

**Lithic Technologies of the Discovery Islands:
Materials, Stone Tool Production, and Communities of Skilled Practitioners**

by

Callum William Filan Abbott
B.A. (Honours), University of Victoria, 2013

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

MASTER OF ARTS

in the Department of Anthropology

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Supervisory Committee

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Abstract

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This thesis explores the findings of a diachronic analysis of three lithic assemblages from Quadra Island, British Columbia. From this, insights flow about the genealogies of technological practice and communities of skilled practitioners who inhabited the study area throughout its deep history. I use qualitative and quantitative methods including macroscopic lithic analysis, thin section petrography, X-ray fluorescence spectrometry, and morphometrics to operationalize these theoretical foundations. This suite of complementary methods and theory weaves a narrative of technological change alongside simultaneous continuity for hundreds of generations of human life. I argue this is evidence of the dynamic, sophisticated, yet enduring knowledge and practice of the inhabitants of the Discovery Islands throughout their deep histories that persist in the present.

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Dedication

This thesis is dedicated to the First Nations communities who call the Discovery Islands “home.”

I hope this work adds to your already rich histories.

Chapter 1: Introduction and Objectives

1.1: Introduction

This thesis explores the findings of a diachronic analysis of three assemblages of lithic artifacts from a region known to contemporary settler society as Quadra Island, British Columbia, Canada. By tracking continuity and change in lithic technologies throughout the last 13,000 years of human habitation in this region of the Northwest Coast of North America, insights flow about the genealogies of technological practice and the communities of skilled practitioners who inhabited the study area throughout its deep history.

Throughout this thesis I explicitly take a *communities of practice* approach to my analyses, interpretations, research, and writing (Lave and Wenger 1991; Wenger 1998). My overall goal in using this theoretical and methodological lens is to better understand *the people* who made the stone tools recovered from archaeological deposits and to acknowledge that these pieces of material culture were never (and still are not) detached from the social contexts within which they were made and used (Perry 2003; Tringham 1996). More than utilitarian “tools,” I define technology as the means by which people mediate social relationships through the production and use of objects and thereby embody the making and remaking of their material worlds (Dobres 2000:1). This framework highlights the co-construction and reciprocal relationships between the makers of material culture and the things they make. Challenging conventional static notions of culture and technology focuses attention on the processes by which skills grow, knowledge spreads, personhood emerges, and communities form—thereby transforming one’s objects of analysis from nouns into verbs. Rather than thinking of these phenomena as fixed and finished products, they are better conceptualized as ever-emergent processes of learning, enskilment, knowing, doing, making, and becoming (Gosden and

Malafouris 2015; Ingold 2000, 2011, 2013, 2016; Lave 2011; Lave and Wenger 1991; Lyons and Marshall 2014; Nicholas 2010; Roddick and Stahl 2016; Wenger 1998). Balancing anthropological theory, empirically-robust methodologies, and reflexive practices opens doors to relational understandings of the past, ancient people, and the material traces of their daily lives. A socially- and historically-grounded approach attuned to the creative tensions at play in learning to make and use stone tools enables me to synthesize method and theory into an innovative way of doing lithic analysis. Using archaeologically observable data and “traces” (Joyce 2012, 2015), I construct genealogies of emergent technological practice (*sensu* Gosden 2005a; Logan and Stahl 2017; Pauketat and Alt 2005) for the generations of people and communities who inhabited the land- and seascapes of the Discovery Islands throughout their deep histories, creating in the process archaeological sites via their intergenerational material practices (Gamble 2017; Grier 2014; Grier et al. 2017; Joyce and Pollard 2010; Letham et al. 2017; Mathews 2014; McLaren et al. 2015; Mills and Walker 2008; Rahemtulla 2016; Randall and Sassaman 2017).

This research is a pilot study seeking to explore communities of lithic practice using a suite of methodological approaches. My methods include macroscopic attribute-based lithic analysis, thin section petrography, X-ray fluorescence spectrometry, and quantitative morphometrics. These interdependent methodologies are complementary ways of tracking stone tool production and use practices such as the selection and acquisition of lithic materials, the techniques of working stone, and the depositional practices that create archaeological deposits observable in the present. Given that my research questions are explicitly concerned with how these practices shift and remain stable through thousands of years, I embrace the data sets I work with for the palimpsests that they are as analytical pathways to genealogies of technological

practice over the *longue durée* (Braudel 1980; 1981). The everyday over millennia is the fulcrum upon which histories make people, but where people simultaneously make histories (Ortner 2006:2). As such, I am not focused on individual artifacts, stratigraphic layers, or components but rather on places of recurrent intergenerational depositional practices whose cumulative residues manifest as archaeological deposits. These “assembling processes” are better conceptualized as broad contexts of deposition, bringing together material assemblages of stone, earth, flesh, bone, knowledge, and practice through the millennia (Lucas 2012:188, 196).

Using the data, observations, and insights derived from the lithic analysis which constitutes the bulk of the empirical content of this thesis, this research also contributes to interdisciplinary dialogues of how embodied practices of everyday life are, in and of themselves, active sites of culture making (Bourdieu 1977; de Certeau 1984; Giddens 1984; Lefebvre 1991). This practice-oriented approach challenges Cartesian notions of material culture as a passive reflection of cultures “out there” and underscores the significance of “being-in-the-world” to the lived experiences and embodied knowledge of people in the past and the present (Ingold 1993; Morgan and Eddisford 2015; Perry and Morgan 2015). Given the dynamic and open-ended processes by which communities are made and remade during the actions of everyday life and their intimate enmeshment with heterogeneous material worlds, these processes have implications for communities of practice in the present as much as they do for the past. By extension, I too am embedded within similar processes of situated learning, enskilment, and knowledge production within my own communities of archaeological practice. Following this interpretive logic, I conclude with a holistic discussion of my own experiences of learning to make, use, and study stone tools and reflexively engage with how this inflects my research practices.

1.2: Research Objectives

“...ordinary material culture—the undecorated potsherd, *the casual flake*—forms the vast bulk of archaeological collections. If we theorize about ‘hot technologies’ [metalwork, exotic goods, cult gear, or monuments] rather than about everything else the archaeological record affords us, we are throwing away most of our data.”
(Robb 2007:2, emphasis added)

My research is driven by three interrelated questions (Table 1). Throughout this process I maintain a focus on the materials that compose the sampled lithic artifacts. This is for both practical and theoretical reasons. It is practical because it is a viable method for organizing and classifying the assemblages while conducting macroscopic lithic analysis. Likewise, these structured data sets facilitate sub-sampling for subsequent analyses such as thin section petrography (TSP), X-ray fluorescence spectrometry (XRF), and morphometric analyses. My theoretical rationale for this emphasis on materials is that the selection of lithic materials is a learned practice in and of itself. Moreover, this choice in the operational sequence (Lemonnier 1990; Leroi-Gourhan 1993[1964]) of flaked stone tool production and use affects all subsequent human gestures, techniques, and actions throughout lithic artifacts’ use-lives. I list my research questions below and follow-up with a brief discussion in order to set the stage for what is to come.

- 1) *What lithic materials did the ancestral inhabitants of the study area use to make stone tools?*
- 2) *What are the relationships between lithic materials and the flows of technological continuity and change?*
- 3) *What do lithic artifact morphologies reveal about the learned bodily practices of working with and shaping stone, using stone tools, and the depositional practices that create archaeological deposits?*

Table 1: Thesis research questions, methodologies, and data sets.

	Questions	Methodologies	Data Sets
1	<i>What lithic materials did the ancestral inhabitants of the study area use to make stone tools?</i>	Visual and tactile engagement Constructing a lithic material type comparative collection Thin section petrography X-ray fluorescence spectrometry	Lithic material type identifications and classifications
2	<i>What are the relationships between lithic material use and the flows of technological continuity and change?</i>	Macroscopic lithic analysis Descriptive statistics	Lithic material type identifications and classifications Lithic artifact typological classifications
3	<i>What do lithic artifact morphologies reveal about the learned bodily practices of working with and shaping stone, using stone tools, and the depositional practices that create archaeological deposits?</i>	Quantitative morphometrics Inferential statistics	Lithic material type identifications and classifications Metric data for morphological attribute sizes

My research workflow (Figure 1) builds successively on the results of each proceeding analysis and concludes with a holistic integration of the varied data sets I produce. I begin by examining each lithic artifact and assessing its material type. Using macroscopic lithic analysis methods and low-powered microscopy, I examine surficial characteristics such as the texture, grain size, homogeneity, phenocryst habit, and colour of each specimen. Concurrently, I examine every artifact's morphological attributes and classify it according to my own typological system based on Andrefsky's (2005) Generalized Morphological Typology.

I then sub-sample representative specimens of previously identified lithic material types in each lithic assemblage in order to evaluate the accuracy of my macroscopic identifications and classifications. I use two methodologies during these stages of analysis: 1) thin section

petrography (TSP) and 2) X-ray fluorescence spectrometry (XRF). These supplemental analyses and data sets are also useful in assessing the geological source locations for some of the sampled lithic artifacts—particularly ones made of obsidian.

In the next stage of my research I draw upon quantitative morphometric methods in order to study the shapes of the lithic artifacts. I argue that the shape of certain lithic artifacts—complete debitage flakes in particular—is the congelation of human gestures (Williams and Andrefsky 2011; Williams et al. 2013). These quantitative data sets are complementary to the qualitative analyses employed in other chapters of this thesis and are a means of discerning patterns of learned technological choices and depositional practices visible in the sampled lithic assemblages.

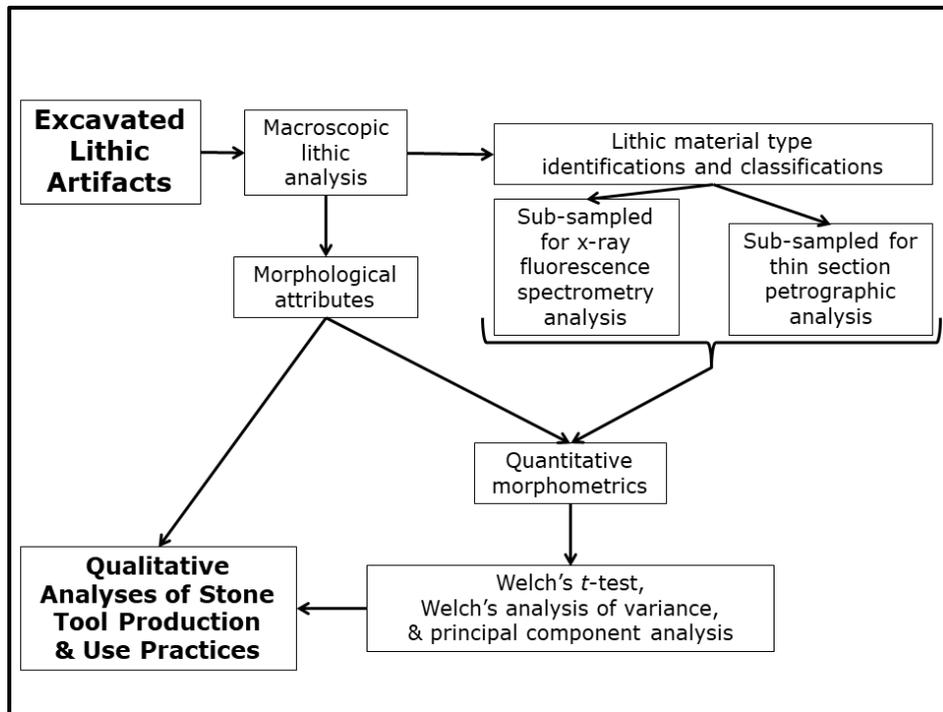


Figure 1: Thesis research workflow.

In short, this thesis is a diachronic case study of lithic technologies in a region of Northwest Coast that has seen little comprehensive archaeological research, despite being situated between better known archaeological regions such as the Queen Charlotte Strait to the

northwest and the Salish Sea to the south. A temporal cross-section of lithic technologies in the study area therefore provides valuable data in its own right for better understanding the region's histories.

An additional *raison d'être* of this thesis is to supplement critiques (Mackie 2001, n.d.; Martindale and Letham 2011; Martindale et al. 2017a; Moss 2011; Oliver 2007, 2010, 2014) of narratives based on notions of progressive developmentalism regarding the orthogenetic emergence of cultural complexity explicitly and implicitly espoused in much of the Northwest Coast archaeological literature. These teleologies are rooted in 19th-century unilineal social evolutionist typologies that can be traced back to Enlightenment ideals of a universal history grounded in ranked notions of Otherness (Fabian 1983, 2000; Gould 1996[1981]; Pels 2008; Stocking 1968, 1987, 1995; Trigger 1980, 1981, 1989). These same assumptions are recast and perpetuated by many archaeologists engaged in research on the Northwest Coast via the questions posed, the interpretations made, and the discourses circulated. Gary Coupland provides a poignant example of what was once (cf. Coupland et al. 2016) a deep-seated disciplinary metanarrative by stating “Marpole [culture type]...represents a fluorescent stage and *a cultural plateau*...The salient contribution of [Northwest Coast archaeology] is the study of cultural complexity” (Coupland 1998:50-51, emphasis added).

Because complex hunter gatherers defy what food producers should look like according to categorical anthropological conventions (Arnold et al. 2016; Butler and Campbell 2004; Groesbeck et al. 2014; Hoffmann et al. 2016; Lepofsky and Lertzman 2008; Lepofsky et al. 2015; Lertzman 2009; Lyons 2017; Lyons et al. 2018; Toniello 2017; Thornton 2015; Thornton et al. 2015; Turner et al. 2013), their alleged deviation from these stereotypes becomes reified as an object of investigation in its own right (e.g., Hayden 1994, 1995, 2005; cf. Prentiss et al.

2005, 2012; Prentiss and Kujit 2004). In other words, when *a priori* assumptions are made about what cultural and technological attributes (e.g., food storage and surplus, sedentism, and social hierarchy) constitute an abstract archaeological construct such as “cultural complexity,” a self-fulfilling feedback loop is created because the same attributes determine the presence of a phenomenon from which they are supposedly the outcomes (McGuire 1983:96). Examples of some resultant discourses include what Monks (1987) coins as “salmonopia” (e.g., Fladmark 1975; Donald 2003). Similarly, Bakewell (2005) critiques Northwest Coast lithic analysts for creating what he calls “basaltopia” in their insistence that all dark grey fine-grained volcanic rocks are basalts. While reflexive critiques are important parts of knowledge production processes, even research programs developed as corrective rebuttals to zooarchaeological anadromous ichthyophilia (e.g., McKechnie et al. 2014; Thornton et al. 2010) and singular lithic dogmatism are not immune to Kuhnian disciplinary paradigm shifts and may one day come to be known as herringopia or “daciteopia” (Osiensky 2014:10). Indeed, many of these same scholars problematize models that posit a solitary phenomenon (e.g., a species, a rock, a least cost path) as the singular driving force of cultural practices (e.g., McKechnie and Moss 2016; Rodrigues et al. 2018). McMillan and McKechnie’s (2015:14) observation that coastal First Nations manage and shape *many* biotic communities and resources emphasizes why monothetic explanatory models and “seductively elegant reductionist scenarios” (Logan and Stahl 2017:1357) should be considered with utmost reticence.

Often shrouded within terms such as economic rationalism, optimization, and resource exploitation, most archaeological research programs are arguably more strongly correlated with the neoliberal capitalist contexts within which many contemporary archaeological practitioners are situated than the lived histories of the people who inhabited the Northwest Coast since at

least the end of the Pleistocene (Clifford 2005; Dirks et al. 1994; Foucault 2002[1969]; Haraway 1988; Knauff 1996; Latour 1999; Stahl 2004; Trigger 1986; Wolf 1982; Wylie 1992a, 1996, 2000). While these paradigms are best thought of as circular or incomplete rather than wholly incorrect (Mackie 2001:6; Martindale and Letham 2011:15), critiques reveal the limitations of approaches grounded knowingly or unknowingly in nationalist, colonialist, and imperialist agendas (Trigger 1984).

A hallmark of this scholarship is an overwhelming concern with an imagined linear and irrevocable emergence of cultural complexity amongst ancestral Indigenous societies of the Northwest Coast (Mackie 2001:4-11; Mathews 2014:14; Moss 2011:29-32). Focusing investigations on this perceived cultural trajectory truncates the very histories that archaeologists try to understand by creating binary oppositions between complex hunter-gatherers and all others (Liebmann 2012; Stahl 2012)—not to mention the tacit gendered labour dichotomy “Man the Hunter, Woman the Gatherer” implied by the hunter-gatherer construct more generally (Moss 2011:29). A result of this exclusionary typological practice is to mark the rest of the ancestral inhabitants of the Northwest Coast, however they are inconsistently defined, as “simple” or “common” hunter-gatherers—with attendant hierarchical and isolating implications.

Within these incomplete and oversimplified frameworks that assume simplicity as a naturalized and universal cultural evolutionary starting point, it is the complexity of so-called complex hunter-gatherers—whose monumental architecture, captivating art, and stratified societies simultaneously fascinate and perplex those who subscribe to classical anthropological models of progressive developmental social evolution—that usurps the very people whose histories we study as the primary research focus (cf. Rowley-Conwy 2001). I argue, along with the scholarship of those cited above, that we must reframe our questions and research practices in

alternate terms. Rather than framing the lives of ancient people as stepping stones towards ethnographically-observed cultural patterns, I propose we shift our attention to the lived experiences of these people and the dynamic nature of communities-in-formation as gleaned through their associated material traces. While we can never fully know the people and communities of the past on their own terms, a communities of practice approach attentive to process (e.g., Fowles 2002; Gosden and Malafouris 2015; Martindale et al. 2017b; Sassaman and Holly 2011), relationality (e.g., Cruikshank 2005; Ingold 2007a, 2015, 2017; Losey 2010; van der Veen 2014; Watts 2013), and reflexive practice (Atalay 2012; Lyons 2013; McLay et al. 2008; Schaepe et al. 2017; Supernant and Lyons 2017) holds promise to more closely approximate the lived experiences of the people whose material culture we study as they deftly manoeuvred and (re)formulated their historically-situated socio-material worlds.

In sum, I investigate the multiscalar and emergent processes that shape and are shaped by situated learning and enskilment within communities of practice. In doing so, I directly link people, artifacts, and archaeological sites through the physicality of skilled movement and depositional practice (Gosden 2008; Joyce and Pollard 2010; Liardet 2014; Tringham 2013; Walls 2012, 2015). I focus my investigation on one particular technological practice: flaked stone tool production. I operationalize my theoretical foundations by tracking change and continuity in the sampled lithic artifact assemblages—proxies for the choices, predispositions, gestures, and actions of skilled practitioners as they engage in the *chaînes opératoires* (operational sequences) of stone tool production and use (Keller 2001; Lemonnier 1990, 1993; Leroi-Gourhan 1993[1964]).

Chapter 2: Geographic Focus

2.1: Geographic Focus – Introduction

The Discovery Islands study area and its adjacent waterways fall within the unceded traditional territories of the We Wai Kai, We Wai Kum, Kwiakah, K'ómoks, Xwemalhkwu, and Klahoose First Nations. These landscapes and seascapes are nestled between Vancouver Island to the West, Johnstone Strait and Queen Charlotte Strait to the Northwest, continental North America to the Northeast and the Salish Sea to the South (Figure 2). This chapter is intended to provide a concise overview of the study area of this thesis by providing contextual detail on aspects of the paleoenvironmental setting, the geological and geomorphological context, regional archaeological research to date, an ethnographic profile, and an introduction to the Discovery Islands Landscape Archaeology (DILA) Project within which my own research is situated.

2.2: Paleoenvironmental, Geological, and Geomorphological Setting

The glacial history of the Discovery Islands study area can be characterized by a series of advances and retreats that took place at varied tempos and scales during the terminal Pleistocene and much of the Holocene (Clague and James 2002). The complex interplay between isostatic rebound due to glacial loading and off-loading, eustatic fluctuations in sea levels caused by glacial melting, and plate tectonics means that relative sea level histories along the Northwest Coast are highly variable from region to region (Eamer et al. 2017; Fedje and Christensen 1999; Fedje et al. 2005a, 2009, n.d.; Letham et al. 2016; McLaren et al. 2014; Shugar et al. 2014). A study conducted by James et al. (2005) within the vicinity of the Discovery Islands study area suggests that relative sea levels in this region were over 180 meters above modern sea level (hereafter ASL) during the terminal Pleistocene-early Holocene transition approximately 14,000 years ago, followed by a rapid drop (~10 cm/year) to about 5 meters ASL by 12,000 cal BP.

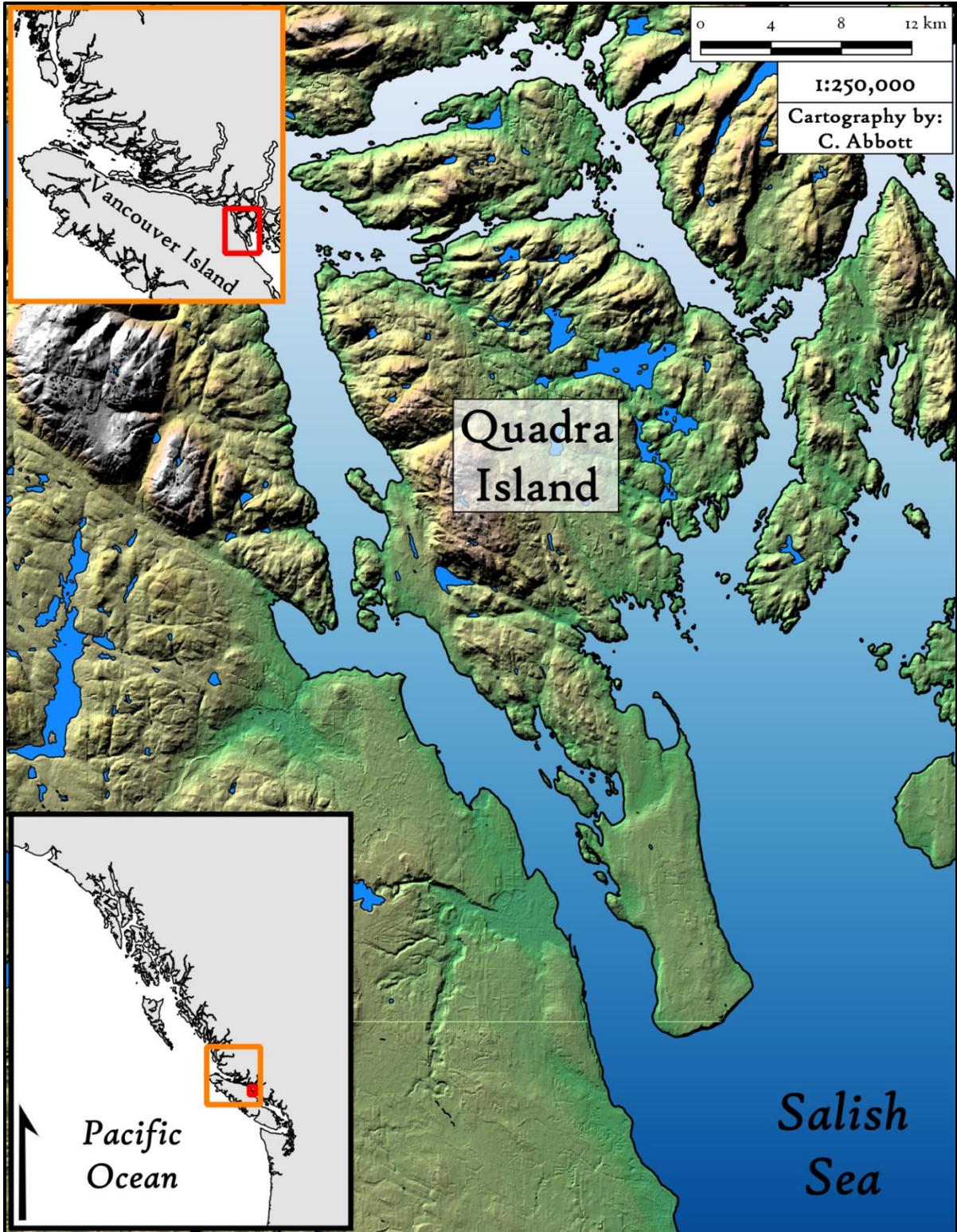


Figure 2: Overview of the Discovery Islands study area.

After this time, there appears to have been a subtle transgression of relative sea levels followed by a gradual regression for the next 11,000 years until the present shoreline configurations emerged (Fedje et al. n.d.; Figure 3).

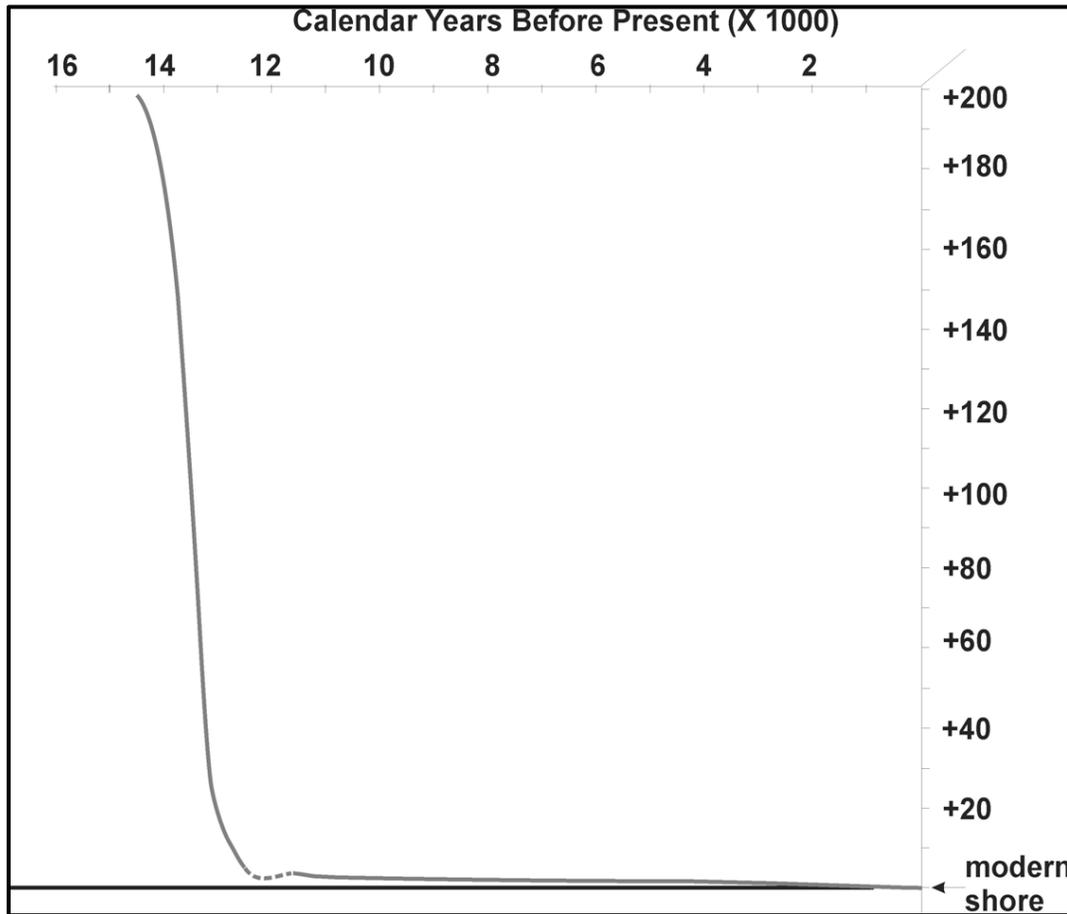


Figure 3: Quadra Island relative sea level curve (Fedje et al. n.d.).

Palynological research by Brown and Hebda (2002) indicates that flora communities proximal to the Discovery Islands study area during post-glacial times were initially composed of pine forests, followed by a mix of pine, spruce, fir, and hemlock. Around the mid-Holocene Douglas fir and alder dominated the region's flora communities, followed by western hemlock, spruce, and fir. The modern vegetation communities are typical of the Coastal Douglas-fir biogeoclimatic zone, containing Douglas-fir, grand fir, western redcedar, bigleaf maple, sword fern, salmonberry, and trillium (Krajina 1965).

The regional geology of western North America is diverse. This region is comprised of an extensive system of mountain ranges and plateaux called the Canadian Cordillera which stretches from below the 49th parallel in the south to the Arctic Ocean in the north, the eastern foothills of the Rocky Mountains in the east, and the continental slope of the Pacific Ocean in the west. This extensive geophysical region can be subdivided into five distinct belts or “terranes” based upon criteria such as rock type, internal structure, and physiography (Yorath 2005:11). These five terranes run in a roughly linear, north to south direction. From east to west the names of the terranes are the Foreland Belt, the Omineca Belt, the Intermontane Belt, the Coast Belt, and the Insular Belt (Gabrielse et al. 1991). The Insular Belt is the result of a collision between the western edge of Laurentia, the name of ancient North America, and Wrangellia, a piece of the Earth’s crust formed at distant latitudes. Vancouver Island and most adjacent Gulf Islands, including Quadra Island, are almost entirely underlain by the rocks of the Wrangellia Terrane or the Insular Belt. Wherever the petrogenesis of Wrangellia occurred, it underwent significant tectonic displacement before it accreted to the western margin of Laurentia (Mathews and Monger 2005).

The Discovery Islands have a moderately diverse bedrock geology. Quadra Island is one of the few places where the boundary between the Insular Belt and the Coast Belt is exposed. While the majority of the boundary between the Insular and Coast Belts is submerged in the ocean or beneath terrestrial sediments, there is a subaerial outcrop exposure at Open Bay that marks the transition from the Quatsino Formation to the Coast Plutonic Complex (Carlisle and Susuki 1965). West of the interface between the Insular and Coast Belts the bedrock geology is basaltic volcanic and undivided sedimentary rocks, while the geology east of the interface is

characterized by a mix marine sedimentary and volcanic rocks along with various intrusive dioritic rocks (Figure 4).

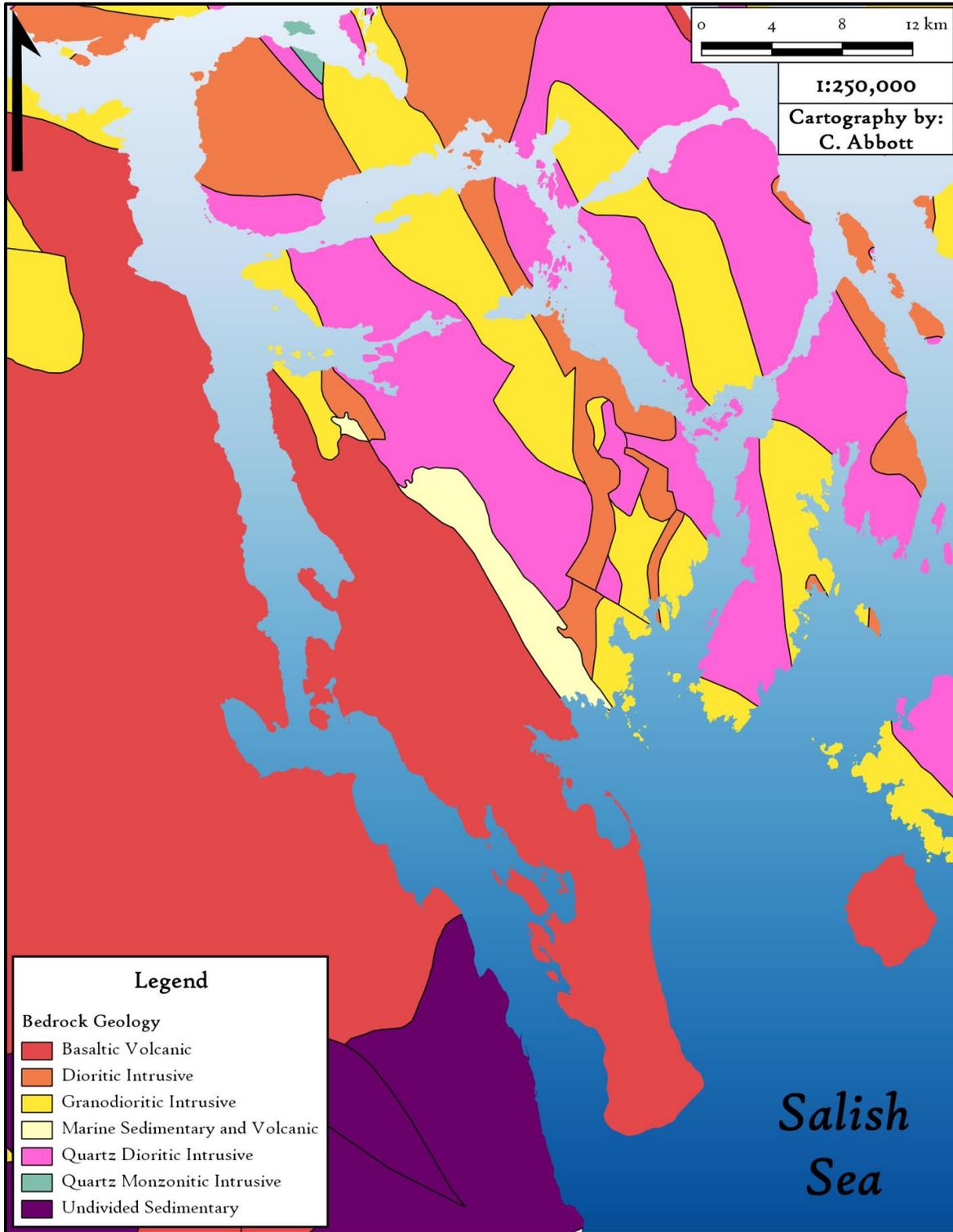


Figure 4: Discovery Islands geological context.

Overlaying the bedrock geology of the Discovery Islands is a geological unit called the Quadra Sand which covers southern Quadra Island (Clague 1976, 1977). Quaternary glacial advances and retreats since at least the Fraser Glaciation approximately 30,000 years ago caused significant modifications to the landscape by eroding, sculpting, transporting, and depositing rocks and sediments (i.e., glacial till) in thick layers that cover the Quadra Sand and the underlying bedrock geology. Adding further complication to these paleoenvironmental processes, subsidence events such as earthquakes, landslides, tsunamis, and liquefaction were likely regular occurrences throughout the Holocene (Crowell 2017).

2.3: Regional Archaeological Chronologies

Prior to several recent archaeological and historical ecological studies (e.g., Crowell 2017; Fedje et al. 2016, n.d; Groesbeck et al. 2014; Toniello 2017), little comprehensive research was conducted in the Discovery Islands study area. A coarse solution to this lacuna of archaeological knowledge is to examine the regional archaeological chronologies for nearby zones that are more thoroughly researched. In this section I conduct a brief literature review and outline regional chronologies for the Salish Sea and the Queen Charlotte Strait, with an emphasis on diagnostic lithic technologies. I purposefully present these data in a neutral descriptive manner in order to avoid portraying the histories of these regions in an orthogenetic fashion, as I critique in the introductory chapter of this thesis.

The oldest currently known and well-documented archaeological sites in the Salish Sea, Ayer Pond (Kenady et al. 2011) and the Manis Mastodon Site (Waters et al. 2011), set a minimal temporal threshold for human habitation in the region at 13,800 cal BP despite a lack of associated lithic technologies. The oldest currently known culture-historic units on the Northwest Coast are the Western Stemmed and Paleoarchaic which date from approximately 10,000 cal BP

to at least 13,200 cal BP (Davis et al. 2012, 2014; Kopperl et al. 2015). Diagnostic technologies include prepared core technology, stemmed, or leaf-shaped projectile points, microblade technology, and expedient opportunistic multidirectional and bipolar technologies. Prepared cores are generally unidirectional blade-like flake, discoidal cores, and Levallois-esque. I discuss the distinctions and relationships between these prepared core technologies in greater detail in Section 5.4.1 but, briefly, all involve the preparation of a platform and, save for unidirectional technology, the removal of flakes from the perimeter of a core towards the center in a radial pattern. Notably, recent investigations by the DILA project at the Yeatman Bay (EbSh-98) site on the east coast of Quadra Island indicate that discoidal and Levallois-esque technologies are present within the study area at approximately 11,000 cal BP.

The next culture historic unit in the neighbouring regional archaeological chronologies is Old Cordilleran which dates from approximately 10,000 cal BP to 5000 cal BP in the Salish Sea (Carlson 1990a; Matson and Coupland) and 6000 cal BP in the Queen Charlotte Strait (Mitchell 1988). Diagnostic technologies include leaf-shaped bifaces, unifacial choppers, and granite technologies.

After the Old Cordilleran culture historic unit, there is a series of shorter culture historic units in the Salish Sea region. The first is Charles (5000-4000 cal BP) with a focus on flaked stone tools including pebble tools, leaf-shaped bifaces, contracting stem bifaces, and bipolar technology (Pratt 1992). Locarno Beach (4000-3000 cal BP) diagnostic lithic technologies include ground and flaked slate projectile points and knives and microblade technology (Burley 1980; Matson and Coupland 1995; Mitchell 1971; Pratt 1992). Marpole (3000-2000 cal BP) diagnostic lithic technologies include ground slate knives and large celts, microblade technologies, and “nipple-top” hand mauls (Burley 1980). Strait of Georgia (2000 cal BP to

contact-era) diagnostic lithic technologies include side-notched triangular arrowheads and ground slate knives (Mitchell 1971).

The Queen Charlotte Strait archaeological chronology is much less well known relative to the Salish Sea. After the Old Cordilleran, there is a gap in the chronology for approximately 1500 years before the Obsidian Culture Type (4500-4000 cal BP) with a focus on bipolar technology and obsidian as a preferred lithic material for fashioning stone tools (Mitchell 1988). The Queen Charlotte Culture Type (3000 to contact-era) is after another gap in the chronology and is characterized by flat topped hand mauls, stone discs, hammer stones, irregular and shaped abrasive stones, and ground stone celts (Mitchell 1990).

2.4: Ethnographic Context

As mentioned at the beginning of this chapter, The Discovery Islands study area is located in the unceded traditional territories of the We Wai Kai, We Wai Kum, Kwiakah, K'ómoks, Xwemalhkwa, and Klahoose First Nations. The purpose of this section is to acknowledge the people and communities who call the Discovery Islands study area “home.” As such I draw on ethnographic texts in order to provide a short account of the cultures of these communities. Given the cursory nature of this section, I emphasize that this is not a thorough ethnographic literature review nor is it intended to speak for these communities.

The ethnographic record of the Northwest Coast is a rich literature. However, uncritical applications that perpetuate and reify an ethnographic present (Meskell 1998, 2002; Trigger 1980, 1981, 1989) and propagate myths of the “unchanging Native” (McMillan 1996:7) are problematic. The era during which the bulk of ethnographic fieldwork was conducted was a time of radical changes to First Nations material culture, subsistence practices, settlement patterns, population sizes and distributions, as well as the extent and nature of social networks. Moss

(2011:23) insightfully and rightfully states that “how we use the ethnographic record affects how we interpret the past” and “First Nations societies are products of their histories, as are all societies...these societies should not be deployed by archaeologists as models for or simulacra of pre-contact societies.” Nonetheless, it is important to recognize that ethnographically documented practices hold value as sources of analogical comparison for past practices despite being the outcomes of complex historical trajectories (Stahl 1993). For these reasons, I concur with Grier’s (2007:305) recommendation that anthropological and archaeological research should work “both in conjunction with and independently of the ethnographic record in a reflexive interplay.”

The histories of the southern Kwakwaka'wakw (We Wai Kai, We Wai Kum, Kwiakah First Nations) and the northern coast Salish (K'ómoks, Xwemalhkwi, and Klahoose First Nations) are complicated. On the one hand, there are accounts of war, bloodshed, and territorial displacements (Angelbeck 2009; Angelbeck and McLay 2011; Taylor and Duff 1956). On the other hand, the importance of relations and connections between them through reciprocal trade and exchange, intermarriage, and resource co-stewardship must not be overlooked. For example, Thom (2005:362) discusses how a marriage between a Cowichan woman and a Laich-kwil-tach man ended the wars and “reopened the Cape Mudge area for island Coast Salish people to fish and camp at for generations after the couples were wed.” This juxtaposition emphasizes the need to be aware of the social, cultural, and material relations within and between these communities that ebb and flow throughout the past and into the present.

The We Wai Kai, We Wai Kum, and Kwiakah First Nations collectively identify as the Laich-kwil-tach. They are members of the Wakashan language family who speak Líq^wala, a dialect of Kwak'wala (Boas 1897). Laich-kwil-tach people trace their origin to the Johnstone

Strait region and aggressively expanded their territory southwards in the late pre-contact era (Bouchard and Kennedy 2002:291; Codere 1990:359). Their current settlements are found at former Island K'ómoks village sites at Cape Mudge and Campbell River. Galois (1994:51-55) describes the recent history of the Laich-kwil-tach as “complex and dramatic, encompassing wars, mergers, and divisions, the end result of which was a significant territorial expansion...apparently beginning prior to direct contact [with Europeans]” and “by 1847, the [Laich-kwil-tach] controlled Quadra Island, adjacent portions of Vancouver Island, and access to Discovery Passage.” Although the exact timing of the Laich-kwil-tach movement into the Discovery Islands study area is debatable, there is considerable evidence of dynamic territorial, social, and linguistic shifts throughout the contact-era. This is most clearly exemplified by the K'ómoks who originally spoke the Island K'ómoks dialect of the Salish language family but have since adopted the Líq'wala dialect. Besides Laich-kwil-tach territorial expansions, population declines stemming from European-introduced epidemics and differential access to firearms likely also contributed to this linguistic shift. However, it is possible that the Island K'ómoks dialect continues to be spoken and is unknown to anyone besides its speakers. A large portion of the K'ómoks First Nation lives on a reserve near Comox Harbour (Kennedy and Bouchard 1990:441; Bouchard and Kennedy 2002:177).

Despite the relatively recent Laich-kwil-tach settlement in the Discovery Islands, there is a strong sense of identity and place amongst the current inhabitants of the study area. An illustration of this can be seen upon examining some of the local place names and oral histories associated with them. Harry Assu identifies *təka* (EdSk-6) at Topaze Harbour in Jackson Bay as a Laich-kwil-tach origin site. It is at this place that “our people were saved at the time of the Flood” by Wai-Kai, the great chief from whom both the We Wai Kai and We Wai Kum First

Nations take their names (Assu and Inglis 1989:3). From here, ancestral Laich-kwil-tach people moved south to *tatapaʔulis* at Whiterock Passage between Read and Maurelle Islands (Assu and Inglis 1989:6). Galois (1994:238) cites this as the location where contemporary subgroups such as the We Wai Kai, We Wai Kum, and Kwiakah split from one another. It should be noted that this place is currently within a Xwemalhkwa reserve which highlights the complicated systems of land and sea tenure within the study area (Assu and Inglis 1989:6). The Kwakʼwala name of Cape Mudge is *tʼsakwaʼlutan* and is described as a Kʼómoks village site prior to Laich-kwil-tach settlement in the Discovery Islands (Galois 1994:274). For a more comprehensive list and description of Laich-kwil-tach place names within the Discovery Islands study area, see Galois (1994:223-276).

As noted above, Kʼómoks communities spoke the Island Kʼómoks dialect of the Salish language family prior to their adoption of Líqʼwala. Xwemalhkwa and Klahoose communities speak the Mainland Kʼómoks dialect of the Salish language family and maintain close affiliations with other Salish speaking communities such as the Sliammon and Sechelt First Nations. Barnett (1938, 1939, 1955) provides an ethnographic overview of Indigenous communities throughout the entire Salish Sea while Kennedy and Bouchard (1983, 1990) focus much more on the communities whose traditional territories are within or near the Discovery Islands study area.

Kennedy and Bouchard (1983:167-169) list several Island Kʼómoks place names within the study area. These include *xwémkwu* (“fast water”), the Island Kʼómoks name for Seymour Narrows; *má7tʼey* (“horse clam”), the name of a large whirlpool at the south end of Seymour Narrows caused by the (now destroyed) underwater rock formation called Ripple Rock; *ká7gichn* (“bent over back”), an Island Kʼómoks village site last inhabited in the mid-1800s where the

stream from Morte Lake enters the shallow bay east of Maud Island; *mímtl'íchn* (“always calm area”), the Breton Islands near Heriot Bay; *kwésay'skin* (“island in mouth”), Quathiaski Cove on the west side of Quadra Island; *ch'kwíwutn* (“Indian-game place”), the southern tip of Quadra Island in the vicinity of the Cape Mudge reserve. The *xwésam* (“having fat or oil”) site at Salmon River in Kelsey Bay was once an Island K'ómoks village site but later became a Laich-kwil-tach settlement.

The Xwemalhkwa and Klahoose First Nations traditional territories include Toba Inlet, Bute Inlet, East and West Redonda Islands, Read Island, parts of Cortes Island, and the adjacent waterways (Bouchard and Kennedy 2002:221; Kennedy and Bouchard 1983, 1990:441-443). Many Xwemalhkwa and Klahoose communities live near the modern settlement of Powell River although they continue to have place names and reserves throughout the study area, of which Kennedy and Bouchard (1983:149-170) offer a detailed account.

2.5: The Discovery Islands Landscape Archaeology Project

The Discovery Islands Landscape Archaeology Project (DILA) is a multi-year research project co-directed by Daryl Fedje and Dr. Quentin Mackie. The primary focus of the project is the early human history of the Discovery Islands, with an emphasis on Quadra Island. Since 2013, a collaborative team of academic, Indigenous, and independent archaeologists has been conducting paleoenvironmental, survey, and excavation-based research on the island. Together we have identified, excavated, and recorded a number of archaeological sites dating to throughout the Holocene.

As discussed in Section 2.2, the sea level history of the Discovery Islands study area changed dramatically during early post-glacial times. As such, refining the local relative sea

level history was a priority during the first years of the DILA project. Sea level curve reconstruction methods included include isolation basin coring (freshwater and marine; Figure 5), natural exposure survey, geomorphic feature survey, and archaeological subsurface testing. Lab analyses focused on core and sediment sample description, diatom analysis, and radiocarbon dating. Sample preparation and diatom analysis was conducted at the University of Victoria and the Hakai Institute Quadra Island Field Station. A publication based on this research program is currently under review (Fedje et al. n.d.).

Using these data to refine the local sea level curve, we were able to target landforms hypothesized to have high potential for late Pleistocene and early Holocene archaeological deposits, although we also identified sites that date to throughout the Holocene. Survey methods consisted of meandering pedestrian traverses and visual inspection of exposed surfaces such as beaches, eroding sediments, creek banks, and tree throws (Figure 6).

In areas assessed to have a high potential for intact archaeological deposits, subsurface testing occurred using soil probes, bucket augers, shovel test, 50 cm² trowel tests, and column sampling from exposures and subsurface test profiles. Soil matrices from trowel, shovel and auger test samples were screened through 3 mm or 6 mm screens. Zones confirmed to have intact archaeological deposits estimated to be relevant to DILA research questions were further explored via controlled excavation, typically in 50 cm² or 1 m² units. Excavation was most often conducted in 10 cm arbitrary levels, but was occasionally reduced to 5 cm arbitrary levels, or a combination of natural layers and arbitrary levels. Where subsurface archaeological materials were recovered, representative profiles or profile schematics were drawn and photographed.



Figure 5: Isolation basin coring at Chonat Lake (left; Photo D. McLaren) and Assu Lake (right; Photo J. McSporrán).



Figure 6: High elevation exposure survey (Photo J. McSporrán).

Column samples were taken from selected profiles for analysis for geoarchaeological questions, or for fine screening for faunal remains, floral remains, or to recover other small cultural remains such as microdebitage.

As of the summer of 2017, the fieldwork component of the DILA project is finished. We are now completing lab analyses, finalizing reports and publications, as well as preparing collected cultural materials for repository submission at the Royal British Columbia Museum in Victoria, BC.

2.6: Geographic Focus Discussion

In sum, the DILA project was a success and our collective archaeological knowledge of the human history of the study area is much greater than it was at the outset of the project in 2013. As discussed in Section 2.4, the Indigenous histories of the Discovery Islands are rich and deep. Part of these rich histories includes territorial, linguistic, and cultural dynamism shortly before and during the contact-era. As such, I felt considerable anxiety during the planning stages of this project about attributing the material culture I was encountering and working with during field and laboratory work to any one specific Indigenous community over the other. This, in part, compelled me to seek out alternative ways of thinking through and engaging with the histories and material culture of the ancestral inhabitants of the study area whose descendants are dispersed across at least six different contemporary First Nations communities. What I required was a conceptual framework that emphasizes people and communities learning, making, and using lithic technologies by highlighting the social relationships within which they live their lives, the topic I turn to in the following chapter.

Chapter 3: Theoretical Framework

3.1: Situated Learning as Making Communities of Practice

“...activity and the world mutually constitute each other.”
(Lave and Wenger 1991:33)

In his manifesto for anthropology as a discipline of correspondence and care, social anthropologist Tim Ingold puts his finger on a humble idea that is fundamental to the arguments I make here: “to join with others” (Ingold 2017:24). These “others” may take many forms that include, but are not limited to, people, communities, objects, technologies, materials, and practices. This process of joining needs to be done carefully though because, as Deloria (1969) and Zimmerman (2009) rightfully observe, archaeologists can (and have) hurt people in their reckless assumptions of their own infallible objectivity. Therefore, interrogating and complicating one’s taken-for-granted dualistic assumptions (Lévi-Strauss 1966, 1983[1964]; Mauss 1990[1935]) is arguably requisite for reflexive and ethical archaeological practice.

Much like the problematic “cultural complexity” binary construct prevalent in much of the Northwest Coast archaeological literature, I problematize other binaries such as heart:mind, body:brain, flesh:soul, nature:culture, us:them, here:there, then:now, and space:time as equally suspect ontological paradigms. “Humanness” according to a Western dualistic ontology is a “paradox of a form of life that can realise its own essence only by transcending it” (Ingold 2011:8). Rather, ontological pluralism accentuates life worlds as “thoroughly entangled rather than transcendent and/or oppositional” (Alberti et al. 2011:896). In contrast to epistemology as a way of knowing, ontology is a way of being (Thom 2017:141). The diversion of scholarly attention towards “being, becoming, existence, and relation” (Lyons et al. 2016:360) shifts analytical awareness from what things *mean* to what things *do* (Fowles 2016:21; Robb 2015).

Therefore, I take a pluralistic ontological approach to my analyses in the pages and chapters to come.

Before moving on, an elaboration of the *communities of practice* literature is warranted. Importantly, this perspective emphasizes the constant socially- and historically-situated learning that takes place during everyday activities and its role in how people come to know and be via processes that Jean Lave and Etienne Wenger term “legitimate peripheral participation” (Lave and Wenger 1991:29). The situated learning analytic is a means of grappling with how apprentices and masters, new-comers and old-timers, as well as their dynamic activities, identities, objects, technologies, and knowledge systems are pervasively enmeshed with one another, thereby highlighting the relational and emergent *processes* of knowledge (re)creation within and across generations. Moss’ (2017) observation of a skilled Tlingit man skinning and butchering a sea otter and the situated insights she developed as a zooarchaeologist studying cultural modifications to bone is an excellent example of legitimate peripheral participation taking place in a cross-cultural context. Similarly, Carriere and Croes’ (2018) “Generationally-Linked Archaeology” connects contemporary cultural specialists with ancestral specialists through collaborative replicative practice.

Contrary to many mainstream models of knowledge transmission that posit knowledge and skills to be handed down in an ahistorical manner as inert and prepackaged blocks (or any other similarly static metaphor), understanding in practice means knowledge and skills are grown organically through situated learning. Each generation of people must discover, grow, and learn for themselves, albeit with guidance from their predecessors (Hallam and Ingold 2014; Lave 1990, 1996). Within this framework, knowing and doing are ecological questions involving a developmental interdependence of bodies, materials, social relations, and environments (Walls

2012, 2015; Walls and Malafouris 2016). This model of learning and enskilment positions making, sustaining, and identifying within communities of practice—defined by Lave and Wenger (1991:98) as “relations among persons, activity and world, over time and in relation to other tangential and overlapping communities of practice”—as key sites where social life is produced and reproduced (Roddick and Stahl 2016:3).

