mouthpiece to fully replicate the Inuit process of making holes.

6.4.2 Experiment 2: Determining the Tang

Following this experiment, other slate drill bits were produced and hafted in various configurations in order to figure out how to best haft the individual bits. It was clear that the rectangular tang was vital for the successful hafting of the drill bit. It allows the bit to be firmly hafted in place, when inserted into the tang slot on the chuck. It is important that the slot be the right size; if it is too loose the drill will slip, dismount, or even break during use. The same would happen if the tang was smaller than the drill bit shaft: the pressures associated with spinning the bit would gradually dislodge it from the haft. This explains why the drill bit tangs found in the archaeological record tend to be rectangular in form.

6.4.3 Experiment 3: Creating a Nephrite Drill Bit

The aim of this experiment is to become familiar with working nephrite and the chaîne opératoire of drill bit production. Since the goal was to make a functional nephrite drill bit, the accuracy of the whetstones used was not felt to be critical. The whetstones used in this experiment included: commercial files, whetstones, diamond dust files and mechanicals sanders. The efficiency of the grinding materials was not timed. It should be noted that this was the only experiment, aside from Experiment 1, to use non-traditional whetstones for grinding. This was done to get an initial feel for the material and tools involved, as well as the time and energy associated with working nephrite.

After breaking a rectangular-shaped piece of the smaller nephrite slab, it was secured in a vice and ground. The diamond dust file performed the best, taking off the greatest amount of material per stroke, until the file became useless due to extensive wear. In order to test the effectiveness of a variety of materials, a bastard file and a portion of a coarse mechanical grinding wheel were used with limited success. The mechanical sander was useless, and removed little material. The bastard file was used to create the V-shaped tip.

The bit was then hafted into a piece of antler to get an idea of how the bow drill worked (Figure 6.1). This was done by drilling a rectangular hole in the end of the piece of antler with a Dremel drill. The bit was then rammed into the hole until it fit snugly and the tip of the antler chuck was tapered by cutting off small wedges with a bone saw. The spindle was then loaded into the bow drill and used to drill materials of varying thickness, strength and material type. After drilling through wood, slate and soapstone, it was clear that a nephrite drill bit could efficiently drill through a range of relevant materials.

Figure 6.1: Initial experimental nephrite drill bit with antler chuck.

The failure of the modern whetstones and sanders demonstrates the resilience of nephrite and the need to have the preform secured in place. If it was not held in place, energy for grinding would have to be divided between grinding and making sure that the bit did not slip away. Making a preform fosters a greater understanding of the chaîne opératoire of Inuit ground stone drill bit production. Based on these trials, the chaîne opératoire for drill bit production can be reconstructed as follows:

1. Form rectangular preform roughly the size of the desired drill bit. Any tapering at one end is an asset, as it decreases the amount of time spent grinding.

2. Grind the tang with coarse-grained whetstones, making it rectangular or square for easy hafting. This will prove difficult later if one is trying to finish the tang while holding onto the more delicate shaft portion of the drill. Grind the corners of the preform opposite the tang, gradually removing more and more until it begins to taper. Repeat until the shaft takes on an oval shape.

3. Smooth the shaft to remove any flaws that might otherwise reduce efficiency or contribute to the breakage of the shaft.

4. Grind tip of shaft into tapered V-shape; add additional facets if required.

5. Haft into spindle or chuck.

This chaîne opératoire will be used as a template for the drill bit replications to follow. Familiarity with the production steps allows the experimental tool maker to better simulate how the drill bits may have been made by the skilled tool makers of the past.

6.4.4 Experiment 4: Drill Bit Production Time Trials

After getting used to the materials and the chaîne opératoire of drill bit production, it was then necessary to begin the more rigorous time trials. Replica drill bits were crafted out of nephrite and slate using a labradorite whetstone. Drill bits were first made without a vice and then secured in a vice and ground with a mixture of water and sand to expedite the production process. Only naturally occurring whetstones resembling those from the artifact assemblage were used, to make the tests more authentic.

6.4.4.1 Experiment 5: Preform Production

The production of the preforms was not timed as part of this experiment. This is largely because the Inuit would not have been working with slabs of polished nephrite like the commercial specimens utilized here. Inuit tool makers would have worked with nodules of nephrite scavenged from the beach or mined from a quarry, requiring additional time and techniques. The uncontrollable nature of nephrite also made it difficult to work; striking repeatedly on the edge of the nephrite slab produces little effect, until it suddenly gives way, breaking unpredictably in any direction. Repeated failures necessitated multiple attempts at trying to make a rectangular preform that could then be fashioned into a functional preform. It can be assumed that the Inuk tool maker would have worked from a piece that resembled the size of the desired drill bit, limiting the amount of material that needed to be removed.

For the later experiments in which the slate and nephrite preform had to be the same size, the slate pieces were always worked later because they were the easier of the two to work. Trying to make slate preforms that approximated the size of the nephrite preform was difficult as the slate did not always fracture predictably. The preforms either broke in half or fractured horizontally along their individual cleavage planes. Some slate samples were also more resistant to hammering than others. For this reason all preforms were made from the same slab of slate. It should be noted that past tool makers may not have been actively trying to produce two preforms of the same size. It would instead be more practical to work with the raw materials available, using a piece already as close to the desired goal as possible, thus reducing the amount of grinding that would need to be done in the end. In addition to this, if the Thule tool maker came across a large slab of nephrite, he might have opted to use it to form some kind of blade, instead of breaking it up into smaller pieces. The refuse from making the blade may have in turn been used to make drills, beads or other small objects.

6.4.4.2 Experiment 6: Drill Bit Production without a Vice

The aim of this experiment was to determine whether or not a nephrite drill bit could be efficiently manufactured without being secured to a vice or a haft. This experiment began with the timed production of a nephrite drill bit comparable to the one made in Experiment 3 (Figure 6.1). This proved to be ambitious, as very little was accomplished after four hours and thirty five minutes of steady grinding with a labradorite whetstone (Figure 6.2 & 6.3). While Darwent (1998) notes that nephrite production takes considerable time, minimal polish after four and a half hours meant that

Figure 6.2: Experimental nephrite drill preform.

Figure 6.3: Experimental nephrite drill bit after 4 hours 35 minutes of grinding without vice or sand.

I was clearly doing something wrong. Nephrite could be ground in this way, but would just take a very long time.

In order to speed things up, I chose to make two smaller drill bits that could feasibly be finished in under an hour. Without spending a great deal of time on the tangs, it was possible to shape a nephrite drill bit with a functional shaft and bevelled tip in thirty six minutes, fifty- eight seconds (Figure 6.4 a), and a comparable slate bit in nine minutes, twenty two seconds (Figure 6.4 b) This initial venture in drill bit production demonstrated that it takes roughly four times as long to make a nephrite drill bit as one out of slate. This leads to two observations. First of all, there must be a benefit to making nephrite drill bits, since a comparable slate bit could be manufactured in just a quarter of the time. Second, experiments investigating a more efficient means of working nephrite need to be conducted.

