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The Influence of Iron on Arctic Thule Migration Patterns

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THE INFLUENCE OF IRON ON ARCTIC
THULE MIGRATION PATTERNS

By

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Bachelor of Science in Anthropology
California Polytechnic State University, Pomona
2013

A thesis submitted in partial fulfillment
of the requirements for the

Master of Arts - Anthropology

Department of Anthropology
College of Liberal Arts
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ABSTRACT

The Influence of Iron on Arctic Thule Migration Patterns

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Arctic scholars have yet to fully understand the reasons behind the migration of Thule culture from the western to the eastern Arctic. This rapid movement across such a vast area into environmentally diverse regions marks a critical period of cultural change that is usually summarized by two theoretical positions. Ecological theories postulated environmental changes placed selective pressures on traditional food sources that required Thule hunters to follow migrating prey. Theories that focused on material acquisition alternately proposed the Thule followed the trail of meteoric iron eastward into northwestern Greenland.

This research sought to examine the eastward Thule migration from another possible perspective. Instead of taking an environmental view, it focused on the search for valuable materials such as meteoric iron. Information on iron artifacts from archaeological site reports was examined to discuss the use of iron tools and possible metalworking methods. I also conducted experimental research into how meteorite iron ore may have been cold forged into endblades. This provided a deeper understanding of how these materials were processed in an environment with such limited resources.

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CHAPTER 1

INTRODUCTION

The motivations behind eastward Thule migration remain a highly contentious issue among Arctic scholars. While environmental models were once considered the sole reason for Thule cultural expansion, several authors are now forming alternative explanations for migration, such as population pressure or the acquisition of valuable raw materials. This is based on the assumption that limited access to raw materials that can be shaped into utilitarian or visually appealing objects increases the social and economic value of said material (Pydyn, 1998; Quesada, 1998; Sinclair, 1998). This research thesis examined large scale Thule migration into the eastern Arctic spurred not by environmental change, but by the search for iron. Seasonal movement, as experienced by most hunter-gatherer Arctic cultures, is an unsatisfactory explanation for the uncharacteristically fast and linear migration pattern of the Thule. In this study I compiled and cataloged reports of iron artifacts from Thule sites along projected eastward migration routes in order to determine whether access to iron stimulated Thule expansion into the Canadian Arctic.

Using archaeological site reports, I also examined tool usage and possible metalworking methods. Literature on early metalworking by indigenous Arctic populations lags behind that of European or Near Eastern research. Such gaps in the literature are detrimental to the understanding of northern people. Meteoric iron was utilized by Arctic Thule hunter-gatherer groups for thousands of years before European contact (Wayman, 1987). Despite this long tradition of iron use, the complex methods used to forge raw meteoric iron into effective hunting tools have gone unstudied in Arctic literature. This can be attributed to the assumption that the “simple” techniques (such as hammering) used by hunter-gatherers produce “simple” tools that

need no further explanation (Frink, 2009). In the case of the Thule, the tools or techniques they may have used to harvest iron from the meteorite and then worked the iron into blades are still debated. To better understand the skills and tools used by Arctic hunter-gatherers, I conducted an experimental study into how meteorite iron ore may have been cold forged into harpoon endblade points by employing possible techniques and materials that would have been available at the time. This provided a deeper understanding of how these materials were processed in an extreme environment with severely limited resources.

Current research on the impact of metal use on large-scale migrations is limited at best (Cooper, 2012). There is a heavy emphasis on environmental change as a catalyst of cultural adaptations in Arctic cultures. While environment does play a major role among Arctic hunter-gatherers, previous research takes on an environmentally deterministic viewpoint, ignoring other cultural factors that contribute more depth to the cultures being studied. To address this issue, my research questions focused on the connections between migration, exchange, and metal, using the following methods. The first was to synthesize existing information on iron artifacts in Thule culture to gain a better understanding of the exchange networks that may have influenced eastward Thule migration. This synthesis involved determining where the meteoric iron is found in the archaeological record. The next method was an experimental project to understand how the meteoric iron may have been harvested and worked. The information gathered from these two methods can be used to infer what role the use of iron played in the adaptation of the Thule to their new environment in the central and eastern Arctic.

This study can be used to support further research linking material goods to rapid large-scale migration. To accomplish this goal, this study aimed to uncover to what extent meteoric iron influenced Thule migration. By finding a pattern between these two variables, we may gain

better insight into the complexities of environment and economic decision-making among Thule hunter-gatherers.

CHAPTER 2

BACKGROUND

Thule culture

The Thule were a pre-colonial culture that once populated the northern and western coasts of Arctic Alaska. Thule culture is believed to have gradually developed from the Birnirk culture in northern Alaska around AD 900. Alaskan Thule are also called the Western Thule as defined by Larsen and Rainey (1948). Early Alaskan Thule were characterized by houses with “multiple rooms built of horizontal logs, sunken entrance passages, and small kitchen extensions” as well as single-spurred harpoon head styles (McCullough, 1989, p. 6).

While some groups of Alaskan Thule settled the northern and western coasts of Alaska, other groups continued to move eastward. Their rapid migration covered an expanse of thousands of kilometers in a short period of time during the Medieval Warm Period through very different ecosystems. The Medieval Warm Period (also known as the Medieval Climactic Anomaly) was a period of warm climate lasting from about AD 950 to AD 1250 (Mann et al., 2009). By AD 1200, Thule people had migrated into the High Canadian Arctic, extending as far as western Greenland and Labrador (Dumond, 1987; Friesen & Arnold, 2008). Before AD 1000, the central and eastern Canadian Arctic was occupied by the Dorset culture. Within a few centuries, it is suggested that Thule immigrants had completely displaced the Dorset (McGhee, 2005). Furthermore, evidence of interaction between the Thule and Dorset is scarce and the reasons for Dorset displacement are poorly understood. The disappearance of Dorset culture is part of an ongoing discourse in Arctic literature today (Park 1993, 2000).

The ancestors of contemporary Greenlandic Inuit, the Classic Thule inhabited the Canadian High Arctic approximately between AD 1000 - AD 1200 (McCartney, 1971). The Classic Thule

are characterized by the archaeological site Naujan (Naujaat) in Repulse Bay, northwestern Hudson Bay. Danish archaeologist Therkel Mathiassen was responsible for the site's discovery and excavation in 1922 during the famous Fifth Thule Expedition. The Danish-sponsored expedition was sent from Greenland into the Canadian Arctic to conduct ethnological and archaeological research concerning the origin of Eskimoan peoples. The Naujan site was the second Thule site to be excavated and has come to represent the standard "type site" of Thule culture. During this period the Canadian Thule lived in circular stone houses and relied heavily on whale hunting as their main form of livelihood. Bone and antler products were used extensively to create technologies such as harpoon foreshafts, arrow points, whaling harpoon heads, ulu handles, bird bolas, sled parts, toys, art, and other objects (Mathiassen, 1927; Rankin, 2009).

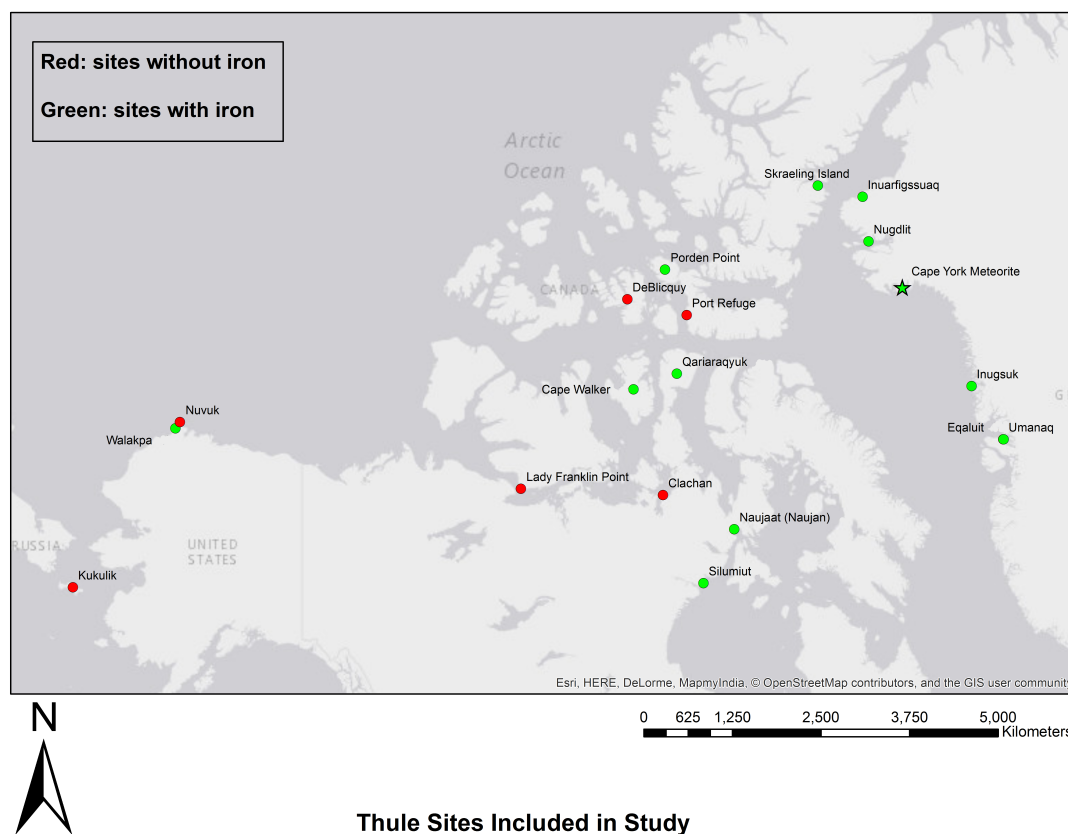


Figure 1. Map of Classic Thule sites throughout the North American Arctic.

Alaskan Thule and Canadian Thule are archaeologically considered two distinct groups characterized by differences in typologies (Morrison, 1981). For the purposes of this study, “Thule culture” will refer to the culture group as a whole and distinctions between Alaskan and Canadian Thule will be made when discussing differences in artifact findings and lifeways.

Because the Thule inhabited most parts of the central and eastern Arctic, one might assume that the closest ethnographic analogue would be central Arctic cultures such as the Copper, Netsilik, and Igloodik Inuit. However, investigation into these societies revealed that they lived very different lives from the Classic Thule (Friesen & Arnold 2008). Scholars contend the “best fit” for the Classic Thule are the Northwest Alaska Inupiat (Friesen, 2009b; Hollinger et al.,

2009). This comparison is primarily based on two key points. First, there is substantial evidence that the Thule originally migrated from northwest Alaska into the eastern Arctic (Friesen & Arnold, 2008; Mason & Bowers, 2009; McCullough, 1989; McGhee, 2000, 2005, 2009). Thus, it is likely that they brought their Alaskan way of life with them. It is important to note that seven centuries passed from the time of their migration to the “ethnographic present,” so it must be assumed that Alaskan lifeways were not static and changed considerably during this time lapse (Friesen, 2009a). Second, there are similarities between the material culture, subsistence strategies, and settlements of the Classic Thule and Alaskan Inupiat. Both lived in semi-subterranean houses, hunted bowhead whale for meat and blubber, and used *umiak* (skin boats) for long distance travel. Because of these similarities in behavior, Arctic archaeologists have extended the use of the Northwest Alaskan analogue to analyze issues of organizational space (e.g., Savelle, 2002a; Whitridge, 2004), worldview (e.g., Whitridge, 2004), and social roles (e.g., Grier & Savelle, 1994; Whitridge, 2002).

Arctic lifeways and subsistence

In order to understand Thule migration, we must first understand the lifeways and subsistence strategies of the Thule. Just as their Inuit descendants do today, the Thule built social and ritual relationships with their living and animal community to become successful hunters (Bodenhorn, 1990; Whitridge, 2001). A highly mobile people, the Thule way of life was heavily dependent on a sufficient food source. The two most important species the Thule relied on were whales and seals, but caribou, fish, and birds were also hunted. Some scholars have questioned the reliance on whaling in Thule economy (see Savelle & McCartney, 1994; Stanford, 1976). While the Thule possibly scavenged for whale products from beached whales, archaeological

evidence from the central Canadian Arctic suggests that they heavily engaged in open water whale hunting, at least in this region (Dumond, 1987).

Many researchers understand that the link between an ethnographic group and the prehistoric people whose artifacts they are studying play a crucial role when applying ethnographic analogies (Binford, 1967; Stiles, 1977). Ethnographic analogies from modern Northwest Alaskan groups have been used to reconstruct the role of subsistence whaling in Thule culture. From this comparison, conclusions can be drawn about the Thule process of subsistence whaling. *Umiat* (singular *umiak*), large open skin boats, allowed whaling crews to pursue prey in open waters. These boats were owned by *umialit* (singular *umialik*), or boat owners, who coordinated sea mammal hunting and rewarded crew members with prestige-enhancing gifts for their labor (Whitridge, 2002). The *qargi*, or men's house, was where whaling crew members assembled to prepare for the whaling season and hold important ceremonies (Whitridge, 2002). Women played an essential role in the process of whaling. They “would enter into relationships of affinity with whales, allowing them to act as intermediaries between hunter and prey” (Whitridge, 2001, p. 242). Even though women were normally prohibited from handling whaling gear or participating directly in the actual pursuit, whale hunting was a communal effort, and provided essential meat and oil (Grier, 1999).

McCartney (1991) suggests the control of the metal trade was influenced by Thule social organization. Again, the North Alaskan historic group analogy is being used to apply the term “societies” to Thule populations – namely, “autonomous socioterritorial units” suggested by Burch (1980, p. 258). McCartney suggests that “each permanent settlement was occupied by one or more local extended families” and were a “bounded and recognized territory” (McCartney, 1991, p. 36). These territories corresponded to hunting and fishing grounds. Among North

Alaskan historic groups, the *umialik* was the head of each local family and “had more of just about everything than anyone else did, and they had considerable control over the distribution of food and other resources to the rest” (Burch, 1980, p. 265). They were also economically self-sufficient, and during times of hardship, the *umialik* would redistribute whale meat and blubber to his crew members. Cassell (1988) likens this managerial role of the *umialik* to redistributive managers in an agricultural economy. They were also responsible for interregional alliances made through marriages, partnerships, and invitation-only feasts or “fairs” (Burch & Correll, 1972; Nelson, 1900). McCartney (1991, p. 36) suggests that in comparison to North Alaskan ranked societies, Thule winter site settlements are the counterparts to the North Alaskan “bounded and recognized” territories mentioned earlier. Although we cannot determine the boundaries of Thule territories in the past, McCartney suggests, “it is reasonable to assume sociopolitical territoriality was observed and economic zonation was a fact” (1991, p. 37). He goes on to say that if these Thule winter settlements were in fact the center of social, political, economic, and spiritual leadership of an *umialik*, with food surpluses and a redistributive organization system, then “it is reasonable to assume that metal was circulated and controlled by [an *umialik*] as well” (McCartney, 1991, p. 37). In summary, Thule *umialit* may have controlled metal by 1) playing a key role in a pan-Arctic redistributive system by way of feasts or alliances, 2) funneling the redistribution of goods within their local family or group, and 3) limiting outsider presence in their territory.