Lave and Wenger’s (1991) emphasis on the interconnected dynamism of community-making and the flows of life worlds fits with the ethos of ontological pluralism. Contrary to Western metanarratives that privilege product over process, situated learning privileges process over product. My goal is not to discover or impose meaningful social units of analysis, but instead to underscore the processes by which communities of practice continually come into being—processes with power-laden and emotional dynamics that simultaneously constrain and produce possibility (Crown 2016; Dilley 2010; Harris and Sørensen 2010). The *communities of practice* concept provides an alternative to potentially reifying and homogenizing archaeological taxonomies such as culture types, phases, sites, or cultural complexity (Blair 2016; Roddick 2009; Stahl 2013, 2016a). Knowledge “on the move” (Lave 2011:174), “in motion” (Roddick and Stahl 2016:28), that “is living [and] breathes” (Lyons and Marshall 2014:510-511), and that “arises from be[com]ing” (Gosden 1994:11) cross-cuts and confronts the dualistic ontologies I critique. As Lave (2008:290) poetically puts it, situated learning is a “way of looking, not a thing to look for.”

In sum, the rationale underlying this research and my chosen methods is grounded in the notion that community- and history-making are dialectical, emergent, and on-going processes with similarly patterned and, importantly, archaeologically observable material traces. I argue this analytical assumption creates productive spaces for insight, given that patterns within

archaeological assemblages and their constituent artifacts are the distillation of a range of discursive and non-discursive choices (Roddick 2013; Roddick and Hastorf 2010). These choices—and associated bodily practices—literally shape individual and collective identities in a mutual and cyclical fashion (Budden and Sofaer 2009; Marchand 2010; Mauss 1979[1935]; Joyce 2005; Robb and Harris 2013; Sofaer 2011; Stahl 2002; Wendrich 2012). It is in these corporeal “doings” (Fowles 2013; Figure 7) that gestures are practiced, skills are grown, innovations are developed, traditions are sustained, and identities are negotiated because

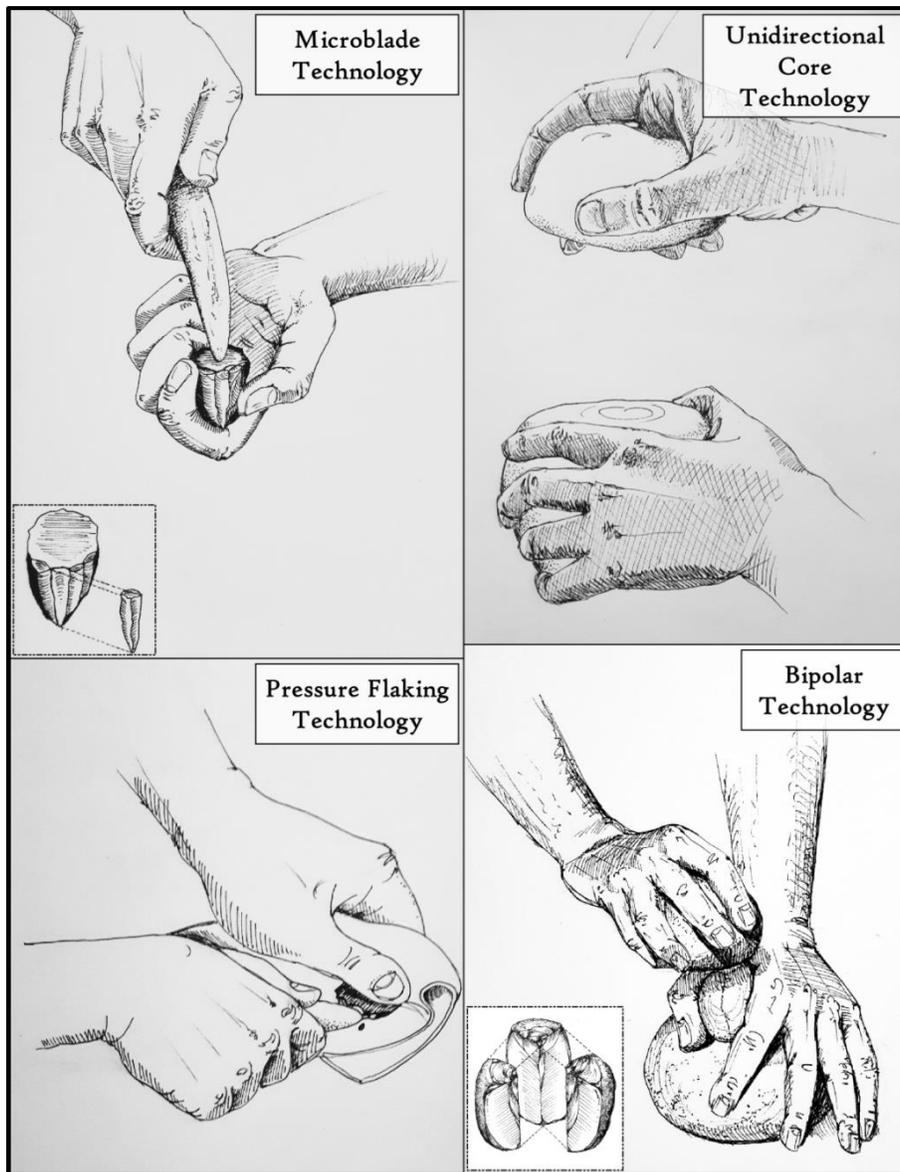


Figure 7: Gestures of stone tool production (Illustrations S. Specker).

“identity, knowing, and social membership entail one another” (Lave and Wenger 1991:152-153). As Bourdieu (1977:35) states, identities “are something people make, and with which they do something.” Personhood is embodied through practice and the study of these processes offers insights about the larger frames of social engagement within which the actions of day-to-day life are situated (Roddick 2009:7; see also Overholtzer and Robin 2015). Moreover, the archaeological study of how material practices shape emergent individual and community identities is operationalized through well-developed analytical methods *vis-à-vis* technological choice and operational sequence (Keller 2001; Lemonnier 1990, 1993; Leroi-Gourhan 1993[1964]).

3.2: Relational Materials: Stone Tool Use-Lives and Lives Lived by Stone

“...practice rests upon a set of relations: relations between persons acting and relations between the social and material worlds.”
(Gosselain 2016a:202)

Key insights of the historical, material, and ontological turns of the 20th- and early 21st-centuries are that creative engagements between materials and social processes shape life itself and that the constitution of life worlds are relational rather than essential (Alberti et al. 2011; Descola 2009, 2013; Viveiros de Castro 1998, 2015; Latour 1993, 2005, 2013; Paleček and Rišjord 2012; Trouillot 1995). As Kakaliouras (2012:S213) notes, “it is not that one way of seeing a thing is more true than another but that the things themselves are produced, maintained, conceived of, and operate in different worlds.” However, paralysis by ontological or epistemological hypochondria (Pels 2008:287) and nihilistic solipsism undermines knowledge production practices and any hope of mobilizing knowledge for altruistic goals. As medical anthropologist Clarence Gravlee argues, culturally constructed categories such as race and gender become embodied through naturalized inequalities like systemic racism and sexism to

form “embedded bodies” (Niewöhner 2011:289) and “local biologies” (Lock 2013:292) with real epidemiological consequences including cancer and cardiovascular disease (Gravlee 2009; see also Gosden 2006). Dismissing race and gender as cultural constructs does not alleviate the realities of health and social inequalities for marginalized people because human biology does not exist without culture and culture is always in biology (Goodman 2013:368). Rather, they are mutually bound up in localized social historical processes.

In a similar vein, historical ecologists postulate all places on Earth have been affected by humans (Balée 2006, 2013; Balée and Erickson 2006; P. Stahl 2011, 2014) and ecosystems are better conceptualized as landscapes or ecoscapes comprised of “historically-particular nexus[es] of ecological and social factors” (Sepez 2008:112). These obstreperous nexuses upset colonial notions of space and place as *terra nullius incognita* by demonstrating the social-historical-ecological processes within which humans are intimately enmeshed, both now and throughout the past (Abbott 2017; Armstrong et al. 2017; Campbell and Butler 2010; Earnshaw 2016; Eldridge 2017; Mathews and Turner 2017; McKechnie 2015; Salomon et al. 2018; Stafford and Maxwell 2006; Turner 2014). In an applied legal sense, these widespread historical ecologies have strong repercussions for Indigenous Rights and Title cases (Armstrong and Veteto 2015; Earnshaw 2017; Martindale 2014; Miller 2011).

My point is, it should not be much of a leap across an ontological chasm to accept that archaeological artifacts, materials, and lithic technologies can “act back” (Loring and Gero 2012; Mathews 2014:9; Miller 2010; Pollard 2008:47; Robb 2015). Indeed, “ontologies are materially constituted and materials are negotiated ontologically” (Harris and Robb 2012: 676-677). This “materiality in the making” is a process in which objects and people are made and unmade, in which they have no stable essences but are contextually and historically contingent, and mutually

bring each other into being (Lucas 2012:165-166). Suffice to say, many—although far from all—contemporary archaeologists now “take materials seriously” (Ingold 2007a:14) and “take seriously the situated nature of what all thinkers do” (Rutherford 2012:466).

If stones have life force (Kii7iljuus and Harris 2005:123) and making is a process of working with rather than a process of doing to materials (Bunn 2011), the implications for archaeological analyses of lithic artifacts are profound. Rather than inert substrata with static properties upon which form is imposed, the materials that compose inhabited worlds are constantly leaking, mixing, mingling, distilling, dispersing, evaporating, and precipitating media (Ingold 2012; Rubio 2016). With each transformation comes renewed potential for a plethora of situationally-contingent material properties. Although these processes can happen at rates that render them unobservable at the practical scale of lived human experience, one needs to look no further than the archaeological subfields of vertebrate taphonomy (Lyman 1994) and geoarchaeology (Rapp and Hill 2006) for evidence of the pervasive effects these phenomena have for, at the very least, archaeological site formation processes. Lithic artifacts are not exempt from this “continual generation and transformation” (Ingold 2007a:7). Whether one takes a use-life history (e.g., Mackie 1995; Schiffer 1976, 1987), object biography (Kopytoff 1986; Gosden and Marshall 1999), or an object itinerary (Joyce and Gillespie 2015) approach, the recursive cycles of stone tool production, use, deposition, recycling, and the effects these processes have on the dynamic morphologies of lithic artifacts—perhaps more so than any other class of objects studied by archaeologists—cannot be overemphasized.

The relative durability of stone means that artifacts made of this material can, and more often than not likely do, pass through many hands throughout their potentially long and varied use-lives. From the time of a lithic artifact’s first anthropogenic modification to the moment it is

excavated by an archaeologist, each hand it encounters has the potential to alter its morphology through retouch, use, breakage, repair, and recycling (Appadurai 1986a, 2015; Dibble 1987, 1988; Dixon 2008; Harrison 2010; Mackie 1995; Rolland and Dibble 1990) in addition to post-depositional taphonomic processes. Lithic artifacts “excavated from archaeological contexts [are] not always—and perhaps only rarely—reflective of some end product that was imagined at the time a nodule was originally struck” (Dibble et al. 2017:827).

The spatiotemporal scales at which these processes occur are inadequately captured by typical archaeological models of linear manufacturing sequences assumed to be carried out by a single person during a discrete knapping episode whose start and end points are predetermined prior to the commencement of the reduction/production process. This is the “hylomorphic” model of making in Aristotelian parlance, whereby form is arbitrarily imposed from the mind of the maker onto a passive external environment (Ingold 2013:20-21). Linear hylomorphic models of production are also the essence of the “finished artifact fallacy” as originally put forward by Davidson and Noble (1989, 1993) and elaborated by Keller (2001), Ingold (2013:33-45), Marchand (2016), and Dibble et al. (2017). In sum, not only is it impossible to answer the question of whether a thing is finished, “it is meaningless to even ask it” (Ingold 2013:41).

Moreover, ethnographic evidence suggests some makers and users of stone tools have little interest in the overall shape of lithic artifacts and are much more concerned with the angle and size of working edges relative to particular tasks at hand (Gould et al. 1971:154). The very notion that some lithic artifacts are tools with specific functions and others are not is a dualistic imposition upon people whose lithic technologies may simply be “pieces of stone, parts of which may be used to perform certain activities” (White and Thomas 1972:278). Since new tasks can arise unexpectedly and working edges can become dull, the modification and maintenance of

these edges during the familiar yet occasionally stochastic interplay of skilled kinaesthetic movements, fracture mechanics, and emergent needs is arguably more indicative of learned technological practices than the overall form of most lithic artifacts. Given my emphasis on the unintended consequences, unpredicted outcomes, emergent causation, and improvisation of material practices intimately enmeshed with relational material worlds (Robb 2013, 2015; Stahl 2015), one is left to wonder how to adequately characterize these recalcitrant social historical processes given data sets such as excavated artifacts, stratigraphic contexts, and radiocarbon dates.

3.3: Lithic Technologies as Situated Social Practice

“Technologies need to be considered for their social implications as well as part of the ‘ecology’ of practices.”
(Angelbeck and Cameron 2014:6)

Archaeological materials, artifacts, objects, and things are sources of insight into the ways cultures were and are actively produced by human engagements with them (Stahl 2010:154). The difficulty, however, lies in devising appropriate research methods for achieving insight. One possible avenue is to replicate objects and technologies using techniques and tools similar to those hypothesized to have been used by people in the past. As Weismantel (2011:314, original emphasis) states, it is a worthwhile exercise to occasionally “abandon *reading* for *playing*” because “not all objects submit to being read.” This “radical particularity of the experience of embodiment” (Weismantel 2011:315) echoes Ingold’s (2007a:14, emphasis added) assertion that the properties of materials are “neither objectively determined nor subjectively imagined but *practically experienced*.” These are some of the reasons why replicative practice is such a core component of many lithic technology studies (e.g., Callahan 1996; Crabtree 1972; Flenniken 1981; Murray 2017; Tringham et al. 1974; Waber 2011; Whittaker 1994).

My own replicative practice takes several forms. My initial clumsy attempts at knapping resulted in a gory melee of battered fingers, bloody legs, and copious amounts of randomly-shaped debitage. However, through situated learning with patient mentors, my knapping skills continue to grow. Regular participation in the University of Victoria (UVic) flintknapping club also facilitates my ongoing enskilment and enthusiasm for this insightful and enjoyable activity (Figure 8). Repetitive movement fosters kinaesthetic memory that operates in tandem with improvisation and innovation thereby “making things stick” (Barber 2007:25). Bourdieu’s (1977:72-95) “hexis,” the way people move and position their bodies in lived worlds, and “habitus,” the structured and structuring dispositions and embodied principles through which people improvise their way through life, are highly relevant here because they are inculcated via bodily practices that in turn generate perception and action (Roddick 2009:83). History channels the body (Robb and Harris 2013) and motor habits such as muscle memory, posture, gestural rhythms, and handedness “bring different muscular and sensory modalities into play, creating in the process different senses of the body and relations with other bodies” (Gosden 2008:2009). In this way, apprenticeship becomes a mode of ethnographic practice (Gowlland 2012; Lave 2011; Marchand 2008) and “materiality emerges through the interaction of embodied action on matter” (Lucas 2012:197).

Besides one’s own enskilment, experiencing these creative tensions first-hand enables insights about the subtle gestures of flaked stone tool production carried out by highly skilled ancestral knappers whose material traces are the focus of nearly all lithic analyses. A slight twist of the wrist, a micro-adjustment to one’s hands, arms, posture, and breathing can transform a bloody mess into a fluid correspondence between person and stone (Tilley 1994, 1996, 2004, 2017). Fluent relational rhythms are “the creators of form” (Leroi-Gourhan 1993[1964]:309; see

also Lefebvre 2004) and, in the hands of a skilled knapper, “stone [momentarily] becomes liquid” (Ingold 2013:44).

Figure 8 is a photograph I took during a meeting of the UVic flintknapping club in 2017. There are several noteworthy features of this image including our similar postures. We are all sitting on chairs, backs curved, arms resting on our thighs. This is no coincidence and certainly not the inevitable outcome of deterministic tool-making evolutionary trajectories. One’s bodily gestures, postures, rhythms and sequences of movement, tools, and chosen materials are all learned practices and technological choices that continually come into being through situated learning within communities of lithic practice (MacKay 2008). These practices may or may not be shared with all people who made and used lithic technologies since the first Oldowan tool was created approximately 3 million years ago. Nonetheless, our corporeal and gestural “doings” (*sensu* Fowles 2013) are our means of corresponding with the skilled practitioners who came before us, those with whom we share our inhabited worlds, and those to come.



Figure 8: Members of the UVic Flintknapping Club sharing their embodied knowledge.

A feature of the photograph that is likely not shared with all ancestral knappers is our choice of glass as a raw material—hence the empty bottles in the background (cf. Martindale and Jurakic 2006, 2015). An attractive characteristic of this material is that its microstructure, like most obsidians, is homogeneous, fluid, and brittle. These attributes, coupled with its current relative ease of acquisition in Victoria, make glass an ideal material with which to learn to knap. The place of this meeting also has its own unique set of characteristics. We are gathered indoors within the same building as the UVic Anthropology Department, on a tarp, next to a deer skeleton, and under fluorescent lights—all of which speak to the sociohistorical and spatiotemporal conjunctures of our small club.

Our particular community of practice, a group of young adults of largely settler descent whose interests in smashing rocks is arguably atypical compared to our fellow UVic students, is one with a mission to create a setting for experiential hands-on learning. There are myriads of potential alternative motivations, reasons, and needs for learning to make and use stone tools throughout the vast swaths of space and time that are the deep history and genealogies of emergent technological practice within which we are all participants through our replicative practice. Making and using stone tools is our way of remembering, sustaining, and honouring ancestral knowledge evoked by cultural practices that create and are created by communities of the past, present, and future (Lyons and Marshall 2014:497-503; Roddick 2016). Although the focus of a given knapping session may vary, situated learning is always taking place.

3.4: Space, Place, and Translocality: Neither Here nor There

Notwithstanding anthropological texts that highlight the power of place (e.g., Basso 1996; Lepofsky et al. 2017; Thom 2005; Thornton 2008), there is a growing body of scholarship that explicitly explores the translocality of place (*sensu* McFarlane 2009). Drawing on metaphors

such as fungal rhizomes (Choy et al. 2009; Tsing 2005; Wallis 2009), knots in meshworks (Ingold 2007b:72-103, 2011:89-94, 2015), nodes in networks (Angelbeck and Grier 2012; Knappett 2011, 2013; Mackie 2003; Mills 2016; Mills et al. 2015; Supernant 2017; Supernant and Cookson 2014; Thom 2009), and assemblages (Hamilakis 2017), these scholars call attention to the simultaneity of near and far relations between human and non-human entities. They also question essentialist suppositions about past, present, and future life worlds. These relational ontologies disrupt Western binary constructs such as center:periphery (Appadurai 1986b; Mackie n.d.) and “bypass the scalar distinction between local and global” (McFarlane 2009:562).

A sobering example of the translocality of place is found in the state-sponsored cultural genocide (i.e., the residential school system) carried out by the Canadian government for over a century (Truth and Reconciliation Commission 2015). Despite intergenerational trauma and abuses perpetrated against the Lost Generation(s), Indigenous people and communities continue to survive because they are tremendously resilient. Although the paternalistic laws and policies that legalized and validated the residential school system originated in urban cities often geographically-distant from the communities most directly impacted by racist legislations—as is the case with most forms of colonialism—their translocal impacts are intimately and painfully felt in the form of, for example, countless abductions, rapes, and murders. Though no longer officially sanctioned by the federal government, ethnocentric structural and not-so-figurative violence in Canada continues today. For example, dozens of Indigenous women have gone missing or been assaulted on the “Highway of Tears” in northern British Columbia since the 1970s (Carrier Sekani Family Services 2017). These dark moments of colonialism in action and “ontological violence” (MacDonald 2010) stress the fluidity, permeability, and translocality of

place and, I would add, the transtemporality of history. As I suggest below, they also exemplify the culturally-constructed distinction between space and time.

Inspired by the wisdom of Ahousaht hereditary chief and Indigenous scholar Umeek-Richard Atleo (2004), cultural anthropologist Kelda Helweg-Larsen's ethnographic research of Tseshaht First Nation-Parks Canada co-management in the Pacific Rim National Park Reserve-Broken Group Unit in Nuu-chah-nulth traditional territories leads her to conclude "*heshookish tsawalk*; everything is one" (Helweg-Larsen 2017:118). Similarly, Supernant and Lyons (2017) point out that Indigenous knowledge holders (and producers) have long perceived and known the inextricable relationality of all past, present, and future life worlds for human and non-human inhabitants alike. Thus Stephen Hawking's remark "space and time not only affect but also are affected by everything that happens in the universe" (Hawking 1988:33) is not so revelatory nor unanimously controversial.

3.5: Time, History, and Transtemporality

Lyons and Marshall (2014: 497) affirm objects, materials, and practices are interwoven relations and connections between life worlds near and far in both space and time. Indeed, objects and events are effectively the same because both occupy a heterogeneous chunk of space-time; they differ only in terms of duration (Lucas 2012:184; Quine 1960:171, 1970:30). As I explore in subsequent chapters, the translocality and transtemporality of intergenerational genealogies of emergent practice resist orthodox archaeological space-time systematics because communities are not necessarily geographically or temporally bounded (Zimmerman 2005:302). While one may not necessarily agree with the translocal and transtemporal ontology I propose, it should have the collateral effect of casting doubt upon the rest of one's deeply held dualistic assumptions.

The notion of collapsing the space:time binary into a space=time non-binary is not without its own hefty baggage. It is uncomfortably parallel to the comparative method borne out of Enlightenment notions that travel in Euclidean space is equivalent to travel in linear time and, therefore, by travelling to lands arbitrarily defined as peripheries (i.e., European colonies), one can literally travel back in time to observe Man living out a nasty, brutish, and short Hobbesian life in his inferior forms according to unilineal social evolutionist typologies (Erickson and Murphy 2003:39). However, a translocal and transtemporal logic can be deployed to counter ethnocentric ontologies by highlighting the mobility of embodied knowledge, skills, situated learning, and processes of becoming for all people at all places and times. Rather than denying the coevalness of non-Westerners by placing “the referent(s) of anthropology in a [Space]Time other than the present of the producer of anthropological discourse” (Fabian 1983:31), the non-binary space=time ontology I advocate situates these people on the same planes of possibility as you or me.

Despite its strengths, Lave and Wenger’s (1991) communities of practice analytic insufficiently characterizes a cyclical and recursive space=time ontology because it emphasizes the “face-to-faceness” of people and communities as requisites for legitimate peripheral participation and situated learning to occur. Etienne Wenger picks up on this scalar quandary in his follow-up book to the seminal volume he co-authored with Jean Lave (Wenger 1998). He states overzealous scholarly applications of the communities of practice concept stretch its relevance “beyond recognition or usefulness” (Wenger 1998:123). His solution to this issue was to coin the term *constellations of practice*, a concept more congruent with the fluid space=time ontology I propose because it presents an analytical toehold for understanding how disparate communities of practice can coalesce into coordinated social units without ever sharing physical

or temporal proximity. A main tenet of Wenger's (1998) translocal and transtemporal constellations of practice is people can learn through human and non-human entities he calls "boundary objects" and "brokers." These diverse entities can take on configurations familiar to archaeologists such as lithic artifacts, materials, and places but may also have environmental forms such as rivers (Harris 2016) or changes in relative sea-level over millennia (Sassaman 2016), entangled mobile maritime boat-crew-site-settlements (Bjerck 2016), and immaterial forms such as histories, metaphors, and "beings" (Schoenbrun 2016). The unifying characteristic of boundary objects and brokers in their varied forms is their ability to link and constellate communities that may or may not share specific practices but are nonetheless coordinated in some manner (Roddick and Stahl 2016:10).

Despite its subtle binary framing, Olivier Gosselain's categories of space are a way of thinking through how the embodied mechanisms of boundary objects and brokers are involved in processes of constellating communities of practice (Gosselain 2000, 2008, 2011, 2016b). These categories of space are places frequented through daily activities—*space experienced*—and the places a person knows representationally or vicariously—*space known*—through interactions with kin, friends, visitors, objects, materials, technologies, ideas, and concepts. Taken in conjunction with this spatial dyad, the interaction and circulation of tangible and intangible boundary objects and brokers facilitate "imagination" and "alignment" (Wenger 1998:173-181) that bridge space and time to render possible social relations beyond the confines of direct physical engagement. In a very literal sense, "remembering presences the past; imagining presences the future" (Ingold 2017:21). As Lucas (2012:208) similarly states, "time is not a series or succession of moments, but a continuum on which the past is stretched into the present." To anyone living or working on the Northwest Coast, relevant examples of relational,

emergent, translocal, and transtemporal space=time ontologies are found in many coastal First Nation communities whose “kinship relations are recognized to extend not only across broad geographic regions but also across generations” (McLay et al. 2008:158; see also Boyd 2009; Thom 2009, 2010, 2014, 2017) and occasionally across species (e.g., Hallowell 1926:58).

Perhaps the most obvious example, though, of a space=time ontology coming into being takes place in the bowels of an archaeological excavation unit. With centimeter- and millimeter-scale precision, artifacts, features, and stratigraphic layers are painstakingly mapped as X, Y, and Z coordinates. With the assistance of similarly three-dimensionally mapped radiocarbon samples, observed spatial relationships bleed into temporal relationships, archaeological chronologies, and inferred historical processes. Whether or not archaeologists *align*, in a Wengerian sense, with people and communities of the past, present, and future, we certainly *imagine* with great gusto.

In sum, through a relational nexus of embodied, cognitive, creative, and habitual practices, people and communities are capable of situated learning and social interaction regardless of geographic or historical association with one another. While these constellating processes may be inflected by simultaneous cooperation and competition of human and non-human participants (Blakely 2012; Brandt 1980; Crown 2016; Debenport 2015; Dilley 2010; Suina 1992), the space=time ontology I outline here erodes the culturally constructed division between space and time and clears a path for archaeological analyses of these emergent translocal and transtemporal processes. In the following chapters, I work towards an understanding of genealogies of emergent technological practice as gleaned through material traces within three lithic assemblages from Quadra Island, BC.

Chapter 4: Methods Overview

4.1: Methods Overview – Introduction

“Practice does not follow theory; practice *is* theory.”
(Robb 2015:167, emphasis in original)

Practice, or human action anchored in accustomed repertoires and improvised creativity in articulation with familiar and novel contexts, is at the heart of the theoretical framework within which I situate my research. The analytical methods I use are my means of putting theory into practice. In this chapter, which is designed to bridge my theoretical position (Chapter 3) with data analysis chapters (Chapters 5-7), I summarize my methodological approach. I begin by outlining in chapter-by-chapter fashion the methods and data sets I use and their sequential application during subsequent stages of analysis. I conclude this overview with a description of the archaeological sites from which the sampled lithic assemblages were excavated.

I open Chapter 5 with a critical discussion of the concept of typology. As one of the most basic and widespread analytical tools in the discipline of archaeology, typological systems are usefully implemented when a specific research question is posed, if the typology provides meaningful units of analysis to the specific research program, and it functions at a practical level while carrying out research and analysis (Adams and Adams 1991; Dunnell 1971; Odell 1981; Read 2007). Nonetheless, the utility, applicability, and collateral effects of archaeological typologies are hotly debated and will likely continue to be critiqued and scrutinized (Bamforth 1986, 1990; Binford 1965; Bordes 1961a, 1961b; Brew 1946; Dibble 1987; Ford 1954a; Krieger 1944; Lucas 2012; Rolland and Dibble 1990; Rouse 1960; Shott 1996; Spaulding 1953). It is this critical scrutiny I pick up on with my introductory remarks to Chapter 5.

I then detail Andrefsky’s (2005) Generalized Morphological Typology, the typological system after which I most closely model my own. After explicitly stating and unpacking some of

the assumptions associated with taxonomic systems, I define my “special-purpose typology” (Mackie 1995:12) designed to describe variation, classify and catalogue the sampled assemblages, and aid in answering my research questions throughout the macroscopic lithic analysis, thin section petrographic (TSP), X-ray fluorescence spectrometry (XRF), and morphometric components of my research. I argue that, while typological classifications inherently parse relational worlds into discrete units of analysis, this is a practical and necessary first step in order to make analytical sense of the dynamic processes by which lithic artifacts and the people who make them take shape. For these reasons I structure the archaeological assemblages in a manner that facilitates subsequent analyses and, ultimately, a reintegration of these materials in the concluding discussion in Chapter 8.

A parallel component of my macroscopic lithic analysis is the identification and classification of lithic material types present in the sampled assemblages. According to geological attributes visible on the exterior surfaces, I classify every lithic artifact to a particular lithic material type (Reimer 2012:90-111; Smith 2004:41-51). The main tools I use during this stage of analysis are a geological loupe, a low-powered stereo optical microscope, and a regionally-specific lithic material type comparative collection I iteratively constructed throughout the course of this project. This lithic material typology provides valuable data in its own right regarding ancestral tool-stone selection and acquisition practices. It also creates units of analysis with which to efficiently and meaningfully sub-sample the assemblages for TSP, XRF, and morphometric analyses.

In Chapter 6 I use TSP and XRF methods to refine and assess the accuracy of the material type identifications made in the previous chapter. I describe the ways these complementary methods work, the mentors with whom I collaborated, my sub-sampling

rationale and procedure for each assemblage, as well as the results of these petrographic and geochemical analyses. I conclude this chapter with an integrative discussion drawing on the data sets produced using macroscopic, TSP, and XRF material analysis methods. I also postulate the geological source locations of some of the lithic material types in cases I feel there are sufficient data with which to confidently make this kind of inference.

In Chapter 7, the final data analysis chapter, I shift my focus to quantitative morphometric analyses. Building on the results of the previous two data analysis chapters, I delve into morphometric methods to quantitatively study the shape of some of the lithic artifacts in the sampled assemblages (Adams and Otárola-Castillo 2013; Clarkson 2013; Clarkson and Hiscock 2011; Davis et al. 2015, 2017; Lycett and von Cramon-Taubadel 2013; Shott and Trail 2010, 2012; Waber 2011:134-200, n.d.). Taking a cue from Williams and Andrefsky (2011) who investigated “the influence of learning traditions and the influence of experience” between different flaked stone tool makers, I stress that lithic debitage morphologies are proxies for the learned gestures, actions, and kinaesthetic movements of the people who produce and use stone tools. Their experimental study found statistically significant variability of morphological attributes such as flake length, width, and platform size within debitage assemblages made by people who learned how to make flaked stone tools in differential flintknapping traditions (Williams and Andrefsky 2011:871). These findings suggest deceptively prosaic debitage flakes are the material manifestations of the skilled movements that detached them from a core; techniques that may be understood as the interaction of gesture and matter (Lucas 2012:198).

Therefore, quantitative data sets for the sizes of morphological attributes are extremely relevant to my theoretical framework previously developed in Chapters 1 and 3. If a debitage flake is the congelation of a gesture then it is also a material link to the moment when it was

detached from an objective piece (e.g., a core). Together they are the traces of emergent genealogies of technological practice. I also argue morphometric data sets can be used to garner insights about subsequent moments in lithic artifacts' use-lives such as hafting and discard. Taken together, I use these morphometric methods and statistical models to derive insights about the operational sequences of stone tool production, use, and the depositional practices which create archaeological deposits—all of which are learned technological choices and embodied practices (Flenniken 1985; Titmus 1985; Wendrich 2012).

After outlining the morphological attributes and quantitative data sets I deem relevant to my research questions, I describe my sub-sampling procedure and rationale for both of the morphometric case studies I undertake in this thesis: 1) Crescent Channel (EbSh-81) microblades and 2) complete debitage flakes from all three lithic assemblages. For each case study I discuss the results of my analyses and propose some interpretations of the models I put forth.

4.2: Sampled Lithic Assemblages

In this section I describe the archaeological sites from which the sampled lithic assemblages are recovered. I focus on the excavation methodologies, stratigraphy, relative and absolute dating, as well as hypothesized site formation processes. In addition to these archaeological site descriptions, I also estimate maximum amount of human generations during site occupations in order to explicitly resituate the people who created these archaeological deposits as they inhabited these places. The parameters I use to make this estimation are: 1) a 25 year average reproduction rate; 2) continuous site occupation; 3) constraining radiocarbon dates, where possible.

The descriptions provided below are largely derived from the DILA 2014 annual report for *Heritage Conservation Act* (HCA) permit 2014-0046 (Fedje et al. 2016). Supplemental

observations from my own field notes and the field notes of other project participants are also drawn upon in the following sections. The archaeological sites I chose to sample, in consultation with DILA project co-directors Daryl Fedje and Quentin Mackie, were based on the following hierarchical criteria:

- 1) Chronological resolution: A temporal cross-section of lithic technologies in the study area throughout the Holocene was desired. For this reason, sites lacking intact stratified deposits (e.g., surface finds, lag deposits) were excluded from consideration.
- 2) Sample size: Larger lithic assemblages were targeted for analysis to increase the likelihood of obtaining a representative sample of lithic technologies within the study area. This criterion has significant implications for the quantitative morphometric components of my research.
- 3) Diversity of lithic assemblage: Preliminary observations of the diversity of lithic material types and technologies made in the field and the laboratory were also taken into consideration when selecting which excavated assemblages to sample. I felt targeting heterogeneous lithic assemblages was most pertinent to my research questions because it increased the concentration of diverse material practices within each assemblage.

After weighing these sampling criteria and through a combination of relative and absolute dating techniques, I selected three lithic assemblages from three different archaeological sites (Figure 9). These sites roughly correspond to the early (Renda Rock Shelter, EaSh-77), mid- (Crescent Channel, EbSh-81), and late (Village Bay Lake Island, EbSh-80) Holocene (Tables 2-3).

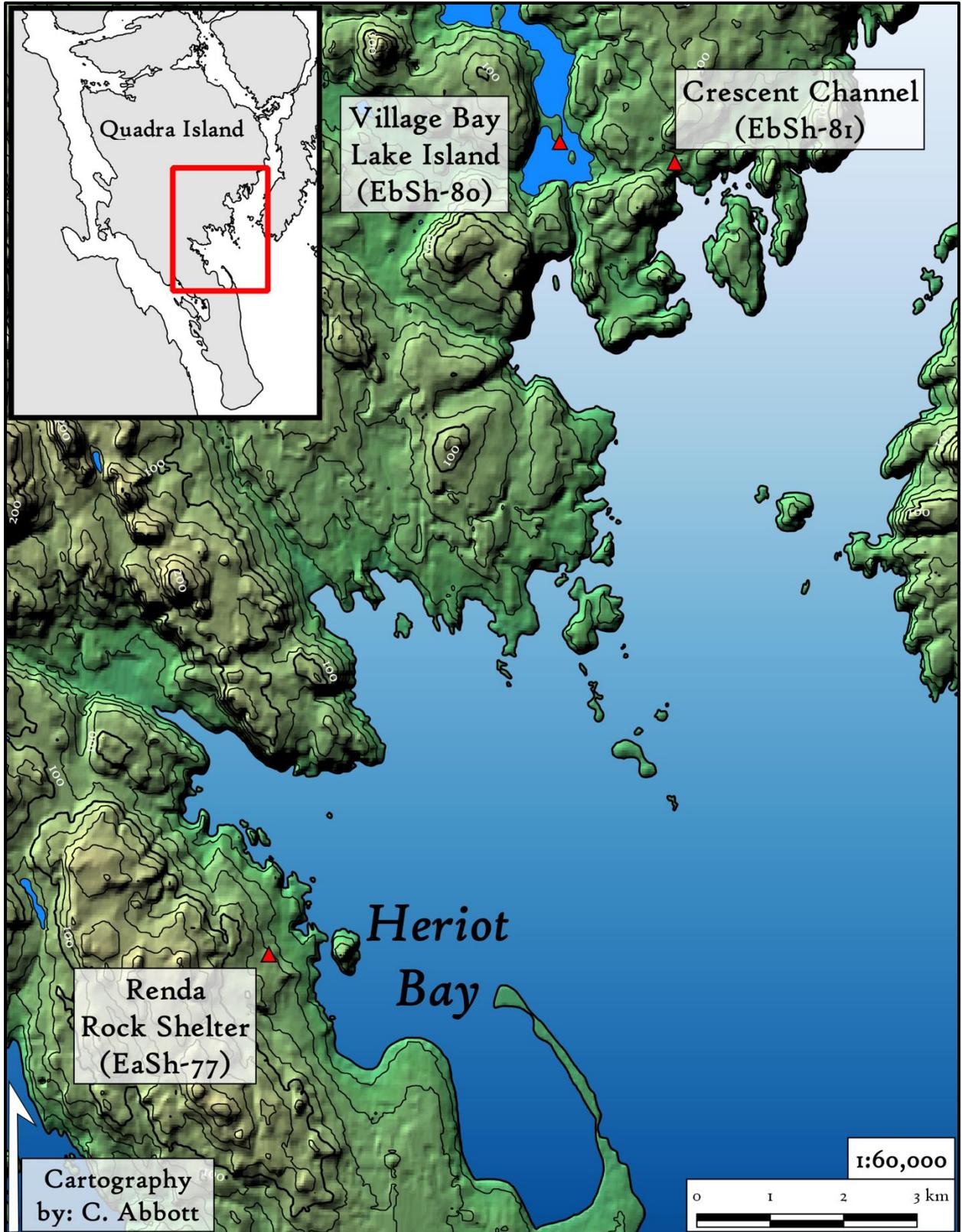


Figure 9: Archaeological sites sampled for lithic analysis.

Table 2: Chronologies for the Discovery Islands study area.¹

Geological Epoch	Calendar Years Before Present (cal BP)	Relative Chronology of Sampled Lithic Assemblages	Estimated Human Generations During Occupations of Sampled Archaeological Sites ⁴	Salish Sea Culture History Chronology ⁵	Queen Charlotte Strait Culture History Chronology ⁶
	15,000				
	14,000				
Late Pleistocene	13,000	Renda Rock Shelter (EaSh-77) ²	Unknown	Western Stemmed Tradition and Paleo Archaic	
	12,000				
	11,000				
Early Holocene	10,000				
	9,000				
	8,000				Old Cordilleran
Mid Holocene	7,000			Old Cordilleran	
	6,000	Crescent Channel (EbSh-81) ^{2,3}	4 ^o		
	5,000				
	4,000			Charles	Obsidian
Late Holocene	3,000			Locarno Beach	
	2,000	Village Bay Lake Island (EbSh-80) ^{2,3}	6 ^o	Marpole	
	1,000			Strait of Georgia	Queen Charlotte
Anthropocene	0				Contact Era

1 = Dashed lines emphasize the permeability that is obscured by orthodox archaeological space-time systematics.

2 = Relative dating using sea-level history (Fedje et al. n.d.), site elevation, stratigraphy, & lithic technologies.

3 = Radiocarbon dating. Dates calibrated using IntCal13 curve (Reimer et al. 2013) and reported as a 2-sigma range.

4 = Estimated maximum amount of generations based on:

i) 25 year average reproduction rate;

ii) continuous occupation;

iii) constraining radiocarbon dates where possible.

5 = Based off of Ames and Maschner (1999); Borden (1975); Burley (1979, 1980); Carlson (1990a, 1990b, 1996a);

Davis et al. (2012); Kopperl et al. (2015); Matson (1996); Matson and Coupland (1995);

Mitchell (1971, 1990); Pratt (1992); Stein (1992, 2000). Not all references are in accord with each other.

6 = Based off of Mitchell (1988, 1990); Mitchell and Donald (1988)

Table 3: Radiocarbon dates for archaeological sites sampled for lithic analysis.¹

University of California, Irvine-Accelerated Mass Spectrometry Laboratory Number	Archaeological Site	Excavation Unit	Quad and Depth (cm) of Sample	Material ²	Uncalibrated Radiocarbon Date	Calibrated Radiocarbon Date Range (cal BP) ³
UCI 146044	Crescent Channel (EbSh-8i)	2	A-28	Charcoal	5730±25	6560-6478
UCI 155096	Crescent Channel (EbSh-8i)	3	SW-48	Calcined Bone	5235±25	5994-5938
UCI 155098	Crescent Channel (EbSh-8i)	3	NE-50	Calcined Bone	5140±25	5928-5895
UCI 155097	Crescent Channel (EbSh-8i)	3	SW-64	Calcined Bone	5805±35	6661-6563
UCI 193684	Crescent Channel (EbSh-8i)	2017-01	A-115	Charcoal	10740±70	12724-12637
UCI 146031	Village Bay Lake Island (EbSh-8o)	1	A-43	Charcoal	1730±25	1695-1606
UCI 146032	Village Bay Lake Island (EbSh-8o)	1	A-50	Charcoal	2825±25	2958-2881
UCI 146033	Village Bay Lake Island (EbSh-8o)	1	A-59	Charcoal	2845±25	2993-2891
UCI 179755	Village Bay Lake Island (EbSh-8o)	2	A-21	Calcined Bone	2970±15	3206-3074
UCI 179752	Village Bay Lake Island (EbSh-8o)	2	D-45	Charcoal	1555±15	1522-1402
UCI 179756	Village Bay Lake Island (EbSh-8o)	2	C-52	Calcined Bone	2885±20	3075-2949

1 = Radiocarbon dates rejected due to suspected stratigraphic intrusion are excluded from table.

2 = Calcined bone $\delta^{13}\text{C}$ values within terrestrial range, no need for marine reservoir effect calibration. See Chatters et al. (2017) and Lanting et al. (2001) for a discussion of radiocarbon dating calcined bone.

3 = Radiocarbon dates calibrated using IntCal13 curve (Reimer et al. 2013), Calib 7.10 (Stuiver et al. 2017), and reported as a 2-sigma range.

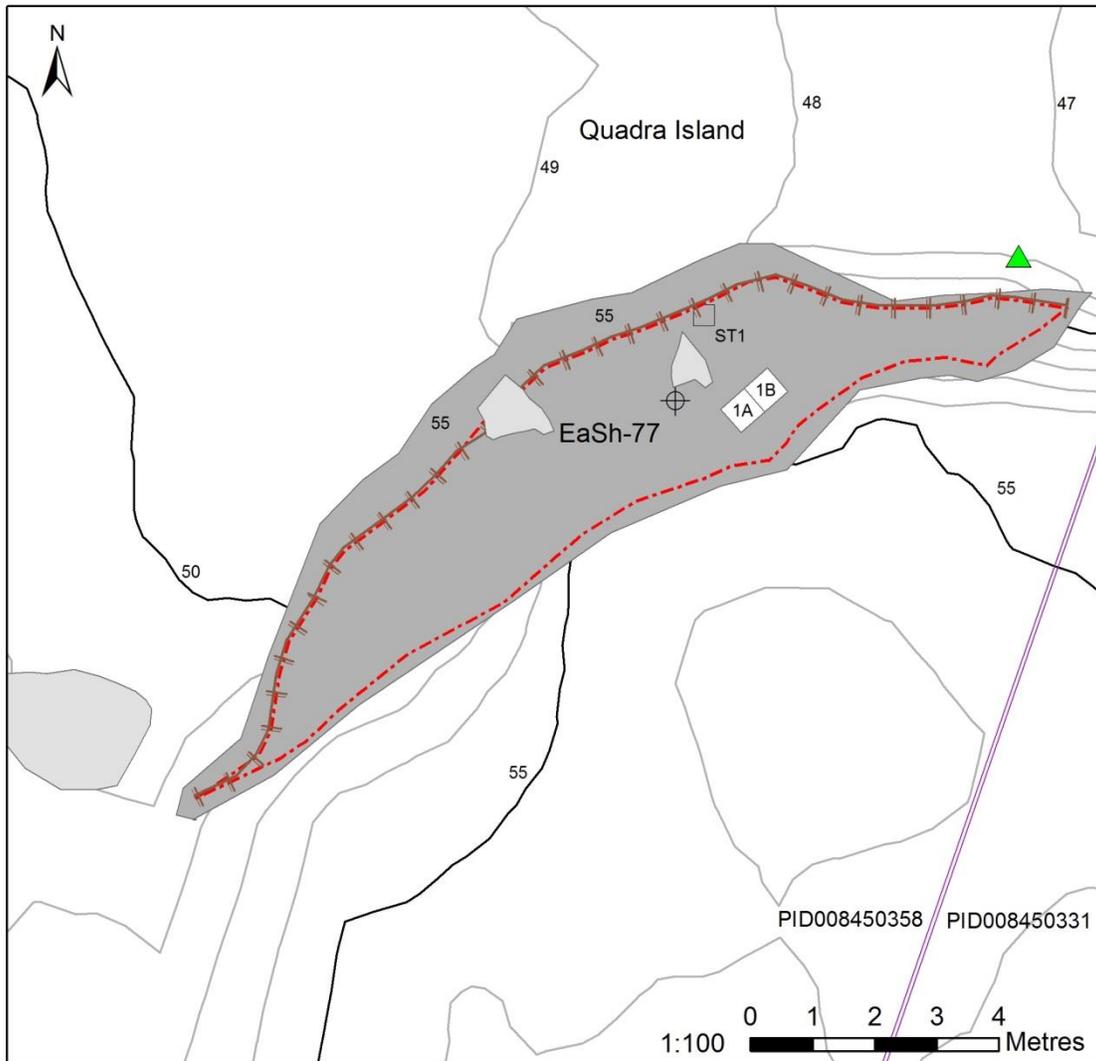
4.2.1: Renda Rock Shelter (EaSh-77)

The Renda Rock Shelter (EaSh-77) site is located approximately 52.5 meters above sea level (hereafter ASL), meaning that it would have been located on or very near a paleoshoreline approximately 13,000 years ago (Fedje et al. n.d.). This site is a small rock shelter with a relatively narrow overhang less than 3 m inside the drip-line (Figure 10). Much of the floor slopes down to the northeast except in a small area where there is a break in slope, which is where the subsurface test was placed (Figure 11). A small lithic scatter was identified on the surface of the site in 2014. The small amount of roof fall at the site made testing at this locale more feasible than other rock shelters investigated as a part of the DILA project (e.g., the Kellerhall's rock shelter [EaSh-74] and the Hopespring rock shelter [EaSh-82]). Several seemingly *in situ* lithic artifacts were observed underneath pieces of roof fall. The paucity of exfoliation coupled with the extensive glacial striae observed on the wall of the rock shelter (Figure 12) suggests that little erosion occurred at the site throughout the last 13,000 years as relative sea levels fell and the site transitioned from marine, to intertidal, to terrestrial contexts.

The excavation unit (Test 1) is comprised of two adjacent 50 cm² trowel tests (1A and 1B; Figure 13). The western unit (1A) was only excavated to a maximum depth of 40 cm below datum (hereafter DBD) due to sloping bedrock while the eastern unit (1B) was excavated to a maximum depth of 80 cm DBD. All excavated matrices were dry screened through nested 6 mm and 3 mm mesh. Wet screening was judged unnecessary because the fine sediments passed easily through the screens.

EaSh-77 Detailed Site Map

NAD 83, UTM Zone 10
Easting: 340932
Northing: 5553284
NTS 92K 014



Cartography N. Smith & A. Lausanne
January 2016

Legend

	UTM coordinate		excavation unit (50cm x 50cm)		dripline
	EaSh-77 Site Boundary		negative shovel test		cherry tree
	Heriot Bay Cadastral		overhang		5m contour intervals
			boulder or roof fall		1m contour intervals

Permit # 2014-0046
Discovery Islands Landscape Archaeology Project
Hakai Institute
Fieldwork date: August 13, 2014

**All contours LIDAR derived

Figure 10: Renda Rock Shelter (EaSh-77) detailed site map (Cartography N. Smith & A. Lausanne).

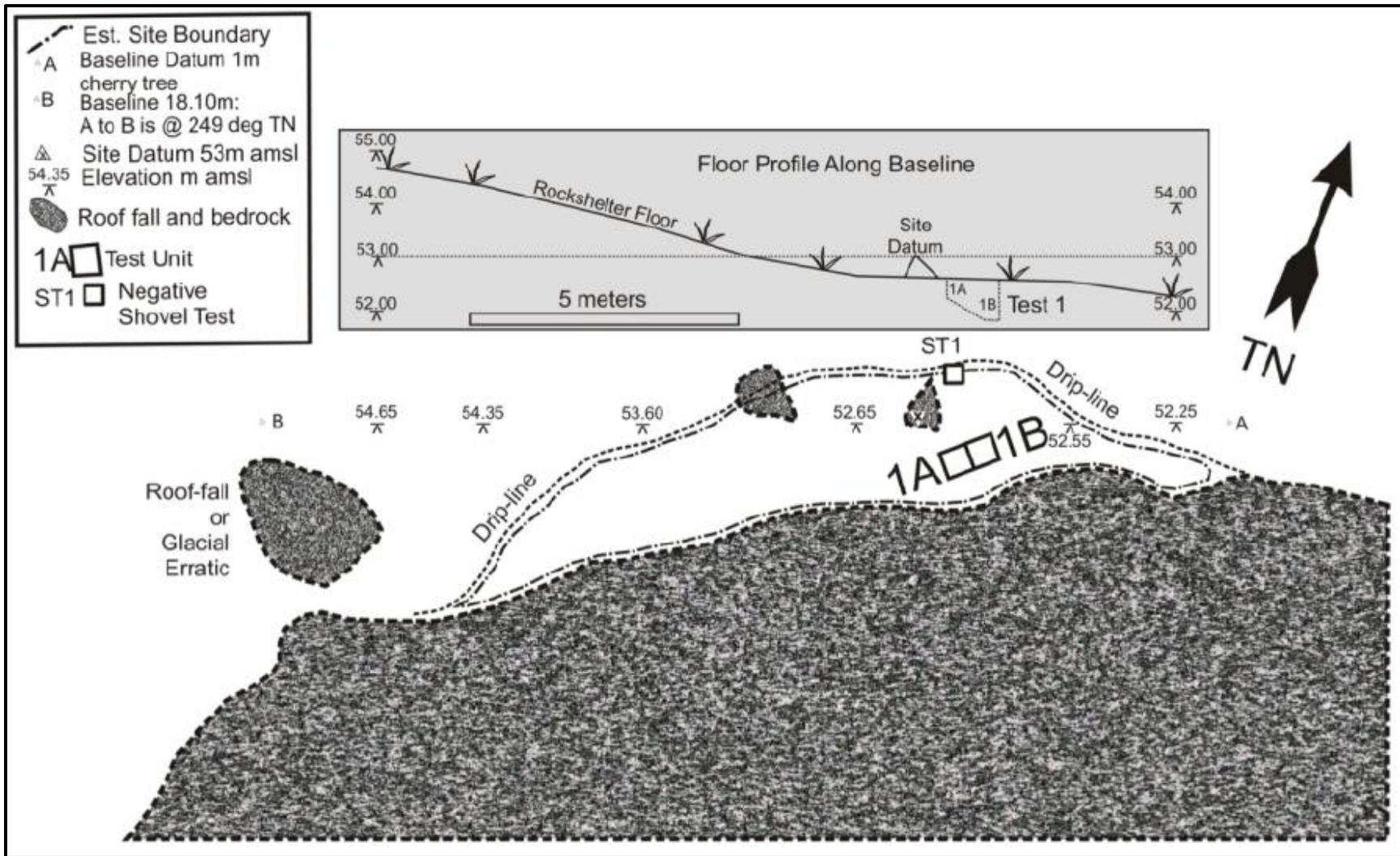


Figure 11: Renda Rock Shelter (EaSh-77) plan view and elevation profile (Cartography A. Mackie).



Figure 12: Extensive intact glacial striae observed on the wall of the Renda Rock Shelter (EaSh-77) (Photo J. McSporrán).



Figure 13: D. Fedje excavating in the Renda Rock Shelter (EaSh-77), Test 1B (Photo A. Mackie).

The basal sediments in Test 1 appear to be beach or glacial outwash matrices of rounded pebbles and cobbles. Based on the local sea-level history (Fedje et al. n.d.), beach deposits at this elevation should date to approximately 13,000 cal BP, meaning that the cultural strata likely date to the early Holocene even if the human occupations of the site occurred several millennia after paleoshorelines regressed this location. Moreover, because relative sea levels were falling rapidly at this time, this location would have been close to a paleoshoreline for only a few decades. Within a few centuries of 13,000 cal BP, multiple other benches and sheltered locations at lower elevations became terrestrial, suggesting that the Renda Rock Shelter (EaSh-77) would no longer be the most readily-accessible landform suitable for habitation by maritime-oriented inhabitants of the Discovery Islands study area.

The hypothesized terminal Pleistocene occupation of the Renda Rock Shelter (EaSh-77) is also supported by the stratigraphy observed in Test 1. The overlying sediment matrix is a bright orange and red pebbly silt underlain by cobbles and red-brown sandy gravel (Figures 14-16). Below this matrix is a compact greenish clay that is likely glacio-marine in origin. The upper 25 cm of the deposit has concentrations of roots and charcoal. While some of this charcoal is likely cultural, there also seems to be quite a lot of recent burned root intrusion. Subsurface cobbles and pebbles are waterworn which supports the hypothesis that this is a paleobeach deposit. Finally, the flat surfaces of the stratigraphic layers suggest an alluvial or marine deposition, likely when relative sea-level was at or just below this elevation approximately 13,000 years ago.