Figure 6.4: Experimental drill bits without vice or sand: a) nephrite, b) slate.

6.4.4.3 Experiment 7: Drill Bit Production with Sand, Water and a Vice

The aim of this experiment was to determine the advantage of securing the preform in a vice, while using water and sand as an active abrasive agent. Securing the tool before production is feasible, though it might not be readily recognized in the archaeological record. Alternatively, the tang may have been worked and then hafted so that the bit could have been worked. Two small drill bits and two large drill bits were produced for this experiment (Figure 6.5 & 6.6).

The procedures used in this experiment were modeled after Darwent's (1998) discussion of the sawing of nephrite nodules into celt preforms. The following procedures were followed for each of these tests, unless otherwise indicated:

1. Both nephrite preforms were chipped from the same piece of a nephrite slab (110.3mm x 66.3mm x 6.4mm).
2. Both slate preforms were chipped from the same piece of slate.
3. The tests began at the grinding stage of production, after the preform was chipped from a larger piece of raw material.
4. The length, width, and thickness of each specimen was recorded to the nearest 0.01mm and recorded before each test (Table 6.1).

Table 6.1: Dimensions of preforms before grinding.

Drill Bit	Length (mm)	Width (mm)	Thickness (mm)
Nephrite (Small)	30.0	7.2	5.1
Slate (Small)	29.7	10.1	3.4
Nephrite (Large)	36.9	15.5	7.2
Slate (Large)	36.4	16.6	5.7

5. A labradorite whetstone (Moh's hardness of six) was used to grind each drill bit.
6. The whetstone was moved repeatedly back and forth across the drill bit preform at an average of one hundred and three strokes per minute. Moderate downward

pressure was also applied to the whetstone during use to ensure that it was making ample contact with the preform.

7. Drill bits were worked differentially based on size (Table 6.2).
8. The same water and coarse-grained sand mixture was used for the grinding of each of the large bits. Sand was recycled during the grinding process, to limit the amount of time associated with introducing new sand each time. Purchased from Canadian Tire, the sand was a mixture of sandstone, quartz and other coarse-grained particles.

Table 6.2: Manufacturing techniques for each nephrite bit used in timed experiment.

Drill Bit	Sand as an Abrasive	Secured by Hand or Vice
Nephrite (Small)	No	Hand
Slate (Small)	No	Hand
Nephrite (Large)	Yes	Vice
Slate (Large)	Yes	Vice

9. All grinding was timed (Table 6.3). Recorded times begin at the time of initial grinding. They do not include the time associated with the production of each preform. If any grinding was halted, the timer was stopped.The small drill bits were timed until they were completed and then photographed. The larger drill bits were timed when the tang was completed, and then timed and photographed at thirty minute intervals.

Table 6.3: Completion times and estimated strokes per tool.

Drill Bit	Completion Time (hh:mm:ss)	Estimated Number of Strokes per Tool (Based on 103 Strokes per Minute)
Nephrite (Small)	00:36:58.4	3,811 strokes
Slate (Small)	00:09:22.4	972 strokes
Nephrite (Large)	03:23:31.6	20,909 strokes
Slate (Large)	00:19:45.3	2,030 strokes

Table 6.4: Dimensions of complete drill bit specimens.

Drill Bit	Length (mm)	Width (mm)	Thickness (mm)	Shaft Diameter (mm)
Nephrite (Small)	21.0	6.9	4.8	3.7
Slate (Small)	26.2	9.1	4.0	3.9
Nephrite (Large)	36.8	14.2	7.2	6.5
Slate (Large)	32.0	14.3	5.4	6.3

10. After the grinding was completed, the length, width, thickness, and shaft width of each specimen was measured to the nearest 0.01mm and recorded (Table 6.4). This was done to ensure that finished drill bits of the same size had similar dimensions.
11. The weight of each specimen was measured to the nearest 0.01gm to determine how much material was removed in the form of dust during the production process (Table 6.5).

Table 6.5: Weight comparison of preform and completed replicas.

Drill Bit	Weight (g)		Material Removed (g)
	Preform	Completed	
Nephrite (Small)	1.5	1.0	0.5
Slate (Small)	1.9	1.5	0.4
Nephrite (Large)	10.0	8.2	1.8
Slate (Large)	6.9	4.4	2.5

6.4.4.4 Results

As expected, it took much longer to produce a functional drill bit out of nephrite than slate. The smaller nephrite drill bit took 3.9 times as long to produce as its slate counterpart, while the large nephrite drill bit took 10.3 times as long as the slate drill bit. This shows a direct relationship between material type and production time.

When compared to the initial nephrite drill bit (Experiment 6, Figures 6.2 & 6.3), the production of the large nephrite drill bit highlights how using a vice and sand as an abrasive agent serve to reduce production times. This drill bit, made without the aid of a vice or sand was not near completion after four hours and thirty five minutes of working. It is thus reasonable to assume that it would have taken at least an additional four hours to grind the bit until it looks similar to Figure 6.3. It is also worth noting that while the grinding of the nephrite drill bit took longer, more slate dust was produced during

Figure 6.5: Large slate drill bit production with water, sand and labradorite whetstone (with times and phases of production).

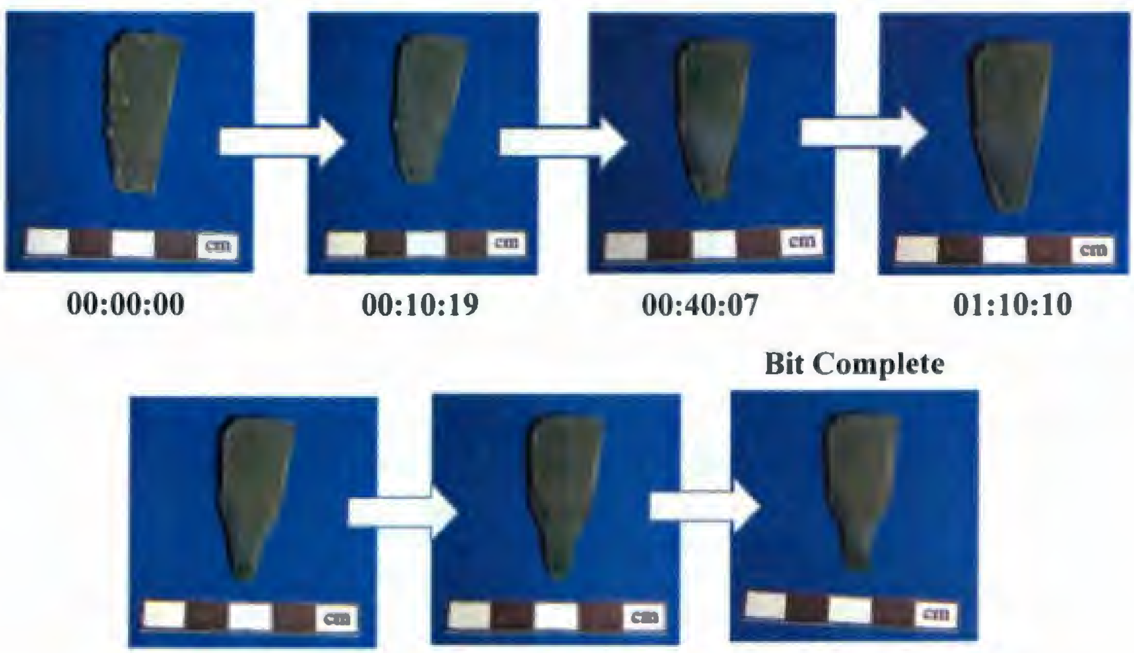


Figure 6.6: Large nephrite drill bit production with water, sand and labradorite whetstone (with times and phases of production).

manufacture. Larger nephrite drill bits were not manufactured without sand and without a vice because an earlier example (Figure 6.2 & 6.3) showed that it would have taken in excess of five or six hours to complete a viable drill bit.

