Fall 2017

The Stones They Chose: Lithic Analysis and Design Selections at Č ı̓́xwicən Village (45CA523)

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Recommended Citation

Sparaga, Joseph, "The Stones They Chose: Lithic Analysis and Design Selections at Č ı̓́xwicən Village (45CA523)" (2017). *WWU Graduate School Collection*. 622.
https://cedar.wwu.edu/wwuet/622

The Stones They Chose:
Lithic Analysis and Design Selections at Čḯxʷicən Village (45CA523)

By

Joseph Sparaga

Accepted in Partial Completion

of the Requirements for the Degree

Master of Arts

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MASTER'S THESIS

Joseph Sparaga

October 19, 2017.

The Stones They Choose: Lithic Analysis and Design Selections at Čḯx̣ʷicən Village (45CA523)

A Thesis
Presented to
The Faculty of
Western Washington University

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October 2017

Abstract

This thesis used a Design Theory approach to analyze lithic artifacts from the Čḯxʷicən village site, particularly to understand the distinctions between utilitarian and prestige values in the production of lithic tools and their intended role within the society. The Northwest Coast has a variety of resources available; how groups utilized these resources for functional and social purposes is important in understanding behavior choices. The Čḯxʷicən village site was a large permanent settlement originally inhabited by the ancestors of the Lower Elwha Klallam Tribe between 2,000 years BP to the historical contact period. The site was rediscovered near Port Angeles, where excavations exposed a number of house structures and associated exterior activity areas.

This thesis addresses the tools associated with one of the house structures and several exterior areas. The qualities of the materials is important in understanding their value in a society: whether the material has a utilitarian or social value. Design Theory is a suitable method for analyzing artifacts and the materials they are manufactured from to determine these different values. This thesis aims to analyze the lithic artifacts from Block A4 to distinguish between their functional, esteem, and prestige values.

My research analyzed 1,515 stone artifacts recovered from Block A4 from the 39,505 total artifacts from Quadrant A. I identified three specific tool industries at Čḯxʷicən village: the production of quartz crystal tools, cortex spall tools, and incised stones. A number of other materials and tools were present at the site, using a combination of reduction manufacturing techniques. Most artifacts had a single material dominating their manufacture, however outliers and variabilities made the design choices of the manufacturers clearer.

The results indicated that the majority of artifacts recovered were utilitarian in nature and manufactured expediently. Only a small number of tools required much extensive investment time. Debitage and cortex spall tools dominated the assemblage. Tools intended to manufacture other objects, such as gravers and abraders, were also present and important for creating incised stones and fishhook shanks, as well as modifying organic materials such as bone and shell. A small number of adzes and edged tools from unique materials were identified: these can be considered investment tools or objects. From the analysis, I determined that a new classification of artifact is need: Investment Tools. These objects have the qualities of a prestige good, being of rare material or requiring significant time investment, as well as fulfilling utilitarian needs, that the combination of material and function are too advantageous not to be functional.

Acknowledgements

I would like to thank my committee: Dr. Sarah Campbell, Dr. Todd Koetje, and Dr. Danial Boxberger for your wisdom and support in the graduate program and in developing this thesis. I am grateful for receiving the Fund of the Enhancement of Graduate Research, which allowed me to use lab equipment from the University of Washington to analyze obsidian sources. I am also thankful for the support from Dr. Michael Sage and Kathy Sage whose generous donation allowed me to focus fully on analyzing artifacts at the Burke Museum of Culture and Natural History. To Dr. Laura Phillips and the staff of the Archaeology lab at the Burke Museum I am happy for the memories, assistance, and effort put in to both the field of Archaeology and also my project. I also thank the Lower Elwha Klallam Tribe for allowing me to study artifacts from their ancestors, and the Washington Department of Transportation for giving me access to the artifacts. I am grateful for the obsidian identification provided by Craig Skinner, who took my data *pro bono* and conducted a second test on the specimens at his laboratory. Thanks to Laura Syvertson for updating and adding chronozones to the artifact database. An enormous thank you for the encouragement, support, and patience from my family and friends in the process of this project.

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Chapter 1: Introduction

Humans have lived and migrated across the world using stone tools. Stone tools are one of the first manufactured inventions which allowed our ancestors the ability to manipulate the environment and process resources. Stone tools are often called lithics in archaeology, a term which covers any stone which has been modified by humans. What is defined as a lithic includes a variety of object types, from projectile points and knives to flakes and tools manufactured through grinding or incising. Lithic tools were used throughout the world until the rise of metallurgy, which replaced lithic technology at different periods of time depending on location (Andrefsky Jr. 2005:4). Through lithic analysis, archaeologists can determine activities, behaviors, trade, and wealth within communities. These are made evident by the choices societies made based on their access to raw materials, use of trade, manufacturing practices, and constraint of specific resources to groups of people with a different social status.

Archaeologists also classify artifacts into categories based on objects which have behavioral meaning and social value, as distinguished from tools with a distinctly utilitarian purpose (Hayden 1998). Hayden suggested the dichotomous categories of practical tools and prestige objects; the manufacture of practical tools was either to solve comfort or subsistence difficulties, while prestige objects were meant to display wealth, success, and power, rather than perform an everyday task (1998:2, 11). This suggests that a utilitarian tool would be an object made out of a suitable material, either a convenient material which can be manufactured expediently, or a material specifically sought out because its qualities make it ideal for the task. Dense stones may take more time and energy to manufacture, but they also are more durable and would not need to be replaced as often. Prestige goods are objects that had significant value to a society and may have identified specific individuals within the population. These artifacts usually have significant value due to the rarity of material, or are difficult to manufacture, and require significant time investment when working with the material.

As archaeologists classify artifacts, they analyze the behavioral and social activities within societies. With limited information, such as an incomplete excavation or taking only a portion of the available data, the definition and identification of what sets apart a utilitarian tool from one of prestige good is reflected by previously understood trends from other archaeological excavations, as well as any historic ethnographic information available. Recognizing the behavior and social significance of objects is not always straightforward, but archaeologists constantly critique and review new data to be accurate. The perception of what is a prestige good when analyzing sites can be influenced by ubiquity of artifacts, or their overall rarity, within an individual excavation or region.

Separating prestige goods from other utilitarian tools has usually fallen to identification of the end product, instead of focusing on the materials and manufacturing processes, the investment of acquiring the materials, and/or the investment in producing the objects. Hayden's (1998:11) definition of prestige goods includes the rarity of a material as a prerequisite for prestige goods. The definition is too broad and does not recognize that some objects manufactured from rare materials and/or requiring intensive effort to manufacture may also have utilitarian function. A better identification for prestige would be to ascertain where the material came from, the investment made to acquire and process the material, and whether the object was to serve a social role, fulfill required tasks for subsistence, or an amalgamation of the two roles.

As in other areas of the world, lithic tools were used by people of the Northwest Coast to process and manipulate the local resources. The Northwest Coast of North America is recognized for the diverse cultural groups which developed utilizing the myriad of natural resources available to them; the diverse and seasonal resources required technological advances in harvesting quantities of food and processing it for storage (Ames and Maschner 1999; Erlandson *et al.* 2008; Moss 2011). Stone tools were fundamental to the processing of these resources. People developed a wide range of different stone tool technologies to aid in the hunting and processing both animal and plant foods, for the manufacturing of other tools out of wood, antler, bone, and also to build wooden structures. Archaeology is essential in identifying the patterns in technology and the shifting adaptations by past societies. Since the 1970s, the concentration of research has focused on studying the manufacturing processes and efficiency of specific tool types (Flenniken 1981; Graesch 2007; Morin 2004). Other researchers set goals to understand the development of social complexity where certain stone tools have implied social values of wealth and prestige (Abadi-Reiss & Schneider 2006; Hayden 1998; Horsfall 1983; Walker & Schiffer 2006).

The trade and transportation of materials can also be interpreted through lithic tools, specifically through identifying the sources of unique materials. Examples of rare and isolated materials which were traded throughout the Pacific Northwest were obsidian and nephrite. Research on nephrite sourcing by Morin (2012) traced nephrite artifacts to source locations displaying the areas where the material was collected and deposited, while Carlson (1994) sourced obsidian artifacts to the different volcanic regions throughout Washington, Oregon, and British Columbia. The research published on trade networks, in association with artifacts from an excavation, can help identify how far materials are transported from initial collection to their final exhaustion and disposal throughout a region. Quarry sites, areas where lithic material is gathered tend to be the location of primary reduction which allows material to be easily relocated. Hunting camps, villages, and quarries are sites of secondary reduction, where manufacture of the material into desired tools and objects took place (Andrefsky Jr. 2005; Erlandson *et al.* 2008).

Along the Northwest Coast, frequently manufactured specialized tools designed for conducting repetitive objectives included ground slate knives, for the processing of salmonids; projectile points, which were utilized in both hunting and conflict; as well as labor-intensive ground stone tools, such as mauls and adzes, for the manipulation of other resources (Ackerman 1992; Erlandson *et al*. 2008; Morin 2004). Depending on the desired tool, and the social or utilitarian value of the object, manufacturers could choose rare or time intensive material to design tools, or focus on rapid manufacturing with less emphasis placed on the replicability of manufacture. These specific design choices distinguish tools between the time investment for durability, or using expedient manufacture for quickly replaceable tools.

While tools can be manufactured for expediency or reliability, many artifacts from the Northwest Coast are also known for their artistic flourishes. These embellishments on lithic tools were included during the design and manufacturing process, and did not compromise the desired purpose of the tool (Ames and Maschner 1999; Stewart 1973). An example are the mauls illustrated by Stewart (1973:53) which show the variety of embellishments in the form of rings at the proximal end, beyond the utilitarian nature of the tool. Embellishment such as those shown by Stewart can be marks of ownership, individual artistic additions, or icons relatable within a society.

As village sites are often areas of trade, secondary lithic manufacturing, and a locus of wealth distribution, they are a valuable source for understanding material availability and how more time-intensive manufacturing processes were conducted. This thesis will analyze a portion of the lithic materials from the Čḯxʷicən village site (45CA243) and evaluate the material choices made during the manufacturing of tools, and how those materials affected the design of the tools. Čḯxʷicən village is located near Port Angeles, and for the last 2,500 years was a large settlement for the Lower Elwha Klallam Tribe, who continue to inhabit the area (Figure 1). The Čḯxʷicən village archaeological site was chosen for my research as the excavation covered a large and comprehensive area, and recovered a large assemblage of artifacts.


Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2016 TerraMetrics

Figure 1: Čḯxʷicən Village Site within Port Angeles.

Additionally, it is currently being examined by several archaeologists from four universities under a National Science Foundation (NSF) grant. Their focus is on examining the intracommunity response to large environmental fluctuations by analyzing the faunal remains at

Čḯxʷicən village (Butler & Sterling 2014). Discussing the project with the researchers provided me with a better understanding of the use of non-lithic resources from the site. This thesis will start the identification of lithic artifacts from Čḯxʷicən, and continue the research of understanding constraints and choices made by the population with the resources available.

This thesis aims to determine the design and material choices crafters were making when manufacturing their tools. Through the analysis of the Čḯxʷicən village lithic artifacts, we can arrive at a better understanding of how the Lower Elwha Klallam Tribe utilized the available resources in their surrounding habitat.

Design Theory, originally developed for understanding engineering designs and machinery manufacture, is extremely useful in understanding tool production in the archaeological record (Pye 1964; Horsfall 1983). Previous analyses using Design Theory have tended to focus on the material differences in specific tool or artifact types, rather than a diverse collection of tools from a single site. This thesis aims to utilize Design Theory to analyze the manufacturing choices of lithic tools made at the Čḯxʷicən village site. The manufacturers understood the types of tools they required, what the end functions would be, chose the appropriate materials to use, and decided which processes were needed to create their tools. These manufacturers developed the familiarity through received knowledge, experimentation with different materials, and production techniques. This established knowledge is used for deciding which materials are chosen for the intended object; the material chosen balanced the reliability and efficiency of the tool against the manufacture cost for production.

Design Theory focuses on these choices from an engineering perspective and assumes logical decisions were made during the manufacturing of tools, and identifying the constraints and invested effort on materials (Pye 1964; Horsfall 1983). Tool manufacturers would have the experience and understanding of the materials to identify the possible end results when developing their tools. While previous work on lithics with Design Theory focuses on the rarity and ubiquity of materials as well as the expediency or time investment (Gasson 1973; Hayden and Gargett 1988), I argue that the functionality in tasks is a significant attribute to consider when analyzing artifacts of both prestige and utilitarian value. I postulate that the materials chosen for the manufacture of tools is deliberate for the necessary function, with the exception of outliers for experimentation, training, or in the case of rare or unusual materials, differences in social status.

The Čḯxʷicən village site had a sizable community for an extended period of time. The artifacts exposed during the excavation are diverse in function, manufacturing methods, the material chosen, providing a substantial amount of information for analysis. During the time period the site was occupied, ranked social organization is believed to have been established, making the Čḯxʷicən village site an excellent location for assessing social differences through the design choices of manufactured items. The social and utilitarian values of the tools analyzed in this thesis helps with the understanding of human behavioral choices in this part of Klallam territory.

Chapter II: Background

The Pacific Coast of North America is a rich and diverse region, where indigenous populations developed specialized sets of tools for processing resources and increasing survivability within regular environmental and subsistence cycles. The predictable seasonal influx of resources included salmonid spawning, as well as bird and whale migrations. Populations throughout the Salish Sea and Northwest Coast developed strategies to harvest and store these resources for future use (Ames and Maschner 1999; Erlandson *et al.* 2008; Moss 2011). The ability to gather and stockpile resource surpluses supported the development of hierarchical societies, which organized the division of labor required for accessing and sharing resources. Indigenous communities of the Northwest Coast utilized these divisions of labor to construct large and relatively stable villages (Ames and Maschner 1999; Morin 2004).

Complex social groups increase the importance of social signaling. In this context some material culture was created solely for social purposes, rather than in utilitarian subsistence pursuits. These prestige goods, by definition, are objects which distinguish individuals from the rest of the community by espousing their inherited or earned achievements (Hayden 1998). These objects are often manufactured with rare materials, can also be labor-intensive to create, have been specifically manufactured to display social power, and are usually associated with groups which have surplus resources and time (Hayden 1998; Morin 2012). Prestige goods are important to study as they not only highlight inequality within societies, they also identify the social importance of specific materials or symbols from the culture. Tool types, and material types are critical in understanding not only inequality, but the design decisions people made based on the availability of resources, effort in processing those resources, and social or behavior norms of the community.

The Salish Sea: A Regional Background

The Northwest Coast of North America has undergone extensive environmental changes over the past 15,000 years, including changes in sea levels, recession of montane and continental glaciers, and coastal isostatic changes and erosion (Erlandson *et al.* 1998). Periods of climate change either reduced or expanded ice sheets causing an overall change in ocean water levels; post-glacial rebound altered the topography of the region as the weight of the glacial sheets melted away (Ames and Maschner 1999). Both the coastline and adjacent regions have different geological formations, which have resulted in variations in the types of geologic sources available to groups throughout the Northwest Coast.

Large tectonic events, such as earthquakes and tsunamis, have affected the geography of the Northwest Coast and have periodically affected resource availability. These natural forces can create abrupt changes in geography such as landslides or avulsion of the shoreline and intertidal zones. Such events are not uncommon throughout the Northwest Coast, including the Strait of Juan de Fuca, and may have resulted in temporary or even permanent abandonment of inhabited areas, due to local resources being damaged or made inaccessible. (Hutchinson and McMillan 1997). Evidence of several large tectonic events have been identified in the region around Číxʷicən village during periods when the site was inhabited, and these circumstances would have affected communities throughout the area (Atwater *et al*. 2004:338).

Several natural and geographic circumstances hamper studying the archaeological record along the Northwest Coast. Wessen (1990) states that the region has poor preservation in regards to the archaeological record due to "heavy precipitation, dense vegetation, acidic soil, and frequently rugged relief, combined with the erosive effects of swift rivers and exposed beaches" which cause cultural materials to weather quickly or be completely disturbed or destroyed.

Acidic soils often deteriorate shell, bone, and antler artifacts unless there is a sizable shell midden to leech sufficient calcium into the soil (Erlandson *et al.* 1998). Because of this soil environment, many organic artifacts are either destroyed or severally degraded over time, and lithic tools are often the only surviving evidence of human behavior found within the landscape. This may cause difficulties during analysis, however it increases the importance of analyzing the design functions of lithics tools as they relate to manufacturing other materials which are no longer present.

Figure 2: Photo of Port Angeles taken from halfway up Ediz Hook. The protected bay and Olympic Mountains are visible. Photo taken by Joseph Sparaga.

These natural conditions are also present at the Číxʷicən village site. The site is located near Port Angeles, Washington; this coastal city is on the north-central section of the Olympic Peninsula along the Strait of Juan de Fuca. This waterway is a link between the Salish Sea and the Pacific Ocean. Nearby geographic features include the Elwha River west of the site and the

Olympic Cascades directly south (Figure 2). A local feature of the site is Ediz Hook, a naturally created spit which formed around 5,000 years ago and created a barrier for the village from storm surges (Galster 1989; Sterling *et al.* 2006a). These features lie within the Cascadia Fault region, an area where tectonic events periodically affect the region (Atwater *et al*. 2004).

Archaeologists have recognized that indigenous populations have inhabited the Northwest Coast up to 13,000 years before present (Erlandson *et al.* 2008). Closer to the Port Angeles area, the shorelines of the Strait of Juan de Fuca have been inhabited for over 10,000 years, on both the Olympic Peninsula and Vancouver Island sides (Ames *et al.* 2010; Waters *et al*. 2011). As populations spread and people settled, semi-permanent settlements were established and the production of more specialized tools were developed in areas where animal migrations were present. The division of labor required to efficiently harvest, process, and store large amounts of seasonal migrating food resources became an important step in creating corporate economic groups (Holstine & Gundy 1999; Morin 2004; Moss 2011). These regular migrating food sources include several species of salmonids moving from the ocean to rivers to spawn, migratory birds, and also whales; beyond the plethora of migratory animals there were also a varied number of terrestrial and maritime fauna and flora which were able to be acquired year round (Ames and Maschner 1999). Large terrestrial mammals were harvested for food, their hide was used for a variety of purposes, and their bones, teeth, and antlers were utilized in tool manufacture (Coupland 1998; Hodgetts & Rahemtulla 2001). Over time, the planning and harvesting of resources would develop into the creation of hierarchical differences within local societies.

The development of hierarchical societies in the Northwest Coast is best represented by a regionally recognizable type of structure: the plank house. The plank houses of the Pacific

Northwest Coast are wooden structures which required substantial labor, resources, and time to construct and maintain, and was where the majority of social interaction within the population took place (Coupland *et al.* 2009). They are representative of the social organization and affluent economy of the Northwest Coast, which often manifested in the gifting of items for social prestige and loyalty (Ames *et al.* 1992).

From 3,000 to 1,500 BCE, plank houses along the Northwest Coast were inhabited by the generations of the same family (Ames and Maschner 1999). Tool manufacture and labor was often organized with a division of industries in order to accumulate the necessary resources to sustain a plank house and associated families (Ames & Maschner 1999; Morin 2004; Moss 2011). Research on activity areas of Ozette households showed that, in plank houses, activity areas can be identified by finding "walls" or "corners" of deposited material; the processing areas of stone tools that were identified by finding areas with dense flake clusters and lithic reduction evidence (Samuels 2006:226). Plank house floors consist of a variety of different material buildups, ranging from the original planks to the matting, debitage, food waste, and broken shells; all of these different materials become compressed over time and become the house floor (Samuels 2006; Sterling *et al.* 2008).

Plank houses are essential for understanding the buildup of wealth as a sign of prestige in the Northwest Coast. In order for plank houses to be maintained through multiple generations, it was necessary for the leading family to have a combination of wealth, followers, and control over resource access (Ames 2001; Grier 2006). By amassing wealth, individuals had more influence to direct others with the gathering of materials, which would subsequently be manufactured into prestige goods within the plank house (Ames 2006). Tool manufacture within the plank house was also segregated; the production areas of different tools were separate from each other, creating clear areas of manufacture in the archaeological record (Ames 2006; Grier 2006). The organization of labor within a plank house was an important and necessary commitment as various tools, such as ground blades and fishhook shanks, require a high manufacturing cost due to the substantial amount of time needed to manufacture. The time investment involved in creating a stockpile of tools allowed the group to have replacements on hand instead of having to remake objects as soon as they broke (Graesch 2007; Morin 2004).

Lithic artifacts from the Northwest Coast have been the focus of substantial research, covering methods of reduction, use, and the appropriation of materials (Ackerman 1992; Ames *et al*. 2010; Andrefsky Jr. 2006; Coupland 1998; Rousseau 2004). A common technique for manufacturing lithic tools was flaking, that is removing portions of a stone through percussive force. A number of different manufacturing techniques were utilized throughout the Northwest Coast. One technique which was identified from the Hoko River site was bipolar reduction (Flenniken 1981). Unlike hand-held percussion flaking, bipolar reduction is applied when the core was too small to hold and strike, so the producer placed the material on an anvilstone and struck it with a hammerstone. This forced the energy from the strike to form concentrated radii instead of a Hertzian Cone, creating a more vertical and straight removal of materials (Andrefsky Jr. 2005:26-27). While not every stone tool was manufactured through this process, it was useful when the only accessible materials were small and difficult to handle stone cobbles.

Another type of manufacture is incising stones to create stylized objects. This form of art has been most notably recorded as large petroglyphs, but there are reported instances of small incised stones being recovered from the Northwest Coast (Ames & Maschner 1999; Holm 1990; Phillips & Charles 2015; Stewart 1973). Incised stones have been found throughout the Salish Sea, yet limited analysis has been published regarding their importance or ubiquity in the region.

Debates have been raised about artifact and material use in the Northwest Coast, with the suggestion that the reliance on flaked stone tools and ground tools transitioned to a reliance on those manufactured from bone and antler by 5,000 B.C.E. (Moss *et al.* 2007). The idea of organic material replacing stone tools is still debated in the Northwest Coast, with counter arguments expressing that organic materials may have augmented and expanded the toolkit as stone tools were continually being utilized into the contact period (Ames 2012). Large excavations of village sites, including Čḯxʷicən, would provide a clearer and more representative tool and material collection. Because Čḯxʷicən village dates back 2,800 years, an analysis of the artifact collection would show any change in reliance on different materials over time (Sterling *et al*. 2006b).

The Klallam at Čḯxʷicən Village & Port Angeles

The Čḯxʷicən village site is located centrally in traditional Klallam territory; early ethnographic accounts detail Klallam settlements or frequently used areas from Hoko River to Port Discovery Bay, and up into the mountains of the Olympic Peninsula (Eells 1996). When ethnographic accounts were being written about the Klallam and other populations in the region, Western technology and ideas had already caused significant changes to traditional activities and tool use (Gunther 1927); changes to indigenous people included different clothing, hunting gear such as rifles, and reduced access to land as settlers arrived. During the early contact period, the Klallam population was recorded at 200 individuals; undoubtedly lower than pre-contact population levels due to raiding by other regional groups as suggested by Gunther (1927:184). The impact of introduced diseases was also a significant cause of depopulation.

Resources available to the Klallam at Čḯxʷicən and the surrounding area were diverse with seasonal food. Fishing was a significant source of food and storable resources for the Klallam since the migrating species changed seasonally. Throughout the year different species of fish were harvested, including spring salmon, dog salmon, silver salmon, steelhead, halibut, long cod, flounder, herring, smelts, and candlefish (Gunther 1927:198). Humpback whales were also taken when convenient. The coastline would have provided the Klallam with a diverse range of shellfish. As missionary Myron Eells described, “Ten kinds of shell-fish are used for food, four of them being different varieties of clams, two of crabs, and one each of oysters, mussels, sea eggs, and scallops, the latter two being found only in the Klallam waters” (1996:27). There is also ethnographic evidence of the Klallam gathering roots, berries, sprouts, and vegetables that grow along the sea (Gunther 1927:196).

The Lower Elwha Klallam, like the majority of indigenous populations along the Northwest Coast, constructed and maintained plank houses. Gunther’s (1927:186) ethnography on the Klallam generalizes their plank house construction and village layout, based largely on observations of plank houses in the village at Washington Harbor. Both shed and gable roofed houses were in use, and Gunther describes them as typically 20 by 30 feet. The layout of the plank houses being generally a single row along the beach with their doors facing the water. The inhabitants were usually close relatives, and the ownership of the house was typically passed down patrilineally (Gunther 1927:188).

The Čḯxʷicən village archaeological site (45CA523) was the subject of a large archaeological excavation that developed during a Washington State Department of Transportation (WSDOT) project in 2003. Previous examination and monitoring was conducted by Western Shore Heritage Services (WSHS), that did not penetrate below the historic fill, which was more than 5’ in places; therefore they recommended monitoring any ground disturbance reaching four feet under the surface (Burns and Rooke 2003; Larson 2006). Once the ground breaking began, extensive intact cultural materials were revealed and Larson Anthropological Archaeological Services Limited (LAAS) was contracted to monitor and excavate the village site, while WHS had a contract to conduct burial recovery in the adjacent cemetery. The Lower Elwha Klallam Tribe (LEKT) was extensively involved in both projects, and worked with archaeologists from LAAS to excavate, catalog, and record the site excavation as well as recover burials encountered at the village.