Figure 14: Renda Rock Shelter (EaSh-77) Test 1, east wall profile.
Note the smooth basal bedrock and water-rounded cobbles that underlie angular roof fall (Photo A. Mackie).



Figure 15: Renda Rock Shelter (EaSh-77) Test 1, south wall profile (Photo A. Mackie).

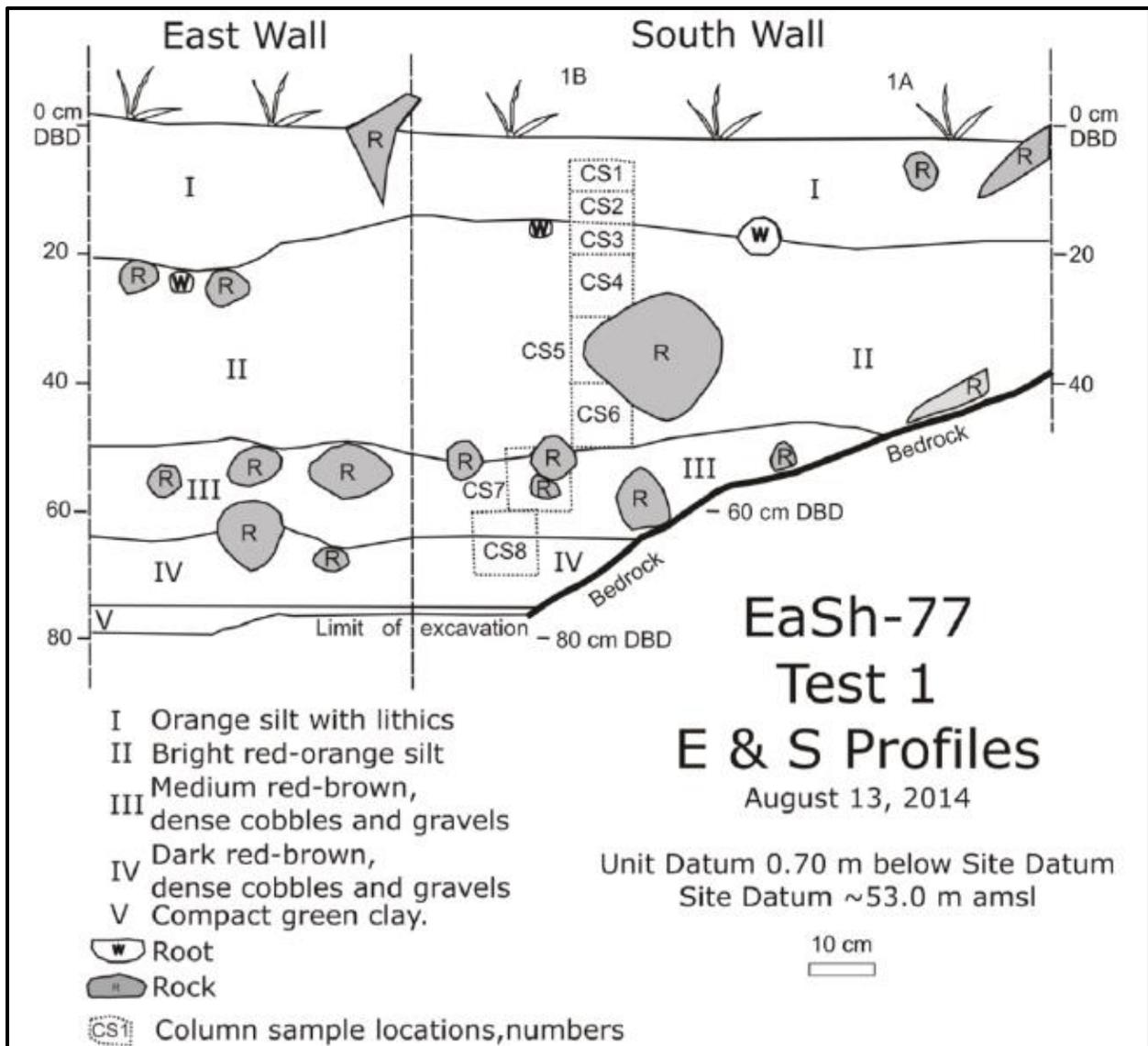


Figure 16: Renda Rock Shelter (EaSh-77) Test 1, east and south wall profiles (Illustration A. Mackie).

Lithic artifacts were encountered at all excavation levels except the lowest, though there is a bimodal distribution with higher artifact frequencies in stratigraphic layers I and III. None of the collected lithic artifacts show evidence of water rolling which suggests the site was occupied after the shoreline regressed this location and it became fully terrestrial. Proveniences for artifacts, samples, and other notable *in situ* discoveries were mapped and bagged separately. Otherwise, level bags for each quad were used for collections made at the screens. Column and radiocarbon dating samples were taken from the profiles. No intact archaeological features (e.g.,

hearths, petroforms, etc.) were observed during survey and subsurface testing at the Renda Rock Shelter (EaSh-77) site. A total of 100 lithic artifacts were collected during the excavation of Test 1. Observations made in the field and during preliminary laboratory analyses noted the presence of blade-like flake cores, Levallois-esque flakes (cf. Boëda 1995), and large expedient flake tools. The presence of prepared core technologies at the Renda Rock Shelter (EaSh-77) site corroborates the geomorphological interpretation of the site's formation processes, although there is an inherent logical circularity in inferring the antiquity of an archaeological site based on the lithic technologies it contains and *a priori* assumptions about when these artifact types are known to appear in the archaeological record. Thus, a goal of future research at the Renda Rock Shelter (EaSh-77) site should be further attempts to discern the age of the archaeological deposits through radiocarbon dating or optically stimulated luminescence (OSL) dating techniques. Nonetheless, the reliability of estimating the age of the site through relative dating techniques is supported by evidence elsewhere on the Northwest Coast at sites with strong relationships between lithic artifacts associated with prepared core technology, intact stratigraphic layers, and terminal Pleistocene or early Holocene radiocarbon dates (Ackerman 1996; Carlson 1979, 1990a, 1996a; Dixon 1999, 2001, 2008; Hobler 1978; Fedje 2013; Fedje et al. 2005, 2008, 2011; Rahemtulla 2006).

Three radiocarbon age estimations were run on charcoal samples from this site. However, none of the dates are congruent with the relatively-inferred age of the archaeological deposits based on the sea-level history, the geomorphological attributes of the landform, and lithic technologies present at the site (Table 2). Two charcoal samples date to 500 cal BP (from 13 and 28 cm DBD, respectively). The third charcoal sample dates to 2400 cal BP but is located vertically (23 cm DBD) between the other two samples. These out-of-order dates, coupled with

the recent fire history of the region, suggest the more recent dates may be related to the study area's history of forest fires (Taylor 2008, 2009). The older date from 23 cm DBD may also be attributable to forest fires.

The Renda Rock Shelter (EaSh-77) has a high potential for an early Holocene occupation as inferred through relative dating techniques such as the site elevation in relation to the local sea-level history, the stratigraphy, the lithic technologies, and other geomorphological attributes observed at the site such as intact glacial striae. Given the relatively-dated age of the site, along with the more pressing practical concern of what archaeological sites were available for sampling during the early stages of this thesis, I judged the Renda Rock Shelter (EaSh-77) to be the most suitable candidate for a terminal Pleistocene-early Holocene lithic assemblage. Had my research objectives been, for example, to specifically investigate lithic technologies dating to the terminal Pleistocene-early Holocene, the Renda Rock Shelter (EaSh-77) site would be less suitable for sampling. However, the flexible nature of my research questions means that I am still able to accomplish my goals of analyzing lithic technologies through space and time despite the somewhat imprecise chronological resolution of the archaeological deposits at this site and even if their temporal range turns out to be more recent than currently hypothesized. Despite the anomalous radiocarbon dating results, I deemed this archaeological site the best candidate for an early Holocene lithic assemblage available for sampling during the planning stages of this research project.

4.2.2: Crescent Channel (EbSh-81)

The Crescent Channel (EbSh-81) site is located on a paleomarine terrace 11-12 meters above sea level (ASL). The upper modern beach below the Crescent Channel (EbSh-81) site is the location of previously recorded archaeological site EbSh-71 (Pratt 2011; Figure 17). A

surface lithic scatter was first observed at the Crescent Channel (EbSh-81) site in 2013 by Quadra Island resident Paul Bishop. The current archaeological site boundaries are constrained by the extent of the public right of way between two private properties to the east and west, respectively (Figure 18). The site likely extends beyond the current site boundaries but subsurface testing within the tracts of private land was impossible as permissions from the land owners were not obtained at the time of DILA project fieldwork.



Figure 17: Previously recorded archaeological site EbSh-71 located in the modern supratidal zone below the Crescent Channel (EbSh-81) site (Left: Facing towards the southeast; Right: Facing towards the south; Photos J. McSparran).

During preliminary field reconnaissance for the DILA project in 2014, artifacts were observed in an exposure created by an old skid road that bisects the terrace in a roughly north-south direction. A 50 cm² shovel test (EU-1) was placed on the terrace edge immediately adjacent to the southern break-in-slope. During subsurface testing at this location a thin lens of shell midden was observed at a depth of 10 cm below surface and testing methodology switched to trowel excavation in 10 cm arbitrary levels. Testing of EU-1 terminated at a depth of 105 cm

below surface due to decreasing excavation manoeuvrability and the exploratory nature of the unit. Using dry screening methods and 6mm mesh, eighty two lithic artifacts were recovered from EU-1.

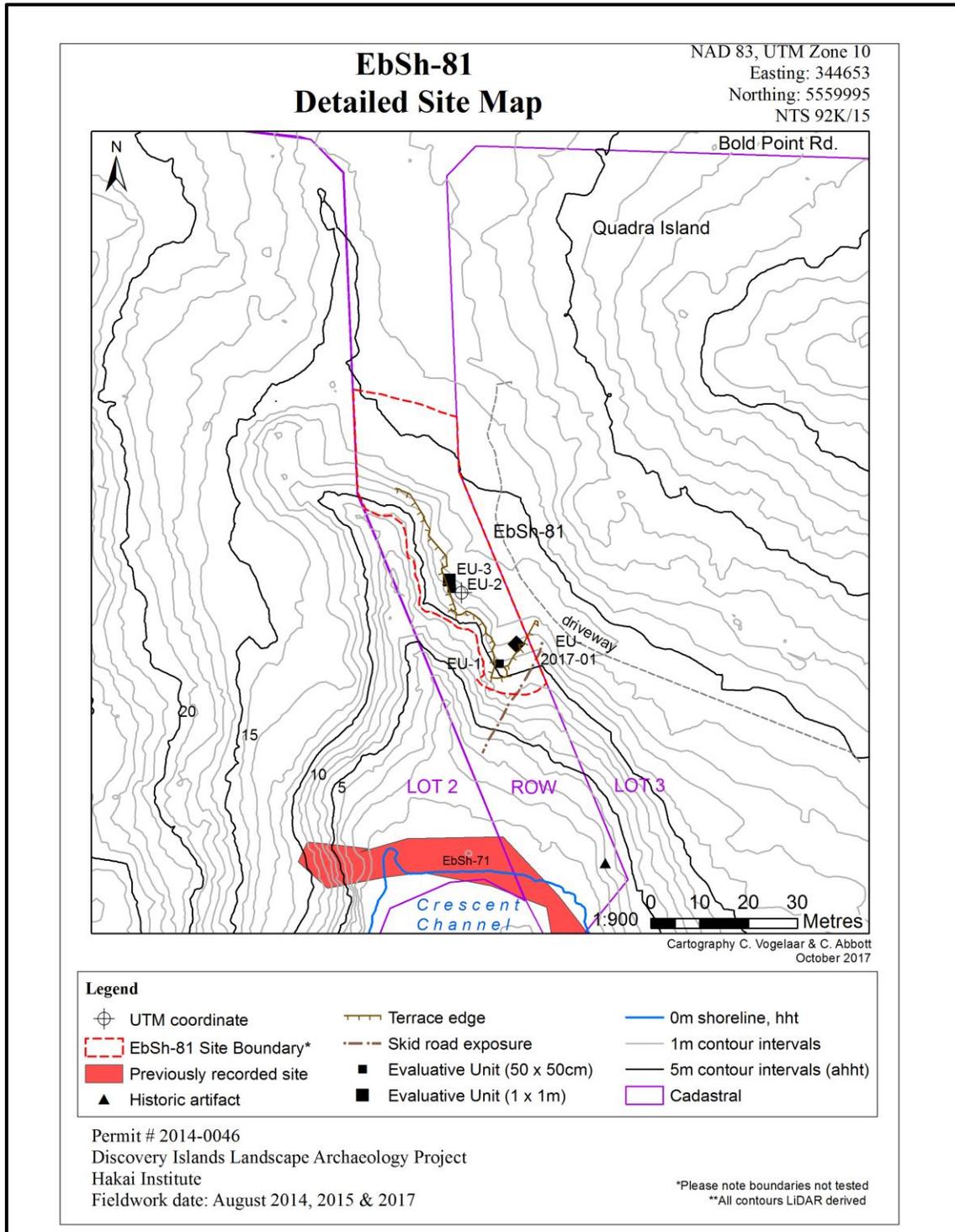


Figure 18: Crescent Channel (EbSh-81) detailed site map (ROW = Right of Way; Cartography C. Vogelaar & C. Abbott).

A second 50 cm² shovel test (EU-2) was placed along the terrace edge approximately 50 meters north of EU-1. No midden was observed in this unit although concentrations of lithic artifacts were encountered to a maximum depth of 80 cm below surface. Using dry screening methods and 6mm mesh, a total of 42 lithic artifacts were collected from EU-2. Based on positive subsurface tests EU-1 and EU-2, a 1 m² evaluative unit (EU-3) was placed adjacent to EU-2. Excavation methodology in EU-3 proceeded in 5 cm arbitrary levels and by stratigraphic layers when possible. Multiple stratified cultural deposits were encountered along with several probable paleosols (Figure 19). A total of 1,751 lithic artifacts were recovered from EU-3.



Figure 19: Crescent Channel (EbSh-81) EU-3. Note charcoal-stained upper layers & complex stratigraphy (Photo J. McSporran).

Although excavated matrices from EU-1 and EU-2 were dry screened through 6 mm mesh (Figure 20), bulk sediment samples from these units were screened at the Hakai Institute laboratory using smaller mesh sizes because small lithic artifacts associated with microblade technology were encountered during subsurface testing. Given this knowledge, a water screening

station with nested 6mm and 3 mm mesh was constructed for EU-3 excavations during the fall of 2014 (Figure 21). Proveniences for artifacts, samples and other notable *in situ* discoveries were mapped and bagged separately. Otherwise, level bags for each quad were used for collections made at the screens. Column and radiocarbon dating samples were taken from the profiles. A fourth subsurface test (EU-2017-01) 1 m² proximal to EU-1 was excavated in the spring of 2017 but is excluded from sampling in this thesis due to time constraints. All further discussion of the Crescent Channel (EbSh-81) site in this thesis therefore refers primarily to EU-1, EU-2, and EU-3 due to pending analysis of the EU-2017-01 lithic assemblage.



Figure 20: A. Lausanne, C. Abbott, & Q. Mackie (left to right) excavating Crescent Channel EU-1 (EbSh-81) (Photo. D. Fedje).



Figure 21: P. Dady water screening during fall 2014 EU-3 excavations at Crescent Channel (EbSh-81) (Photo J. McSparran).

Aeolian, beach berm, and alluvial depositional processes are evident at the Crescent Channel (EbSh-81) site. Three probable paleosols, as identified by distinct shifts in matrix colour and texture, are present in the cultural sand and pea gravel layers (VI, VII, VIII) at depths up to 100 cm below surface (Figure 22). Upper sediments are largely medium-grained to coarse sand with rounded clasts and gravels. EU-1, at the south end of the terrace, sharply increases in concentration of coarse sand and gravel deposits at approximately 100 cm below surface. In EU-2 and EU-3 to the north, coarse alluvial and/or colluvial deposits were encountered at 100 cm below surface, suggesting that these lower stratigraphic layers are paleobeach deposits (Figure 23). Intriguingly, silt and fine sand deposits with abundant shell casts at depths greater than 100 cm below surface were encountered in EU-3 and EU-2017-01. Geoarchaeological and sedimentological analyses of site formation processes at the Crescent Channel (EbSh-81) site are a focus of UVic MSc student Alexandra Lausanne's thesis research (Lausanne 2018; Lausanne et al. n.d.; Figure 24).

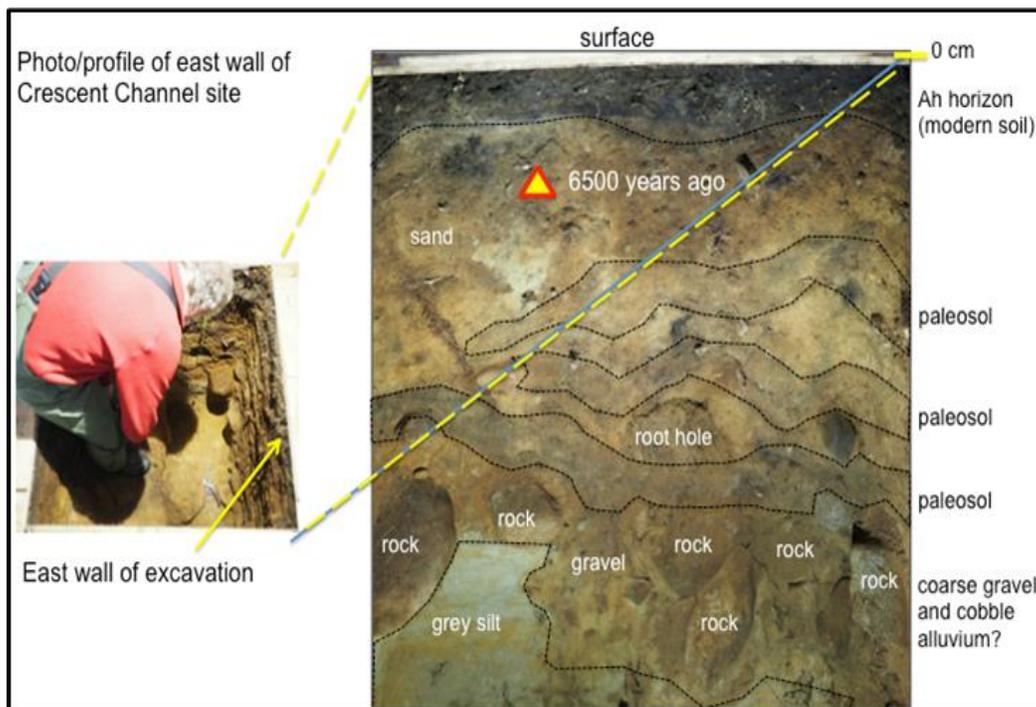


Figure 22: Crescent Channel EU-3 east wall profile. Note intact stratified deposits including three probable paleosols. Orange and yellow triangle indicates location of radiocarbon dating sample (Photo J. McSparran).



Figure 24: A. Lausanne sampling the profile of Crescent Channel (EbSh-81) EU-3 (Photo J. McSporrán).

A total of 1,875 lithic artifacts were recovered through DILA surveys and sub-surface testing at the Crescent Channel (EbSh-81) site. This multi-component assemblage contains over 200 artifacts associated with microblade technology including microblade cores, microblades, and microblade rejuvenation flakes (Figures 25-26). A highly siliceous dark grey fine-grained volcanic (FGV) stone (Figure 27) dominates the Crescent Channel (EbSh-81) lithic material type in the assemblage and there is an asymmetrical distribution of complete microblades compared to microblade fragments, particularly proximal pieces. I pick up on both of these observations in subsequent data analysis chapters (Chapters 5-7). Besides lithic artifacts associated with microblade technology, the assemblage is diverse and includes a large proportion of debitage.

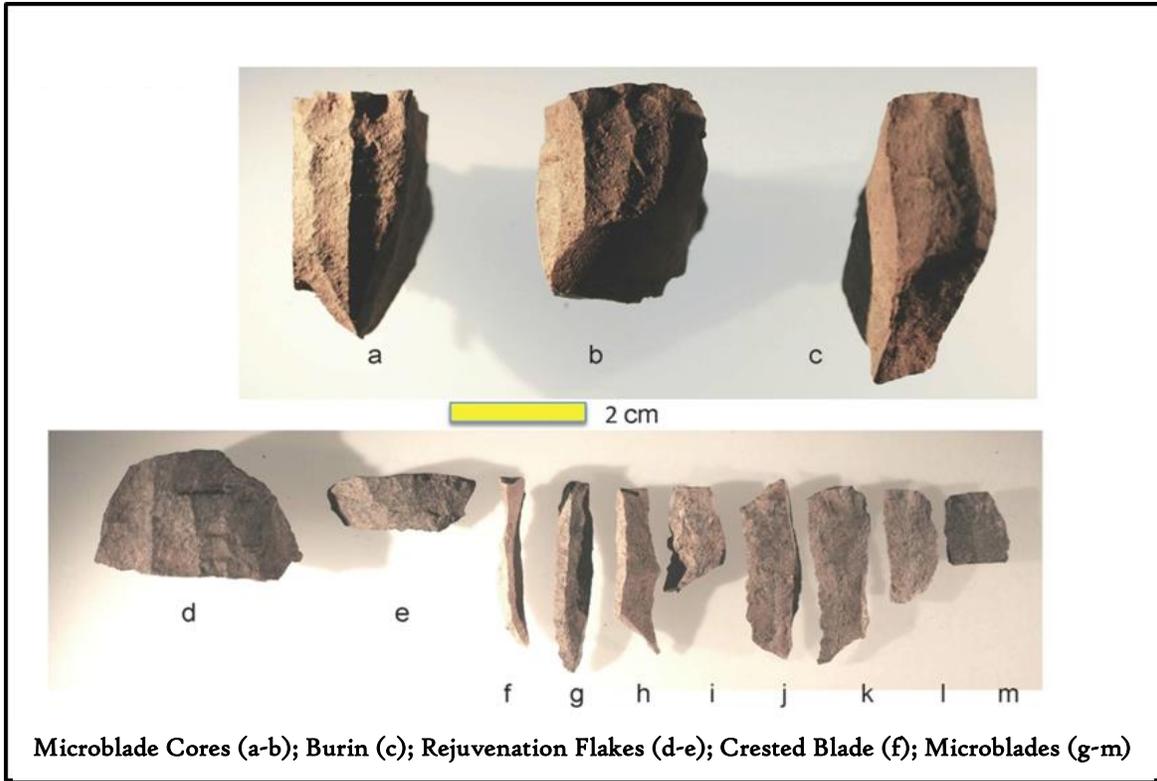


Figure 25: Lithic artifacts associated with microblade technology from Crescent Channel (EbSh-81) (Photos D. Fedje).



Figure 26: Microblade core from Crescent Channel (EbSh-81) (Photo J. McSparran).



Figure 27: Microblade core made of dark grey fine-grained volcanic (FGV) lithic material. This lithic material dominates the Crescent Channel (EbSh-81) assemblage (Photo. C. Abbott).

Observations made during excavations at the Crescent Channel (EbSh-81) site and in subsequent laboratory analyses indicate the microblade-bearing component also includes lithic technologies likely derived from lower deposits containing prepared core technology similar to lithic assemblages on the northern and central Northwest Coast that, as discussed in Section 4.2.1, typically date to the early Holocene. This, combined with several waterworn lithic artifacts in the lower paleobeach and/or paleodeltaic stratigraphic layers, suggest the presence of an earlier cultural component at the site. A radiocarbon date of 12,724-12,637 cal BP was obtained from a charcoal sample adhered to a cockle (*Clinocardium sp.*) shell cast at a depth of 115 cm DBD in EU-2017-01 thereby confirming the relatively-inferred terminal Pleistocene-early Holocene age of stratigraphic layer I. However, since *in situ* cultural materials from the lower stratigraphic layers are sparse and inferring the association of cultural materials on the basis of a single radiocarbon date is challenging, it is difficult to confidently infer an early Holocene occupation of the site based on the current data set.

A robust dip in stratigraphic layers VI and VII is observable in the west wall profile of EU-3 (Figure 23). The unique configuration of these stratigraphic layers is likely associated with a large pit feature and possibly a subterranean dwelling feature (i.e., a pit house), although this architectural form is rare on the Northwest Coast due to poor drainage in the region's generally wet climate (Coupland et al. 2009; Sobel et al. 2006; Springer 2013; Springer and Lepofsky 2011; Wigen, personal communication 2016). EU-3 excavations only caught the edge of this stratigraphic dip which makes current assessments of this intriguing feature speculative. If it is the remains of a pit house though, its construction may have exacerbated mixing of early and mid-Holocene components at the Crescent Channel (EbSh-81) site as the excavation of a pit house would require digging into earlier cultural deposits. Additionally, several charcoal concentrations were observed that are possibly shallow basin hearths although none are definitively cultural.

Ten radiocarbon samples from the Crescent Channel (EbSh-81) site were submitted for analysis. The materials selected for dating include shell, charcoal, and calcined bone. A sample from 28 cm below surface in EU-2 returned a date of ca. 6500 cal BP (Table 3) while the other five samples from EU-1 and EU-2 returned dates between 500 and 1000 cal BP, likely due to stratigraphic intrusion during excavations in the constricted 50 cm² units or root burns from forest fires. Three dating samples from the larger 1 m² EU-3 were submitted and all returned dates ranging from 6000-6500 cal BP (Table 3), thereby corroborating the older date from EU-2 and confirming that the most intensive occupation of the site dates to the mid-Holocene. As mentioned above, a radiocarbon sample from a depth of 115 cm DBD in EU-2017-01 returned a date of ca. 12,700 cal BP.

In sum, Crescent Channel (EbSh-81) is a highly significant mid-Holocene microblade-bearing site whose boundaries are likely much larger than currently defined in the BC Archaeology Branch's Remote Access Archaeological Database (RAAD) because subsurface testing was confined to a public right of way (ROW) bracketed by parcels of private land. The site's elevation and location on a paleomarine terrace means that the landform likely developed approximately 12,700 years ago, as inferred using the relative sea-level history of the region. Although the site would have theoretically been viable as a human habitation site shortly thereafter, the its extreme exposure to southeasterly winds and wave fetch during the terminal Pleistocene and early Holocene likely made it less desirable as a habitation site at this time (Lausanne et al. 2017; Vogelaar 2017; Vogelaar and Mackie 2017). This hypothesis fits with the increased concentrations of mid-Holocene cultural deposits at the site and suggests that, as the location became more sheltered due to sea levels regression and the formation of shorelines approximating modern configurations, the location became more attractive for human habitation. However, due to an earlier underlying but ephemeral component of the Crescent Channel (EbSh-81) site that was possibly obliterated through erosion of the terrace edge, an early Holocene occupation cannot be ruled-out.

The Crescent Channel (EbSh-81) lithic assemblage is large and diverse with a strongly represented mid-Holocene microblade component. Therefore it offers an excellent opportunity to track stone tool production practices in an area of the Northwest coast previously unknown to contain mid-Holocene microblade technology-bearing archaeological sites (cf. Forngeng et al. 2007; Pegg et al. 2007; Streeter 2006; Waber 2011). For these reasons, I deemed this archaeological site the best candidate for a mid-Holocene lithic assemblage available for sampling during the planning stages of this research project.

4.2.3: Village Bay Lake Island (EbSh-80)

The Village Bay Lake Island (EbSh-80) site is located on a small inland islet 8 to 11 meters above sea level (ASL) (Figure 28). It was first identified as an archaeological site when eroding shell midden and obsidian artifacts were observed during a canoe-based survey of the Village Bay Lake system in 2014 (Figure 29). Subsequent subsurface testing with soil probes and augers revealed a largely shell-free cultural component located on the bedrock bench 2-3 meters above and approximately 10 meters inland from the lake shore (8 meters ASL). It is notable that this location continues to be a hot spot of human activity as many Quadra Island locals and tourists flock to this prime swimming zone during summer months.



Figure 28: Aerial view of Village Bay Lake Island (EbSh-80), facing towards the northwest. Note the braided stream estuary that would have been an ocean channel at higher sea levels, thereby transforming the Village Bay Lake System into a marine lagoon and inlet system. Photo reproduced courtesy of the Quadra Salmon Ecocentre.



Figure 29: D. Fedje, N. Smith, & L. Wilson (left to right) surveying the Village Bay Lake Island (EbSh-80) site in 2014, facing towards the southeast (Photo J. McSparran).

Based on the results of exploratory subsurface probe and auger tests, a 50 cm² test (EU-1) was excavated in 2014 and a 1 m² unit (EU-2) was excavated in 2016 (Figures 30-31). Excavation methodology for EU-1 and EU-2 consisted of trowel testing in 5 cm arbitrary levels and by stratigraphic layers when possible. All excavated matrices were dry screened through nested 6mm and 3mm mesh. Proveniences for artifacts, samples and other notable *in situ* discoveries were mapped and bagged separately. Otherwise, level bags for each quad were used for collections made at the screens. Sloping bedrock was encountered at 40 cm DBD in EU-1 which resulted in the maximum depth of 60 cm being reached in only the southeastern corner of the unit. Sloping bedrock was also encountered in EU-2 resulting in variable terminal depths. The maximum depth reached in EU-2 was 110 cm DBD in the northwestern corner of the unit.

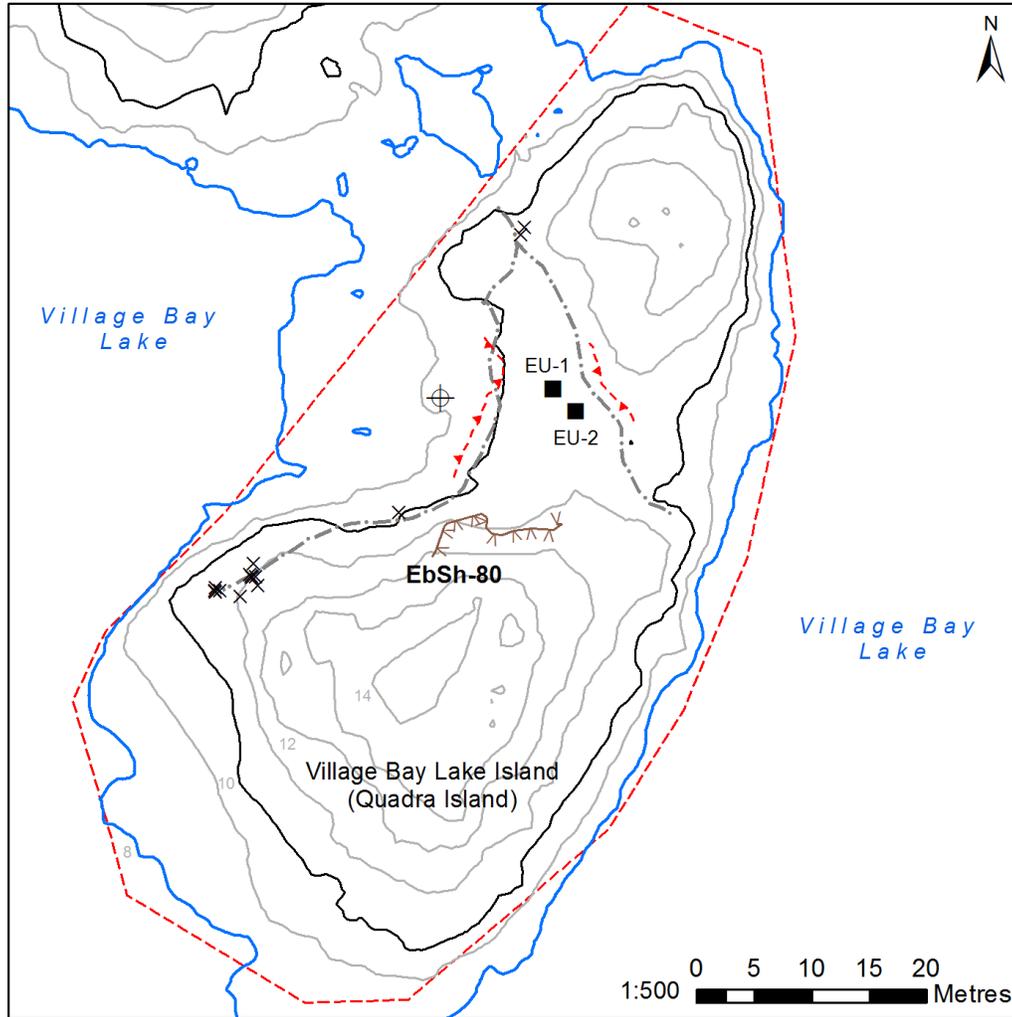


Figure 30: L. Wilson, A. Mackie, C. Roberts, N. Smith, & D. Fedje (left to right) excavating Village Bay Lake Island (EbSh-80) EU-1 (Photo J. McSporrán).

Multiple paleosols rich in artifacts were encountered in EU-1 (Figures 32-33). Similarly complex and artifact-rich stratigraphic layers were also encountered in EU-2 (Figures 34-35). Layer VII (approximately 50 cm DBD) is an intact shell-free midden layer. Multiple layers (II, III, IV, VII, IX) contained abundant charcoal, ash, and discoloured sediments probably related to cultural burn events—although no definitive intact hearth features were observed in EU-2. Stratigraphic layers IX and X contain water rounded pea gravels and pebbles, respectively, which suggests marine depositions for these lower layers. As the site is located on a rocky islet, it is hypothesized that much of the non-cultural sediments are either aeolian in origin and/or slope wash from adjacent rocky bluffs. The sediments are well-stratified, with layers alternating in particle size and in abundance of charcoal and cultural remains. Several waterworn lithic artifacts from the lower stratigraphic layers are present.

EbSh-80 Detailed Site Map

NAD 83, UTM Zone 10
 Easting: 343660
 Northing: 5560260
 NTS 92K/015



Cartography N. Smith, A. Lausanne, C. Vogelaar, & C. Abbott
 September 2017

*Please note boundaries not tested
 **All contours LiDAR derived

Legend	
 	EbSh-80 site boundary*
■	Excavation Unit
⊕	UTM Coordinate
- - -	Midden Exposure
×	Surface Lithic
v v v v	Bedrock Outcrop
- - -	Trail

Permit # 2014-0046
 Discovery Islands
 Landscape Archaeology Project
 Hakai Institute
 Fieldwork dates: August 2014 & June 2016

Figure 31: Village Bay Lake Island (EbSh-80) detailed site map
 (Cartography N. Smith, A. Lausanne, C. Vogelaar, & C. Abbott).



Figure 32: Village Bay Lake Island (EbSh-80) EU-1 east wall profile (Photo D. Fedje).

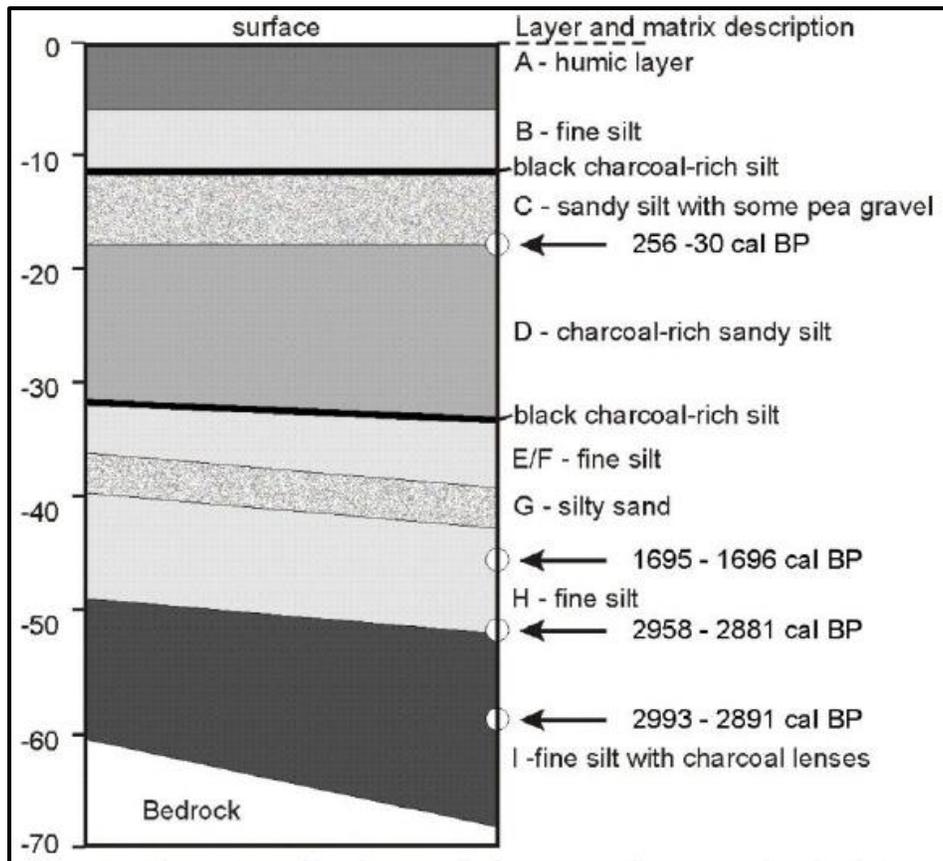


Figure 33: Village Bay Lake Island (EbSh-80) EU-1 east wall profile, stylized stratigraphic layers (Illustration D. Fedje)



Figure 34: Village Bay Lake Island (EbSh-80) EU-2 north and east wall profiles (Photo J. McSporrán).

A total of 408 lithic artifacts were recovered through DILA surveys and sub-surface testing at the Village Bay Lake Island (EbSh-80) site. The assemblage is characterized by diverse material types and an emphasis on bipolar technology and microliths fashioned from blade-like flakes typically less than a centimeter long. This focus on the production and use of small lithic technologies stands in contrast to the generally large lithic technologies recovered from the early Holocene Renda Rock Shelter (EaSh-77) site. Similarly, and although there is a shared focus on the production of small lithic artifacts, the lithic assemblage at the Village Bay Lake Island (EbSh-80) site is also quite distinct from the mid-Holocene microblade assemblage of the nearby Crescent Channel (EbSh-81) site, both in terms of its material composition and stone tool production practices. The lithic material type distribution in the Village Bay Lake Island

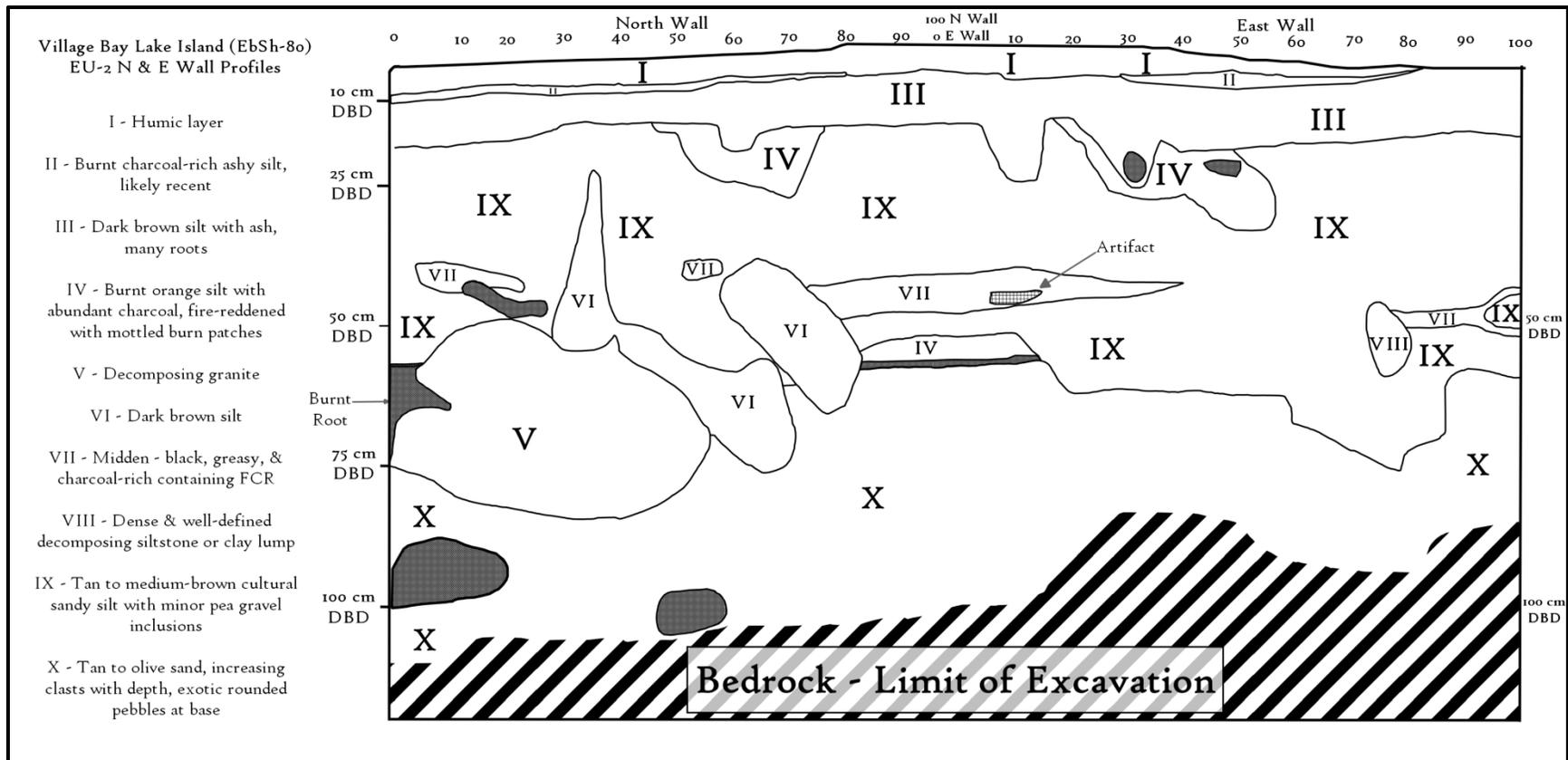


Figure 35: Village Bay Lake Island (EbSh-80) EU-2 north and east wall profiles (Illustration Q. Mackie & C. Abbott).

(EbSh-80) assemblage is dominated by obsidian, albeit with many other materials present in limited quantities. Indeed, the Village Bay Lake Island (EbSh-80) assemblage is the most heterogeneous in terms of lithic material composition of all three archaeological sites sampled in this thesis despite its modest size. Given the emphasis on obsidian as well as the associated late Holocene radiocarbon dates, the relationship of the lithic technologies at this site and the people who created them to Mitchell's (1988, 1990) "Obsidian Culture Type" emerged as a topic of interest early in my research. This and the hypothesized geological source locations of the obsidian artifacts are topics I address in Chapters 5, 6, and 8.

Radiocarbon dates indicate that most of the archaeological deposits at the Village Bay Lake Island (EbSh-80) site investigated thus far range from approximately 3000 to 1600 cal BP (Table 3). The EU-1 radiocarbon sample from 18 cm below surface that returned a close-to-modern date of 256-32 cal BP is from a C₃ photosynthetic plant ($\delta^{13}\text{C} = -13.1$), of which none are known to grow in BC without anthropogenic intervention (i.e., modern industrial agriculture and/or international commercial trade). The species of this sample is currently unknown but "is likely a woody plant such as bamboo or sugar cane (Southon, personal communication 2014)" (Fedje et al. 2016:93). For these reasons, it is considered the result of recent stratigraphic intrusion perhaps related to minor disturbances during historic times (< 100 cal BP). The three other radiocarbon dates on charcoal samples from EU-1 are in expected stratigraphic order and yielded dates of 1695–1606 cal BP at 43 cm DBD; 2958–2881 cal BP at 50 cm DBD; and 2993–2891 cal BP at 59 cm DBD (Table 3). Three radiocarbon samples (2 calcined bone, 1 charcoal) from EU-2 were also submitted for dating. Although the results of these radiocarbon dates are not in expected stratigraphic order (3206-3074 cal BP at 21 cm DBD;

1522-1402 cal BP at 45cm DBD; 3075-2949 cal BP at 52 cm DBD), they nonetheless corroborate the late Holocene dates from EU-1.

The lithic assemblage from the Village Bay Lake Island (EbSh-80) site is of moderate size yet very diverse. Like the Crescent Channel (EbSh-81) site, there is a profusion of debitage in the Village Bay Lake Island (EbSh-80) lithic assemblage. Although obsidian is the most abundant material type, the 60+ other lithic material types identified in the assemblage suggest that the people who created these archaeological deposits participated in communities of practice much more heterogeneous than the name of Mitchell's (1988, 1990) "Obsidian Culture Type" might suggest. Although Mitchell (1990:353) also includes hammerstones, abraders, bone bipoints, unipoints, awls, composite toggling harpoon valves, as well as mussel shell celts and knives as diagnostic technologies of this archaeological construct, his chosen nomenclature masks technological diversity with its emphasis on the relative abundance of a single lithic material type.

As gleaned through attribute analysis of the morphology of the lithic artifacts, there are also technological and gestural practices represented in the assemblage that are inadequately characterized by flaked stone tool production alone (e.g., drilled- and ground-stone artifacts such as beads, knives, and abraders). This is somewhat unsurprising considering this pattern is also observed in many other late Holocene lithic assemblages in both the Salish Sea (Mackie 1995; Mitchell 1971, 1990) to the south of the study area and the Northwest Coast as a whole (Ames 2009; Hobler 1990; von Krogh 1980). For the reasons described above, I deemed the Village Bay Lake Island (EbSh-80) site the best candidate for a late Holocene lithic assemblage available for sampling during the planning stages of this research project.

Chapter 5: Macroscopic Lithic Analysis

5.1: Data Analysis I – Introduction

In this chapter I present and discuss the results of a macroscopic lithic analysis which entailed examining the morphological attributes of each lithic artifact and classifying them according to a modified version of Andrefsky's (2005) Generalized Morphological Typology (hereafter GMT). A flexible approach based solely on the morphology of lithic artifacts, this typology is not intended to reflect function nor chronology and is well-suited to initial organization and structuring of the assemblages for subsequent analyses. I concurrently examine attributes such as texture, grain size, homogeneity, phenocryst habit, and colour in order to identify and classify the lithic material type of every artifact. I then detail the lithic artifact and material types present in each assemblage via descriptive statistics. By situating and contrasting these traces of technological practice and varied operational sequences alongside one another, I track their ebb and flow and highlight their relational character(s) in order to work towards insights about the ways material practices can mutually transform each other through space and time (Gosden 2004, 2005b; Lucas 2012).

5.2: A Note on Typology

“No typology can be defended, or even logically discussed, unless the selection criteria of its constituent attributes are known.”
(Mackie 1995:12)

As I introduce in Chapter 3, lithic artifacts are subject to morphological variation along a spectrum ranging from nil to extreme throughout their potentially long and varied use-lives. Additionally, as I foreshadow in Chapter 4, archaeological taxonomies and typological systems can be considered useful if constraining heuristics in order to structure relational life worlds into data sets that facilitate answering one's research questions. Despite parsing life processes into

discrete and static units of analysis (Andrefsky 2005:30), typologies can still serve a purpose as an analytical tool for making sense of dynamic processes (Mackie 1995:40). Like soil horizons and culture-historical units, artifact typologies are units of analysis and heuristic constructs whose primary utility lies in their ability to describe phenomena in a consistent manner. However, due to the potential for slipping into the kinds of hierarchical classification schemes rooted in the ethnocentric social evolutionist typologies I critique in Chapters 1 and 3, unpacking and cautioning against the baggage of typological systems as well as explicitly stating their limitations is a prerequisite to their successful implementation.

Archaeological debates about the merits and problems regarding the definition, application, and justification of typologies are not new discourses and are perhaps most concisely exemplified by an exchange during the 1950s between Albert Spaulding and James Ford. The crux of this debate revolved around “whether (or in what sense) archaeological types can be said to exist and what cultural significance they can be presumed to have” (Wylie 2002:45). Spaulding (1953:305) initiated this discussion in the literature with the, at the time, controversial assertion that typologies should be a “process of discovery of combinations of attributes favoured by the makers of the artifacts, not an arbitrary procedure of the classifier.” Spaulding’s position, in effect, argued for the value of attempting to take an emic approach to knowing the past, although he did not explicitly use the term “emic.” Importantly, Spaulding (1953) contended that this internalist knowledge is knowable by archaeologists because it is directly expressed through material traces such as the morphology of artifacts. What he argued for is the need to devise appropriate methods for ascertaining artifact types with alleged cultural significance to the people who made and used them.

Ford's (1954a) rebuttal offered a staunch defence of status-quo archaeological practice grounded in broad culture-historical generalizations. His position was that, through the imposition of structure onto archaeological materials, artifacts, and assemblages, taxonomies are developed that may or may not have any inherent structure fundamental to the phenomena being described and classified. Ford's justification of this approach was that archaeological classifications and types are constructs that serve specific analytical functions, whether these functions are discursively acknowledged or not. The polarized views of Spaulding and Ford set the stage for a series of follow-up publications between the two and other scholars (e.g., Ford 1954b; Spaulding 1954a; 1954b; Steward 1954) that would radically shift archaeological method and theory in the coming decades—most notably through the eager adoption by practitioners of the “New Archaeology” (e.g., Binford 1965; Clarke 1973) of the hypothesis-testing empiricism and processualism advocated by Spaulding.

In terms of who was right and who was wrong in this academic debate, both Spaulding and Ford were simultaneously correct and incorrect—perhaps the only time they were ever in scholarly synchronization. As Steward (1954), Sneath and Sokal (1973), and Romesburg (1984) astutely observe, both approaches to archaeological taxonomies are equally valid because, for both typological systems, “there is no way of testing their absolute reality” (Mackie 1995:11). In retrospect, the resultant series of publications initially spurred by Spaulding (1953) were mostly a heated ideological squabble—although arguably a necessary one in order to usher in dialogue and productive debates amongst archaeological practitioners of the day.

Perhaps the most useful aspect of Ford's approach, as echoed by Adams and Adams (1991), is that the criteria used to define a “type” may be based on pragmatic research goals and constraints. This leads to the next piece of the typological quagmire: the supposed distinction

between general-purpose and special-purpose typologies. Special purpose typologies, in contrast to their general counterparts, are designed to describe variation as an aid in answering research questions rather than in the formulation of such questions (Mackie 1995:12). This, coupled with the irony that even so-called general-purpose typologies could equally be conceived as special-purpose typologies whose purpose is generality, underscores why archaeological typologies must have explicit applications in order to justifiably defend the choice of which attributes are relevant to their constitution (Mackie 1995:15). Andrefsky's GMT, a typological system based solely on the morphologies of lithic artifacts rather than inferred function or chronology, exemplifies this blurring of speciality and generality. For example, it is special-purpose because it recognizes attributes in an arbitrarily hierarchical or monothetic fashion, meaning that any single constitutive attribute or set of attributes may be selected by a researcher depending on their specific research question(s) (Andrefsky 2005:67). Yet Andrefsky's GMT is also general purpose because it "is general enough to encompass most regional typologies" and it provides a set of standardized terminology to "expedite communication about various artifact shapes" (Andrefsky 2005:85).

Perhaps the most pressing pragmatic concern of devising archaeological typologies is that, no matter how rigorous or insightful archaeologists might perceive their research practices to be, no typology is all-purpose and it is impossible to include all potential variation in one typology (Mackie 1995:12-14). This potential disjuncture between scholarly epistemologies and alternative ways of knowing and becoming is an inescapable function of pluralistic ontological worlds, as I discuss in Chapter 3. Therefore, special-purpose typologies with unambiguously stated goals and applications as augmented by clearly defined criteria deemed relevant to the specific context of the research question(s) being asked opens, at the very least, a dialogue about

how and why archaeological knowledge is produced, circulated, consumed, and reproduced. In this way “‘theory’ enters into practice (including the practices of description and [classification]) and interacts with practice in the formulation of objectives” (Wylie 1992b:491).

Despite the pros and cons of various types of typologies and their philosophical underpinnings, they can be useful analytical tools, which is why I created and implemented the typology used in this thesis and described below in Section 5.3.1. However, the baggage of archaeological taxonomies implicit in the nomenclature used to describe variation within and between types is a consequence of the historical legacy of the discipline. The reification of rigidly conceived analytical categories—with which many archaeological typologies are synonymous—can lead to a lack of critical thinking with implications for analysis (Gnecco and Langebaek 2014; Henry et al. 2017). For example, lithic analysis discourses abound with loaded terms (Gero 1991:164) implying particular functions (e.g., scraper, projectile point, hand axe) and, therefore, a direct correspondence between form and intended purpose (cf. Iovita 2011; Iovita and McPherron 2011; Iovita and Sano 2016; Newman and Moore 2013; Rots and Plisson 2014). This is a questionable logic because, even without morphological modifications, a projectile point can be used as a knife or for anything else the hand that wields it desires and knows how to do (Menzies 2017).