Seasonal behaviors differed between Canadian and Alaskan Thule. From historic accounts we know Canadian Thule settlements were not occupied year round (Park, 1997; Boas, 1964). In the winter months they lived in semisubterranean houses, with sites made up of a cluster of one to six houses (Park, 1999). Some sites contained kitchen areas that warmed the house when

wood or animal fat was burned (Dumond, 1987). These wintering sites have been found throughout the central Arctic. However, the Alaskan Thule built rounder winter houses, with walls of stone slab and whalebones, and roofs built with whale ribs covered by sod (Dumond, 1987). Both Canadian and Alaskan Thule made *qarmat* (singular *qarmaq*) and were used inter-seasonally, mostly between the fall and spring. These structures were constructed using animal bones, stone, sod, or blocks of snow, and covered with seal skins. Historically, we know men were responsible for the collection and construction of the dwelling framework (Wilson & Stewart, 2008). Women and children prepared the animal skins for roofing and siding (Wilson & Stewart, 2008). Summer *qarmat* were easy to transport during the highly mobile summer hunting season (Henshaw, 2000).

Hunting implements characteristic of Canadian Thule contained elements of their Alaskan origin. Appearing in Canadian Thule assemblages are kayaks, sealing harpoons, bows, arrows, bolas, fish spears, and darts propelled by throwing boards, all similar to designs found in Alaska (Dumond, 1987). Other artifacts similar to Alaskan examples have also been found: men's and women's polished slate knives, bone needle cases, combs, and snow goggles. While ice flow determined whether hunters would be able to procure sea animals, Canadian Thule possessed a variety of hunting techniques for hunting at sea, on land, or on the coast, all resembling Alaskan techniques. In open waters, floats and new forms of large harpoon heads facilitated hunting of large sea mammals. On land, travel across the icy landscape became easier with dog-pulled sleds. Toggles and buckles (used as parts of mushing harnesses), as well as the physical remains of the dogs themselves, were found in Thule sites to support the utilization of dog transportation (McMillan & Yellowhorn, 2009). In the winter months, the Canadian Thule hunted seal at breathing holes, demonstrated by the discovery of ice picks attached to the butt of harpoon shafts

appearing alongside ice scoops and three-legged stools (Dumond, 1987). Ice scoops, three-legged stools, and ice picks attached to harpoon shafts were newer additions to the Canadian Thule toolkit that were not Alaskan in origin.

Sources of fuel differed between Canadian and Alaskan Thule. Without the flooding of the Yukon River that brought trees and other debris into the Bering Sea, driftwood did not appear as frequently in the central Canadian Arctic as it did in northwest Alaska. Fat was another essential source of fuel and, like driftwood, could be used for cooking, light, warmth, and tool making (Cachel, 2000; Anderson, 2011). The scarcity of driftwood and fat is reflected in Canadian Thule pottery and metal artifacts: Thule pottery is thick, coarse, and poorly fired; often being referred to as “Thule crudware” by Arctic archaeologists (Arnold & Stimmell, 1983; McMillan & Yellowhorn, 2009). Pottery is common in Alaskan Thule sites in the western Arctic, with some being found farther east. However, pottery making was mostly abandoned throughout the central and eastern Canadian Arctic due to the lack of clay and the wood to fire it. Instead, the Thule utilized soapstone to create lamps and cooking pots. Metal artifacts found in Canadian Thule sites show no evidence of heat application, meaning they were not hardened or softened using any amount of heat (Buchwald & Mosdel, 1985).

Eastward migration

Environmental positions

Most research on Thule migration focused upon the impact of climate change and the migratory patterns of several food sources, in particular bowhead whales (Finkelstein et al., 2009; McCartney & Savelle, 1985; Moss & Bowers, 2007; Schledermann, 1976). Ecological theories contended the Thule were forced to migrate eastwards due to changes in the

environment that altered the migration patterns of wild game (Dumond, 1987; Morrison, 1999; Taylor, 1963). While it is true that the environment plays an important role in hunting behavior, we must first examine typical Thule hunter-gatherer mobility to understand why in the case of the Thule migration, a pattern of linear eastward movement is uncharacteristic of a migration propelled solely by environmental factors.

The mobility strategies of Thule hunter-gatherers in the central Canadian Arctic were heavily interwoven with their subsistence. During the Classic Thule period, the subsistence of the Thule was heavily based on the bowhead whale, and seasonal movement involved hunting bowhead whale across a landscape that the Thule had intimate knowledge of. Furthermore, the Arctic landscape, while devoid of large vegetation, was still populated with caribou, birds, fish, and seals. The Thule fully exploited all of these available resources. The puzzling question is why the Thule would abandon an area rich in resources to inhabit territories outside of their established location, travel in a specific direction, and leave after a brief amount of time.

Paleoenvironmental data suggest the Thule were in no way “following” whales during the Medieval Warm Period. Rather, to reach the greater Lancaster Sound area and Baffin Island they had to cross hundreds of kilometers of “essentially uninhabitable wasteland” (Morrison, 1999). It is generally accepted that “typical” hunter-gatherer seasonal movement, including the seasonal movement of the Thule, involves making seasonal rounds between already known locations (Boas, 1964; Kelly, 1983). However, during their mass migration the Thule were migrating well out of their established territory in northwest Alaska, taking over both the western and eastern Arctic. Friesen suggests this was an aggressive push eastward due to increasing evidence that the Thule had pushed Late Dorset populations further and further from their own territories (Friesen, 2009a). Others suggest that population pressure in Alaska or the introduction of a more efficient

whaling technology may have prompted the exodus (McMillan & Yellowhorn, 2009). Upon examination of these behaviors, it becomes clear that previous research based solely on environmental factors cannot fully explain the reasons for Thule migration.

The Classic Thule period between AD 900 – AD 1400 was characterized by a warmer climate than before, with pack ice retreating from the coast, a reduction in drift ice, longer periods of open water, and new, thinner ice forming later in the season (McGhee, 2000; Stanford, 1976). Early environmental positions suggested these changes greatly affected whaling methods as the interception of migrating whales depended upon trapping them in narrow channels created by pack ice in the spring and fall (Dumond, 1987). Scholars believed this increase in open water forced the Thule to migrate into distant territories in pursuit of whales and other marine mammals (Arnold & McCullough, 1990; Maxwell, 1985). Currently, researchers debate whether shortages in game corresponded with major climate change, and if these factors affected Thule migration at all. Warmer climatic conditions may have had little effect on year round ice barriers along possible Thule migration routes. In fact, these constant ice conditions may have been a permanent obstacle to human and whale travel altogether (McGhee, 2009).

Furthermore, radiocarbon dating research has placed Thule migration at dates much later than once believed (Friesen, 2004; Friesen & Arnold 2008; McGhee, 2000). This more accurate dating of the Thule's move eastward no longer corresponds with the climate changes believed to have altered migratory patterns of marine life (Friesen & Arnold 2008). Friesen and Arnold (2008) propose a migration date during the thirteenth century, demonstrating that the Thule migration was more rapid and widespread than previously believed. Furthermore, they suggest the Thule migration was a "relatively brief phenomenon," only lasting for about 200 years or less (Friesen & Arnold 2008, p. 527). Subsequently, Thule culture may not have been forced to move

eastward by hunting prospects, but rather, motivated to inhabit new territories for other reasons. However, the dependence upon sea mammal meat was essential to Thule survival, similar to modern indigenous Arctic groups. Therefore, ecological theories should not be totally disregarded, but instead be seen as one of many possible causes for Thule migration.

Material acquisition positions

Through extensive trade networks spanning throughout central Canada, the presence of iron in the east may have enticed some Thule to migrate towards the source. Like McGhee (1984), Friesen (2009a) speculates that Thule migration may have been a more deliberate and immediate transition than once believed. Evidence from Dorset sites in the eastern Arctic indicates meteoric iron was being utilized for tool technologies before the arrival of the Thule (Friesen, 2007; LeMoine et al., 2003; Meldgaard 1952; Rowley 1940). The Late Dorset site of Arvik contained approximately 288 artifacts of both meteoric iron and copper (Buchwald & Mosdel, 1985). The news of iron use by the Dorset may have trickled into Thule territories via exchange networks, and prompted the Thule to migrate eastward in pursuit of it. This rapid movement of Thule peoples into traditionally Dorset areas in order to obtain the Dorset's iron material may have led to the displacement of the Dorset population (Friesen, 2009a).

In more recent times, this mass migration in pursuit of metal is exemplified by the mass migration of American gold-seekers into California during the mid 1800s (Holliday & Swain, 1981). Like the Thule migration, the California Gold Rush was a large-scale movement of people across difficult and unknown terrain into populated territories within a brief amount of time. California State Archives from 1849-1880 estimates that around 300,000 people traveled by sea or over land from the East Coast or abroad within a span of seven years in order to obtain gold

that was initially made public through rumors alone (Rohrbough, 1998). Travel to California was limited by infrastructure and technology, and many early immigrants (later called “forty-niners”) died along the way (Holliday & Swain, 1981). Early Thule migrants may have faced similar issues in regards to traversing an unknown terrain (Stern, 2010). A technological boom in transportation was developed to accommodate the forty-niners, negatively affecting the environment and the vast Native American population in California (Holliday & Swain, 1981). Similarly, the Late Dorset people already inhabited the eastern Arctic during the time Thule migrants began to arrive. Friesen (2004, p. 690) suggests that the disappearance of the Dorset may have been due in part to “social and demographic factors stemming from relations with incoming Thule.” The Native American groups who resided within California for the past 14,000 years had been able to sustain their livelihoods in this harsh environment even up to the 19th and 20th centuries (Holliday & Swain, 1981). The invasion of miners, loggers, and settlers disrupted traditional hunting, gathering, and agricultural practices. It is estimated that from a population of 150,000 in 1845, less than 30,000 Native Americans remained by 1870 due to disease, starvation, and violence against them (Holliday & Swain, 1981). While there are no ethnographic records that could have been produced during Classic Thule times to support similar behavior during the Thule migration, nor are there similarities in lifeways between American miners and Thule and Dorset hunter-gatherers, we can still compare the general themes possessed by both migrations. Both migrations were large-scale mass movements of people from one territory into a distant, unknown, and already inhabited territory. Both migrations were conducted in a relatively brief amount of time with regards to available transportation. And lastly, in both migrations, the obtainment of precious metals played a significant role.

Other proposed theories

The deliberate exodus of Thule culture may have also been influenced by conditions outside of their immediate territory. Alaskan Thule may have been experiencing a shortage in iron after the rise of Genghis Khan, as they were dependent on East Asian sources of iron before they made use of Greenlandic sources in the western Arctic (Stern, 2010). Ancestral sites in Alaska and Siberia reveal that iron had been traded into the region from East Asia for at least a millennium before Thule development (Mason, 1998; McCartney, 1988). Political changes under Genghis Khan may have closed off trade for iron tools, causing the Thule in the Bering Strait region to leave in search of other iron sources.

Other researchers suggest the political issues were more localized. Internal conflict among polities may have pushed other groups farther east to alleviate social tension (Stern, 2010). Some argue that rivalries between and within these polities developed over control of prime whale hunting sites and access to long-distance goods such as iron (Stern, 2010; Mason, 1998). In the 19th century, European and Euro-American visitors to the Bering Strait region described hostilities kept in check through marriage alliances, regional feasting, and fictive kin relationships (Stern, 2010). Archaeologists have recovered pieces of slate armor as evidence of violence, suggesting inter-village warfare was a reality for proto-Thule groups (Stern, 2010). Historic accounts of regional hostilities among Inuit communities in northwest Alaska have shown that these tensions sometimes erupted into violence (Allen & Jones, 2014; Stern, 2010). Some archaeologists believe that these regional tensions and sociopolitical divisions among proto-Thule groups later led to the social division that ultimately created the distinctions between modern Inuit and Yupik peoples (Rasmussen & Toft, 1987; Stern, 2010).

Another factor of migration that we cannot downplay, regardless of how simple it may seem, is curiosity and wanderlust. Although these things cannot be seen in the archaeological record, curiosity has an adaptive underpinning. Meltzer (2009) suggests that hunter-gatherers are well aware of the fluctuations of their immediate environment; therefore they routinely search for new places, even when times are good, for when local conditions start to deteriorate.

McGhee (1984) suggests that the first set of Thule immigrants to enter the eastern Arctic were probably small families struggling to survive in their original homeland. The species of sea mammals that the Thule subsisted off of were not confined to western and eastern Arctic oceans, so Thule families who migrated eastward would have been able to procure the same resources in Hudson Bay as they did in Amunsend Gulf (Figure 1, page 5). This would be incentive for Thule families to move east as they could still hunt familiar food sources without changing their methods of hunting or processing.

Furthermore, their only competitors, the Dorset, were small in number and poorly armed (Friesen, 2000; McGhee, 2009, 1997). Friesen (2004, p. 686) suggests the Thule were considered “more territorial, aggressive, and technologically complex” than the “smaller-scale, relatively non-territorial Dorset society” (Friesen, 2004, p. 686). While Dumond notes there is archaeological evidence that the Dorset had some increase in the efficiency of their transportation and hunting, other changes, such as the lack of dogs and the bow and arrow falling out of use, seemed “retrogressive and inexplicable” (1987, p. 97). McGhee goes on to propose that they would not have posed much of a threat to the en-mass migration of Thule communities (McGhee, 2009).

Therefore, by moving into the eastern Arctic, there were many advantages to be gained by the Thule. Firstly, they would still be able to acquire similar food sources without much change

to their hunting or processing methods. Secondly, they would gain better access to meteoric iron to work organic materials such as ivory, antler, and bone. While these hard materials can be worked using stone tools, iron tools have a sharper edge and would have made working with these materials easier (Buchwald & Mosdel, 1985). Thirdly, they also had the option of trading with Greenlandic Norsemen. This is indicated by the presence of Norse artifacts in some Thule sites (McCullough, 1989; Schledermann, 1978; Schledermann & McCullough, 1980; Sutherland et al., 2014). For these reasons, scholars are now questioning the environmentally focused explanations that were once believed to have exclusively influenced Thule eastward migration.

Introduction to iron

Iron played a major role in the development of tool technology throughout the central and eastern Arctic. Metal usage in the Arctic dates back to the Okvik/Old Bering Sea stage, approximately 2,000 years ago in Alaska (McCartney, 1988, 1991). Other archaeological cultures such as the Ipiutak, Punuk, and Birnik also utilized metal artifacts (McCartney, 1991). Thus, it is evident that these western predecessors to the Thule had metal before the Canadian Thule's spread into the central and eastern Arctic. After Mathiassen's expedition into the central Canadian Arctic, the evidence for iron use among Neo-Eskimo groups is overwhelming. Mathiassen notes, "there is no doubt that the Eskimos of the Thule culture had had access to metal, presumably in very limited quantities, but still enough to leave its impression on certain of the forms of their implements" (Mathiassen, 1927, p. 127). By the 1930's, Mathiassen (1935) recognized that iron continued to play a critical role among Greenlandic Eskimo technology as well:

...Some of the [stone] implements are types widely distributed with the Thule culture and thus are very old; others are local types not appearing

outside West Greenland. Nearly all are represented in large finds – Inugsuk, Igdlutalik, and Igdlorssuit. Most of them belong to the Inugsuk culture, but many of them were in use at a much later time, in fact until the abundance of iron made them superfluous. As a matter of fact, West Greenland had never had a real ‘Stone Age’; even the oldest finds contain some iron, telluric iron from the basalt; in the Cape York district the Eskimos were well acquainted with meteoric iron, which they regarded as a rock and hammered cold, just as the Canadian Eskimos did with the native copper (p. 412-413).