The Čḯxʷicən village site became the largest excavation project in Washington. The excavation covered over 518 m^2, removed 261 m^2 of sediment, and uncovered multiple plank houses with a wide array of features, artifacts, fauna, and human remains (Larson 2006). The excavation area was broken into four different quadrants, A through D, with excavation blocks within each quadrant (Figure 3). After increasing costs and recognizing the possible size of the site, WSDOT decided to terminate the graving dock project. Their remaining limited post-excavation funding was used to produce a basic excavation report and field catalog, which did not include analysis of the recovered assemblage of artifacts, faunal remains, and features.

Several researchers have begun analyzing sections of the Čḯxʷicən village collection, analyzing the faunal materials using a National Science Foundation (NSF) Grant. As the site is large, complex, and yielded a very extensive archaeological assemblage, analysis of the entire site was beyond the scope of a single research project, and so the analysis has been focused on specific blocks of the site. This M.A. thesis follows their example, and focuses on 5 blocks within quadrant A, the most extensively excavated portion (Figure 4). Block A4 is the largest of the 5 blocks, comprising 37 one by one meter units, and is the focus of this research. This block was in periodic or continual use throughout the lifespan of the site, and included a portion of a plank house.

Radiocarbon dates obtained from throughout the site indicate that the location had been in use for over 2500 years (Butler and Sterling 2014). The dates from the plank house in Block A4 determined that it had been utilized from 1500 to 500 BCE, which would make it a multi-lineage house structure (Coupland *et al.* 2009; Gunther 1927; Sterling *et al.* 2006b). Only the northern corner of the plank house was excavated during the field season.

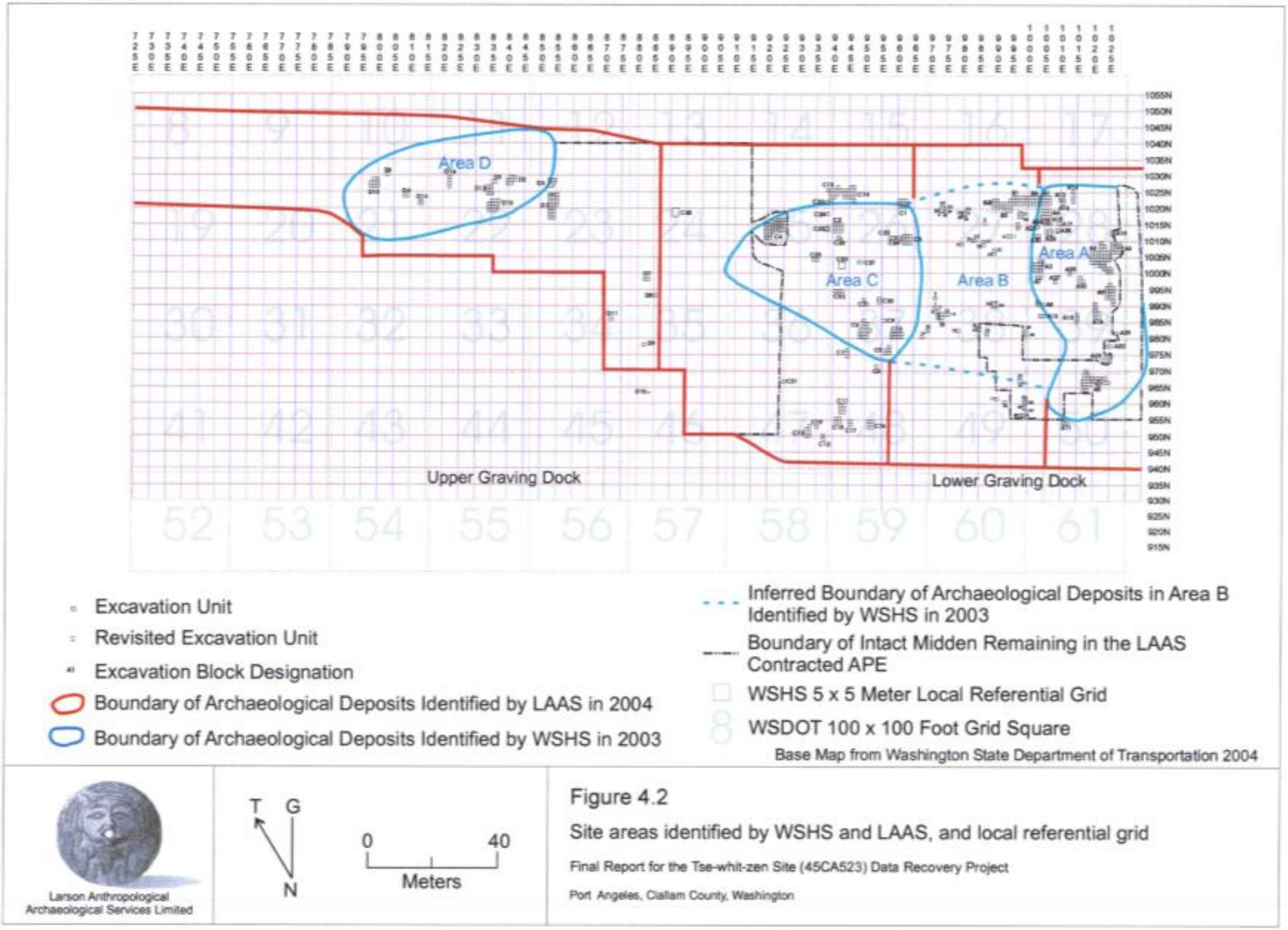


Figure 3: Map of the entire Čǐxʷicən village site (Larson 2006:4-3).

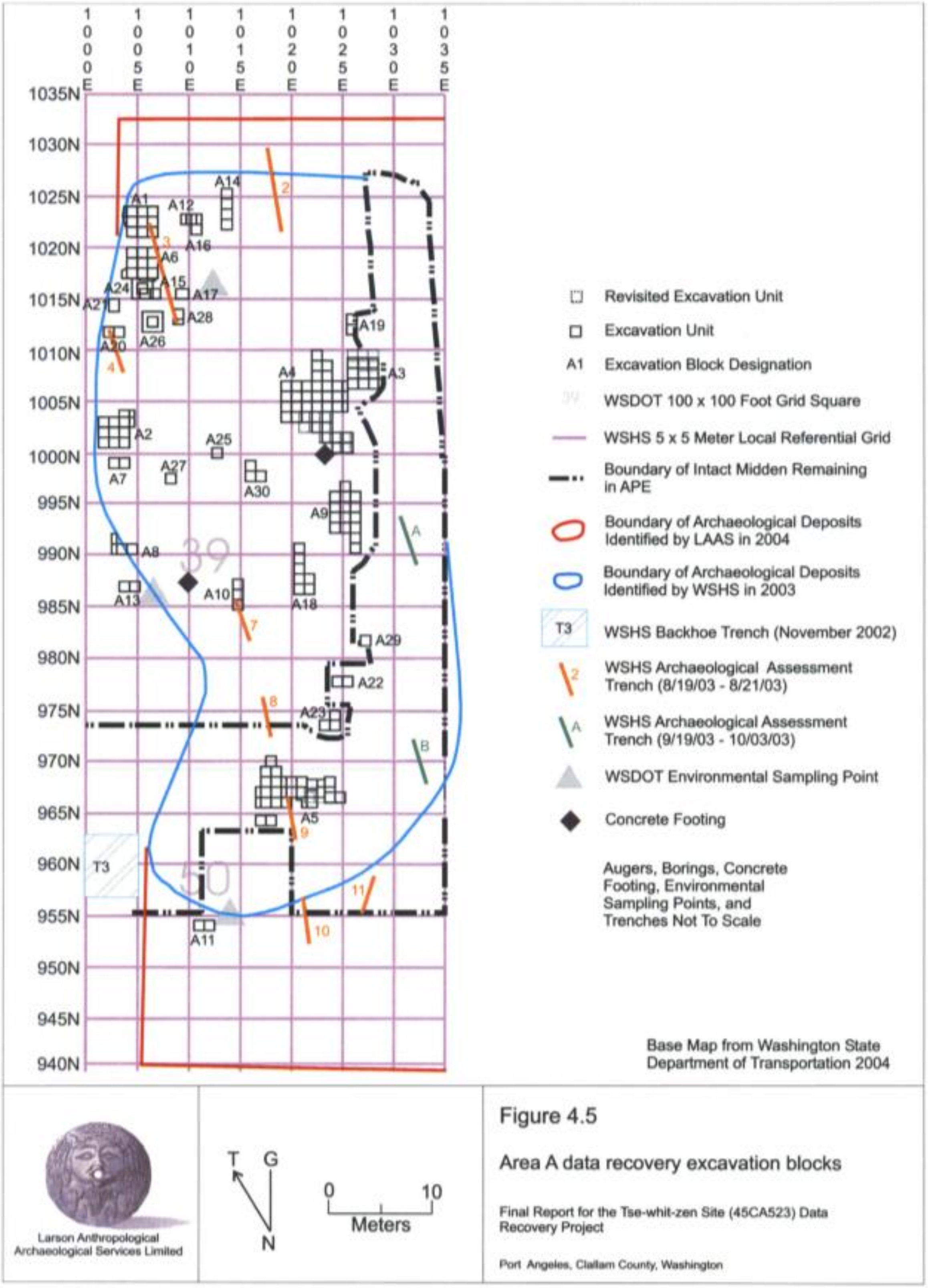


Figure 4: Area A of the Č̕ix̣ʷicən village site (Larson 2006:4-28).

Tools: Prestige and Utilitarian

As societies develop different social orders, the distribution of materials or artifact types becomes associated with rank. The development of prestige artifacts often results from a group's ability to procure enough resources to have surpluses, develop specialists for the manufacture of tools and the use of said tools, and the ability to acquire and process rare or difficult raw materials (Nassaney 1996). When groups elevate individuals to a position of social power, the individuals are able to dictate the organization of labor. In the Northwest Coast, this meant that they could have groups focus on the production of time-intensive tools while other groups are directed towards other goals. The ability to have a dedicated group of crafters creating specifically purposed tools allowed the stockpiling of these specialized tools. This allowed the population to utilize time-intensive manufactured tools, which had a single purpose and were more effective at processing large quantities of resources; then if breakage occurred another tool could be taken from the stockpile (Hayden 1998). Having dedicated manufacturers cultivates specialists, who can focus on the design of their objects, eventually creating more uniquely shaped versions or utilizing more unique materials. These more unique versions of objects can then be used as symbols of prestige, as the community is capable of manufacturing objects not intended for a utilitarian use.

Accumulation of wealth in the Northwest Coast can be identified by the collection of prestige goods and use of potlaches. Hayden (1998:11) describes the purpose of a prestige good in the Northwest Coast as:

> "Not to perform a practical task, but to display wealth, success, and power. The purpose is to solve a social problem or accomplish a social task such as attracting productive mates, labor, and allies or bonding members of social groups together via displays of success… I suggest that the main goal of prestige technologies is

> to employ as much surplus labor as possible to create objects that will appeal to others and attract people to the possessor of those objects due to admiration for his or her economic, aesthetic technical, or other skills."

This definition is effective in describing the social aspects of prestige goods, but is missing a set of criteria for identifying what particular cultural remains functioned as prestige goods in a particular society. What threshold of material exoticness and labor investment was the transition to prestige goods from functional items? Hayden and Schulting (1997) argue that for the interior plateaus, the following artifacts could be identified as prestige goods throughout the Plateau of the Northwest Coast, including:

> "bone and antler combs, incised tooth and bone gaming pieces, antler digging-sticks handles, bone tubes, L-shaped awls, fine tubular pipes, zoomorphic and nipple topped mauls, zoomorphic bowls, bone and stone clubs, eccentric chipped-stone pieces and pendants, shaped slate pendants, rock art motifs, thinned incised decorative bone, incised dentalia shells, bird and predator claws, and perforated elk canines. And we would add nephrite celts/adzes, dogs, and slaves as prestige items (Hayden and Schulting 1997:58)."

Hayden and Schulting (1997) discuss their reasoning for selecting these artifact types as indicators of prestige goods. There are several issues with their list and how they have described some of the artifacts. This list includes several objects which are used to alter other objects or process resources. These tools include L-shaped awls, which are considered prestige due to their rarity in the archaeological record (Hayden and Schulting 1997:66). Elongated and non-functional nephrite adzes were also included in their list as they take an exorbitant amount of time to manufacture, nephrite material is sourced only to a few areas in the region, and elongated and non-functional adzes have been used as grave goods (Hayden and Schulting 1997:72). There is a difference between larger, possibly ceremonial adzes and more utilitarian versions as discussed by Morin (2012:18) which brings to question a variability in size and prestige. Many of the objects they have listed out are functional, utilitarian tools, especially organic artifacts such as antler-digging stick handles and combs, which may be considered rare and prestigious (based on their rarity in the archaeological record). I think that this list could be re-evaluated to give greater consideration to the utility of the objects, before determining their prestige.

Stone Procurement and Access

Stone technology was developed by humans throughout the world and was intimately related to “the production and maintenance of houses, tools, and clothing, or food procurement, such as hunting and butchering” (Andrefsky Jr. 2000:211). Often the stone material required to create the needed tools is not located near the loci where people have developed their societies. This required a network for acquiring materials through gathering, raiding expeditions, trade, gifting, or planned expeditions. This behavior was also exhibited in the Northwest Coast region, which relied heavily on stone tools. Lithic analysis has been used to define behavioral activity areas within sites and for understanding regional mobility/sedentism and possible material constraints, such as access or availability (Ackerman 1992; Andrefsky, Jr 2001; Morin 2004).

In many archaeological habitation sites, fragments of stone tools and exhausted stone tools are identified in addition to complete, functional tools, but unless the quarry site is close most lithic material has already been reduced. The primary production sequence is not always represented, however, as the initial manufacturing may have taken place elsewhere. If every product and byproduct was found at a site, an archaeologist could refit the lithic and understand decisions made during manufacture (Chippendale 1986). Even without all of the material, archaeologists can infer reduction strategies, transportation, and trade. Identifying the production and movement is key for understanding human activities in the archaeological record as it demonstrates design choices and object planning in manufacture. Not only do the types of tools help define what activities were conducted, occasionally materials discovered at a site can show inter-group trading. By identifying time-consuming tool manufacture as well as non-local, uncommon materials, artifacts can be better understood as prestige or utilitarian.

Design Theory

Identifying the designed purpose of an object is important in understanding the behavior of a group of people and identifying if objects were created for function or prestige. Design Theory analyzes artifacts in a way that aids in determining what constraints a society dealt with and what resources the tools were designed to exploit (Chippendale 1986; Gasson 1973). Gasson (1973), an early author on Design Theory, argues that design follows two points: first, an object is manufactured to satisfy a need, and secondly, once the original need is satisfied it will create a new need. Gasson (1973) states that humans will take a activity, such as processing salmon, and design a tool to be as efficient as possible, which then allows more time for another need to be addressed. The specialization of a tool reduces time expenditure for a society, allowing it to pursue other needs. This can contribute to the development of more complex societies, which in turn produces objects which are not required for survival, but for society. Gasson (1973) classified two types of values for these objects: Use Value and Esteem Value. In archaeological contexts it has been considered their utilitarian purpose and their prestige (Hayden 1998). However, as prestige in archaeology has often been viewed as a sign of wealth, it should be different than the Esteem Value; because of this I separate Use, Esteem, and Prestige for this thesis.

Design theory has been used use to analyze several lithic tool groups from different regions of the world. Horsfall (1983) used the theory to understand the forms and functions of grinding stones in Mayan cultures and observed differences of material, the types of technologies, and the socioeconomic factors. Abadi-Reiss and Schneider's (2006) work on grinding stones in the Mediterranean region identified prestige differences by analyzing the manufacturing cost of acquiring material which had restricted availability; these restrictions included size, weight, appearance, availability, distance of transport, and energy required for manufacture. Skibo and Schiffer (2008) further split design theory into four sub-categories: the life history/behavior chain, activities and interactions, technical choices, and performance characteristics and compromises.

Use Value / Functional Tools

Functional tools are utilitarian in nature and are manufactured in order to carry out tasks for survival, which include processing food and constructing shelter (Hayden 1998). Design Theory suggests that, when choosing the manufacturing approach to developing a tool, people will take into account possible trade-offs. These include the locality and material types, the time investment involved in acquiring and processing the material, and the reliability and efficiency of the finished tool, in which these differences may be perceived trade-offs or objectively understood (Chippendale 1986; Hayden 1998; Horsfall 1983; Nelson 1991). An example of these deliberate decisions comes from Morin's research on salmon processing. As Morin described, several different types of tools or materials were used to carry out the task of salmon processing in the Northwest Coast. The choice depends on material availability and time commitment to each population. His research included ground slate knives, flaked blades made from quartz crystal or quartzite, cortex spalls from water-worn stones, and quartz crystal microblades; all of these materials were designed by manufacturers to take advantage of resources (Morin 2004).

Design theory uses a tool's characteristics to evaluate the object's value. The analytic concept of use value relates the physical characteristics of the tool and its component material to the functional purposes in processing resources. When evaluating the value of a tool, it is necessary to identify the characteristics of the material; identifying the effectiveness includes classifying the material as sharp but brittle or hard but difficult to reshape when being used. Another important factor when evaluating the effectiveness of a tool is identifying a combination of the tool's ability to complete a task and its reliability to be repeatedly used before having to be reshaped or replaced (Bleed 1986; Graesch 2007; Nelson 1991).

Understanding design choices begins with identifying materials, their sources, and the cost of their procurement. Costs of procurement vary with whether materials are rare or ubiquitous, and whether sources are local or distant, easily accessible or not. Workability also varies with material type. While a tool can accomplish specific goals, the material and manufacture processes demonstrates the availability of resources and labor commitment a society is willing to devote to them (Abadi-Reiss & Schneider 2006; Hayden 1998; Morin 2004; Stewart 1973). A valuable clue to understanding design choices is identifying if there are tools which are manufactured from different materials, or if there is a variability in manufacturing technique to create an end product.

Several types of materials are only found in certain areas, and acquiring them takes both significant time and effort to locate, or through trade. As described earlier, nephrite adzes are a significant tool for wood working; the rarity of nephrite made them a symbol of prestige (Darwent 1996; Morin 2012). Darwent argued in his dissertation that the prevalence of nephrite adzes and their importance as a tool was due to its durability in use, as well as the increasing demands of building plank houses and canoes beginning roughly around 4000 BCE (1998:22).

Nephrite is not a common material and can only be accessed directly from exposed veins or “floated” nephrite boulders, which is nephrite exposed and displaced during the ice age by glaciers (Morin 2012). While the material is rare, the durability in use as an adze is unique, with few if any other material able to be used for the length of time as nephrite.

Manufacturing durable tools is a time consuming process, and sometimes is not the most beneficial. One strategy is to manufacture tools which have low reliability, but can be made quickly and replaced with local materials; in contrast are tools with a high manufacturing cost but allow the user to repeat their tasks without constant replacement. Morin (2004) conducted experiments manufacturing ground slate blades, and found that making a single ground slate blade takes over 16 times longer than a flaked quartz crystal blade; this made ground slate blades a more consistent tool in repeating the same action, but required lengthy preparation in manufacturing the tool compared to the quick manufacture of flaked blades. Having a reliable tool is essential in attaining efficiency and maximizing the use value, as repetitive tasks which can be completed reliably will save energy, and the tool will be more valuable. Hafted ground slate blades take more initial time investment to manufacture, however they surpass hafted quartz crystal blades in the reliability of their purpose and increase the efficiency of the harvest (Hayden and Gargett 1988; Graesch 2007; Morin 2004). The expediency of flaked quartz crystal tools is useful, especially when harvesting an expected animal, but when a group effort is made to harvest a resource consistently and requires the end product to be consistent, the time investment pays off.

Esteem Value

As the Use Value is the utilitarian function of an artifact, the Esteem Value of a tools is the social value that is interpreted. This is separate from prestige, as it is not necessarily wealth, but a culturally accepted symbol which groups identify with. Stylistic additions to clothing or objects which do not impart an increase of stature or hierarchy, but identification or story-telling. These embellishments are isolated to materials and objects which do not require substantial time investment, or the use of rare and difficult to source materials as the value of such items tips the object to a prestige good. Ames and Maschner (1999) discussed in their chapter “Status and Ritual” that prestige and wealth can be measured through analyzing artifact types within a region that are restricted to specific individuals, are constructed from rarer materials, and may have been significantly stylized. Cooper (2012) suggests that materials which distort or reflect light - including copper, shell, minerals, and some stones - can be considered objects with strong social or spiritual value.

Prestige Value

Prestige artifacts are symbols of success and wealth within societies, with ownership restricted to specific individuals. Prestige goods become more apparent within societies as the surplus of resources and labor increases trade and access, or enough control is established to allocate laborers such as slaves or craftsmen to manufacture with time intensive materials (Hayden and Schulting 1997; Hayden 1998). Particularly important materials associated with prestige are nephrite, obsidian, crystalline volcanic rock (CVR), and steatite; all of these materials naturally occur in localized areas. The primary argument for their prestige value is because of the extra effort or cost required to obtain the raw materials or the already completed manufactured item (Ames & Maschner 1999; Darwent 1996).

Ground stone tools also take more effort and time commitment in manufacture, which increases the value of the object (Darwent 1996). Design Theory evaluates the material choices to determine when ground stone tools are no longer utilitarian and can be considered a prestige good (Abadi-Reiss and Schneider 2006). Darwent (1997) makes this argument for nephrite adzes with exaggerated sizes, and Hayden (1998) for time intensive materials which includes nephrite adzes, incised objects, or unusually shaped objects. The extensive manufacture time to create exaggerated or minimal size versions of tools that are not functional to their tools intended tasks becomes the defining difference between the tool's use and prestige value (Darwent 1996; Morin 2012).

Many of the materials previously mentioned are time-intensive for the manufacture of tools and objects, however the visible qualities of a material can become more important than the difficulty to alter or manufacture. Quartz crystal is an example of a material which can be used for prestige, while not necessarily taking much effort to manipulate. Hayden (1998) stated that visual qualities of quartz crystal, to reflect or refract light, makes it a prestige good. However there are many examples of the material being manufactured into a functional tool required for survival (Morin 2004). Due to the dual nature of quartz crystal, it is a material that cannot be classified as prestigious unless the end result of manufacture is of a prestigious item, such as a pendant or an ornate object (Torrence 1990).

Attributes associated with prestige goods include scarcity of the raw material, the amount of time and skill required to craft it, and the limited numbers of the objects in the site (Hayden and Gargett 1988). Objects that display all of these different traits - i.e., high manufacturing costs, rare materials, and limited production - can reasonably be considered prestige items. Hayden and Schulting (1997) note that prestige items identify the elite persons within a society. Wealth can be associated with a class of individuals who can direct or influence the population to acquire a surplus of resources, which in turn can allow the production of more trade goods. As more trade goods are produced, the ability to acquire rarer materials is increased, and allows the development of more specialized tools or prestige objects (Ames and Maschner 1999; Cooper 2012).

The development of criteria for identifying prestige artifacts of all material types in this region has been hampered by differential preservation of stone and organic materials (Ames and Maschner 1999; Hayden and Sculting 1997). Another issue is the binary approach; prestige and utility are perceived as mutually exclusive categories that objects are assigned to. While a material may take a long time to manufacture, such as nephrite or serpentine, the material and tool type combination are the most efficient design that can be used, making the time investment manufacturing cost advantageous within the technology.

Chapter III: Methods

This thesis is based on the analysis of a subsample of lithics originally collected at Čḯxʷicən village (45CA523) in 2004 by Larson Anthropological Archaeological Services (LAAS). The first section of this chapter briefly describes the field work methods at Čḯxʷicən village, particularly how artifacts were recovered and how the sample for this research was selected. I also discuss background preparation for analyzing the collection and how the analysis was conducted at the Burke Museum. Changes to the research protocols and formulation of the research questions occurred in response to the analysis process; these are also described where relevant.

Excavation Methods

Excavations of Čḯxʷicən began in Port Angeles in late April 2004 with the cooperation of LAAS and the Lower Elwha Klalla Tribe (LEKT) (Larson 2004: 4-16). Details of the excavation methods during the project can be found in the report, *Data Recovery Excavation and Archaeological Monitoring at the Tse-whit-zen Site (45CA523)* (Tse-whit-zen is the English transliteration of the site, which has been rewritten to the Clallam spelling of Čḯxʷicən since this publication).

Artifacts were collected in situ or by water screening, then recorded in a brief field catalogue. Artifacts were taken to an on-site lab for initial cataloging; after excavation the artifacts were organized by excavation day and sent to the Burke Museum. The analysis for this thesis did not involve further excavations at the site.