Furthermore, usually little consideration is given to the use-life history of lithic artifacts and that their form when recovered by archaeologists is likely only one moment in a continuum of repeated modifications (Ahler 1971; Clarkson 2006; Dibble 1987, 1988; Hiscock 2006; Hiscock and Attenbrow 2005; Hoffman 1985; Thomas 1981). Analytical attention is typically focused on how their current morphology is perceived to be similar or dissimilar to predetermined artifact classes. As Rolland and Dibble (1990:481) critique, this stagnant

paleontological perspective portrays typological units of analysis as “immutable, invariant, natural, and discrete categories.” Mackie (1995:40) analogizes this paradigm to palaeontologists attempting to study ancient environments without understanding or knowing about processes of ontogeny, ecology, or sexual dimorphism. In contrast, use-life history models explicitly acknowledge idiosyncratic human behaviour(s) in relation to continuous processes such as breakage, repair, and recycling throughout artifacts’ use-lives. Schiffer’s (1976, 1987) concept of “systemic context” formally describes these processes through abstractions of human “behavioural pathways” and posits that when pieces of material culture enter the archaeological record they often have less utility than they previously held. Therefore, most artifacts are disproportionately more likely to be discarded—and end up in archaeological deposits—at the end of their use-lives. Adding further complication to these models of archaeological site formation processes, discarded objects, particularly relatively durable ones made of stone, may be taken up at later times and reused for similar applications to which they were once put or recycled for new ones (Dibble et al. 2017; Joyce and Gillespie 2015; Roddick 2015).

The awkward analytical reality that successive modifications throughout artifacts’ varied and recursive use-lives can be so extensive that, at various points in this continuum of morphological dynamism, artifacts may pass through multiple forms that would be classified as different tool types depending upon the typological system being implemented (Goodyear 1974; Frison 1968; Jelinek 1976; Rolland and Dibble 1990) is often ignored. Notable exceptions include archaeologist Don Crabtree, an early lithic specialist renowned for his skilful replicative practice, who developed “Crabtree’s Law” which posits the greater the degree of working of a stone artifact, whether by flaking, grinding, or polishing, the harder it is to conclude the lithic reduction processes and techniques which produced it (Crabtree 1972). Mackie (1995:74)

provides another example of these recursive recycling process within a use-life history model of Salish Sea nephrite celts by describing how a longitudinal bisection, likely driven by conscious desires and/or intuitive predispositions to optimize and prolong the use-life of artifacts requiring significant labour investments, alters the width to thickness ratio and “blurs the initial type boundaries between ‘adzes’ and ‘chisels.’” By the same token, Dibble et al. (2017:814, 828) note “artifact forms do not have simple one-to-one functional referents” and “categories such as end-products, by-products, and waste reflect the archaeologists’ perspective more than past reality.” For these reasons, in addition to post-depositional taphonomic processes, non-functional and non-stylistic variations (cf. Dunnell 1971, 1978) that influence artifact morphologies “should always be considered in a typological study” (Mackie 1995:14) because they have a direct impact on artifact type frequencies and, thus, assemblage compositions.

Likely the most blatant functional and typological assumption in lithic technology studies is the word *tool* in the phrase “stone tool.” Because vocabularies manifest in the ways archaeological artifacts, strata, and sites are classified, they feed back into how knowledge about the past is formulated and influence how such knowledge is (re)instantiated (Henry et al. 2017:28-29). Similarly, and as I critique throughout this thesis, these naming and labelling practices are caught up in the ways people and communities can come to be hierarchically classified, often as an indirect result of how their material culture is classified within archaeological taxonomies. In short, archaeological definitions of what constitutes a tool require broader considerations in order to avoid recapitulations of normative discourses reinforcing narratives of “rugged men doing primal things” (Gero 1991:167).

As I argue in Chapter 3, “tool” is an ambiguous term and a fluid construct with no essential link between particular artifacts’ form and specific function(s) or use(s) (Holdaway and

Douglass 2012), some of which defy Western associations of lithic technologies with utilitarianism. Even the seemingly simple question of whether or not an artifact was ever put to use by humans is complicated by issues of equifinality because non-cultural processes can mimic use-wear (Chase et al. 2009) and some uses leave no use-wear traces (Dibble et al. 2017:822). Indeed, nearly all products of lithic reduction can be used for something (Binford 1986:553; Hayden 1979:29-37) and it is highly difficult if not impossible to determine whether or not a piece of stone ever had cultural uses just because it lacks use-wear traces. Therefore, archaeologists are, at best, occasionally overconfident in our assessments of lithic artifacts as tools and are, at worst, reliant upon a false dichotomy between “tools” as desired products and “debitage” as waste. Paton and DeSilvey (2014:221) touch on a similar notion with their introspective and reflexive study of “the processes of material growth and transformation implicated in the working of stone” and the emergent relationships between a stone sculptor/sawman/mason and granite, the material with which he primarily works, in a contemporary Cornish quarry. In their discussion of the sludge created when using a rock saw to cut pieces of granite from large slabs of the quarry, they note “[the sludge] is the residual trace of the transformation of granite” and argue for “an appreciation of the residual matter produced through [its] making” (Paton and DeSilvey 2014:223, 234). Just as the term “tool,” typically employed in lithic technology studies to imply desired utility and form, is built upon assumptions of tenuous certainty, so too are the negative connotations of terms such as “sludge” and “debitage.”

Short of reinventing the analytical jargon we use in our daily research practices—which is beyond the scope of this thesis but not entirely out of the question as a long term goal for the discipline of lithic technology studies—explicitly unpacking the assumptions and historical

legacies of these terms, as I do above, is an important initial step towards countering negative effects and implications lurking beneath the surface of the words we use and the units of analysis we create (Watkins 2001, 2006). Despite theoretical and methodological challenges to studying and coming to know the past through archaeological analyses of lithic technologies and stone artifacts, the nomenclature archaeologists use persists and, if nothing else, provides a shared language with which to communicate with one another. Indeed, much of archaeological field, laboratory, and archival work can be described as processes of assembling and time-averaging through which depositional assemblages are converted into typological ones, creating stability that serves to make objects possible in an otherwise continuous flux of assemblages (Lucas 2012:196, 214). Put more simply, “classification reduces variability into manageable units to facilitate communication” (Andrefsky 2005:61). Rather than getting bogged down in issues of problematic lithic technology nomenclature, I choose to make these issues unambiguous and then harness these defused terms for my own purposes.

A key point I belabour is that, contrary to the alleged simplicity of determining whether or not a lithic artifact was ever used for a particular task, uncritically employing use-wear traces as the only proxy of use is fraught with challenges. Nonetheless, an artifact that does show evidence of use-wear is often referred to as a “tool,” with the connotation that its morphology was altered through some form of human action. Whether or not a lithic artifact was ever indeed used by humans to perform a task is, in many ways, a moot point to my research questions. This is because an unretouched or unmodified lithic artifact is (approximately) in its “original” form whether or not it was ever used for cultural practices. I can hypothesize with reasonable certainty that these artifacts are less likely to be gestural palimpsests than, say, a bifacially-flaked point or even a flake exhibiting extensive edge damage. This is not to imply that every complete and

unmodifieddebitage flake in the sampled lithic assemblages was never used as a tool or served other less utilitarian functions. It simply means that they show no macroscopically-observable morphological modifications subsequent to the moment they were detached from objective pieces. While I cannot resolve pervasive issues of equifinality in the discipline of archaeology, I can side step them by purposely sampling artifacts with minimal alterations to their morphology. This creates an analytical toe-hold for using lithic artifact morphologies as a proxy data set of learned gestural practices and processes of situated learning inherent to communities of flaked stone tool production and use.

In sum, much like the fact that shell middens are not the piles of garbage the etymological roots of this English phrase imply (Carlson 1999; Gamble 2017; Grier et al. 2017; Letham et al. 2017; Luby 2004; Martindale et al. 2017b; McLay et al. 2008; McNiven 2013; Menzies 2015; Watkins 2006),debitage flakes are not superfluous waste nor are they inconsequential by-products carelessly discarded in favour of what some lithic analysts consider to be more charismatic artifacts (cf. Andrefsky 2001). Lithic artifacts that I classify as “debitage flakes” are, for my purposes, lithic artifacts with a discernable platform, ventral and dorsal surfaces, as well as intact lateral margins. Following Andrefsky (2005:262), I use the term “tool” as a flexible short-hand for any lithic artifact whose morphology is visibly modified through cultural or taphonomic processes subsequent to its original detachment from an objective piece, but I make no assumptions about how or why its morphology was altered. I use both of these terms as neutral linguistic descriptors of the morphological attributes of lithic artifacts, the sole criterion upon which my typological classifications are based. Truly, and as Mackie (1995:20) rightfully observes, “it cannot be overemphasized that the types which result from a descriptive classification have no [necessary] functional, spatial or temporal meaning.”

Thus, the lithic artifact types discussed in the sections below describe the morphologies of lithic artifacts only at the moment they were excavated from one of the three archaeological sites sampled in this thesis. These artifact types do *not* refute the possibility that these pieces of material culture had diverse forms prior to their shape at the moment of archaeological recovery via controlled excavation, nor do they imply mutually exclusive functions. They are simply words and phrases with particular descriptive meanings—meanings of which I go to great lengths to define—in order to structure the lithic assemblages in a manner that facilitates subsampling, further analyses, and, ultimately, to provide insights to the research questions I outline in Chapter 1. What is needed is a well-defined and efficient archaeological taxonomy structured exclusively by artifact morphological attributes as its defining criterion, the topic to which I now turn.

5.3.1: Morphological Attribute Analysis

“Human behaviour clearly does not consist only of the production of finished objects with stylistic or functional significance. This is especially true with lithic materials, which can be remodified continuously and repeatedly...”
(Rolland and Dibble 1990:482)

The first step in my research process, like many other lithic analyses, is to organize and catalogue the sampled lithic assemblages. During the fall of 2016, professional archaeologist Angela Dyck and I inspected every object from the provenience-specific level bags collected from the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) sites during fieldwork for the DILA project (Figure 36). By examining the morphological attributes of each piece, we decided a) whether or not it is indeed cultural in origin; b) how it fit into the chosen typological system; and c) what lithic material type it is. Equipment we used included a geological loupe, a low-powered stereo optical microscope, and a regionally-specific lithic material type comparative collection. Each artifact was assigned a

unique alphanumeric code corresponding to the Borden number of the archaeological site it was recovered from as well as its order of entry into the catalogue (e.g., “EbSh-81:01” for the first catalogued artifact from the Crescent Channel site, and so on). Pieces we agreed were non-cultural were set aside while ambiguous cases were set aside for additional assessments by more experienced lithic analysts in order to verify and supplement our initial classifications. The catalogue number and associated contextual data (archaeological site, provenience, collection date, artifact typology, lithic material type, size of morphological attributes, and any other observations we made) were recorded in an Excel file and stored on my computer hard drive. In the interest of concision, the “raw data” (i.e., dozens of columns and thousands of rows of the spreadsheet) are not incorporated in this thesis. However, these data will be available in the forthcoming DILA project final report.



Figure 36: Macroscopic lithic analysis by A. Dyck and C. Abbott in the archaeology laboratory at the University of Victoria. Note the lithic material type comparative collection in the foreground (Photo S. Duffield).

In order to address my research questions outlined in Chapter 1, my task was to derive structured data matrices from collections made during fieldwork for the DILA project. One of my chosen tools for accomplishing this task is a modified version of Andrefsky's (2005) Generalized Morphological Typology (GMT). A goal during this stage of analysis was to isolate complete and unmodified flakes from the rest of the sampled lithic assemblages and to collect metric data for the size of morphological attributes such as length, width, and platform size for these pieces of debitage. This was motivated by the aim of generating size data on multiple morphological dimensions as an aid to answering questions about the learned kinaesthetic movements of flaked stone tool production and use (Williams and Andrefsky 2011; Williams et al. 2013). The logic underlying the rationale for the creation and implementation of the typological system used in this thesis is as follows:

If morphological attributes = lithic artifact types

and

*morphological attributes of some lithic artifacts =
proxies of learned gestures and bodily practices*

then

some lithic artifact types = proxies of learned gestures and bodily practices

Besides the goal of creating data sets I can use for my own research purposes, the practical and ethical dimensions of archaeological collections management and curation were also a consideration. Had my only concern been to isolate complete and unmodified flakes from the rest of the sampled lithic assemblages, a simple binary taxonomy would have been all that I required (i.e., is a given lithic artifact a complete and unmodified flake or not?). While this likely

would have made time spent in the laboratory significantly shorter, ethical and professional responsibilities to the We Wai Kai, We Wai Kum, Kwiakah, K'ómoks, Xwemalhkwu, and Klahoose First Nation communities and fellow researchers alike dictated that I create a more thorough catalogue of the assemblages. As per *Heritage Conservation Act* (HCA) permit 2014-0046 under which the DILA project operates, analyzing, cataloguing, labelling, and packaging each artifact in the sampled lithic assemblages in order to prepare them for repository submission and storage at the Royal British Columbia Museum was a secondary goal of the macroscopic lithic analysis stage of my research.

The lithic typology I developed (Figure 37), modeled closely after Andrefsky's (2005) GMT, meets these criteria while balancing my research goals. The most heavily weighted classificatory criterion is the directionality of visible flake scars. I chose to emphasize directionality of flake removals because this morphological attribute is closely bound up in the learned gestures of how to hold a core while knapping and how to reposition the core as its morphology shifts during reduction. If I observed flake removals oriented in one plane that originate from a single platform, I classified the artifact as associated with "Unidirectional Technology." If I observed flake removals in multiple directions, I classified the artifact as associated with "Multidirectional Technology." If I observed flake removals oriented in a centripetal pattern suggesting continuous platform maintenance, I classified the artifact as associated with "Prepared Core Technology." I also inspected every lithic artifact for evidence of additional morphological attributes diagnostic of microblade and bipolar technologies such as lateral margin symmetry, platform morphology, core face fluting, bulb of percussion shearing, and overall size.

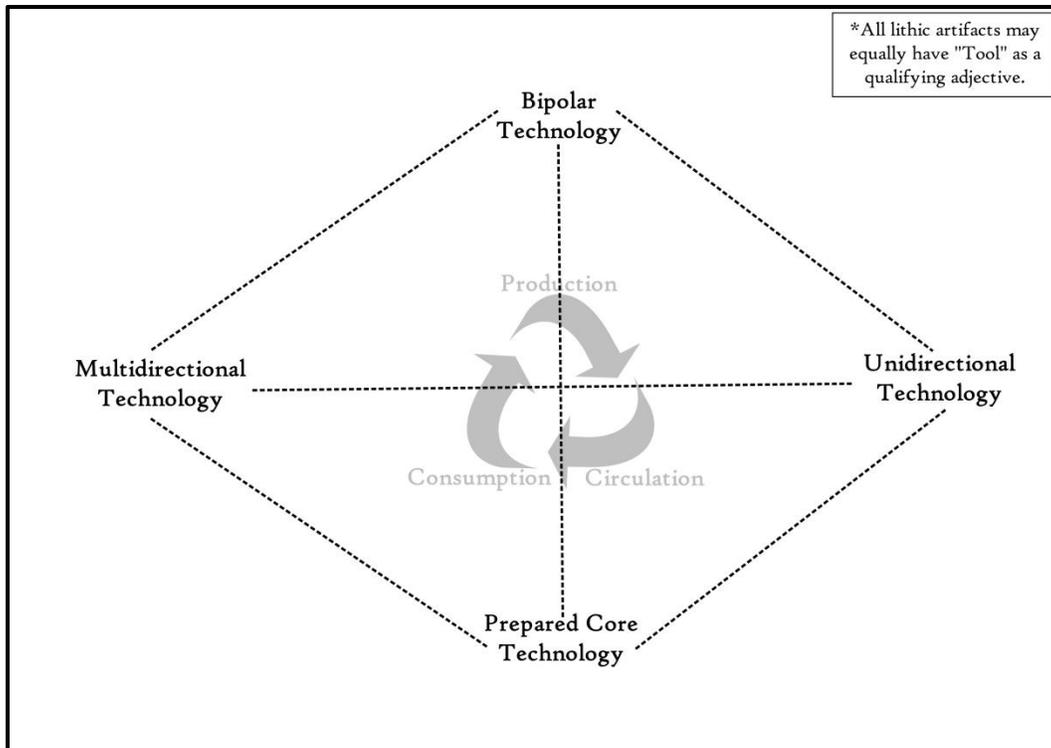


Figure 37: Taxonomic system used during macroscopic lithic analysis.

Following Rolland and Dibble (1990:483), the “types” of lithic artifacts in this typology are not truly discrete categories but are instead states along continuums of transformation through resharpening, rejuvenation, and reduction events. This typology is an attempt to reconcile static typological categories with fluid processes of lithic technology production, circulation, and consumption. In particular, the dashed lines that connect each technology emphasize the relationality of these diverse yet linked lithic reduction processes.

Any lithic artifact may equally have "tool" as a qualifying adjective within this taxonomic system, meaning it possesses visible modifications to its morphology through cultural and/or taphonomic processes subsequent to the initial gesture that detached it from an objective piece. In the strictest sense of this logic, all cores must be considered tools. However, in the interest of reducing ambiguity between this typology and conventional lithic analysis nomenclature, my

differentiation between "cores" and "core tools" is based on obvious use-wear traces such as retouch, microflaking, or striations.

Additional qualifying adjectives such as "cobble" and "cortex" are occasionally provided in order to enhance descriptive capacity but they are not requisite typological categories. Similarly, I include bifacial, discoidal, and Levallois-esque core technologies as sub-categories within the more inclusive "Prepared Core Technology." Pressure-flaked microblade and hard hammer blade-like flake technologies are sub-categories of the more inclusive "Unidirectional Technology." Artifacts associated with pecked, ground, and drilled stone technologies are omitted from Figure 37 because they are not the technological practices upon which I primarily focus in this study, although they are noted when relevant within the descriptive statistics and cumulative density plots below. Lithic artifacts exhibiting morphological attributes associated with multiple typological categories were classified by reconstructing their operational sequence and inferring the technology or reduction approach associated with the most recent morphological modifications. Finally, this archaeological taxonomy is a special-purpose typology designed for implementation within the context of this thesis. Therefore, the typological categories are defined so as to include lithic artifacts present in the sampled assemblages but no effort was made to accommodate all possible shape variations within and across the full spectrum of lithic technologies known (and unknown) to lithic analysts.

An unexpected but appreciated outcome of the laboratory analysis was the emergence of several new research questions and relevant data sets I did not originally consider during the early stages of the project. Specifically, microblades, which can be considered a highly regularized flake, are equally germane to my research questions and are a useful source of data.

I was also able to develop my lithic analysis skills—skills that will serve me well in my post-graduate school professional practice—to a much greater capacity than had I, say, cherry-picked the complete and unmodified flakes while ignoring the rest of the assemblages. The parallels between the theoretical position I develop in Chapter 3 regarding situated learning and my enhanced enskilment as a corollary of doing a more comprehensive lithic analysis are not lost upon me.

The typological system I developed during the macroscopic lithic analysis stage of my research is primarily designed to identify complete pieces of unmodified debitage within the three lithic assemblages sampled for this study in a systematic and reproducible manner. This typology is not without assumptions but, by focusing exclusively on visible macroscopic morphological attributes rather than inferred functions or chronologies, I control for these assumptions by making them explicit. Furthermore, a morphologically-based typology forms the foundations of the morphometric components of my research (Chapter 7) by ensuring that all members within a given category share morphological attributes, which renders quantitative comparisons and analyses of their shapes possible. Without this data set structuring, morphometric analyses would be highly skewed and practically meaningless. Indeed, “there are an infinite number of attributes that can be measured on any phenomenon” and “the attributes that the researcher keys in upon when classifying lithic artifacts are determined by the needs of that researcher” (Andrefsky 2005:64). As I elaborate in Chapter 7, measuring and recording the size of microblade and debitage morphological attributes (Figures 38-39) creates the proxy data sets I need to describe, analyze, interpret, and discuss the skilled movements, learned gestures, and bodily practices of the ancestral knappers who created these lithic artifacts as they made and used stone tools. In the interest of concision in this chapter, I collapse all flakes into the single

category of “Debitage - Flake” regardless of whether or not they are complete. However, I split these units of analysis into their respective portion sub-types (i.e., complete, proximal, medial, distal) in Chapter 7 in order to target the appropriate elements of the assemblages for morphometric analyses.

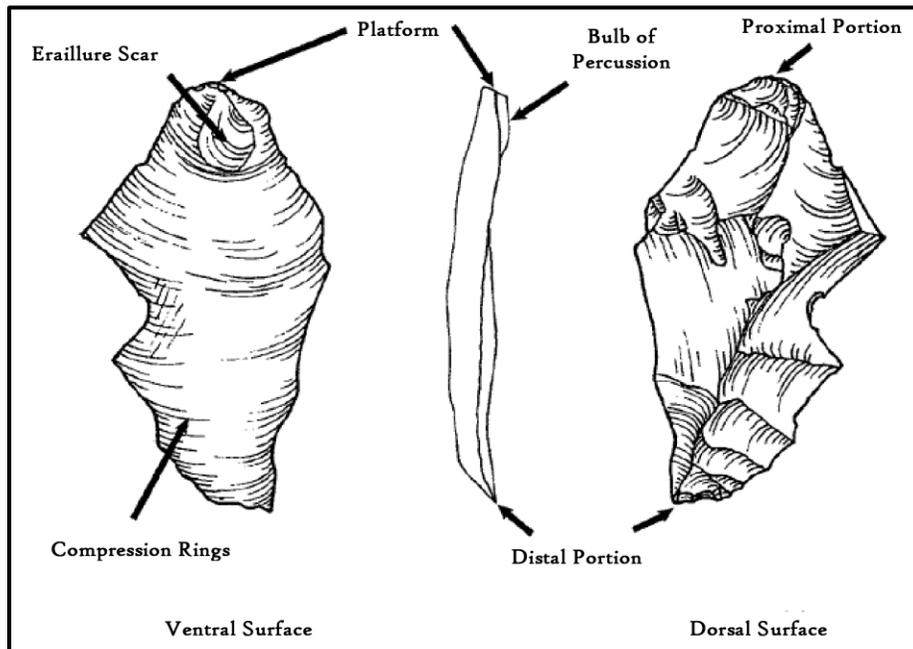


Figure 38: Schematic of complete debitage flake morphological attributes. Modification of image by Andrefsky (2005:19).

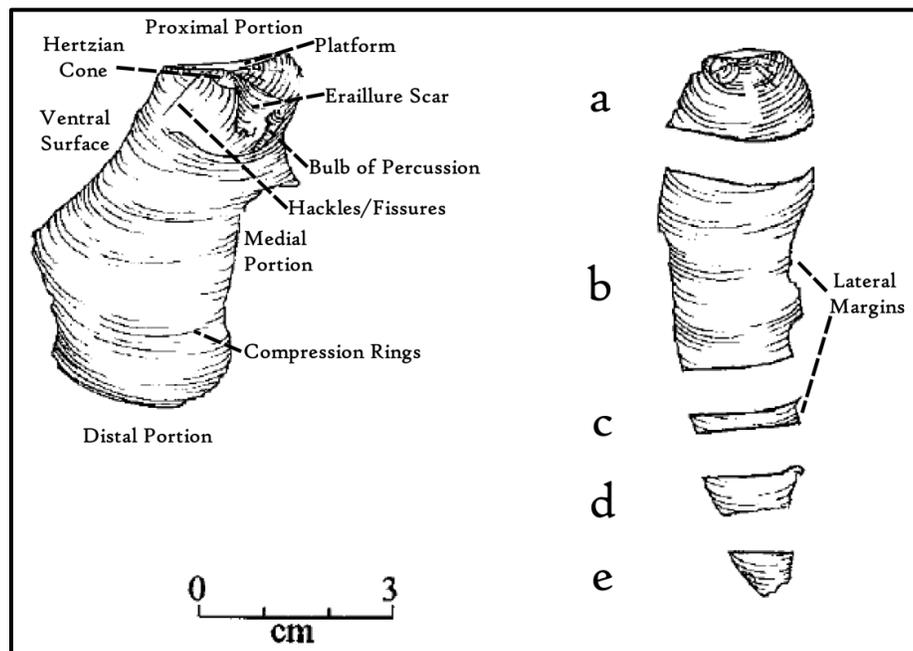


Figure 39: Schematic of broken debitage flake morphological attributes: complete flake (left), proximal flake (right-a), medial flakes (right-b, c, d), distal flake (right-e). Modification of image by Andrefsky (2005:83).

5.3.2: Lithic Material Types – Visual Identification by Surficial Attributes

The other important aspect of this stage of analysis was the iterative construction of a lithic material type comparative collection specific to the Discovery Islands study area.¹ During the analysis of each lithic artifact I visually compared its surficial attributes such as texture, grain size, homogeneity, phenocryst habit, and colour to the other type-specimens in the comparative collection. If the artifact in question did not match any of the type-specimens already in the comparative collection, this piece was added and became the type-specimen for a new lithic material type (in addition to giving it a catalogue number and recording it in the data base). In this way, I always compared artifacts to the same artifact of a given lithic material type which enhanced the consistency of material type identifications and classification over the months during which these analyses took place. Moreover, I purposefully took a liberal “splitting” approach to the material type identifications I made in order to control as best I could for the confounding effects of differential chemical weathering and patina formation on the external surfaces of the artifacts. Since I planned to sub-sample representative specimens from the lithic material types identified using macroscopic methods for subsequent analyses such as thin section petrography (TSP) and X-ray fluorescence spectrometry (XRF), I judged a “splitting” approach to be the most prudent tactic despite the risk of falsely identifying more lithic material types than are actually present in the sampled assemblages. This is because a liberal approach to lithic material type identifications would set me up for further investigation via sub-sampling for TSP and XRF methods whereas a “lumping” approach would mask this potential variability (Reimer 2012:90-111; Smith 2004:41-51).

¹ I am grateful to Duncan Johannessen, senior laboratory coordinator in the School of Earth and Ocean Sciences at UVic, who kindly spent time teaching me what geological attributes to look for when making lithic material type identifications and patiently answered my many questions.

A total of 83 lithic material types were identified during the macroscopic lithic analysis that Angela Dyck and I conducted (Appendix A). Self-evident names were chosen whenever possible in order to decrease ambiguity amongst the identified lithic material types (e.g., ‘Dalmatian Granite’ for a particular type with a speckled pattern reminiscent of the coat of a Dalmatian dog). Like the lithic artifact types I discuss and unpack earlier in this chapter, the names I chose for the lithic material types also have specific descriptive meanings. Unlike the artifact types that are linguistically linked to the technological and gestural practices that led to their current morphologies, the classifications I made and names I chose for the lithic material types are largely related to their inferred petrogenesis. The type-specimens that make up the comparative collection are currently housed in the archaeology laboratory at the University of Victoria but will eventually be reintegrated into the lithic assemblages from which they are derived prior to repository submission at the Royal British Columbia Museum.

The data presented in Appendix A are the result of a didactic analytical process. At the beginning of this research my knowledge of geology, petrography, and even lithic technologies was admittedly limited. However, through situated learning in the laboratory, my confidence and aptitude for these subjects grew as I became more familiar with the range of variation in the sampled lithic assemblages and with practical laboratory procedures that streamlined the analyses. For example, secondary inspections under the mentorship of Duncan Johannessen, senior laboratory coordinator in the School of Earth and Ocean Sciences at UVic, of my initial lithic material type identifications occasionally led to inferred petrogeneses that differed from those implied by the nomenclature of my initial classifications. This phenomenon of incongruence between the initial and secondary inspections is most prevalent within lithic material types I initially identified as a “cherts.” Secondary inspections of these specimens

generally suggest igneous rather than sedimentary petrogenesis. Rather than altering my initial lithic material type classifications, I used the results of this two-step identification process to inform my sub-sampling strategy for TSP and XRF methods, as I elaborate on in Chapter 6. The first column of the table in Appendix A lists my initial material type identifications. The second column includes secondary identifications made under the tutelage of Duncan Johannessen and descriptions of the inferred petrogenesis of each lithic material type. The third column summarizes the observations I made prior to working with Duncan Johannessen and ones we made together by stating the congruency of observations made before and during this informal geological apprenticeship.

5.4.1: Renda Rock Shelter (EaSh-77) Macroscopic Analysis Results

The Renda Rock Shelter (EaSh-77) site is the smallest of the three lithic assemblages sampled in this thesis ($n = 100$) and also the first one I analyzed. As discussed in Chapter 4, radiocarbon dating of the archaeological deposits at this site thus far are anomalous in terms of expected age based on relative dating techniques such as the site's elevation in relation to the study area's sea level history; the water rounded basal layers reminiscent of paleobeach deposits; the flat surfaces of the overlying stratigraphic layers which suggest alluvial or marine depositions; and the lithic technologies themselves. The Renda Rock Shelter (EaSh-77) lithic assemblage is characterized by abundant debitage, both unmodified pieces and flake tools. Artifacts associated with multidirectional technology and prepared core technologies such as discoidal and unidirectional blade-like cores as well as a Levallois-esque flake tool are also present (Figures 40-41).

Boëda (1995:61) defines formal Levallois technology as a prepared core with two intersecting flaking surfaces that create a perimeter used as a striking platform; that these two

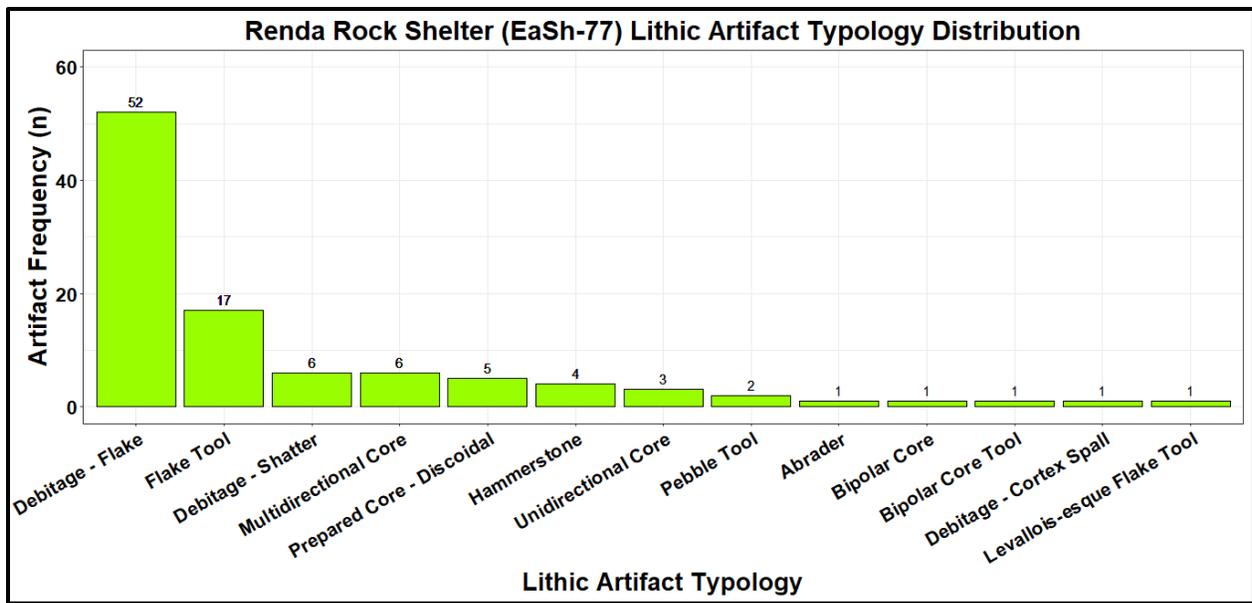


Figure 40: Macroscopic lithic analysis results of artifact typologies for the Renda Rock Shelter (EaSh-77).



Figure 41: Levallois-esque flake tool from the Renda Rock Shelter (EaSh-77).

flaking surfaces have a hierarchical relationship to one another; and that a series of preparatory trimming flake removals around the circumference of the core are necessary between the removal of each Levallois flake. By striking parallel to the platform, a large Levallois flake is detached with its distinctive plano-convex profile, dorsal surface morphology reminiscent of a tortoise shell, and remnant flake scars from the previously removed circumferential trimming

flakes is detached. This detachment also rejuvenates the platform angle so the reduction process may be repeated.

The relationship between the two flaking surfaces of a Levallois core is inferred to be hierarchical in that the “lower” surface is thought to be preferentially used for platform angle maintenance because its lateral and distal convexities propagate percussive force in a more controllable manner relative to the concave geometries of the “upper” surface (Brantingham and Kuhn 2001). In maintaining the platform by removing flakes from the “lower” surface throughout reduction, which would also be functional flake tools, controlled removals of Levallois flakes from the “upper” flaking surface are possible (Odell 2003:90; Whittaker 1994:121).

Discoidal core technology can be distinguished because, while sharing the gesture of a parallel strike to the platform with Levallois technology, the fracture plane is secant rather than parallel to the plane of intersection of the two flaking surfaces (Vaquero 1999). There is also less of an inferred hierarchy between the two flaking surfaces as each side of the core may be used to detach flakes for immediate use or flake blanks for subsequent modifications into various other forms of stone tools. That is to say, a discoidal core can be flipped in the hands of a knapper at any point in an operational sequence and the functions of the two flaking surfaces may be reversed (Delagnes and Rendu 2011:1778; Picin and Vaquero 2016:71; Picin et al. 2014:90; Vaquero and Carbonell 2003:72). This cyclical geometric inversion of the core allows for continuous reduction of a nodule of stone without the need for extensive platform rejuvenation(s) characteristic of Levallois technology.

Discoidal technology is an efficient and flexible approach to stone tool production but does not meet Boëda’s (1995) strict definition of Levallois technology. Yet both technologies

require centripetal flake removals from two planes of a core. Moreover, both of these technologies require considerable skill, kinaesthetic coordination, and technological proficiency. In terms of the implications for the communities of practice within which the knappers who use these reduction techniques participate, both Levallois and discoidal technologies likely require considerable amounts of situated learning in order to master. An implication of this hypothesis is that greater investments of time and energy, for both apprentices and teachers, would be necessary in order for intra- and intergenerational enskilment to occur. Therefore, and following Vaquero and Carbonell (2003:79) who question the utility of the Levallois and discoidal typological debate, I side-step it by purposefully using inclusive nomenclature and include both within the “Prepared Core Technology” category.

The lithic material types that make up the Renda Rock Shelter (EaSh-77) assemblage are dominated by “Unknown A,” a moderately coarse and degraded quartzite with abundant voids or “vugs” throughout the matrix (Figures 42-43). Prior to my analysis a preliminary lithic analysis was conducted by other members of the DILA project who used letters in association with their ‘Unknown’ classifications. Given the already established classificatory system and my relative inexperience at the time, I chose to continue using this letter series when naming, identifying, and classifying lithic material types in this assemblage.

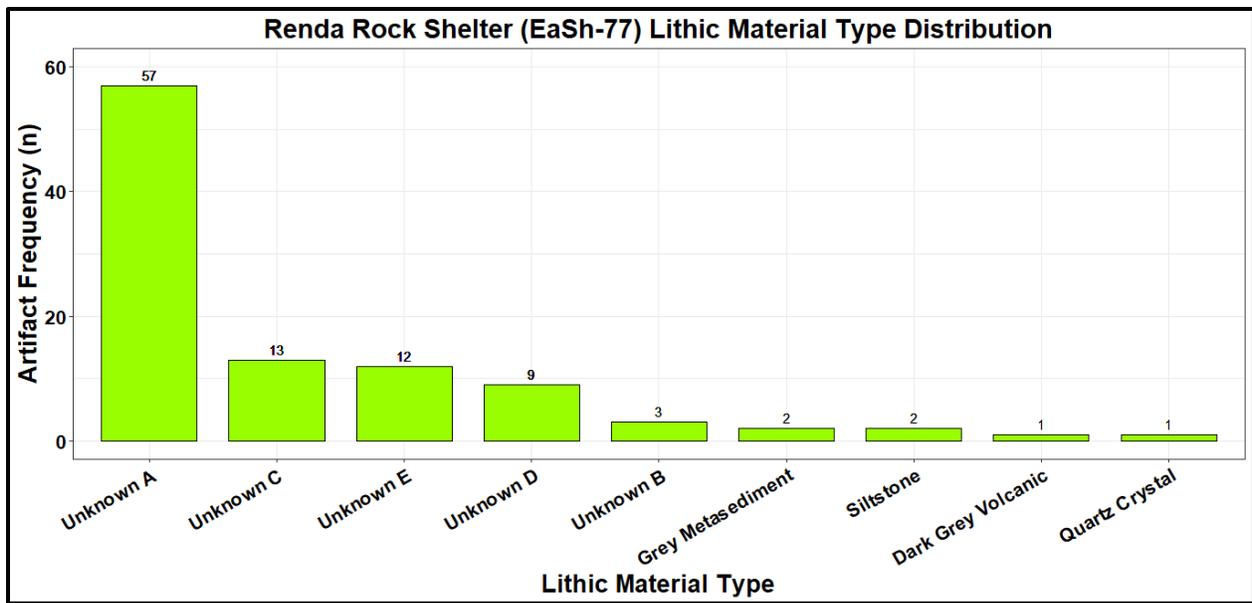


Figure 42: Macroscopic lithic analysis results of lithic material types for the Renda Rock Shelter (EaSh-77)



Figure 43: Example of a discoidal core from the Renda Rock Shelter (EaSh-77) (Photo C. Abbott and C. Vogelaar).

Besides the major trends observable in the Renda Rock Shelter (EaSh-77) lithic assemblage, there are notable outliers that add to the diversity of this small yet intriguing data set. Specifically, three unidirectional cores and a single bipolar core suggest that these alternative technologies, along with their respective skilled gestures and embodied knowledge, were a part of the overall operational sequences of the other prepared core technologies more prevalent in the assemblage (Figure 44). For example, the unidirectional blade-like cores could be an early stage in a reduction sequence in order to shape the morphology of the core and prepare a

circumferential striking platform in such a way that the morphologies of discoidal or Levallois-like technologies emerge. However, it is unclear whether or not the ancestral makers and users of these stone tools purposely reduced cores to alter their morphology in such a way that they would be recognizable to lithic analysts as these prepared core technologies or if this artifact type is an epiphenomenon of repeated blade and blade-like flake removals.

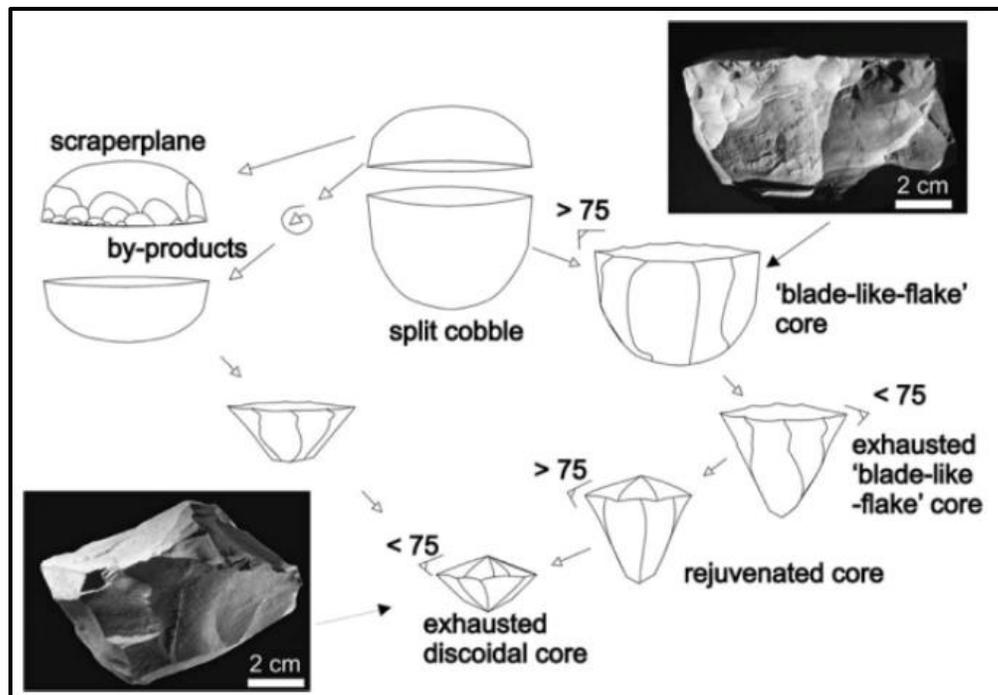


Figure 44: Schematic of hypothesized prepared core technologies operational sequences (Fedje et al. 2011:330). Note the morphological dynamism and typological multiplicity as lithic artifacts are worked and reworked.

Either way, as nodules of lithic material move through typological reduction continuums and as prepared cores become exhausted through repeated removals, switching to the less controllable but more flexible and opportunistic bipolar or multidirectional technologies—on either the core itself or any of its previously detached flakes—facilitate further detachments of useable flakes and would prolong the use-life of the core and the lithic materials at hand (Flenniken 1981:13; MacLean 2012:144). Core reduction technologies are necessarily dynamic processes given the shifting shapes of cores and ever-decreasing amounts of lithic material. Traces of these gestural variations are materialized by lithic artifacts and are closely linked to the

dynamic adjustments made by ancestral knappers during the reduction process as they improvise and respond to the materials with which they work. Similarly, Bordes (1961a) emphasizes that Levallois technology is better conceptualized as a production method rather than a particular product, an insight that can arguably be extrapolated to all lithic technologies. Divergent theories amongst Palaeolithic archaeologists about whether or not Levallois and discoidal technologies are indeed distinct and discrete approaches to flaked stone tool production (e.g., Boëda 1993; Jaubert and Farizy 1995; Jaubert and Mourre 1996; Pasty 2000) or, rather, linked sets of practices along a flexible technological continuum (e.g., Lenoir and Turq 1995; Slimak 1998; Baena Preysler et al. 2003; Vaquero and Carbonell 2003) highlight the contentiousness of the debates surrounding what is known and knowable about the past by studying stone tools and lithic artifacts.

My response to these epistemological and philosophical debates, in line with the critiques I introduce in Chapters 1 and 3 of Western ontological priorities of product over process, is to question how goal-oriented were the stone tool production and core reduction practices of the people and communities who inhabited the archaeological sites sampled in this thesis. Rather than thinking of these pieces of material culture as the end result of a materialized “mental template” (Deetz 1967:45), I argue it is worthwhile to consider the possibility that the current forms of these lithic artifacts, and thus their classification within the typological system implemented in this thesis, develop from relational processes between the ancestral knappers who made them, the lithic materials themselves, and their familiar yet occasionally stochastic interplay at the interfaces of skilled kinaesthetic movements, fracture mechanics, and emergent needs. This does not preclude the possibility that ancestral knappers intended to make specific products, but rather creates analytical space for the processes by which these products come into

being. Therefore, lithic analysts would do well to maintain awareness that neither product nor process can exist independently of the other. As such, I carve out analytical pathways to these linked phenomena by directing attention to both the products of knapping such as cores and tools (this chapter) and the residues of the processes by which they take shape as inferred through debitage assemblages (Chapter 7).

Alternatively, the unidirectional blade-like and bipolar cores in the Renda Rock Shelter (EaSh-77) assemblage could be the result of technological practices distinct from the more ubiquitous prepared core technologies and from each other. If this is the case, it suggests members of discrete communities of lithic practice inhabiting the site either contemporaneously or at different periods throughout its occupation(s), with implications for differential genealogies of learning and technological practice. Regardless, the assemblage as a whole hints at the dynamic technological practices of the people who made the artifacts that constitute it. Moreover, the presence of single artifacts made of ‘Dark Grey Volcanic’ and ‘Quartz Crystal’ lithic material types are also the traces of the diverse genealogies of emergent technological practice in which the ancestral knappers at this site participated. Intriguingly, both of these lithic material types become very frequent lithic materials in the later mid-Holocene Crescent Channel (EbSh-81) and late-Holocene Village Bay Lake Island (EbSh-80) assemblages. One potential explanatory scenario of these patterns includes a mixing of archaeological deposits from early and later times, although this seems unlikely based on the minimal erosion of the site and seemingly intact stratigraphic layers. Alternatively, it could also imply lithic material selection and acquisition practices during the terminal Pleistocene and early Holocene that are echoed in later archaeological deposits of the Crescent Channel (EbSh-81) and Village Bay Lake Island (EbSh-80) sites, a topic I take up in Chapter 6.

5.4.2: Crescent Channel (EbSh-81) Macroscopic Analysis Results

The Crescent Channel (EbSh-81) assemblage is the largest of the three lithic assemblages sampled in this thesis. 734 microdebitage artifacts (~1 mm) were recovered from EU-3 but are omitted from analysis because, given my methods of using callipers to manually measure morphological attributes, I felt the magnitude of measurement error would skew the results of any morphometric analyses for these very small artifacts. However, future research using alternative data recording methods such as 3D laser scanning or photogrammetry are viable alternative avenues for undertaking microscale analyses of this minute sub-assemblage. Thus, the results presented below are drawn from the combined EU-1, EU-2, and EU-3 assemblages ($n = 1875$) minus the microdebitage sub-assemblage ($n = 734$) resulting in a sample size of $n = 1141$ for the Crescent Channel (EbSh-81) site. Radiocarbon dating results suggest the most intensive occupation(s) of the site took place over approximately 600 calendar years during the mid-Holocene (Table 3), although earlier terminal Pleistocene-early Holocene occupations cannot be ruled out at this time.

The Crescent Channel (EbSh-81) lithic assemblage is characterized by abundant debitage and artifacts associated with microblade technology including microblades, microblade cores, and microblade rejuvenation flakes (Figure 45). Unlike centripetal prepared core technologies, microblade technology is characterized by direct application of force rather than percussive strikes to a prepared platform. The gestures used to prepare the platform in such a way that it is suitable for controlled detachments of thin, long, narrow, and parallel-sided flakes exhibiting one or two dorsal arrises parallel to the long axis of the blade (Figure 46) may differ, but the eventual switch to a less powerful but more precise reduction technique is a defining feature of microblade technology.

There is a relatively low proportion of semi-crested blades ($n = 8$) in the Crescent Channel (EbSh-81) lithic assemblage. Following Waber (2011:43), who argues that the relative proportions of this artifact type is a more reliable indicator of bifacial microblade cores than a binary measure of their presence or absence, the low proportion of semi-crested blades in the assemblage suggests unidirectional core reduction was the most common technique used by the people who practiced making microblades at the Crescent Channel (EbSh-81) site. Additionally, several microblade cores exhibit intact cortex (Figure 47) and indicate, at least for these objective pieces, the selected nodules of stone were small cobbles or pebbles. The rounded morphology of the intact and heavily-weathered pyroclastic cortex exhibiting extensive “bread-crust surface” (Le Maitre 2002:7), in contrast to the relatively pristine surfaces created by cultural knapping events, suggests these microblade cores were once pyroclastic ejecta or “bomblets” (Fisher and Schmincke 1984:82; Guffanti and Weaver 1988:6515; Green et al. 1988:563; Vernon 2004:30) that landed near the Crescent Channel (EbSh-81) site or were transported through glacial and/or anthropogenic movement, topics I address in Chapter 6. Additionally, and as mentioned in Chapter 4, there is a notable asymmetry of complete microblades relative to proximal microblade fragments in the assemblage, an observation that forms the backbone of the first morphometric case study in Chapter 7.

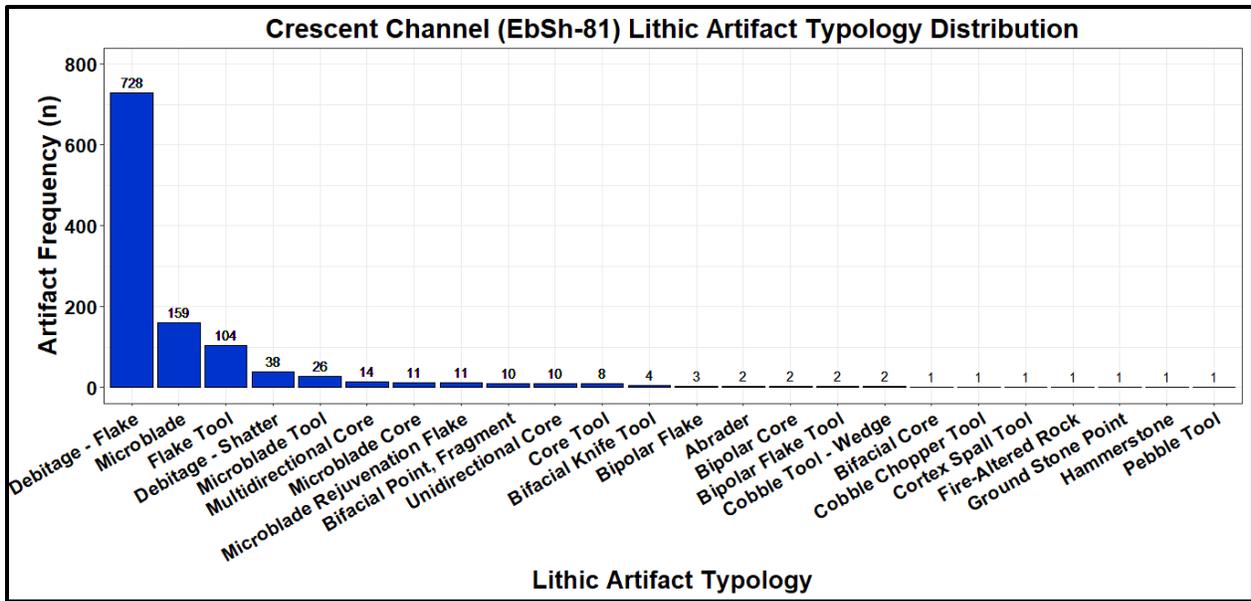


Figure 45: Macroscopic lithic analysis results of artifact typologies for Crescent Channel (EbSh-81)

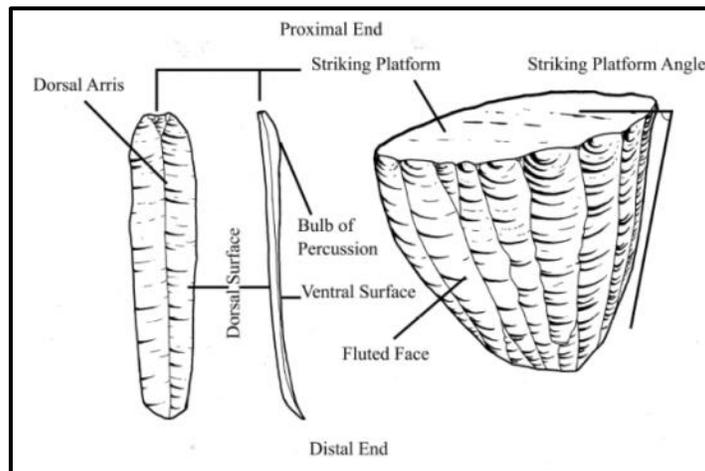


Figure 46: Illustration of microblade technology diagnostic morphological attributes (Waber 2011:33) .



Figure 47: Example of microblade core from Crescent Channel (EbSh-81). Arrows indicate platform. Note the intact pyroclastic cortex (Photo S. Duffield and C. Vogelaar).

The most dominant lithic material type in terms of frequency of artifacts in the Crescent Channel (EbSh-81) assemblage is 'Dark Grey Volcanic,' a very silica-rich felsic igneous rock (Figure 48). I hypothesized it to be a dacite or a rhyolite based on its sugary texture and glassy lustre (Higgins 2006; Vernon 2004). Overall, volcanic tool-stones are highly ubiquitous in the assemblage. This observation is bolstered by TSP and XRF analyses which suggest even lithic material types whose initial working names during the macroscopic stage of analysis (e.g., 'chert' or 'metasediment') imply alternative petrogeneses (i.e., sedimentary or metamorphic) but may actually be the result of igneous petrogenesis.