6.4.5 Nephrite Ulu Production

The aim of this experiment was to explore the difficulties associated with making a medium sized ulu out of a 110.3mm x 66.3mm x 6.4mm polished slab of nephrite (Figure 4.8 a). The main factor contributing to the difficulty of working this material is that nephrite fractures unpredictably, and cannot easily be worked through flaking or bipolar percussion. The experiment was not entirely realistic as it began with a small slab of nephrite, eliminating the production time associated with getting a piece of nephrite to that point. The chain opératoire of ulu production (Figure 3.1) discussed in Chapter 3 acts as a template for the following experiment.

The aim of this experiment was to make an ulu blade approximately the same size as IgCx-3:4276 (Figure 4.8 g), or approximately half the size of the slab of raw material. Initial bipolar percussion was undertaken using cylindrical copper billets, labradorite, and sandstone hammerstones essentially anything hard enough to fracture this difficult material.

After placing the nephrite slab on a hard piece of slate as an anvil, I struck the center of the slab four times, as hard as I could, until it broke in half (Figure 6.7 a). I proceeded to work the edges of the blank in order to form the desired ulu preform. After thirty minutes of intensive hammering, two small pieces were removed from the preform.

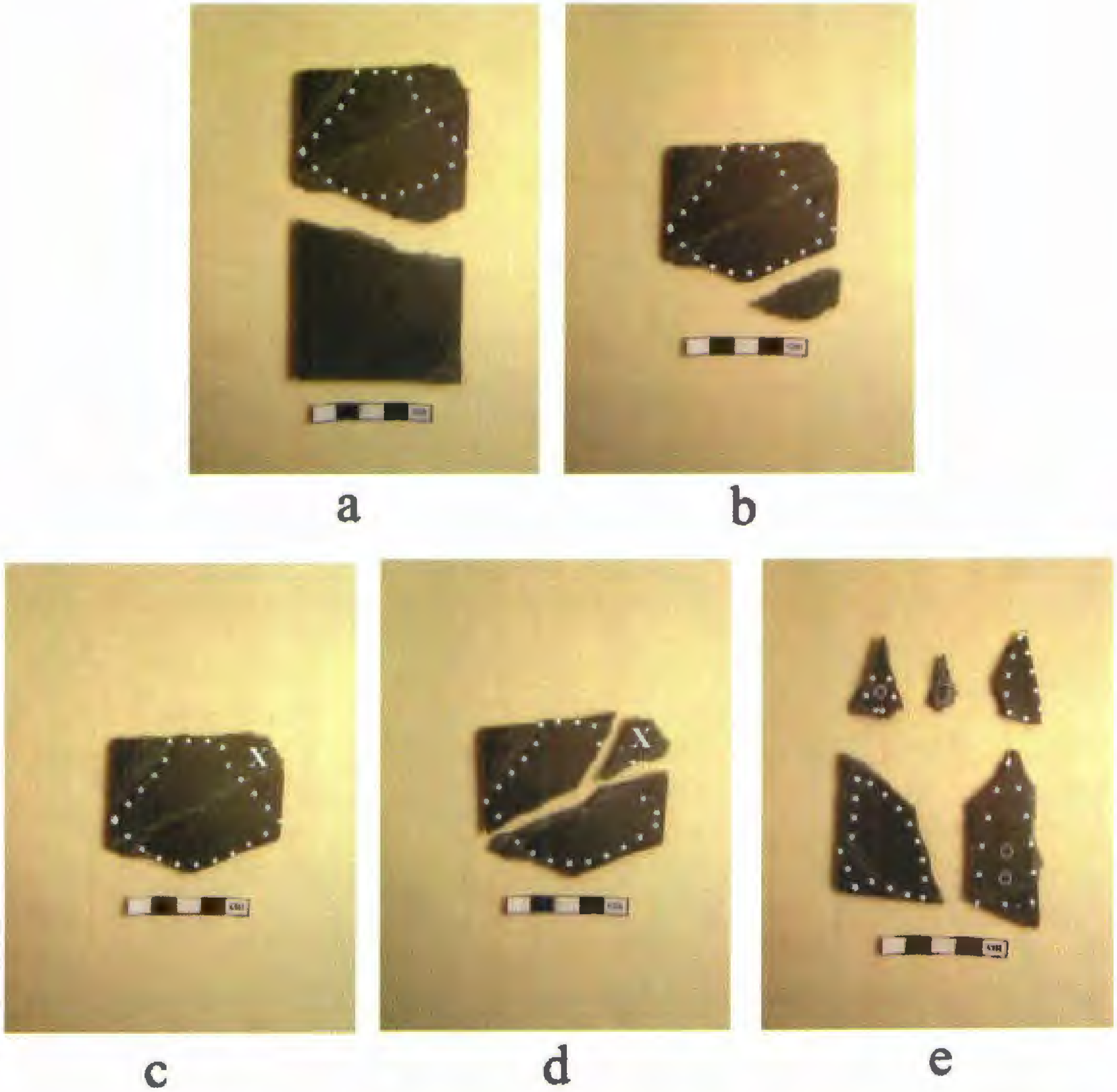


Figure 6.7: Nephrite ulu production with end goal highlighted with dotted line: a) reducing raw material, b) reducing nephrite preform, c) nephrite ulu preform before hitting it at point "X", d) nephrite slab after hitting it at point "X", e) Alternative uses for the broken nephrite pieces,bead, drill bit, side slotted knife blade, miniature ulu, drilled harpoon head end blade, respectively.

(Figure 6.7 b, 6.7 c). An additional forty minutes of hammering the stone as hard as possible along the desired edge, resulted in the fracture of the blade preform into three pieces (Figure 6.7 d).

This failure reinforces the aforementioned toughness and unpredictability of nephrite. The only guarantee is that it will eventually fracture somewhere in the targeted area. Additional techniques are likely necessary to guide the production process. For example, incising a line for the groove and snap method would serve to interrupt the percussive forces travelling through the medium, thus focusing them all into one area.