According to Collins (1954), the Thule did not use ground chert or slate burin and knife blades like the Dorset, but rather metal burin and knife blades to reduce and carve ivory, bone, and antler. Among the Late Dorset culture in the central and eastern Canadian Arctic, metal use evolved independently, probably due to their knowledge of and their proximity to the Cape York meteorite in Greenland. McGhee (1984) suggests that migrating Thule encountered Dorset groups in the central Arctic and may have learned of the existence of the Cape York meteorite as an iron source from them. McCartney suggests that this knowledge generated by Dorset interaction either served “as a ‘pull’ to draw Thule groups further east” or a “‘push’ from Alaska by virtue of an in-place metal exchange system” (1991, p. 41). The use of metal by the Thule can then be seen as part of their adaptation to the Canadian Arctic. Similar to regional goods such as soapstone, jade, baleen, bones, and other implements, metal was also distributed within these Thule networks in order to reduce bones, or carve antlers, sleds, and wooden pieces (Blaylock, 1980). The demand for these products required a consistent flow of metal into Thule exchange networks, and trading between Thule groups mitigated the impact of unevenly dispersed goods and resources.

Even in recent times, Neo-Eskimo groups have made use of iron. McGhee (1984, p. 15) labels the Thule Eskimos as possessing an “iron age” culture, with McCartney echoing this sentiment as the “frequency of metal and the apparent dependency on it for manufacturing tools”

(McCartney, 1991, p. 29). However, despite the uneven quantities of metal pieces produced by almost every excavated Thule wintering house, McCartney (1991, p. 30) notes, “there has been essentially no systematic excavation effort to locate metal at Thule sites (including the use of metal detectors and water screening of matrix), and thus there is little information on quantity of metal actually used per site.” He further suggests that the lack of knowledge about Thule metal use “reflects the state of Thule archaeology in general” (McCartney, 1991, p. 38). To remedy this situation, he suggests particular research methods. Most pertinent to this study is the suggestion of a more systematic approach to Thule metal use, such as cataloging iron artifacts from excavated Thule sites and understanding their location along trade route locations (McCartney, 1991). Current research offers a greater understanding of meteoric iron and its distinct physical characteristics than before, but still lacks the increased interest from archaeologists which would generate more research.

Iron types

Iron that occurs naturally in the Arctic is limited to two main forms: meteoric iron and telluric iron (also known as native iron). The most well-known source of meteoric iron is from the Cape York meteorite, believed to have crashed into southwestern Greenland around 10,000 years ago (Buchwald & Mosdel, 1985). There are eight fragments of the Cape York meteorite that are named individually. The largest, known as *Ahnighito* (the Tent), weighs approximately 30,900 kg. Because of its sheer size, *Ahnighito* is often mistaken for the Cape York meteorite itself. All eight fragments were once located in southern Greenland. The Woman and the Dog are the second and third largest fragments, respectively. For the purposes of this study, I referred to the meteorites collectively as the Cape York meteorite and only made distinctions when discussing particular fragments.

Telluric iron (also known as native iron) is a rare form of naturally occurring iron that is only found in a few locations in the world. The largest deposit of telluric iron in the world is located in Disko Bay, Greenland. Very few telluric iron artifacts have been found and those that have been are confined to Greenlandic sites.

Wrought iron of European origin was also utilized by the Thule. Norse iron artifacts have been found in numerous Thule occupation sites and indicate that the Thule were reworking and repurposing Norse wrought iron into indigenous tools such as knife blades and needles (McCartney, 1991; McCullough, 1989; Rankin, 2009). The extent of Thule-Norse interactions is beyond the scope of this research; however, it is clear that wrought iron was another source of iron available to the Thule.

Cape York meteorite composition

The composition of the Cape York meteorite must be taken into consideration to understand how its workability is affected. About 8% of the Cape York meteorite consists of the following metals: 7.58% Ni (nickel), 19.2ppm Ga (gallium), 36.0ppm Ge (germanium), and 5.0ppm Ir (iridium), (Buchwald and Mosdel 1985). The remaining 92% consists of Fe (iron). Overall, the iron alloy of the meteorite is considerably dense and resistant to deformation.

Metalworking processes

Cold working or cold forging, despite the word “cold,” occurs at or near room temperature. This process deforms metals when they are below their recrystallization temperature (a point at which the grains of a material grow in size, lowering the strength but increasing the ductility of the material), therefore small driftwood fires would be enough of a heat source for smaller iron

pieces to improve workability (Liu et al., 2010). However, there are many problematic factors in working with meteoric iron. Iron meteorites are high in nickel content, ranging from 7-15% (a typical modern kitchen knife contains between .5-2% nickel). The Cape York meteorite is approximately 8% nickel. Nickel in an iron alloy serves to strengthen the metal, making it more resistant to changing shape. Even with the application of heat, it takes considerable effort to shape modern iron alloys with low nickel content. If the Thule were utilizing some form of cold forging to shape these iron objects, it would have been a very labor intensive and very resource expensive process. This implies the Thule were forging materials that required incredible amounts of strength, precision, and skill to form into a usable object. Another issue is the physical structure of the meteoric iron itself. A small piece of meteoric iron will contain cracks from its passage through the atmosphere and its impact with the ground. When hammered, these cracks can grow and cause the meteorite to fragment. The experimental study conducted for this project in Chapter 6 discusses more difficulties that can arise during forging.

Iron usage

Iron artifacts that have been found in Thule assemblages have been meteoric, telluric, or European in origin. The Thule did not differentiate between the three different types of iron, all were used to forge harpoon endblades, *ulus* (semicircular knives), and small knife blades (Buchwald & Mosdal, 1985; Schledermann, 1971). This has been identified through the analysis of iron oxide stains left in hafts designed for thin metal blades. What is being called into question is how the Thule were able to work these dense materials using stones, antler, or ivory. McCartney and Mack (1973) assert that early Thule were heavily dependent on metals such as iron and copper for use as tools to work bone, antler, and ivory. Figure 2 (p. 24) is a meteoric

iron ulu blade from the Nugdlit site. Buchwald and Mosdel (1985, p. 13) suggest “this sample represents the ultimate in Eskimo technology. From a small meteorite fragment a surprisingly large blade, ductile and hard, of excellent quality for a cutting has been produced.” At Inuarfigssuaq, a corroded adze (or possible scraper) contained a meteoric iron blade inset into a handle made of antler (Figure 3, p. 23). Metallographic examination determined the meteorite fragment was of Cape York origin and had been shaped through cold-working (Buchwald & Mosdel, 1985). From the historic Thule site of Egaluit in the Umanaq district, telluric iron flakes constituted the cutting edge of an ulu (Figure 4, p. 24). Two of the remaining flakes were analyzed to determine that the forming of each flake was done by cold-hammering only, “possibly assisted by some grinding and polishing” (Buchwald & Mosdel, 1985, p. 19). This indicates that even into the historic period, the Thule were still utilizing native forms of iron despite European contact.

Assemblages in the Classic Thule site of Qariaraqyuk contained a substantial amount of metal artifacts (23 in total), suggesting the inhabitants were trading goods equivalent to the value of raw iron. These assemblages were discovered in association with objects categorized into men’s tools more so than women’s tools (Whitridge, 2002). The distinction between male, female, and uncertain gender affiliations was “based on ethnographic patterns of tool use and adornment” and inferences made based on direct historical analogy and cross-cultural information from Inuit and Yupik groups throughout Siberia and Greenland (Whitridge, 2002). It is evident that metal use was not restricted to specific genders as iron *ulus* (a woman’s tool) were found in association with harpoon endblades (a man’s tool) (McCartney, 1988). Other artifacts in the same assemblage include 3 ulu blades, 5 end-slotted knife blades, 4 side-slotted knife blades, 1 graver bit, 1 engraving tool bit, 1 fragment, 2 blades, 2 baleen shave blades, 2 adze bits, 1

arrowhead endblade, and 1 slotted object (Whitridge, 2002). As an exchange good, iron was valuable currency that highlighted social differences and was utilized for material construction as well as maintaining the whaling-led social system.



Figure 2. Heavily corroded meteorite iron ulu blade (Buchwald & Mosdel, 1985).



Figure 3. Meteoric iron blade inset into antler handle (Buchwald & Mosdel, 1985).

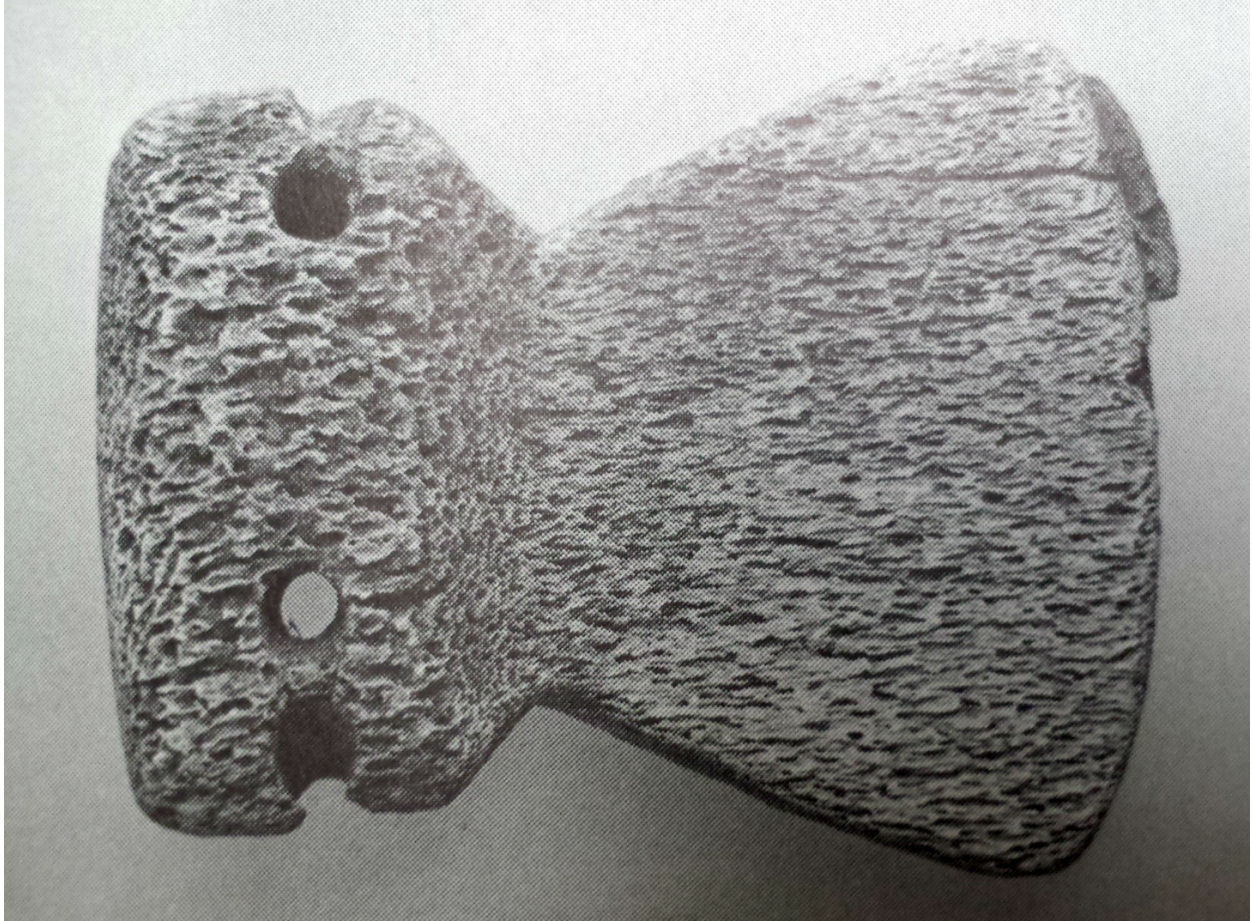


Figure 4. Ulu with inset telluric iron flake, historic period. One flake was removed for analysis (Buchwald & Mosdel, 1985).

Methods of metalworking

Buchwald and Mosdel (1985) present important information regarding the possible methods of metalworking that were available to the Thule. In this discussion they note, “During the present investigation, signs of hot-working or forging were never observed. It appears that the Eskimo never applied forging methods, perhaps because of their very restricted access to adequate fuel, perhaps also by the lack of knowledge of proper methods” (Buchwald & Mosdel, 1985, p. 18). While sources of fuel did exist in the Arctic, they were very difficult to acquire.

Lack of fuel sources is a very likely limitation that may have restricted the use of any form of heat-based metalworking. Without any application of intense heat, this implies that the Thule

metalworking tradition was not a transformative craft, but rather an extractive-reductive craft with “close technical ties to stone working” (Miller, 2007, p.147). Further ethnohistoric accounts support the use of this form of metalworking. In 1818, British Arctic explorer Captain John Ross documented the use of meteoric iron among the Cape York or Smith Sound Inuit (Wissler, 1918). He reported that these people were using knives and harpoon points edged with bits of iron. The iron flakes were inset into a piece of bone to act as a blade. Wayman (1987, p. 70) suggests such flakes are consistent with iron that was obtained through mechanical working of pieces from large meteorites or boulders containing telluric iron. Ross describes an encounter with one of the Inuit named Meigack who told him that the iron “was found in the mountain before mentioned; that it was in several large masses, of which one in particular, which was harder than the rest, was a part of the mountain; that the others were in large pieces above ground and not of so hard nature; that they [the people] cut it off with a hard stone, and then beat it flat into pieces of the size of a six pence, but of an oval shape” (Ross, 1819, p. 104). This method of using hammerstones is supported by other ethnographic observations that “several of the [Cape York] meteorites were found surrounded by piles of hammerstones which the Inuit had brought from some distance and used to laboriously beat small pieces off the meteorites” (Wayman, 1987, p. 67) Several other reports also support this statement (see Buchwald 1975; Buchwald and Mosdel 1985; Rickard 1941). In these ethnographic observations there is no mention of the use of heat being applied to the iron objects.

Another method that may have influenced the final form of meteoric iron is grinding and polishing. However, the state of corrosion of archaeological artifacts has prevented any way of proving these methods were used in the Arctic (Buchwald & Mosdel, 1985). The common method of cutting metal among other North American cultures is to drill a line of holes through

the metal object and break the piece off along the line (Miller, 2007). Historic accounts of the Copper Inuit (who are the contemporary descendants of Thule culture) demonstrate this technique as one method of working native copper (Jenness, 1923). If the Thule were cutting meteoric iron in this way, the strongest material available to use would be basalt, antler, or ivory.

Numerous positions offer possible explanations for eastward Thule migration. While older theories were more environmentally focused, newer theories suggest topics ranging from iron acquisition, to warfare, to global linkages. While the reasons for migration are still debated in Arctic literature today, what is undisputable is the evidence for iron usage among prehistoric Arctic cultures.