Notable outliers in the Crescent Channel (EbSh-81) lithic assemblage include artifacts associated with unidirectional, multidirectional, and bipolar technologies. Microblade technology is strongly represented but the presence of artifacts associated with other lithic technologies provides insights into the connections between these diverse technological practices. Similar to the Renda Rock Shelter (EaSh-77) lithic assemblage, the observed heterogeneous trends in artifact types could be the result of artifacts entering the archaeological record at differential moments in the operational sequence(s) of microblade technology production and use rather than discrete reduction sequences by skilled knappers participating in wholly separate communities

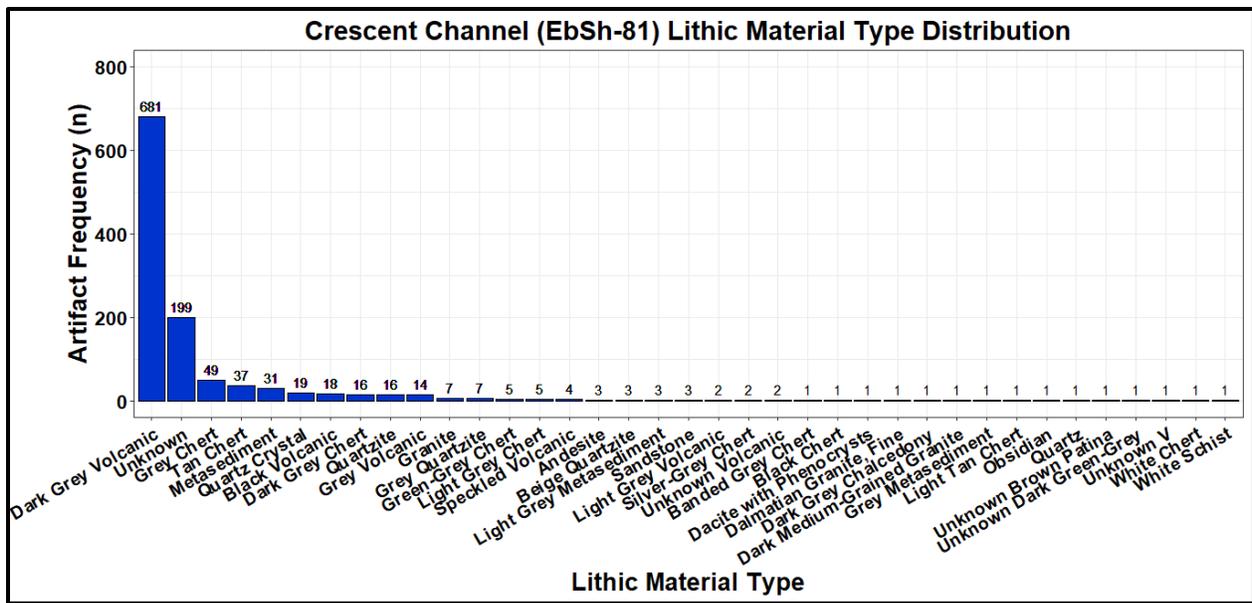


Figure 48: Macroscopic lithic analysis results of lithic material types for Crescent Channel (EbSh-81).

and constellations of practice. As mentioned in Section 4.2.2, there may be some mixing of components at the Crescent Channel (EbSh-81) site due to the construction of a possible subterranean dwelling feature. However, and as I mention in the introduction of this thesis, this kind of broad depositional context spanning many generations is actually well-suited to my research questions because it is the manifestation intergenerational depositional practices. Either way, the pervasive archaeological issue of equifinality complicates definitive conclusions about the relative isolation or cohesion of the gestures, people, and communities of practice that created the diverse pieces of material culture that make up the Crescent Channel (EbSh-81) lithic assemblage. Their co-occurrence in the same archaeological deposits suggests at least some affiliation, even if not through contemporaneous face-to-face interactions.

The distribution of lithic material types in the assemblage is also diverse. Many lithic material types are present including quartz crystal, obsidian, and even granite/granodiorite—a material often hypothesized by archaeologists and lithic analysts to be a tool-stone too coarse and unpredictable to be suitable for flaked stone tool production (e.g., Andrefsky 2005:52; Ozburn

2015:2). During the analysis of this assemblage I began a new ‘Unknown’ series, this time utilizing roman numerals (e.g., ‘Unknown V’) instead of the letter series from the Renda Rock Shelter (EaSh-77) lithic assemblage. Once again, the traces of ephemeral technological, material, and gestural practices co-occurring alongside more frequent and strongly represented ones hint at the creative tensions between innovation and tradition during the everyday lives of the inhabitants of the Crescent Channel (EbSh-81) site as they flexibly made, used, remade, and reused the pieces of stone that constitute the range of lithic technologies in the assemblage.

5.4.3: Village Bay Lake Island (EbSh-80) Macroscopic Analysis Results

The final lithic assemblage sampled in this thesis is from the Village Bay Lake Island (EbSh-80) site ($n = 406$). Radiocarbon dating supports inferences of a late Holocene occupation of the site from approximately 3000-1500 cal BP (Table 3). The assemblage is characterized by abundant debitage and a greater relative frequency of artifacts associated with bipolar technology than the previous two sampled assemblages (Figure 49).

Opportunistic and flexible approaches to lithic reduction such as multidirectional and bipolar technologies are the most ubiquitous technological practices represented in the assemblage. Bipolar technology is a technique where the objective piece is held on an anvil stone and struck sharply with a hard hammer. The anvil stone mirrors the percussive force delivered by the knapper’s strike and sends opposing percussive force through the core hence the name *bipolar* technology. The bidirectional and increased propagation of force characteristic of bipolar technology is enabled by a wedging initiation, described by Andrefsky (2005:26) and Cotterell and Kamminga (1987:688) as the concentration of applied force at the center of what would normally be the radii of a Hertzian cone, but instead a crack forms due to excessive force. Diagnostic morphological attributes of bipolar technology include exaggerated and opposing

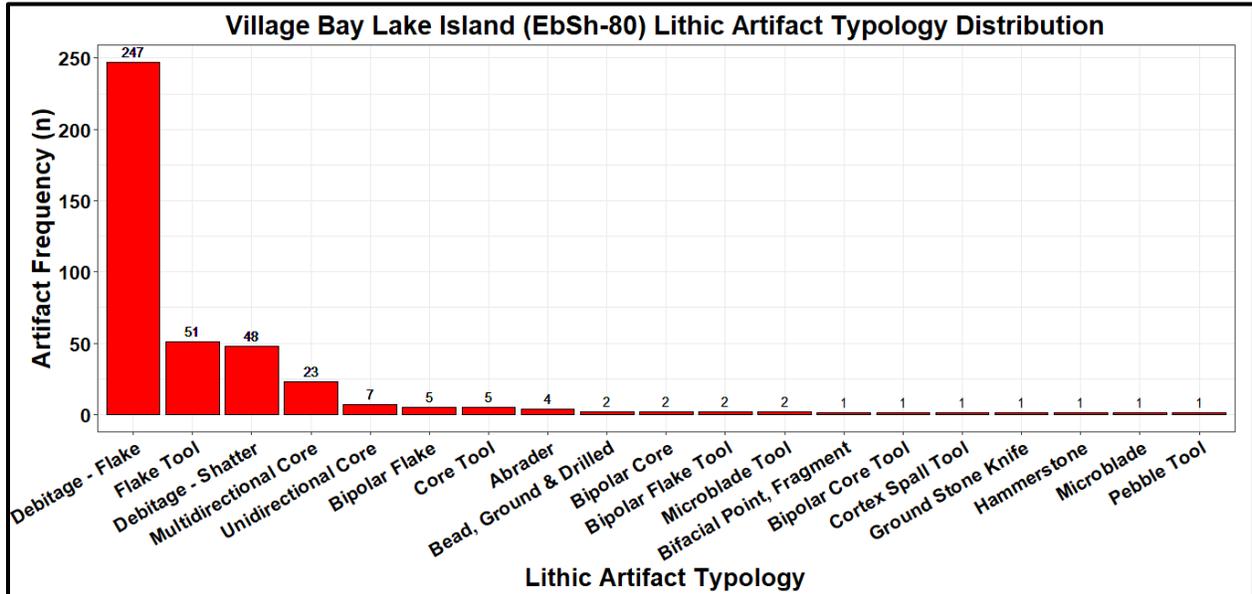


Figure 49: Macroscopic lithic analysis results of artifact typologies for Village Bay Lake Island (EbSh-80).

compression rings and hackles, crushed or battered platforms at each end, as well as shearing of the Hertzian cones which nullifies any bulbs of percussion (Crabtree 1972; Goodyear 1993; Cotterell et al. 1985; Figures 50-51).

Although bipolar technology produces less regularized flakes and is, presumably, less controllable than prepared core technologies, it is arguably a more flexible reduction technique. This is because bipolar technology favours brute force over core preparation and an ideal range of platform angles, both of which require greater overall gestural precision. The flexibility of bipolar technology extends the use-life of an otherwise exhausted objective piece. As mentioned above, this approach to flaked stone tool production is apparent in limited quantities in the earlier sampled assemblages and was likely a way to initiate flaked stone tool operational sequences on objective pieces too small to hold for freehand flaking and/or for splitting objective pieces such as water-rounded cobbles and pebbles that lack suitable platforms. Additionally, it is a viable method to prolong the use-life of cores no longer readily reducible via unidirectional blade-like

and microblade as well as prepared core technologies more ubiquitous in the early and mid-Holocene assemblages.

Another reason why artifacts associated with bipolar technology become more common in the late Holocene Village Bay Lake Island (EbSh-80) assemblage relative to the two earlier assemblages sampled in this thesis could be related to shifts in hafting practices. Specifically, as people and communities develop innovative ways to effectively haft objects such as using novel cordage or new glue recipes—both of which require their own skills and knowledge developed through situated learning—these technological innovations could create new possibilities of what kinds of objects may be hafted, thus feeding back into lithic technology production practices. Irregularly-shaped microliths that may have previously been regarded as unusable would suddenly become perfectly functional cutting edges suitable for hafting (Tixier 1963).

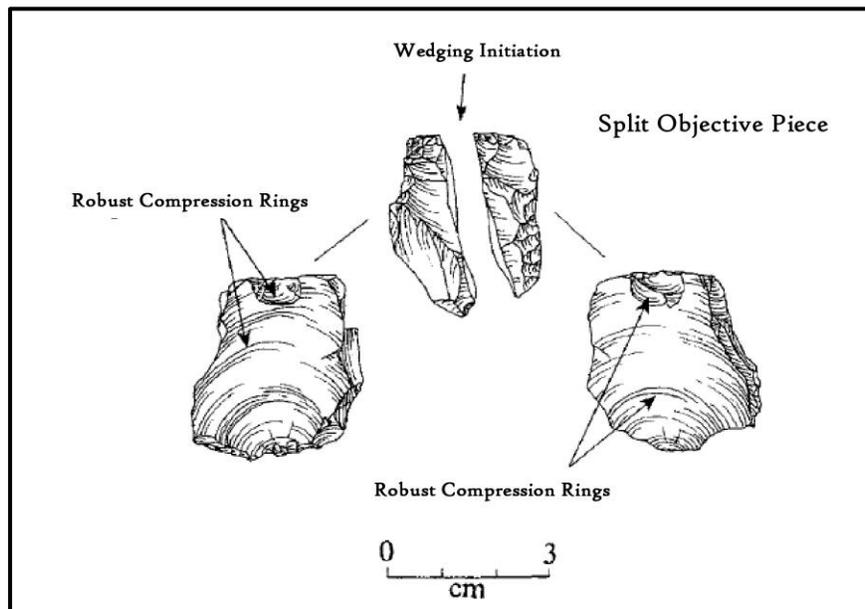


Figure 50: Lithic artifacts and morphological attributes associated with bipolar technology. Modification of image by Andrefsky (2005:125).

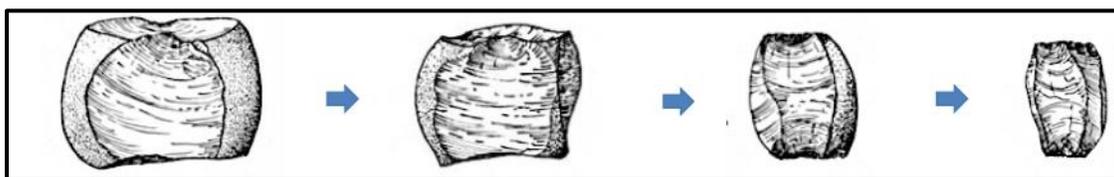


Figure 51: Schematic of bipolar technology operational sequence. Modification of image by Clarkson (2007:87).

Obsidian and quartz crystal are the most frequent lithic material types in the Village Bay Lake Island (EbSh-80) assemblage (Figure 52). The increase in lithic artifacts associated with bipolar technology, arguably a resource-optimizing approach to lithic reduction, could be related to the florescence of obsidian as the most frequent lithic material type in the assemblage. As I discuss in greater detail in Chapter 6, obsidian is a relatively rare tool-stone on the Northwest Coast because its *in situ* bedrock geological distribution is restricted to a few discrete outcrops (Carlson 1994; Erlandson et al. 1992; Fladmark 1984, 1985; James et al. 1996; Nelson 1975; Reimer 2015), with the nearest one located in the alpine zone at the head of Kingcome Inlet approximately 150 linear kilometers northwest of the Discovery Islands study area (Skinner 2009; Stafford et al. 2013). Nonetheless, the frequency of obsidian in Northwest Coast archaeological sites increases sharply during the latter Holocene (Carlson 1994; Mitchell 1988, 1990)—a pattern that the Village Bay Lake Island (EbSh-80) lithic assemblage substantiates. Because the acquisition and circulation of obsidian would likely require widespread social and economic networks and associated mobility practices relative to lithic materials whose geographic distributions are more prevalent, lithic technologies that maximize the use-lives of this material make sense—at least from a utilitarian perspective.

In addition to a shift towards obsidian, the Village Bay Lake Island (EbSh-80) assemblage is by far the most diverse in terms of the range of lithic material types of the three assemblages sampled in this thesis. Many of the close-to-one-off lithic material types are a continuation of the Roman numeral series of ‘Unknowns’ I began with the Crescent Channel (EbSh-81) assemblage. I chose to continue this classificatory system for ambiguous lithic material types because I analyzed the Crescent Channel (EbSh-81) and Village Bay Lake Island (EbSh-80) assemblages in tandem. The extensive yet mostly fleeting distribution of 64 identified

lithic material types suggests that the communities of lithic practice who created the artifacts that make up this assemblage engaged in greater amounts of opportunism, experimentation, or trade in terms of their choice(s) of materials with which to fashion their stone tools. This seemingly greater degree of improvisational practice could be correlated with a focus on obsidian because access to this relatively rare tool-stone may have been more restricted than preferred lithic materials during earlier times. If one's access to obsidian was limited or constrained, novelty and innovation in tool-stone selection and acquisition would have been a technological necessity.

Further, much like shifts in hafting practices discussed above would likely feed back into stone tool production practices, so too would these paired technological innovations feed back into lithic material selection and acquisition practices. For example, the glacial till and outwash that constitutes the Quaternary colluvia throughout the Discovery Islands study area is a widespread "local" source of lithic materials. However, many of these nodules of stone may not be suitable for prepared and unidirectional core technologies either because of the coarseness of the materials or the generally rounded morphologies of objective pieces lacking suitable platforms. However, with an increase in bipolar technology during the late Holocene, this widespread and readily accessible source of lithic material would become a viable source of tool-stone, a pattern that fits with the proliferation of lithic material types identified in the Village Bay Lake Island (EbSh-80) assemblage despite its moderate size. These ecologies of technologies speak to the relationality of their human and non-human constituents through space and time (Angelbeck and Cameron 2014; Carlstein 1982; Walls and Malafouris 2016).

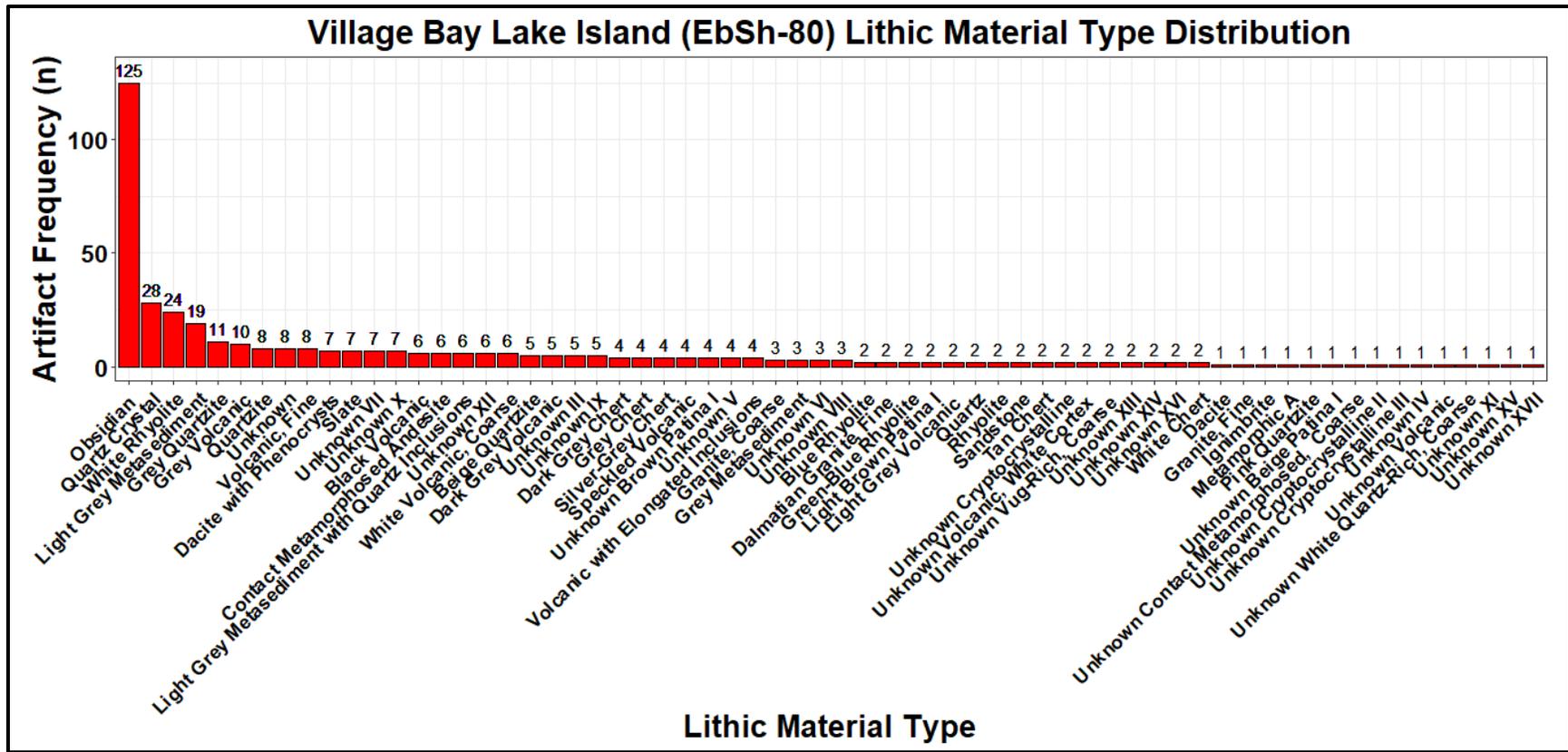


Figure 52: Macroscopic lithic analysis results of lithic material types for Village Bay Lake Island (EbSh-80).

5.5: Macroscopic Lithic Analysis Discussion

With each assemblage introduced, I now juxtapose them in order to emphasize the diachronic nature of the sampled lithic assemblages as a whole. Considering them through time and in relation to one another accentuates their dynamic and cyclical heterogeneity, the continual productive tensions between innovation and tradition, and the concomitant nature of technological change and technological continuity. Indeed, the skilled practitioners who made and used stone tools were “flexible in their use of lithic technologies and sometimes applied only one knapping strategy, different methods simultaneously, or combined them” (Picin and Vaquero 2016:70; Figure 53). The traces of these enmeshed and emergent technological processes are gleaned from macroscopic analyses and the resultant descriptive statistics for both lithic artifact type and lithic material type frequencies in each assemblage. The cumulative density plots below (Figures 54-55) represent the relative proportion of these categorical variables in each assemblage which facilitates comparisons between them given that sample sizes vary.



Figure 53: Core collected from the surface of the Crescent Channel (EbSh-81) site. Note morphological attributes associated with both microblade (left) and Levallois-esque (right) technologies.

All three assemblages are composed of a high relative proportion of debitage, a feature well-suited to the morphometric analyses in Chapter 7 (Figure 54). The proportion of lithic artifacts associated with bipolar technology is greatest in the Village Bay Lake Island (EbSh-80) assemblage. Unsurprisingly, this assemblage also has the greatest proportion of debitage shatter,

defined as lithic artifacts lacking morphological attributes useful for discerning the direction of removal due to stochastic fracturing, which is to be expected given the decreased controllability and predictability of the expedient yet flexible bipolar technology. In a similarly unsurprising manner, the Crescent Channel (EbSh-81) lithic assemblage has the greatest proportion of artifacts associated with microblade technology. Finally, prepared core technology is evident in the Renda Rock Shelter (EaSh-77) assemblage but not in any of the others.

In each lithic assemblage there is an unambiguously higher proportion of a different lithic material type: 'Unknown A' for the Renda Rock Shelter (EaSh-77), 'Dark Grey Volcanic' for Crescent Channel (EbSh-81), and 'Obsidian' for Village Bay Lake Island (EbSh-80). None of the assemblages are completely homogeneous in terms of their lithic material type compositions and proportions though, with all sharing the pattern of a single lithic material type accounting for a large proportion of the assemblage contrasted against fleeting traces of a range of alternative tool-stones. Although the emic reasons why alternative lithic material types were chosen for the production of lithic technologies are archaeologically unknowable, sustained heterogeneity hints at the long term dynamic practices of the people and communities who made and used these stone artifacts. Moreover, lithic technology production and use practices that *are* archaeologically inferable provide insights into the genealogies of practice of the ancestral inhabitants of the Discovery Islands, as discussed throughout this chapter. For example, the increase in artifacts associated with bipolar technology in the Village Bay Lake Island (EbSh-80) assemblage also suggests differential processes of enskilment that coincide with the innovative and relational technological practices already discussed such as novel hafting practices and choices of lithic materials. While bipolar technology undoubtedly requires skill, the degree of gestural precision and kinaesthetic training is arguably less than what is required for prepared

core technologies more ubiquitous in the early and mid-Holocene assemblages. This hypothesized decrease in lithic technology specialist knowledge during the late Holocene has implications for the networks and structures of learning within and between these communities and constellations of practice that arguably ripples out into all aspects of their situated social practices (Angelbeck and Cameron 2014; MacKay 2008).

Intriguingly, there is an overlap in some lithic material types across two or more of the assemblages which suggests continuity in tool-stone selection and acquisition practices, even if only ephemerally, despite hundreds of generations of human life between the people and communities of practice who created the archaeological deposits and lithic assemblages sampled in this thesis. This pattern is illustrated below in Figure 55 by a gradual rise of the lines across the lithic material type categorical variables on the X-axis, some of which overlap across sites, contrasted against a spike in each assemblage representing the relative dominance of a single lithic material type. Although the most prolific lithic material type frequencies shift from assemblage to assemblage, there are shared patterns of lithic material heterogeneity across all three archaeological sites.

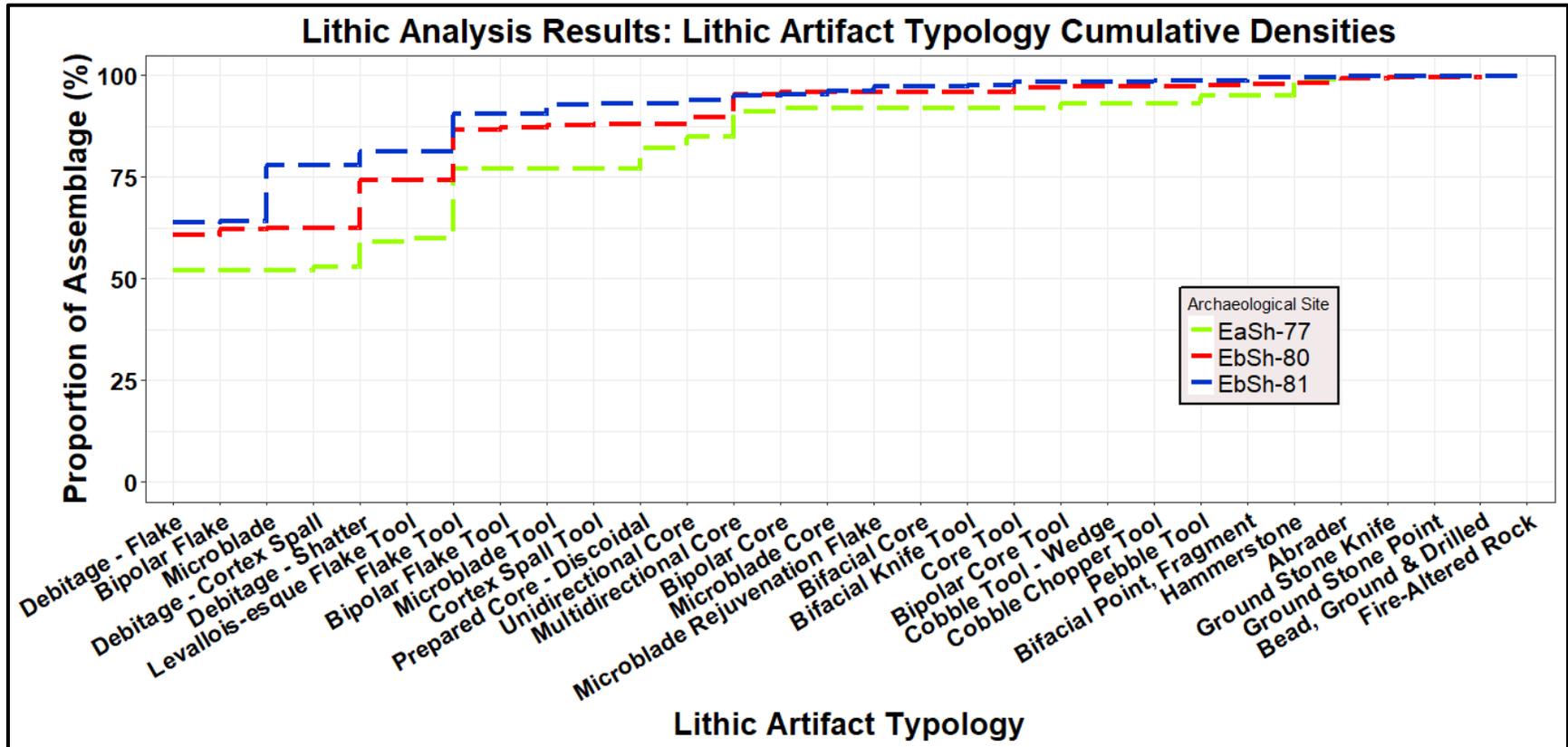


Figure 54: Cumulative density plot of lithic artifact typology distributions for all three sampled lithic assemblages.

As I show here and have shown elsewhere (Abbott 2016a, 2016b), there are clear trends in the data sets observable using macroscopic lithic analysis methods. However, as my critical discussion of typological systems and archaeological taxonomies at the beginning of this chapter suggests, types should be “mutable and always to some extent experimental” (Adams and Adams 1991:61). The enmeshed operational sequences I propose based on my observations of lithic artifact and material type frequencies within and across the sampled assemblages hints at simultaneous processes of technological change and continuity (McLaren 2003:126). This creative tension between the fluxes and flows of technological practice parallels the analytical tensions between the static typological systems archaeologists work with in order to structure data sets and the fluid processes of stone tool production.

It should be clear by now that the constructs we employ shape the questions we ask, the units of analysis we create in an attempt to answer them, the resultant data sets we produce, how we come to know and understand such data, and the next question(s) we ask. Indeed, “data, observations, and ‘experience’ to which expectations are to conform are not themselves autonomous of these expectations” (Wylie 1992b:490). A heterarchical, rather than hierarchical, approach to archaeological practice (Crumley and Levy 1995) creates space for a “plurality of typologies [in order to] know the past in multiple ways” (Henry et al. 2017:31). In keeping with this emphasis on pluralistic ontological worlds, I adopt a methodological pluralism by shifting my attention to thin section petrography (TSP) and X-ray fluorescence spectrometry (XRF) analyses in Chapter 6 and then morphometric methods in Chapter 7.

Chapter 6: Material Analysis

6.1: Data Analysis II – Introduction

Building upon the discussion I initiated earlier in this thesis of the ontological centrality of historically-situated socio-material worlds, close analytical scrutiny of the materials that constitute lithic technologies is warranted because the selection and acquisition of stone is the first choice in the learned operational sequences of stone tool production and use. Both the shape of the objective piece and the material it is made of strongly impact how and why ancestral knappers make and use stone tools in the ways that they do (Dibble 1985, 1987; Rolland and Dibble 1990; Kuhn 1991, 1992; Jones 1984). To put it plainly, “without stone there are no stone tools and without flakeable stone there are no flaked stone tools” (Smith 2004:6). Even when one explicitly acknowledges the recursive cycles of use, repair, and recycling characteristic of lithic technologies, as I do in Chapters 3 and 5 of this thesis, the materials with which one works are central variables.

In this chapter I direct attention to the petrographic and geochemical components of my research. Using two complementary analytical techniques, thin section petrography (TSP) and X-ray fluorescence spectrometry (XRF), I reassess and refine the macroscopic lithic material type identifications and classifications made in the previous chapter. Additionally, these data offer a means with which to estimate the geological source locations of some of the lithic materials in the sampled assemblages, particularly obsidian. I begin by describing how TSP and XRF methods work, the mentors I collaborated with, my sub-sampling rationale and procedures, as well as the results. Section 6.2 focuses on TSP analysis while Section 6.3 focuses on XRF analysis. Section 6.4 presents the results of a small lithic material survey I conducted in the summer of 2017 based off intriguing results from the TSP and XRF analyses. Section 6.5 concludes the chapter and summarizes my material analysis findings.

6.2: Thin Section Petrography

Despite the significant roles of lithic materials in stone tool production, accurately and precisely identifying the types of rocks that make up an archaeological lithic assemblage is typically not addressed in more than a cursory manner. Archaeologists and lithic analysts usually rely solely on macroscopic lithic material type identification and classification methods, although even these are not always applied rigorously or systematically. As I argue in Chapter 5, initial macroscopic identifications and classifications are necessary in order to make efficient preliminary observations and to structure data sets for sub-sampling. Unfortunately, these colloquial working names are too often the analytical terminus. For example, this phenomenon manifests amongst Northwest Coast archaeologists in the common practice of calling all dark and fine-grained volcanic rocks “basalt.” While the term is an understandable short-hand that facilitates communication, this archaeological vernacular or “basaltopia” (Bakewell 2005) may cause more problems than it solves. Since “the classification of rock is not straightforward and the informal macroscopic approaches that archaeologists rely upon can result in contradictory categorizations” (Smith 2004:18), “visual analysis alone will not suffice” (Reimer 2012:117). Supplemental petrographic and/or geochemical analyses of lithic materials are necessary in order to make more informed assessments.

Thin section petrography (TSP) is a technique used in the field of optical mineralogy to study the microstructures of rocks and the sizes, shapes, and relationships of minerals to one another (Andrefsky 2005:48; Nesse 2004). While the identification of rock structures and minerals is possible using macroscopic methods, by using a diamond saw to slice a thin section from a sample and then grinding it to a thickness of approximately 30 μm one is able to inspect “the various minerals alongside each other, rather than piled confusingly all around each other” (Vernon 2004:1). This technique was originally developed in the early 19th-century by William

Nicol but was not put to use for the investigation and analysis of rocks and rock microstructure until the 1850s (Sorby 1851).

While TSP analysis examines what are effectively two-dimensional thin sections of three-dimensional objects (Hibbard 1995), these dimensionally-reduced rock samples can still provide important data for the identification and classification of a sample's constituent minerals and its microstructure. These petrographic data are also useful for inferring the geological geneses of the parent rock, although theories and hypotheses of how and what geological formation processes create minerals and particular rock microstructures are at times controversial and contradictory. This may make the resolution of broad classifications based upon inferred formation processes seem coarse and highly subjective (Vernon 2004:2). However, Andrefsky (2005:46) makes it clear that "it is important to study the genesis of rocks in order to understand how rocks are classified." TSP is an effective way to understand the structural relationships of rocks and minerals and for inferring their petrogeneses because slicing a two-dimensional thin section from a sample and transmitting polarized light through it reveals diagnostic attributes of its constituent minerals due to their characteristic colour, pleochroism, refractive index, relief, morphology, and cleavage angles (Roddick 2009:307).

6.2.1: Sub-Sampling Rationale and Procedure

Due to the destructive nature of TSP analysis, as well as budgetary and time constraints, strategically sub-sampling representative specimens from across the three sampled lithic assemblages was necessary. My hierarchical TSP sub-sampling rationale and procedure was as follows:

- 1) Relative proportion of material types within each sampled lithic assemblage as identified and classified via macroscopic methods in Chapter 5. Ubiquitous lithic material types were preferentially targeted for TSP analysis.
- 2) Congruency of initial and secondary macroscopic lithic material type identifications and classifications (third column in Appendix A). Lithic material types and individual specimens with incongruent or ambiguous identifications and classifications were preferentially targeted for TSP analysis.
- 3) I excluded surface finds and artifacts recovered from auger tests in order to maximize chronological resolution of the TSP data set.
- 4) Specimens classified as “Debitage-Shatter” according to the typological system implemented in this thesis were preferentially selected for this destructive technique because they arguably have less interpretive potential than other specimens. Sub-sampling a piece of shatter was not always an option due to low frequencies of artifacts for some lithic material types. Broken or complete debitage flakes were targeted for TSP analysis in these cases.

In some cases, more than one specimen of a lithic material type was selected for sub-sampling in order to probe the variability within and consistency of my macroscopic identifications and classifications. Written descriptions, metric data, and photographs of all sub-sampled specimens were recorded prior to destructive TSP analysis. Using this judgmental sub-sampling strategy, I selected a total of 44 representative specimens for TSP analysis from across the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) lithic assemblages (Table 4).

Table 4: Specimens sub-sampled for thin section petrographic analysis.¹

Macroscopic Lithic Material Type Identification and Classification	Specimen(s) Sub-Sampled for TSP Analysis	Macroscopic Lithic Material Type Identification and Classification	Specimen(s) Sub-Sampled for TSP Analysis
Black Chert	EbSh-81:560	Quartzite	EbSh-80:176
Black Volcanic	EbSh-81:554	Speckled Volcanic	EbSh-80:261
	EbSh-81:558		
Dacite with Phenocrysts	EbSh-81:20	Tan Chert	EbSh-81:198
	EbSh-81:27		EbSh-81:321
	EbSh-81:106		EbSh-81:1042
Dark Grey Chalcedony	EbSh-81:535	Unknown A	EaSh-77:56
Dark Grey Chert	EbSh-81:166	Unknown B	EaSh-77:13
	EbSh-81:448		
Dark Grey Volcanic	EbSh-81:465	Unknown C	EaSh-77:94
	EbSh-81:601		
	EbSh-81:1027		
Green-Grey Chert	EbSh-81:283	Unknown D	EaSh-77:79
	EbSh-81:564		
	EbSh-81:565		
	EbSh-81:633		
Grey Chert	EbSh-81:151	Unknown E	EaSh-77:81
	EbSh-81:185		
Grey Metasediment	EaSh-77:73	Unknown Dark Green-Grey	EbSh-81:245
Grey Quartzite	EbSh-81:129	Unknown V	EbSh-80:145
	EbSh-80:260		
Grey Volcanic	EbSh-81:935	Unknown VII	EbSh-80:174
Light Grey Chert	EbSh-81:377	Volcanic, Fine	EbSh-80:161
Light Grey Metasediment	EbSh-80:200	Volcanic with Elongated Inclusions	EbSh-80:152
Metasediment	EbSh-81:244	White Rhyolite	EbSh-80:173
	EbSh-81:383		EbSh-80:187
	EbSh-81:607		

¹ = See Appendix B for petrographic descriptions, classifications, and photomicrographs.

6.2.2: Methods

Once representative specimens were identified and sub-sampled for TSP analysis, I packaged and couriered them to Vancouver Petrographics, Ltd. located in Langley, British Columbia. Using the methods described in Section 6.2, thin section technician Jim Montgomery prepared a total of 14 slides as many contain multiple specimens (Figure 56). Once complete, the thin section slides were sent to Dr. Fabrizio Colombo in Vancouver for TSP analysis.



Figure 56: Example of prepared thin section slide. Note multiple specimens mounted onto one slide.

Dr. Colombo is a professional geologist with more than 15 years of petrographic analysis experience who specializes in the study of igneous, metamorphic, and sedimentary rocks using optical microscopy (Ultra Petrography and Geoscience 2017) and generously offered his expertise and professional services free of charge. Using methods summarized above in Section 6.2, Dr. Colombo described and classified each specimen according to the British Geological Survey (BGS) Rock Classification Scheme (Gillespie and Styles 1999; Hallsworth and Knox 1999; Robertson 1999). Contrary to the lithic material type nomenclature used in Chapter 5 of this thesis, the BGS Rock Classification Scheme is based exclusively on descriptive attributes

directly observable in thin sections rather than inferred petrogenesis (Gillespie and Styles 1999:3).

In the TSP analysis conducted as a part of this thesis, a petrographic microscope with a Nicol prism polarizer was used to filter light beneath the sample slide containing the thin section(s). When a single Nicol prism polarizer is used, the thin sections are viewed in plane polarized light. When two Nicol prism polarizers are oriented perpendicular to each other, the thin sections are viewed in crossed-Nicols polarized light. Comparing and contrasting the images—or photomicrographs as they are commonly referred to by petrographers—of these complementary light transmission methods allows for more holistic petrographic descriptions and classifications of rock samples.

6.2.3: Thin Section Petrography Results

In the interest of concision within the body of this thesis, detailed TSP analysis results are provided in Appendix B which includes petrographic descriptions, classifications, and photomicrographs for all 44 sub-sampled specimens. Generally-speaking, the TSP data set is in agreement with the macroscopic lithic material type identifications and classifications previously discussed in Chapter 5. The most obvious consistency is that Dr. Colombo's petrographic classifications of the sub-sampled specimens are diverse both within and across the three lithic assemblages. Two of the three 'Dark Grey Volcanic' specimens (EbSh-81:465 and EbSh-81:601) I sub-sampled for TSP analysis had identical microstructures and mineral compositions (Figure 57). The parallels between my macroscopic lithic material type identifications and Dr. Colombo's petrographic classifications for these two specimens adds credence to the notion that there is decent internal consistency within the 'Dark Grey Volcanic' lithic material type that is so ubiquitous in the mid-Holocene Crescent Channel (EbSh-81) lithic assemblage.

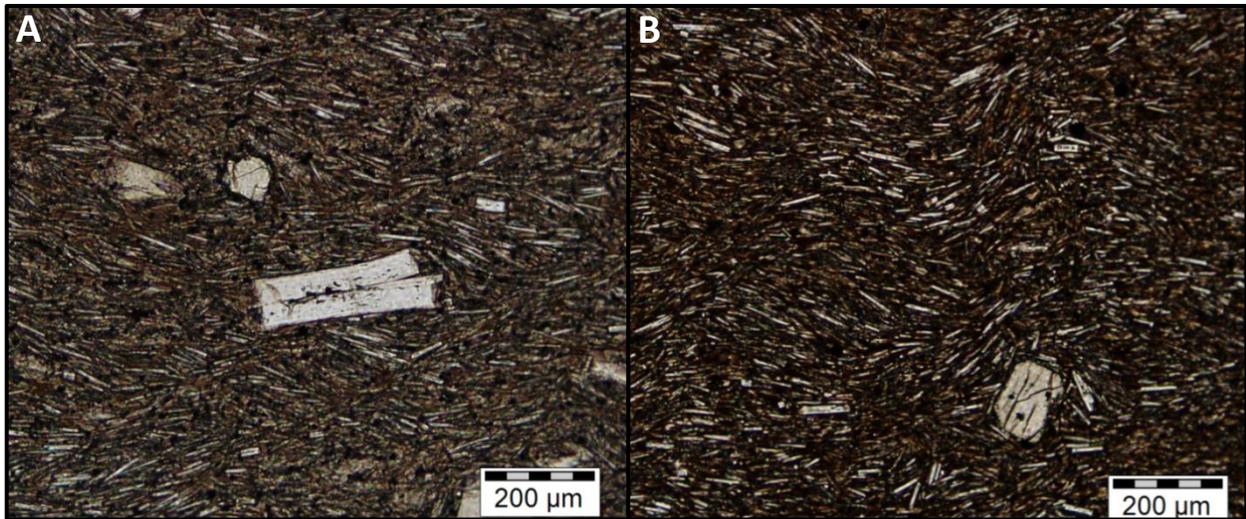


Figure 57: ‘Dark Grey Volcanic’ thin section specimens EbSh-81:465 (A) and EbSh-81:601 (B). Plane polarized light photomicrographs. Note the similar mineral compositions and microstructures.

As alluded to in the previous chapter, the results of the TSP analysis also suggest some of the lithic material types identified using macroscopic methods may not be accurately characterized by some of the nomenclature used in Chapter 5. For example, I identified and classified the lithic material type of specimen EbSh-81:321 as ‘Tan Chert.’ Its ‘Altered Lava’ petrographic classification and mineral composition (Figure 58), however, suggest it is more closely affiliated with igneous and metamorphic rather than sedimentary petrogenesis. In fact, the TSP analysis results suggest that most of the specimens I classified as various kinds of cherts are likely not sedimentary rocks. This alone demonstrates the value of using additional analytical techniques to augment macroscopic observations. Similarly, I classified the lithic material type of specimen EbSh-81:1027 as ‘Dark Grey Volcanic’ yet the TSP analysis results suggest it is quite distinct from the other two sub-sampled ‘Dark Grey Volcanic’ specimens (EbSh-81:465 and EbSh-81:601). Its very fine-grained microstructure containing patchy replacement aggregates of quartz (Figures 59) indicates that specimen EbSh-81:1027 underwent a geological alteration process that the other two specimens did not. It is worth emphasizing that specimen EbSh-81:1027, while sharing many macroscopic attributes with other members of the

‘Dark Grey Volcanic’ lithic material type, was sub-sampled for TSP analysis because I observed it to be a qualitative outlier.

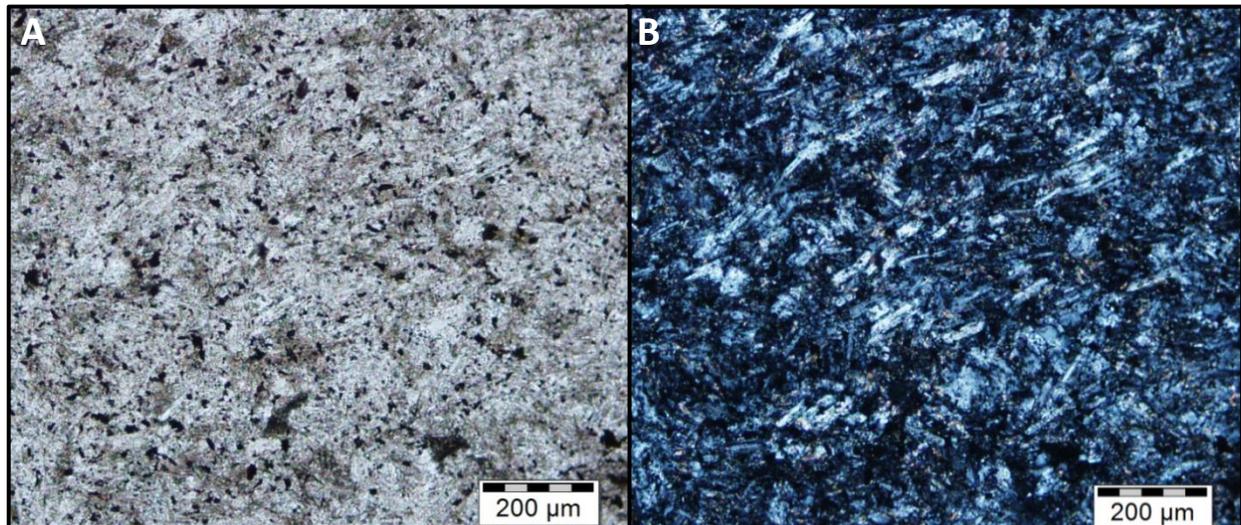


Figure 58: ‘Tan Chert’ thin section specimen EbSh-81:321.
Plane polarized light (A) and crossed-nicols polarized light (B) photomicrographs.

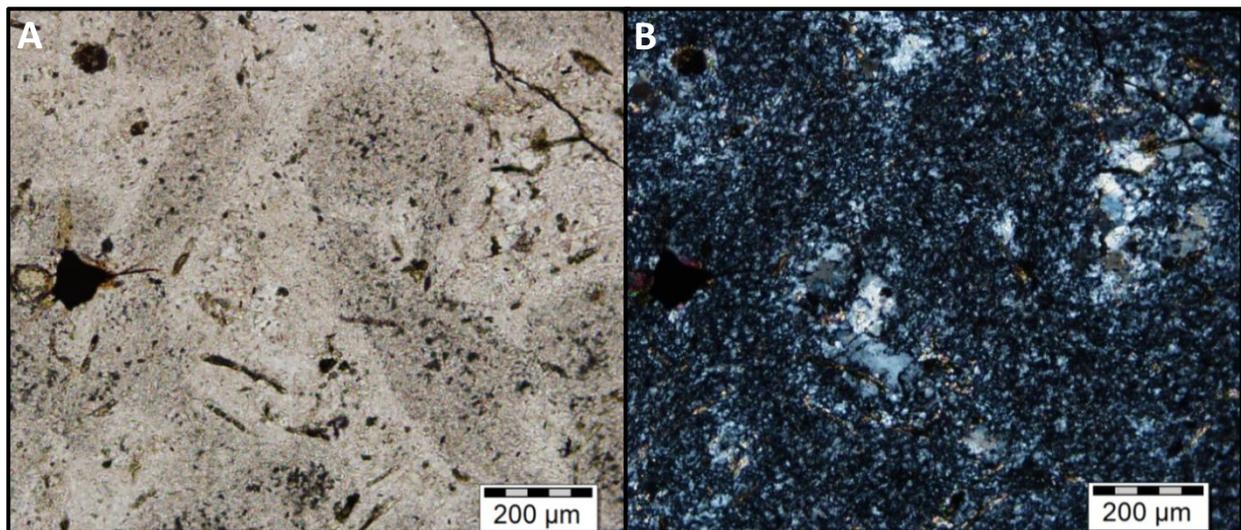


Figure 59: ‘Dark Grey Volcanic’ thin section specimen EbSh-81:1027.
Plane polarized light (A) and crossed-nicols polarized light (B) photomicrographs.

Because I preferentially sub-sampled material type specimens that were ambiguous within the macroscopic lithic analysis data set, the TSP analysis results may at first appear to suggest that many of the macroscopic lithic material types are erroneous units of analysis. However, I would counter this argument by pointing out that my sub-sampling strategy targeted lithic material types I already identified as ambiguous and, therefore, worthy of further investigation

via TSP analysis. The expected lack of representation of confident macroscopic lithic material type identifications within the sub-sampled TSP data set perhaps exaggerates incongruences between macroscopic identifications and petrographic classifications. While I cannot be certain that all of the lithic material types I identified and classified using macroscopic methods are completely internally consistent, my confidence in my identifications of these lithic material types leads me to hypothesize that these units of analysis still retain a reasonable amount of analytical value.

The results of the TSP analysis largely enhance macroscopic identifications and assessments of the lithic material types in the sampled lithic assemblages. They are also a preliminary exploration of the utility of optical mineralogy and TSP methods in Northwest Coast lithic technology studies more generally. While the TSP results might seem to produce more questions than they answer, the high resolution of this data set is nonetheless helpful in better understanding some of the lithic material selection and acquisition practices of the ancestral inhabitants and communities who created the archaeological deposits sampled in this thesis. For example, Dr. Colombo also proposed geological suites for every sub-sampled specimen in addition to making petrographic classifications (Table 5). Gillespie and Styles (1999:21) define a geological suite as rocks formed in a particular magmatic cycle or in association that share common mineralogical characteristics. These more inclusive categories are to petrographic classifications as genus or family is to species within a Linnaean biological taxonomy.

I extrapolated the results of the TSP analysis in order to assign geological suites to many of the artifacts in the three sampled assemblages (Figure 60). Rather than making assumptions about the mineralogical or chemical composition of lithic material types that were not sub-sampled for TSP analysis, I assigned these cases to the 'Unknown' geological suite category.

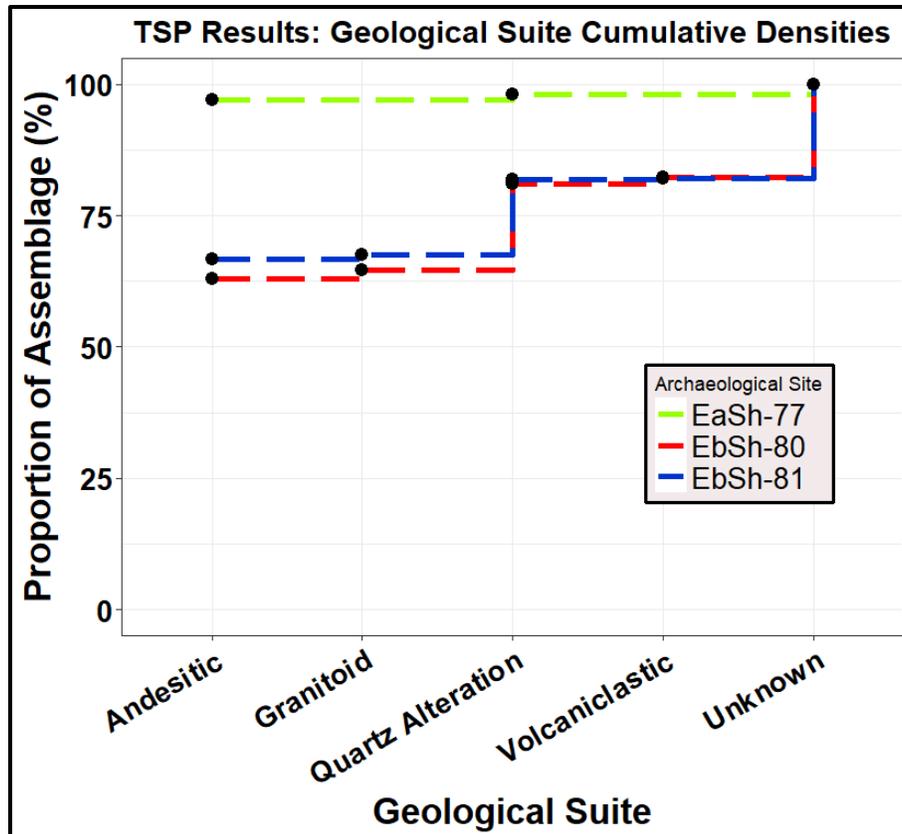


Figure 60: TSP results – cumulative density plot of geological suite distributions for Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) lithic assemblages.

Table 5: TSP results – geological suites identified within the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), & Village Bay Lake Island (EbSh-80) lithic assemblages.

Geological Suite	Definition	Reference
Andesitic	Basic to acidic rocks that contain hypersthene (basalts and andesites) or hornblende or biotite (dacites and rhyolites), and show little or no iron-enrichment	Gillespie and Styles (1999:22)
Granitoid	A group of rocks where the dominant lithology is dioritic with a characteristic texture of coarse-grained, euhedral hornblende in a matrix of anhedral to poikilitic feldspar	Gillespie and Styles (1999:22)
Quartz Alteration	Rocks whose mineralogical and/or chemical compositions have been altered in such a way that quartz minerals deform	Gillespie et al. (2011:43)
Volcaniclastic	Any clastic material composed in part or entirely of volcanic fragments formed by any particle-forming mechanism	Halls worth and Knox (1999:24)

An exception to this rule is artifacts macroscopically identified as ‘Obsidian’ where, although no representative specimens from this lithic material type were sub-sampled for TSP analysis, I felt assigning a geological suite based only on macroscopic observations was reasonable because of its obvious attributes.