Despite the failure of the attempt to produce an ulu preform, the blank was not entirely ruined, as it still had the potential to be further worked into an end blade, drill bit, bead, or any other small artifact (Figure 6.7 e). In this instance, a knife blade or a long end blade could arguably be made out of this preform, as the inconvenient breakage produced two pieces longer than they are wide.

6.5 Experimental Use

6.5.1 Assessing Drill Bit Efficiency

In order to test the effectiveness of the drill bits, I first had to produce the implements required for their use, namely the mouth piece, spindle, bow, chuck and a variety of media, comparable to drill specimens found in the archaeological and ethnographic records. Compromises are discussed in instances where authentic materials were not available. The drill bits created in Experiment 7 (Figure 6.5 and 6.6) were hafted and used in this test, rather than spending the time to produce additional nephrite drill bits.

6.5.1.1 Making of the Bow Drill.

Mouthpiece/Handhold: In lieu of using caribou astragali as mouth pieces, a handhold made of softwood was used (Figure 6.8 c). Once a comfortably sized handhold was made a cone-shaped hole was gouged in the centre of one side, at approximately a forty five degree angle, enabling the tip of the spindle to stay in place, while at the same time facilitating the spinning process (Moc 2006). Extensive use resulted in the

Figure 6.8: Components of experimental bow drill: a) alder bow with leather thong, b) wooden drill shaft with nephrite drill bit, c) handhold.

development of polish and rounding on both the inside of this hole and the tip of the spindle, similar to examples found in the archaeological record (Koerper & Whitney-Desautels 1999, Schlederman 1975). In some instances, both became so hot from spinning that they began to smoke. This illustrated why other, less flammable materials might have been used (i.e. bone and antler) as well as the ease with which a fire may be produced with the use of a bow.

Spindle: While initial experiments involved the use of alder branches, bone and antler as spindles and chucks, it revealed that green (fresh) branches do not grip the string as well as dried branches or other coarse media. The fresh branches do not provide enough resistance and friction for the bow to be effective. For the purposes of the timed experiment two identical spindles were carved out of soft wood, with ample space for the hafting of the drill bit, a thinned mid section, and a rounded, tapered tip that would assist the spinning. As mentioned earlier, if the spindle is too fat, either a longer bow or more strokes are needed to equal the rotations of a thinner spindle.

Bow: The accuracy of the experiments required that the bow be both strong and flexible. Moc (2006) notes that if the bow cannot bend, the strings will occasionally slip or possibly break. On the other hand, if the bow is too flexible, the string will slip, limiting the amount of torque available for effective drilling. A green alder branch was used for the experiment, as it provided ample flexibility for affixing the string, with added durability once it dried (Figure 6.8 a).

String: The string needed to be coarse enough to grip the spindle. Moc (2006) maintains that a wide string such as leather or cotton hockey skate lace is ideal. It should be approximately one and a half times as long as the bow so that it can be adequately affixed to either end of the bow, while at the same time be able to grip the spindle. If it is too loose the spindle will not stay in place, and if it is too tight the spindle will not move.

For my initial experiments with the bow drill I used stock cotton wrapping twine. With this, the spindle slipped too much, as it could not provide enough friction. The twine also broke after minimal use. It was then replaced with a 10mm wide leather thong, which provided ample friction and flexibility while at the same time lasting much longer than the cotton thread.

Chuck: For this experiment, the drill bits were placed directly into a slot at the end of the spindle and affixed firmly in place with synthetic sinew (Figure 6.8 b).

6.5.1.2 Using the Bow Drill

The drilling process began with a small scratch on the surface of the medium to hold the spindle in place. It was then necessary to step on the medium being drilled, bracing the hand that held the handhold against my leg (Figure 6.9).

Figure 6.9: Experimental use of the bow drill.

The string must then be wrapped around the spindle so that it is on the outside of the bow (Figure 4.19 & 6.9). This prevents the bow from knocking against the spindle during use. At this stage, "the spindle must feel like it is going to pop out" (Moc 2006). If this is not the case, the string must be tightened either through retying one end, or pinching the string against the side of the bow with the thumb. If the string is too tight, it may break the bow. Holding the loaded spindle and bow in the right hand (Moc 2006), the tip of the drill bit is placed at the location of the prospective hole:

> Cap the other end with the handhold and apply some pressure to keep the spindle from popping out. Let go of the bow. The bow should be pointing itself up towards you. If it is pointing down, reload the spindle so the bow is pointing up (Moc 2006).

Next, the bow is slowly stroked back and forth until the drill bit starts to take hold. The speed is gradually increased until the hole is complete. As with the archaeological examples, thicker pieces may have the hole drilled partially on one side, and then be flipped over and drilled on the other. This saves time, and allows for short shafted drill bits to drill thicker materials.

6.5.1.3 Assessing Drill Bit Efficiency Based on Material

The aim of this experiment was to determine the relative efficiency of drilling with nephrite versus slate. A variety of media, similar to the materials found archaeologically, were drilled with both the nephrite and slate drill bits.

The following procedures were followed for every test:

1. An initial groove was made in each specimen at the beginning of each experiment before drilling. This was done to establish where the hole would be placed, and make sure that time was not wasted with the drill bit slipping along the surface of the drilled media.
2. The same handhold and bow were used in each experiment. The bow was made of a piece of fresh alder with a leather thong 10mm wide for the string.
3. Drill bits were hafted into identical spindles and held in place with synthetic sinew (Figure 6.8 b).
4. The same drill bits were used to drill each medium. This is due in part to the time associated with making a functional nephrite drill bit. If each specimen took upwards of three and a half hours to complete, creating a nephrite drill for each of the six media would have required an additional twenty hours of preparation time.
5. None of the media were treated by soaking them in water or urine prior to drilling. This is especially relevant for drilling antler, as LeMoine (1997) demonstrates that it does increase the workability of the material.
6. Each of the media were secured in place beneath the ball of the foot during the experiment.
7. After the initial stroking associated with the beginning of the hole, stroking continued at a steady rate until the hole was completed. Consistent downward pressure was applied against the spindle during the drilling process via the handhold.
8. All drilling was timed from start to finish. Any time the drilling halted the timer was stopped.

9. Photographs were taken before and after each drilling experiment.

Nephrite effectively drilled through all media except for the untreated antler (Table 6.6). Drilling was abandoned due to the minimal progress attained after sixteen minutes and forty three seconds of constant drilling. It reaffirms LeMoine's (1997) argument that antler must be soaked for three days before it can easily be drilled. This failure is also a testament to the strength of antler as a raw material, and the difficulty associated with carving it. It is for this reason that knives and gravers are used to score incised lines in pieces of antler before it is split.

Table 6.6: Experimental drilling times for various media.