Preliminary Research, Access, and Permission

The Čḯxʷicən village is a large and complex archaeological site, which was excavated in a number of area blocks (Figures 3 and 4 in Chapter 2). I decided to focus this thesis within Area A, specifically Block A4. This focus is due to the ongoing research conducted on Block A4 identifying and analyzing faunal remains, obtaining radiocarbon dates, and defining cultural contexts. I determined that the total number of lithics identified from the excavation catalog was a large enough sample size for my analysis.

The Čḯxʷicən village collection is currently held in trust by the Burke Museum, which has provided the space since the site was excavated. In order to obtain research access to the artifact collection I contacted Laura Phillips, the Archaeology Collections Manager at the Burke Museum. Through her, I sent a request explaining the purpose and objectives of my research plans to the Washington State Department of Transportation (WSDOT), which has ownership over the collection, as well as the LEKT for permission to analyze and publish data regarding the site. An initial investigation of the collection gave me an idea of what types of artifacts and materials I would find, which I used for the development of an artifact classification system.

Analysis Methods

Once I compiled the initial information regarding Block A4's material and artifact types, I created mutually exclusive artifact categories as a basis for my analysis. I considered reports from nearby sites to see what artifacts were being identified to develop my classification system. Once the classification system was designed, I devoted six weeks to analyzing each individual artifact at the Burke Museum. I recorded the attributes, material type, and the metric data of size and weight on acid-free paper with pencil; in addition, I included an artifact classification tag to each artifact bag which included a portion of the classification. The classifications, measurements, attributes, and material types were recorded into a Microsoft Excel Database which I shared with the Burke Museum. The Burke Museum supplemented this project with the artifact bags, acid-free paper, scale, and calipers used in the analysis. I selected examples of both unique and common artifacts to photograph, and illustrated many of them to scale on their individual recording sheet.

At the time I conducted my analysis, 31 artifacts were not available because they were on display in an exhibit at the Elwha Klallam Heritage Training Center in Port Angeles, Washington. After communicating with Laura Philips about this gap in the data, she provided me with a list of all artifacts separated from the main collection for display. This information was taken from the 2004 LAAS field catalog which did not have any further analysis done on the display artifacts. Because of this lack of detailed information, these artifacts were not included in the total numbers for this research or in the recorded measurements.

Artifact Classification:

Artifacts from the Číxʷicən village site were classified using artifact types I developed after evaluating literature on nearby sites on the Olympic Peninsula, specifically the reports from the Hoko River site (Croes 2005), the Sequim Bypass site (Holstine and Gundy 1999), and the Ozette site (Samuels 2006). Artifacts were identified through mutually exclusive object types defined by their manufacturing procedure, morphology, and utilization. These measurements and attributes were defined from previous lithic analyses approaches including works by Andrefsky Jr. (2005; 2006), Flenniken (1981), and Banning (2000). The manufacturing processes used to reduce or shape the artifacts was also documented, as well as descriptive notes on decorations or damage.

The design choices of tools, their material or manufacturing decisions, are important in the analysis of these artifacts. Using examples from the reports from Ozette (Samuels 2006), Sequim Bypass (Holstine and Gundy 1999), and Hoko River (Croes 2005), I compiled a list of common materials used in the area and how they were identified. With that information, I was prepared to analyze the collection and identify materials visually. Several materials were very difficult to identify without testing the material itself and so characteristic labels of coarse grain, medium grain, and fine grain were used. This compromise was made when identifying the three specific lithic materials as the identification of the lithic materials would have required destructive testing.

The identification methods were based on visual appearance and qualities using both my experience from working in archaeological labs as well as from graduate school at Western Washington University (WWU). Lithic samples from the WWU Anthropology Department's archaeology lab were also examined to confirm identification and material structure of artifacts that were difficult to identify. The categories defined below incorporate modification by secondary reduction where applicable. The amount of modification as well as the material chosen are key in understanding whether the tool was manufactured out of expediency or whether it was specialized and required specific materials. Below, I describe the object type definitions and any specific attributes. Measurements from some artifact types are defined by specific landmarks, as described in their categories. For all other objects, length was defined as the greatest dimension, width as the greatest dimension perpendicular to length, and thickness as the greatest dimension perpendicular to both.

Flaked Industries

Tools with flaking as the initial reduction are classified under Flaked Industries.

Flake

Flakes are pieces of stones which have been removed through percussion strikes or applied pressure (Andrewfsky Jr. 2005:12). These can be divided into three subcategories: primary, secondary, and tertiary flakes. Primary flakes are created through initial reduction and have cortex on the entirety of the dorsal surface. Secondary flakes were removed from a primary flake or a core, in which cortex is still visible on the flake. Flakes which have no cortex visible are tertiary flakes. Flakes are manufactured a number of ways, they can be removed from a core or cobble by freehand percussion, through bipolar flaking with a hammerstone and anvilstone, or through pressure flaking with an antler tine (Andrefsky Jr. 2005:28).

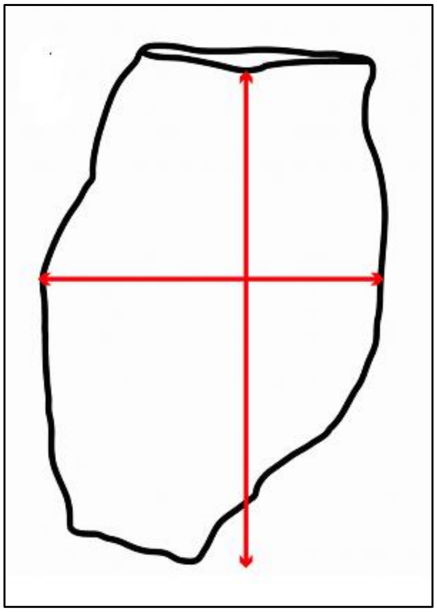


Figure 5: Protocol for measuring flakes with the length measured from the strike platform to the farthest termination, and the width at the widest point. Drawing from Dogandžić et al. (2015:7).

Flake, Modified

Modified flakes are primary, secondary, or tertiary flakes which have had additional flaking or modification by retouching on one or more edges. The modification of the flake is a sign of use which has affected the shape of the flake, which confers a deliberate use beyond flaking, and so it is a specific tool type. These are measured in the same way as flakes, with length measured from the point of impact to the opposite termination.

Scraper

Scrapers are flakes with a crescent shaped distal end created through use wear and unifacial pressure flaking. The proximal end is thin and rounded for hafting. These objects were either hafted or, if large enough, held between fingers (Flenniken 1981). The length of a scraper was measured from the distal use edge to the proximal end, and width and thickness perpendicular to length.

Blade

Blades are a specific sized flake used for cutting and scraping. Blades are long and thin, two times the length of the width. Usually manufactured from specially purposed blade cores, they can also be produced from other core types (Odell 2004:45). Cortex can be either present or absent, with one or both long parallel edges displaying or missing use wear and retouch. Length was measured from the distal tip to the base, width from the widest part perpendicular to the length, and thickness measured at the center of the blade.

Microblade

Microblades are specialized lithic blades, which are usually manufactured to be used as component of a composite tool. Microblades have the same physical traits of blades as they are at least two times longer than they are wide, however they are constricted by their small size; microblades do not exceed two to three centimeters in length (Andrefsky Jr. 2005; Odell 2004). These tools are measured with the length taken down the center from the striking platform, the width perpendicular to the length, and the thickness measured from the center.

Graver

These tools are long slender flakes with grinding and crush wear on one or both ends. Lithics identified as gravers are by the heavily ground distal point of the object, which was used for creating small grooves or incisions on other artifacts and materials. Gravers were measured with length taken from the used distal end, width from the edges, and thickness measured from the center.

Biface

Bifaces are stone artifacts created from flakes, cores, or cobbles by bifacial removal of flakes; many examples have been reduced extensively enough to alter the shape of the original material to reduce the weight, sometimes creating an ovoid or triangular shape as a preform of a future tool (Andrefsky 2005). The manufacture process of a biface begins with a core, which is reduced bifacially to make a thinner object; these thinner flaked objects can be used as a hafted chopping or cutting instrument, and reduced further to a blade or projectile point until exhausted (Andrefsky 2005; 2006). I included both complete bifaces and biface fragments in this category.

Fragments can be recognized by the extensive alteration of a single surface. Bifaces were measured lengthwise down the midline from the two points farthest apart for length, with the width taken at the widest part perpendicular to the determined midline. Fragments were measured from the furthest two points for length, and perpendicular to that for width at the widest point. The thickness was taken from thickest portion of the biface.

Projectile Point

> Projectile points are a subgroup of bifaces, with a distal pointed end opposite to a haft created by tapering or notching. The body or blade of the point can be lanceolate, leaf-shaped, or triangular in shape. These points were attached to a haft, as either a projectile haft such as an arrow or throwing spear, or a handle or hand spear; projectile points have a variability to their manufacture, so that there are numerous styles (Ames & Maschner 1999; Andrefsky 2005). Projectile points were measured lengthwise down the midline, and width was greatest distance perpendicular to length.

Cortex Spall Tool

This object type includes large primary flakes which are ovoid in shape, with a point of impact located at a single lateral end. This distinctive artifact type was identified at the Sequim site by Holstine and Gundy (1999:7.26), who suggested that they were manufactured by striking a discoidal cobble using bipolar reduction with a hammerstone and anvilstone. A split cobble, with the impacted area having a rounded cortex present and the distal edge ending in a feather termination. Morin (2004) and Rousseau (2004) have experimented with the manufacture of these tools as well as their efficiency in processing salmonids; an image from Rousseau's publication can be seen in Figure 6. Dimensions were taken similar to other flakes. Length was measured from the point of impact to the termination edge, with width measured perpendicular to length, and thickness measured at the thickest section.

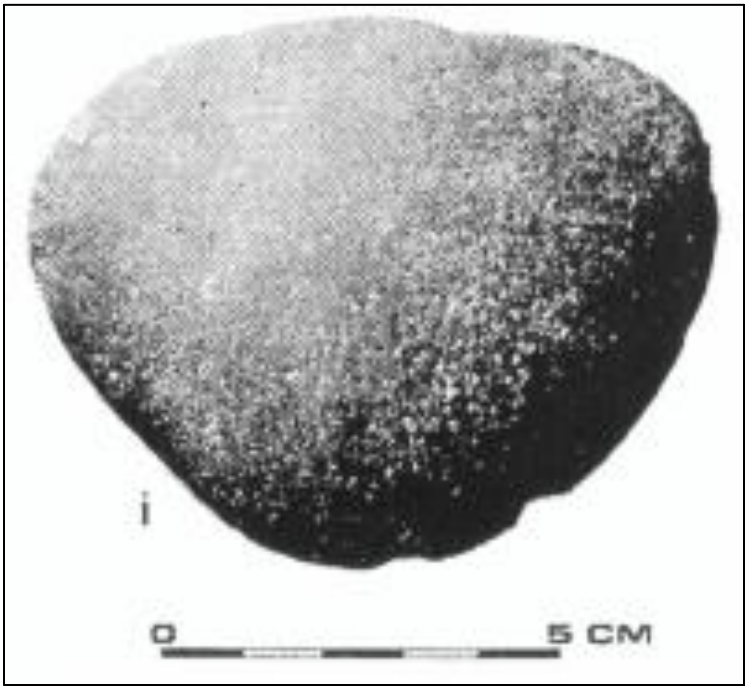


Figure 6: An example of a Cortex Tool from the Mid-Fraser River Region (Rousseau 2004:15, Figure 6i).

Cortex Spall Tools, Retouched

This sub-classification of Cortex Spall tools has a distinct and visible bulb of percussion along one wide edge. They were then further modified by flaking along the thicker edge near the point of impact to round the surface; pressure flaking was used along the width and the distal edge (Figure 7). Further modification also includes grinding along the distal edge from which small portions of cortex occasionally broke off. This wear is likely from use, with the tool being used like a saw. Rousseau determined that these tools were “durable and effective... struck from discoidal cobbles, and are commonly observed at many large fishing-related sites” (2004:26-27).

Figure 7: Cortex Spall Tool, Retouched. Use wear is evident along the bottom edge, with pressure flakes seen along nearly all edges to form the tool into shape.

Core

Cores are the initial material from which flakes are removed, and were defined for this study as having two or more flake scars (negative bulbs of percussion) and no positive bulb of percussion. This is a broad definition which encompasses amorphous, bipolar, and unidirectional cores, depending on the number of areas and angles from which flakes were removed. Dimensions were measured as greatest width, length, and thickness.

Shatter

Shatter consists of fragments created through crushing, flaking, or percussion. They do not have any of the defining attributes of a flake other than relatively smooth surfaces that might be part of a conchoidal fracture. Cortex may or may not be present. No metric dimensions were taken for shatter.

Ground Industries

Tools manufactured by grinding as the initial reduction of material are represented in this category. This includes objects which were sawn into shape and then had a secondary manufacturing process to create a specialized tools and objects. Many of these objects are manufactured into blanks and then further reduced into a finished form, such as adze blanks.

Adze

Adzes are edged tools generally created by grinding. The body has parallel or slightly tapering sides in planar view and is rectangular or sub-rectangular in cross-section. The distal, working end is a sharp edge created by grinding a facet or bevel on one or both faces of the distal point (Mitchell 1971:158-159). The body of the adze is generally ground smooth on all sides, similar in shape to a small cylinder. The proximal end, which is bound to or inserted into a haft, is often not ground and may have rougher surfaces. They often have a remnant groove down the length of the artifact from being sawed off a larger parent block, an example of this groove can be seen on the adze in Figure 8. Adzes are predominantly manufactured from tough, cohesive materials that can withstand heavy blows, such as jadeite, nephrite, and serpentine. They are seldom found attached to a haft. Length was measured from the distal beveled edge to the proximal end, and width measured perpendicular to length, and thickness at the middle of the object.

Figure 8: Nephrite adze with saw and snap and distal edge damage.

Fishhook Shank

Fishhook shanks are stone tools which have been ground on every surface to create a specialized composite tool. The proximal end has at least one ground notch for tying a line; the distal end has a smooth, rounded groove at a diagonal angle away from the body with one or more thin grooves perpendicular to assist in lashing a bone barb. An example can be seen in Figure 9.

Figure 9: Two examples from the Royal BC Museum which have a similar proximal end to one sample in the collection (Lynn 2013:6, Fig 5)

Maul

Mauls are symmetrical, cylindrical hand held percussion tools with a flared base and a variable top. Mauls are made of dense cohesive stone, examples being nephrite, dacite, or andesite. The sides, base and top are ground smooth, although initial shaping by pecking is sometimes still evident in the form of pit remnants deeper than the ground plane. Maul shapes can vary, but many examples have a shaft that is ground down leading to a flared base, which can be either circular or have symmetrical designs. Stewart illustrates some of the variety of mauls, see reproduction in Figure 10. The proximal section of the maul can have a variety of different designs which can include spirals, nipple-top, an anthropomorphic or zoomorphic form, or a ring. Length was measured from the distal flat surface to the proximal end and width as the diameter of the base of the maul. Thickness was measured at the center of the handle.

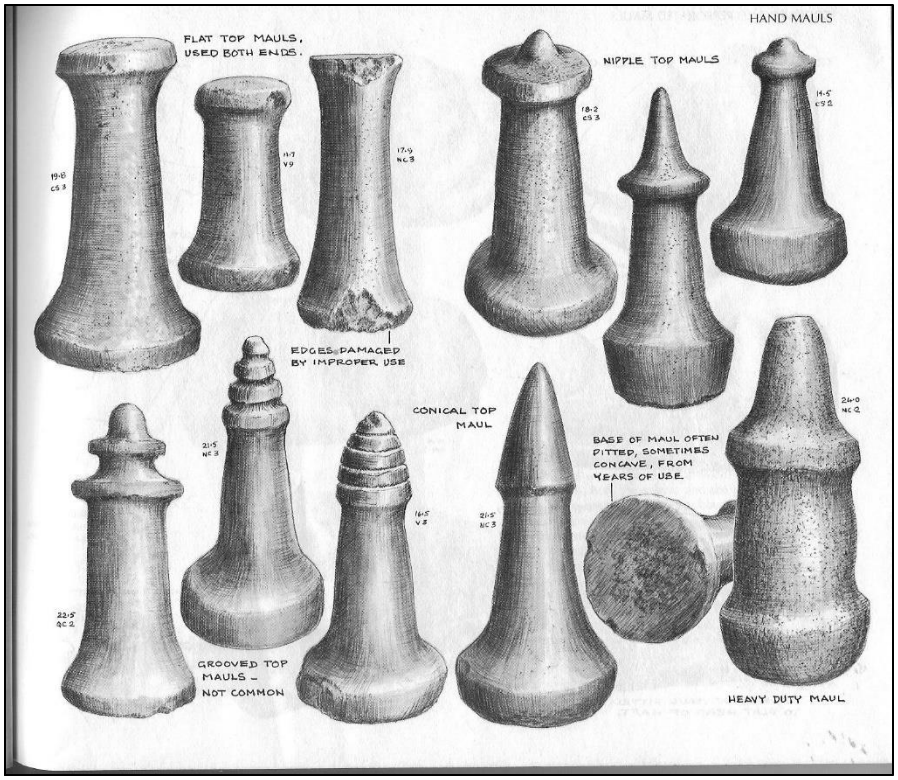


Figure 10: Illustration of different stylized mauls from Stewart (1973:53).

Pigment Bowl

A pigment bowl is a rounded stone with a round or oval concavity on one surface with visible remnants of ochre or other coloring material. Pigment bowls were measured with the painted cavity facing up. Length was measured as the greatest dimension in that plane, width perpendicular to length, and thickness measured from the rim of the cavity to the bottom of the stone.

Stone Bead

This artifact type is comprised of small, rounded cylindrical or spherical stones, which have been perforated with a circular hole made by pecking and/or drilling. The hole is used as the length measurement, with the width and thickness measured around the circumference. If the bead is not a perfect circle, the measurements are taken with the widest part for width, and the thickness measured perpendicularly.

Slate Blade

These tools are manufactured from slate blanks, which are then ground on both broad faces to create a thin straight profile with one long side or parallel edge ground to a beveled edge (Morin 2004). Slate blades were measured with the length taken parallel to the long beveled edge, width taken perpendicular to length, while thickness was the greatest dimension perpendicular to both.

Base Object Industry

This classification includes artifacts that were used or modified in their natural form without any primary reduction. A base object is the natural cobble or stone with evidence of use, such as battering wear on a hammerstone. Incised stones are included in this industry because, although they involve deliberate manufacturing processes to create the designs, they are based on natural cobbles modified only by incision of the surface.

Abrader

This category represents stone tools on which either a single broad surface or both faces have grinding striations or surfaces that have been flattened or made concave from use. The purpose of these tools is to manufacture other objects made of bone, antler, shell, or stone (Croes 2005; Morin 2004). The length of an abrader is measured from the farthest two points width was measured perpendicular to the length, and thickness was measured at the center of the tool.

Anvilstone

Anvilstones are large, heavy stones which have evidence of percussion impacts in the center of the broadest surface. These were used as part of the bipolar reduction of objects; the anvilstone was the base upon which objects were struck by a hammerstone. The weight was measured with the digital scale when possible, but some specimens exceeded the capacity of the scale and were recorded as 2,000+ grams.

Hammerstone

This category includes rounded cobbles of dense material, consistently sized to be hand-held, with percussion evidence on at least one surfaces. This tool type was utilized for manufacturing flakes either freehand or in tandem with an anvilstone during bipolar reduction. Hammerstones are also used to break down bones, process other organic materials, and reduced or blend pigments. Hammerstones were measured lengthwise from the used distal end to the opposite end, width was measured perpendicular to the length, and thickness was measured at the midline of the tool.

Incised Stone

Incised stones are naturally discoidal cobbles with incisions ground into one or both flat surfaces of the stone. The incisions may cover part or the entirety of a surface (Figure 11). These incisions ranged from being deep and quickly recognizable to shallow and faint patterns that were only detectable by holding the stone up to a bright light at a range of angles. Designs range from clearly anthropomorphic imagery, to abstract combinations of lines. Length was defined as the greatest dimensions, width was measured perpendicular to length, and thickness was measured at the center of the object.

Figure 11: An example of an incised stone taken for the Seattle Times from a blog written by Q. Mackie (2010).

Net Sinker

Net sinkers are oval or disc-shaped stones which have grooves or holes to provide a means of suspension. They were often used to sink fishing nets and were connected with fibrous ropes. Net sinkers can have grooves, notches, flaked or pecked on both long ends (Figure 12), but could also have notches on all four sides. The length of a net sinker was measured from furthest notch to notch, with width measured perpendicularly to length, and thickness at the center.

Figure 12: Net Sinker from Block A4.

Painted Stone

These artifacts fit in the base industry in that they have no reduction, however they have a combination of other materials on a single object. Because there only four specimens I did not define a separate additive industry.

Painted stones are natural discoidal stones with no modification other than designs painted on one or both flat surfaces with mineral pigments. Myron Eels (1889:42) noted when writing about the Clallam of the Olympic Peninsula, that ochre was the primary paint but was also mixed with other materials to change the color of the pigment. Length was measured between the two farthest points, width was measured at the greatest width perpendicular to the length, and thickness was measured at the center.

Photographs

After I had completed classifying and measuring the samples from Block A4, I photographed examples of several artifacts. I used the camera provided by the Burke Museum, a Nikon D5100 with a Nikon DX AF-S NIKKOR 18-55 mm lens. This was mounted to a camera platform (Figure 13), with either a centimeter or millimeter scale, depending on the size of the object, and the artifact's identification tag. Each artifact was photographed two to four times at different sides and angles to establish good lighting and to show visible features. In this thesis, I have also used some photographs taken during excavation that show artifacts *in situ*.

Analysis of Additional Blocks

In order to better understand the artifact and material types of Block A4, I decided to expand my analysis to additional blocks selected from those being studied in the National Science Foundation (NSF) project. I used the catalogue entries to determine the sample size from each of the blocks and ultimately chose Blocks A3, A18, and A23, each of which represented extramural activity areas. These three blocks yielded 239 artifacts in total. I focused on the classification, modification, and material

Figure 13: Artifact photography table layout with camera stand and lights.

type of the artifacts and did not take size measurements for any specimens. All of the data was directly entered into Microsoft Excel files rather than creating artifact cards as I had done for A4.

X-Ray Fluorescence Testing

Certain materials are unique in their chemical composition and can be matched to a particular geologic source; obsidian falls into this category. Block A4 had two obsidian flakes and Block A3 had a fragmented biface and I added sourcing of these objects to my analysis. I used an X-Ray Fluorescence (XRF) machine, specifically a Micro X-Ray Fluorescence (µXRF) version which takes the measurement of elements from specific micrometer-sized points on the sample and then averages the separate points into a single, precise measurement of elements within a sample (Kanngieβer & Haschke 2007). XRF is a method of elemental analysis where a sample is tested with an electric beam made of high energy, causing it to emit a characteristic wavelength that is used to identify the number of photons in the sample. By analyzing the number of photons, it is possible to detect present elements and their concentration, which is described in Figure 14 (Guthrie & Ferguson 2012).

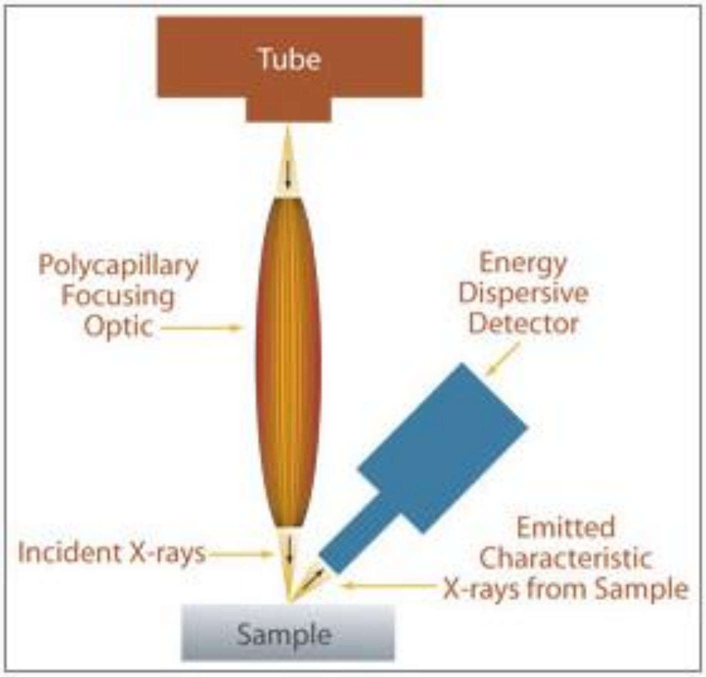


Figure 14: Illustration of the standard setup for a Micro X-Ray Fluorescence Spectrometry (XOS 2016)

The two obsidian flakes from Block A4 as well as the obsidian biface from Block A3 underwent XRF testing at the University of Washington’s Materials Science and Engineering department under the care of Tuesday Kuykendall, Jack Johnson from the Burke, and myself. The three samples were individually placed in a Bruke M4 Tornado Micro X-Ray Fluorescence (µXRF) machine. Tuesday Kuykendall conducted the analysis, which focused on particular trace elements, while Jack Johnson and I observed. The obsidian samples were examined with the µXRF individually, which used a series of five separate spectra, focused for 60 seconds each, on each obsidian artifact. The spectrums focus was set at 50 kilovolts and 700µA (microampere) using normal concentrations. Results were sent to Craig Skinner of Northwest Research Obsidian Studies Laboratory in Corvallis, Oregon, to compare to his samples and database.