Figure 60 reveals two notable patterns in the TSP data set. First, the Renda Rock Shelter (EaSh-77) assemblage is composed nearly entirely of andesitic tool-stones (~97%). While this could be the result of a small sample size ($n = 100$), it could also be related to the prepared core technology that is most prevalent within this assemblage. Prepared core technology arguably requires larger objective pieces and more homogeneous lithic materials than opportunistic reduction techniques. Thus, it is unsurprising that there is such an extreme focus on andesitic tool-stone by the skilled practitioners who inhabited this place on the landscape approximately 13,000 years ago. They would have learned and known what lithic materials were suitable to their ways of making lithic technologies, a pattern that is substantiated by the observed extreme focus on lithic materials made of a single geological suite. The second notable pattern is the nearly identical distribution of geological suites for the Crescent Channel (EbSh-81) and Village Bay Lake Island (EbSh-80) lithic assemblages. Similar proportions of geological suite distributions across all three sampled lithic assemblages is perhaps evidence of constellated communities of practice who discursively or non-discursively selected lithic materials possessing similar microstructures and mineral compositions as their predecessors did even if the exact stones are incongruent. As Andrefsky’s (2005:60) notes, the names of lithic materials—particularly names imposed by archaeologists—are likely not as important to the ancestral knappers who worked with them as stones’ general characteristics and fracture mechanics. Geological suites as units of analysis and their implications for understanding lithic technology

production practices through space and time are discussed further in Chapters 7 and 8. Now that the petrographic data and TSP analysis are introduced, I shift my focus to the geochemical data and XRF analysis.

6.3: X-Ray Fluorescence Spectrometry

X-ray fluorescence spectrometry (XRF) is a geochemical method used to characterize the elemental composition of, for example, lithic materials, metals, and ceramics. Archaeological applications of XRF began in earnest in the 1960s (e.g., Hall 1960; Renfrew 1969) and are frequently employed in so-called “sourcing” studies of lithic materials such as obsidian (e.g., Reimer 2014, 2015; Shackley 2005). As Shackley (2008:196) notes though, “nothing is ever really ‘sourced’” and “all we can do is provide a chemical characterization and a probable fit to known source data.” For this reason, rather than using the colloquial term “sourcing” in this thesis, I use the more appropriate phrase “source estimation.”

In energy dispersive X-ray fluorescence spectrometry (ED-XRF), the type of XRF analysis undertaken in this thesis, primary X-rays are produced by an X-ray tube or, occasionally, a radioactive source. The X-ray tube has a metal anode that emits X-rays when bombarded with electrons as electrical currents pass through it. These primary X-rays pass through approximately 200 μm of the surface of a sample placed at the end of the X-ray tube and displace electrons from the inner orbits of the surficial atoms. As electrons from a sample’s outer atomic electron shell(s) fill these vacancies in the inner electron shell, energy is released in the form of secondary or fluorescent X-rays. The wavelengths of these fluorescent X-rays are diagnostic of the particular element from which they emanate. Using an X-ray detector mounted onto the XRF unit, one can measure the wavelengths of the fluorescent X-rays and quantify the concentrations of elements in a sample. One of the most appealing aspects of ED-XRF in archaeological compositional

studies is, unlike TSP analysis or other kinds of XRF analysis, it is non-destructive. Refinements of this analytical technique in recent years and careful sampling strategies that target artifacts free of extensive patination (Davis et al. 2011; Godfrey-Smith 1985) suggest it is a useful instrument for producing accurate geochemical data sets, particularly for relatively homogeneous samples such as obsidian and other fine-grained volcanic (FGV) lithic materials (e.g., Glascock 2011; Hancock and Carter 2010; Jia et al. 2010; Reimer 2015, 2018; Reimer and Hamilton 2015).

Of all lithic materials, obsidian is by far the most extensively studied using XRF methods. The extrusive and relatively discrete petrogenesis of obsidian makes its *in situ* geological distribution restricted and its elemental composition relatively distinct to other obsidian flows (Glascock 2002:2; Tykot 2003:63). These attributes make obsidian a lithic material particularly well suited to satisfying the conditions of the “Provenance Postulate” which posits elemental compositions within a geological source location need to be less variable than between source locations (Glascock and Neff 2003; Neff 2000; Weigand et al. 1977:24). These factors, in addition to its conspicuous visual characteristics which make macroscopic identifications easy and reliable, are largely why obsidian is so amenable to source estimation studies using geochemical methods such as XRF. Obsidian’s long history of research means that comparative geochemical data sets of trace element variance within flows from known geological source locations are often available. Although the Northwest Coast does not have as many obsidian flows as other regions such as the Great Basin (Steuber and Skinner 2015) or the American Southwest (Shackley 2005), the ones that do exist and whose locations are known are reasonably well studied (Carlson 1994; Erlandson et al. 1992; Fladmark 1984, 1985; Godfrey-Smith 1985; James et al. 1996; Moss and Erlandson 2001; Nelson 1975; Reimer 2012, 2014, 2015; Figure

61). These comparative data sets are useful for assessing where pieces of obsidian originated because they are a baseline against which to compare the trace element composition of archaeological artifacts.

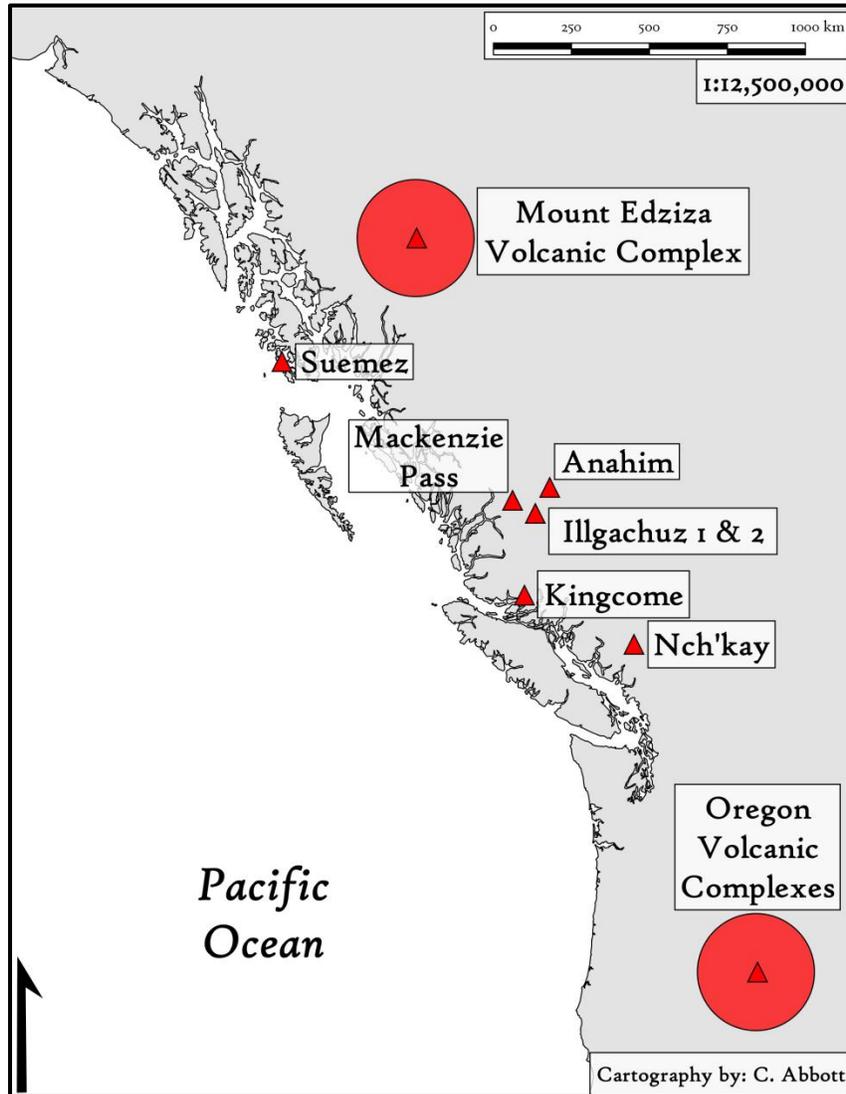


Figure 61: Select obsidian flows and geological source locations of northwestern North America.

Additionally, there is a burgeoning field of research in Northwest Coast lithic technology studies examining the utility and methodological challenges of using XRF to characterize FGV lithic materials other than obsidian (Close 2006; Kwarsick 2010; Osiensky 2014; Reimer 2012, 2018; Reimer and Hamilton 2015; Rorabaugh and McNabb 2014; Rorabaugh et al. 2015; Taylor 2012). Although source estimation studies of many FGV lithic materials are less likely to satisfy

the conditions of the “Provenance Postulate” (Weigand et al. 1977:24) because their petrogeneses may render *in situ* geological distributions less spatially discrete than obsidian, research to date suggests that, for at least some FGV lithic materials, ED-XRF will provide valid and comparable results (Shackley 2008:204). For these reasons, in addition to the obsidian samples which are the primary sub-sampling targets for XRF analysis in this thesis, I also sub-sampled some non-obsidian FGV lithic materials for exploratory XRF analysis.

6.3.1: Sub-Sampling Rationale and Procedure

I was able to select specimens more liberally than I did for TSP analysis because ED-XRF is a non-destructive compositional analysis technique. My hierarchical XRF sub-sampling rationale and procedure was as follows:

- 1) I primarily targeted specimens composed of obsidian for XRF analysis due to the enhanced potential for accurate and informative geological source location estimations.
- 2) I targeted specimens identified as FGV other than obsidian in order to explore the utility of ED-XRF for characterizing the trace element compositions of alternative lithic materials.
- 3) I excluded surface finds and artifacts recovered from auger tests in order to maximize chronological resolution of the XRF data set.
- 4) I preferentially selected specimens without extensive patination or concretions adhered to their surfaces because, since primary X-rays do not penetrate deeper than 200 μm into the surface of a sample, I wanted to minimize the chance of skewing the geochemical data set with spurious results (Davis et al. 2010; Godfrey-Smith 1985).

Due to the dominance of obsidian in the Village Bay Lake Island (EbSh-80) lithic assemblage, I disproportionately sub-sampled artifacts from this site. I also sub-sampled the only obsidian artifact in the Crescent Channel (EbSh-81) lithic assemblage. The remaining ten sub-sampled artifacts are the result of the exploratory FGV XRF analysis component of this research.

I selected a total of 110 specimens for XRF analysis from across the three lithic assemblages using this judgemental sub-sampling strategy (Table 6).

Table 6: Frequencies of specimens sub-sampled for X-ray fluorescence spectrometry analysis.

Archaeological Site	Macroscopic Lithic Material Type Identification and Classification				Total
	Black Volcanic	Dark Grey Volcanic	Grey Volcanic	Obsidian	
Renda Rock Shelter (EaSh-77)	0	1	0	0	1
Crescent Channel (EbSh-81)	2	2	2	1	7
Village Bay Lake Island (EbSh-80)	0	0	3	99	102
Total	2	3	5	100	110

6.3.2: Methods

I contacted Dr. Rudy Reimer/Yumks at Simon Fraser University (SFU) located in Burnaby, British Columbia and requested use of his ED-XRF spectrometer for analysis of the 110 sub-sampled lithic artifacts. Dr. Reimer's XRF laboratory at SFU was an ideal setting to learn about and to apply this geochemical analysis technique because I received mentorship and gained access to comparative trace element composition data sets that Dr. Reimer and others at SFU maintain and update through their own XRF research. In order to reduce instrumentation error and source estimation ambiguity, all comparative trace element composition data used to estimate geological source locations in this study are derived from SFU XRF laboratory control samples that were analyzed by the same instrument used in this study rather than making attempts to compare the results to data sets derived from other XRF instruments or other geochemical methods such as neutron activation analysis (NAA) or laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS).

The XRF instrument in this study is a Bruker Tracer III-V+ portable XRF spectrometer. The system is equipped with a Peltier cooled Ag-free SiPIN detector with a resolution of 5.9 kiloelectronvolts (keV) in an area of 12 mm. The X-ray tube operates at 40 kilovolts (kV) and 15

microamps (μA) from an external power source. These settings allow primary X-rays of 17-40 keV to pass through the surface of a sample and thus excite elements ranging from iron (Fe^{26}) to molybdenum (Mo^{42}), a range of the periodic table useful for estimating the geological sources of obsidian and other igneous rocks (Ferguson 2012). All samples ran for a total of 200 live seconds in order to maximize the accuracy and precision of element composition measurements. Element compositions for each sample were calibrated to parts per million (ppm) values with Bruker's S1CalProcess calibration program, which uses linear and nonlinear models to estimate expected ppm values based off of the "raw" spectra photon counts (Rowe et al. 2012). The most important input variable into this calibration program is the rock type or geological suite of the sample being analyzed, an assessment that the results of the macroscopic lithic analysis and TSP analysis assisted with immensely.

Five trace elements, rubidium (Rb^{37}), strontium (Sr^{38}), yttrium (Y^{39}), zirconium (Zr^{40}), and niobium (Nb^{41}), are typically used to estimate the geological source location of obsidian and FGV artifacts. Because the relative composition of these elements is strongly correlated with the petrogenesis and deposition of lava flows, they are useful for discriminating between samples whose trace element compositions are otherwise similar (Reimer 2012:30; Shackley 2008:203).

During analysis at the SFU XRF lab I discovered that the only Renda Rock Shelter (EaSh-77) FGV artifact and seven of the Village Bay Lake Island (EbSh-80) obsidian artifacts targeted for sub-sampling lacked suitably flat and clean surfaces or were simply too small for the XRF spectrometer to return trace element composition data, thus prohibiting any further XRF analysis for these specimens. The adjusted sub-samples resulted in a total obsidian XRF sample size of 93 and a total FGV XRF sample size of 9.

6.3.3.1: X-Ray Fluorescence Spectrometry Results – Obsidian Artifacts

The spectrometer produced calibrated trace element composition values (ppm) for 93 of the 100 sub-sampled obsidian artifacts, as shown in the raw data, descriptive, and inferential statistics (RDI) plot below (Figure 62; Appendix C). The raw data are plotted as semi-transparent coloured points with a small amount of random variation on the X-axis. This variation is an aesthetic parameter that jitters the data points in order to minimize overplotting that might mask the distribution of each element. Similar to a boxplot, the black horizontal bars show the mean of the distribution of each element while the shape of the coloured violins illustrate descriptive statistics about each element's range, skewness, kurtosis, and unimodality, bimodality, etc. Inferential statistics are illustrated by the light grey rectangles showing the 95% confidence intervals around the mean of each element. Summary statistics are provided in Table 7.

In order to determine which trace elements in the XRF data set are the most useful for discriminating between geological sources, I conducted a principal component analysis (PCA) for five trace elements (Nb, Rb, Sr, Y, and Zr) using the R statistical computing environment (R Core Team 2017). PCA is a form of exploratory data analysis useful for teasing out trends in multidimensional data sets (Glascok et al. 1998; Wickham and Grolemond 2017). Using an orthogonal transformation, PCA converts a set of variables or observations into a set of values of linearly uncorrelated principal components (Faraway 2005:133; Jolliffe 2002:ix). This transformation is defined so the first principal component captures the largest possible amount of variation in the data set and each successive component accounts for the highest variance possible under the constraint that it is optimally orthogonal to the preceding principal component. The maximum number of components extracted always equals the number of input variables. The eigenvectors, which are comprised of coefficients corresponding to each input variable, are used to calculate the principal component loading scores for each original

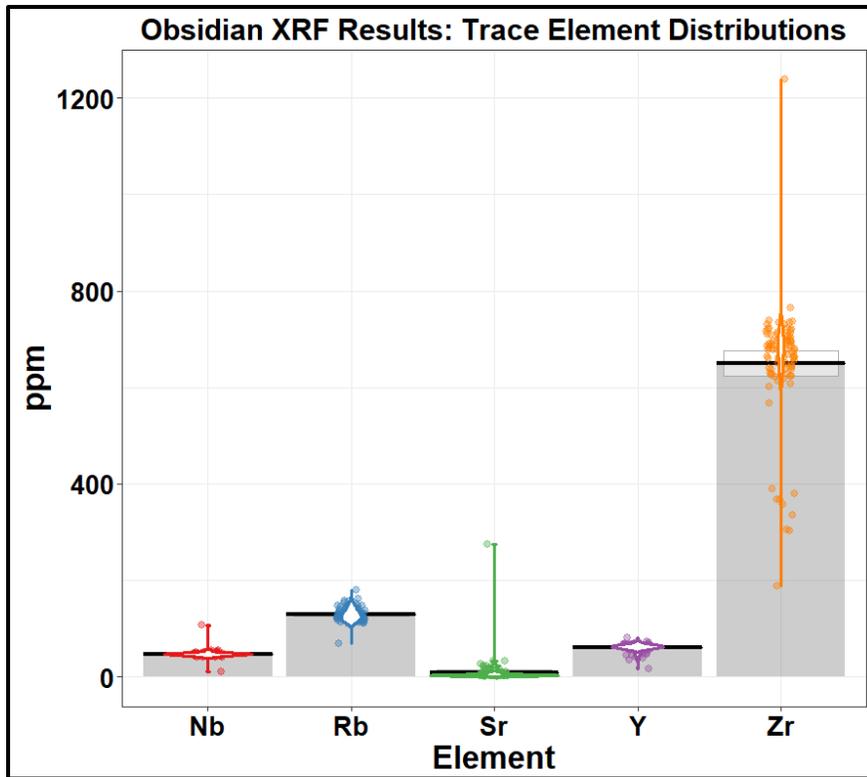


Figure 62: Obsidian XRF results – RDI plot of trace element distributions.

Table 7: Obsidian XRF results – trace element summary statistics.¹

Element	<i>n</i>	Minimum	Maximum	Median	Mean	SD
Nb	93	11.0	107.0	47.0	47.3	7.9
Rb	93	69.0	181.0	128.0	129.4	14.5
Sr	93	1.0	275.0	4.0	9.1	28.6
Y	93	17.0	81.0	62.0	60.8	8.6
Zr	93	188.0	1238.0	678.0	649.8	126.0

¹ = All trace element values in parts per million (ppm).

observation in the data set. The eigenvector coefficients indicate the relative weight of each variable onto each component. Eigenvector coefficients close to 1 or -1 indicate that the variable strongly influences the component while eigenvector coefficients close to 0 indicate that the variable has a weak influence on the component.

Reducing the dimensionality of a data set in which there are a large number of interrelated variables while retaining as much of the variation as possible facilitates visual assessments and

comparisons of data structure(s) using two-dimensional plots. To use a fruitful metaphor, rather than trying to compare apples to oranges, PCA transforms data into grapefruits. Just as grapefruits are pomelo-orange hybrids, principal components are dimensionally-reduced optimally-orthogonal hybrids of input variables. Because the primary function of this PCA model is to determine which trace elements in the XRF data set are most useful for discriminating between geological source locations, I needed to determine which eigenvector coefficients account for the most variance within the model. In other words, I am interested in the element that loads most positively onto principal component 1 and the element that loads most negatively onto principal component 5. I provide the complete calibrated trace element XRF data set used for input variables into the PCA model in Appendix C.

The results of the PCA model indicate that trace elements yttrium (Y) and zirconium (Zr) are the most useful elements for discriminating between geological sources because the respective eigenvector coefficients for these elements account for the most variance within the PCA model (Figure 63; Table 8). I plot the Y and Zr trace element composition data of the 93 sub-sampled obsidian artifacts along with the SFU comparative data set for ten obsidian flows within the vicinity of the Discovery Islands study area (Figure 64). The distributions of trace element values for samples from each geological source location in the SFU comparative data set are used to calculate 95% confidence interval ellipses in Figure 64. Frequentist probability theory predicts a sample's distribution would occur within this ellipse 95 times out of 100 if the population was resampled, thus statistically significantly reducing the chance of retaining a false negative or a type II error (Madrigal 2012:95). Using this inferential statistic, if an archaeological datum plots inside of an ellipse then one can accept the null hypothesis and infer it is drawn from the same population as the samples in SFU comparative data set.

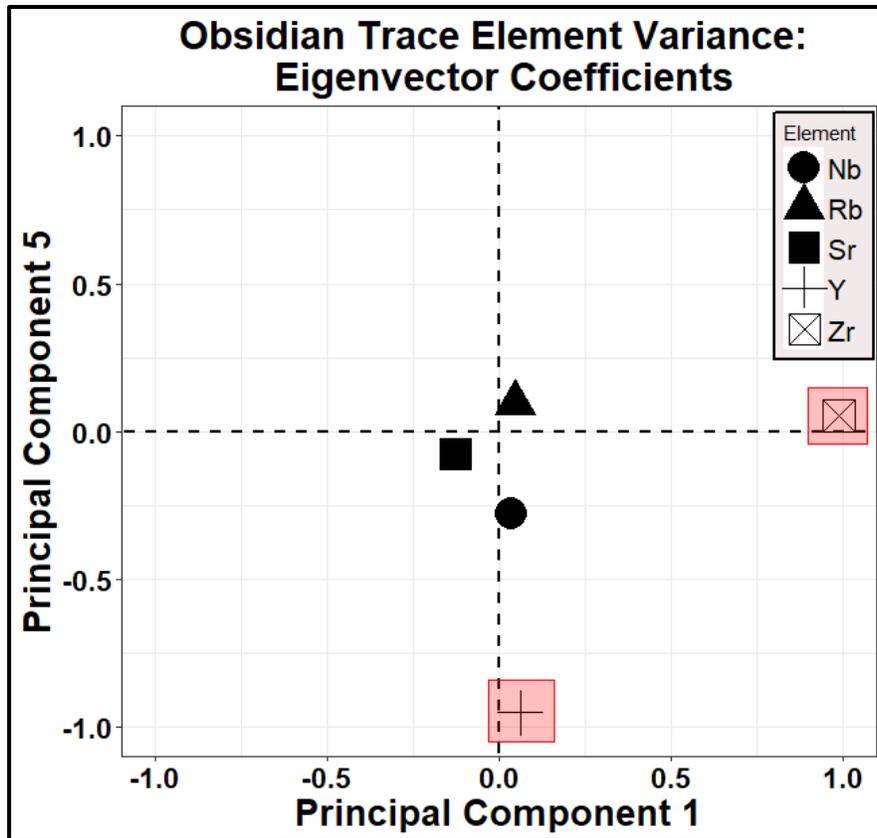


Figure 63: PCA results – component 1 and component 5 loadings for obsidian trace elements.

Table 8: PCA results – eigenvector coefficients for principal components of five trace elements.¹

Element	Component 1	Component 2	Component 3	Component 4	Component 5
Nb	0.036	-0.079	0.296	-0.910	-0.278
Rb	0.047	-0.202	0.929	0.292	0.097
Sr	-0.124	0.964	0.222	0.007	-0.077
Y	0.061	-0.067	-0.012	0.295	-0.951
Zr	0.989	0.138	-0.026	0.002	0.055

¹ = Highlighted eigenvector coefficients account for the most variance within the PCA model.

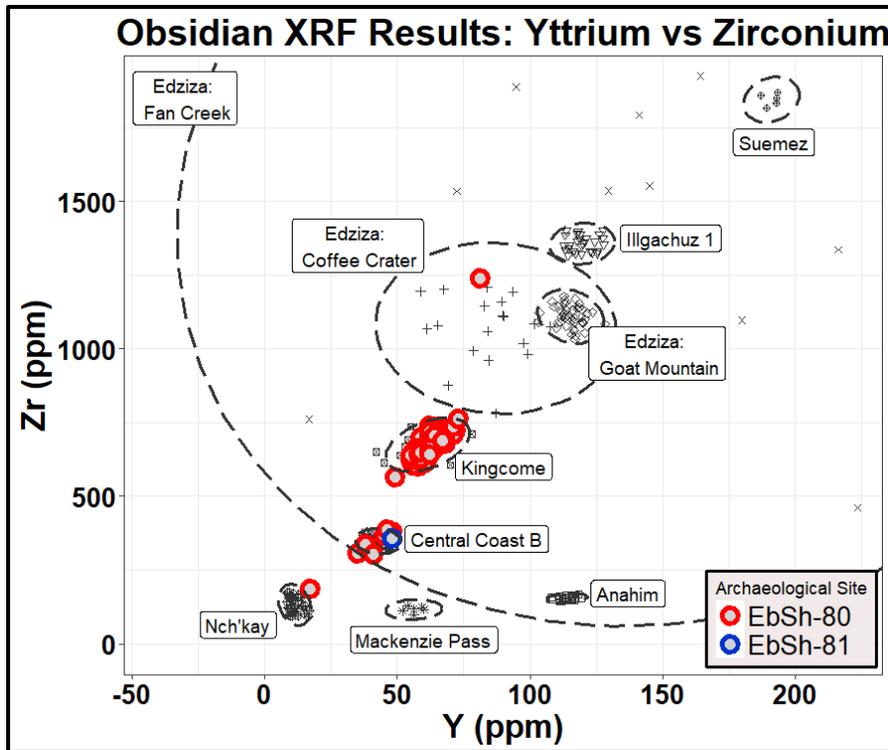


Figure 64: Yttrium and zirconium distributions for Crescent Channel (EbSh-81) and Village Bay Lake Island (EbSh-80) obsidian artifacts. SFU comparative data set = dark grey shapes.

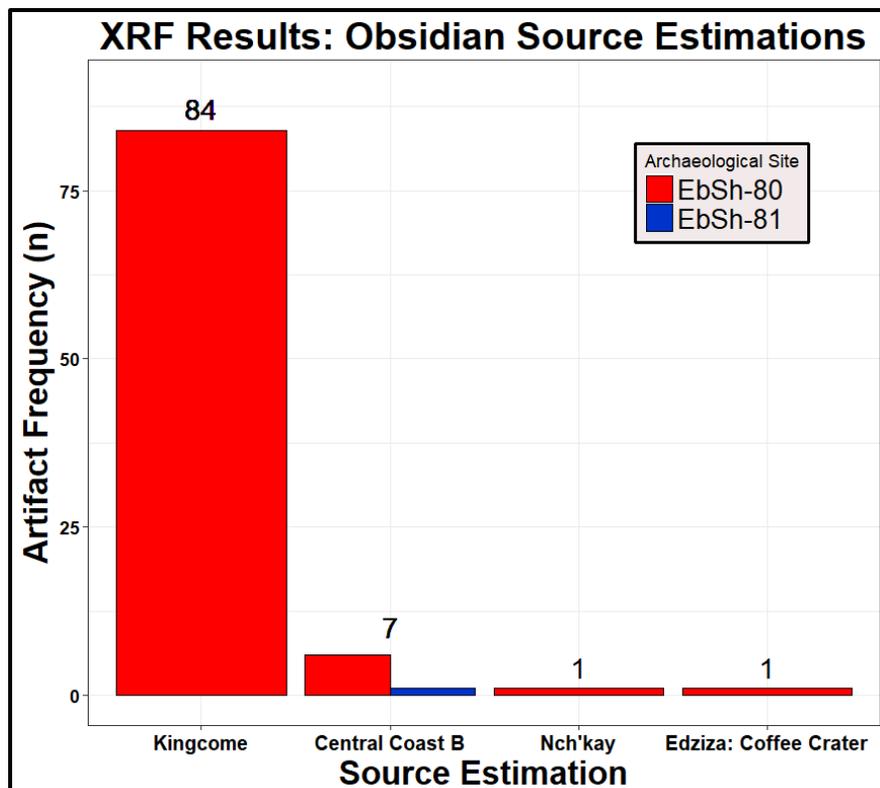


Figure 65: Crescent Channel (EbSh-81) and Village Bay Lake Island (EbSh-80) obsidian artifact source estimations.

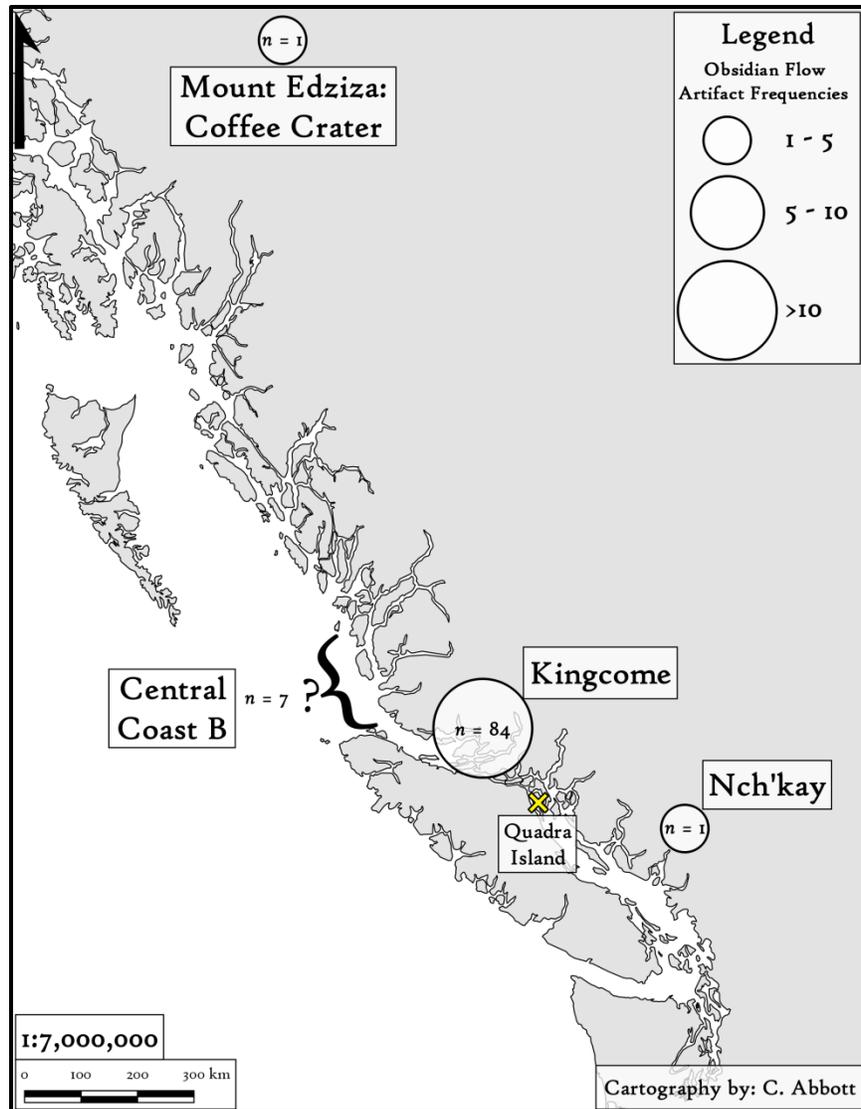


Figure 66: Geographic density distribution of obsidian source estimations.

The distributions of trace elements Y and Zr indicate that the Kingcome obsidian flow, previously dubbed “Central Coast A” (Skinner 2009; Stafford et al. 2013), is the most likely geological source estimation for the majority of the sub-sampled obsidian artifacts (Figures 65-66). Central Coast B, whose precise geographic location is unknown to archaeologists but is hypothesized to be located at the head waters of Rivers or Knight Inlet (Reimer 2012:167; Stafford, personal communication 2017), is the most likely geological source estimation for the second greatest frequency of sub-sampled artifacts. Because I sub-sampled 74% of all obsidian artifacts within the Crescent Channel (EbSh-81) and Village Bay Lake Island (EbSh-80) lithic

assemblages, three intriguing results emerged that might not have been observed had I not sub-sampled such a large proportion of this lithic material type.

First, while the Kingcome and the Central Coast B obsidian flows are the geological source estimations for the majority of the sub-sampled obsidian artifacts, a single artifact from the Village Bay Lake Island (EbSh-80) assemblage plots most closely to the distribution of comparative samples from the Nch'kay geological source location. This artifact datum does not plot within the 95% confidence interval ellipse but it is barely outside of it so I judged it justifiable to qualitatively estimate it as drawn from the same population and, hence, likely originating from the Nch'kay obsidian flow. This artifact, a complete flake weighing 0.2 grams, has a slightly matted appearance that differentiates it from the rest of the obsidian artifacts sampled in this thesis, suggesting the Nch'kay obsidian flow may be somewhat recognizable via macroscopic methods (Figure 67).

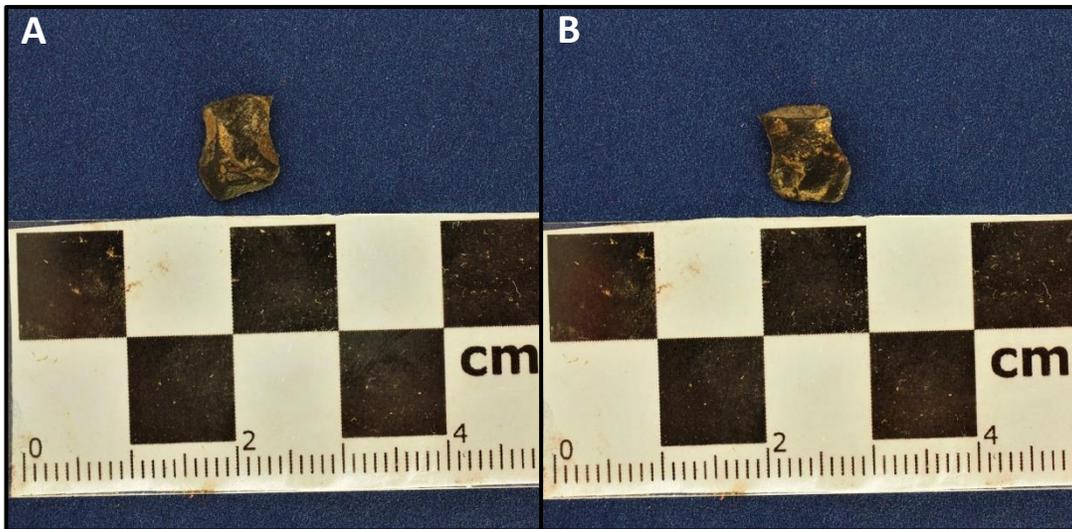


Figure 67: Lithic artifact EbSh-80:428: dorsal surface (A) & ventral surface (B).
Obsidian source estimation = Nch'Kay.

Second, the only obsidian artifact from the mid-Holocene Crescent Channel (EbSh-81) assemblage plots within the 95% confidence interval ellipse of the Central Coast B comparative samples. Because there are several data points from the late Holocene Village Bay Lake Island

(EbSh-80) assemblage that also plot within this ellipse, a pattern of lithic material continuity across several millennia is evident.

Third, a complete flake weighing 0.1 grams plots within the 95% confidence interval ellipse of the Mount Edziza: Coffee Crater comparative samples (Figure 68). This particular obsidian flow in the Mount Edziza volcanic complex does not overlap with the distributions of any of the non-Edziza comparative samples, thus increasing confidence in this geological source estimation despite its distance (~1200 linear kilometers) to the Discovery Islands study area. Carlson's (1994:352) study and Reimer's (2015:425) recent revision of the known spatial distribution of Mount Edziza obsidian shows that lithic materials originating from this volcanic complex are found in archaeological sites as far south as approximately 300 linear kilometers north of the Discovery Islands study area. This means that this artifact in the Village Bay Lake Island (EbSh-80) lithic assemblage is now one of the most southern known occurrences of Mount Edziza obsidian in an archaeological site in North America.

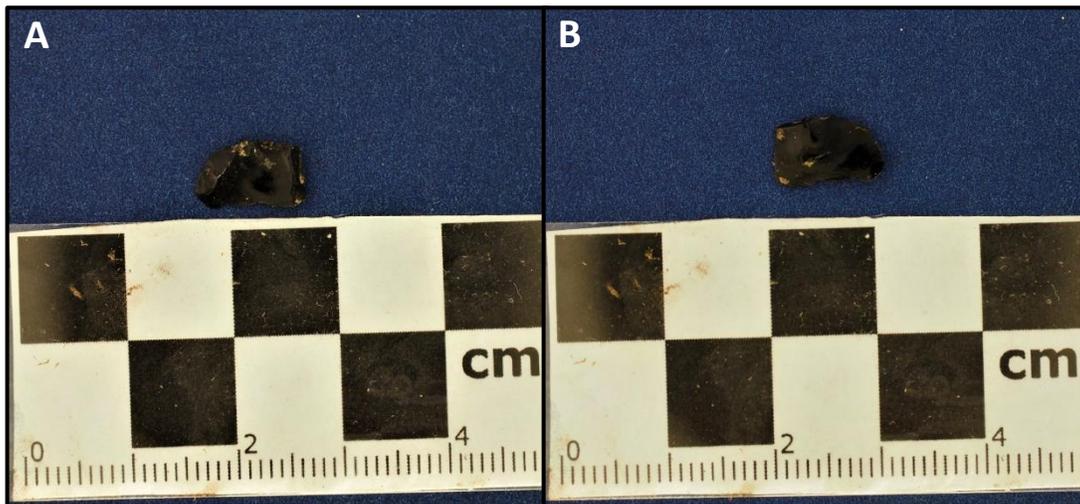


Figure 68: Lithic Artifact EbSh-80:419 - dorsal surface (A) & ventral surface (B).
Obsidian source estimation = Mount Edziza: Coffee Crater.

6.3.3.2: X-Ray Fluorescence Spectrometry Results – Fine-Grained Volcanic Artifacts

The spectrometer produced calibrated trace element composition values (ppm) for 9 of the 10 sub-sampled fine-grained volcanic artifacts (Figure 69). Summary statistics are provided in Table 9.

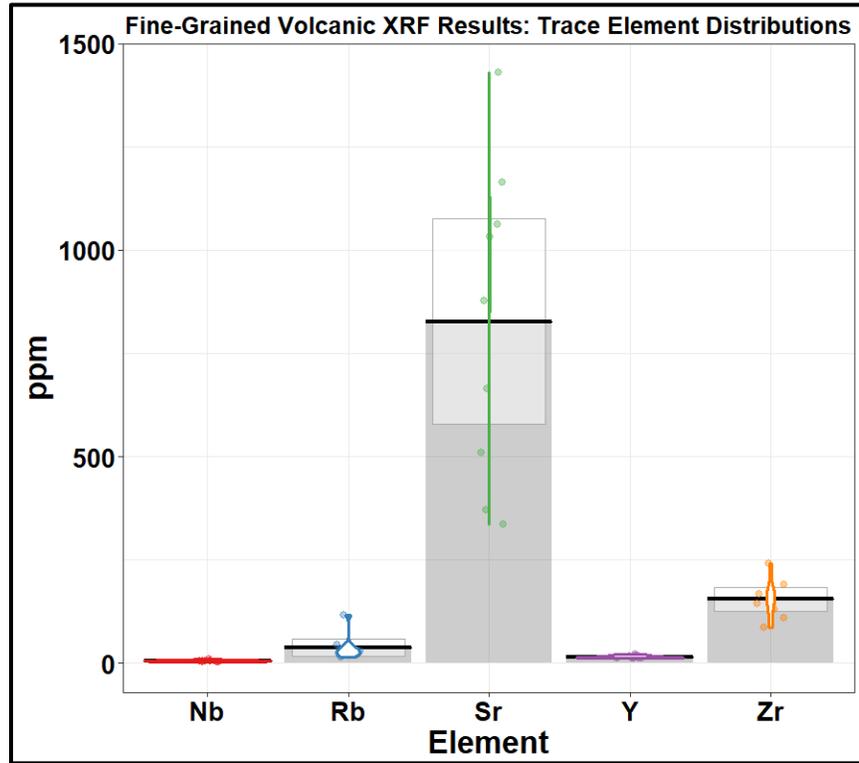


Figure 69: Fine-grained volcanic XRF results – RDI plot of trace element distributions.

Table 9: Fine-grained volcanic XRF results – trace element summary statistics.¹

Element	n	Minimum	Maximum	Median	Mean	SD
Nb	9	2.0	10.0	5.0	4.8	2.5
Rb	9	15.0	117.0	28.0	37.8	31.1
Sr	9	336.0	1429.0	876.0	827.3	379.4
Y	9	12.0	22.0	13.0	15.1	3.5
Zr	9	85.0	241.0	159.0	154.2	45.6

¹ = All trace element values in parts per million (ppm).

The SFU comparative data set of fine-grained volcanics is much more spatially restricted relative to its obsidian equivalent (Figure 70). All samples are derived from primary geological

source locations, three in the Squamish River Valley (Turbid Creek, High Falls Creek, and Brandywine Creek), one on the northeastern shores of Howe Sound (Watts Point), and one on the Interior Plateau (Arrowstone Hills). Reimer and Hamilton (2015:65-66) provide the complete comparative trace element data set used for FGV geological source estimations in this thesis.

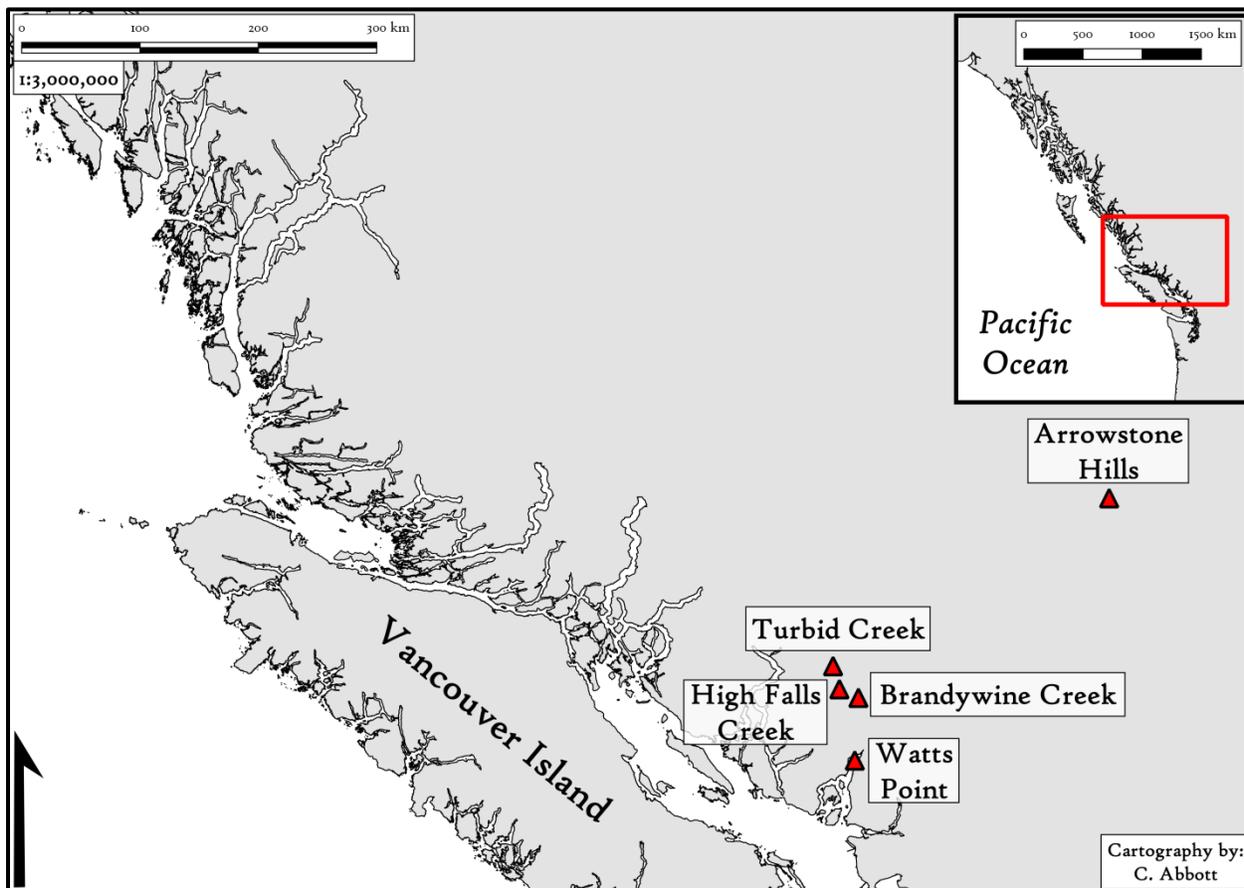


Figure 70: Select fine-grained volcanic flows and geological source locations of northwestern North America.

Using a PCA model to quantitatively determine which elements in the FGV XRF data set have the most variance was not feasible due to statistical uncertainty stemming from a small FGV artifact sample size. A qualitative inspection of the trace element distributions, however, reveals that Sr has the most variance and Rb and Zr are the elements with the second and third most variance. Therefore, I decided to plot Sr against Rb and Zr in two separate plots and compare the results (Figure 71).

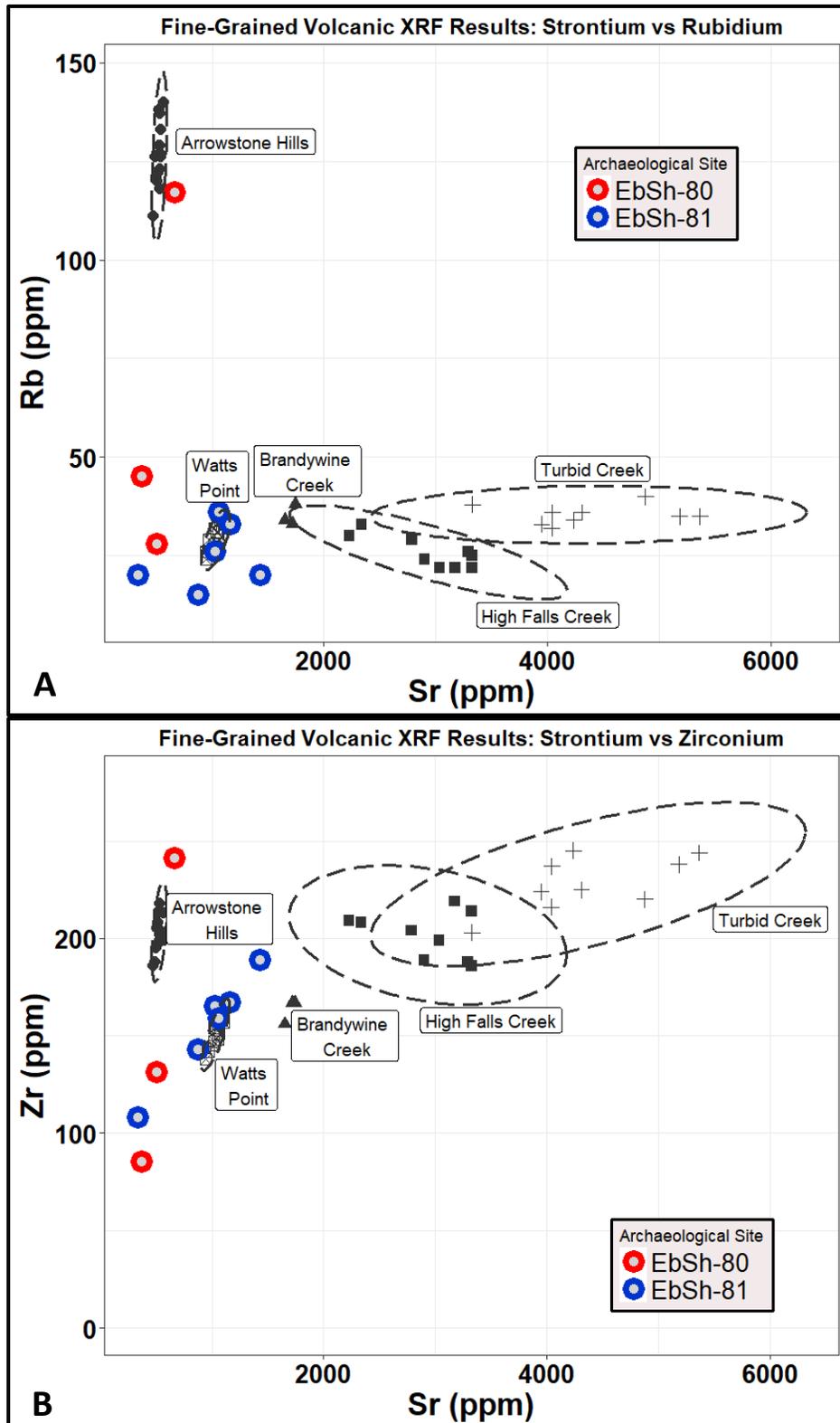


Figure 71: Strontium and rubidium (A) & strontium and zirconium (B) distributions for nine Crescent Channel (EbSh-81) & Village Bay Lake Island (EbSh-80) fine-grained volcanic artifacts. SFU comparative data set = dark grey shapes.

Two intriguing results are apparent in the FGV XRF results despite a small sample size. First, three of the sub-sampled FGV artifacts from the Crescent Channel (EbSh-81) site plot within the tightly distributed 95% confidence interval ellipse of the Watts Point geological source location, a pattern that holds true whether Sr is plotted against Rb or Zr. Additionally, a fourth Crescent Channel (EbSh-81) artifact datum plots very close to the Watts Point ellipse in the Figure 71B. This suggests that Watts Point is the most likely geological source estimation for these three or four FGV artifacts based on the currently available comparative data set. If one extrapolates these findings to the rest of the FGV artifacts from the Crescent Channel (EbSh-81) lithic assemblage, particularly ones macroscopically identified as 'Dark Grey Volcanic' that dominate the assemblage, a pattern of intensive use of this specific tool-stone source by the ancestral inhabitants of this mid-Holocene archaeological site begins to emerge.

Second, a flake tool from the Village Bay Lake Island (EbSh-80) lithic assemblage plots very close to the 95% confidence interval ellipse of the Arrowstone Hills geological source location (Figure 72). This artifact plots further from the Arrowstone Hills ellipse in Figure 71B but it is nonetheless positioned parallel to the orientation of the distribution of the Arrowstone Hills comparative samples, suggesting it may be a distant outlier in the tail of the distribution of the same population from which the comparative samples are drawn. The provocative notion that lithic materials from the Arrowstone Hills geological source location circulated so extensively that they are found in a late Holocene archaeological site located on Quadra Island is not unreasonable considering findings by Mallory-Greenough et al. (2002:54) that Arrowstone Hills lithic materials are widely distributed throughout archaeological sites in the Interior Plateau of British Columbia. Likewise, obsidian and other lithic materials such as nephrite (Morin 2015a, 2015b) and quartz crystal (McLaren and Gray 2017) also circulated extensively throughout

western North America during the Holocene. While the sample is small and more research is needed to confidently estimate Arrowstone Hills as the geological source location for this lithic artifact, it is nonetheless an exciting preliminary finding.

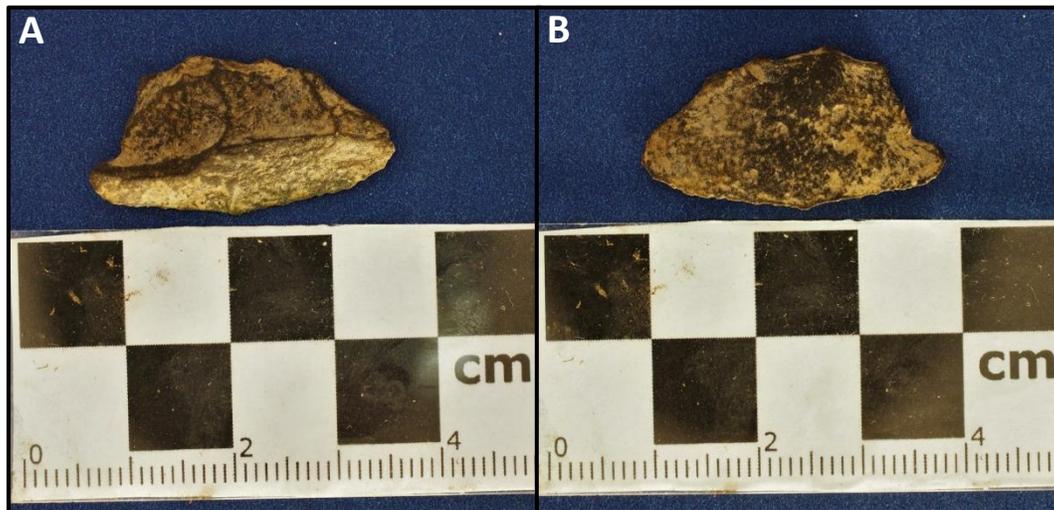


Figure 72: Lithic artifact EbSh-80:352 - dorsal surface (A) & ventral surface (B).
Geological Source Estimation = Arrowstone Hills.

Given the intriguing yet somewhat unclear FGV XRF results, I undertook a small lithic material survey in the summer of 2017 to supplement them. The goal of the survey was to investigate if any additional observations could be made that might provide some clarifying insights regarding the Watts Point geological source estimations for three Crescent Channel (EbSh-81) lithic artifacts.

6.4: Watts Point Survey

In the summer of 2017 I led a small one-day survey at the Watts Point volcanic centre. The survey crew consisted of Seonaid Duffield (UVic), Colton Vogelaar (UVic), Nicholas Waber (UBC), Ian Sellers (Inlailawatash Limited Partnership), Quintin Finocchio, and I. Our primary objectives were:

- 1) To inspect the spatial distribution and accessibility of lithic materials at this location.

- 2) To qualitatively inspect the attributes of lithic materials in this vicinity in order to make comparisons to the FGV artifacts from the Crescent Channel (EbSh-81) lithic assemblage.