Material Being Drilled	Rating on Moh's Scale of Hardness	Drilling Time (Minutes: Seconds)		
		Nephrite Drill Bit 1	Slate Drill Bit 1	Slate Drill Bit 2
Talc	1	5:49	4:12	3:00
Soapstone	1	3:40	n/a	5:54
Slate	5	2:07	n/a	n/a
Untreated Antler	?	16:43	n/a	n/a
Soft Wood	?	8:20	n/a	12:01

The slate drill bit began to disintegrate after only four minutes and twelve seconds of drilling into talc. Not only did this mean that I had to produce another slate drill bit in order to resume the tests, but it also had ramifications for the interpretation of the use of slate drills. The dissolution of the slate drill bit may have been caused by a number of factors. The slate used to produce the drill bit might have been too brittle, too much downward pressure may have been applied on the tip of the bit during use, or alternatively the material being worked might have been too hard to have been successfully drilled with slate. The latter was probably not an issue in this instance because the slate drill bit fractured while drilling talc, the softest material on Moh's scale of hardness. It is assumed that the bit would fracture only on a material of equal or greater hardness, namely slate or untreated antler.

Because the olive talc and dark grey soapstone are geologically the same, they share the same hardness. The difference in drilling times is largely due to the different thicknesses of each sample. Future experiments will require samples of equal thickness so that production times may be adequately compared between material categories.

Remarkably, the second slate drill bit outperformed the nephrite drill bit when drilling the talc sample. The slate drill bit was also able to drill through samples of wood and soapstone without incident. This shows that nephrite drill bits are not required for all drilling activities. Having said that, nephrite would be needed to drill the harder materials like slate or untreated antler as slate was ineffective against both. Both of equal hardness, the slate drill bit merely scratched the surface of the slate piece, and only wore through some of the weathered surface of the untreated antler. Grinding of both of these ultimately dulled the slate drill bit by wearing away the tip.

6.5.1.4 Problems with Experimental Drilling

In conducting the drilling experiments, numerous problems were encountered while trying to make the tests consistent. The efficiency of the drill depends largely on how well the spindle spins. Repeated use of the bow drill shows that this depends on the fluidity of the strokes, which are directly affected by the tightness and width of the string. Extended use of the same string results in it getting looser from stretching and coiling up as it doubles back on its self. In addition to this, the longer the string the better, as the spindle would ultimately spin more with each stroke. Other problems encountered during experimental drilling include lining up the holes when drilling from each side of the media; staying far enough away from the edge of the media so the drill bit does not fall out; and the delay associated with operating the timer when drilling commences and halts. It would be best if someone else was timing all the experiments. Preliminary use of a bow drill shows that it is much more complicated than it seems, and that many variables must be controlled for a fair test.

6.6 Conclusion

The experiments and time trials presented in this thesis serve to refine the procedures and problems associated with ground stone tool production. By timing the experiments this process illustrates what methods work and those that are ineffective, as well as those that could work provided more time and experience in tool making were available. It also serves to illustrate the need for alternative approaches to working nephrite, such as the addition of an abrasive agent.

The experiments add to an understanding of the production process by detailing the involved steps and thought processes. They also provide a useful perspective on the artifact assemblage by allowing one to organize the artifacts according to provisional function, as well as their role in the production process. By creating the same types of forms, tools and debitage, it is easier to organize and better understand the artifact assemblages we uncover.

Chapter 7: Discussion

The experimental approach reported in this paper is an initial foray into understanding Inuit ground stone technology by making and using replica tools. The comparison between the use of nephrite and slate, as well as of the related implements and techniques, is explored along with the successes and failures of an experimental approach. The advantages and disadvantages of working with nephrite are made evident through experimentation and preliminary use studies. While nephrite is invariably harder and thus more durable than its slate counterpart, this strength comes at a price. The crystalline structure that gives nephrite its strength also ensures that it breaks unreliably and is impervious to many manufacturing techniques. Although slate is more readily available and more easily worked, the experiments presented here show that slate tools are only a fraction as strong as comparable nephrite examples.

Framing the experimental approach in terms of a "constellation of knowledge" concept of agency and chaîne opératoire serves to systematically break down the steps and decisions needed to successfully create accurate Inuit ground stone replicas. Combined with detailed artifactual, ethnographic and experimental studies, analyzing a tool assemblage in this way helps us better understand the tools and the mind set of their Inuit creators.

Variations in style, hafting technique and tool type show that the stages of production were not rigid. Suggested chaîne opératoire models offer just one possible sequence of events in an artifact's life history. While some of the basic steps are essentially immutable, namely working, chipping and grinding a preform into the desired shape, others remain fluid, such as when the haft is made, which edge is sharpened first, or when a particular hole is drilled. Additional work is needed with particular artifacts to determine the intricacies of their specific life histories. For example, by examining the polish around a hole one could determine if it was made before or after the surface was polished.

The experimental approach presented in this paper also emphasizes the usefulness of considering the interrelatedness of manufacturing techniques, implements, raw materials and end goals in relation to a particular tool's history. Acting as a means to acknowledge the less tangible thought processes behind selecting particular tools and materials, the experimental approach enables the tool maker to better align him or herself with the thoughts and limitations of the original tool maker. The experimental tool maker gets at these ideas through the detailed analysis of the ground stone assemblage and subsequent experimental trials.

7.1 Characterization by Ground Stone Assemblage

The characterization of the ground stone assemblage by provisional function was crucial in understanding the breadth of tools available to the Inuk tool maker. The varying shapes and sizes of knives, end blades and other tools attest to specialization of tool types meant to be used for specific tasks. Dull unifacially sharpened uluit, for example, would be useful for the scraping of hides, but considerably less efficient for cutting them into manageable strips. In this instance, a sharper bifacially worked ulu would be needed to finish the job. Some tools were certainly multipurpose in nature, with the blade edge and associated wear only reflecting the last instances of use, (i.e. since it was last resharpened).

The characterization of tools by provisional function involved active comparison of tools with ethnographic and archaeological examples. Trying to ascertain a tool's function makes it apparent that some tools may belong to more than one category, with the classification of some end blades and end blade fragments being the most difficult. While function can be determined by hafting style and size, identification may be impossible when diagnostic portions of the tools are missing due to breakage. When it is unclear where they belong, they must ultimately be relegated to the categories of miscellaneous blade or polished fragment. These catch-all categories were crucial in ensuring that too much time was not spent dwelling on the formal use of particular artifact fragments. While artifacts were assigned to the various tool categories with confidence, extended analysis of the miscellaneous and polished specimens may eventually lead to the reclassification of some of the artifacts. Using the experiments to better understand the transition from blanks to discarded tool would also help in the reclassification of the tools. Miscellaneous and polished specimens and debitage from experiments could be carefully documented and compared with those found in the assemblage. Any reclassifications would likely be minimal and would not drastically alter the statistics and analysis offered in this paper.

Characterization of the ground stone assemblage by an artifact's role in the production process was also critical in the application of an experimental approach. Ascribing artifacts to such categories as manufacturing implements, unfinished tools, by-products and finished tools shows that Inuit ground stone technology is much more than the finely ground and often complete specimens that typify most Inuit ground stone assemblages. In fact, 48% of the ground stone tools from Nachvak Village (IgCx-3) were finished tools, 22% were manufacturing implements, 20% were unfinished blanks and preforms, and a further 9% were miscellaneous and polished fragments (Figure 4.33). It should be noted that these numbers do not include the copious amount of flakes and other debitage strewn throughout the deposits.