CHAPTER 3

THEORETICAL FOUNDATION OF THE STUDY

In this study, I explored iron use to determine if iron access may have been a contributing factor in Thule migration. Critical to this discussion is an understanding of exchange mechanisms that may have facilitated migration rather than the environmental causes emphasized by early Arctic research. In this section I first examined models of exchange and social connectivity and how they may have played a part in eastward migration. I then discussed the role of value and prestige in regards to metal and migration.

Environmental determinism and “Neo-environmental determinism”

Environmental determinism is the belief that the physical environment dictates human development towards specific trajectories (Butzer, 1971). During the 19th and early 20th century, environmental determinism provided a scientific justification for the colonization of non-European cultures. Followers of this theory used it as evidence to suggest that “the climate and topography of a given environment” would result in specific traits appearing in given populations, therefore allowing researchers to assign certain racial characteristics to a population based on environment alone (Painter & Jeffery, 2009, p. 177). Early Arctic research and exploration were not exempt from this. The bulk of early Thule migration research proposed environmentally driven theories to explain timing, motivation, and fundamental nature behind the movement (e.g. McCartney, 1977; McGhee, 1969, 1970; Mathiassen, 1927). While the application of this theory is mostly obsolete in academic research, a resurgence of another form of environmental determinism – labeled “neo-environmental determinism” – has influenced discourse in the 21st century.

The revival of environmental determinism has mostly been accredited to American author and geologist Jared Diamond, with several of his works becoming popular among the general public (Sluyter, 2003). His most popular work, *Guns, Germs, and Steel* (1997) claims that differences in the physical environment have determined the different “fates of human societies” (Diamond, 1997, p. 3). Opponents of his work suggest this is damaging to the intellectual community as it implies that “the horrendous living conditions of millions of people are their natural fate” and the potential to promote harmful policies based on this research are immense (Sluyter, 2003). Others suggest the resurgence of neo-environmental determinism is due in part to the belief that it provides a morally innocuous explanation for many of the social and economic inequalities in the world (Judkins et al., 2008).

Current Arctic research is still attempting to find a balance between environmental determinism and post-structural/post-modernist theories. On the extreme end, some post-structural/post-modernist theories suggest the natural environment holds little to no effect on human societies and that no certain truths about nature exist outside of what is constructed through human discourse (Soper, 1995). What is needed in Arctic literature is to recognize both the influence of environment and the ability of human societies to shape their relationships with their environment. As suggested by Morris (2010), one method to do this is to conceive of the environment as a source of opportunities and constraints mediated by culture. In this way, the environment does provide opportunities and constraints for individuals, but the exact opportunities and constraints depend on the culture (Sahlins, 1964; Webb, 1974). We cannot view Arctic hunter-gatherers as solely motivated by nature, despite how crucial the environment is in economic decision-making.

Exchange mechanisms

A major aspect of Thule migration that needs to be explored is the role of exchange networks that may have spread the presence of iron across the Arctic and influenced further movement towards an eastern source of iron. There are several mechanisms that were responsible for the movement of metal from its native source. Using terminology from Renfrew (1984, p. 119-121), the likely means of exchange are separated into the following categories:

1. Direct access: No actual exchange occurs. Families or groups travel directly to the source to collect metal.
2. Reciprocity: Metal is exchanged between others at or near the points of origin.
Exchange may also take place at territorial boundaries between two groups.
3. Down-the-line: Also called successive reciprocal exchange. Metal is traded between intermediate individuals and makes its way across territories.
4. Central place distribution: Metal is exchanged at a particular location or node, such as an Eskimo “fair” (McCartney, 1991).
5. Middlemen: Metal is exchanged through “specialist” traders who collected raw material or a surplus of metal tools to be traded to outlying groups.

There are many examples of all of these forms of exchange occurring in Eskimo ethnographic literature. Regarding category 1, Copper Inuit families traveled to lakes and rivers for the sole purpose of collecting driftwood or materials for tool making (Stefansson, 1914b). For category 2, copper, stone lamps, and wood were traded between Inuit groups along territorial borders (Jenness, 1922). Category 3 is exemplified by multi-linked trading chains to disperse materials from the source, such as ivory, tobacco, and metal (Stefansson, 1914b). For category 4,

Stefansson also observed trade “fairs” at Barter Island and Colville River for the sole purpose of exchange (Stefansson, 1914). And lastly in category 5, Inuit collected a surplus of wood articles in order to trade with groups further from sources of wood (Stefansson, 1914). The *umialit* led redistribution system, discussed above, can be seen as a form of exchange in that it served to transport goods from one person or place to another. Sahlins referred to this economic relationship as “pooling” or “redistribution” (1972, p. 188). Redistribution as an exchange mechanism is “an organization of reciprocities, a system of reciprocities” (1972, p. 188) that mitigates the flow of resources within a kin or social group.

These trade routes or “roads” through the Canadian Arctic were used well into historic times. As Boas notes, “in trading of the single tribes, the routes were mentioned which are followed by the natives as they travel from shore to shore and from settlement to settlement. These routes are established by tradition and the Eskimos never stray from them” (Boas, 1964, p. 54). This suggests that the Central Eskimo groups may have also been using the same routes that the Thule used before them.

Another form of central place distribution can be seen in physical spaces with utilitarian purposes that offer resources that help in the production of high value items (McCartney, 1991). Near the crater in Melville Bay, Greenland, where the Cape York meteorite was once located, archaeologists have found “piles of hammerstones” (Wayman, 1986, p. 67), possibly numbering “in the thousands” (Buchwald, 2001, p. 56). It is suggested that the Inuit brought the basalt hammerstones and small fragments of meteoric iron pried off of larger blocks to *Ahgnihito* (The Tent), or the Woman, and established “workshops,” using the larger basalt blocks as anvils (Buchwald, 2001, p. 57). The movement of these materials may imply that migrating towards the source provided better access not only to the raw iron material but also to these “workshops” and

“workshop tools.” Raw Cape York iron may have already been exchanged through trade networks into central Canada, but without the proper resources to work it locally, this trade may have been more motivation to migrate into areas where it could be readily accessed *and* worked.

Exchange is not only an economic phenomenon. Marcel Mauss’s definition of exchange is that it is a “total social phenomenon,” not purely motivated by economics, but also by moral, social, and political factors (Mauss, 1966, p. 1923-24). Exchange networks not only involve material goods, but also complex interactions and services circulated further by kin relations and power structure (Voutsaki, 1992). Therefore, these exchange networks reinforce the standing political systems. Inherent to this social aspect of exchange is the emphasis on reciprocity. This does not imply that goods or services were exchanged solely out of moral compulsion. It would be naïve to conclude that hunter-gatherers were not making calculative decisions based on the value of an item. Voutsaki (1992) suggests that if profit is the main motivation of modern monetary exchange systems, then the equivalent motive in hunter-gatherer societies is prestige through the transaction of highly valuable items.

With all these options available for local exchange, the question that remains is why the Thule chose to migrate towards the eastern iron source rather than to simply maintain exchange networks for it in Alaska. The influence of environmental models has already been discussed. While important to the overall story, it has already been made clear that other issues were occurring in Alaska during this time. Violence, warfare, and control over land – all of these could have influenced the decision to migrate.

Value and prestige

Concepts such as value and prestige are difficult to assess from the archaeological record

alone. However, their inclusion in discussions of large-scale migration paints a more holistic view of the past. This section discusses how value, skill, and prestige affect exchange mechanisms and how these factors may have affected Thule migration.

Webb (1974) writes on the value of material in regards to exchange, stating “material of manufacture is itself a kind of artifact attribute; therefore, grouping together artifacts by specific material of composition may, even in cases when the source remains unidentified, reveal clusters of indicative of spatial connection, temporal change, or cultural selection” (1974, p. 360). These exchanged materials hold value, but the determination of what objects hold value is culturally subjective. However, according to Pydyn (1998, p. 97), some aspects of value may have “absolute or universal character and very often they form the basis for social communications and social relations.” Value is then dependent upon cultural and symbolic factors (Cooper, 2006).

Building on Marx (1867), Renfrew (1986) discusses different aspects of value. Value itself is ascribed arbitrarily by an individual or society. This suggests that value is either ascribed based on the predicted usefulness of an item (use value) or the amount of effort required for production (labor value). Renfrew (1986) builds upon this idea and suggests there is another form of value more related to prestige goods, called prime value. Here, prestige goods are regarded as having an intrinsic value. He then goes on to suggest that these materials or goods do not have a universal intrinsic value, but rather an ascribed intrinsic value. Prime value is thus “the equivalent of ascribed intrinsic value” (Renfrew, 1986, p. 159). Therefore, it is difficult to fully accept the Marxist notion that no object can have value without being something of utility (Marx, 1870). This is especially so in pre-capitalist societies, “whose utilitarian character was geared to obtain goods, which then could be exchanged for prestige and power, while the objects

themselves could have a very limited practical use” (Pydyn, 1998, p. 97). The literature already suggests that meteoric iron may have had a certain level of value due to its rarity (Cooper, 2012; McCartney, 1988, 1991; McGhee, 2005). Archaeologists argue that if a large amount of labor and effort goes into procuring exotic objects, then the value of those objects must be high (Dillian & White, 2009). Examples of labor or effort being put towards an object include: travelling to the source of an exotic material over long distances and needing to acquire multiple tools or other materials in order to produce or acquire the exotic material. As a result, a strong correlation is assumed between the distance to a source and value (Dillian & White, 2009; Renfrew, 1984).

The process of how an item or material inherits prime value outside of a monetary economy has been studied through gift exchange. Mauss (1990) examined power and prestige through reciprocal gift exchange where the creation of indebtedness over time fueled the continued exchange of prestige goods. The social status of the participants plays a crucial role as well, not just the value of the object (Voutsaki, 1997). Whitridge (2002) connects the use of metals in men’s houses in the central Canadian Arctic to possible displays of acquisition and prestige. Central to his argument is the role of the *umialik* and the system of gift-incurred debt through the trade of exotic materials. In order to maintain the labor and support of whaling crew members, *umialit* needed rare or locally scarce goods. Long distance trade was essential in obtaining these objects. *Umialit* accrued surpluses of food and other commodities that were expected to be distributed throughout the community. This flow of goods from wealthy *umialik* to poorer community members created *umialit* of Big Man-like status (Whitridge, 2002). Therefore, it is probable that the Thule considered migrating closer to iron sources in order to procure more raw materials due to the importance of maintaining trade networks. The decision

by the Thule to stay in these new territories *after* the initial migration may have then been based on environmental and societal deterioration.

Value may also come in the form of labor and scarcity. Value in labor is the cornerstone of Marxist theory. However, in prehistoric societies this concept is not entirely applicable. Firstly, there is no all-encompassing measure of value in hunter-gatherer societies. Furthermore, labor is “not a commodity, but is exchanged either reciprocally between the domestic units or along kin obligations” (Voutsaki, 1992, p. 44). Voutsaki further suggests that “labor” is defined by ritualized skills, not energy expenditure (1992, p. 44). This implies that value is not created at the moment of production, but can be culturally constructed during exchange.

Scarcity is another mechanism that influences value in exchange. In order for prestige items to maintain their value, they must be restricted from circulation by socially prescribed channels (Voutsaki, 1992; Bohannan, 1955). One of the most common ways to do this is by creating restricted spheres of exchange (Bohannan, 1955). For example, items are separated into ranked circuits where high value items are only exchanged for high value items and low value items are only exchanged for low value items. This limits the range of items that can be exchanged for a high value item. Conversion between the two ranked circuits is not possible, thus restricting the flow of value items within a specific group (Voutsaki, 1998, 1992).

Therefore, is it possible to conclude that scarcity breeds value, and high value items are valuable because they are scarce; and to a certain degree this may be so. Gold is not ubiquitous, and neither is iron in the western Arctic – but rocks are prevalent and none are considered valuable objects. However, a natural scarcity due to the environment is not the only form of scarcity. It is possible to have a small amount of something valuable and distribute it evenly among individual members of a group. What makes gold scarce is not only the natural environment, but the

culturally and politically influenced consumption of it. While “objects are valuable because they are scarce” may be true, the converse “objects are scarce because they are valuable” can also be true.

Another aspect of migration to consider is the influence of prestige. Gaining prestige may have motivated Thule families to move closer to the source of iron, rather than rely solely on exchange networks. Based on theories of rare materials and labor intensity, there is an assumption that an individual can accrue prestige and influence in their worlds based on the accumulation, display, and access to rare goods (Mithen, 1990; Pydyn, 1998; Sinclair, 1995, 1998). Archaeologists have considered metals from archaeological contexts as an appropriate tool for evaluating concepts such as prestige, value, and power (Cooper, 2012; Pydyn, 1998; Voutsaki, 1997). Renfrew (1986) and Cooper (2006) note that materials like copper and iron are “rare, durable, and somehow satisfying to view” (Cooper, 2006, p. 152). In his discussion of prestige technologies, Hayden (1998, p. 13) also reflects this statement as he suggests prestige goods are those that have wide appeal and “pan-human aesthetic responses.” Meteoric iron may well have served this purpose as the Cape York meteorite fits this description; direct access to the Cape York meteorite was limited to the eastern Arctic, the physical composition of meteoric iron rates as very durable on the Vicker Hardness Test scale (Buchwald & Mosdel, 1985), and the reflective quality of polished meteoric iron can be considered appealing. Metals such as iron may enhance prestige because of their rarity in terms of inaccessibility, durability, supernatural association, and visual appeal (Saunders, 2002; Skibo & Schiffer, 2008).

Experimental archaeology as a method of archaeological interpretation

A major component of this thesis is an experimental project that attempted to replicate the

production of a Thule endblade using the resources and techniques that would have been available during the Classic Thule period. This experimental project sought to provide a better understanding of Thule metalworking. However, there were clear differences between myself reproducing this activity in Las Vegas, Nevada, versus a Thule craftsman producing these tools to survive in the Arctic. Some may suggest these differences are too great to serve as an accurate interpretation of past behavior. This section addresses such concerns regarding the use of experimental archaeology in the archaeological interpretation of human behavior.

Ethnographic methods and observations have long been used by archaeologists to reconstruct prehistoric human behavior (Stiles, 1977). The applications of ethnography as a tool of archaeology form the framework of a subdiscipline of anthropology termed “ethnoarchaeology.” Experimental archaeology is a component of ethnoarchaeology that attempts to reconstruct past human activities by replicating the methods in the present in order to gain a better understanding of these activities in the past. While “replicating” is used loosely, experimental archaeology differs from producing exact copies or reconstructions because there are limits to its efficacy. Even with the completion of a successful experiment it is impossible to say that prehistoric people made their artifacts in the exact same manner, but it is possible to say that they *may* have done it that way.