The Watts Point volcanic centre is the southernmost flow in the Garibaldi volcanic belt of the Cascades volcanic arc (Green et al. 1988; Guffanti and Weaver 1988). It is located on the northeastern shores of Howe Sound approximately 10 km south of the town of Squamish. This place is known as *Lexwlúxwls* in *Skwxwú7mesh* (Squamish First Nation) oral histories and was created by the transformation of a group of ancestral Lil'wat First Nations people into a landform that resembles “a human lying down, resting, arms on chest and head pointing outward into Howe Sound” (Reimer 2012:77). The Watts Point volcanic centre is approximately 0.3 km² and rises to 240 m ASL. Bye et al. (2000) conducted an in-depth geological study here and hypothesized that the Watts Point volcanic centre formed in a subglacial to englacial environment, meaning that it erupted while beneath or in glacial ice during the Salmon Springs (>50,000 cal BP) or Fraser (26,000-10,000 cal BP) glaciations (Green et al. 1988; Mathews 1952). This eruption formed a high dome-shaped feature of rectangular jointed columnar dacite characteristic of rapidly cooling lava within glacial tunnels (Bye et al. 2000:4; Reimer 2012:77). The subglacial formation hypothesis is also supported by the stratigraphic relationship of the dacite formations to overlying glacial till and postglacial sediments.

Lithic materials hypothesized to originate from the Watts Point volcanic centre are the focus of several archaeological studies that began in the early 1990s. Bakewell's (1993, 1996, 2005) early work used geochemical and petrographic analyses to compare archaeological lithic artifacts to samples from the Watts Point volcanic centre and led him to coin the term “basaltopia” for the pervasive phenomenon amongst Northwest Coast archaeologists of uncritically labelling all fine-grained volcanic rocks as “basalts.” Since then, the spatial

distribution of Watts Point dacite in archaeological, primary geological, and secondary geological or colluvial contexts (i.e., locales where lithic materials are transported through geomorphological processes) are the focus of several additional studies (Close 2006, Kwarsick 2010; Osiensky 2014; Reimer 2012, 2018; Rorabaugh et al. 2015; Taylor 2012), a topic I address in Section 6.5.

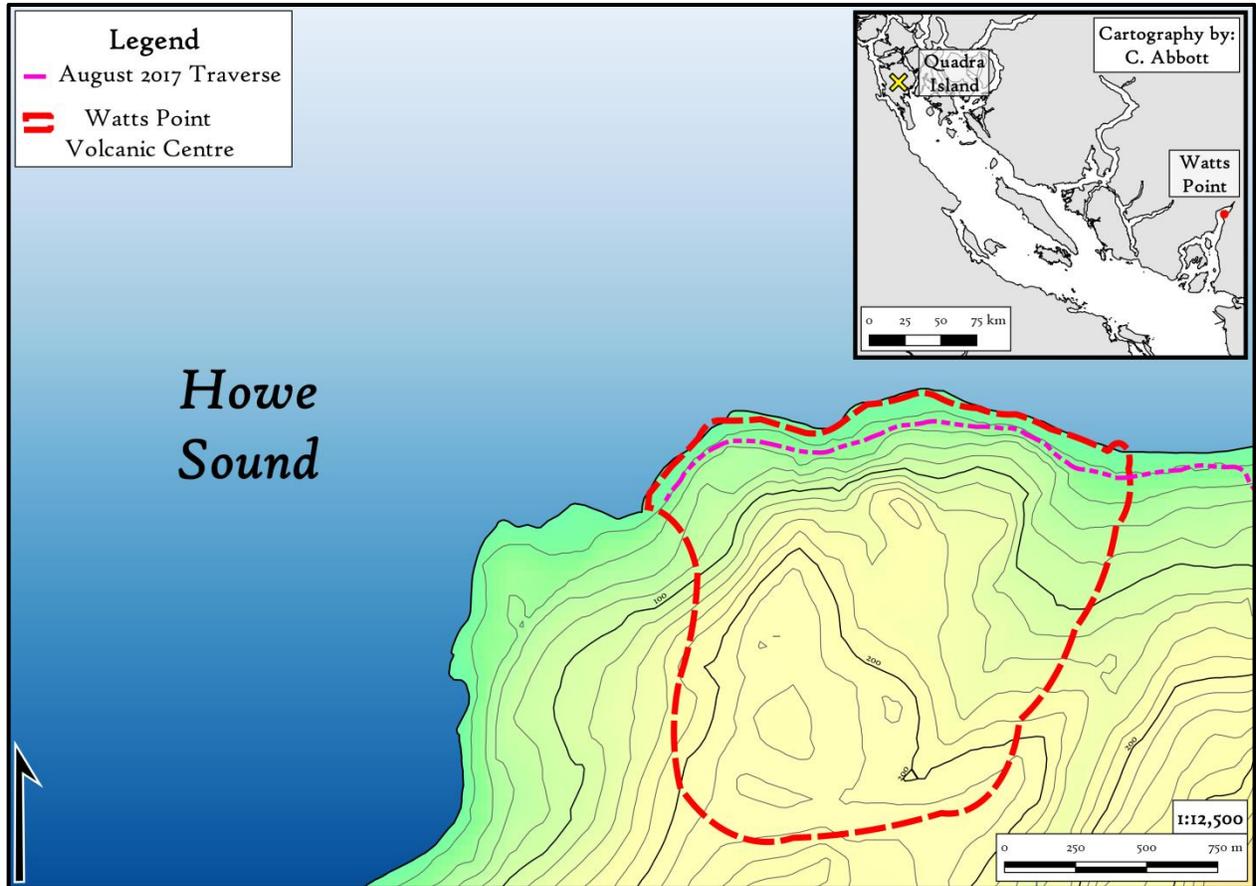


Figure 73: Watts Point volcanic centre survey coverage. X on inset map marks the location of Quadra Island.

The Watts Point volcanic centre survey consisted of multiple meandering pedestrian traverses with six crew members generally spaced 10-50 meters apart depending on terrain and visibility (Figure 73). Traverses were constrained by the steep topography rising towards the south and the shoreline to the north. Our primary survey target was the railroad thoroughfare with significant geological exposures identified by Bye et al. (2000:3). Additional surface and subsurface exposures such as sparsely vegetated areas, tree throws, creek banks, and rock

outcrops were inspected for lithic materials. Specifically, we were searching for nodules of stone with weathered cortical surfaces in order to compare against the intact cortices of cores identified in the Crescent Channel (EbSh-81) lithic assemblage (Figure 47).

Access to the survey target was relatively easy, largely because the Watts Point volcanic centre is located very close to extensive infrastructure characteristic of the southern coast of British Columbia such as road and railway networks. We observed multiple exposed jointed columnar dacite formations, abundant pieces of highly siliceous exfoliated bedrock, and weathered tabular slabs (Figure 74). Testing some of these nodules of stone confirmed that they fracture in a conchoidal manner (Figure 75). Moreover, the intact cortical surfaces of many of the weathered tabular slabs exhibited similar patinas as the intact cortices on many of the Crescent Channel (EbSh-81) cores. While the cortical colours of the weathered tabular slabs observed during the Watts Point survey seem somewhat lighter than those of the Crescent Channel (EbSh-81) cores, one can expect slightly different weathering patterns given that they were exposed to different weathering environments for several millennia. This finding alone does not indisputably confirm that lithic materials in the Crescent Channel (EbSh-81) assemblage originated from the Watts Point volcanic centre but it is a promising observation.

The Watts Point lithic material survey took place over a single day and should not be considered exhaustive. For example, our survey coverage was restricted to portions of the Watts Point volcanic centre below 50 ASL largely because the majority of its higher elevations are an active industrial rock aggregate quarry. Gaining clearance from the quarry managers and conducting intensive surveys both in the low and high elevation areas of the Watts Point volcanic centre as well as sampling some of the collected pieces for XRF analysis would yield more



Figure 74: Exposed jointed columnar dacite formations at the Watts Point volcanic centre. Note the stratigraphic relationship to overlying glacial till and the large trees for scale.



Figure 75: Weathered Watts Point dacite tabular slab tested by the survey crew. Note the highly siliceous texture and dark grey colour of the freshly exposed surfaces.

comprehensive data that are necessary in order to better assess the relationship of this geological source location to FGV lithic artifacts in the Crescent Channel (EbSh-81) assemblage.

6.5: Material Analysis Discussion

The material analysis results presented in this chapter provide some clarification but simultaneously pose new questions regarding the lithic material selection and acquisition practices of the ancestral inhabitants of the archaeological sites sampled in this thesis. I discuss and summarize their implications in this concluding section.

The results of the obsidian XRF analysis are relatively straightforward. The petrogenesis of this lithic material renders the spatial distribution of *in situ* geological source locations discrete and trace element compositions relatively distinct from one flow to the next, with the notable exception of the Mount Edziza: Fan Creek obsidian flow. This phenomenon plays out in the tight clustering of the trace element distributions and lack of overlapping 95% confidence interval ellipses for the rest of the SFU comparative samples in Figure 71. Similarly, all of the 93 obsidian artifacts I sub-sampled plot within or very near the 95% confidence interval ellipses of SFU comparative data set samples which reduces ambiguity in estimating their geological source locations.

Due to these strong patterns in the obsidian XRF data set for both the comparative and archaeological samples, explanatory models of direct and/or down-the-line lithic material procurement are feasible despite the Euclidean distances and circulations required for these “pieces of places” (Bradley 2000; Reimer 2012) to end up in the hands of the people who created the archaeological deposits sampled in this thesis. Similarly, these patterns in the data set result in inferred trade and travel practices that likely would not shine through had my obsidian XRF sampling strategy been less thorough. While the intensive focus on obsidian from the Kingcome

obsidian flow in the late Holocene Village Bay Lake Island (EbSh-80) lithic assemblage fits with Carlson's (1994) hypothesis that the geographic distribution of obsidian on the Northwest Coast became more "localized" during the times this site was inhabited, his sweeping generalization somewhat mischaracterizes my obsidian XRF results. On the one hand, they fit Carlson's (1994) model of a localized lithic economy because the closest known obsidian flow approximately 150 linear kilometers northwest of Quadra Island near the head of Kingcome Inlet dominates this assemblage. However, the contemporaneous occurrence of obsidian from the Central Coast B, Nch'kay, and Mount Edziza geological source locations hint at interwoven social geographies, extensive and enmeshed travel networks, entangled economic circulations, and dynamic lithic material selection and acquisition practices that persist into the late Holocene. Furthermore, the Central Coast B geological source estimation for the single piece of obsidian in the mid-Holocene Crescent Channel (EbSh-81) lithic assemblage suggests continued use and importance of these pieces of places across approximately 180 generations of human life. This an impressive feat of technological continuity on par with other long-term habitation sites on the Northwest Coast such as Namu (Carlson 1994:314; Hutchings 1996; Moss 2011:109; Rahemtulla 2006).

Liebmann's (2017) analysis of archaeological obsidian artifacts from around the Valles Caldera in northern New Mexico is an example of the kinds of archaeological insights about intergenerational connections to place that are achievable by producing geochemical data sets with XRF methods. Liebmann (2017) foregrounds obsidian selection and acquisition as diachronic and relational social practices. In doing so, he effectively demonstrates how articulations between ancestral Jemez Pueblo communities and Spanish colonizers during the 16th- and 17th-centuries influenced oscillations in the amounts of *Wâavēmâ* obsidian, a group of obsidian flows in the Valles Caldera, in archaeological sites dating to these tumultuous times.

During periods before (pre-1598) and between (1680-1692) colonial rule in the region, ancestral Jemez Puebloans lived “unfettered by the shackles of colonialism...and quantities of [*Wâavēmâ*] obsidian spiked” (Liebmann 2017:654). He argues that increased labour demands imposed by the colonial regime onto the ancestral Jemez communities who inhabited this region “transformed Pueblo life” and their “ability to move through the landscape in the same ways they had done before the Spaniards arrived” (Liebmann 2017:655). Yet during intervening years (1680-1692) they resumed their previous mobility and obsidian acquisition practices, as inferred by the spike in *Wâavēmâ* obsidian in archaeological deposits dating to this brief time period. Ancestral Puebloans’ return to this place after nearly a century of imposed restrictions upon their territories and bodies (Spielmann et al. 2009) speaks to deeply embedded social memories and resilient connectedness to *Wâavēmâ* that remained vital in maintaining their cultural identities through the centuries (Liebmann 2017:657).

Although the ancestral inhabitants of the Discovery Islands did not face the oppression of colonialism during the times that the archaeological sites sampled in this thesis were inhabited, a similar narrative of enduring connections to place via the circulation of lithic materials shines through. For example, the Kingcome Inlet obsidian flow, the nearest source of obsidian to the Discovery Islands study area, is currently only accessible during the warmest months of warm years (Stafford, personal communication 2017). The ubiquity of Kingcome obsidian in the late Holocene Village Bay Lake Island (EbSh-80) assemblage speaks to the resilient connections to this place that the ancestral inhabitants of the Discovery Islands practiced despite its intermittent and weather-dependent accessibility, which would have only been more restricted during glacial readvances that occurred throughout the Holocene within the vicinity of the Kingcome Glacier (Mood and Smith 2015). This speaks to an enduring northern connection via the acquisition of

obsidian, particularly when one also considers the persistence of Central Coast B obsidian circulating within and between these communities through the millennia.

The materiality of collecting obsidian from these locations is a practice that enabled these communities to be “of” these places by drawing upon memories of the numerous generations whose footsteps they follow while simultaneously maintaining and fostering connections to the broader physical, spiritual, and social landscapes they inhabited (Reimer 2012:179-181). These constellating processes are a form of “memory work” (Mills and Walker 2008) that would have only been enhanced by observing the traces of those who came before them such as quarried outcrops, caches, and debitage strewn throughout the landscape (Roddick 2013, 2015). In this way, “the landscape is constituted as an enduring record of—and testimony to—the lives and works of past generations who have dwelt within it, and in so doing, have left there something of themselves” (Ingold 1993:152). Further, these literal “pieces of places” (Bradley 2000; Reimer 2012) are material links not only to their geological source locations but also to the hands that they passed through as they circulated amongst ancestral communities up and down the Northwest Coast as well as the Interior.

Despite these tantalizing if not somewhat speculative insights, obsidian may be equally (if not more) valued by archaeologists than it was by the ancestral inhabitants of the Northwest Coast (Moss 2011:71). Its seductive interpretive potential due to its geological and geochemical properties I discuss above unsurprisingly results in intensive research and enthusiastic conclusions that connect seemingly far-flung locales to many archaeological sites across the Northwest Coast and the Interior Plateau. While it is likely that these inferred patterns of trade and movement within these diverse yet interconnected landscapes and seascapes took place in

some form throughout the Holocene, archaeological romanticism of obsidian or, dare I say, obsidianopia is overdue for a reevaluation.

Although obsidian may be unique in its petrogenesis and consequent geochemical properties, it is not well-suited to every use nor is it the only lithic material chosen for making and using lithic technologies, an assertion supported by my macroscopic lithic analysis, TSP, and XRF results. The extreme brittleness of obsidian makes it a rather unforgiving material with which to work while producing flaked stone tools and not terribly durable once put to use. These characteristics mean obsidian is a material suitable for certain tasks such as precision cutting—not to mention less utilitarian uses—but certain tasks such as chopping or coarse scraping simply require stone tools fashioned from more hardy lithic materials.

Given the diversity of the lithic materials selected and acquired throughout space and time, composite analytical methods are likely necessary in order to facilitate archaeological insights about these alternative tool-stones (Greenough et al. 2004; Smith 2004). The TSP and exploratory (non-obsidian) fine-grained volcanic XRF analyses I describe in this chapter are a step in this direction. While the results of these analyses are more ambiguous than the obsidian XRF results, they hold promise to elicit similarly exciting inferences. Admittedly though, more baseline data are needed in order to achieve similarly confident interpretive results as those typically attained through geochemical analyses of obsidian.

As I summarize in Section 6.3.3.2, several implications of my exploratory fine-grained volcanic XRF analysis are clear. A likely unavoidable confounding variable in XRF research of fine-grained volcanic lithic materials is the greater variability within the trace element distributions of some geological source locations. Greater variability means greater uncertainty when estimating the geological source locations of FGV lithic materials, as illustrated by the

large and overlapping 95% confidence interval ellipses for the High Falls Creek and Turbid Creek samples in the SFU comparative data set visible in Figure 71. However, the trace element distributions of some FGV geological source locations may be tightly distributed in a manner similar to most obsidian flows, as shown by the Watts Point comparative samples. Indeed, Reimer (2018:505) concludes in his recently published study of the Watts Point volcanic centre that “Watts Point...trace element signatures are distinct in primary and secondary source contexts,” thus facilitating XRF source estimation studies for lithic materials hypothesized to originate from this place.

Regardless of the amount of uncertainty in any statistical model or geological source estimation, supplementing FGV XRF analyses with TSP analyses and field surveys—as I do here—are likely necessary in order to better understand the variability of FGV geological source locations and, in turn, to be able to make more informed assessments of their circulations within communities and constellations of lithic practice throughout the deep history of the Northwest Coast. Even some obsidian geological source locations may benefit from analytical revisits using multiple lines of evidence in order to clarify questions about overlapping trace element distributions (Karl et al. 2011; Moss et al. 2016:117-118).

One lithic artifact, EbSh-81:601, was sub-sampled for both TSP (Table 4) and XRF analyses. This artifact plots within the 95% confidence interval ellipse of the Watts Point comparative samples (Figure 71) but its microstructure and mineral composition are somewhat inconsistent with the petrographic descriptions and classifications Bye et al. (2000:6) made during their own TSP analysis of samples from the Watts Point volcanic centre. Specifically, sample EbSh-81:601 is a porphyritic lava with a trachytic microstructure meaning that it is composed of phenocrysts with distinctly different shapes and sizes compared to the smaller

parallel minerals that make up the groundmass (Vernon 2004:60). TSP analysis by Bye et al. (2000:6) indicates that there are at least three distinct petrographic textures that occur within their 18 samples from the Watts Point volcanic centre, the third of which they characterize as a devitrified porphyritic pyroxene dacite with slight to strong trachytic texture. While this petrographic description is not an exact match to EbSh-81:601, it suggests there are portions of the Watts Point volcanic centre that approximate the petrographic description of archaeological sample EbSh-81:601.

The subglacial formation hypothesis of the Watts Point volcanic centre means that lava on the periphery of erupting flows would likely come into contact with glacial ice and cool at differential rates, thus explaining the variable petrographic textures Bye et al. (2000) observe. The porphyritic textures of both sample EbSh-81:601 and the third petrographic description category Bye et al. (2000) provide are consistent with a multi-stage cooling process which prompts the formation of multiple phenocrysts with distinct morphologies—a mineral composition and microstructural attribute shared by the archaeological and geological samples. However, given small sample sizes for archaeological artifacts analyzed by both TSP and XRF techniques ($n = 1$) in this study and in Bye et al.'s (2000) TSP analysis of samples from the Watts Point volcanic centre ($n = 18$), the results are too inconclusive to make definitive statements about whether or not sample EbSh-81:601 originated from the Watts Point volcanic centre.

To further complicate matters, Shackley (2008:204) asserts that thorough geoprospection of a study area's *in situ* primary geological composition and secondary Quaternary colluvia are necessary in order to accurately and reliably estimate the geological source locations of any lithic material no matter the precision of the instruments or geochemical analyses being employed.

This observation is apt because Bye et al. (2000:3) note “the Watts Point [volcanic] centre is petrographically and geochemically similar to other dacite lavas in the Garibaldi belt.” Given this potential petrographic and geochemical ambiguity, better baseline data about the distribution of lithic materials in the landscape are requisite.

Terminal Pleistocene and Holocene glacial activities in western North America were “punctuated by advances and retreats on a variety of timescales” (Menounos et al. 2009:2049). This means that the spatial distribution of Quaternary colluvia and secondary geological sources of lithic materials on the Northwest Coast is extensive and likely quite variable. For example, Mood and Smith (2015) provide evidence that the Franklin Glacier, located approximately 125 km north of the Discovery Island study area and near the head of Knight Inlet, expanded and retreated at least nine times since 13,000 cal BP. Friele and Clague (2002) document similar Quaternary glacial dynamism in the vicinity of the Watts Point volcanic complex. Unsurprisingly, Kwarsick (2010), Osiensky (2014), Reimer (2018), Rorabaugh et al. (2015), and Taylor (2012) all observe lithic materials in secondary colluvial contexts throughout the southern Salish Sea that they hypothesize originate from the Watts Point volcanic centre based on macroscopic, petrographic, or geochemical analyses.

Quaternary glacial models put forward by Clague (1989) and Clague and James (2002) postulate that the general ice-flow direction of the Cordilleran ice sheet was in a northwest to southeast direction leading up to and during the last glacial maximum. Since the Watts Point volcanic centre is located southeast of the Discovery Islands study area, it is unlikely that lithic materials and glacial till were transported northwards. Rather, it is more likely that lithic materials were transported by glaciers southwards to the Discovery Islands study area from more northern volcanic centres in the Garibaldi volcanic belt (Green et al. 1988) or the Cascades

volcanic arc (Edwards and Russell 2000). This means there are at least three alternative and non-mutually exclusive explanatory scenarios that account for the presence of lithic materials on Quadra Island whose petrographic, geochemical, and macroscopic attributes are similar to comparative samples derived from the Watts Point volcanic centre on the northeastern shores of Howe Sound:

- 1) Quaternary colluvia containing lithic materials from the Watts Point volcanic centre were transported south from their *in situ* primary geological source location, deposited in the southern Salish Sea, and subsequently moved north via anthropogenic intervention such as direct and/or down-the-line procurement.
- 2) Lithic materials from the Watts Point volcanic centre's *in situ* primary geological source location were moved north via anthropogenic intervention such as direct and/or down-the-line procurement.
- 3) Quaternary colluvia containing lithic materials similar to those found at the Watts Point volcanic centre were transported south by glacial advances occurring north of the Discovery Islands study area.

The cogency of these potential scenarios is difficult to assess based on current archaeological and geological knowledge of these phenomena, but it is noteworthy that the first two scenarios currently have stronger evidence than the third. This interpretive murkiness manifests in divergent archaeological explanatory models that typically invoke either direct procurement from the Watts Point volcanic centre (Bakewell 2005; Close 2006) or down-the-line exchange and/or accessing proximal secondary geological source locations (Kwarsick 2010; Osiensky 2014; Rorabaugh et al. 2015; Taylor 2012). Still others propose a mix of all of these scenarios that are perhaps embedded within other daily activities (Reimer 2012, 2018; Reimer and Hamilton 2015; Rorabaugh and McNabb 2014). In spite of the reality that none of these models are necessarily mutually-exclusive, debates will likely persist unless contextually-specific bodies of knowledge that incorporate multiple lines of evidence (e.g., archaeology,

petrography, geochemistry, geomorphology, and field survey) are created and shared. For example, increasing the sample size of FGV artifacts sub-sampled for TSP and XRF analyses would reveal whether or not the geological source estimations I provide are substantiated. Alternatively, surveys for comparative samples from primary and secondary geological contexts in the Discovery Islands study area could shed light onto whether or not lithic materials similar to those found at the Watts Point volcanic centre occur in the landscapes proximal to the archaeological sites sampled in this thesis.

The skilled makers and users of lithic technologies who inhabited the archaeological sites sampled in this thesis may have selected and acquired their lithic materials from secondary geological or colluvial contexts closer to the Discovery Islands study area than the Watts Point volcanic centre, but the best currently available comparative data set is of insufficient resolution to make this claim. Moreover, in addition to geomorphological evidence which suggests Quaternary glaciations likely did not transport colluvia north, one's ability to access and transport lithic materials over hundreds of kilometers is a very real possibility given knowledge of water transportation technologies such as canoes (Ames 2002; Arnold and Bernard 2005). Therefore, constraints upon literal carrying capacities imposed by exclusively terrestrial models of lithic material procurement are radically moderated (Blair 2010). Much like the ecological technological relationships between hafting practices and stone tool production practices discussed in Section 5.4.3, the effects of maritime mobility practices on coastal lithic technologies is a topic of research that requires greater consideration not only on the Northwest Coast but globally as well (cf. Bjerck 2016; Fedje et al. 2005, 2011; Anderson-Whymark et al. 2015).

The analyses, results, and discussions I present in this chapter are the fruition of the material analysis questions and methods I propose in Chapter 1 (Table 1). Intriguing results are apparent that prompt exciting hypotheses and interpretations about the lithic material selection, acquisition, and circulation practices of the ancestral inhabitants who created the archaeological deposits sampled in this thesis. In some cases, though, it is also clear that additional data are necessary in order to more fully understand the implications of some of these analyses. In the following chapter, I build upon the more concrete results of Chapters 5 and 6 in order to track skilled kinaesthetic movements of stone tool production through space and time using morphometric methods.

Chapter 7: Morphometric Analysis

7.1: Data Analysis III – Introduction

In this final data analysis chapter I quantitatively examine the shapes and sizes of some specific lithic artifacts through two complementary morphometric case studies. The first case study focuses on microblades in the Crescent Channel (EbSh-81) lithic assemblage and tests a model of microblade production and hafting practices. In the second case study I apply similar quantitative analytical methods in order to investigate the shapes of complete debitage flakes in the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) lithic assemblages.

These morphometric analyses take a cue from the work of Williams and Andrefsky (2011:871) who investigated “the influence of learning traditions and the influence of experience” between different stone tool makers and found statistically significant morphological variability within experimental debitage assemblages made by people who learned how to make flaked stone tools in differential flintknapping “schools.” Their findings suggest that proxy data of the learned bodily gestures and techniques of flaked stone tool production characteristic of particular communities and constellations of practice are rendered by describing and analyzing the shapes of some lithic artifacts. Microblades and deceptively prosaic debitage flakes, then, are the material manifestations of the skilled movements that detached them from objective pieces, links to the moments when they were created, and the material traces of diachronic genealogies of emergent technological practice.

7.2: Methods

Morphometrics is the quantitative study of form, shape, and size. Archaeological morphometric analyses are numerous and include applications in lithic analysis (e.g., Davis et al. 2015, 2017; Lycett et al. 2010; Waber 2011, n.d.; Williams et al. 2013), zooarchaeology (e.g., Grier et al. 2013; Singh and McKechnie 2015; Moss et al. 2014; Orchard and Szpak 2011), and bioarchaeology (e.g., Kurki 2013, 2017; Kurki and Decrausaz 2016). I pursue the analysis of lithic artifacts via the quantification of individual morphological attributes, in contrast to procrustes-based geometric morphometrics.

During the macroscopic lithic analysis described in detail in Chapter 5, I measured and recorded the size of microblade and debitage morphological attributes using manual calipers and recorded these values in an Excel spreadsheet which functioned as a centralized data base. The three morphological attributes I chose to describe the shapes and sizes of the lithic artifacts subsampled for the two morphometric case studies in this chapter are defined as follows:

Length: The maximum dimension parallel to the Y-axis, as determined by dorsal arises and/or ventral surface compression rings or hackles indicating the direction of force. Calipers were positioned flush with the platform as much as possible. Thus, microblade and flake curvature is somewhat represented by this measurement too because curved microblades and flakes will result in somewhat shorter length measurements than their completely straight counterparts.

Width: Maximum dimension on the X-axis perpendicular to length.

Platform Size: The maximum dimension of the platform. Often the plane of this measurement was parallel with the X-axis but not necessarily. I observed some very small and some very large microblades and flakes with “deep” platforms whose maximum dimensions are parallel to the Z-axis (i.e., thickness).

7.3.1: Morphometric Case Study 1: Crescent Channel (EbSh-81) Microblades

Since microblades may be regarded as a kind of highly specialized flake, they are arguably less sensitive to palimpsest effects of repeated modification, recycling, and consequent morphological dynamism throughout their use-lives than most other lithic artifacts. The inferred relative morphological stability of microblades—but not necessarily microblade cores—makes these minute lithic artifacts suitable to the morphometric questions I pose in this chapter.

Microblade technologies are the focus of a considerable amount of study, particularly in regions surrounding the northern circumference of the Pacific Ocean (e.g., Carlson 1996b; Fladmark 1986, 1989; Kuzmin et al. 2007; Mitchell 1968; Moss et al. 1996). Rather than attempting to tackle debates about the origins and emergence of microblade technologies in northwestern North America (cf. Magne and Fedje 2007), my aim is to test a specific model of microblade hafting practice. This model postulates that the people who made and used the microblades in the Crescent Channel (EbSh-81) lithic assemblage hafted them as insets into slotted points in order to create composite tools. Waber (2011, n.d.) draws on a wide array of evidence including microblade morphometric data, paleoecological reconstructions, as well as replicative practice and experimentation (Figure 76) to conclude that microblade technologies at the Richardson Island site located in southeastern Haida Gwaii fit the expectations of the organic haft composite slotted point microblade hafting model despite no preserved hafts at this archaeological site. Building upon this research, the questions I pose in this first morphometric case study are: **a)** did the ancestral inhabitants of the Crescent Channel (EbSh-81) site also haft microblades into composite slotted tools and, if so, **b)** what does this imply about constellations of microblade practice through space and time on the Northwest Coast?



Figure 76: Replicated composite bilaterally-slotted point with microblade insets (Waber 2011:5).

Direct archaeological evidence of preserved slotted points with microblades hafted into their lateral margins include six unilaterally-slotted and bilaterally-slotted artifacts made of antler, bone, and ivory from Zhokov Island off the northeastern coast of Siberia with components that date from 8200 ± 40 ^{14}C BP to 7450 ± 220 ^{14}C BP (Giria and Pitul'ko 1994:32) and a composite antler slotted point with preserved hafting adhesive from the Gladstone ice patch in southwestern Yukon Territory that dates to 8020-8185 cal BP (Helwig et al. 2014:658). More geographically-specific to the Northwest Coast, fragmentary slotted antler point hafts lacking microblade insets were recovered from Coho Creek on Haida Gwaii (Christensen and Stafford 2005:266) and Namu on the central coast of British Columbia (Carlson 1996a:95). Additionally, excavations at the Hoko River wet site located on the east side of the Olympic Peninsula of northern Washington State encountered a microblade knife end-hafted onto a preserved piece of wood which offers a glimpse into an alternative form of composite tool microblade hafting practices on the Northwest Coast (Croes 1995:186).

One of the most charismatic pieces of evidence supporting the composite slotted point microblade hafting model comes from Haida Gwaii. Fladmark (1986; 1989) details a remarkable *in situ* discovery at the Lawn Point site on the east coast of Graham Island where two distinct clusters of microblades and a microblade core were encountered in the same stratigraphic layer approximately 15 horizontal centimeters apart. The first cluster contained 57 short and curved microblades laid out in a “disorderly heap” (Fladmark 1986:48). The second cluster, on the other

hand, contained 11 neatly stacked long, parallel-sided, and straight microblades oriented parallel to one another along with the core from which they were detached. The provenience of these two groups of lithic artifacts offers an extraordinarily intimate glimpse of the discursive and non-discursive technological choices made by the person or people who inhabited this site and, in turn, the communities and constellations of practice within which they participated (Figure 77). Fladmark's (1986, 1989) interpretation of these clusters of microblades is that the long, straight, and parallel-sided ones were preferentially selected over their short and curved counterparts and bundled together with organic cordage prior to deposition. Given the morphological constraints imposed upon microblades suitable for hafting into composite slotted points by the very morphologies of the slots in question, the Lawn Point *in situ* discovery is perhaps evidence of an interrupted operational sequence where microblades were selected prior to hafting into a composite slotted point. A broader implication of this hypothesis is that a learned criterion of the "right" microblades to select for hafting and/or use according to this model is correlated with microblade morphologies—an archaeologically-visible attribute that is knowable by studying the shapes and sizes of these small lithic artifacts.

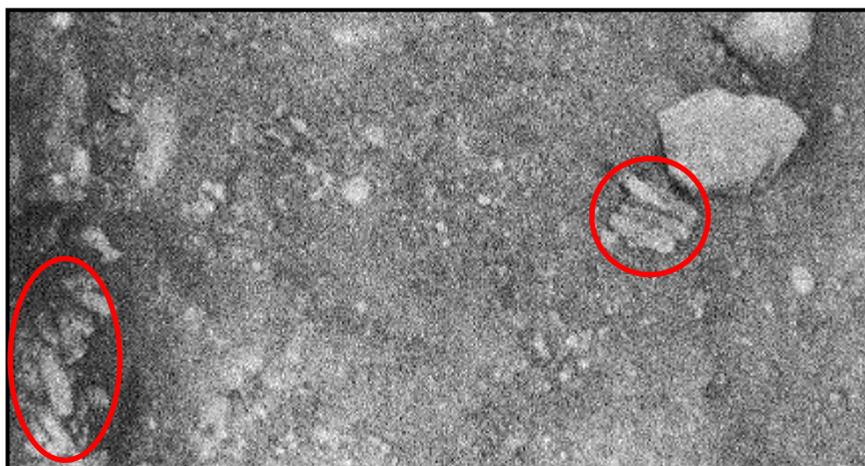


Figure 77: Lawn Point *in situ* pile of curved (left) and bundle of straight (right) microblades. Modification of image by Fladmark (1989:210).

Although this kind of iconic *in situ* discovery is lacking at the Crescent Channel (EbSh-81) archaeological site, field and laboratory observations of the asymmetrical distribution of microblade portions in this lithic assemblage (Figure 78A) prompted questions about the operational sequences and technological choices of the ancestral inhabitants who made and used these lithic artifacts. Since the composite slotted-point microblade hafting model predicts that microblades made and selected for hafting will be strongly influenced by the slot morphologies along the lateral margins of the antler, bone, or wooden hafts into which they may be inset, I hypothesize that there should be a statistically significant difference between certain morphological attributes of microblades selected for hafting and those that are not. Additionally, the disproportionate amount of proximal microblades relative to complete, distal, and medial microblades in the Crescent Channel (EbSh-81) lithic assemblage led me to hypothesize that certain microblades were preferentially selected based on their morphologies and “snapped” prior to hafting in order to remove irregularly-shaped bulbs of percussion that might impede the insertion of the otherwise uniform portions of microblades into a slotted point. While the production of microblades and organic slotted hafts both require considerable skill and technological acumen, the labour investment required to make a slotted point out of organic materials such as antler, wood, or bone is substantially greater than the relatively quick production of microblades once a core is sufficiently prepared (Waber 2011:182). Simply put, it is probably easier to snap off a portion of a microblade that is slightly too large for one’s slotted point than it is to modify the slots or to make a new haft (Grimes and Grimes 1985:40; Jeske 1989:36; Mackie 1995:39).

One can analytically infer the technological choices of this particular microblade hafting model by analyzing the size of microblade morphological attributes such as length, width, and

platform size. I chose to focus on these three attributes rather than microblade thickness and curvature (cf. Waber 2011) primarily because Williams and Andrefsky (2011) identified length, width, and platform size to be the most useful morphological attributes for discriminating between knappers in their experimental study.

Of the 185 complete and segmented microblades recovered by DILA excavations at the Crescent Channel (EbSh-81) site, 11 microblades exhibited partially obliterated platforms or Type 2 edge damage, defined as microflaking, chipping, crushing, or extensive lateral margin rounding. Since the goal of this morphometric analysis is to examine the shapes and sizes of microblades hypothesized to be produced and selected for insertion into composite slotted points—a moment in the hypothesized operational sequence that precedes use—these artifacts are excluded from the morphometric sub-sample due to the chance that they might skew this kind of analysis. Furthermore, these microblade “tools” may be the result of post-depositional trampling or weathering because I conducted no formal use-wear analysis and based my classifications only on attributes visible through macroscopic methods and low-powered microscopy. Even so, I observed no obviously backed-blades in the assemblage, which is congruent with the hypothesis that the areas of the Crescent Channel (EbSh-81) site excavated thus far through the DILA project are microblade production spaces rather than microblade use and discard zones. The adjusted Crescent Channel (EbSh-81) microblade morphometric sub-sample resulted in a sample size of 174. The distributions of the Crescent Channel (EbSh-81) microblade morphological attributes are illustrated as raw data, descriptive, and inferential (RDI) plots (Figure 78). Like the RDI plots in Chapter 6 (Figures 62 & 69), the raw data are plotted as semi-transparent points with a small amount of random variation on the X-axis to minimize overplotting that might mask the distribution of each variable. Similar to a boxplot, the pink horizontal bars show the mean of

the distribution of each variable while the shape of the blue violins illustrate descriptive statistics about each variable's range, skewness, kurtosis, and unimodality, bimodality, etc. Inferential statistics are illustrated by the white rectangles showing the 95% confidence intervals around the mean of each variable. Summary statistics are provided in Table 10.

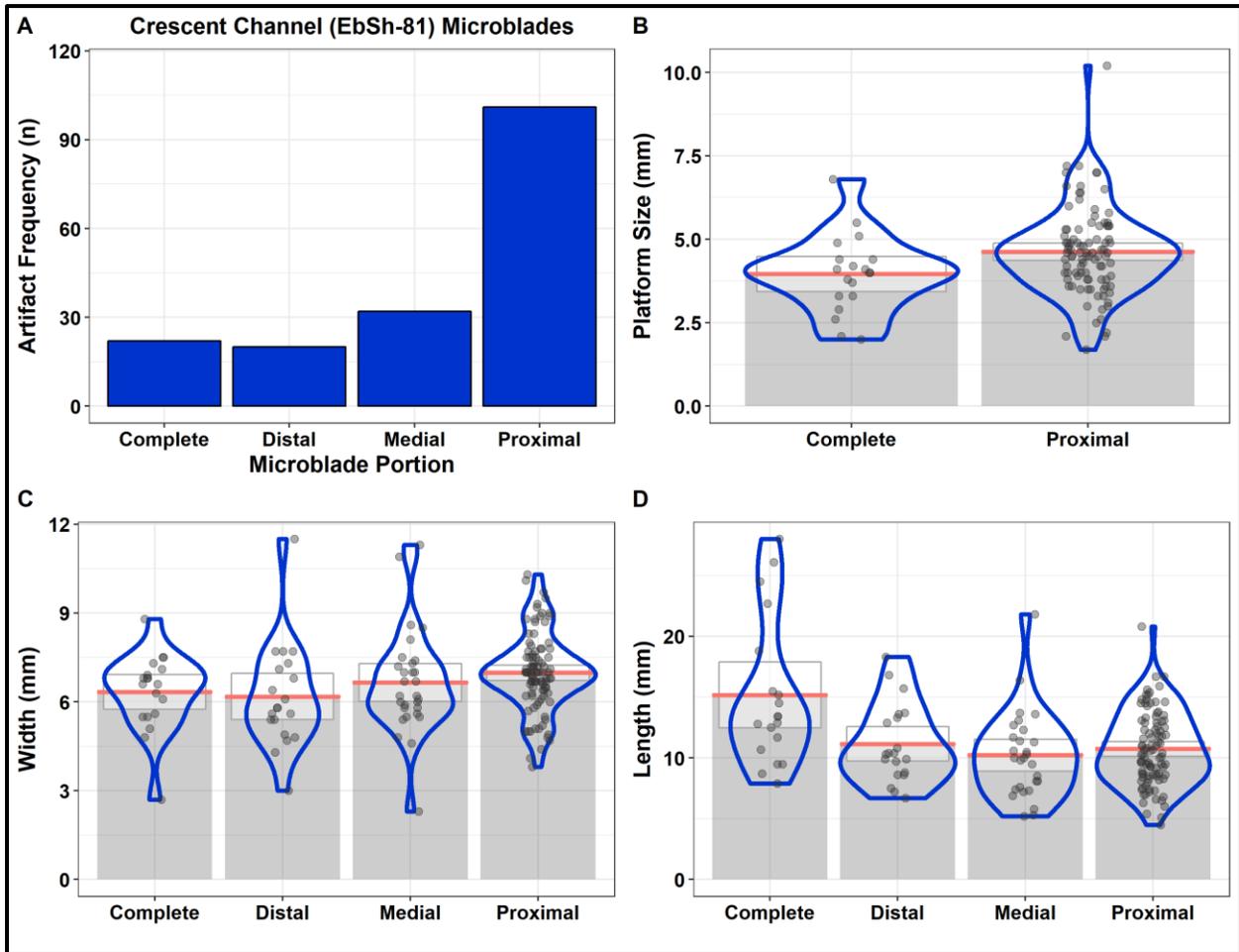


Figure 78: RDI plots of Crescent Channel (EbSh-81) microblades.

Table 10: Crescent Channel (EbSh-81) microblades summary statistics.¹

Morphological Attribute	Microblade Portion	n	Minimum	Maximum	Median	Mean	SD
Platform Size	Complete	23	2.0	6.8	4.0	3.9	1.1
	Proximal	101	1.7	10.2	4.6	4.6	1.3
Width	Complete	23	2.7	8.8	6.6	6.4	1.3
	Distal	21	3.0	11.5	5.8	6.2	1.8
	Medial	29	2.3	11.3	6.2	6.7	1.8
	Proximal	101	3.8	10.3	7.0	7.0	1.3
Length	Complete	23	7.9	31.3	14.5	16.3	6.5
	Distal	21	6.7	18.3	10.4	11.2	3.2
	Medial	29	5.2	21.8	10.0	10.2	3.6
	Proximal	101	1.8	20.8	10.4	10.6	3.1

¹ = Morphological attribute values in millimeters (mm).

A visual inspection of the distributions above reveals some intriguing patterns in the data. In Figure 78D the mean length of complete microblades is, unsurprisingly, much greater than the mean length of any of the other microblade portions. More interesting though, the mean length of medial microblades is less than the mean lengths of both the distal and proximal microblades in the sample. This suggests that if people were snapping complete microblades at the Crescent Channel (EbSh-81) site, as the composite slotted point microblade hafting model predicts, they were likely snapping them twice in order to remove large, presumably undesirable, portions from both the proximal and distal portions of microblades selected for slotted point insets. Additionally, this is also possibly evidence that longer medial microblades were preferentially selected for hafting and, thus, absent from the Crescent Channel (EbSh-81) microblade sample. If this hypothesis is correct, it reveals up to two distinct learned kinaesthetic gestures practiced by the communities of skilled microblade producers and users who inhabited this place on the landscape during the mid-Holocene.

Similarly, and although the mean length of complete microblades in Figure 78C is much larger than any of the other microblade portions in the sample, the actual lengths of

approximately 75% of the complete microblades fall well within the length ranges of distal, medial, and proximal microblade portions. The elevated mean value is due to the wide distribution of the remaining ~25% of the complete microblades sample which pulls up the mean considerably. In fact, the distribution of the complete microblade lengths sample borders on bimodal, as shown by the lack of data points in the middle of the distribution. This suggests that the people who produced these microblades preferentially selected, perhaps for snapping and subsequent hafting into composite slotted points, microblades whose lengths fell within the “goldilocks” zone: not too short but not too long.

As much as these intriguing results are discernable via a visual inspection of the microblade length distributions in the sample, length is arguably the least constrained morphological attribute according to the composite slotted point microblade hafting model. While there are some patterns in these data which suggest microblades were preferentially selected for length, attributes such as width and platform size are more likely to impact the technological choices of which microblades to select for insets into slotted points. While long microblades can take up more space within a slotted point and negligibly impact functionality—the implications of which are unknown in terms of learned technological choices and cultural preferences—disproportionately wide microblades would protrude from the cutting edge. This is not necessarily an undesirable technological attribute, but it could negatively impact the functionality of the tool. Very large platforms, on the other hand, simply would not fit into slots whose size ranges are too small and would either require modifications to the haft or snapping of the microblade in order to remove the larger portion(s). Given these analytical assumptions driven by the composite slotted point microblade hafting model, one can hypothesize that there may be statistically significant differences between the shared morphological attributes of the

complete, distal, medial, and proximal microblades in the sample such as width and platform size.

I use one-way analysis of variance (ANOVA) and *t*-test parametric linear models in order to formally test these hypotheses. Both ANOVAs and *t*-tests compare the means and standard deviations of metric attributes to evaluate the probability that two or more samples are drawn from the same population (Williams and Andrefsky 2011:867). The null hypothesis for both of these linear models is that the samples are drawn from the same population. In this case, statistical populations are synonymous with microblades whose morphological attributes are significantly different sizes ($\alpha = 0.05$). This kind of statistical inference is based upon assumptions of an underlying statistical model. Assumptions of parametric models include equal variances in the samples, Gaussian or normal distributions, and that the observations are independent of each other (Madrigal 2012:102). In order for the results of these tests to have any interpretive value, one must ensure that the data sets meet the assumptions of a parametric model or, if they do not, approach the tests using an alternative method.

Shapiro-Wilk's test for normality indicates that widths of the complete ($p = 0.28$), distal ($p = 0.06$), and proximal ($p = 0.12$) microblade samples are normally distributed while the medial ($p = 0.04$) microblade sample is not normally distributed. However, it is always good practice to also plot the distributions of one's samples in histogram and quantile-quantile formats in order to visually assess their distributions. These diagnostic plots indicate that the samples mildly violate the normality assumption and have unequal variances (Appendix D). Therefore, I use Welch's one-way ANOVA which performs well under mild violations of the normality assumption and does not assume equal variances in the samples (Jan and Shieh 2013). However the disproportionate ratio (~5:1) of proximal microblades relative to all other samples still

presents an analytical challenge due to a decrease in power of the test and consequent increased probability of falsely rejecting the null hypothesis, a type I error (Rusticus and Lovato 2014).

I use a bootstrap resampling approach in order to account for disproportionate sample sizes (Carlson 2017:165; Efron and Tibshirani 1993). This method is a form of Monte Carlo simulation based in Central Limit Theorem (Roberts 2017:8) that involves repeatedly resampling the data set in order to observe the results for a target variable over many iterations of a repeated statistical test (Faraway 2005:103; Gray 2008:68). Although each bootstrap resampling iteration of a Monte Carlo simulation sacrifices part of the original data set, the power of every test is greater than if one were to run a single ANOVA or *t*-test with unequal samples sizes. Some iterations can be expected to produce results uncharacteristic of the original data set due to the randomness of each resampling draw, but the overall trend of the results over many runs will tend towards the distribution of the data set from which resampling draws are derived. Given the increased statistical power of each resampling iteration, the averaged results of the Monte Carlo simulation are more meaningful for hypothesis-testing than a single test with very unequal sample sizes which would be rather prone to type I errors.

In this analysis, I randomly resampled 21 complete, 21 medial, and 21 proximal microblade samples so that the resample sizes of each portion would match the size of the distal microblades sample. I then ran a Welch's analysis of variance (ANOVA) on this resampled draw of 84 microblades. In the next iteration, each microblade was replaced back into the data set and had an equal chance of being resampled regardless of whether or not it was sampled in any previous runs. Repeating these measures 100,000 times results in a distribution of 100,000 *p*-values, with the median *p*-value being used to interpret the overall result of the bootstrap resampling Monte Carlo simulation (Figure 79).

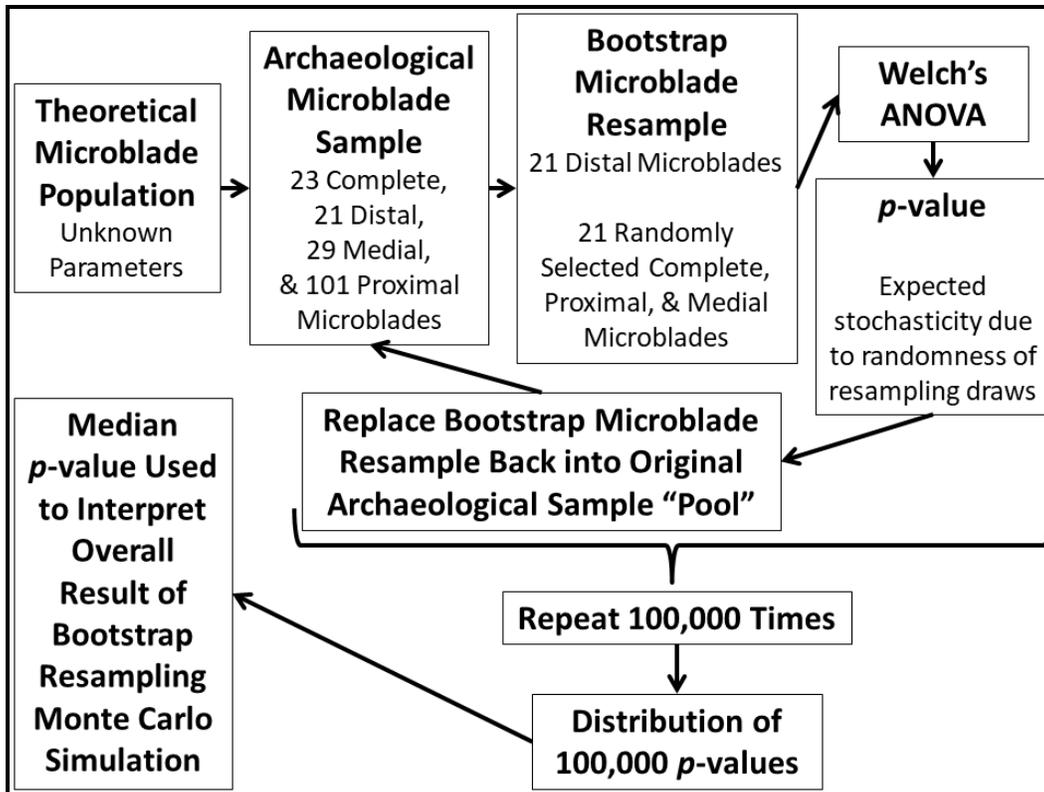


Figure 79: Crescent Channel (EbSh-81) microblade widths bootstrap resampling Monte Carlo simulation workflow.

The result of this Monte Carlo simulation indicates that there are no significant differences (median $p = 0.08$) between the widths of microblade portions in the Crescent Channel (EbSh-81) microblade assemblage (Figure 80). It is very close to the alpha level though and adding only a few more microblades to the sample could presumably produce a different result. Nonetheless, I cannot reject the null hypothesis that the microblade portion width samples are drawn from the same population. Despite Waber's (2011:159) assertion that width may be one of the most variable microblade morphological attributes, it appears that the ancestral inhabitants of the Crescent Channel (EbSh-81) site made microblades of a relatively regular width. Based on the samples in this case study, these people learned and knew how to make microblades of a particular width range and did so in a consistent manner. This finding is, in and of itself, a testament to their skilled microblade production practices.

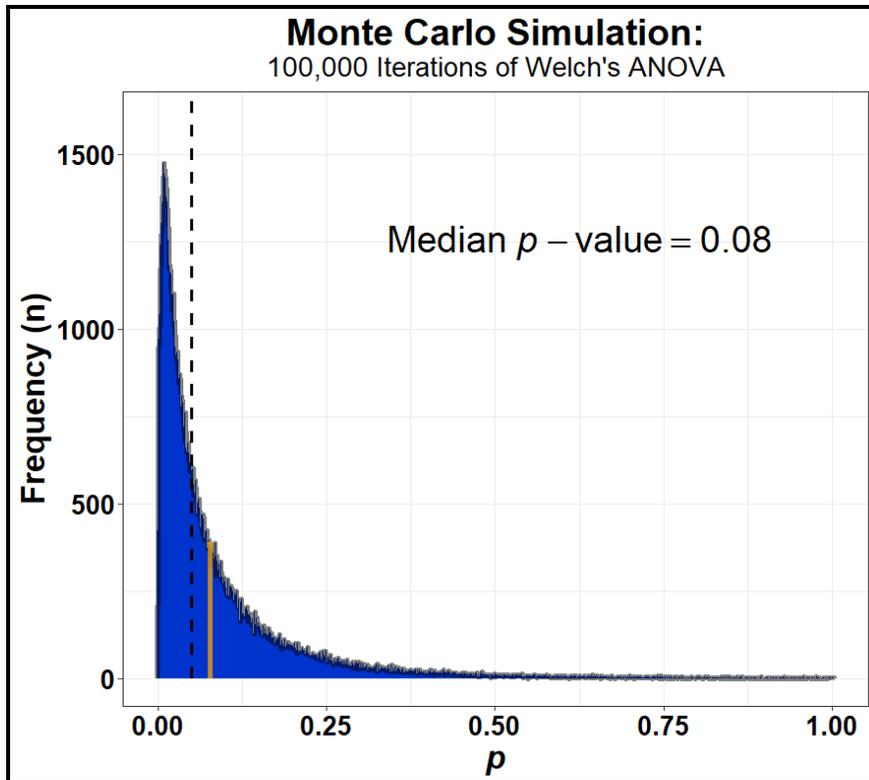


Figure 80: Results of 100,000 bootstrap resampling iterations of Welch's one-way analysis of variance (ANOVA) comparing the mean widths of complete, distal, medial, and proximal Crescent Channel (EbSh-81) Microblades.