Detailed analysis of the manufacturing implements shows the importance of whetstones. Of the 666 ground stone artifacts analyzed, 128 are whetstones. Fine-grained whetstones are most numerous, followed by medium-grained and coarse-grained, respectively (Table 4.7). The abundance of fine-grained whetstones attests to their use for polishing tool surfaces and blade edges, not only making them aesthetically pleasing but also more efficient. Nicks and scratches represent weak points where the tool may catch and subsequently break during use. Similarly, a blade edge with nicks would also be less efficient, potentially creating unwanted holes and/or uneven surfaces.

The greater number of fine-grained whetstones may also reflect the soft nature of the stone compared to their medium and coarse-grained counterparts. Extensive use may mean that they are worn more extensively, breaking into multiple fragments, and requiring the addition of more fine-grained whetstones to the tool assemblage. Another reason for the abundance of fine-grained whetstones may be their use to resharpen and rework the ground stone tools as needed. The nature of the ground stone tool industry requires that the blade edges be resharpened frequently over a tool's life history. Rankin and Lebreche (1991) note that each woman would have had a whetstone with her ulu for resharpening when needed. Maintaining the blade edge would be important to avoid a seal or caribou skin being ruined during processing.

There is also a notable lack of hammerstones, peckers and anvil stones as compared to whetstones. Conversations with other experimental archaeologists suggest that hammerstones can be very personal. It is often hard to find a stone that fits comfortably in the hand and can thus be used to manipulate a core effectively. In my personal experience, when learning how to flintknap, the instructor would often show others how to flintknap, passing on the preform, allowing others to practice and see what has been done. However, he would seldom relinquish the prized hammerstone. It is conceivable that the Inuk tool maker may have also have had a personal relationship with his/her particular hammerstone.

There may also be a more practical reason for a lack of hammerstones in the archaeological collection. It may be more to do with excavation methods and the experience of the excavation team. While they were actively collected during excavations at Nachvak, depending on the excavator's mandate, not all hammerstones may be collected. Likewise, minimal use wear on the hammerstones surface could result in it being overlooked. There may also be an abundance of unworked cobbles among the ruins of a typical semi-subterranean sod house.

Examination of the preforms and blanks also helps the experimental archaeologist visualize the potential of the raw material. Studying the transition from blank, to perform, to finished tool fleshes out the chaîne opératoire of each tool type. Duplicating the production process in experiments aids in understanding why the unfinished tools look the way they do. Likewise, an experienced tool maker could eventually envision what the next step should be and would be able to pinpoint any errors that were made leading to the abandonment of a particular preform. An overzealous tap with a hammerstone could have broken the preform into many unwanted pieces, as was done in the attempted experimental production of the nephrite ulu.

7.2 Comparison of Slate and Nephrite

An examination of Inuit ground stone technology would be very limited without the comparison of slate and nephrite. There are numerous reasons that could explain the abundance of slate as opposed to nephrite in the Inuit ground stone assemblage. Slate is easier to work, can be quarried more readily and is strong enough to be used for most tool categories. In contrast, nephrite takes much more time and effort to work, requires additional manufacturing techniques and implements, and is largely used for tools that require a strong durable edge, namely adzes, awls and drill bits. Equal numbers of slate and nephrite beads also highlight the ornamental nature of their use. Much time and effort would be invested in creating circular beads out of both these materials. The fine drilling and polishing involved in finishing the beads would require additional implements and techniques.

The experimental approach to understanding these materials is just as important as understanding the production sequences of the ground stone tools themselves. When working with nephrite, the tool maker must learn to deal with the unpredictable fracturing of nephrite and its general resilience. As discussed by Darwent (1998), an experimental approach to understanding nephrite proves to be a monumental task. Aside from the time and energy associated with grinding, one must obtain a piece of nephrite as close as possible to the desired end product. Time and energy demands increase with the size of the preform. It is for this reason that all of the slate and nephrite drill bit preforms were made to approximately the same dimensions before commencing the time trials.

Experiments discussed in this paper have also shown that nephrite is most effectively worked when the desired preform is secured in place and ground with the coarsest whetstone available. A whetstone with a Moh's hardness of 6.5 or greater proves to be ideal, and such examples were found in the archaeological record. The materials with greatest potential include labradorite, feldspar, granite, and other stones with high concentrations of quartzite inclusions. The softness of fine and medium-grained whetstones means that they disintegrate with minimal use. Even the coarse-grained stones are eventually ground smooth and rendered ineffective for grinding nephrite.

7.3 Experimental Use

Success and failure go hand in hand with an experimental approach to understanding Inuit ground stone technology. It is for this reason that all experiments were carefully recorded. Both the lithic analyst and the experimental tool maker need to understand and appreciate the appearance of preforms and tools that provide evidence of incidents when things went right and when things went wrong. As illustrated in the experimental production of a nephrite ulu (Figure 6.7), a poorly placed strike could in effect ruin a preform. With ample practice, however, an effective tool maker should eventually be able to minimize such mistakes, visualizing what steps are needed to successfully achieve the end goal. If a mistake is made, a seasoned tool maker instinctively is able to reassess, improvise, and makes the best of the situation. While the breakage of the nephrite ulu preform halted the ulu production sequence, it led to the production of multiple smaller blanks that could ultimately be transformed into smaller items, such as beads, drill bits, end blades and miniature ulu blades (Figure 6.7 e).

Experimental replication has shown that it is easiest to make a tool by working with a piece of raw material that closely resembles the shape and/or size of the desired end product, such as making an end blade out of a tear drop-shaped flake. This improvisation is exemplified in the reworking of tools, for instance the reshaping of a knife tip into a miniature ulu blade (Figure 4.8 e). This not only conserves materials, but is a practical means of creating another useful object.

By addressing the potential information that can be derived from performs, it is also possible to assess functional areas of a site. Particular areas could be used as manufacturing hubs, or simply areas where expedient tools were made and/or reworked, taking into consideration curation, seasonality and site function. Many smaller specimens reflect how broken pieces could easily be reworked into much needed tools.

Experimenting with various media and techniques also allows the tool maker to better understand how materials work together. The experimental grinding of nephrite revealed the need for durable, coarse-grained whetstones. While the fine and medium-grained whetstones deteriorated rapidly when used against nephrite, deterioration was more gradual when used to grind slate. This, and the greater proportion of fine-grained whetstones, could suggest that the coarse-grained whetstones may not have been necessary for the grinding and shaping of slate tools. Comparing the time associated with the production of comparable nephrite and slate drill bits shows how grinding nephrite takes at least four times as long as slate, using the same whetstone and the same slurry of water and sand. Similarly, the drill use timed trials revealed that slate was effective at drilling soapstone and softwood, but ineffective on slate and untreated antler. It should be noted that both slate drill bits outperformed the nephrite drill bit in the drilling of soapstone sample 1 (Table 6.6). The additional time spent crafting the nephrite drill bit was not warranted in this instance.