Experimental studies have occurred since the 1800s (Carrell, 1992; MacAdam, 1860; Pitt-Rivers, 1887; Smith, 1893) albeit some were not conducted within larger anthropological contexts. For example, stone tools have been replicated in order to determine their effectiveness (Evans, 1897; Semenov, 1964). Replica wooden ploughs were hitched to oxen and used to till the soil to determine how much effort went into pre-Iron Age agriculture and food production (Reynolds, 1967; Glob, 1951; Aberg & Bowen, 1960). Early attempts at experimental work were

often seen as interesting or even eccentric side projects to the “real” study of archaeology (Carrell, 1992). While this view is changing, especially within the context of historical archaeology (Butzer, 1980; Carrell, 1989; Deetz, 1977), more experimental projects need to be undertaken to understand the processes behind the creation of artifacts. Carrell writes,

Ethnographic information reveals the nuances of process and ideas and is the most accessible link to behavior... Archaeology provides the tangible evidence of past human endeavors. However, none of these avenues of research, even in combination, can demonstrate *how* many artifacts, technologies, or processes worked. The construction or replication of objects and their use can provide this insight (1992:4).

Experimental archaeology is more than just a test or trial to determine the efficiency of an artifact. Due to the fact that experimental archaeology uses material culture, it is also a way to test the validity of what past human behaviors are reflected onto an artifact (Carrell, 1992). This is done in a scientific manner using procedural rules to insure reliability and repeatability of the results. The design, materials, and methods of the experiment must be as similar as possible to the original. This is because modern substitutions “introduce a degree of error that is difficult to quantify and eliminate” (Carrell, 1992, p. 5). Furthermore, the techniques used in the process “cannot exceed that which was within the knowledge or competence of the contemporary culture. Modern technologies, such as the use of special analyses or equipment, can be used but should not interfere with or replace ancient methods except in so far as they further an understanding of past processes” (Carrell, 1992, p. 5). However, with these working definitions, the only types of replicas that can be made are those for which there is complete information. Because the majority of archaeological objects are not complete upon discovery, the archaeologist’s role is to fill in the missing information based on hypothetical reproductions (Carrell, 1992; Outram, 2008). In fact, many artifacts (especially in museum displays) are

hypothetical reproductions. These hypothetical reproductions are what are most often tested in experimental archaeology (Carrell, 1992).

Experimental archaeology is a useful tool that can be used to clarify and improve theoretical models to more fully encompass the complexity of the past. For example, archaeometallurgy is a subset of experimental archaeology that attempts to understand the metallurgical processes involved in the replication of copper and iron objects, as well as test the methods behind the production of ancient metal artifacts. Archaeometallurgical research on mining heavily focuses on firesetting, a process of exposing a rock face to high temperatures to increase the brittleness of a rock and allow it to give way during the mining process (Crew, 1990; Lewis, 1990; Timberlake, 2007). Most early research would douse a rock face with water after firesetting, assuming it made the rock face easier to excavate. This process, called quenching, was a standard step in most firesetting experiments (Crew 1990; Lewis 1990; Timberlake 2007). However, the outcome of later firesetting research found that the quenching process was not necessary at all and had no affect on excavation (Timberlake, 2007). In this case, experimental work changed a model that had become standard practice in the field.

Of course, like with many disciplines, experimental archaeology has its limitations. There is a cultural distance between the ancient craftsperson and the modern archaeologist that may lead to misunderstandings in the processes involved with metalworking (Killick, 1991). Furthermore, if an experiment is unsuccessful it is difficult to determine if this is due to the techniques used or the individual who planned the experiment (Mathieu, 2002). Despite these difficulties, experimental archaeology is a valuable tool in the interpretation of artifacts. It can provide alternative explanations and interpretations of human behavior through material culture. It allows for the scientific study of processes that can be reproduced in multiple settings.

Furthermore, it forces archaeologists to question preconceived notions should the results suggest otherwise. To summarize James Deetz (1988, p. 231), experimental archaeology is an opportunity for archaeologists to be wrong in a creative and interesting way, rather than right in a dull and predictable one.

CHAPTER 4

RESEARCH OBJECTIVE

Research questions and hypotheses

There is little to no information on how the Thule worked iron into usable tools nor how this raw material may have affected migration patterns. One way to answer these questions is to synthesize the information pertaining to iron usage in order to gain an overall better understanding of Thule culture. Producing such a synthesis of this information was the main goal of this project. In order to synthesize this information, research was based on the following research questions.

First research question: As the Thule migrated eastward towards the Cape York meteorite, did the quantity of iron implements in the archaeological record increase or decrease?

The primary goal of this research project was to synthesize data concerning iron artifacts from Thule culture sites throughout the North American Arctic in order to determine if these artifacts were considered a factor in Thule migration, alongside the environment. I hypothesized that as the Thule neared the eastern source of meteoric iron, there would be an increase of iron artifacts. This could also suggest that the Thule preferred to gather iron directly from the source instead of relying solely on exchange networks to obtain iron. I compiled data from numerous Thule sites across their projected migration route to determine the frequency of iron implements.

Second research question: What can the increase or decrease in the quantity of iron implements in the archaeological record suggest about the meaning of iron in Thule culture?

I hypothesized that if there exists a connection between migration, exchange networks, and

the quantity and value of iron tools, then such a connection can be evaluated through a catalog of iron artifacts and existing exchange models. I further hypothesized that where iron was readily available, the number of iron implements would increase while simultaneously decreasing the overall level of value associated with them. This last hypothesis explores the relationship between sources of value –namely access –and its relative importance in Thule culture.

Third research question: Given the limited resources available to the Thule, how might they work meteoric iron?

I pursued an experimental study after finding there was a large gap in information on how the Thule worked raw meteoric iron into usable tools. I hypothesized that working meteoric iron required a high degree of expertise, or at least some level of specialized skill, to create useable tools. In the process of trying to create a replica iron endblade, I found scant information in the literature on how the Thule may have forged their iron objects (Buchwald & Mosdel, 1985). A secondary aspect of this experiment was to understand possible methods of metalworking that may have been used by the Thule, based on recovered tool-making artifacts. The experimental process was thus dependent upon research by Buchwald and Mosdel (1985), who have analyzed the chemical structures of meteoric iron artifacts from Greenland and found that no evidence of heat treatment was present on any of the iron specimens. With this information, I then worked my iron endblade using cold hammering techniques. I fully discuss this experimental study in Chapter 5.

Research methodology

In order to better understand the role of iron in Thule migration, I conceptualized and

tested my hypotheses by cataloging Classic Thule period archaeological sites, and then applying exchange mechanism and valuation models to this catalog. Furthermore, I also tested how the Thule may have worked meteoric iron through an experimental study discussed in Chapter 5.

The hypotheses that were conceptualized are as follows:

- There was an increase of iron implements as the Thule migrated eastward
- An increase of iron implements implies a requirement for meteoric iron
- A high degree of expertise was needed to work raw iron ore using the limited resources available

For the first hypothesis, I surmised that the archaeological record would reveal an increase of iron tools as the Thule neared the Cape York meteorite. If this hypothesis was correct, I would expect to see more iron artifacts as the Thule neared the eastern source of iron in Greenland. This could be attributed to proximity of the source and an intensification of trade. To test this hypothesis I collected data from numerous Thule site reports and made note of the frequency of iron artifacts recovered at each site. I mapped these sites to determine if there was a pattern in the presence of iron in Alaska, Canada, and Greenland (see Figure 5, p. 49). The map suggested there was in fact a pattern, so a goodness of fit statistical analysis was conducted to examine this further. These results are discussed in more detail in Chapter 5.

In the second hypothesis, I suggested that an increase in iron implements implied a need for more meteoric iron that, alongside environmental factors, may have influenced the Thule's decision to migrate. In order to support this hypothesis, I used the data compiled in the first hypothesis and performed goodness of fit statistical analysis. I specifically chose ethnographic models pertaining to massive migrations spurred by metals such as iron or copper. These historic migrations, while not concerning hunter-gatherer populations, are well documented and offer

insight into the allure of high value metals. I chose archaeological models that also discussed migration, but because the literature covering both prehistoric migration and metal use at the same time is sparse, I used what was available even though they did not focus entirely on Arctic hunter-gatherers.

The final hypothesis models possible techniques involved in the coldworking process used by the Thule. It also attempts to understand how specialized skill may have affected the outcome of the iron products. The experimental reproduction of an iron endblade was a way of testing this hypothesis. The goal of this experiment was to determine how much skill or expertise was needed to work the Cape York meteorite without the application of intense heat. This experimental project was built upon the framework set by Buchwald and Mosdel (1985), who first documented their attempts to work meteoric iron using contemporary metalworking methods such as applying heat and pounding the specimen with a modern steel hammer. This experimental study used the Henbury iron meteorite to replicate a Thule iron endblade. I coldworked the meteorite over a course of ten days, working for 1 to 3 hours a day. The details of this process are discussed in Chapter 5.

CHAPTER 5

DATA COLLECTION

In this chapter, I employed one of the methods suggested by McCartney (1991) for the study of iron artifacts in the Arctic. I catalogued Thule iron artifacts that were recorded in archaeological reports pertaining to Classic Thule sites. These sites are dated to be during the Thule migration, and thus are the closest representation of their possible trade routes in current discourse (Friesen & Arnold, 2008). From this catalog I was able to construct a visual representation of the quantity of iron artifacts across Alaska, Canada, and Greenland. A goodness of fit statistical analysis was used to determine if the iron artifacts were evenly distributed across the Arctic. The test assumes all the data are evenly distributed, so if the information is not, it is considered statistically significant. Below is the chart used to catalog the iron artifacts (p. 51).

Chart

Table 1 (following page) catalogs Thule occupation sites and the number of iron artifacts at each site. I compiled data from numerous Thule site reports organized by the date of each site. All sites have been identified as Thule occupation sites using lithic typologies of other non-iron artifacts found at each site. These include slate, ivory, bone, and antler typologies. The sites included in this study are representative of major Thule sites during the Classic Thule period.

Wrought iron of Norse origin was also present at some Thule sites. Although important to the Thule chronological sequence, sites that contain wrought iron from 1650 AD and later are excluded from the study for the following reasons. Evidence suggests that by 1600 AD most Thule had abandoned the High Arctic due to changes in climate (Fagan, 1991). Those that remained lived near open water and were not as affected by the decrease in temperature (McCartney & Savelle, 1985). During this time, other local groups emerged in the area. The

hypothesis is that the Thule diversified – creating the socially distinct Inuit groups present in the Arctic today. All of these factors signify immense social change in Thule culture, therefore the iron artifacts produced during after 1650 AD do not reflect the traditional lifeways of Classic Thule society prior to the historic period, and are excluded from this study.

Table 1. Thule sites with and without iron artifacts

Date, A.D.	Site	Location	Iron Reported	Material	Artifact type (s)	# of artifacts	Figures	Comments
900 - 1200	Kukulik	St. Lawrence Island, Alaska	No	N/A	NA	N/A		
900 - 1400	Walakpa	northwest Alaska	Yes	N/A	engraving point	1		Type of iron not identified in Rankin (2009)
1000 – 1200	Nuvuk	Point Barrow, Alaska	No	N/A	N/A	N/A		Yankee toggle-iron found but excluded from this catalog (Jensen 2007)
1000 – 1200	Naujaat (Naujan)	Northwestern Hudson Bay, Canada	Yes	M	small blade	1		
1050 or 1100	Skraeling Island	Ellesmere Island, Canada	Yes	N/A	N/A			number not included in Schledermann (1977) report
1000 - 1300	Porden Point	Devon Island, NWT, Canada	Yes	M	engraving points	2		one point is 9mm long, another is 21mm long
1140 or 1200	Silumiut	Northwestern Hudson Bay, Canada	Yes	M	end blades	3		
1300 (?)	Lady Franklin Point	southwestern Victoria Island, Canada	No	N/A	N/A	N/A		
1200 - 1400	Qariaraqyuk	southeast Somerset Island, Canada	Yes	M	ulu blade (3); end-slotted knife blade (5); side-slotted knife blade (4); graver bit (1); engraving tool bit (1); fragment (1); blade (2); baleen shave blade (2); adze bit (2); arrowhead end blade (1) slotted object (1);	23		
1200 - 1500	Cape Walker	Prince of Wales Island, Nunavut, Canada	Yes	M	‘bear’ arrow head with iron point	1		see Rankin (2009)
1200 - 1500	Clachan	Western Coronation Gulf, Canada	No	N/A	N/A	N/A		
between 12th and 14th century	Port Refuge	Devon Island, NWT, Canada	No	N/A	N/A	N/A		
between 14th and 16th century	DeBlicquy	Bathurst Island, Nunavut, Canada	No	N/A	N/A	N/A		
900-1200	Nugdliit	Qaanaaq (Thule), Greenland	Yes	M	corroded blades and fragments	25	Figure 2	Figure 2 is a corroded ulu blade
900 - 1200 (?)	Inuarfigssuaq	Inglefield Land, Greenland	Yes	M	corroded adze or scraper	1	Figure 4	
1200 - 1300	Comer’s Midden	Qaanaaq (Thule), Greenland	Yes	M	fragments	2		
second half of 13th century	Inugsuk	Upernivik, Greenland	Yes	M	harpoon head endblades and knives	NA		number not included in Mathiassen (1930) report
Before 1650	Eqaluit	Umanaq district, Greenland	Yes	W/T	knife 5 (T); harpoon blade 1 (T); ulu 5 (T); ulu 2 (W)	13	Figure 3	Figure 2 is an ulu with inset telluric flakes as the blade

The following map (Figure 5) charts the Thule sites along the projected migration route. Sites where iron was reported are identified by a green circle. The number of iron artifacts found at sites with iron is labeled in parentheses. Sites where no iron was reported are indicated by a red circle. The location of the Cape York meteorite is marked with a star.

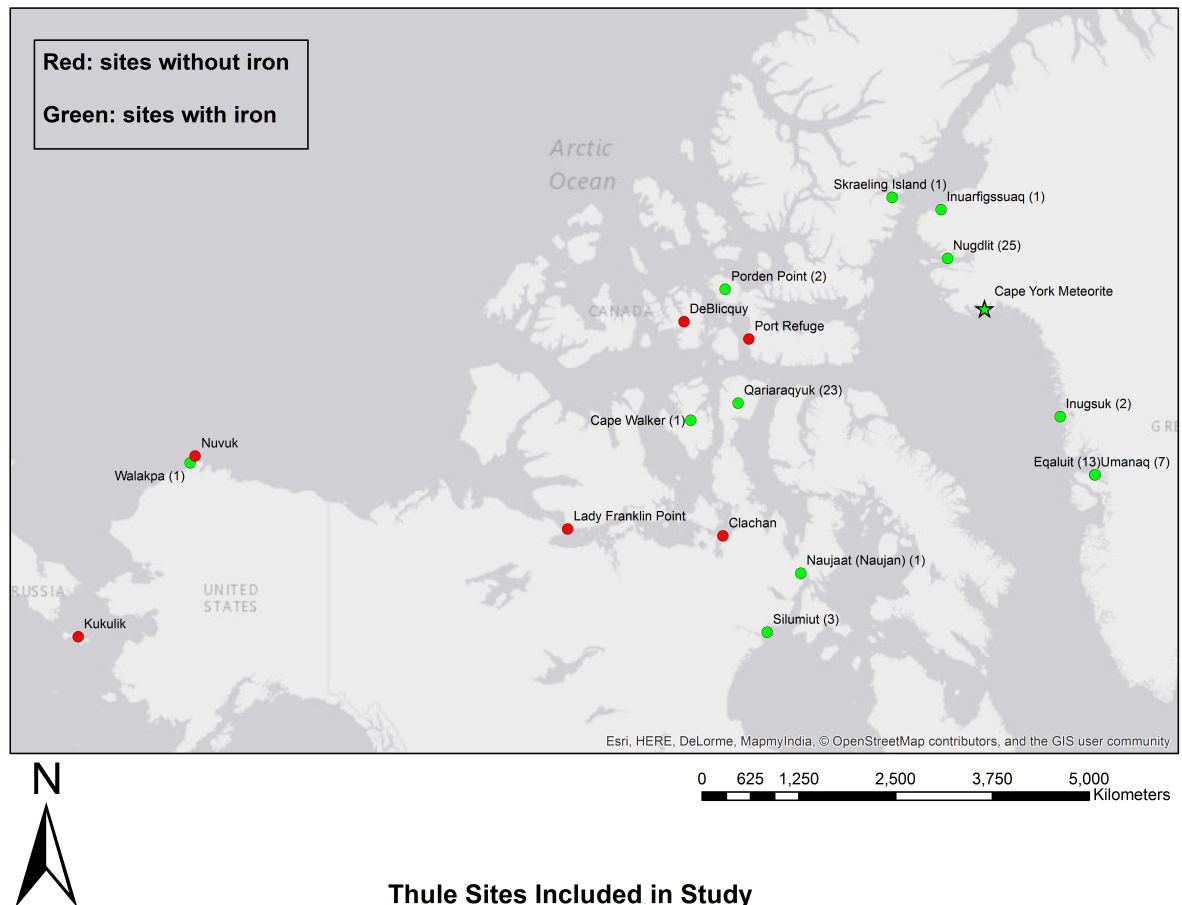


Figure 5. Classic Thule sites with and without iron.