Chapter IV: Results

In this chapter, I present the results of my artifact analysis. I have broken the artifact types into industries which, in some cases, is further described by material type. The Block A4 artifacts were the primary focus of research, and the results of the analysis of artifacts from Blocks A3, A18, and A23 provide contrasts and extend evidence of artifact and material diversity. Table 1 shows the total numbers from all four blocks analyzed for this thesis. My original request to the Burke Museum was for 1,099 recorded artifacts in the catalog, later expanded to the 1,315 specimens from all four sample areas. Some of the objects were excluded from the analysis while other entries included multiple items, resulting in analysis of 1,754 objects.

Table 1: Sample sizes by block.

Block	Block A4	Block A3	Block A18	Block A23	Totals
Number of Catalog Entries	1,099	119	82	15	1,315
Number of artifacts Analyzed	1,515	117	107	15	1,754
Artifacts not Available	31	1	0	0	32
Specimens excluded	48	0	0	0	48

Table 2 shows the total numbers by their industry and block, with artifacts separated by classification. The assemblage from Block A4 is significantly larger than the other three blocks that were analyzed, and has more diversity in artifact types as would be expected from a larger sample size.

Table 2: Total artifact counts by industry and block

Industry	Artifact Classification	Block A4	Block A3	Block A18	Block A23	Total:
Flake Industry (n=1,364)	Flake	898	31	67	5	1001
	- Blade	6				6
	- Graver	14		1		15
	- Scraper	1				1
	Biface	6	2			8
	- Projectile Point	4	3			7
	Cortex Spall Tool	219	5		2	226
	- Cortex Spall Tool, Retouched	29	13	4		46
	Core	40	3	2		45
	Microblade	8				8
Ground Industry (n=14)	Adze	3	1			4
	Fishhook Shank	2				2
	Maul	2				2
	Pigment Bowl	1				1
	Projectile Point	1				1
	Slate Blade	3	1			4
	Stone Bead	1				1
Base Object Industry (n=260)	Anvilstone	2				2
	Hammerstone	5		1	1	7
	Incised Stone	146	35	24	1	206
	Net Sinker	5	3			8
	Painted Stone	4	1			5
	Abrader	24	7	1		32
	Total:	1,424	105	100	9	1,638

The tool variation identified at Čı̓́xʷicən village represents three different industries, and the materials represented in these tool types are important in relation to their design. Table 3 breaks down the classification by material choice, exemplifying the diversity in some materials and the concentration of others. As will be discussed below, manufacturers focused on what materials were readily available for quick and expedient manufacture; rarer and more difficult materials were manufactured with care and retouched to extend their usefulness, resulting by having less material represented. The rarer materials, obsidian (3) and CCS (14), have almost no debitage; the tools manufactured from these materials were only flaked, and most of the examples are exhausted. More readily available materials including quartz crystal (892), fine grained (259), and coarse grained (223) were the most common materials, and were used as the material of choice for multiple tools. The quartz crystal was only used with flaked industry tools, while the fine and coarse grained materials were used in all three industries.

Table 3: Material types by industry and artifact type, all blocks combined.

Industry	Artifact Classification	CCS	Coarse Grain	Fine Grain	Medium Grain*	Mudstone	Nephrite	Obsidian	Quartz	Quartz Crystal	Sandstone	Siltstone	Slate	Total
Flake Industry	Flake	3	54	30	50			2	5	854		1	2	1,001
	- Blade									6				6
	- Graver									15				15
	- Scraper									1				1
	Biface	3						1						4
	- Projectile Point	2		1	4									7
	Cortex Spall Tool		137	10	78									225
	- Cortex Spall Tool, Retouched		18		25									43
	Core		6	11	20					8				45
	Microblade									8				8
Ground Industry	Adze						4							4
	Fishhook Shank			2										2
	Maul				2									2
	Pigment Bowl			1										1
	Projectile Point												1	1
	Slate Blade												4	4
	Stone Bead			1										1
Base Object Industry	Abrader		2	4	4	4					14	4		32
	Anvilstone		1		1									2
	Hammerstone		4	2	1									7
	Incised Stone	6		191	2						6	1		206
	Net Sinker		1	2	4						1			8
	Painted Stone			4							1			5
	Total:	14	223	259	182	4	4	3		892	22	6	6	1,638

*Includes crystalline volcanic rock (CVR)

Flaked Industries

Flaked tools and their byproducts dominate the assemblage in the blocks analyzed. The percentage of flaked industry was greater in Block A4 than the other three blocks, making up 1,226 of the 1,424 stone artifacts (81%) while Block A18 totaled 69% of the collection, 49% in Block A3, and 46.7% in Block A23 (Table 4). In the following section, I describe several industries distinguishable by use of a specific material, such as quartz crystal or obsidian, or by the goal of producing a specific finished tool type.

Table 4: Flaked lithic totals, including percentages of flaked tools to total lithics by each block.

Artifact Classification	Block A4	Block A3	Block A18	Block A23	Totals
Flake	898 (59%)	31 (26%)	67 (63%)	5 (33.3%)	1,001
- Blade	6 (0.4%)				6
- Graver	14 (0.9%)		1 (0.9%)		15
- Scraper	1				1
Biface	6 (0.4%)	2 (1.7%)			8
- Projectile Point	5 (0.3%)	3 (2.6%)			8
Cortex Spall Tool	219 (14.5%)	5 (4.3%)		2 (13.3%)	226
- Cortex Spall Tool, Retouched	29 (1.9%)	13 (11%)	4 (3.7%)		36
Core	40 (2.6%)	3 (2.7%)	2 (1.9%)		45
Microblade	8 (0.5%)				8
Totals	1,226 (81%)	57 (49%)	74 (69%)	7 (46.7%)	1,364

Flaked Quartz Crystal Artifacts

Quartz Crystal (QC) represents the most abundant material in Block A4, and 86% of all flakes. Tertiary flakes account for the majority of QC flakes, though there is still a significant number of primary and secondary flakes (Table 5). The presence of primary, secondary, and tertiary quartz crystal flakes suggests that initial reduction and continual processing was being conducted at the site.

Table 5: Flakes by material and type in Block A4.

Material	Primary	Secondary	Tertiary	Total
CCS			2	2
Coarse Grain	24	19	3	46
Fine Grain	8	16	3	27
Medium Grain	23	15		38
Obsidian			2	2
Quartz Crystal	117	154	503	774
Quartz	3	2		5
Siltstone		2		2
Slate	1		1	2
Totals:	176	208	514	898

The quartz crystal flakes analyzed from the Čḯxʷicən village have a roughened, weathered cortex, with no specimens displaying the original prismatic form and growth faces of the euhedral crystals. Quartz crystal in its natural prismatic form can be found in the Olympic Mountain range. The presence of water-worn QC cortex infers that the Čḯxʷicən inhabitants were collecting water-transported nodules that began as euhedral crystals in the mountains and were roughened and rounded on their journey to the coast down the Elwha River and other streams (Figure 15). Flakes fell into a narrow specific size range, as seen in Figure 16. This is due to the small size of the original nodules which were subsequently flaked through bipolar percussion. No examples showed the natural crystalline surfaces on any of the primary or secondary flakes. All of the samples also exhibited less clarity than euhedral crystals due to multiple internal fractures. This interior structure may have resulted in part from the bipolar reduction fracturing the interior of the lithic.

Figure 15: Quartz crystal flakes from Block A4. The sample on the left has the weather-worn cortex that was present throughout the collection.

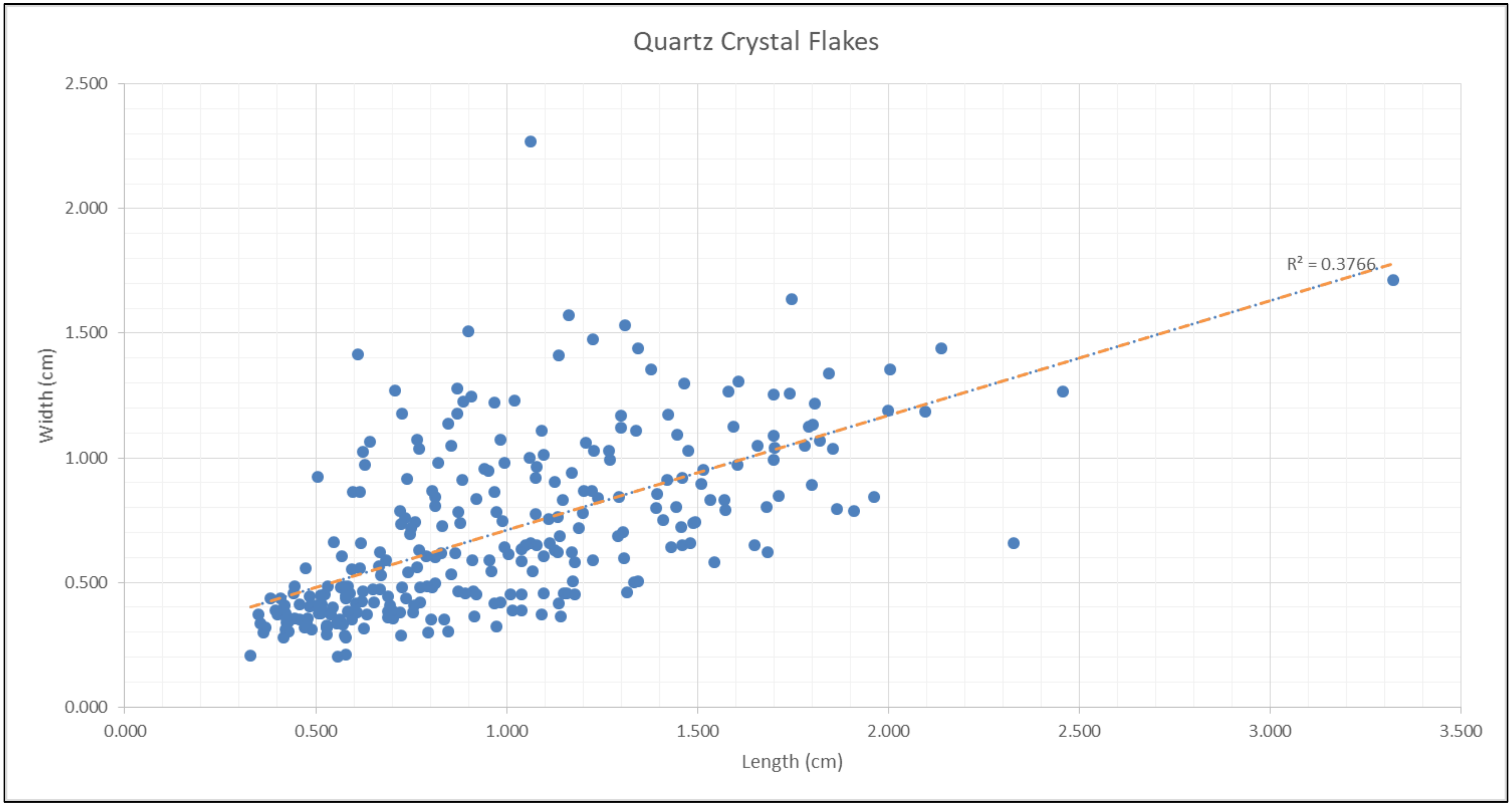


Figure 16: Scatter plot of Quartz Crystal Length versus Width (N=775).

The people of Čḯxʷicən used bipolar flaking of quartz crystal to produce a number of tools. Bipolar reduction of the water worn nodules would have limited the control of manufacturing and size of resulting flakes, four different products were being manufactured: bifacially formed points, gravers, blades, and microblades. These are likely the intended tools, while modified flakes were the result of manufacturers trying to repurpose flakes into a usable form. Scrapers may have also been an intended tool, however the lack of representation suggests it may be manufactured when the opportunity arose instead of purposeful.

Four bifaces (points) manufactured from quartz crystal were identified. In each case, uniform retouch along two or three edges created a triangular plan shape coming to a point. The measurements of these specimens are available in Table 6. These were likely one of the desired shapes from the bipolar reduction technique was being used to manufacture.

Table 6: Quartz crystal biface measurements.

Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-14268.02.04.02	1.47	0.70	0.44	0.20
WS-14701.01.01	1.12	0.51	0.23	0.05
WS-15898.01.07.01	0.99	0.83	0.26	0.10
WS-2425.02.02	1.75	0.95	0.43	0.60

A total of fourteen gravers were identified in Block A4. Cortex was present on four of these, and all had visible crushing and grinding wear on long edges or at the ends. The gravers show the same internally fractured matrix that the flakes exhibited from bipolar reduction. Table 7 shows the dimensions from the Block A4 gravers. There was also a single graver identified from Block A18, with one end ground down from use.

Table 7: Quartz crystal graver dimensions.

	Gravers N=14			
	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
Mean	1.51	0.73	0.42	0.5
Median	1.67	0.77	0.40	0.35
SD	0.42	0.19	0.19	0.34

Six quartz crystal blades were identified, two of which still had cortex visible. These are all midsection fragments with one feathered lateral margin while the opposite margin was stepped. In some cases the feathered margin exhibited retouch. It is not clear if this was purposeful, a sign of exhaustion, or from excavation.

Eight microblades were identified in the Block A4 assemblage. These are important in the creation of composite tools, attaching the blades to antler or wooden shafts. No sample had any evidence of a residue or resin.

A single quartz crystal scraper was also identified from Block A4. The scraper has no cortex present. One edge has been unifacially flaked into a crescent shape, with the retouch coming from the ventral face. It is 1.23 cm long, 1.47 cm wide, and 0.29 cm thick with a total weight of 0.7 grams.

Eight of the 40 cores analyzed from Block A4 were manufactured from quartz crystal. These cores included three bipolar/blade type cores, and five amorphous cores which had been split in half and flaked similarly to a microblade core until exhausted. Figure 17 is an example of one of the bipolar cores identified in the collection, with the dorsal surface having worn cortex present. The mean measurements of the quartz crystal cores are 1.4 cm in length, 0.86 cm in weidth, 0.56 cm thick, and a weight of 0.78 grams.

Tse-whit-zen Site – 45CA523
Lithic Analysis, Area A4
Cat.#: WS-13308.02.07
Unit: 29 **Strat:** 5 **Level:** 3
ID: Core

Figure 17. Sample of a quartz crystal core from Block A4. The reverse side is a rounded cortical surface.

The tool types manufactured from quartz crystal (QC) are small in size (Table 8), a result from both the bipolar reduction manufacturing and the small size of the starting material. As seen on Table 8, the tools manufactured from QC were larger than the average size of the flake debitage. After the original QC nodules were bipolarly reduced, the largest materials were selected and further modified into tools.

Table 8: Average size for all QC artifacts.

Artifact	Total	Length (cm)/SD	Width (cm)/SD	Thickness (cm)/SD	Weight (g)/SD
Blade	6	1.56 / 0.66	0.88 / 0.25	0.3 / 0.11	0.49 / 0.52
Core	8	1.4 / 0.55	0.86 / 0.3	0.56 / 0.21	0.78 / 0.68
Graver	14	1.51 / 0.42	0.73 / 0.19	0.42 / 0.19	0.5 / 0.5
Microblade	8	1.13 / 0.43	0.59 / 0.12	0.21 / 0.06	0.07 / 0.1
Point	4	1.33 / 0.35	0.75 / 0.19	0.34 / 0.11	0.24 / 0.25
Scraper	1	1.23	1.47	0.29	0.7
Flake	774	1.03 / 0.5	0.76 / 0.43	0.31 / 0.35	0.27 / 0.58

Obsidian

Three obsidian artifacts were recovered from the four blocks analyzed; two tertiary flakes from Block A4 and a biface fragment from Block A3. These three artifacts were subjected to compositional analysis in addition to morphological classification and measurement.

The obsidian artifacts from Block A4 were complete tertiary thinning flakes, that ended with feather terminations. Table 9 displays the dimensions of the flakes. The obsidian artifact from Block A3, A3-2.01.01, is a distal fragment of a late stage obsidian biface, with sub-parallel flake scars covering the entirety of the specimen. There is no cortex present. Retouch has formed a point at one end while the opposite end has been been broken off.

Table 9: Obsidian flake measurements.

Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-13688.01.09	0.55	0.26	0.06	0.01
WS-1928.01.09	0.71	0.68	0.1	0.01

Micro X-Ray Fluorescence Results

The scans made on the µXRF machine are presented in Appendix I of this thesis. Scanning was not successful for the two obsidian flakes from Block A4 as they are so thin that diffraction occurred. The scanning results were sent to Craig Skinner of Northwest Research Obsidian Studies Lab (NROSL) in Corvallis, Oregon for his interpretation. Skinner attempted to match the µXRF data to his library but the differences between the data produced by the University of Washington's µXRF and the Handheld XRF at NROSL made the comparison inconclusive. After receiving permission from WSDOT, the Burke Museum delivered the three obsidian specimens to Craig Skinner to be tested with the Handheld XRF at NROSL. He determined that all three obsidian samples came from the Glass Buttes Source Complex in central Oregon. The two tertiary flakes are from Glass Butte 1, and the biface material is from Glass Butte 3 (see report from Skinner, Appendix II).

CCS

Crypto-crystalline silicate (CCS) material was rare in the assemblage, represented by only six objects: three biface fragments, two projectile points, and two tertiary flakes. The measurements for all of the CCS artifacts are listed in Table 10. The two small CCS tertiary flakes are likely debitage from tool retouch due to their size. The two bifaces may have been originally projectile points or some larger object, but both were exhausted with sheared portions missing.

Table 10: CCS biface, flake, and projectile point measurements.

Catalog #	Classification	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
A4-141.01.01	Biface	2.02	1.46	0.61	1.90
WS-15736.02.04	Biface	1.48	0.51	0.31	0.30
WS-12287.01.01	Flake	0.85	0.515	0.221	0.01
WS-9708.01.01	Flake	0.505	0.611	0.080	0.01
A4-502.01.01	Projectile Point	7.92	3.78	0.84	25.40
WS-349.02.01	Projectile Point	1.98	1.24	0.39	0.83

Two fragmented sections of bifaces manufactured from CCS were identified in the A4 assemblage. A4-141.01.01 appears to be a fragment from the lateral portion of a completed biface with a convex edge, while WS-15736.02.04 is a medial fragment with flake scars emanating from both edges. There are also two CCS projectile points in Block A4. A4-502.01.01 was bifacially flaked, and is leaf-shaped with the proximal end reduced to be thinner than the medial portion (Figure 18). A4-502.01.01 resembles projectile points identified by Carlson (2008:137-138) as a Type Ic Medium-sized Foliate Point with Straight Base, as seen in his Figure 6:j. The second projectile point, WS-349.02.01, was bifacially flaked from both edges, with offset shoulders and with the thickness of the point decreasing as you measure closer to the point. A single CCS biface was identified from Block A3. Specimen A3-78.01.01 is a medial fragment with evidence of thinning flake patterns generating from the edges. Both ends are broken off. All of these bifaces are end products, with the fragmented specimen’s likely coming from a shattered projectile point or similar object. Block A3 also had a single CCS flake: a small tertiary flake which is most likely debitage from tool retouch.

Figure 18. Projectile Point from Block A4. Identified as a Type Ic Medium-sized Foliate Point with Straight Base (Carlson 2008:137).

Crystalline Volcanic Rock

Crystalline Volcanic Rock (CVR) was not originally recognized in the material collection and was counted as a medium grain material. Recognition that there were four projectile points, probably dacite, prompted a reevaluation of how this material was treated distinctly. Two flakes manufactured from CVR (not shown seperately in Table 3) are both small tertiary fragments, and were likely retouch modifications to the CVR projectile points. Three amorphous CVR cores are described later in the chapter.

There are also three projectile points manufactured from CVR, all complete. The CVR projectile points each have a distinct plan shape and resemble different point types defined by Carlson (2008) for the Gulf and San Juan Islands. The first point, WS-7235.01.01, resembles a Type IVa Barbed with Contracting Stem shown in his Figure 10:g (2008: 142). Type Iva has been found in contexts ranging from over 3,000 years to a little over 1000 years in age. Unfortunately, the Čḯxwicən specimen was recovered from overburden. WS-794.06.01 is an unstemmed triangular point with an asymmetrical base. It resembles examples of Carlson’s Type VIa (specifically specimens aa and hh in Figure 14). This type, which he terms triangular, un-barbed, un-notched with variable base, has been found in multiple sites in contexts dating from 1800 years ago and later. The Čḯxwicən specimen was found in deposits assigned to CZ7, post-dating 300 years ago. The third specimen, WS-9253.04.01, was found in association with a house floor in Block A4 dated to CZ4 (1300 to 1000 BP). It has a rounded convex base that is wider than the blade, forming an inverse shoulder, and it does not resemble any of Carlson’s types. It is possible that this tool was reworked from a broken foliate point that had a converging stem, and that the orientation was reversed. The dimensions are shown in order on Table 11.

Table 11: CVR projectile point measurements at Block A4.

Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-7235.01.01	1.78	1.00	0.35	0.42
WS-794.06.01	3.64	1.78	0.66	3.30
WS-9253.04.01	5.39	3.46	1.17	18.60

Flakes

The remaining flaked products are manufactured from a variety of igneous and metasedimentary rocks that cannot be identified easily in hand specimens. Therefore, they were categorized as fine, coarse, and medium-grained material as previously shown in Table 5. Unlike obsidian or quartz crystal, it was harder to identify whether any one of these materials represents a specific industry in the sense of material selection and working it in predictable ways. They are discussed together here to facilitate recognizing opportunistic and patterned usage. Table 12 displays the different artifacts types manufactured from non QC, CCS, or obsidian material; these materials were utilized to create a different tool set than the higher quality flaking material.

Table 12: Flaked industry by other material from all blocks analyzed.

Artifact Classification	Coarse Grain	Fine Grain	Medium Grain	Siltstone	Slate	Total
Flake	54	30	41	1	2	128
- Blade						
- Graver						
- Scraper						
Biface						
- Projectile Point		1	4			5
Cortex Spall Tool	137	10	78			225
- Cortex Spall Tool, Retouched	18		25			43
Core	6	11	20			37
Microblade						
Total	215	52	168	1	2	438

Flakes from materials other than quartz crystal, obsidian, and CCS occur in all four blocks. The fine and medium grained material was occasionally of a quality allowing for the production of bifaces; however the main product being manfuactured from from these materials were cortex spall tools. Flakes of coarse, medium, and fine grained materials are likely debitage from the manufacture of cortex spall tools. The debitage was likely created through bipolar reduction which sheared off a portion of the rock; the resulting flakes are similar in size to the flakes selected to be used as cortex spall tools (Table 13). I did not identify any flakes that could be attributed to retouching the cortex spall tools. There are two small slate flakes, both secondary, these may have been the result of shaping slate material before grinding manufacture. The siltstone flake may not have been an intentional flake.

Table 13: Average flake size for coarse, medium, and fine grain materials. This includes primary, secondary, and tertiary flakes.

Material	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)	σ (L,W,T)
Coarse Grain (N=46)	6.641	7.864	1.552	124.31	3.48
Medium Grain (N=36)	6.662	7.269	1.373	92.27	3.22
Fine Grain (N=27)	4.531	2.767	0.753	22.58	2.53

Modified Flakes

There are a number of flakes from all three materials which show signs of further use (N=18). These were not shown separately in previous tables. While these flakes may not have been intentionally created for use, the size was suitable for certain tasks such as cutting, scraping, or sawing. Modifications include retouch from flaking as well as grinding wear along the edges. All but three of the flakes from these three materials have cortex present.

Cortex Spall Tools

Cortex spall tools seem to have been the primary tools manufactured from beach cobbles, which were present along the shoreline. They appear to be large flakes removed from dischoidal cobbles by bipolar flaking. They lack obvious bulbs of percussion and the point of impact is not clearly evident. Table 14 breaks down the total number of cortex spall tools by their material and size and wether they had been retouched.