In discussing the time associated with making and using ground stone tools, it is also important to address the notion that the Inuk tool maker would not have had the same constraints on time as the experimental tool maker. It may not have been an issue whether or not it took five minutes or thirty minutes to drill a hole through something. Similarly, the manufacture of the tool may not have been completed from beginning to end in one sitting, as is evidenced by the abundant number of preforms. One method of production would be to shape a series of blanks or preforms which could be shaped and refined when needed. The time taken to make a tool may be hard to surmise as the tool may have been shaped and/or reworked by more than one person, such as an expert tool maker passing a partially worked adze on to an apprentice, or a woman using her whetstone to maintain an ulu's blade edge. Finlay (1996) notes that the role of children and women are often overlooked when considering the production, use and analysis of lithic assemblages. The chaîne opératoire of a particular tool may not be contiguous; many actors: male, female, young or old, could have contributed to the life history of the artifacts represented in the ground stone assemblage. Modern notions of time and immediacy should not be imposed upon the tool making of the past.

7.4 Experimental Replication of Inuit Drilling Technology

The experimental production of a drill also supports its identification as both a finished tool and a manufacturing implement. A drill is needed for the production of many ground stone tools, as well as for the drilling of other media (sled runners, knife handles, etc.). The use of the drill also highlights the intricate knowledge and implements needed to complete such as process. Ground stone technology should not be considered separately from other Inuit technologies. While ground stone tools may account for a majority of tool types, they are, for the most part, hafted into organic hafts and used along with other tools to complete a task.

These factors were most evident in the production of the drill kit. An essential part of replicating the use of slate and nephrite drill bits, the creation of the drill bit was labour intensive in and of itself. While the materials may not have been those found in the archaeological record (Schlederman 1971, 1975) (Figure 4.8 a, b), a process of trial and error was needed to create a drill kit mechanically similar to those used by the Inuit. Green branches were substituted for the curvature of caribou ribs, and a wooden handhold was used in lieu of drilling with a caribou astragalus mouth piece. The basic mechanics were explored, controlling multiple variables to allow for accurate assessments of the difficulties associated with each material. Attempts at hafting the drill bits reinforced the importance of the rectangular tangs present in the assemblage (Figure 4.21, 4.22 d, f, j, k, n, o). This tang ultimately affects the design of the hafting socket on the chuck, since a rectangular socket is needed to hold the drill bit in place (Figure 4.20). Initial hafting and drilling attempts revealed that drilling efficiency decreased with the loosening of the haft. This resulted in the spindle wobbling, eventually dismounting and or breaking the drill bit. The process of drilling also required the use of additional gestures and materials, not otherwise associated with the ground stone tool industry. Finding the right materials and techniques needed for the construction of the bow, spindle, chuck and mouth piece, aided in the understanding of this part of the process.

In addition to knowing how to make the drill bit and the related implements, it is also important not to underestimate the importance of the particular operating sequence required in operating the drill bit properly and efficiently. Many interrelated variables had to be controlled, including bow string tightness, optimal downward pressure on the spindle end, and the rhythm of the whirling bow. Any errors meant that the spindle would wobble, boring a wider hole, knocking the bit out of the hole, or in some instances breaking the drill bit, as was evident when the initial slate drill bit shattered during use. While the fracture of the drill bit in this instance may be related to using soft slate to drill much harder antler, such a failure could also be attributed to human error. There may have been an issue with my technique, or with the design and manufacture of the slate drill bit or replica drill kit. For example, the tip of the drill bit may not have been at the right angle for the task.

Differences in the media being drilled reflect the differential needs for both slate and nephrite drill bits. The benefit of using each material should be considered. It would be pointless to attempt to drill a dry piece of antler or a piece of nephrite with a slate drill bit. While it might work eventually, it would take much more time and effort than using a comparable nephrite drill bit. The higher number of slate bits may confirm that slate bits break more often than nephrite bits, and/or that nephrite was more highly curated. It may also indicate simply that slate drill bits were widely used, with additional techniques being employed to minimize the disadvantages of using this material. Such techniques may include: adding something to the process, such as an abrasive agent (sand), or lubricants (water or fat); or the pre-treatment of a particular medium such as working on a material when it is fresh, or after it has been soaked in urine or water for an extended period of time (LeMoine 1997).

7.5 Future Research

The experimental approach to Inuit ground stone technology explored in this thesis discusses the ground stone assemblage in terms of the materials, techniques, and implements used by the Inuit tool makers. It also provides insight into the use of an experimental approach. Additional experiments must be conducted to more fully explore the intricacies of Inuit ground stone technology and the knowledge required to conceive and manufacture these finely made tools.

Future explorations of Inuit ground stone technology may also draw upon the knowledge and experience of surviving Inuit elders, who may have a living memory of working stone. While stone working has been relegated to the carving of beautiful and unique carvings for sale to the global economy (McGhee 2004), there may still be lessons to be learned, from when knowing how to work slate and nephrite would have been essential for survival.

Community based research should be conducted to assess whether or not such continuities still exist, if metal blades are still maintained and sharpened in the same manner, or if they have been more recently replaced with European techniques brought on by the trade and use of metal files and other tools. Such community based approaches also illustrate how contemporary examples of the same tools are used. Uluit, bow drills and harpoons are still used in varying capacities by the current Inuit population.

Future research should also involve extensive use wear studies involving the production and use of ground stone tools. Analysis of wear patterns may be used to contradict or reaffirm traditional views of how a tool was used. Going beyond conventional identifications of artifacts based on the ethnographic and archaeological record, use wear analysis may be used to determine specifically how a tool was used, and if it was used at all (Semenov 1963, LeMoine 1997).

Attempts should be made to build on Darwent's (1998) useful exploration of prehistoric nephrite use on the British Columbia plateau. A comparable study is needed for the prehistoric use of nephrite among the Inuit. This project is just one step toward achieving that goal. This type of study would focus more closely on the manufacture and use of replicas using additional timed and controlled experiments. These experiments could further compare the differences between working slate and nephrite. Exploring nephrite use may also lead to a better understanding of its former importance to the Inuit culture, in light of the ease with which slate and available metals (iron, copper, etc.) could be manipulated to create tools.

It would also be useful to make a concerted effort to locate potential nephrite sources and quarries in the Eastern Arctic. While some potential areas and avenues have been presented in this paper, more geological expertise and new field data are greatly needed. Understanding the geological formation processes is a crucial part of finding a sizable nephrite outcrop. Quarry sites could be identified, studied and most importantly protected from misuse and/or destruction. Knowing what the nephrite looks like in its raw state would also shed light on the early production techniques.

In addition to slate, nephrite and varying grades of whetstones, Inuit also made use of soapstone and to a limited degree serpentine. While soapstone was widely used in the production of pots and lamps, serpentine was used both for whetstones and as a paving material. While it is not widely discussed, nephrite often forms in association with soapstone and serpentine. Knowing more about these materials and where they may be procured may also aid in locating sources of nephrite.