A chi-squared test of independence was completed to determine whether or not there was a statistically significant difference in the number of sites with iron present across the three regions (Alaska, Canada, and Greenland).

Experimental study

The experimental study sought to shape a Henbury iron meteorite into a replica Thule iron endblade. To further examine the use of metal by the Thule and model possible techniques involved in making a meteoric iron endblade, I visited the Department of Engineering of San Diego State University, California and collaborated with Michael Lester and his team of undergraduate students in the Fabrication Support shop. The materials used in this experiment consisted initially of four pillow basalt hammerstones, one pillow basalt anvil, and one fragment of the Henbury meteorite. I used pillow basalt hammerstones and a pillow basalt anvil from Avila Beach, California. The cold working process was split into two separate sessions. A second session was pursued when the project was provided funding to obtain more hammerstones. The following sections will first detail the materials used in the cold working process, then discuss the hammering techniques that were employed or discontinued. Lastly, I break down the experiment process day by day, providing photographs of the changes that occurred to the meteorite specimen.

Materials

While Buchwald and Mosdel acquired an authentic piece of the Cape York meteorite, I was unable to obtain one due to monetary constraints. Therefore, I decided to acquire a meteorite that was similar in chemical composition. The first element of conducting this experimental study was determining what iron meteorite would be used to replicate the Cape York Meteorite. Meteorites are classified into structural groups based on their internal composition, so I first determined which meteorites fell into the same IIIAB group as the Cape York meteorite. This was done using the Meteoritical Society's Meteoritical Bulletin database. The Meteoritical

Society is a non-profit scholarly organization that publishes the major planetary science journal, *Meteoritics and Planetary Science*. With this database, I then found a meteorite that had a similar chemical composition to the Cape York meteorite. The result was the Henbury meteorite, a IIIAB group meteorite with the composition 7.47% Ni, 17.7 ppm Ga, 33.7 ppm Ge, 13 ppm Ir. There was only a 0.11% difference in nickel content between the two meteorites. Despite this difference, both meteorites have similar workability properties (Buhl & McColl, 2015). Based on the larger similarities in physical and chemical structure, I determined that the Henbury meteorite was the most compatible and accessible alternative to the Cape York meteorite. I purchased the Henbury meteorite fragment from an authorized seller and member of the International Meteorite Collectors Association (I.M.C.A). This ensured that the meteorite fragment was authentic as sellers within the I.M.C.A are given member identification numbers that can be reported and held accountable for selling counterfeits.

The original dimensions of the meteorite fragment were 31mm in length, 14mm in width, and 10 mm in thickness. It weighted approximately 17.6 g. Buchwald and Mosdel observed that “meteoric iron objects do not exceed about 7x2.5cm and 10g mass” (1985, p. 9). I used these measurements to determine how small my final endblade should be.

I consulted with mechanical engineers Michael Lester and his team of undergraduate students with the San Diego State University Department of Engineering to examine how to process the meteorite for cold working. I determined that the meteorite fragment should be cut in two pieces in order to have smaller specimens to experiment with. Simply put, I wanted a second meteorite piece to work with in case I destroyed the first specimen in the cold working process. However, Dr. Lester determined that cutting the meteorite into two pieces would not be possible. He determined that the specimen was too small to cut safely without prior preparations. Firstly,

the specimen was too small to fit in any of the machinery vice grips that were available. He suggested that the specimen be set in a resin to resolve this, however he estimated the process would be more expensive than simply purchasing another meteorite. Secondly, stress cracks that naturally occur in meteoric iron could cause fragmentation during the cutting process, thus increasing the possibility of dangerous iron shards being flung from the machine table. Lastly, he predicted that due to the composition of the meteorite, cutting through solid nickel-iron would damage the machinery lab's diamond blade saw. With this information I decided not to cut the meteorite in two and resolved to purchase another meteorite in case the initial fragment broke.

The process of hammering the meteorite required tools that could simulate what the Thule would have had available to them. Buchwald and Mosdel (1985) identify numerous pillow basalt hammerstones in the Greenlandic and Canadian Thule assemblages and suggest that these tools were being carried around by craftspeople over long distances. However, they do not state what this claim is based upon. Other pillow basalt stones found in the central Canadian Arctic and northwest Greenland were larger and weighed up to 40kg. It is presumed these larger stones were used as anvils (Wilken, 2015). Today, pillow basalt is the most prevalent type of basalt found in the High Arctic. Assuming a degree of geological continuity over time, it is likely that the Thule would have also utilized this type of basalt. Pillow basalt occurs naturally in many parts of the world. Based on archaeological and ethnohistoric reports it is likely that the Thule used pillow basalt as hammerstones and anvils (Buchwald, 1992; Buchwald & Mosdel, 1985; Rickard, 1941; Ross, 1819; Wayman, 1987; Wilken, 2015), I obtained numerous pillow basalt samples from Avila Beach, California. This was done to model the Thule iron endblade manufacturing process as closely as possible. These pillow basalt rocks were primarily used as hammerstones during the experiment, while one larger pillow basalt slab was used as an anvil for the entire experiment.

I collected four pillow basalt stones to use as hammerstones and one large pillow basalt slab to use as an anvil. I experimented with hammerstones of varying weights and sizes to see if these variables altered my ability to work the meteoric iron (Figures 6-9). At the beginning of the experiment, the dimensions of the meteorite fragment were 31mm in length, 14mm in width, and 10 mm in thickness. It weighted approximately 17.6 g. The anvil I used was approximately 11.3kg (Figure 10).



Figure 6. Hammerstone A. Photograph by author.



Figure 7. Hammerstone B. Photograph by author.



Figure 8. Hammerstone C. Photograph by author.



Figure 9. Hammerstone D. Photograph by author.



Figure 10. Anvil. Photograph by author.

While heavier hammerstones resulted in greater deformation of the specimen, the heft of the tool quickened operator fatigue. If someone were doing this as part of their subsistence, they may have worked up the muscle and endurance in a similar way to modern blacksmiths. Even so, this would clearly be a tolling process. It is interesting to note that every hammerstone I used in this experiment shattered after a few uses. They first broke off in small pieces before shattering into larger fragments.

Techniques

I experimented with several hammering techniques during the cold working process. These techniques were not demonstrated in any technical archaeological reports, but rather improvised

during the actual cold working process when the need arose. This was mostly due to the lack of technical reporting on hunter-gatherer metalworking methods in general. I found little information on how to hammer a meteorite without the application of heat, especially in regards to using rocks as hammering tools. However, many engineering reports provide in depth information on the transformations that occur to iron during cold working. The transformations to the crystal lattice (the molecular structure of an object), will occur regardless of the cold working tool being used as long as stress is applied onto the material (Askeland & Fulay, 2009). Dislocations are generated within the crystal lattice when stress (such as hammering) is applied (Askeland & Fulay, 2009). The process of forming dislocations creates permanent deformations in the iron. These are all processes that occur during work hardening, which strengthens the iron (Askeland & Fulay, 2009).

The first hammering technique, which was the most basic, involved placing the meteorite on top of the anvil and striking it with a hammerstone. This technique did not involve securing the meteorite to the surface of the anvil in any way. While this method produced visible results, it was not the most efficient because the meteorite specimen would shift under the force of the hammerstone and shoot off the anvil.

For the second technique, I decided to employ the use of modern pliers to hold the meteorite in place on top of the anvil. The use of pliers was necessary for safety purposes, this was especially important as more force was being applied to the iron meteorite, increasing the likelihood of injury to myself. By Day 3, this technique was abandoned because if I was not holding the pliers at a particular angle, the jaws would block the hammerstone from coming into contact with the specimen. Furthermore, the accidental discovery of a fourth technique, discussed later on, was more efficient and produced more visible results.

The third technique was the same as the second technique, but with the addition of an assistant. Similar to contemporary blacksmithing, my assistant and I placed the iron meteorite on top of the anvil and held it in place with long handled pliers. While my assistant held the pliers, I used Hammerstone D to strike the iron specimen. This technique was effective and produced visible results when either myself or the assistant were able to make physical contact with the iron specimen, but the jaws of the pliers quite often got in the way by blocking the full impact of the strike (as in the second technique). However, this technique did allow for resting time as we would alternate between striker and plier holder. Unfortunately, this technique was only possible when an assistant was available.

The fourth technique was the most preferable and was used for the duration of the experiment after its discovery. This method was similar to the first, in that the specimen was simply placed on top of the anvil and hammered with a basalt hammerstone. However, between the anvil and the meteorite specimen was finely powdered basalt dust that had not been cleaned off during the hammering process (Figure 23, p. 74). This basalt dust acted as a gripping agent and held the meteorite in place without the use of the pliers.

These techniques were all effective in flattening the iron meteorite. However, I found preference in using the fourth technique as the basalt dust allowed for faster hammer strikes without pausing to put the iron meteorite back into place. It should be noted that the hammerstones seemed to be breaking at a faster rate using this method, but the explanation for this is uncertain.

Session 1

Day 1:



Figure 11. Unforged Henbury specimen. Photograph by author.



Figure 12. Unforged meteorite on top of anvil. A towel was placed beneath the anvil to limit the amount of impact absorbed by the anvil.

Above is a photo of the raw meteorite specimen before cold working (Figure 12). I began the first day of cold working at 1:30pm and continuously hammered the meteorite specimen using the first technique for 2.5 hours, finishing at approximately 4:05pm. I used Hammerstone D for the entirety of Day 1. I did not apply any form of heat before, during, or after working the meteorite, in order to replicate the resources available to the Thule as closely as possible. This decision was inspired by Buchwald and Mosdel's (1985) report on the absence of evidence of the application of heat in early Greenlandic Thule assemblages. After the first hour of hammering, no noticeable difference in thickness was visible. The orange reddish outer layer of the meteorite

was still very prominent, and only a few scratches from hammering were apparent (see below).



Figure 13. Henbury specimen at the end of Day 1. Photograph by author.

The goal in working this meteorite was to flatten the specimen as much as possible without fracturing or breaking it. After the first day, no visible cracks or overhangs indicated signs of breakage. From an original thickness of 10mm, the meteorite specimen was now 9.5mm.

Day 2:

While progress was becoming more noticeable, it was also very slow. I continued to use the second technique with Hammerstone D for all of Day 2, and I found Hammerstone D to be the tool with the most comfortable weight and size for my frame. I began cold working at

1:30pm and finished at 3:30pm. At the end of the cold working process for Day 2, the meteorite was approximately 9mm in thickness. Also becoming more noticeable were sharp, flattened pieces of iron that hung over the original specimen (Figure 14, below).



Figure 14. Henbury specimen at the end of Day 2. Photograph by author.



Figure 15. Sharp overhanging pieces of iron on surface of specimen. Photograph by author.

Day 3:

Over the course of two days the specimen was flattened by 1mm. I began cold working at 1:30pm, using the first technique for the duration of the day. I cold worked the specimen for approximately an hour, finishing at 2:34pm. I used Hammerstone D until it had shattered in half around 1:45pm, only 15 minutes into the process for the day (Figure 16, see below). Before this, I had noticed small pieces of the hammerstone crumbling off. I then began using Hammerstone C. After finishing for the day, the meteorite was 8.6mm - only 0.4mm thinner than at the start of Day 3.



Figure 16. Underside of Henbury specimen at the end of Day 3. Photograph by author.



Figure 17. Shattered Hammerstone D. Photograph by author.

Day 4:

On Day 4, I began cold working at 1:30pm and concluded at 2:30pm. I switched back to the second technique, deciding the pliers would quicken the process by keeping the meteorite in place. The specimen was approximately 8.2mm thick by the end of Day 4. The sharp iron overhangs were now more obvious. The underside of the specimen was starting to fan out as it was being flattened. A slight angle was starting to develop at the end of the specimen, resembling an acute triangle from the side view.



Figure 18. Henbury specimen at the end of Day 4. Photograph by author.



Figure 19. Sharp iron overhangs are now more prominent. Photograph by author.



Figure 20. Side view of meteorite specimen at the end of Day 4. Photograph by author.

Day 5:

I began cold working at 1:30pm using the second technique and concluded at 2:36pm. Much of the outer rust layer had been hammered away or covered by pillow basalt dust that became trapped in the pockets of the surface during hammering. The iron overhangs were sharper and thinner than before, and the slant at the edge was more prominent. The specimen had been thinned by 0.4mm since Day 4 and 2.2mm since Day 1. The specimen was now 7.8mm thick by the end of the day.



Figure 21. Henbury specimen at the end of Day 5. Photograph by author.

Day 6:

Cold working began at 1:30pm and concluded at 2:30pm. I continued cold working the specimen using the second technique. Hammerstone C had shattered within the first few minutes of use, and small chunks of Hammerstone A began to break off as well. I continued to use Hammerstone A regardless. The bottom of the specimen was flattening out due to the impact it was sustaining against the anvil. The meteorite was approximately 7.5mm at its midsection by the end of the work day.



Figure 22. Henbury specimen at the end of Day 6. Photograph by author.

Day 7:

The fourth technique came into use serendipitously. I had misplaced the modern pair of pliers used in the second technique and decided to revert to the first technique once more. While cold working, I noticed that the meteorite was staying in place far better than it had at the beginning of the experiment. I realized this was due to the build up of pillow basalt dust from striking the hammerstone. Rock dust had filled in the divots in the anvil stone and gripped the iron specimen securely. I worked the meteorite from 1:30pm to 2:41pm using this new technique, and labeled it as the fourth technique. Hammerstone A had shattered halfway through this process, leaving only Hammerstone B to work with. At the end of Day 7, the meteorite was approximately 7mm at its midsection.