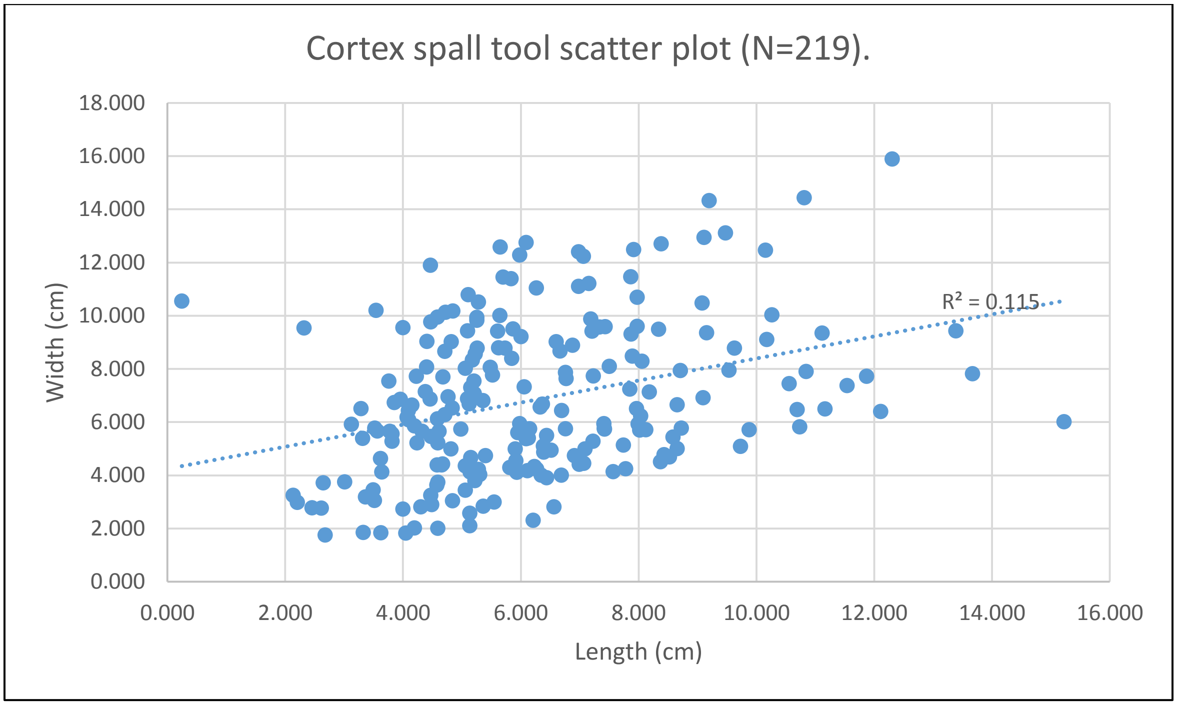
Some cortex spall tools have been retouched on the proximal flake edge; I believe this retouch was to create a crescent shaped handle which was also the proximal end of the tool. The opposite end, which is the distal feather termination of the original primary flake, is also the distal end of the tool (Figure 19). This is demonstrated because of microflaking visible along the edge. The 29 retouched specimens were medium and coarse grain materials; there were no fine grain examples. Based on my observations of the flake morphology it is likely that the flakes chosen for the retouch varient were flakes that had been produced from impact on a long edge of a discoidal cobble rathern than the narrower end.

Figure 19: Cortex spall tool, retouched, with microweare along distal feather edge. Retouch for handle is evident on proximal edge.

Table 14: Average size of cortex spall tools and retouched spall tools comprising of coarse, medium, and fine-grain materials. Retouched versions are the second measurement in each material group.

Coarse Grain: 153 Specimens			
Length (cm) / SD	Width (cm) / SD	Thickness (cm) / SD	Weight (g) / SD
6.42 / 2.23	7.46 / 2.90	1.66 / 1.92	99.07 / 103.11
7.61 / 1.68	9.59 / 2.98	2.01 / 1.43	169.55 / 131.63
Medium Grain: 82 Specimens			
Length (cm) / SD	Width (cm) / SD	Thickness (cm) / SD	Weight (g) / SD
6.63 / 2.66	7.11 / 2.74	1.38 / 0.65	94.07 / 84.06
7.02 / 1.72	9.28 / 1.98	1.48 / 0.63	137.14 / 97.50
Fine Grain: 10 Specimens			
Length (cm) / SD	Width (cm) / SD	Thickness (cm) / SD	Weight (g) / SD
5.36 / 2.30	6.04 / 2.19	1.03 / 0.26	37.97 / 22.21
N/A	N/A	N/A	N/A

As mentioned above primary reduction to create the tools appears to have been done in two different ways: typical cortex spall tools were reduced with the initial percussion strike at the narrow end of an oval cobble, while the retouched variant appears to have initial percussion on the wider edge of an oval cobble. Figure 20 is two scatter plots showing the length and width measurments of all the cortex spall tools and retouched variants. There is a statistically reliable difference between the archetypal cortex spall tool and the retouched ($p < 0.01$).



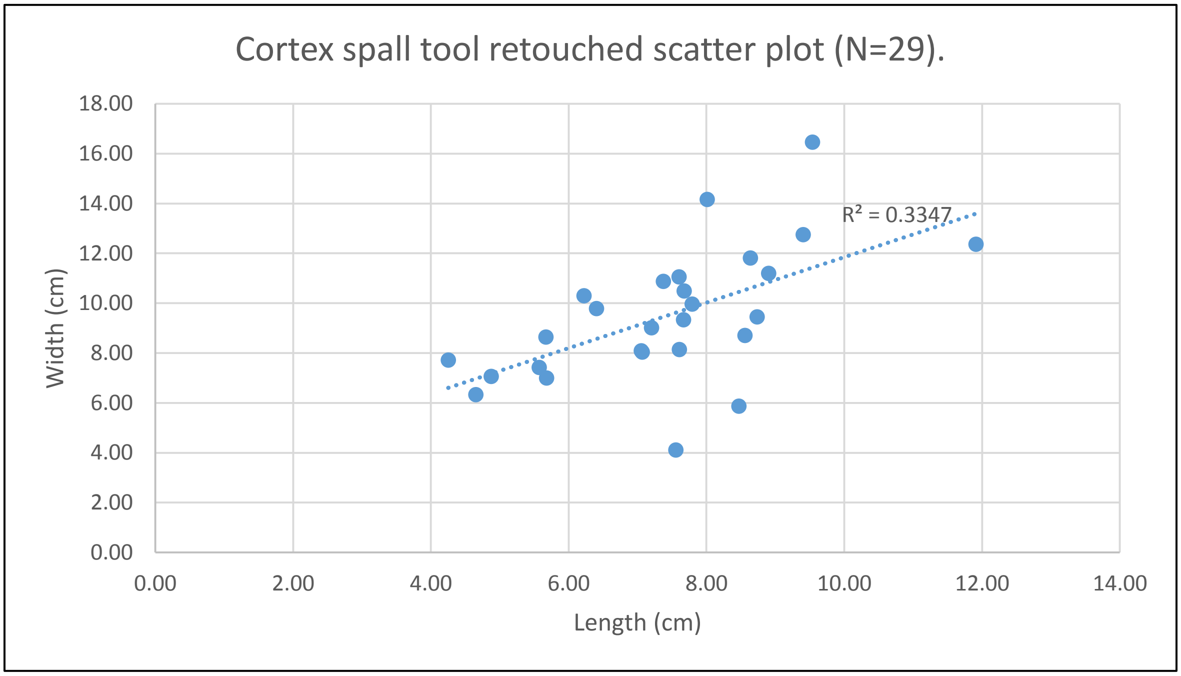


Figure 20: The top chart shows cortex spall tool measurements with the trend line suggesting a preferred size ratio (N=219). The bottom chart shows measurements for the cortex spall tool retouched with the corresponding trend line suggesting the desired shape (N=29).

Cores

The 45 cores identified in the assemblage comprise a variety of different materials. As stated previously, there were eight QC cores identified and three CVR. Cores of coarse (6), medium (13), and fine (10) grain materials, exibited very similar manufacturing as described below. All of the the sizes are shown in Table 15.

There are six coarse grain and thirteen medium grain cores from Block A4. All six have signs of initial bipolar reduction followed by further free-hand. These cores are oval in plan and disc in profile. The cores share the same size qualities as the previously mentioned cortex spall tools, but were used for further flake production. The ten fine grain cores also show evidence of bipolar reduction, but only two were further modified as described above. The fine grain cores tended smaller than the coarse and medium grained cores.

Three cores produced from CVR have cortex present on many sides. The intial reduction was bipolar, with flakes taken off the sides strategically for largest flake.

Table 15: Average core measurements.

Material	Length (cm) / SD	Width (cm) / SD	Thickness (cm) / SD	Weight (g) / SD
Coare grain	15.55 / 6.27	10.08 / 4.69	3.49 / 1.87	869.52 / 588.17
Medium grain	13.68 / 5.84	10.59 / 4.64	3.87 / 1.83	787.87 / 573.16
Fine grain	9.36 / 4.06	6.44 / 3.38	2.51 / 1.66	301.82 / 473.17
CVR	6.28 / 1.92	4.72 / 0.69	2.35 / 1.24	67.93 / 55.5

Ground Stone Industry

Ground stone artifacts make up a smaller total number than either the flaked or base object industries, but they are important in understanding design choices at the site. The ground stone industry from Block A4 is larger and more diverse than in Block A3, the only other block with ground stone tools (Table 16).

Table 16: Total ground industry artifacts.

Artifact Classification	Block A4	Block A3	Block A18	Block A23	Total
Adze	3	1			4
Fishhook Shank	2				2
Maul	2				2
Pigment Bowl	1				1
Slate Blade	3	1			4
Stone Bead	1				1
Totals	12	2	0	0	24

Adzes

All the adzes in the assemblage were manufactured from nephrite, and adzes were the only artifact created from nephrite in the collection. Three nephrite adzes were recovered from Block A4. All three samples had abrupt and unmodified proximal ends; the distal end had been ground into a beveled edge and had use wear. A single adze was manufactured from light tan nephrite while, the other two are dark green (Table 17). Two of the specimens have been polished smooth entirely except for the unmodified proximal end, while the third has been shaped and beveled but not polished smooth. Thermal alteration may have changed the exterior surface, making it rougher in texture. One specimen still has evidence of where it had been sawn and snapped from the original blank, as seen in Figure 8 (Chapter 3).

Table 17: Adze measurements Block A4.

Catalog #	Color	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-10799.03.01	Very Dark Green	7.30	3.34	2.03	81.40
WS-12102.01.01	Very Dark Green	11.52	3.48	1.44	108.60
WS-14869.03.01	Light Tan	5.85	2.51	1.49	23.80

A single nephrite adze was recovered from Block A3. The exterior surface was not ground and polished like the nephrite adzes from Block A4. The exterior of the adze from A3 was thermally altered, creating a lightly colored rough surface. The adze was ground into a beveled edge, with one side more ground than the opposite.

Mauls

Two mauls were identified, made of two different materials. A broken hand maul from A4 is the single example of grinding being applied to CVR. A4-19.01.01, as shown in Figure 21, is a broken maul which has a cylindrical shaft with a flare at the distal end. A portion of the distal pounding surface is represented, but the proximal end of the shaft is missing. The fragment has measurements of 11.11 cm long, 5.53 cm wide, 2.26 cm thick, and weighs 93.4 grams.

A second maul from A4 was manufactured from coarse grain material. It is a tapering cylinder split in half lengthwise (the width is still measureable). The proximal shaft end is missing and the distal percussion face is missing. The fragment is 12.18 cm long, 9.08 cm at its widest and 5.68 cm at narrowest, 3.69 cm at its thickest and 2.06 cm at its thinnest, and weighs 391.4 grams.

Figure 21: CVR maul fragments exterior, A4.

Fishhook Shanks

Two fishhook shanks were identified from Block A4, both of fine grain material (Table 18). The first specimen (WS-18116.05.01), a distal portion of a fishhook, is brown and tan in color, and has three lines ground along the circumference right above a smooth crescent groove at the base for a barb (Figure 22). The second specimen (WS-17795.04.01) is a proximal section, of light gray material. The end is ground into an abrupt shoulder and the tang has two bumps.

Figure 22: Fragment of a Fishhook shank, with engraved wrapping area visible. Not shown in picture is a rounded ground area for a shank, but the ground area is shown with an orange line.

Table 18: Measurements of the ground fishhook shanks.

Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-18116.05.01	3.85	1.29	0.70	5.00
WS-17795.04.01	6.89	1.22	0.53	6.50

Pigment Bowl

A single pigment bowl was identified in the assemblage. This small, medium grained stone had a ground or drilled notch in the center of the stone which opened up to one side, with a light orange residue present. This stone is 3.65 cm long, 2.65 cm wide, 1.68 cm thick and weighs 16.9 g.

Figure 23: Photograph of the single pigment stone sample, with the grinding opening to the right.

<u>Stone Bead</u>

A single stone bead was identified in the collection; it is 3.21 cm long, 2.63 cm wide, 2.07 cm thick, and weighs 13g. It has been ground into a rounded shape with slight visible striations, but sections have become obscured by wear. There are no clear indications of how the hole, which is parallel to the length, was created (Figure 24). It is not perfectly circular, but maintains a similar diameter throughout, with the opening measuring 1.15 cm by 1.25 cm on one side, and 1.13 cm by .92 cm on the opposite side. It also appears that a portion of the bead's interior has been weathered away and the hole is irregular on the inside.

Figure 24: Stone bead, looking from the top of the artifact through the perforation, A4.

<u>Ground Slate Blades and Blanks</u>

There are four examples of ground slate blade fragments, three from A4 and one from A3. These are medial fragments with both broad faces ground flat and uniform, and a single beveled edge. A4-47.01.01, a prepared blank slate fragment, has only partial grinding on its broad surfaces and is not as uniformly smooth as the other specimens; it also lacks a beveled edge. It's greater length and width is consistent with it being a blank (Table 19), it is also thicker but close enough in thickness to the finished pieces to not required substantial grinding to complete it.

Table 19: Slate blade measurements from Block A4.

Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-8934.02.03	1.83	0.78	0.24	0.30
A4-391.01.01	6.37	2.66	0.36	7.90
A4-483.01.01	4.37	2.96	0.33	5.60
A4-47.01.01	12.92	4.95	0.67	80.30

Base Object Industry

The artifacts in this industry are catagorized being naturally occuring stones that could be used without any reduction. Incised stones constitute a large portion of this industry (Table 20), but other functions are represented as well. This section describes features of each artifact type.

Table 20: Base object totals.

Artifact Classification	Block A4	Block A3	Block A18	Block A23	Total
Abrader	24	7	1		32
Anvilstone	2				2
Hammerstone	5		1	1	7
Incised Stone	146	35	24	1	206
Net Sinker	5	3			8
Painted Stone	4	1			5
Totals	186	46	26	2	260

Incised Stones

Incised stones are a significant component of the assemblage and represent a distinct and unique production. The 146 specimens represent nearly 10% of all stone artifacts from Block A4 (Table 2). These are categorized as a base object industry because the only modification of the stones was the incision of a design onto the cobble. Almost all (N=142) are made of fine grained material; four are sandstone or siltstone; these are discussed in greater detail below. The stones chosen to create these are oval shaped, disk-like in plane view, relatively uniform in size, and are water-worn smooth (with 4 exceptions, discussed below). On average, the incised stones are about palm size: 6.05 cm (σ = 1.91) long by 2.66 cm (σ = 1.18) wide, with a thickness of 0.98 cm (σ = 0.87) and weight of 28.79 g (σ = 31..12). While there is a degree of variability in size of incised stones, Figure 25 shows a strong trend in the length to width ratio of these objects. Three of the incised stones have been broken in half lengthwise; none of the fragments refit to each other. It is unclear whether the broken specimens were damaged before or after the excavation.

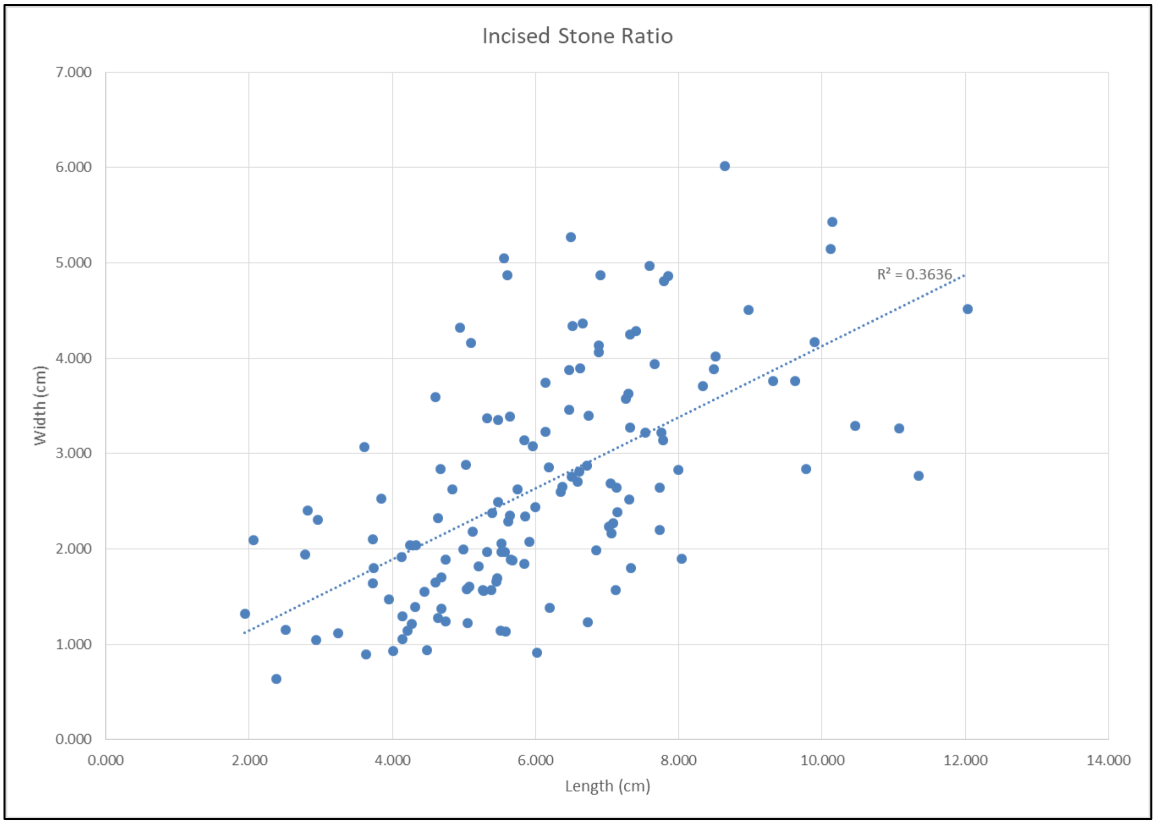


Figure 25: Measurements of incised stones, with the trend line showing a consistency in the size ratio.

Designs were created on either one (N = 123) or both (N = 23) broad faces. One specimen, WS-1570.04.01, exhibited incisions on one face as well as ochre paint on the opposite side. Several of the smaller stones have only a series of dashes etched into them and are lenticular, while the larger stones are oval in shape with a high variability of design. No two incised stones are identical in their markings. In addition to anthropomorphic featuers, I observed the following designed motifs: vertical, horizontal, diagonal, sloping diagonal, cross-thatched, chevron, sideways chevron, and tree incisions (Figure 26). I did not record the types or numbers of motifs used per stone, as requested by the LEKT. My scope focused on manufacturing methods, size, and representation within the assemblage. Many of the incisions on the samples were shallow and difficult to notice. I could not determine if that was from the workmanship or slow weathering of the stones. The single specimen from Block A23 had a circular depression on one face above the incised designs. I could not determine if the concavity was natural or evidence of modification.

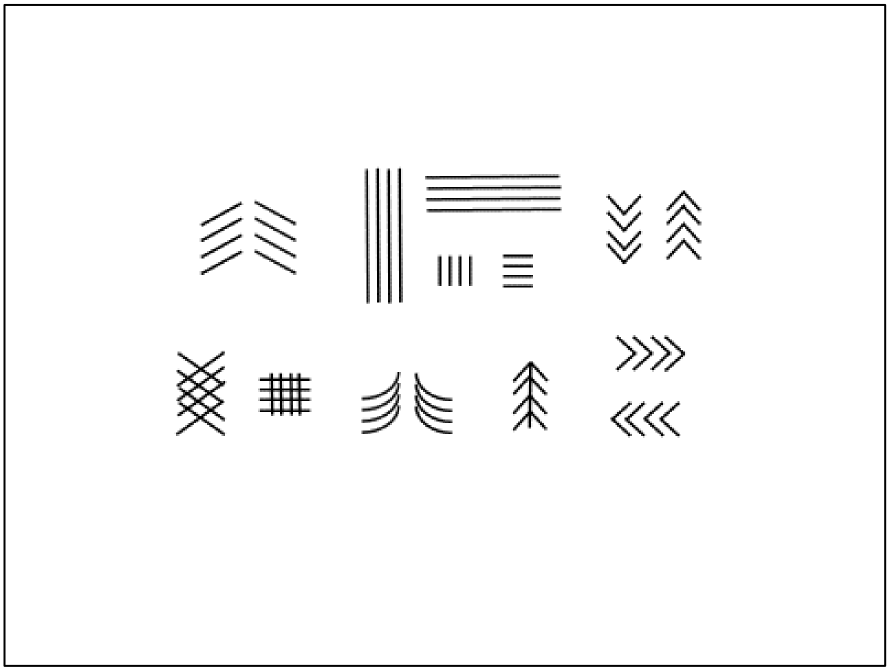


Figure 26: design motifs observed on the incised stones of Block A4. Artifacts had at minimum one of these designs and combinations of several were common.

The material types of incised stones vary in proportion between blocks (Table 21). Fine grained material dominates all four blocks. Sandstone is very distant second in abundance, occurring in two of the four blocks. The siltstone and sandstone examples from A4 and A3 had markings on one side, and were heavily weathered, but fell within the range of sizes and shapes of the fine grain stones (Figure 25). Four of the incised stones from A18 are quite distinct; they are made of a light colored metasedimentary material which is not water worn, and the edges of these stones shows a jagged edge. Even the fine grained specimens do not have the smooth cortex other blocks, instead having a porous weathering pattern These are unique to the category as no other incised stone is made from non-waterworn material. Overall the incisions on the

Block A18 stones are less visible and are noticeably more worn than their Block A4 counterparts. This may be the result of a difference in the soil or mineral composition.

Table 21: Incised stones by block and material.

Material	Block A4	Block A3	Block A18	Block A23	Totals
Fine Grain	142	29	20	1	192 (93.5%)
Medium Grain		2			2 (1%)
Sandstone	3	3			6 (3%)
Siltstone	1				1 (.5%)
Metasedimentary			4		4 (2%)
Totals	146	34	24	1	205

Abraders

Abraders are base object artifacts with little to no apparent modification of the overall shape; the major modification consists of abrasive use wear. They are made from materials that range in coarseness of grain size; abrader materials vary from mudstone through fine, medium, and coarse grained material, as well as metasedimentary rocks (Table 22). The design choice for using different material coarseness could either be attributed to grinding diverse materials, or using a series of different abraders for grinding a tool to a desired smoothness. The diverse materials could have been for modifying not only other stone tools, but also bone, antler, and seashell; the desired product would require careful consideration of abrader material in order to maximize the speed and reliability of manufacture. Table 23 displays all of the measurements of the abraders, separated by the material of the tool.

Table 22: Total abrader counts by block.

Material	Block A4	Block A3	Block A18	Block A23	Totals
Fine Grain	3				3
Medium Grain	4				4
Coarse Grain	1	1			2
Sandstone	7	6	1		14
Mudstone	2				2
Siltstone	3				3
Totals	20	7	1	0	28

Sandstone was the most common material used in manufacturing abraders; examples were identified in all blocks except A23. Of the seven specimens from A4, one has striations on both broad faces, while the other six are single sided. The sandstone abraders varied in size, from smaller hand-held abraders to larger, less mobile variations. Two of the sandstone abraders from A3 have evidence of grinding on both broad faces, while the other abraders only have a single ground surface. The single sandstone abrader from Block A18 is worn on both sides.

There are four abraders of medium grain material. Two of the specimens are very large, likely placed on the ground or lap, and have an end section broken off; the missing section comprising less than half of the object based on symmetry and freshness of break. I am uncertain if the break was intentional or if these large abraders were discarded due to the tool breaking. However, their presence shows that larger objects were being ground down, and enough time and effort was expended in this activity to develop large abraders. Figure 27 is an example of one of the larger abraders. The single abrader specimen made out of coarse grained material is broken on both long ends, with striations in parallel to the length of a single broad surface.

Table 23: Abrader measurements by material.