While the experiments presented in this paper discuss some of the plausible techniques associated with working nephrite, many questions remain unresolved. It is unclear whether or not the Inuit tool makers used natural vices to hold nephrite in place to facilitate the manufacturing process. It is also difficult to demonstrate the use of a slurry of sand and water/fat as an abrasive agent. At this point it is impractical, if not impossible, to separate sand by-product and sand used as a potential abrasive agent within a given soil matrix. Examples of nephrite specimens with hafting holes also lead to questions about how people were able to drill such a hard material. It would not have been a matter of soaking it for a couple days, as could be done with permeable organic materials such as antler (LeMoine 1997). It can be assumed that an abrasive agent was used to produce nephrite drill bits, but further tests will be needed to explore this hypothesis. In sum, more work is needed to uncover the secrets of this alluring green material.

The eight incised artifacts (Figure 5.4) reflect how the groove and snap technique may have functioned as an alternative means of working ground stone, where flaking may be ineffective (Darwent 1998:33). While not directly incorporated into the discussed experiments, additional work needs to be conducted to determine the practicality and costs associated with working slate and nephrite in this way. With six out of the eight incised artefacts being made of nephrite, it is clear that this method was actively used in the working of nephrite. It should be noted that during the production of the drill performs, grooves were made into the nephrite to facilitate a reliable break. In the current experiments, prolonged use of a low quality diamond file appeared to be the sole means of making a substantial groove. Future experiments are needed to explore the nature of the groove and snap technique as well as the types of naturally occurring "non-brittle stones" (Darwent 1998:33) that can be used to efficiently work the material without rapid deterioration.

An experimental approach cannot be adopted successfully without a comprehensive knowledge of the ground stone assemblage and its role in the greater Inuit society. To accurately replicate the tools of the past we must try to deduce the reasoning behind every stage of the production process. We must try to explore the mindset of the Inuk tool maker, visualizing why a particular tool is needed and how such a tool can be created. While it is important to know where and how people procured their raw materials, it is also important to understand the limitations and difficulties associated with the materials in question. The costs and benefits of each tool type and material are important for understanding why particular decisions were made. By understanding the life history of the artifacts, we may better understand the life history of their creators.

Chapter 8: Conclusion

An experimental approach to understanding Inuit ground stone technology requires knowledge of the prehistoric Inuit culture, the various tools that were used, and an appreciation for the time and patience associated with the detailed analysis of collections and the experimental replication and use of tools. To accurately replicate the tools and outlook of the Inuit tool makers, it is important to understand the wide variety of tools that make up the ground stone assemblage and Inuit technology in general. The ground stone tools cannot be separated from the context in which they were conceived, manufactured and used. Only after a detailed study of the tools can one begin to understand how and why particular materials, techniques and tools were employed.

As with any archaeological research project, an experimental approach must be grounded in theory. Concepts of agency, chaîne opératoire and the anthropology of technology form the basis of the experimental approach. Combining the stages of production with the analysis of thought processes involved in making and using ground stone tools, these theories deal with both the practical and cognitive sides of tool production. This meshes well with the aim of an experimental approach, namely putting the experimental tool maker into the shoes of the prehistoric Inuk who made and used the tools so many years ago. These theories help to map out and keep track of the information attained while making, using and sometimes breaking experimental ground stone tools.

Separating the ground stone tools according to function also highlights artifact variability. This variability requires the tool maker to add or remove various steps as needed, once again requiring the tool maker to improvise and plan ahead. Depending on the desired goal, for example, this might involve hafting a knife blade with a stem or using hole and rivets, or choosing between creating a single or double bladed knife. Depending on culturally bound knowledge, skill level and materials available, a slab of slate could be shaped into virtually anything, from a large flensing knife, to the tiniest bead.

Nephrite is harder to work, and requires more time and energy than working other materials. Time trials show that the time associated with working nephrite is compensated by the durability and efficiency of the end product. Experimental nephrite drill bits outperformed their slate counterparts in most instances (Table 6.6). It is also important to note that nephrite was largely used in the manufacture of tools that required a durable edge that was resistant to fracturing under intense use (i.e. awls, adzes and drill bits). Harpoon blades, on the other hand, did not need to be made out of nephrite, because whether they were made of slate or nephrite they would still penetrate the animal. The loss or breakage of a nephrite harpoon end blade during use would be much more costly than a slate one, factoring in the hours of tedious grinding and shaping associated with its manufacture.

Experimentation with nephrite and other materials also highlight implements and techniques not otherwise included as part of the ground stone technology. This may include: the use of sand as an abrasive agent and/or organic vices or lashings to hold the nephrite in place during the chipping and/or grinding process. The observation that nephrite cannot be as reliably flaked as chert or slate also attests to the varying techniques required to work the material. Nephrite could be seen as breaking more like Styrofoam (Tim Rast, pers. comm. 2006) than slate. The interlocking crystals that give nephrite its strength result in unpredictable bonds. This underscores the usefulness of starting with a blank that is as close to the final goal as possible.

The experimental production of tools teaches us much about the nuances of creating Inuit ground stone tools. Analysis of the stages of an artifact's life history, including its transition from raw material to blank, preform, finished object, used piece, and damaged, retouched and discarded object, allows one to better recognize their correlates during the analysis of the ground stone assemblage. While an experimental approach may also be useful in determining if a tool was reworked, the most efficiently reworked artifacts are undetectable; all remnants of their previous life would have been removed through extensive reshaping and resharpening.

In sum, this project suggests that with ample time and resources, it is possible to recreate and explore the methods associated with working nephrite and slate. The experimental approach requires that a large number of ground stone tools be studied before accurate replicas begin to take shape. By dividing the tools by provisional function and role in the production process, the experimental tool maker can eventually look at a piece of raw material and intuitively assess its potential. Knowing the limitations of particular materials and the associated methods for working them, the interrelatedness of the components of the ground stone technology become self-evident. Knowledge of the tools, materials, decisions and gestures are vital to understanding the Inuit approach to ground stone technology.

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Appendix I

Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database

The enclosed CD contains the Nachvak Village (IgCx-3) 2004-2006 ground stone tool database. This database consists of the provenience, measurements, description and other raw data for all artifacts discussed in this thesis. The database has been saved in multiple formats to ensure compatibility with both Microsoft Access and Microsoft Excel.

The files are labelled as follows:

- Appendix I - Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database (Access 2003)
- Appendix I - Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database (Access 2007)
- Appendix I - Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database (Excel 2003)
- Appendix I - Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database (Excel 2007)

An Experimental Approach to Inuit Ground Stone Technology at Nachvak Fiord, Labrador

John Higdon

Appendix I

Contents:

- Appendix I - Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database (Access 2003)
- Appendix I - Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database (Access 2007)
- Appendix I - Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database (Excel 2003)
- Appendix I - Nachvak Village (IgCx-3) 2004-2006 Ground Stone Tool Database (Excel 2007)

CD 1 of 1