Figure 23. Iron meteorite specimen on top of basalt dust. Photograph by author.

Day 8:

I began cold working using the fourth technique at 1:31pm and concluded work at 2:47pm. The pointed end of the specimen was beginning to take shape, resembling an arrow. Small pieces of Hammerstone B had shattered and broken off the main chunk, however seeing as how this was my last hammerstone in Session 1 I continued to use it. I also wore thick leather gloves to avoid injuring myself on the sharp edges of the broken hammerstone. At the end of Day 8, the blade was now 6.4mm in thickness at the midsection.



Figure 24. Sharp edges of broken hammerstone B. Photograph by author.

Day 9:

On the ninth day of cold working I began at 2pm and concluded at 2:55pm due to rainy weather. Using hammerstone B, I hammered the specimen using the fourth technique to approximately 5.8mm in thickness at the midsection. At this point in the process the outer rust layer was almost entirely gone, flaking off as I hammered the specimen. The light silver area in the center of the meteorite (Figure 25) was produced from grinding the specimen against the anvil to remove basalt dust. I continued grinding the specimen during Day 10.



Figure 25. Henbury specimen at the end of Day 9. Photograph by author.

Day 10:

On Day 10 I began at 1:30pm and concluded at 2:15pm. This was the last day of cold working for Session 1, as Hammerstone B broke at 2:15pm. I concluded the experiment for the day when this happened. At this point the meteorite was approximately 5.3mm in thickness at the midsection, a reduction in thickness of almost 50% since Day 1. The silver-grey coloring in this photograph was partly due to dust from the pillow basalt wedged within the small crevices and bumps on the surface.



Figure 26. Henbury specimen at the end of Day 10. Photograph by author.

Without hammering tools to continue cold working, I pursued the grinding method I had tried during Day 9. This time I ground the entire meteorite specimen against the basalt rock.

Although it is undetermined if the Thule ground or polished their iron objects (Buchwald and Mosdel 1985), I experimented with a grinding process to determine its effects. I first rubbed the iron specimen against a chunk of pillow basalt in a linear motion (Figure 27).



Figure 27. Grinding iron meteorite against rock. Photograph by author.

This removed most of the basalt dust that had been trapped within pockets of the iron. Not only did this process smooth down the bumps and ridges created during hammering, it also revealed a brilliant, reflective silver surface. I further ground the iron meteorite in circular motions. This did not produce significantly different results from the horizontal grinding besides a change in the direction of the scratches. I further experimented with grinding the meteorite against a wet and dry basalt rock. Against a dry surface, the process was faster and more

abrasive, with the result being a rougher surface finish. Using a wet surface, the process was slower and less abrasive, but resulted in a smoother surface finish.

Figures 28 and 29 depict the finished product from Session 1. At the widest point the specimen is approximately 5.2mm in thickness. The original unworked specimen was 10mm in thickness, suggesting a 50% reduction in thickness. At this state, it is unlikely this experimental meteorite fragment could be fastened to a harpoon to pierce flesh. While the tip is pointed, the midsection is too wide to fit securely within a harpoon endblade slot.



Figure 28. Top view of partially flattened meteorite. Photograph by author.



Figure 29. Side view of meteorite ground against anvil over entire surface. Photograph by author.

Session 2

A second round of experimental hammering was conducted during the Summer 2015 season to attempt to flatten the meteorite further. With funding courtesy of the University of Nevada, Las Vegas Angela Peterson Scholarship, I traveled back to Avila Beach, California to obtain more hammerstones to work the meteorite. During the first round of experiments, the initial hammerstones had fractured into pieces too small to use. I collected 34 hammerstones, anticipating another long process of hammering and shaping the meteorite. However, this was not to be the case.

Day 1:

I arranged the specimen on top of the anvil in the same way I had done in Day 1 of the first session. I began cold working at 2pm, intending to work for one hour. However, a fracture appeared halfway through cold working. Figure 30 shows a deep fracture through the midsection of the meteorite (following page). This suggests that the hammering during the initial round of experiments had introduced a large amount of internal stresses into the meteorite, enough to fracture the material. I completed cold working around 2:30pm.



Figure 30. View of fracture down midsection of meteorite specimen. Photograph by author.

Day 2:

With the fracture in the meteorite spreading with every hammer strike, there was no way this endblade would be able to retain its shape any further. In order to salvage the meteorite

fragment, I then decided to determine how much the meteorite could be cold worked before the internal stresses built up to a point where the specimen broke entirely. I began cold working at 2pm, but had only worked for approximately 10 minutes when the meteorite broke in half (Figure 31). This concluded the last day of metalworking. The two separate fragments were measured independently. The smaller fragment, ultimately what would have been the thinned blade part of the endblade, was approximately 4.2mm in thickness, 14.1mm in width, and 20.7mm in length. The larger fragment, which would have been the part inset or hafted into a groove, was 6.4mm in thickness, 25mm in length, and 17.7mm in width.



Figure 31. Iron meteorite specimen broken in two pieces on top of anvil. Photograph by author.



Figure 32. Top view of two meteorite fragments. Photograph by author.



Figure 33. Bottom view of two meteorite fragments. Photograph by author.



Figure 34. Side view of two meteorite fragments. Photograph by author.

CHAPTER 6

RESULTS

This experimental project demonstrates that meteoric iron can be cold worked using stone tools without any application of heat. Previous research had demonstrated working meteoric iron was possible (Buchwald & Mosdel, 1985) but did not do so using tools and methods available to the Thule. Grinding the specimen against a rock flattened the surface of the specimen, and the Thule may have used this technique as part of their tool making process. However, due to heavy corrosion over time, current technology is still unable to determine if the Thule ground or polished their metal tools (Buhl & McColl, 2015). The iron specimen used in this experiment was reduced in thickness by 50% before breaking. Fracturing down the middle of the specimen was a sign that the meteorite was going to break soon (Figure 32). The two broken meteorite pieces were different dimensions: the smaller fragment on the right (Figure 36) was 4.2mm in thickness, 18.1mm in width, and 20.7mm in length. The larger fragment on the left (Figure 36) was 6.4mm in thickness, 25mm in length, and 17.7mm in width.

This experiment used a total of five pillow basalt hammerstones, with four breaking during the first session. It is important to note that the fragmentation from the hammerstones produced a fine basalt powder that secured the iron specimen in place on the anvil. However, as the hammerstones split into smaller pieces during use, they did not have enough mass to cause any noticeable alterations to the meteorite and a fresh hammerstone had to be used.

There were a total of four techniques used throughout the experiment, with each capable of deforming the specimen. However, I preferred some techniques to others. The first technique, although effective, was inefficient due to having to reposition the specimen on top of the anvil when it ricocheted off. The second technique was also effective, but the use of modern pliers

ruled it out as a method that the Thule would have used. The third technique required an assistant, but it was effective to a certain degree. The fourth technique was the most preferred as I worked the meteorite without assistance from another person, kept the meteorite in place with only the pillow basalt dust generated as the hammerstones wore down, and struck the meteorite continuously without having to pause to put it back in place, therein allowing me to hit it more frequently.



Figure 35. (Left and center) Comparison of two Thule iron end blades (McCullough 1989) and my own iron end blade (right) prior to breaking (photograph by author).

Lastly, the results of the catalog indicate that the majority of sites containing iron artifacts are clustered around the eastern Canadian Arctic and Greenland. After creating and reviewing the map (Figure 5), a pattern appears to exist, with an increased presence of iron closer to the Cape York meteorite. As the map showed a pattern, a goodness of fit statistical analysis test was performed. This test assumes all the data are evenly distributed, so if the information is not, it is considered statistically significant. The test did not reach statistical significance ($\chi^2 = 4.2$, $df = 2$,

$p = .122$), possibly due to the low number of sites that make up the Classic Thule period.

Although the extent of the pattern was found to be not statistically significant, there was still a strong trend of iron sites near the Cape York meteorite.

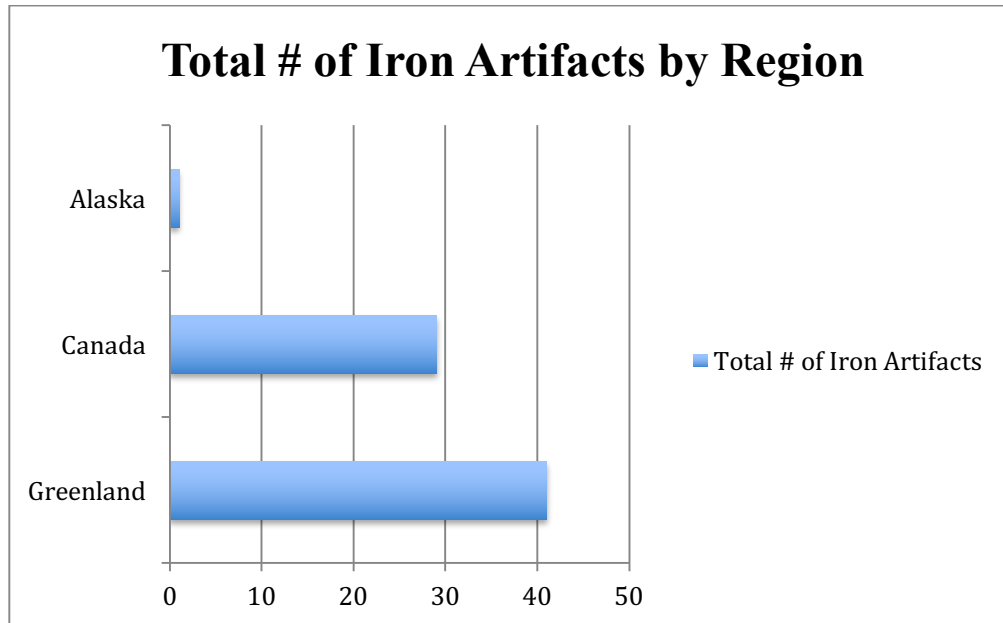


Figure 36. Number of iron artifacts sorted by region.

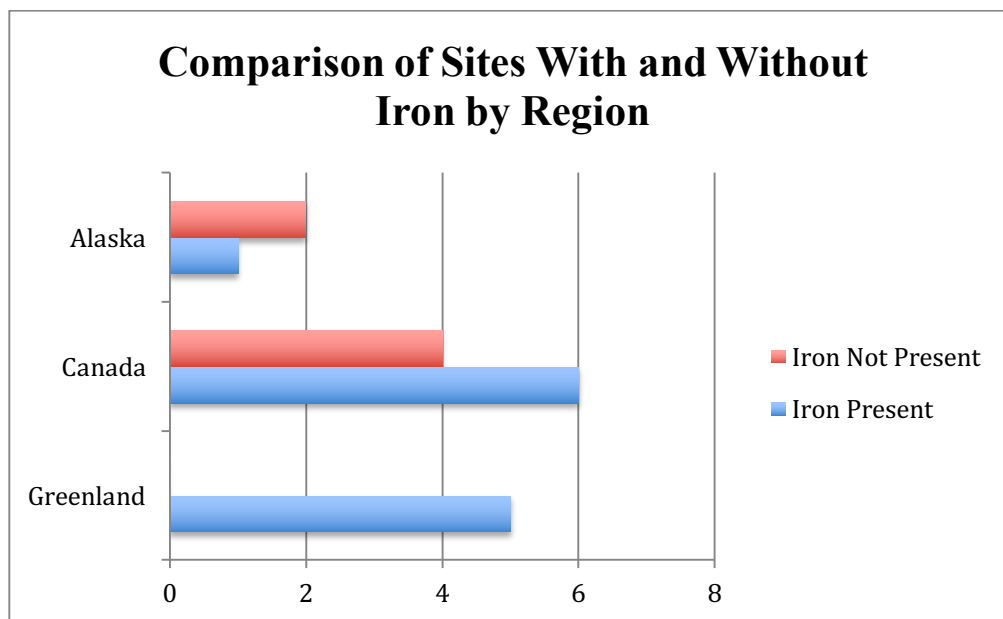


Figure 37. Thule sites with and without iron present sorted by region.

Out of the 11 sites that included individual descriptions of each artifact found, seven of

them contained iron blades or fragments of iron blades. The knife blade was the most prevalent type of iron tool found in all 18 sites included in the study.

CHAPTER 7

DISCUSSION

This research used data collected from Thule sites throughout the North American Arctic and an experimental study to better understand the influence of metalworking on their migration. Several themes observed in the chart statistics and during the experiment warrant further discussion.

Interpretation of the results

Initially I hypothesized that as the Thule neared the eastern source of meteoric iron, there would be an increase of iron artifacts. I further hypothesized that where iron was readily available, the number of iron implements would increase while simultaneously decreasing the overall level of value associated with iron implements. This was based on the concept of value created by scarcity discussed in Chapter 3. While the statistical data did show a strong trend in increasing iron artifacts near the Cape York meteorite, there was not enough data to fully understand this pattern. However, some conclusions can still be drawn.

A total of 71 iron artifacts were found across Classic Thule sites in Alaska, Canada, and Greenland. In the context of Arctic archaeology, this is considered a robust sample size. Unfortunately, only seven of the 18 sites included in this study properly report the type or quantity of meteoric iron found. These seven sites account for 60 of the 71 iron artifacts, meaning they may represent the Canadian and Greenlandic Thule populations well, but under represent Alaskan Thule sites. The results from the catalog (Table 1) indicate that one iron engraving point was reported in Alaska and 70 iron implements were located in Canada and Greenland. Of the 70, 29 were located in Canada and 41 were found in Greenland. The single

iron artifact found in Alaska has not been tested to determine whether it is of meteoric, telluric, or wrought type, although Rankin (2009) suggests it is wrought iron of European origin, having drifted ashore as part of a Norse ship. Therefore, without proper testing, we cannot determine if the single Alaskan Thule artifact included in the data could support the use of meteoric iron in Alaska. The chances of the Alaskan piece of iron being meteoric are unlikely as McCartney and Mack (1973, p. 329) suggested, “No meteoric iron has been identified in Alaska from either a local or Greenlandic source.”

The clustering of sites in the Canadian and Greenlandic sites suggests that more iron objects were found in these regions compared to Alaska. Statistics were run to determine the extent of patterning on the map. Although it was not statistically significant, there was a strong trend of iron at sites near the Cape York meteorite. If more data were available, it may be possible to better understand this distribution.

Based on the type of iron tools found, one topic of discussion is the activity use of iron amongst the Thule. There were approximately ten ulus found in the sites included in this study, three of meteoric iron, five of telluric iron, and two of wrought iron. The three meteoric iron ulus were found in Qariaraqyuk, and the five telluric iron ulus and the two wrought iron ulus were found in Eqaluit, Greenland. Ulus are unequivocally linked to women in the Arctic (Dumond, 1977, p. 66; Frink et al., 2003). They were used to process fish and butcher both sea and land animals (Frink et al., 2003). This suggests that iron and iron use was not entirely restricted to men or women. Other tools included in the data also reflect this usage. A total of 49 knife blades were found that might indicate food processing or butchering use, as well as other tasks such as hunting.