Sandstone Abraders				
Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-13474.03.01	10.39	5.50	1.40	144.60
WS-16735.05.01	13.02	14.47	2.11	542.20
WS-7036.03.01	8.67	3.74	1.06	56.80
WS-2238.04.01	15.58	7.90	2.53	457.82
WS-9300.07.01	10.03	7.01	2.26	230.20
A4-398.01.01	4.48	6.77	1.92	84.30
WS-3310.03.01	8.24	6.69	0.66	51.00
Coarse Grain Abraders				
Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
A4-12.01.01	8.86	10.5	1.79	343.4
Medium Grain Abraders				
Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-10390.06.01	7.26	6.15	2.23	155.20
A4-560.01.01	29.32	16.30	6.39	2000+
WS-3703.03.01	12.68	16.09	6.63	1681.40
A4-344.01.01	13.53	8.37	2.85	473.00
Fine Grain Abraders				
Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
A4-323.01.01	8.17	6.69	3.48	273.20
WS-10168.05.01	5.63	2.17	0.97	20.90
WS-1136.03.01*	6.63	4.07	1.52	61.50
Mudstone Abraders				
Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-9419.03.01*	8.73/5.78	4.30/3.36	1.05/.67	86.50
A4-200.01.01	10.85	8.92	2.69	493.00
Siltstone Abraders				
Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-442.01.01	5.91	8.21	1.12	102.40
A4-533.01.01	6.36	4.87	0.62	27.60
A4-598.01.01	11.74	4.48	0.85	82.10

* See text about measurements.

Figure 27: Large medium grain abrader with striations.

Three abraders developed from fine grain cobbles were identified, with a single specimen broken into two pieces. All three specimens have grinding striations along one or both broad faces and a single sample has evidence of wear along a corner. One of the specimens (WS-1136.03.01) is broken, and was measured after being refit (Table 23).

Two of the abraders in the collection are made of mudstone. The first specimen, A4-200.01.01, has striations down the broad face of the object and includes a single deep groove on the surface. The second specimen, WS-9419.03.01, is broken into three pieces; two pieces refit together, and their combined measurement along with the third piece are shown separately in Table 23.

Three siltstone abraders were identified from Block A4; their sizes are consistent with a hand-held tool. A single specimen (A4-533.01.01) has two end shaped by grinding. All three specimens have smoothed broad faces with striations present on both faces.

Anvilstone

There are two anvilstones from Block A4. They are generally circular in shape with a flat broad face on both sides and percussive wear. WS-2204.04.03 was manufactured from coarse grain material and has percussion use centrally located on a single broad face. The second anvilstone, WS-8566.04.02, was made using a medium grain boulder and has percussion damage centrally on both faces leaving pitted concavities. There are shallow flake scars along one edge, but this is most likely from breakage and not intentional flaking. The size and mass of the specimens make them the largest and heaviest lithic tool type in the collection (Table 24). The weight of these objects is more than twice the weight of the hammerstones in the collection, consistent with the functional requirements of an anvil.

Table 24: Anvilstone measurements.

Catalog #	Material	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-2204.04.03	Coarse Grain	23.01	20.55	10.50	2000+
WS-8566.04.02	Medium Grain	10.80	17.92	4.77	1367.30

Hammerstone

Seven hammerstones were recovered: five from Block A4 and one each from Block A18 and A23 (Table 25). Grain size did not appear to be a criterion in the selection of material for these tools, as they were manufactured from fine (N = 3), medium (N = 1), and coarse grained material (N = 3). Four of the hammerstones have percussion wear on one end only, while the other three have evidence of wear on both ends. There is no apparent difference in the intensity of use by material type. Measurements for the A4 hammerstones are located in Table 26.

Table 25: Hammerstone material by block.

Material	Block A4	Block A18	Block A23
Fine Grain	2		1
Medium Grain	1		
Coarse Grain	2	1	

Table 26: Hammerstone measurements, Block A4.

Catalog #	Material	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
A4-183.01.01	Fine Grain	18.15	5.68	5.2	815.20
WS-16156.04.01	Fine Grain	11.05	8.14	6.82	580.90
WS-6913.05.01	Medium Grain	16.39	10.00	3.10	709.40
WS-13731.03.01	Coarse Grain	10.00	6.01	2.25	230.90
WS-15675.05.01	Coarse Grain	14.08	7.99	2.76	499.60

Net Sinkers

A total of eight net sinkers were identified in Block A4 and Block A3 assemblages. All are natural cobbles, oval in shape and relatively thin, which were modified by flaking or pecking to create a notch or groove. This is considered secondary modification since it does not alter the plan and cross-sectional shape of the cobble; it simply removes material from a limited area to improve securing lashings. Therefore I have included them in the base industry. Table 27 shows the different modications made to the net sinkers organized by block, while Table 28 has the individual net sinker measurements. Figure 28 is an example of a net sinker with the narrowest of two sides flaked.

Table 27: Net sinkers by material type and notch patterns.

Block	Catalog #	Material Type	Notch Pattern
A4	A4-540.01.01	Medium Grain	Worn notched grooves on both long ends
A4	A4-545.01.01	Medium Grain	Worn notched grooves on both long ends
A4	WS-2394.03.01	Fine Grain	Notches on with width edges
A4	WS-3090.03.03	Fine Grain	Worn notched grooves on both long ends
A4	WS-9029.05.01	Coarse Grain	Lengthwise groove around the circumference
A3	A3-21.01.01	Medium Grain	Notched groove on the width edges
A3	WS-11107.03.01	Sandstone	Notched groove on the length edges
A3	WS-11576.06.01	Medium grain	Notches on the length and width, width notches show wear

Table 28: Net sinker measurements.

Catalog #	Material	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-2394.03.01	Fine Grain	12.28	7.91	2.81	447.10
WS-3090.03.03	Fine Grain	12.38	8.24	2.34	434.60
A4-540.01.01	Medium Grain	13.34	10.41	6.02	1256.10
A4-545.01.01	Medium Grain	11.55	8.02	4.05	569.30
WS-9029.05.01	Coarse Grain	10.44	6.41	5.07	449.20

Figure 28: Net sinker from Block A4, with percussion reduction on opposite sides.

Painted Stones

This category includes only one artifact type: painted stones. This tool type has no reduction at all, but instead has had material added to it creating a composite artifact.

There are four painted stones in Block A4. All four are fine grain cobbles that have ochre applied in a design, or concentrated in a small area. In size and shape, the cobbles selected for this treatment are indistinguishable from those selected for incised stones. The measurement for the four specimens from Block A4 are shown in Table 29. A single painted stone from Block A3 is a fine sandstone cobble with red lines painted on single broad side .

Table 29: Fine grain painted stone measurements.

Catalog #	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
WS-11197.07.01	6.19	4.89	1.24	62.10
WS-18470.05.01	9.05	3.77	1.77	89.80
WS-9868.03.01	6.67	3.90	0.89	30.70
WS-11481.02.05	2.30	1.33	0.62	2.20

Block Comparisons

The analysis of Block A4 displays a majority of artifacts manufactured through flaking techniques, which Blocks A3, A18, and A23 also echo. All of the material types identified from Block A4 are also present in the other blocks. Quartz crystal materials and cortex spall tools are the most numerous lithics from all blocks. Block A4 has a larger sample size and artifact diversity, the only artifact type not represented in A4 is a ground slate projectile point, which was found in Block A3.

Quartz Crystal

There were 31 flakes recovered from A3, with the most ubiquitous material being quartz crystal. Block A3 had 24 quartz crystal flakes in total, with 9 primary, 5 secondary, and 10 tertiary flakes. The percentage of primary quartz crystal (38%) material in comparison to Block A4 (15%, see Table 5), suggesting more initial reduction in this area. Other materials, including CCS (2) and fine (1), medium (3), and coarse (2) grained materials, are present in low numbers resembling Block A4.

Quartz crystal flakes also dominate the flakes in Block A18, where 65 of the 67 flakes were manufactured from quartz crystal. Representation of manufacturing stages is similar to Block A4 for QC, with A18 totaling 13 primary flakes, 15 secondary, and 39 tertiary flakes. A single QC secondary flake was identified from Block A23.

Cortex Spall Tools

The ratio of cortex spall tools to the retouched variant is significantly different in the other blocks compared to Block A4 (refer back to Table 4). This ratio is inverted in Block A3, with the retouched variant counted at 72% (N = 13) in Block A3 compared to 11% in Block A4. Block A18 also had no cortex spall tools, while having four retouched cortex spall tools. This may indicate a different activity in this extramural areas. There are five cortex spall tools identified from Block A3 as well as 13 of the retouched variation identified. Two of the cortex spall tools were manufactured from coarse grained material, while the other three and all of the retouched variant were manufactured from medium grained material. The four retouched spall tools in A18 are medium grain. Block A23 had two medium grain cortex spall tools identified with no retouched versions.

Cores

The ratio of cores, which might reflect manufacture reduction areas, are similar to Block A4 (2.8%, reference Table 2). Three specimens (3%) of medium grain cores were identified in Block A3. All exhibited evidence of initial bipolar reduction; two samples showed signs of continued unifacial reduction, and one showed flake scars from the initial reduction. Two cores (2%) were in Block A18, one of fine grain material and the second of medium grain. The fine grained core is unifacial with cortex present. The medium grain core is a fragment with cortex present and has a large flake scar originating from the fragmented end.

Projectile Points

Two flaked projectile points were identified from Block A3, which was 3% of the block assemblage. This is significant as projectile points were 0.28% of the assamblage in Block A4, and are absent in Block A18 and A23. Both of the projectile points from A3 were manufactured from a dark medium grain material, likely CVR. The projectile points differ in form, and were not identified to known projectile point types. The first is symmetrical down the center with rounded shoulders and barbs and a straight stem. The second example is ovate and symmetrical, with a straight stem and no noticable barbs.

Ground Projectile Point

A single ground slate projectile point fragment was recovered from Block A3 (WS-11607.06.01). Only the distal portion remained. Both broad surfaces were ground flat and the beveled edges tapered to meet at the point, creating an isosceles triangle. The presence of this artifact is interesting, as there are a small number of flaked projectile points which relate to the material identified at this site. The ground projectile point may have been an isolated manufacture, or a different set of tools which are cached elsewhere.

Chronozones

As Čḯxʷicən village was inhabited for a long period of time, the artifacts collected are not all from the same time period. Research conducted by other investigators on the site has assigned materials to seven chronological zones. My analysis encompasses artifacts from all seven chronozones (CZ), but the assemblage sizes per CZ are very different. Table 30 shows types of artifacts by CZ, and Table 31 shows the breakdown of material types by CZ. Table 32 shows the percentages of the flaked, ground, and base industries by CZ. With the exceptions of CZ 1 and 2, which have extremely small sample sizes, the proportion of the assemblages made up of each of these industries shows no chronological trend. Flaked industries increase from 85% to 91% between CZ 3 and 4, then drop to 80% or below in CZ 5, 6, and 7. The percentage of base industry is roughly the inverse of the flake industry in this closed array because the ground industry is so rare. The base industry ranges from 9% to 21%, dipping to its lowest value in CZ 4. The ground industry represents between 1% and 2% in the larger assemblages (CZ 4 and 5), is absent in the smaller samples (CZ 1, 3, and 7) and may be overrepresented in CZ 2.

Table 33 shows the relative frequency of incised stones as a percentage of the base industry total for the assemblages within ≥ 30 (CZ 3-7). Percentages range from 71% to 89%; in this case there is a possible temporal trend, with CZ 4 as the peak frequency. Looking at the combined cortex spall tools and retouched variant in relation to the flake industry, there does appear to be a general temporal trend with the percentage increasing overall from CZ 3 through CZ 6 (Table 33). There is an exception in CZ 4, due to the sheer numbers of quartz crystal objects. The relatively high percentages in CZ 5 and 6, 26% to 41%, may reflect a new value that these tools provided.

The most significant difference in material type over time relates to quartz crystal (Table 33). The percentage of the quartz crystal out of all artifacts ranges from 25% to 82%. We see a large increase in the relative frequency of quartz crystal from CZ 3 to CZ 4, then a decrease from CZ 4 to CZ 7 (Table 33). The highest percentage of quartz crystal, 82.2% in CZ 4, correlates with the peak in incised stone. Because quartz crystal is so abundant, changes in quartz crystal tend to drive relative changes in a closed percentage matrix. For example percentages for coarse, medium, and fine grain material drop to a significant percentage in CZ 4 due to the high percentage of quartz crystal material. To examine changes in the relative proportion of the coarse, medium, and fine grain material separate percentages were calculated to compare these three materials to each other (Table 34). The percentages of these material types fluctuates between CZs; the most notable difference is the high percentage of fine grain material in CZ 4 (CZ 2 is higher but it is an extremely small sample size). This is certainly related to the increased number of incised stones in the same CZ (Table 33) as they were preferentially made from fine-grained material.

Table 35 looks at changes in material representation in a different way, summarizing the sample sizes, material richness, and percentage of other materials in CZ 3 to CZ 6. While CZ 4 has the largest sample size, it does not have the highest material richness and has the lowest percentage of other materials; again this reflects the fact that the large assemblage size is due to the high number (N = 443) of quartz crystal objects. Both CZ 5 and 6 have greater diversity of material types and higher percentages of “other” material types (not quartz crystal or fine, medium, and coarse materials). The greatest occurrence of exotic materials, nephrite and obsidian, is in CZ 5 and 6.

Table 30: Artifacts by CZ for all blocks (excludes shatter).

Industry	Artifact Classification	CZ1 Pre-1750 BP	CZ2 1750-1550 BP	CZ3 1550-1300 BP	CZ4 1300-1000 BP	CZ4B Secondary	CZ5 1000-525 BP	CZ6 525-300BP	CZ7 300 BP - Contact	NPA	Total:
Flake Industry (n=1,364)	Flake	1	10	154	434	33	240	102	12	20	1006
	- Blade			1	3		1	1			6
	- Graver			2	3	1	6	3			15
	- Scraper								1		1
	Biface				1		1	1			3
	- Projectile Point			1	2		2		1	2	8
	Cortex Spall Tool	1	2	12	12	9	70	73	7	25	211
	- Cortex Spall Tool, Retouched			4	8	1	22	7		1	43
	Core			1	11	3	12	8	7	2	44
	Microblade			1	2		4	1			8
Ground Industry (n=14)	Adze				1		2	1			4
	Fishhook Shank					1	1				2
	Maul									2	2
	Pigment Bowl		1								1
	Pendant						1				1
	Projectile Point				1						1
	Slate Blade				1		2				3
	Stone Bead						1				1
Base Object Industry (n=260)	Anvilstone			1				1			2
	Hammerstone				1	1	4	1			7
	Incised Stone		2	22	40	7	72	41	7	4	195
	Net Sinker		1	3	1		3				8
	Painted Stone		1	1	1		2			1	6
	Abrader			4	2	1	9	9		2	27
	Total:	2	17	207	524	57	455	249	35	59	1,604

Table 31: Material types by CZ from all blocks (includes shatter).

Artifact Classification	CCS	Coarse Grain	Fine Grain	Medium Grain	Mudstone	Nephrite	Obsidian	Quartz	Quartz Crystal	Sandstone	Siltstone	Slate	Total
CZ1 Pre-1750 BP				2									2
CZ2 1750-1550 BP			7	2					12				21
CZ3 1550-1300 BP	1	18	27	23				1	152	3	3		228
CZ4 1300-1000 BP	2	16	50	15				1	443	2	1	9	539
CZ4B Secondary		11	9	10					28	1			59
CZ5 1000-525 BP	4	70	99	86	2	2	1	4	213	11	1	7	500
CZ6 525-300 BP	1	72	71	50	4		1	1	77	3	2	1	283
CZ7 300 BP - Contact		7	14	9					10				40
NPA	2	31	10	18					7	1	1		70
Total:	10	225	287	215	6	2	2	7	942	21	8	17	1,742

Table 32: Percentage of artifacts by industry.

Chronozone	Flaked Industry	Ground Industry	Base Industry	N =
CZ 1 Pre-1750 BP	100%	0%	0%	2
CZ 2 1750-1550 BP	71%	6%	24%	21
CZ 3 1550-1300 BP	85%	0%	15%	228
CZ 4 1300-1000 BP	91%	1%	9%	539
CZ 5 1000-525 BP	79%	2%	20%	500
CZ 6 525-300 BP	79%	0%	21%	283
CZ 7 300 BP-Contact	80%	0%	20%	40

Table 33: Relative frequency of quartz crystal and incised stones in Chronozone 3 to 7 (CZ 1 and 2 are omitted because they have sample sizes ≤30).

Chronozone	Total number of artifacts*	Percentage quartz crystal to total number	Percentage of incised stones of base industry	Percentage of cortex spall tools of flaked industry
CZ 3 1550 – 1300 BP	207	67%	71%	9%
CZ 4 1300 - 1000 BP	524	82%	88.9%	4%
CZ 5 1000 – 525 BP	455	43%	80%	26%
CZ 6 525 - 300 BP	249	24%	78.8%	41%
CZ 7 300 BP - Contact	35	25%	71%	25%

*excludes shatter

Table 34: Material distribution of cortex spall tools by chronozone.

Chronozone	Coarse Grain	Medium Grain	Fine Grain	N =
CZ 1 Pre-1750 BP		100%		2
CZ 2 1750-1550 BP		22.2%	77.8%	9
CZ 3 1550-1300 BP	26.5%	33.5%	40%	68
CZ 4 1300-1000 BP	19.8%	18.5%	61.7%	81
CZ 5 1000-525 BP	27.5%	33.7%	38.8%	255
CZ 6 525-300 BP	37.3%	25.9%	36.8%	193
CZ 7 300 BP-Contact	23.3%	30%	46.7%	30
Total number of spall tools per material:	183	268	187	638

Table 35: Material richness and percent of other materials from chronozone 3 to 6.

Chronozone	Total lithics	Material Richness	Percentage of other materials
CZ 3 1550-1300 BP	228	8	3.5%
CZ 4 1300-1000 BP	539	9	2.8%
CZ 5 1000-525 BP	500	12	6.4%
CZ 6 525-300 BP	283	11	4.6%

Chapter V: Discussion and Conclusions

In this chapter, I utilize design theory to interpret the results of the analysis of artifact categories described above to better understand the choices made by craftsmen at Čḯxʷicən village. My analysis of the end product tools, the by-products, and the materials identified aim to explain the manufacturing decisions of the people at Čḯxʷicən village and how design theory explains their choices. Many of these stone tool types are manufactured to process other materials, such as bone or shell, increasing the variety of available resources. These would include tools such as adzes for woodworking and abraders for sharpening and forming bone or shell tools. The manufacturing steps for creating the stone tools is illustrated in Figure 29, starting with the manufacturing method, and showing intermediate tools and final products. These stages are important in understanding the reduction manufacturing practice at Čḯxʷicən village, and the engineering decisions being made by the crafters.

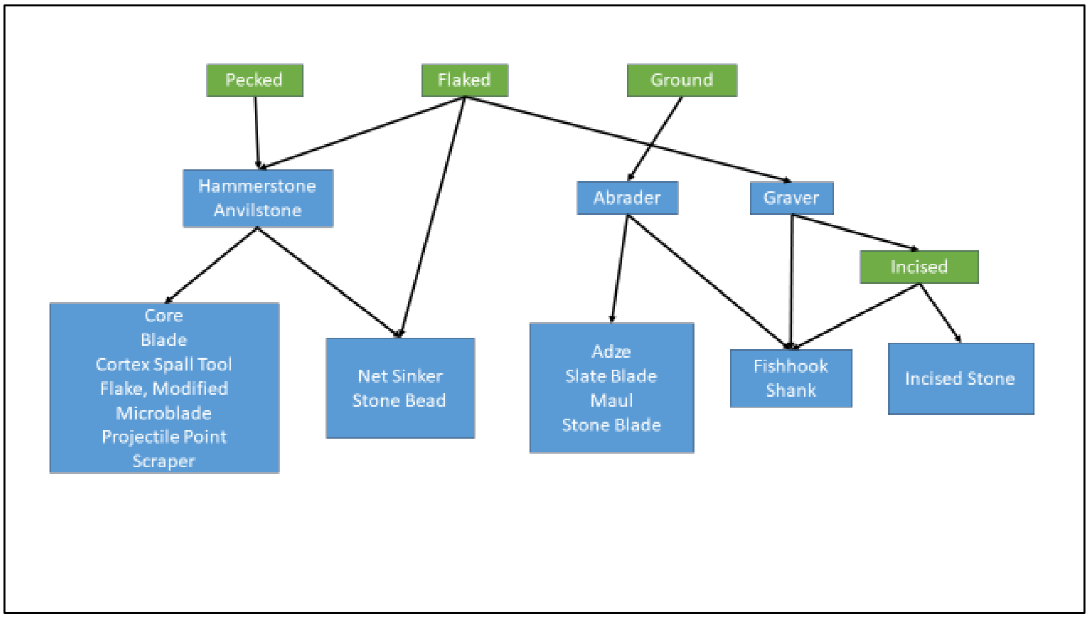


Figure 29: An example of how some lithic tools were used to manufacture other tools. The green boxes are reduction processes, the blue boxes are tools. Wood, bone, and shell would also be worked using abraders and gravers, as well as tools such as adze blades and microblades resulting from the stone manufacturing processes.

Many of the artifacts that were identified from the site are used in the manufacturing processes of non-lithic materials. The analysis of non-lithic material is beyond the scope of my research. However a number of bone and antler artifacts have been informally analyzed. Dr. Sarah Campbell identified 181 bone and antler artifacts showing modification by abrasion and limited percussion (Personal communication 2016). They represent a variety of functions; the majority are differing size and shape for use in composite fishing gear.

During the analysis of the artifacts, I decided to separate the artifacts into three industries based on the primary reduction strategy. This included flaked, ground, and base industries. The flaked industry encompasses artifacts where the primary method in the creation of the tool was percussion or pressure flaking. The ground industry focused on tools which had been ground into shape. The base industry consisted of artifacts for which the unmodified shape of the material was apparently an important element, as evidenced by minimal alterations beyond use-wear.

Flaked Industry

Flaked artifacts dominate the site, and represent several distinct reduction sequences in the production of tools and their expected utilization. The presence of considerable cortex visible on the quartz crystal artifacts and the cortex spall tools suggests that the village site itself was the location of primary reduction of these materials. Andrefsky (2005) discusses the difference between quarry sites, which would typically have evidence of primary reduction, and village sites, which would have evidence of secondary reduction. The Čḯxʷicən village assemblage differs from those unique descriptions as it is both a permanent village and the primary reduction site of the majority of lithics, as well as the secondary reduction process. If there was a known area near the village where the quartz crystal could be located, it may have been collected while gathering and fishing (Mierendorf 1999). The villagers of Číxʷicən village could also have collected large quantities of water-worn cobbles from the nearby beach areas to create cortex spall tools.

Quartz Crystal

Quartz crystal was by far the most common material identified at the site and represents the most complete sequence of manufacturing. There are cores as well as primary, secondary, and tertiary flakes and shatter. End-products from the reduction of quartz crystal pebbles include blades, gravers, points, microblades, and possibly scrapers. Some of the flakes show informal modification but the majority are debitage that was not useful.

All of the primary and secondary quartz crystal flakes have a weathered cortex, indicating that the pebbles were transported by rivers; the size and shape of the flakes also indicates that they are derived from bipolar reduction. These water-transported pebbles were likely collected nearby, possibly from Clallam Bay or the Elwha River (Mierendorf 1999). The manufacture of gravers, blades, points, and microblades was likely the outcome of favorable results from bipolar reduction; as the water worn pebbles were reduced, the manufacturers took the resulting pieces of appropriate size and shape, and further processed the material to suit the needed tools.

That bipolar reduction was used for manufacturing quartz crystal artifacts is evidenced through the curvature of the cortex and internal fracturing present on a number of the flakes. A total of 365 of the flakes have rough and weathered cortex. The small, tough, rounded quartz crystal pebbles required bipolar reduction, which creates compression fractures within the material instead of a normal Herzian Fracture (Odell 2004:53, 61). Compression fractures are visible on the faces of all of the quartz crystal flakes analyzed (Figure 30).

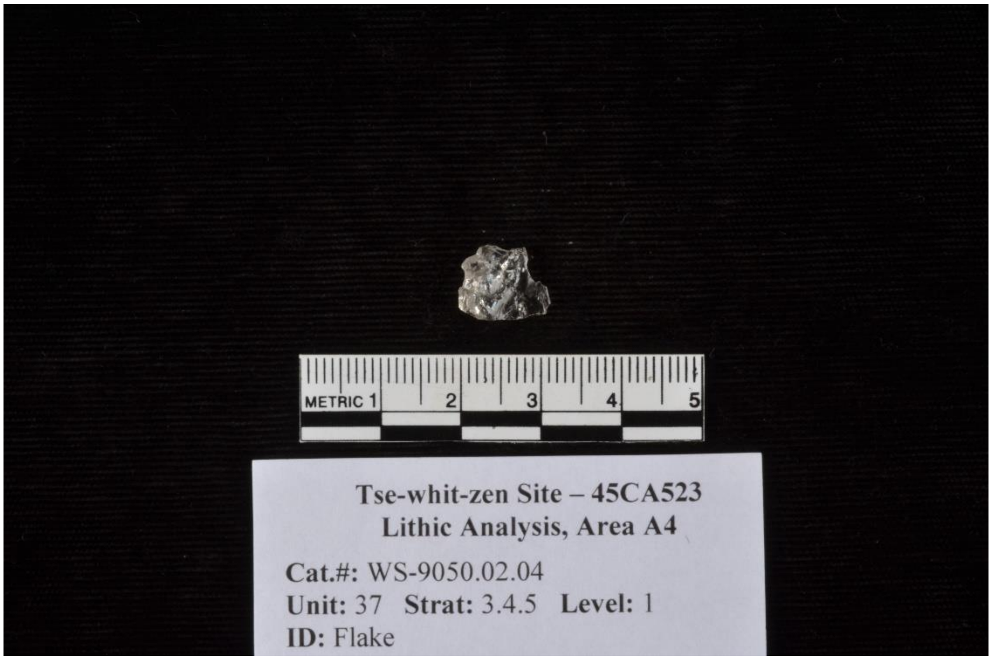


Figure 30: Quartz crystal flake with fractured interior matrix.