My second hypothesis stated that an increase of iron implements would imply more

extensive use of iron. While the statistical data did suggest a trend that more iron artifacts were found in the eastern Arctic than the western Arctic, this result was not statistically significant enough to definitively support this hypothesis. There are also several confounding variables to consider.

Firstly, the issue of preservation is a major concern. Any degree of moisture in an environment can affect a meteorite, causing rust to develop quickly (Buchwald, 1977; Peterson et al., 1977). This rust will eventually corrode the entire meteorite. Considering the proximity to the ocean of many coastal Thule sites and Arctic conditions in general, moisture is unavoidable. While meteoric iron is more durable than smelted iron because of the higher nickel content, the level of preservation is dependent upon environmental factors (Johnson, Jr. & Francis, 1980). If the environment is predominantly dry (such as in a cave or tomb) or mostly anaerobic (such as in an underwater shipwreck), rust will develop at a slower rate (Johnson, Jr. & Francis, 1980). Coating iron in oil is one method of preventing corrosion (Buchwald, 1977). This is demonstrated by Roman gladiators who coated their iron swords with oil (Cohen, 2003; Friendship-Taylor & Jackson, 2001) and is a method that is used by modern meteorite collectors today. However, there has been no research to determine if an oil, such as seal or whale oil, was used in this manner on Thule iron tools. Furthermore, poor preservation methods by earlier researchers may have contributed to the accelerated deterioration of iron artifacts upon excavation. Once unearthed and removed from their mostly anaerobic environment, rust developed quickly (Buchwald, 1977; Buchwald & Mosdel, 1985; Johnson, Jr. & Francis, 1980). Without proper methods of preservation an iron artifact can deteriorate within a few years (Buchwald & Mosdel, 1985). An example of this is a meteoric iron blade that was excavated in the 1970s that was approximately 12cm in length, but by the time it was reexamined in the 1980s

it had deteriorated to approximately 5cm (Buchwald & Mosdel, 1985). Therefore, the lack of iron artifacts in Alaskan Thule sites may simply be due to corrosion.

Secondly, because Alaskan Thule sites are for the most part older than their Canadian and Greenlandic counterparts, the iron artifacts that may have existed in these sites have had longer periods of time to corrode (Johnson, Jr. & Francis, 1980). In addition, there are problems in determining corrosion rates of archaeological metals (Johnson, Jr. & Francis 1980; Uhlig, 1954). The only basis for corrosion assessment is a photograph of the iron artifact labeled either “lightly” or “severely” corroded. These descriptions lack any radiographs or photomicrographs of metallurgical cross-sections that can determine the corrosion layer thickness (Johnson, Jr. & Francis, 1980). Also, corrosion environments are described in general terms such as “wet” or “dry,” making it difficult to compare long-term corrosion rates of artifacts in variable environments. Finally, Classic Thule sites span a range of approximately 200 years, which is a sufficient amount of time for corrosion to develop on an artifact given the right conditions.

The lack of meteoric iron artifacts among Classic Thule sites does not mean iron was not used in Alaska at all. Collins (1937, p. 304-305), Larsen and Rainey (1948, p. 83-84), and Levin and Sergeyev (1964) all found engraving tools with small iron blades inset in them from Old Bering Sea and Ipiutak sites. These were not meteoric iron in origin but Asiatic, possibly being traded in from Siberia (McCartney & Mack, 1973). This source of Asiatic iron probably originated from the Amur River-Okhotsk Sea region where it was available during the first millennium B.C. (McCartney & Mack, 1977). As discussed in Chapter 2, the political rise of Genghis Khan may have hindered iron trade into Alaska, causing Alaskan Thule to search for iron elsewhere.

The Greenlandic ulus from Eqaluit are of telluric and wrought origin dating from before

1650. The use of telluric iron is highly concentrated around Greenland because the largest deposit of telluric iron in the world is located there (Buchwald, 1977). The presence of wrought iron may indicate either the use of scavenged European iron left behind from Norse occupations, or indirect or direct contact between Greenlandic Thule and European explorers (McCartney & Mack, 1973). Most of the iron artifacts were found in the Greenlandic sites of Nugdlit and Eqaluit. An increase of iron tools in this area may simply reflect proximity to the source of meteoric iron. As with the Alaskan Thule sites, preservation issues also influence the interpretation of the data. Because Greenlandic Thule sites are relatively younger than Alaskan Thule sites, more iron artifacts may have been found simply because they have had less time to corrode (Johnson, Jr. & Francis, 1980).

In the experimental portion of the thesis, the third and last hypothesis stated that a high degree of skill was needed to work raw iron ore using the limited resources available. Based on my experiment, I can speculate that these iron tools took physical strength and some expertise to create. It was noted that during the cold working process, there was a slow decline in the rate of material being flattened out. This is explained by Askeland and Fulay (2009); when stress is constantly being applied to a material (in this case iron), it toughens the material through a process called work hardening. The material becomes more difficult to work as the internal stresses within the crystal lattice of the material build up. In contemporary blacksmithing, applying heat to the material relieves the internal stresses in a process known as annealing. However, in this experiment, since I did not apply any form of heat to anneal the iron specimen, the internal stresses continued to build up and not only make thinning the specimen more difficult, but also eventually led to it fracturing. This process explains why only an average of 0.4mm reduction in thickness occurred despite working it in the same manner for the same

amount of time. Therefore, the endblade took longer to flatten because it was becoming harder without fire to release the internal stress.

A craftsperson's selection of a meteorite fragment to start cold working may have greatly influenced the outcome of the iron tool. A wide, thin fragment would mean less hammering and thus a lesser chance of cracking. It also suggests that an individual would be more likely to see the completion of their tool. Furthermore, a skilled craftsperson would also need to hammer a meteorite fragment in the exact same spot repeatedly in order to obtain the desired shape within a limited time frame.

The experimental study provides valuable information on how the Thule may have worked meteoric iron. The fourth technique used to hammer the meteorite specimen revealed that the debris from the hammerstone could be ground into a fine enough powder to hold the meteorite in place on the anvil. I suspect this may be how the Thule set smaller pieces of iron in a fixed position without the use of a gripping tool. The experiment may also support Wayman's (1986) and Buchwald's (2001) assertion that thousands of hammerstones are found in Greenlandic Thule sites (Wilken, 2015). While it was known that these hammerstones were being used to work iron and other materials, it was unknown why so many hammerstones were present. This experiment shows that pillow basalt hammerstones do not last long when cold working meteoric iron, which is strong evidence for the large volume of hammerstones found.

Limitations of the study

This research can be seen as a pilot study in the attempt to understand the influence of meteoric iron on Arctic Thule migration patterns. As such, it is by nature limited in scope. While conducting this study, I noted three major limitations in regards to the sample data and the

experimental project.

The first limitation of the study regards the quantity and type of iron artifacts presented in the data. Without this information for eight of the 18 sites included in this study – with two out of three Alaskan sites included – any generated graphs would automatically be skewed towards Canadian and Greenlandic sites. While it may be likely that the Alaskan sites did not include any mentions of iron artifacts because none were found, without proper documentation methods of iron artifacts in archaeological reports, we can only assume this was the case. Secondly, the scope of the study only includes Classic Thule sites within the timeframe of the Thule migration. This only spans approximately 200 years of occupation, while all of the Thule stages combined span from AD 600 into the historic era (Dumond, 1977). This period of time does not fully represent Thule culture overall and should only be seen as indicative of a period of immense change and movement. Although this study only focuses on a period of mass migration, the limited timeframe should still be kept in mind.

In regards to the experimental project, a minor limitation that should be noted is that a fragment of the Cape York meteorite was not used and instead a meteorite of similar composition was substituted. While the two are similar in workability (Buhl & McColl, 2015), it would be more accurate for future research to try to obtain a Cape York meteorite, despite the expense.

Recommendations for future study

The lack of research on Thule metal use reflects the underdeveloped state of Arctic archaeometallurgy in general (Buchwald, 2005; McCartney, 1991). Increased study in sociocultural aspects of metal use could greatly improve the understanding of Thule iron

technologies. The following recommendations are based on the obstacles that I encountered while trying to conduct my research.

First, more excavations need to be conducted with the primary purpose of identifying iron in Thule sites. Electronic metal detection and water screening could be used to improve the finding and retrieval of iron pieces (McCartney, 1991, p. 38). Archaeological reports could then include the quantity and tool type of each iron artifact. Furthermore, looking for partially formed iron specimens and comparing the shape and hardness to unworked specimens and completed tools could help determine how far along a craftsman was in the cold working process. This will be useful in understanding the extent of metal usage in Thule culture. Second, further chemical and metallographic analyses of newly found and existing iron samples could be used to determine the source of iron as well as examine material use patterns across the Arctic.

Third, the excavation of Thule houses with tight stratigraphic control can be used to locate activity areas where metalworking occurred. This can also be used to locate areas with rust piles containing corroded or discarded tools. With this information it may be possible to make a case for a high failure rate in tool production and ascribe even more value to a successfully built tool. Fourth, Thule burials can be examined for metal or other exotic materials that might reflect symbolic differences in status that may support the hypothesis of iron as a prestige item. Lastly, more information on metal usage can be extracted from non-metal tools found in association with metal objects. Excavations can be conducted to look for piles of pillow basalt flakes and cracked pillow basalt hammerstones to determine if a site was used for metal processing.

The methodology presented in this research could be used as the framework for other studies documenting the role of pre-colonial iron in other regions. Once more regions have been studied, a comparison study could be used to identify common themes in ferrous metalworking

regarding prestige value. In contrast, it may perhaps demonstrate that no such themes exist; suggesting iron and iron tools were obtained and created for different purposes in separate regions. Research such as this would significantly contribute to studies on metalworking in the Arctic.

Conclusion

Very few iron artifacts have been analyzed from Arctic archaeological sites. This was the first research study to catalogue and analyze iron artifacts from Thule sites across the North American Arctic. This research was also the first of its kind to examine the influence of pre-colonial iron on an Arctic hunter-gatherer population, especially in regards to their migration. In addition, an experiment to work meteoric iron using possible period methods was conducted to more fully understand the social and economic significance in processing meteoric iron. Although the results of the catalog did not reach statistical significance, the possible trend of meteoric iron artifacts closer to the Cape York meteorite could be expanded upon with more data and could help explore eastward Thule migration further.

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CURRICULUM VITAE

Alina Truzal Aquino

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Professional Profile

- Accomplished undergraduate career demonstrating a successful academic record and valuable contributions to peer leadership organizations.
- Active participant in multiple archaeological excavation projects with Cultural Resource Management firms and universities
- Knowledgeable in the application of Cultural Resource Management laws and regulations.
- Consistent success in maintaining above a 3.8 GPA.
- Extensive activism in academic clubs and women's rights organizations.
- Effective and articulate communicator with the ability to lead, organize, problem solve, and reach consensus.

Education

M.A. Anthropology (emphasis in Archaeology), in progress
University of Nevada, Las Vegas

B.S. Anthropology (emphasis in Cultural Resource Management), Jun 2013
California Polytechnic State University, Pomona, California
Cum laude

Related Coursework

Archaeological Lab Methods
Archaeological Theory and Methods
Anthropological Theory
California Native Americans
Cultural Resource Management
Ethnographic Field Methods
North American Archaeology

Archaeological fieldwork

SWCA Environmental Consultants, Kotzebue, AK, USA— May 2014 - Jun 2014

- Employed as a Cultural Resource Specialist to excavate human remains found during the construction of an airport landing strip.
- Excavated five articulated human individuals.
- Mapped individual remains and associated artifacts.
- Analyzed and catalogued human remains using Microsoft Excel.

Fort Independence Paiute Reservation, Mojave Desert, CA, USA — Oct 2012 - Dec 2012

- Assisted Tribal Historic Preservation Officer in the analysis and assemblage of human

remains uncovered on a construction site.

- Completed surveying across three transects of land.
- Mapped multiple milling features and burial areas.

Bird Springs, Mojave Desert, CA, USA — Oct 2012 - Dec 2012

- Participated in Bureau of Land Management project that analyzed the impact of the Medieval Warm Period in the Western Mojave.
- Served as crew chief over a group of three students.
- Taught proper methods of unit excavation and profile mapping.
- Demonstrated ability to lead and implement procedure.

Yukon-Alaska Borderlands Field School, YT, Canada — Jun 2012 - Jul 2012

- Seven week long, full immersion field research program that emphasized all aspects of archaeological excavation, artifact identification, and collection cataloging.
- Directed by Norm Easton of Yukon College.
- Main emphasis in prehistoric subarctic archaeology.
- Included exposure to the curation and analysis of historic First Nation artifacts and records.
- Heavy emphasis on ethnographic conduct and notation.
- Advanced training in GPS, profile mapping, total station usage, and unit excavation.
- Received intermediate training in sequence stratigraphy and scientific illustration.

Big Bear, CA, USA — Apr 2010 - Jun 2010

- High altitude field class in the San Bernadino National Forest that taught advanced skills in GPS, surveying, profile mapping, and unit excavation.

Experience

Intern, State Historic Preservation Office, Las Vegas, NV — Aug 2015 - Dec 2015

- Responsible for the organization and maintenance of the online database of cultural and historic sites throughout Southern Nevada.
- Led volunteers with the Nevada state site stewardship program into the field and taught introductory methods of site recording and navigation.

Docent, Chinese American Museum, Los Angeles, CA — Jun 2011 – Sep 2012

- Conducted tours throughout the Chinese American Museum for a diverse clientele including school children and adults.
- Presented historical material relevant to the Chinese American community for discussion purposes.

Lab Volunteer, California Polytechnic State University, Pomona — Jan 2010 - Sep 2012

- Prepared debitage analyses and data entry of archaeological site artifacts into official catalogues using Microsoft Excel.

Volunteer, Arroyo Seco Foundation, Pasadena, CA— Jun 2010 - July 2010

- Assisted park rangers in cleaning recreational areas and protected forest sectors.

Student Volunteer, Balungao National High School, Philippines — Summers Jun 2006 - Aug 2010

- Taught basic English courses to impoverished primary school children.
- Assisted faculty with lesson plans and activity organization.

Tutor, Forest Park Elementary School, Fremont, CA — Sept 2006 - May 2009

- Applied language skills in an after school English program for lower socioeconomic elementary school children.
- Mentored students through one-on-one interactions in reading comprehension and vocabulary acquisition.

Skills

- Advanced fluency in Tagalog.
- Basic fluency in Spanish and Japanese.
- Competent with GIS programs such as ArcMap and ArcCatalog.
- Advanced training in wilderness survival and remote field camping.

Presentations

- Aquino, A. **The Influence of Iron Hunting Tools on Thule Migration Patterns.** *Second annual meeting of the Anthropology Research Forum, Las Vegas, NV, USA, 2014.*

Academic Affiliations

Anthropological Society of Cal Poly Pomona - Secretary, 2011-12

Anthropological Society of Cal Poly Pomona - Vice President, 2012-13

Pi Gamma Mu - Vice President, 2012-13

The Education Against Abusive Relationships - Vice President, 2011-12

The Education Against Abusive Relationships - Co-President, 2012-13 Lamda Alpha Honors Society - Member, 2013-2014

Professional Associations

Alaska Archaeological Association

American Anthropological Association

Chinese American Museum of Los Angeles

Society for American Archaeology

Society for California Archaeology