Bipolar reduction results in more debitage flakes than usable flakes, as many smaller fragments shatter off. In Flenniken's research on the Hoko River site, he analyzed 30 bulk samples and identified 60% of lithic material as "miscellaneous debitage," and 21% of the sample as "non-functional debitage" (1981:34, 43). His definition of miscellaneous debitage was flakes that had no notable use-wear; while non-functional debitage was shatter from reduction. Block A4 shows a similar percentage to Hoko River, with flakes amounting to 58% (N=774) of the total count. Figure 31 is my visualization of the production stages of quartz crystal material from deposit to final form.

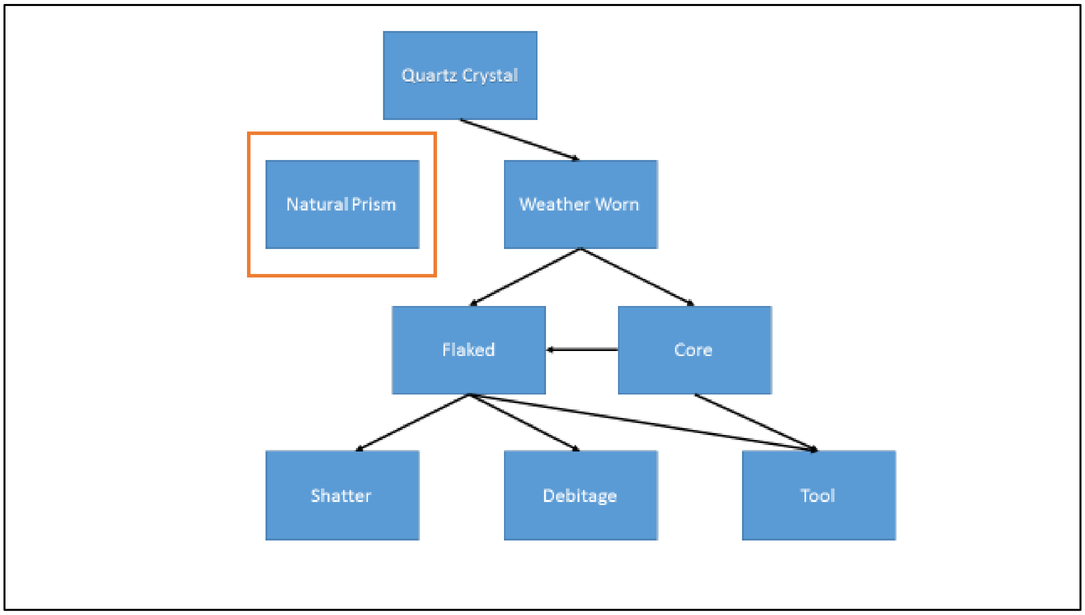


Figure 31: Quartz crystal flaked reduction process. No artifacts manufactured from the natural prism form were identified in the assemblage.

Quartz crystal used as a raw material for flaking is not uncommon to the Salish Sea, especially in the Locarno Beach period (3500-2400 BP). In prism form, it can easily be made into microblades and knives, and sources are located sporadically throughout the region (Kannegaard 2015; Morin 2004). However, none of the quartz crystal that I analyzed from Čḯxʷicən village appeared to originate from prism form. A grainy white cortex, rough to the touch, was found on all primary and secondary quartz crystal flakes as well as any tools with cortex present. Internal fracturing from the compression due to bipolar reduction is visible on all of the quartz crystal artifacts; the fine fracture lines disrupt the material's ability to refract and reflect light, so the social value attributed to these qualities is unlikely (Cooper 2012). The visual reflective quality of all of the quartz crystal objects from Čḯxʷicən is obstructed by either weathered cortex or internal fracture.

I think that the reflective qualities were less important to the Čḯxʷicən artisans than the durability of the edge as Flenniken has suggested for the quartz and quartz crystal microliths at Hoko (Flenniken 1981). While the quartz crystal products are generally small, averaging less than 2 centimeters in length, the designers selected larger flakes for further modification and utilization (Table 36). Some flakes were utilized “as is” while others were selected for further modification - likely pressure flaking - to manufacture the gravers, blades, and points that were not produced by initial reduction. Thinner quartz crystal fragments were used as gravers, while wider objects were used as blades; flakes that were large enough were further modified to also take advantage of a cutting edge.

Table 36: Average measurements of quartz crystal tools.

Classification	Total #	Length (cm) / SD	Width (cm) / SD	Thickness (cm) / SD	Weight (g) / SD
Biface (Point)	4	1.33 / 0.35	0.75 / 0.19	0.34 / 0.11	0.24 / 0.025
Blade	6	1.56 / 0.66	0.88 / 0.25	.3 / 0.11	0.49 / 0.52
Core	8	1.4 / 0.55	0.86 / 0.30	0.56 / 0.21	0.78 / 0.68
Flake	758	1.00 0.45	0.73 / 0.42	0.3 / 0.35	0.24 / 0.39
Flake, Modified	16	1.27 / 0.66	0.99 / 0.32	0.3 / 0.15	0.52 / 1.05
Graver	14	1.51 / 0.42	0.73 / 0.19	0.42 / 0.19	0.5 / 0.34
Microblade	8	1.13 / 0.43	0.59 / 0.12	0.21 / 0.06	0.07 / 0.10
Scraper	1	1.23	1.47	0.29	0.7

Gravers are tools with a fine point created on a flake or core. All of the gravers identified had use wear on a long edge or their point; an example of a graver can be seen in Figure 32. The gravers may have been hand held or hafted; while there was no residue visible on the tools, their size (Table 36) makes it difficult to suggest if it was held or hafted. The gravers were used to grind the intricate lines on the incised stones, or the grooves in the fishhook shanks.

Figure 32: Example of a graver from Block A4. The left end is the distal used end with cortex still present along the length of the body.

The collection included a number of blades manufactured from quartz crystal (N = 6). As seen from Table 36, they are slightly larger than flakes and were recognizable by their long straight edge. Although these resemble midsection fragments of blades produced on a blade core, they may not represent true blade production. As cortex was either absent or minimally present, blades were either opportunistic finds from the central part of the pebbles, or were larger flakes later modified for shape. The 16 modified flakes identified in the assemblage are likely attempts to reshape flakes into a cutting blade, and used if beneficial or discarded.

As the quartz crystal tools were produced from water worn cobbles and not prisms, it would be difficult to intentionally manufacture microblades, and the microblades that were produced would have likely been opportunistic. The microblades identified had no cortex present, and had the same compressed micro-fractures as all of the other quartz crystal flakes from the site. Microblades are generally designed to be hafted in composite tools (Andrefsky 2005).

Quartz crystal biface points were an unexpected find in the collection. Because of their small size (Table 36), they are not designed as projectile points for hunting. All of the points have bifacial retouch to form linear edges starting from a flat base, until all of the edges converge to a point. No wear or residues were visible on the points using a hand lens. These may have been for perforation of organic materials such as hide.

As well as the four primary tool types identified from quartz crystal, there was a single scraper specimen. The single specimen, WS-22614.01.03, has no cortex present and exhibits retouch along three sides, creating a crescent shape with a blunt proximal edge. Given its size, less than 1.5 centimeters in length and width (Table 36), it was possibly hand held, but more likely attached to a shaft at the blunted proximal end, although no evidence of any lashing or adhesive was observed on the artifact.

Cortex Spall Tools

Cortex spall tools were the most common tool type in Block A4 representing 248 of the total artifacts, or 16% of the collection. Cortex spall tools comprise 219 of these, while the retouched variant consisted of the remaining 29. These tools were manufactured through bipolar reduction, and are an expedient and yet highly replicable tool type. The size and shape of the base material was important, as many of the cortex spall tools are manufactured from similar sized cobbles, which decreases the amount of variation and makes the tool type very reliable in its function. While three different materials were chosen for the manufacture of cortex spall tools, a one-way ANOVA run on the length and width measurements revealed no statistically significant difference in size by material type {length is [$F(2,215) = 0.83$, $p = .44$] and width is [$F(2,201) = 0.92$, $p = 0.4$]}. There was also the retouched variant of the cortex spall tool, which appeared to have a different manufacture design and purpose.

The most prevalent material was the coarse grained stones; therefore, it does not appear that sharpness of the edge was critical. Rather the shape was a more important factor in its manufacture. Coarse grain stone comprised 62% of the total, 34% was manufactured from medium grain, and only 4% was manufactured from fine grained stones. There also appeared to be an optimal size and shape that was desired, with the primary reduction starting on the wider edge instead of one end point.

Both the cortex spall tools and their retouched versions have been identified previously by Stewart (1973:68) as a type of flaked tool created from water weathered pebbles which could be used to cut or saw and were quick to retouch or reproduce. Morin (2004:288) suggests that cortex spall tools compare favorably to other fish processing tools, “having considerably more cutting edge, are more durable, can undergo more resharpening, are made of largely readily available quartzite cobbles, and are easier to hold.” Nearly all of the retouched cortex spall tools at Číxʷicən village are heavily ground flat on the wider distal use edge. It is uncertain whether this is due to use or manufacture, however the strained use edge may be from a back and forth action on a material. If they were intended for fish processing, smoothing the distal edge would make them more effective at slicing. If the abrasion is not due to manufacture, then the tools were used in a cutting or sawing manner on a harder material, such as sawing abraders into appropriate sizes or girdling bone or antler to make the material easier to snap off.

Obsidian

The presence of obsidian at Čı́xʷicən village from the Glass Buttes of Oregon is an example of a unique material being imported into the region. The material source is approximately 600 km southeast of the Olympic Peninsula, and approximately 370 km from the Pacific shoreline. The transportation effort for moving obsidian from this source would be expected to increase its prestige value. Because of the distance between Čı́xʷicən village and Glass Buttes, the material would have likely been transported after initial reduction, at a later stage of production as shown in Figure 33 to further reduce the size or weight, or to completely finish the intended tool.

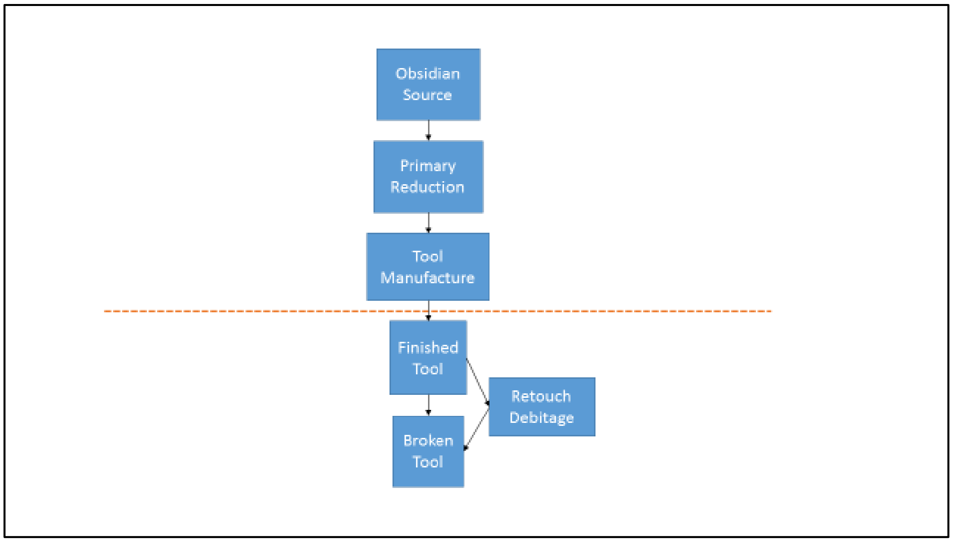


Figure 33: Steps taken in the manufacture of obsidian tools. Above the dotted line are manufacturing choices made at the source location and below the line is the expected material at the village site.

Previous research on transportation of obsidian in British Columbia and Northwestern Washington by Carlson (1994:342-343) shows that during the years that Čı́xʷicən village was inhabited, obsidian from a number of sources in Oregon, including the Three Sisters, Newberry Caldera, and John Day, was circulating in the Salish Sea Region. After reviewing the results taken from the University of Washington's Department of Materials Science and Engineering as well from his own Northwest Research Obsidian Studies Laboratory, Craig Skinner determined that the obsidian came from two chemically distinct subsources from the Glass Buttes source complex; the two obsidian flakes from Block A4 were from Glass Buttes variety 1, and the biface fragment from Block A3 came from Glass Buttes variety 3 (Craig Skinner personal communication 2016). Figure 34 shows the geographical location of the two different varieties from the Glass Buttes region of Oregon. Craig Skinner noted that "Previous analyses of Clallam County artifacts have turned up Newberry Volcano, Obsidian Cliffs, and Whitewater Ridge (along with a single piece from BC) but these are the first I've seen there from Glass Buttes"

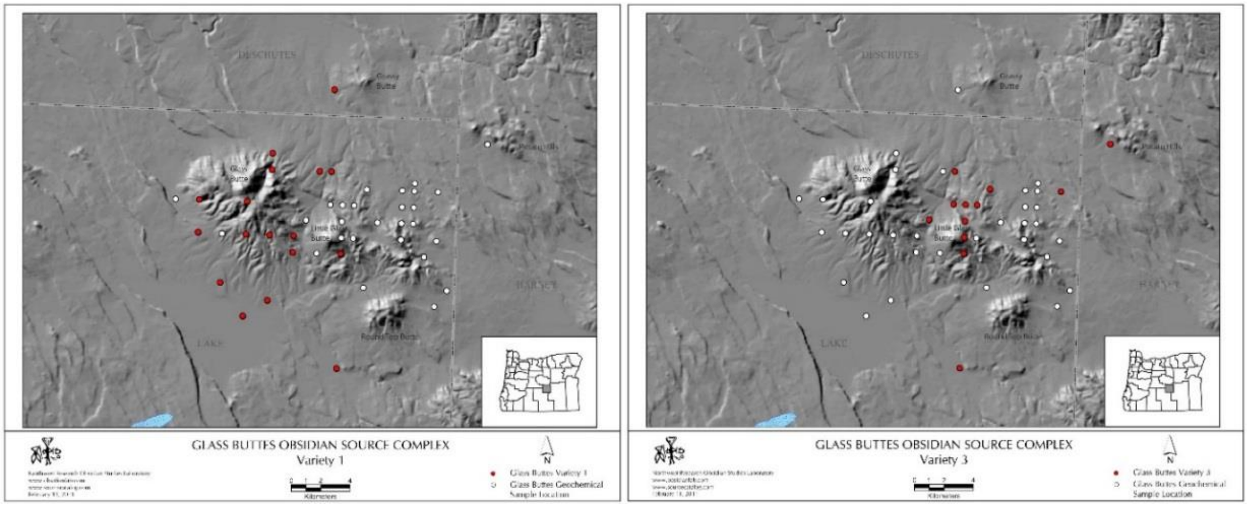


Figure 34: Maps of Variety 1 and Variety 3 obsidian sources at Glass Buttes, Oregon (Northwest Research Obsidian Studies Laboratory 2016).

(Personal communication 2016).

Previous authors argue that only a select group of individuals would have access to these materials, increasing the prestige and status of those in possession of artifacts manufactured from the obsidian (Andrefsky 1994; Clark and Perry 1990; Cooper 2012; Hayden 1998). I suggest it is difficult to determine whether the material served a utilitarian and functional purpose or was a symbol of prestige, or even a combination of both, without a larger assemblage from the site. The material itself is one of the highest quality flaking materials for edged tools, such as blades, projectile points, or microblades, however it also may have been used for personal adornment and social signaling.

Crypto-Crystalline Silicate

The nature of the crypto-crystalline silicate (CCS) artifacts at Čḯxʷicən village suggests it is an uncommon material that was difficult to acquire, although this has not been tested through field work on local beaches. The lack of cortex on all of the CCS objects suggests that it was similar to obsidian when it comes to transportation: most of the reduction and manufacture was done before the tool arrived to the village. The sizes of completed tools are also functional, not being of excessive size for use. This means that while the material is rare, it has been worked to be used functionally for utilitarian purposes.

The single complete CCS tool, the projectile point A4-502.01.01, is similar to the Type Ic Medium Foliate Point with a Straight Base (Carlson 2008:137). Carlson (2008:137) states that these types of projectiles are similar to those found at Cattle Point and English Camp, and are considered to have an age range of 1130 ± 100 and 1100 ± 90 BP. The Čḯxʷicən specimen is from CZ 4, a somewhat older context estimated to date between 1550 and 1300 BP. This artifact is not miniaturized, or exaggerated in size, making it more than likely a utilitarian purposed tool. Further analysis of the site may produce more examples of CCS which could better define the design choices of this material.

Ground Industry

The ground stone industry in Čḯxʷicən is much smaller than the flaked industry, however artifacts identified are important in understanding the human behavior at Čḯxʷicən village. The manufacturing of ground stone tools produces a minimal amount of waste than flaking due to the nature of production; the waste is dust or small grains removed through abrasion. Although less numerous and less varied than the products of the flaking industry, the types of ground tools present such as mauls, fishhook shanks, and adzes, require a substantial amount of manufacturing time. These tools are specialized for fulfilling a specific function. The time and effort expended in manufacturing these objects was necessary, as more expedient materials were not capable of fulfilling the function. Tools such as mauls and adzes receive significant amounts of impact use; the dense, ground stones needed for these tools could not be done with flaking. Fishhook shanks are a highly specialized tool, and require careful shaping to fit the composite gear.

Nephrite

Nephrite is not local to the Olympic Peninsula, so the material was imported over a distance to the site. Nephrite is a dense, heavy material, so it likely was manufactured into a blank or tool by the time it arrived at Čḯxʷicən village. The likely source of nephrite would have been the Fraser River and the North Cascades, the nearest sources identified by Morin (2012). Nephrite is the optimal material from which to manufacture adzes because it is resistant to breakage due to its cohesiveness, and would not require constant replacement even when used to work wood and antler with heavy percussive force.

The amount of time invested in creating these tools and the distance required to import the material would increase its prestige value. The utilitarian value of this tool, with the durability of the material makes it more than a sign of prestige, which means it would fall under what I have termed an Investment Tool. Darwent (1996) defined nephrite adzes as prestige goods if they are miniature or excessive in size, and this definition is useful in Design Theory to distinguish different values within the same material. The adzes identified at Čḯxʷicən village were not miniature or excessive in size, which leads me to conclude that they were manufactured for a utilitarian purpose rather than a social statement.

Ground Slate

Ground slate was rare and occurred as fragments within the analyzed blocks. Three slate blade fragments were identified, and a slate blade blank with no edge. A slate projectile point from Block A3 was the only other slate specimen identified. Slate blades are common in many Northwest Coast sites dating to the last 2500 years (Ames & Maschner 1991; Morin 2012). Mitchell (1971) notes that they are common at fishing sites in the Marpole phase because they are used for processing fish. The rarity of slate at Čḯxʷicən village suggests that the inhabitants didn’t have regular access to the material. The inhabitants may have opted to fulfill similar functions with other materials or forms such as shell or the cortex spall tools. There are ethnographic reports of some Northwest Coast groups substituting seashell for platy materials (Ames 2010; Stewart 1973).

Fishhook Shank

Two fragments of fishhook shanks were identified from the collection. These are important in recognizing the manufacturing process of a functional tool, highly valued for its role in fishing, a fundamental subsistence task. These two specimens are manufactured from fine grain material, similar to other fine grain objects seen in the collection, suggesting the material is local. Fishhook shanks require a significant amount of time to manufacture, both in grinding the object down to the necessary shape, as well as incising the grooves to tie the line and the barb to the body of the object.

Base Object Industry

Artifacts analyzed from the Base Object Industry include both utilitarian objects and esteem goods. The primary objects identified were abraders and incised stones, both of which are interesting when looking into the behavior of the people of Č̓íxʷicən village. Net sinkers were also an important artifact type that presented design choices to the artisans.

Abraders

Abraders are a numerically significant proportion of the ground stone industry. These fabricators represent a wide range of materials. The 24 abraders identified represented seven different materials. This variability is likely to have to do with the production of bone and shell artifacts within the site, as abraders with different grain size may have been used on different materials. Another reason for the range of materials could be that they were used in subsequent stages of reduction; as the ground object was first shaped with coarser grained materials, then with finer grained materials until the desired shape and surface texture was achieved.

Net Sinkers

Net sinkers are a valuable subsistence tool, used in tandem with organic ropes for the collection of fish and sometimes birds. The material choices for manufacturing were flexible, as the weight of the stone was the necessary objective. In a large assemblage it might be possible to identify weight modalities reflecting specialized net applications. Four of the weights are similar in size averaging (N = 4) at 11.66 (σ = 0.90) cm long, 7.64 (σ = 2.55) cm wide, 3.57 (σ = 1.24) cm thick, and with a weight of 475.05 (σ = 63.16) g. The last net sinker from Block A4, A4-540.01.01, had a weight that was enough of an outlier that I did not include it in the average measurements, at 1256.10 g. This fifth net sinker was not significantly larger in other dimensions.

The notches are manufactured in different areas of the stone, creating four different notch patterns. Six of the net sinkers had paired notches: two samples had notches where width is measured, while four samples had notches at the longest extents. A single sample had notches on all four ends, and one sample had a groove around the entirety of the circumference. Different types of notching may reflect a different way that the sinker would be attached to a net, or a personal preference.

Incised Stones

The incised stones identified in the collection show a distinct effort to produce a non-utilitarian object. The consistency of material choice shows that the material unity was important, and the unique use of sets of particular shapes resulted in a diverse collection of designs; while incised stones were mostly of the same material, no discernable repeated sequence of designs were evident. Of the 146 samples from Block A4, only 18 had designs on both broad faces. There was variability in the depth of many of the incisions, from samples having deep incisions where the designs were clearly visible to the eye, to shallow incisions nearly impossible to identify without the use of a lamp and hand lens. Likely weathering has caused many of the incisions to fade.

The materials that incised stones were manufactured from are different between Block A4 and Block A3. Samples in Block A4 were all fine-grained stone, except for the four sandstone samples which comprised 3% of the total. Block A3 had 29 samples manufactured from fine grain material while the other five were made from different materials, a difference of 15%. From a design perspective, the reliance on a specific material could be for the fine grain materials ability to resist weathering, or possibly an aesthetic quality that was socially valued.

The incised designs are predominantly made with straight lines with only a single motif showing slight curves (refer to Figure 26); this suggests the use of tools with sturdy points or edges. Of the materials and artifact types found at Block A4, it is reasonable to suggest that the quartz crystal gravers and some of the quartz crystal flakes which were being produced in the area were used for manufacturing the incised stones. Four incised stones had ochre as well and one similarly sized cobble had pigment but no incision. Laura Phillips has since demonstrated that pigments were added to many of the incised stones but are not clearly visible without digitally assisted technology (Personal communication 2017).

Incised stones are under-reported and poorly described throughout the Salish Sea region and Northwest Coast, although they are present in the archeological record (Doris 1974; King 1950). The purpose and meaning of these symbols is not within the scope of this research. Laura Phillips of the Burke Museum has been consulting with Lower Elwha Klallam Tribal Chair Woman Frances Charles concerning how these relate to incised stones from other areas of the Salish Sea, as detailed descriptions have rarely been presented in the literature (Laura Phillips, Personal communication 2017).

Design Theory Applicability

The Čḯxʷicən site provides a great deal of information on design choices and material constraints. The predominance of flaked materials which have been reduced through bipolar manufacture displays a dependence on tools which can be quickly manufactured and reproduced at a reliable size and function. While there is overall diversity in the materials used, the analysis shows that specific materials were chosen for manufacturing particular tool types with little variation. The only tool type that has a wide range of material variation is abraders, where the difference is one of grain size. As discussed previously I believe this is due to their use for reductive manufacture of multiple materials including stone, bone, antler, and shell. While the materials chosen for many of the tools had a specific purpose, the material choices made for abraders was deliberately more variable. This is likely because the difference in the grain sizes of materials is useful when grinding different materials and polishing objects to a desired smoothness.

Some objects found at the site required time and effort in manufacture and served non-utilitarian purposes. Painted and incised stones were likely objects of social relevance which may have represented significant events or social differences in a community. While the base cobbles are relatively uniform in material and size, there are no repeated designs incised or painted onto their surfaces. This indicates that the creators are making deliberate selection choices in base material for making these objects. Each incised stone is detailed individually for their purpose, whether it be a form of identification, storytelling, maps, or other. From the perspective of this thesis, the incised and painted stones are esteem goods due to their role as a socially accepted objects of significance. They are manufactured from locally readily material which is also used for utilitarian functions, thus access to the material does not appear to have been limited.

While some artifacts in the assemblage, particularly projectile points and adze blades, have been classified as prestige goods by researchers in other contexts, I do not think they fit the definition at Čḯxʷicən village. The CCS projectile point is functional in size and does not appear to have been manufactured for a non-utilitarian function; the adzes manufactured from nephrite are also functional, being of an appropriate size for use, as well as having evidence of use wear on the beveled edge. I think that the use of a material that is rare, and yet also perfectly suits the function requires a new artifact type: Investment Tools.

A Different Value: Investment Tools

While the manufacture of time-intensive tools has been perceived as prestige, it is hard to ignore that in some cases, such as adzes, the combination of the material and the objects create the most efficient utilitarian tools. While similar to prestige goods in that they require time and labor to produce, benefits for utilitarian use such as durability are substantial. I think that a category beyond the dichotomy of functional vs. prestige needs to be added. Investment Tools fulfill important utilitarian functions, such as house construction or specialized hunting, and their efficiency is due to their construction with rare materials and/or time intensive in manufacture.

Objects from Čḯxʷicən that fall under the classification of an investment tool include adzes manufactured from nephrite, and tools manufactured from obsidian or CCS. These three materials are not readily available in the Strait of Juan de Fuca, and would have had to be imported into the region. Obsidian is a valuable material due to its predictable fracturing patterns and sharp edge, and was considered a valuable commodity as both a raw material and in the form of finished tools (Glascock *et al.* 1998:16). Both obsidian and CCS were apparently reserved for making projectile points based on the assemblages at Čḯxʷicən village.

Mauls and fishhook shanks are time-intensive tools which require tremendous amounts of work to manufacture because they are made by grinding and must be made from hard, tough stone to have any expectation of durability in use. Fishhook shanks are small components for specialized fishing gear, important to the subsistence strategies of the Northwest Coast. These tools requires a significant time investment to manufacture, as well as skill. Mauls also require a significant amount of time to shape; the two mauls analyzed derived from cylindrical cobbles, with significant pecking and grinding to remove material to shape an efficient handle without sacrificing its pounding surface area.

Managing the Values

To better understand the difference between Utilitarian tools, Prestige goods, Esteem objects, and Investment tools, I have developed a system of definitions. Figure 36 shows the steps of behavioral choices for tool manufacture and qualifying steps for understanding the design choices being made. This includes breaking down utilitarian and prestige goods into possible values: efficiency, reliability, social, and wealth. By evaluating the materials that items are made of, the differences between functional and esteem items can be better quantified and described. This produces a better understanding of behavior choices when relating material used in tool production, and a replicable system for analysis that can be taken to analyzing other collections.

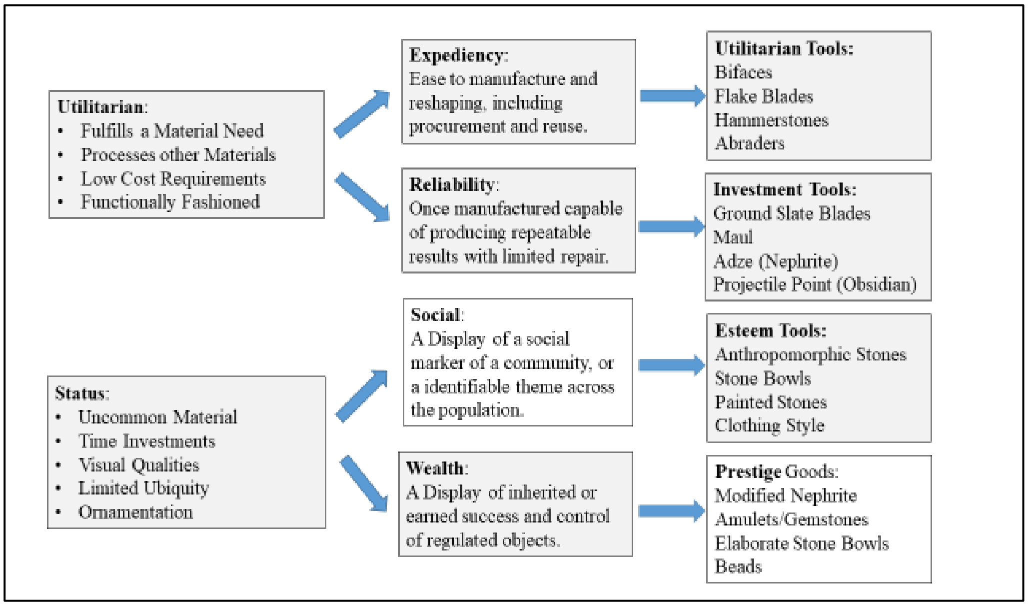


Figure 35: Relationships between social and utilitarian values.

Alternative Material Choices

While the Northwest Coast of North America is known for its diverse environmental resources, social and geographic constraints are present to limit the types of materials accessible to specific groups. This thesis recognizes this limitation, specifically in relationship to cutting implements. While the cortex spall tools provided a durable cutting tool, their size and shape make them an unwieldly tool for fine cutting tasks. Quartz crystal seems to be a locally available material for producing cutting edges, but the small size of the pebbles and the necessity of using bipolar reduction was unreliable in creating a consistent sized tool for the production of microblades or knife-sized flakes. The tools manufactured from obsidian and CCS would be excellent for these tool types, but the lack of local sources of the material at Číxʷicən village makes this material type less accessible, and more restricted. Even compared to Hoko River, 50 miles to the West where 40,203 lithic artifacts were analyzed (Croes 1995:193), blades, microblades, and scrapers were underrepresented.

On the Northwest Coast the shell of *Mytilus californianus* has been identified as an alternative material for cutting tools from Prince Rupert through the Fraser River region to the Ozette site on the Olympic Peninsula (Ames 2010; Borden 1970; Macdonald & Inglis 1981; Wessen 1990). Analysis of the invertebrate remains at Western Washington University by Dr. Sarah Campbell and Ryan Desrosiers identified 81 specimens of *Mytilus sp.*, 54 specifically from Block A4, which had been modified by grinding or drilling (Personal communication 2017). Because of this, the use of shell, such as *Mytilus californianus*, could have supplied the knives and scrapers often seen in stone (Ames 2010).

According to Eells (1996) and Gunther (1927), the collection of *Mytilus californianus* as a food source was common throughout Klallam territory, and it is likely that they also took advantage of the shell as a source for tools. As the mussels are collected in dense packs on low water rocks, the material traits of the shells would be quickly identified as a useful and easily accessible material which was already being exploited (Stewart 1968). Gunther also notes that the Klallam used mussel shell knives in the manufacture of twine and rope (1927:220). The presence of the 54 specimens of *Mytilus sp.* from Block A4 with grinding striations and ground bevels indicates that these alternative materials are being manufactured with the abraders.

Conclusion

The lithic collection from the Čḯxʷicən village site reveals an interesting mix of manufacturing decisions by the people living there. Primary reduction by hammer and anvil flaking of materials which could be easily gathered and transported is the principal manufacturing choice. These materials were primarily quartz crystal nodules and beach cobbles; imported materials such as obsidian and CCS were scarce yet present as either retouched debitage or as fully completed tools. Ground tools were an important industry, with limited artistic additions to the utilitarian function of the object. The investment in their manufacture was primarily functional, with limited but present efforts for having aesthetically attractive objects, primarily seen in the fishhooks.

This artifact typology and associated material choices indicate that the Čḯxʷicən village makers of stone tools focused primarily on expedient tools that could be easily replaced. Nelson (1991:80) states that tools which are made for expediency are likely to have little to no visible retouch or maintenance and would be discarded when exhausted. While many of the tools are being manufactured expediently, the tools did not sacrifice reliability. The focus of manufacturing would be to manufacture tools as needed. The quantity of cortex spall tools, and extensive presence of weathered quartz crystal cortex, suggest that the tool manufacturers at

Číxʷicən village took advantage of the local tough material to produce the majority of their desired tools.

Several of the ground materials, including mauls, ground fishhooks, and adzes, do not fit the definition of a prestige good because of their utilitarian use, and I suggest the new descriptor: Investment Tools. Investment tools are a more appropriate term for defining objects which take more time and effort in manufacturing, or are also a rare material that is uncommon to the region, but the end manufacturing result still fulfills the roles of a utilitarian tool. This definition is a better separator for artifacts combined values generally considered functional or prestige. This definition better suits artifacts which have combined qualities which are considered utilitarian with qualities that have often been designated prestige.

Design theory provides an excellent method to explore the roles of use, esteem, and prestige values in the lithic technology represented in an archaeological collection. The use of a system of values is important in understanding the cultural behavior, providing a model for questioning the utilitarian or social uses of objects, and logically understanding the purpose of the tools. Applying design theory to the entire stone assemblage, including fabricators, rather than focusing on a particular tool end product or a single technology, was helpful in understanding the rarity of materials at the location, as well as the time investment and efficiency of both the manufacturing process and the finished tools.

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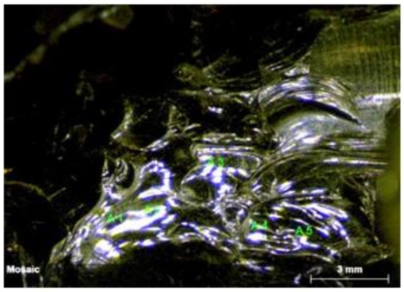
Appendix AA:

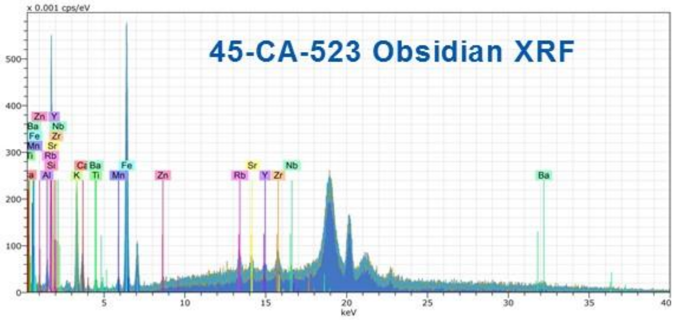
Micro X-Ray Fluorescence Results

Taken at the University of Washington’s

Department of Material Science and Engineering



Video MosaicDate:3/28/2016 1:35:54 PMImage size:810 x 600



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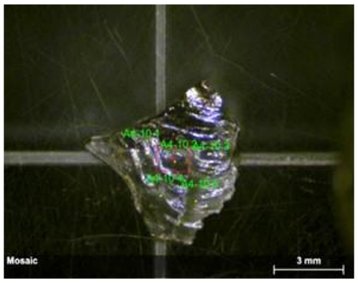
Mass percent (%)
Spectrum         Al     Si      K   Ca     Ti   Mn   Fe    Zn   Rb   Sr     Y   Zr     Nb   Ba
-----------------------------------------------------------------------------------------------

 A 1          10.48 71.06 12.21 2.03  0.42 0.14 3.28  0.00 0.05 0.03  0.00 0.04  0.00  0.27
 A 2          11.16 71.00 12.03 1.75  0.31 0.15 3.19  0.01 0.04 0.03  0.00 0.04  0.00  0.30
 A 3          11.13 71.84 11.33 1.76  0.31 0.14 2.97  0.01 0.04 0.03  0.00 0.03  0.00  0.40
 A 4          10.25 71.37 12.40 1.82  0.34 0.17 3.27  0.01 0.05 0.03  0.00 0.03  0.00  0.27
 A 5           9.65 72.52 12.01 1.66  0.39 0.15 3.27  0.01 0.04 0.03  0.00 0.03  0.00  0.25
-----------------------------------------------------------------------------------------------
Mean value:  10.53 71.56 12.00 1.80  0.35 0.15 3.19  0.01 0.04 0.03  0.00 0.03  0.00  0.30

Std. Abw.:    0.64  0.63  0.41 0.14  0.05 0.01 0.13  0.01 0.00 0.00  0.00 0.00  0.00  0.06
```

```
Spectrum:                 norm. C   Atom. C Error (1 Sigma)
El AN  Series    Net        [ppm]     [ppm]           [ppm]
-----------------------------------------------------------
Al 13 K-series   232   96456.72 106380.71          114.38
Si 14 K-series  3283  725171.71 768344.21         2733.78
K  19 K-series  1692  120064.95  91380.92           37.11
Ca 20 K-series   406   16576.89  12308.19            1.88
Ti 22 K-series   164    3866.63   2403.12            0.20
Mn 25 K-series   178    1471.95    797.29            0.02
Fe 26 K-series  5590   32719.67  17434.37            1.73
Rb 37 K-series   498     435.54    151.64            0.00
Sr 38 K-series   328     270.67     91.92            0.00
Zr 40 K-series   472     347.66    113.41            0.00
Ba 56 L-series   111    2479.97    537.38            0.28
Nb 41 K-series     0       0.00      0.00            0.00
Y  39 K-series    62      48.12     16.11            0.00
Zn 30 K-series    40      89.50     40.73            0.00
-----------------------------------------------------------
                 Total:1000000.001000000.00
```

A3-2.01.01



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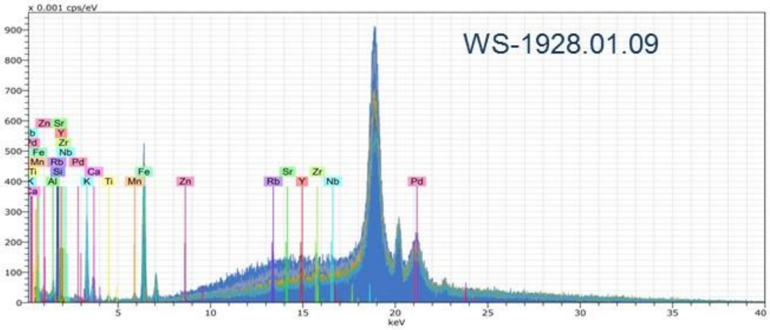
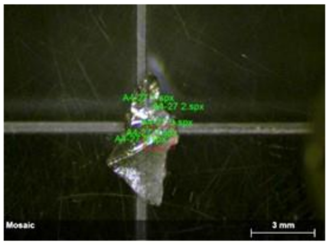


```
Mass percent (%)
Spectrum          Al     Si     K      Ca     Ti     Mn    Fe     Zn     Rb      Sr     Y     Zr     Nb    Pd
-------------------------------------------------------------------------------------------------------------
  A4-10 1       10.28  71.20 13.59  1.18   0.36   0.13  2.70  0.01   0.03    0.01  0.01  0.02  0.01  0.47
  A4-10 2        9.75  72.05 13.08  1.32   0.36   0.15  2.78  0.01   0.03    0.01  0.00  0.02  0.01  0.42
  A4-10 3        8.47  71.09 14.97  1.43   0.35   0.11  2.97  0.02   0.02    0.00  0.01  0.02  0.01  0.53
  A4-10 4        9.48  71.93 13.40  1.26   0.26   0.15  2.82  0.00   0.04    0.00  0.00  0.03  0.01  0.62
  A4-10 5        8.42  71.16 14.24  2.23   0.42   0.13  2.77  0.01   0.01    0.00  0.00  0.01  0.02  0.58
---------------------------------------------------------------------------------------------------------------
 Mean value:     9.28  71.49 13.85  1.48   0.35   0.14  2.81  0.01   0.03    0.00  0.01  0.02  0.01  0.52
 Std. Abw.:      0.82   0.46  0.76  0.43   0.06   0.02  0.10  0.01   0.01    0.00  0.01  0.01  0.00  0.08
```

```
                        norm. C   Atom. C Error (1 Sigma)
                         [ppm]     [ppm]           [ppm]
El AN  Series   Net
------------------------------------------------------
Al 13 K-series  209  84168.43  93609.90           109.62
Si 14 K-series 3404 711629.52 760345.64          2834.80
K  19 K-series 2111 142416.43 109305.37            52.93
Ca 20 K-series  555  22285.30  16685.98             3.07
Ti 22 K-series  180   4230.25   2651.25             0.17
Mn 25 K-series  162   1323.52    722.93             0.02
Fe 26 K-series 4776  27708.74  14888.68             1.41
Rb 37 K-series  171    146.23     51.34             0.00
Pd 46 K-series 1959   5803.19   1636.37             0.15
Nb 41 K-series  242    166.96     53.93             0.00
Zn 30 K-series   30     66.61     30.57             0.00
Zr 40 K-series   76     54.81     18.03             0.00
Y  39 K-series    0      0.00      0.00             0.00
Sr 38 K-series    0      0.00      0.00             0.00
------------------------------------------------------
               Total:1000000.001000000.00
```



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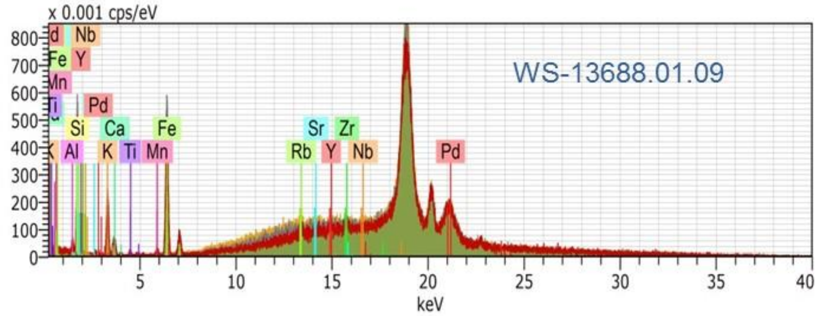

```
Mass percent (%) Al     Si     Cl     K     Ca     Ti    Mn    Fe     Rb      Sr      Y     Zr     Nb     Pd
---------------------------------------------------------------------------------------------------------------

  A4-27 1       10.77 71.69  0.20 12.34  1.25  0.36 0.15 2.72  0.03   0.00   0.01  0.01  0.01  0.45
  A4-27 2       10.82 69.02  0.62 13.81  1.89  0.39 0.15 2.75  0.03   0.00   0.00  0.00  0.02  0.50
  A4-27 3        9.35 71.91  0.02 13.07  1.50  0.40 0.16 3.10  0.01   0.00   0.00  0.00  0.01  0.46
  A4-27 4        8.69 71.03  0.65 13.49  1.89  0.31 0.15 3.16  0.02   0.00   0.00  0.01  0.01  0.59
  A4-27 5        9.63 71.66  0.37 12.58  1.56  0.26 0.17 3.14  0.03   0.01   0.01  0.01  0.01  0.57
---------------------------------------------------------------------------------------------------------------

 Mean value:     9.85 71.06  0.37 13.06  1.62  0.34 0.16 2.98  0.02   0.00   0.00  0.01  0.01  0.51
 Std. Abw.:      0.93  1.19  0.27  0.61  0.27  0.06 0.01 0.22  0.01   0.00   0.01  0.01  0.00  0.06
```

```
El AN  Series   Net   norm. C   Atom. C Error (1 Sigma)
                       [ppm]     [ppm]            [ppm]
-------------------------------------------------------
 Al 13 K-series  206  96287.08 106519.67         101.37
 Si 14 K-series 2887 716582.55 761574.87        2168.62
 Cl 17 K-series   29   3700.90   3115.92           0.51
 K  19 K-series 1604 125769.83  96016.78          33.40
 Ca 20 K-series  343  15613.69  11628.62           1.43
 Ti 22 K-series   98   2583.41   1610.52           0.08
 Mn 25 K-series  185   1706.49    927.17           0.02
 Fe 26 K-series 4797  31409.19  16787.48           1.33
 Rb 37 K-series  276    270.44     94.45           0.00
 Y  39 K-series  135    116.27     39.04           0.00
 Zr 40 K-series  172    141.95     46.45           0.00
 Pd 46 K-series 1671   5674.81   1591.68           0.12
 Sr 38 K-series   72     66.54     22.67           0.00
 Nb 41 K-series   97     76.86     24.69           0.00
-------------------------------------------------------
               Total:1000000.001000000.00
```

Appendix BB

X-Ray Fluorescence Tests from

Craig Skinner

Northwest Research Obsidian Studies Laboratory

Results of X-Ray Fluorescence Analysis

Craig E. Skinner

2015

Northwest Research Obsidian Studies Laboratory

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: Tse-whit-zen Village (45-CA-523), Clallam County, Washington

			Trace Element Concentrations									Ratios		
Site	Specimen No.	Catalog No.	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe^2 O^{3T}$	Fe:Mn	Fe:Ti	Geochemical Source
45-CA-523	1	A3-2.01.01	98	68	27	104	6	NM	NM	1240	NM	NM	NM	Glass Buttes 3
			± 2	1	1	1	1	NM	NM	22	NM			
45-CA-523	2	WS-1928.01.09	85	25	48	98	9	NM	NM	NM	NM	NM	NM	Glass Buttes 1 *
			± 1	1	1	1	1	NM	NM	NM	NM			
45-CA-523	3	WS-13688.01.09	90	23	47	84	9	NM	NM	NM	NM	NM	NM	Glass Buttes 1 *
			± 2	1	1	1	1	NM	NM	NM	NM			
NA	RGM-1	RGM-1	158	109	25	222	6	NM	NM	771	NM	NM	NM	RGM-1 Reference Standard
			± 2	2	1	2	1	NM	NM	23	NM			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured; * = Small sample; FGV = Fine-grained volcanic specimen.

Table 1. Summary of results of trace element analysis of obsidian artifacts.

PROJECT SITE	**N=**	**PERCENTAGE**
Glass Buttes 1	1	2
Glass Buttes 3	1	1
TOTAL	**6**	**7**

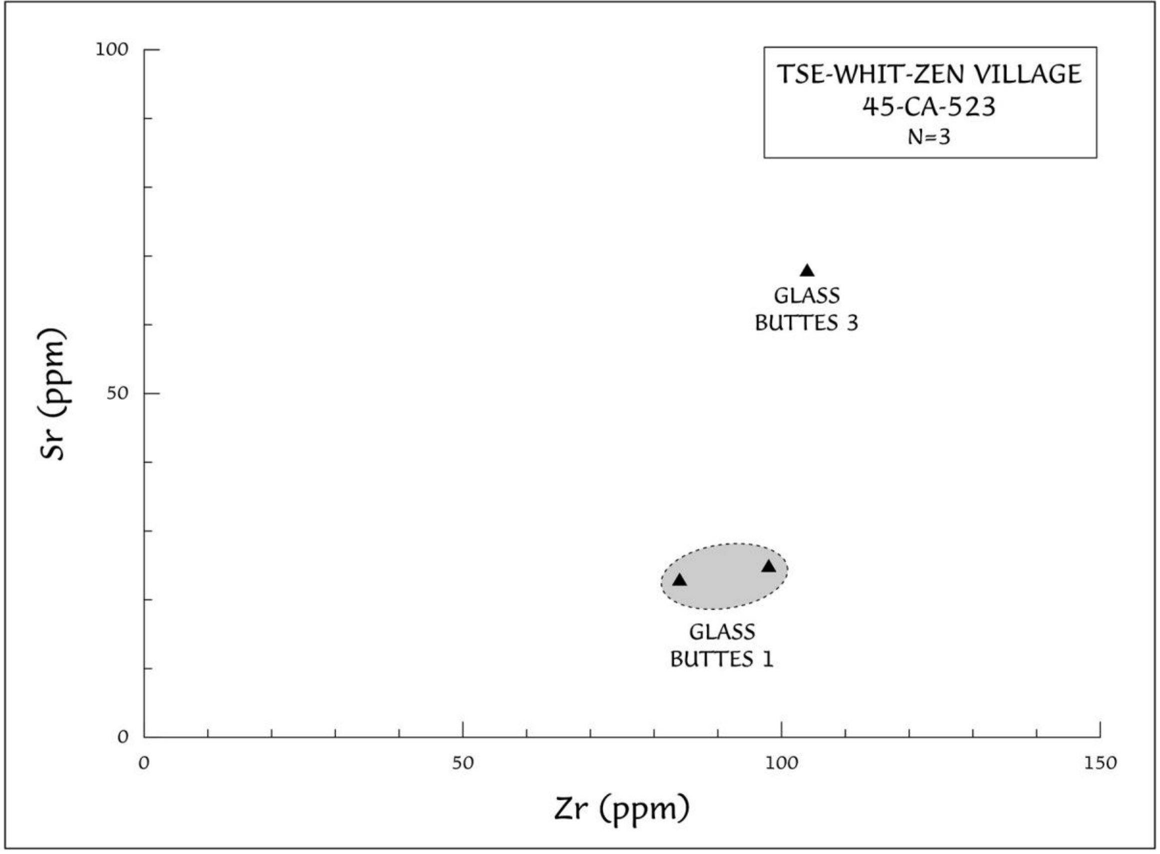

Figure 1. Scatterplot of zirconium (Zr) plotted versus strontium (Sr) for all analyzed specimens.