Making microblades of a particular width and length is the first technological choice in the operational sequence hypothesized by the composite slotted point microblade hafting model. However, practices and actions are embedded within an infinite relational universe of learned choices, possibilities, and predispositions. Box and Draper's (1987:424) aphorism "all models are wrong but some are useful" is relevant here because data do not speak for themselves, differing models may be chosen, and variable conclusions may be drawn (Faraway 2005:150). For the purposes of this case study though, the detachment of complete microblades from the fluted face of a microblade core can be considered the first choice in the hypothesized operational sequence of the composite slotted point microblade hafting model.

The second choice in this model is the selection of microblades for insets. As discussed above, length may be a morphological attribute that influences this technological choice but is

likely not as tightly constrained by slot morphologies. Platform size, which is correlated with maximum microblade thickness, is much more tightly constrained within this model of technological practice and should have a significant influence on which microblades are selected for snapping and then hafting, the hypothesis I test next.

Shapiro-Wilk's test for normality indicates that platform size distributions of the complete ($p = 0.36$) microblade sample is normally distributed while the proximal ($p < 0.01$) microblade sample is not normally distributed. However, p -values are very sensitive to sample sizes (Faraway 2005:60) and inspection of the diagnostic plots reveals that both samples have a single outlier in the tail of their distributions (Appendix D). With a large sample, almost any slight departure from normality can be significant, as is the case with the proximal microblade platform size sample ($n = 101$). Therefore, it is appropriate to use Welch's t -test to compare the means of the samples which, like Welch's ANOVA, is relatively robust in terms of its tolerance of samples that violate the normality and equal variance assumptions (Moser and Stevens 1992; Ruxton 2006). I use the same bootstrap resampling Monte Carlo simulation method as above to control for unequal samples sizes except that in each draw I randomly sampled 23 proximal microblades for a total of 46 microblades in each resampling iteration (Figure 81).

The result of the second bootstrap resampling Monte Carlo simulation indicates that there is a significant difference (median $p = 0.04$) between the platform sizes of the complete and proximal microblade samples (Figure 82). Therefore, I can reject the null hypothesis that these samples are drawn from the same population. This statistically significant size difference suggests the second and third technological choices in the composite slotted point microblade hafting model, selecting which microblades to snap and then snapping them, are valid for the Crescent Channel (EbSh-81) microblade assemblage. This is strong evidence that small

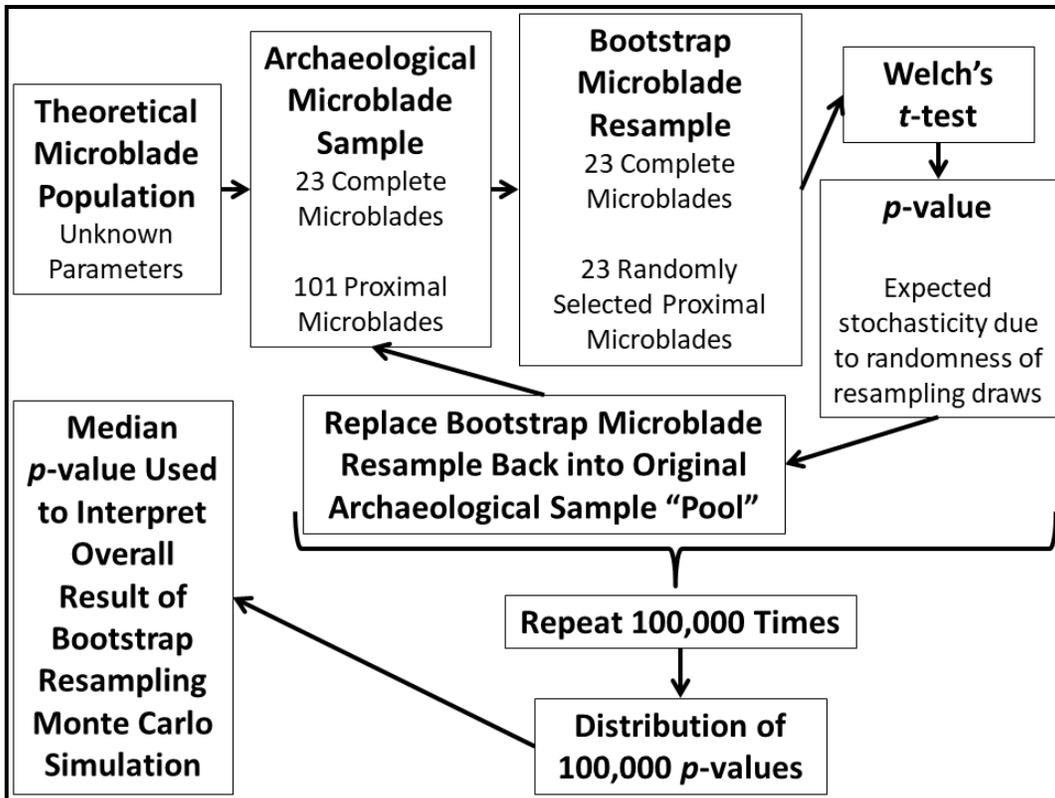


Figure 81: Crescent Channel (EbSh-81) microblade platform sizes bootstrap resampling Monte Carlo simulation workflow.

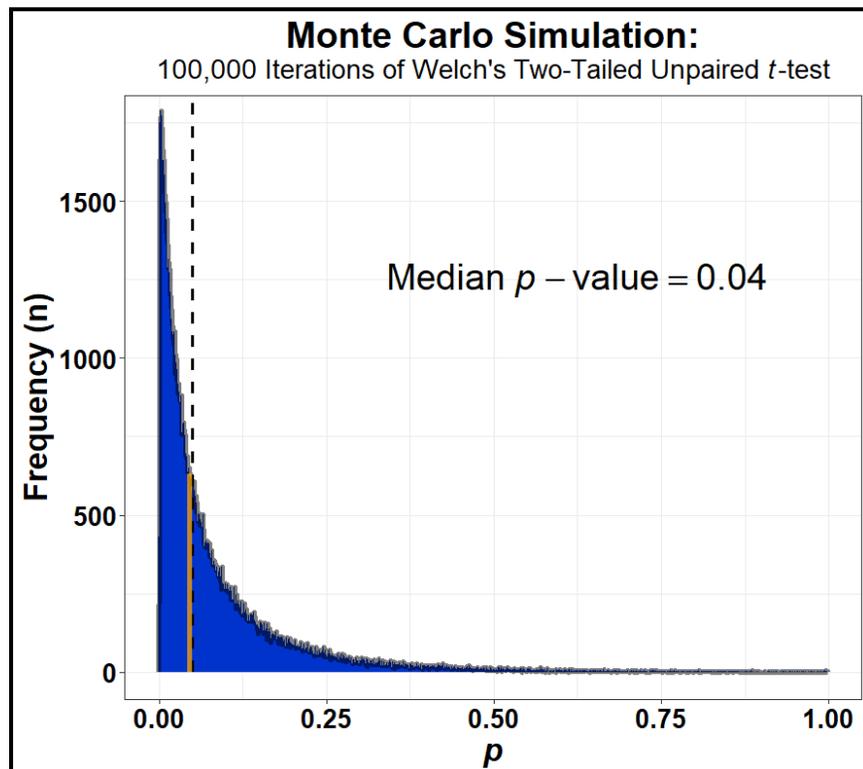


Figure 82: Results of 100,000 bootstrap resampling iterations of Welch's two-tailed unpaired t -test comparing the mean platform size of complete and proximal Crescent Channel (EbSh-81) microblades.

microblades were left as is, while microblades with large bulbs of percussion but with other morphological attributes of the right size were preferentially selected for insets and snapped. The people who made these microblades not only knew what sizes and shapes of microblades they required but also practiced these learned choices, preferences, and predispositions in a statistically significant manner.

7.3.2: Morphometric Case Study 1 – Discussion

This first morphometric case study tests a particular hypothesis derived from a specific model of microblade production and hafting practices. The results of this analysis support the hypothesis that, overall, some microblades were preferentially selected based on their morphologies for composite slotted point insets. However, the statistical models and tests used to reach this conclusion preferentially focus on the mean and median values of each sample. While useful data for quantitatively testing a formal hypothesis, by definition these measures preference the central tendencies of the samples at the expense of outliers. The reality that the Crescent Channel (EbSh-81) microblade assemblage *does* contain outliers and the distributions of the samples are somewhat non-normal suggests that, while the people who made these microblades may have produced microblades in a manner that generally conforms to the assumptions of the composite slotted point microblade hafting model, there may also be alternative microblade production practices taking place that the current morphometric samples only capture in an ephemeral manner. For example, the somewhat multimodal distribution of the proximal microblade width sample (Figure 78C) indicates that there are likely two other populations represented in this sample whose shared characteristics are correlated with an attribute other than maximum width, perhaps due to alternative hafting practices more akin to end-hafted microblade knives from Hoko River wet site (Croes 1995).

In a similar vein, the complete and proximal microblade platform size samples both have a single extreme outlier at the upper end of their ranges (Figure 78B). These data points are two separate artifacts which suggest relatively large microblades were occasionally made. It is possible these large microblades are accidental occurrences—which in itself is intriguing evidence of situated learning and improvisational practice (Crown 2016; Milne 2012)—but they could equally be the traces of less frequent alternative ways of producing and using microblade technologies. The relationship between these multiple potential microblade production practices is difficult to discern based on the current samples from the Crescent Channel (EbSh-81) lithic assemblage but they nonetheless hint at overlapping communities and constellations of microblade practice.

The morphometric analysis results presented thus far lend credence to the notion that the people who inhabited the Crescent Channel (EbSh-81) site during the mid-Holocene produced microblades in a highly skilful manner. Moreover, if they were indeed producing and using microblades as insets for composite slotted points, the gestures and actions necessary for these technologies to be created and used effectively include a range of discursive and non-discursive technological choices such as selecting and acquiring the appropriate lithic materials, shaping them into microblade cores, detaching appropriately-shaped microblades, along with the similarly skilled and labour-intensive practices required to make the hafts. All of these practices doubtlessly require significant amounts of situated learning and enskilment within and in relation to other communities of practice.

This case study is confined to a single mid-Holocene microblade assemblage but nonetheless corroborates studies elsewhere on the Northwest Coast that microblades were part of a multi-material composite tool kit (e.g., Helwig et al. 2014; Waber 2011, n.d.; Wood and

Fitzhugh n.d.). The strength and nature of these multiple technological relationships through space and time is a question precluded by a data set drawn from a single temporally- and spatially-discrete microblade assemblage but future comparative studies that include a greater diversity of microblades from multiple dated archaeological components is an area of research well-worth investigating. Nonetheless, this study lays the groundwork for and develops the analytical tools required to achieve insights from specific assemblages and contexts. These data can then be used to build up a comparative perspective both spatially and temporally as new data become available.

This morphometric case study demonstrates that the learned technological practices of making microblades are somewhat “inscribed” in their morphological attributes. Given these insights, conducting a similar morphometric analysis of the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) non-microblade lithic debitage assemblages should provide similarly intriguing insights about the learned gestures and technological practices of the people who made and used stone tools at these places throughout the Holocene.

7.4.1: Morphometric Case Study 2: Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) Complete Debitage Flakes

The processes by which communities of practice (re)create themselves through their relational material practices during everyday activities such as the production, maintenance, and use of stone tools is the theoretical focus that unifies the multiple analytical approaches I take in this thesis. While the first morphometric case study of this chapter tests a specific model of microblade production and hafting practices, this second case study uses similar methods but takes a broader perspective by examining the shapes of one of the most ubiquitous

archaeological objects: complete and unmodified debitage flakes. By focusing analytical attention on a seemingly less glamorous aspect of the archaeological record, I am able to access an aspect of technological practice that supplements more typical objects of lithic analysis such as, for example, projectile point sequences (e.g., Carlson and Magne 2008). Ultimately, my goal is to provide a more comprehensive story of the genealogies of emergent technological practice whose material traces manifest in the morphologies of lithic artifacts.

Like microblades, complete debitage flakes lacking visible retouch or use-wear are presumably less sensitive to confounding palimpsest effects than lithic artifacts whose morphologies are likely to be more dynamic throughout their use-lives. Given my discussion in Section 5.2 of the effects these processes have on lithic assemblage typological compositions, studying the morphologies of debitage flakes offers empirical means and an analytical toe hold to track the emergent processes of lithic artifact morphological dynamism within and across assemblages—proxies for time in this study. Building on the results of Williams and Andrefsky's (2011) experimental study, the crux of this argument is that flake morphologies are correlated with the gestures of stone tool production and use which are, in turn, correlated with particular genealogies of learning and communities of lithic practice.

Rather than formally testing a hypothesis, this second morphometric case study is a form of exploratory quantitative data analysis in order to describe the shapes of the debitage flakes in the three sampled lithic assemblages. My aim is to examine the traces of intergenerational genealogies of lithic technological practice in the Discovery Islands study area. The sample for this second morphometric case study includes 435 complete debitage flakes from the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) lithic assemblages. The size distributions of the morphological attributes for this sample when

split by archaeological site and by geological suite are illustrated below in RDI plot format (Figures 83-84). Summary statistics are provided in Tables 11-12.

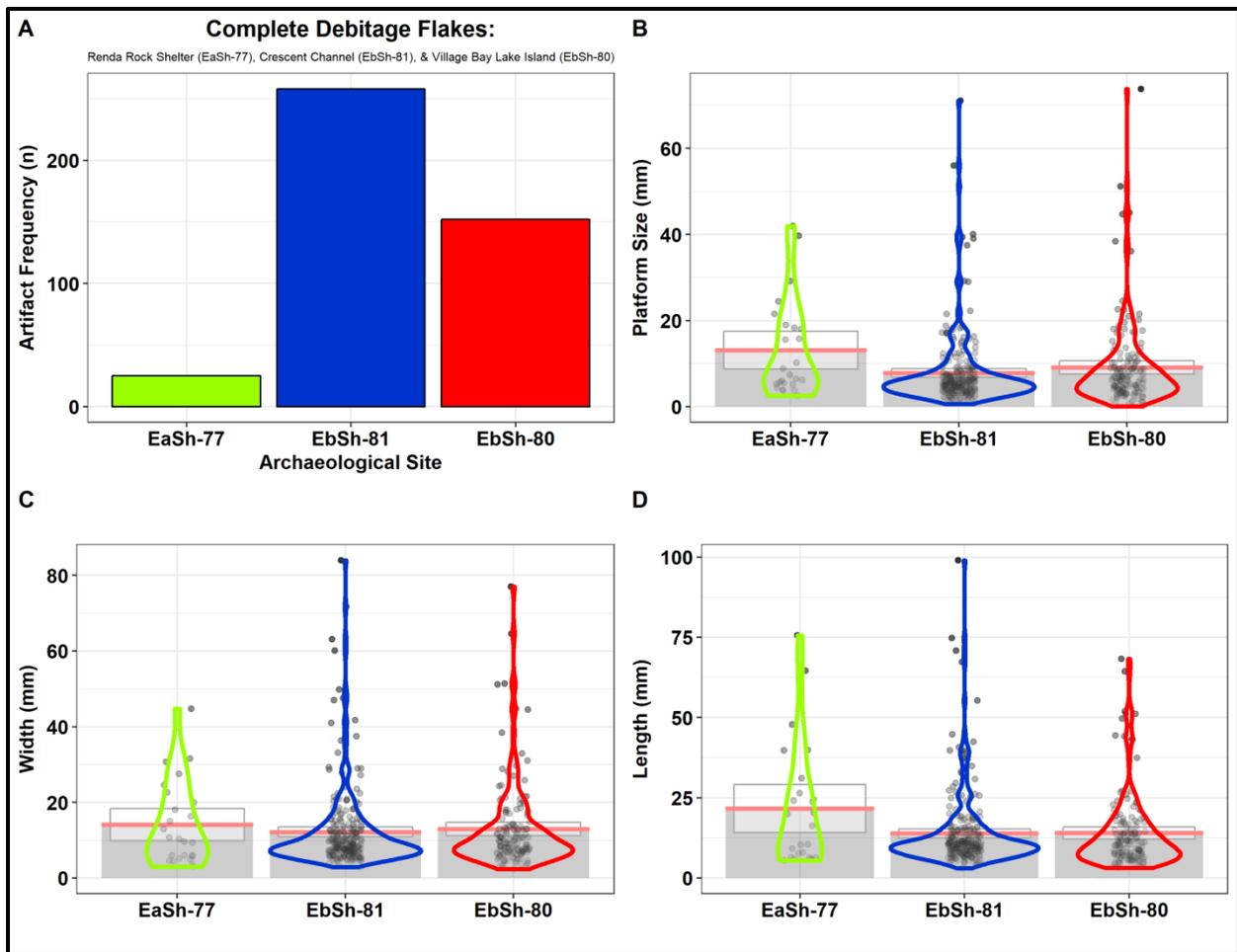


Figure 83: Complete debitage flakes RDI plots – Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), & Village Bay Lake Island (EbSh-80) lithic assemblages.

Table 11: Complete debitage flakes summary statistics – Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), & Village Bay Lake Island (EbSh-80).¹

Morphological Attribute	Archaeological Site	n	Minimum	Maximum	Median	Mean	SD
Platform Size	EaSh-77	25	2.5	41.9	7.4	13.1	11.1
	EbSh-81	258	0.6	71.0	5.5	7.8	8.4
	EbSh-80	152	0.9	73.8	6.4	9.1	9.8
Width	EaSh-77	25	3.0	44.7	10.4	14.1	10.9
	EbSh-81	258	2.9	84.0	8.8	12.2	10.5
	EbSh-80	152	2.4	77.0	9.4	13.0	11.2
Length	EaSh-77	25	5.5	75.6	16.3	21.7	19.1
	EbSh-81	258	3.0	99.0	10.5	13.9	11.6
	EbSh-80	152	3.1	68.2	10.5	14.0	11.8

¹ = Morphological attribute values in millimeters (mm).

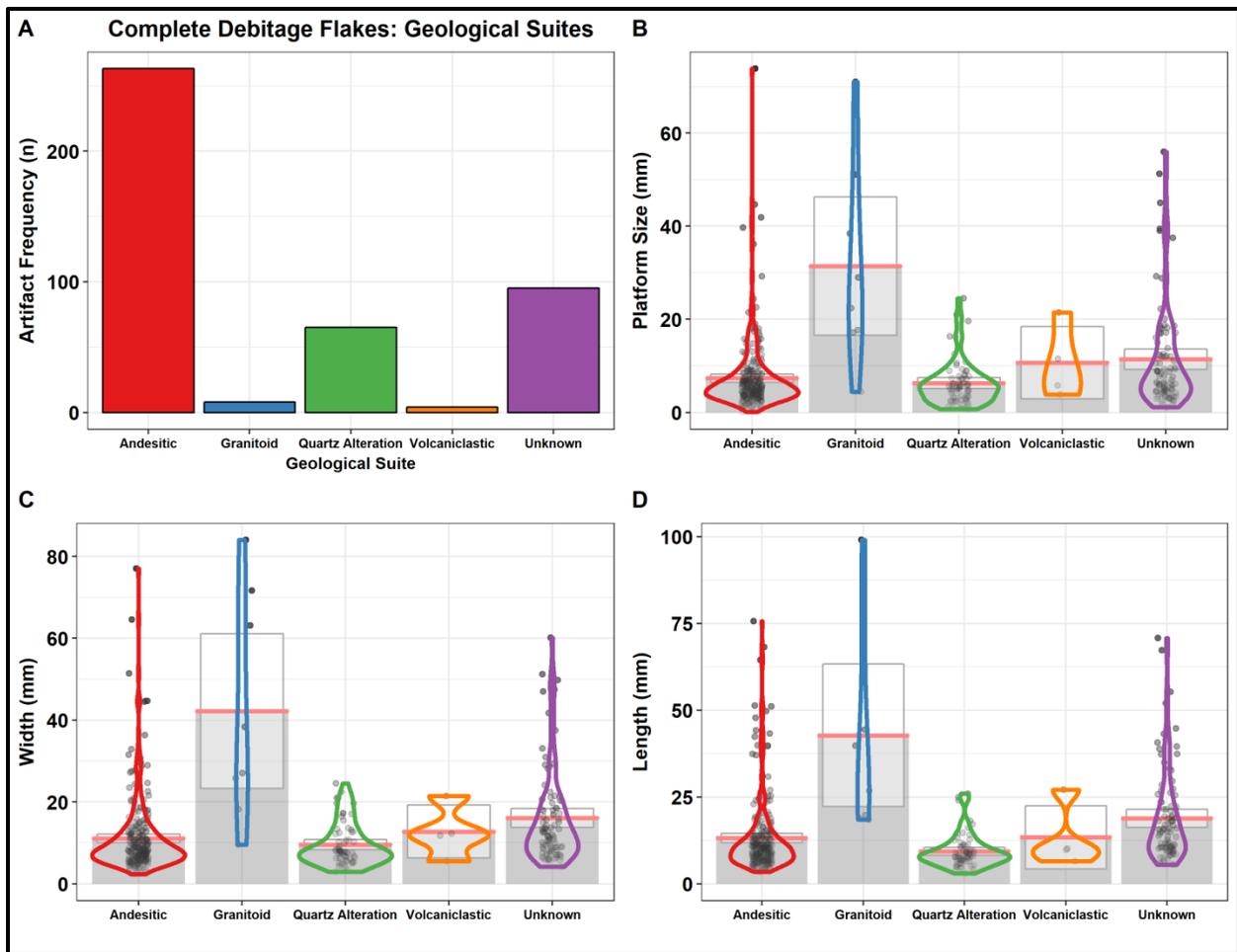


Figure 84: Complete debitage flakes RDI plots – geological suites.

Table 12: Complete debitage flakes summary statistics – geological suites.¹

Morphological Attribute	Geological Suite	n	Minimum	Maximum	Median	Mean	SD
Platform Size	Andesitic	263	0.9	73.8	5.5	7.4	7.4
	Granitoid	8	4.4	71.0	25.7	31.4	21.4
	Quartz Alteration	65	0.7	24.5	5.6	6.3	4.8
	Volcaniclastic	4	3.8	21.5	8.7	10.7	7.9
	Unknown	95	1.1	56.0	7.6	11.4	11.1
Width	Andesitic	263	2.4	77.0	8.4	11.1	9.0
	Granitoid	8	9.6	84.0	32.7	42.2	27.3
	Quartz Alteration	65	2.9	24.5	7.7	9.6	5.2
	Volcaniclastic	4	5.5	21.5	12.0	12.8	6.6
	Unknown	95	4.2	60.1	12.6	16.1	11.5
Length	Andesitic	263	3.4	75.6	10.2	13.2	11.0
	Granitoid	8	18.5	99.0	33.3	42.8	29.6
	Quartz Alteration	65	3.0	26.0	8.0	9.4	4.8
	Volcaniclastic	4	6.5	27.1	10.0	13.4	9.3
	Unknown	95	5.5	70.8	15.0	18.8	13.1

¹ = Morphological attribute values in millimeters (mm).

In Chapter 6 I use principal component analysis (PCA) to determine which trace elements account for the most variance in the obsidian and fine-grained volcanic XRF data sets. PCA is also an appropriate quantitative technique to examine the relationships between the morphologies of debitage flakes because it reduces the dimensionality of the data set while still retaining much of the variance. Typical archaeological applications of PCA include computing confidence interval ellipses based on the distribution of a sample's principal component scores. Assessing the relative similarity between samples may be accomplished by visually inspecting the amount of overlapping data points or confidence interval ellipses. An example of this multivariate method is found on the front cover of David Carlson's (2017) recently published book *Quantitative Methods in Archaeology Using R*. This image compares three types of ceramics, with the 'New Forest' sample as the most distinct relative to the other two pottery types because it plots further away in the morphospace and its confidence interval ellipse does not overlap with those of the other two samples (Figure 85).

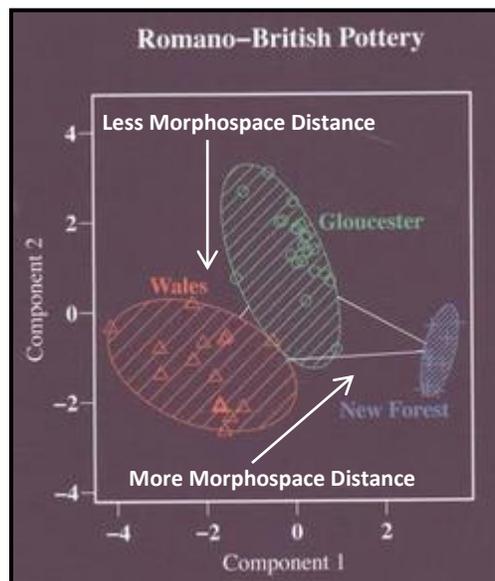


Figure 85: Example of morphospace assessment of similarity within a PCA model (Modification of image by Carlson 2017).

The main goal of the second morphometric case study in this chapter is to assess if the shapes of the 435 complete flakes in the debitage data set form distinct clusters when plotted

a) by archaeological site or b) by geological suite. Discrete clustering of principal component scores in the morphospace may be interpreted as distinctly-shaped debitage assemblages. Alternatively, overlapping principal component scores and confidence interval ellipses may be interpreted as similarly-shaped debitage assemblages, thus providing proxy indicators of shared gestural practices across the spatial and temporal contexts sampled in this thesis. I conduct a principal component analysis (PCA) in order to calculate principal component scores for each lithic artifact and to determine how much variance each component accounts for in the PCA model (Table 13).

Table 13: PCA results – three morphological attributes of complete debitage flakes.

		Component 1	Component 2	Component 3
Eigenvector Coefficients	Platform Size	-0.571	-0.676	0.466
	Width	-0.594	-0.052	-0.803
	Length	-0.567	0.735	0.371
Proportion of Variance		0.877	0.086	0.037
Cumulative Proportion of Variance		0.877	0.963	1.000

The results of the PCA model indicate that the first two principal components account for approximately 96% of the variance within the complete debitage flakes data set, as demonstrated by the 0.963 value in the cumulative proportion of variance row in the Component 2 column of Table 13. The eigenvector coefficients indicate that all morphological attributes load more or less equally onto component 1, indicating that gross size primarily comprises this component. Platform size and length load most strongly onto the second component while width loads most strongly onto the third component. Plotting the first and second principal component scores of all 435 sampled debitage flakes is therefore a way to graphically represent 96% of their three-dimensional shapes in a two-dimensional morphospace (Figures 86-87).

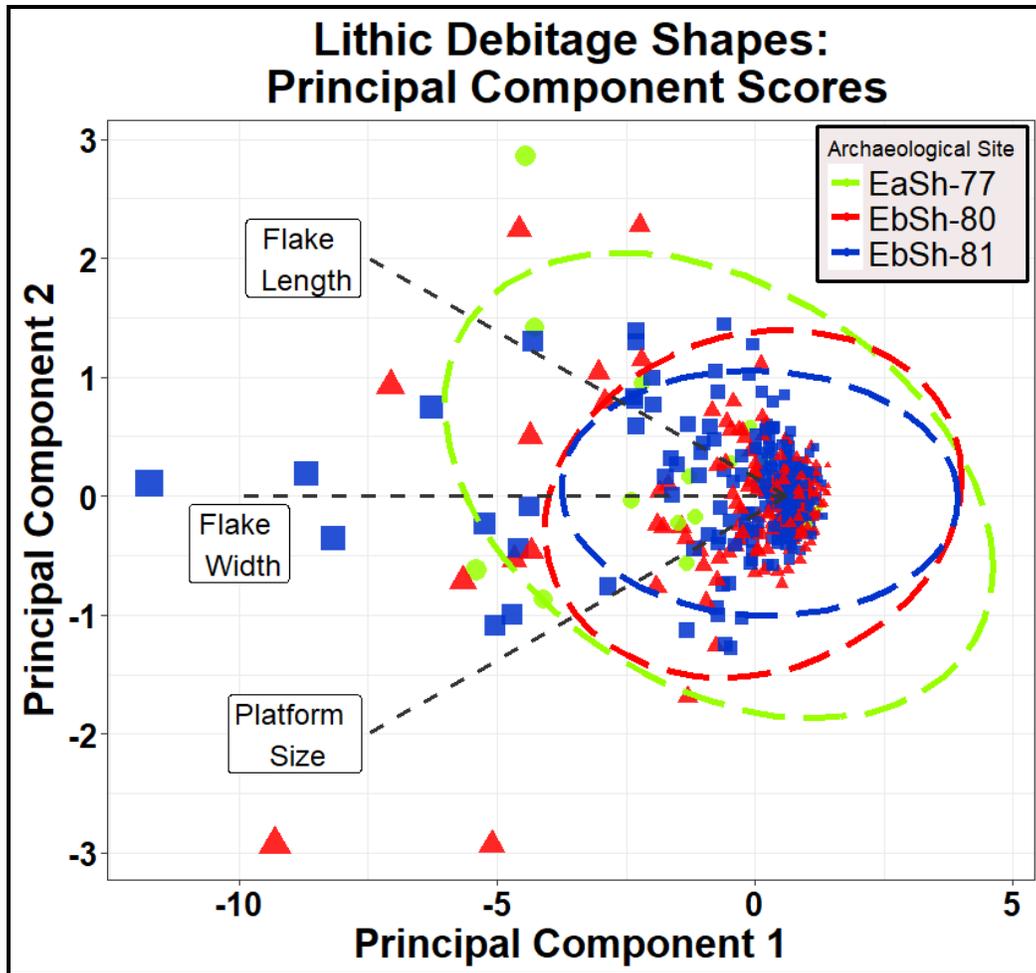


Figure 86: PCA results – component 1 and component 2 scores for lithic debitage flake morphological attributes by archaeological site.

The results of the PCA model illustrated in Figure 86 demonstrate a tremendous amount of similarity between the shapes of complete debitage flakes in the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) lithic assemblages as most artifacts from all three assemblages cluster around the 0,0 morphospace coordinate. Similarly, the confidence interval ellipses overlap substantially. In contrast to orthodox archaeological space-time systematics which typically privilege change over continuity, the results of this morphometric analysis demonstrate considerable continuity in the shapes of complete debitage flakes throughout the Holocene. If, as Williams and Andrefsky (2011) argue, debitage flake shapes are proxies for the gestures of stone tool production and use, then the

results of this second morphometric case study also imply shared gestural practices across hundreds of generations of human life. This is a remarkable feat of situated learning and evidence of constellated communities of practice despite a pan-Holocene temporality.

Similarly intriguing results are apparent by plotting the same data coded by geological suite, as inferred from the thin section petrography analysis results in Chapter 6. Plotting the results of the PCA model according to geological suite is a way to track the technological choices and operational sequences of flaked stone tool production and use including lithic material selection, acquisition, and the skilled kinaesthetic movements of reduction.

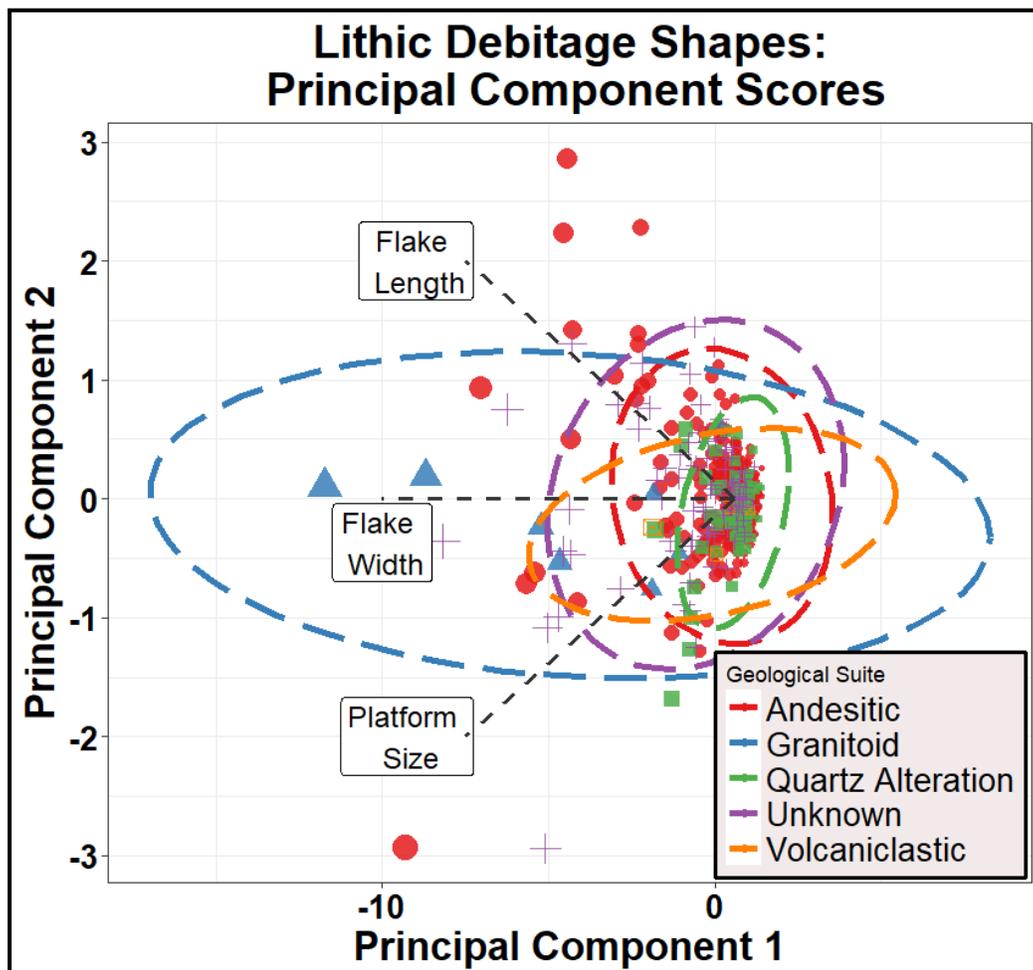


Figure 87: PCA results – component 1 and component 2 scores for lithic debitage flake morphological attributes by geological suite.

Figure 87 also shows a strong clustering of debitage flake shapes around the 0,0 morphospace coordinate for most geological suites except the granitoid sample. As in the first principal component scores plot (Figure 86), perfect overlaps do not occur but a general pattern of overlapping gestural practices is nonetheless apparent. The differential shapes of debitage flakes, particularly outliers that plot outside of any confidence interval ellipses, are likely the traces of alternative technological practices or innovations such as flakes that are made for or produced through less frequent activities uncharacteristic of the majority of the flakes in the data set. These outliers could be due to emergent needs and novel ways of producing and using flaked stone tools. For example, more robust flakes are necessary for activities such as chopping or scraping tough materials.

Alternatively, they could be the result of misstrikes and stochastic fracturing because fracture mechanics of different geological suites are also likely implicated in the distribution of debitage flake shapes in the morphospace. Indeed, the granitoid flakes are the most dispersed geological suite, a pattern consistent with its generally coarse and heterogeneous microstructure prone to stochastic fracturing. Alternatively, the misalignment and loose fits of some confidence interval ellipses are also partially a result of differential sample sizes. Much like *p*-values, the distribution of a confidence interval ellipse is very sensitive to sample size because smaller samples result in greater model uncertainty. Greater model uncertainty means that a confidence interval ellipse must encompass a larger area of the morphospace in order to capture 95% of the distribution of a theoretical population.

7.4.2: Morphometric Case Study 2 – Discussion

The macroscopic lithic analysis, thin section petrography, and X-ray fluorescence spectrometry results in Chapters 5 and 6 demonstrate that the people and communities who

created the archaeological deposits sampled in this thesis used a variety of lithic materials and made new forms of stone tools through time. Variations in the learned technological choices and operational sequences of flaked stone tool production hint at the improvisational inflection of established ways of doing that manifest in technological innovations.

Despite shifts in lithic materials and technologies outlined in previous chapters, the distributions of debitage flake shapes in Figures 86 and 87 do not form distinct and readily-separable clusters according to archaeological sites nor geological suites. Using debitage flake shapes as proxies for the gestures that created them implies considerable kinaesthetic coordination through space and time. I argue this is evidence that the people who created these pieces of debitage participated in and shaped overlapping communities and constellations of practice through shared gestures of stone tool production and use. Rather than wholly separate communities who selected different lithic materials with which to fashion distinctive stone tools, the skilled kinaesthetic movements of the makers and users of these objects were similar regardless of the places and times they inhabited, the kinds of stones they worked with, and the kinds of stone tools they made.

The second morphometric case study results speak to the merit of acknowledging the interpretive value of lithic debitage (*sensu* Andrefsky 2001). This quantitative morphometric debitage analysis characterizes gestural continuity through space and time and the cycles of tradition and innovation that are undoubtedly facets of many emergent human lives and communities of practice (McLaren 2003:126). Simultaneous processes of technological change and technological continuity underscore why artifacts some archaeologists may regard as less charismatic offer an analytical avenue to holistic knowledge of lithic technologies (Storey

2008:203), the people and communities who make and use them, and the historical processes archaeologists may infer when we “follow the stones” (Mathews 2014:208).

Some might argue that specifically sampling complete and unmodified debitage flakes for this case study silences the voices of the ancestral inhabitants of the Discovery Islands by ignoring the technological innovations that they *did* create and practice throughout the Holocene. Rather, my aim is the antithesis of silencing or homogenizing these people and communities. My rationale for focusing on an aspect of the archaeological record too often ignored or glossed over is to emphasize the intergenerational relationality of people and communities that is obscured by orthodox archaeological space-time systematics which typically privilege change over continuity. As I discuss in Chapters 5 and 6, there are rich histories discernable by tracking changes in both lithic technology production and lithic material selection and acquisition practices across sites and through time. The main point I want to make through the second morphometric case study in this chapter is that these exciting technological innovations took place within shared non-discursive repertoires of possibility, predisposition, and choice that span millennia.

Although the products of lithic production may shift through time, pervasive processes of enskilment and situated learning where novice knappers develop the knowledge and gestures required to make flaked stone tools are the shared medium that makes the (re)production of skills and knowledge within and across generations possible. Without coming to know what lithic materials to select, how to effectively prepare a platform, what tools to use, or how to position and move one’s body during knapping, rich genealogies of emergent technological practice would effectively be severed. Humble pieces of debitage are the material traces of these situated learning *processes* that go hand-in-hand with the *products* of stone tool production.

I began Section 1.2 of this thesis with a quote that argues for reinvigorated analytical appreciation of ordinary and ubiquitous material culture such as “the casual flake” (Robb 2007:2). This morphometric case study of lithic debitage shapes is one way of doing so. The PCA results suggest there are some variations in the shapes of complete debitage flakes within and across the three sampled lithic assemblages but, overall, there is tremendous morphological overlap and gestural continuity. This blurring of distinctions between people, places, and times highlights the relationality of the hundreds of generations of people and communities who lived in, shaped, and were shaped by the Discovery Islands study area since time immemorial. This case study demonstrates that archaeologists would do well to reconsider assumptions about the impermeability of our “taxonomic boundaries” (Martindale et al. 2017b:134). In the next chapter I integrate the multiple lines of evidence throughout this thesis and make a final argument for making and using stone tools as situated social practices and emergent technological processes.

Chapter 8: Discussion

8.1: Emergent Lateral Taxonomies

“...the questions we direct at the archaeological record and the epistemologies, methods, and interpretive logics we use reveal as much about ourselves as they do about past peoples.”
(Martindale et al. 2016:189)

Throughout this thesis I repeatedly draw attention to the analytical tensions I create by structuring relational life worlds into relatively static units of analysis and data sets. This imposition of structure onto oscillating “non-localizable dynamical processes” (Gosden and Malafouris 2015:707) is arguably necessary in order to facilitate exploratory data analysis, hypothesis testing, and knowledge production practices more generally. However, the ways we come to know the past are recursively entangled with our knowledge production practices in the present and, as Martindale and Nicholas (2014:457) keenly observe, “our views on the past are inevitably partial.” I emphasize this inevitable partiality by drawing upon diverse methodologies which produce differential analytical results. Following Wylie and Nelson’s (2007) call for an explicitly value-rich rather than falsely value-free praxis, I turn the ontological mirror upon myself and offer a reflection of how my own situated knowledge inflects my current research practices. After considering my own locatedness, I summarize the implications of my findings for the research questions I initially pose in Chapter 1 (Table 1).

My most obvious bias might be my fascination with learning about learning. My use of Lave and Wenger (1991) and Wenger’s (1998) concepts of communities and constellations of practice, with their obstinate insistence that situated learning is never-ending and takes place far beyond the walls of formal academic institutions, might have more to do with subconscious anxieties I hold about the prospects of life after graduate school. While I no doubt look forward to finishing my thesis, perhaps the walls of academia are more of a warm womb to me than I

discursively know. Although, in my own ontological defence, I would counter an argument against students learning about learning by saying that, following this same logic, archaeologists should not dig digging!

Word play aside, there are serious on-the-ground consequences for careless knowledge production practices that include the perpetuation of colonialism through continued discrimination and structural violence against marginalized people. Take the morphometric methods I use in Chapter 7 for example. They are useful tools because they enable me to visualize the permeability and fluidity obscured by taxonomic boundaries characteristic of Northwest Coast archaeological chronologies. Nonetheless, morphometric methods have their own uncomfortable histories that should “make us squirm” (La Salle and Hutchings 2016). During the 19th- and 20th-centuries, there was a mass of data generated throughout Europe and its colonies through measurements of skull shape, skin colour, hair type, and the shape of human bodies in general (Gosden 2006:2; Gould 1996[1981]). The scientific ordering of the “natural” environment via measurement and quantification was integral to the entire colonial project in its ability to tame, subjugate, and exercise control over the colonies of expanding European Empires (Wells 2015:144).

The inferential statistics I use during the first morphometric case study in Chapter 7 have their own not-so-subtle binary of statistical significance:non-significance. While a useful tool for formally testing a hypothesis derived from a specific model of technological practice, it can be an easy slippage back into the very dualistic ontologies I seek to escape. Given that the communities of practice concept is *not* about defining who is in and who is out but rather the processes by which communities make and remake themselves, “gunning for significance” (Wolverton et al. 2016:260) via an arbitrary alpha value (e.g., $p < 0.05$) is precisely the kind of

inclusion:exclusion binary I argue against. Quantitative methods can have ethically-sound applications but we should not draw hasty conclusions from the results of, for example, a *t*-test. This is the reason why I scrupulously crafted and implemented my morphometric research design in order to control as best I could for confounding effects of differential variances and sample sizes. To practice archaeological research any other way would be to deny ourselves the opportunity to engage with the objects we study and the data we create in more meaningful, substantive, and productive ways (Buck and Meson 2015). Only through repeated reflexive quantitative analyses is it possible to arrive at a Geertzian “thick significance” (Niewöhner 2011:298). For this reason I am in full agreement with Thomas (1978:243) who argues that, rather than blind opposition to quantification in archaeological research, blind quantification is what should be opposed.

All of my quantitative morphometric analyses were preceded, however, by assemblage sorting and macroscopic typological classifications. As I discuss at length in Section 5.2, archaeological practices of naming and classification are closely bound up in processes of knowing. An unfortunate collateral effect of linguistic markers such as “tool” and even “artifact” is that they can carry considerable colonial baggage and may or may not accurately characterize what lithic technologies are to the people who make and use these forms of material culture (Lyons et al. 2016:368). An example of similar ontological disjuncture is found in situations involving human remains. Increasing recognition that bones housed in North American museums and academic institutions are ancestors to be put away and laid to rest rather than things to be studied means these “repatriatables” effectively bridge, albeit sometimes contentiously, settler and Indigenous object worlds, creating new identities in the process of moving from hand to hand (Kakaliouras 2012:S216-S218). In this way, “objects themselves resist and reshape the

order we attempt to impose on them” (Wylie 1992b:487). These ontological questions deserve careful consideration throughout all lithic analyses, particularly during early stages of sorting and classification. Through this naming process I imposed a specific structure onto these objects: the structure I required to attempt to answer my research questions. However, as I moved through the various stages of my research program, my understanding and knowledge of these lithic assemblages transformed time and time again. Each analysis offered new ways of thinking about and engaging with these stone artifacts. They went from bags of rocks and values in a spreadsheet to pieces of places and traces of genealogies of lithic technological practice, a process that likely would not have transpired had I not named and classified them at the outset of this work.

In contrast to the emergent lateral taxonomies I iteratively created and discovered throughout the course of this project, fixed taxonomies (e.g., cultural complexity, phase, culture type, tool type, nation, race) run the risk of becoming reified at the expense of obscuring or “silencing” (*sensu* Trouillot 1995) emergent relationships between people, communities, practices, places, and times (Pels 2008:281). For example, static and discrete spatial-temporal units are an ontology based in presuppositions tied to the formation of modern nation states (Pels 2008:283) and the disciplining of inquiry (Foucault 1977). Perhaps more directly relevant to lithic technologies, Storey’s (2008) analysis of stone tools from the Richardson Island archaeological site located in southern Haida Gwaii reveals persistence in unifacial technologies throughout early and mid-Holocene inhabitations of this site. While an early Holocene transition from bifacial to microblade technologies at Richardson Island and other sites in the archipelago serves as a keystone for structuring archaeological chronologies of Haida Gwaii (Fedje and Mackie 2005:158; Waber 2011), contemporaneous continuity of unifacial technologies

demonstrates how altering one's units of analysis may lead to divergent archaeological taxonomies.

The widespread and deeply entrenched archaeological practice of categorizing the past into discrete spatial-temporal units or phases obscures variability in the archaeological record (Ames 2009:2), as subversively noted by Abbott (1972) at a time when the culture-historical approach was the dominant theoretical framework of Northwest Coast archaeology. His assertion that “no one site may be expected to reflect the total culture of any group” (Abbott 1972:274) is as relevant today as it was nearly half a century ago. Mitchell (1990:340) proposed doing away with the term “phase” all together in favour of “culture type” which he defines as “a group of components distinguishable by the common possession of a group of traits.” Mitchell’s (1990) attempt to address the rift between archaeological constructs and the social-historical processes they supposedly depict was lost on many of his colleagues though and the terms “phase” and “culture type” quickly started being used interchangeably. The continued (mis)use of these terms by many contemporary Northwest Coast archaeologists (Ames 2009:6) reveals our discipline’s retrospective bias towards temporality relative to the generally prospective positionality of past people and communities navigating and reformulating their lived worlds (Logan and Stahl 2017:1357).

In many ways, my use of Lave and Wenger (1991) and Wenger’s (1998) concepts of communities and constellations of practice as units of analysis for attempting to understand the people and communities who made and used lithic technologies at the archaeological sites sampled in this thesis parallels Mitchell’s (1990) definition of culture types. Both are bottom-up units of analysis rather than top-down *a priori* assumptions about how ancient material culture and people “should” be through space and time. The primary difference lies in that the

communities and constellations of practice concepts are explicitly concerned with emergent *processes* and consider the boundaries between people and communities to be much fuzzier, flexible, fluid, and relational than archaeological constructs such as phases or culture types typically do (Kodesh 2008; Sofia 2000). Indeed, this phenomenon plays out in the case of the Richardson Island site in southern Haida Gwaii where multiple researchers collectively weave a diverse tapestry of narratives by holistically examining multiple facets of the site's lithic technologies alongside each other such as lithic material types (Smith 2004), unifaces (Storey 2008), bifaces (McLaren and Smith 2008), and microblades (Waber 2011). The point is, these cumulative studies fortify our knowledge of the ancestral inhabitants of this site by playing off of and complementing each other—a phenomenon that is arguably transferable to all forms of archaeological practice. Lucas' (2012:225) discussion of how archaeological “data and theory are interwoven at all stages” is relevant here. Through the materialization processes of disaggregation and assembly we separate and/or group objects into categories, creating in the process new assemblages of objects, samples, artifacts, archives, discourses, knowledge, and practices (Lucas 2012:234). Yet these “archaeological interventions” are possible only insofar as the parts that make up these fluid entities relate to one another because “disaggregation is simultaneously the beginning of an act of assembly” (Lucas 2012:237). Within this relational framework, space and time become continuous variables (Ames 2009:40) and analytical silos crumble (Logan and Stahl 2017; A. Stahl 2014, 2016b).

Much like Bayesian and simulation-based modelling of radiocarbon data sets are prompting archaeologists to reevaluate extant chronological frameworks (e.g., Bronk Ramsey 2009; Lulewicz 2018) and reaffirming others (e.g., Edinborough et al. 2017; Martindale et al. 2017b), focusing analytical attention on alternative units of analysis and forms of material

culture too often ignored in archaeological research such as complete debitage flakes weaves a narrative of technological continuity occurring simultaneously alongside and within technological innovation and change, with implications for linked genealogies of learning and technological practice through space and time. Highlighting the permeability of taxonomic boundaries and the fluidities that belie one's units of analysis casts light onto the emergent and on-going processes by which these objects of analysis take shape. The recognition that our objects of empirical study are socially produced does not, however, erase the responsibility to ethically respond to the constructed nature of our units of analysis (Trouillot 2003:128).

As I propose in Chapter 3, a translocal and transtemporal logic may be deployed to counter ethnocentric ontologies by highlighting the mobility of embodied knowledge, skills, situated learning, and processes of becoming for all people at all places and times. As Fowles (2016:22) argues, one of the greatest contradictions within ethically-questionable contemporary scholarship is the ignorance or, worse, the purposeful evasion of “all struggles between human subjects—including between anthropologists and ‘the natives.’” Effectively decolonizing contemporary archaeological practice requires the “deconstruction of the many fundamental assumptions and essentialized categories arising from colonialism that premise [much of] our research” (Ferris et al. 2014:16). These categories include, for example, labels which tacitly equate “debitage” or “midden” with waste and garbage. A relational space=time ontology is, at the very least, a useful heuristic tool for practicing archaeology reflexively and ethically.

In sum, communities of archaeological practice influence the units of analysis we create and use in our daily research practices which, in turn, feed back into what we know and what we do as situated archaeological practitioners participating in and shaping these same communities and constellations of practice. Knowing truly is “a process shaped by multiscale interactions that

in turn configure emergent communities and constellations of practice” (Roddick and Stahl 2016:24), meaning that archaeological knowledge is made and constructed just as much as it is discovered (Lucas 2012:228). Therefore, I argue it is worthwhile and necessary to refocus attention on the emergent lateral taxonomies of life worlds in their unfinished processes of becoming (Ferris 2014; Harrison 2014). I pursue this objective throughout this thesis by approaching my research questions from several methodological angles and with multiple analytical techniques. I summarize and integrate the results below.

8.2: Data Analysis Synthesis

The XRF analysis results in Chapter 6 defy reductionist expectations of lithic material selection and acquisition practices. These “pieces of places” (Bradley 2000; Reimer 2012) are strong evidence of both the dynamism and enduring continuity of practices during the daily lives of the people who inhabited and created the archaeological sites sampled in this thesis. In particular, the Mount Edziza: Coffee Crater, Nch’kay, and Arrowstone Hills geological source location estimations for several lithic artifacts prompt narratives of extensive social networks, long-distance travel, and widespread lithic material circulations within and across multiple physiographic, cultural, political, linguistic, and temporal boundaries. These boundary-crossings create a cascade effect in that my own bounded conceptions of where these artifacts came from were crossed. The biographies and itineraries of these objects (Appadurai 1986, 2015; Gosden and Marshall 1999; Joyce and Gillespie 2015; Kopytoff 1986) masked by my prior macroscopic lithic material identifications and classifications (e.g., ‘Obsidian’ and ‘Dark Grey Volcanic’) suddenly became enlivened. With the XRF results and geochemical data set in hand, I was now able to link geographic places to the Discovery Island study area via the movements of lithic materials across landscapes and seascapes. These pieces of places carry with them histories,

memories, and social relationships (Mills and Walker 2008; Reimer 2012:7). They are material anchors that constellate communities of practice in the past as well as the present, offering views of “dynamic world[s] through different eyes” (Liebmann 2017:657).

The implications of the XRF results in this thesis are twofold. First, the relationship between the ancestral inhabitants and communities of the Discovery Islands study area to the Central Coast B obsidian flow remained intact through at least three millennia, as inferred by the persistence of this geological source estimation for obsidian artifacts in both the mid-Holocene Crescent Channel (EbSh-81) and late Holocene Village Bay Lake Island (EbSh-80) lithic assemblages. The enduring relationships to lithic materials originating from this place are, much like the second morphometric case study in Chapter 7 where I demonstrate considerable gestural continuity throughout the Holocene, evidence of long-term intergenerational knowledge re-creation and enskilment.

Second, persistent relationships to this place juxtapose simultaneous alternative lithic material selection and acquisition practices. The dominance of obsidian originating from the Kingcome obsidian flow in the Village Bay Lake Island (EbSh-80) lithic assemblage is unsurprising given the geographic proximity of Kingcome Inlet to the Discovery Islands study area. However, traces of relationships to alternative and seemingly distant places are also present in the form of Central Coast B, Mount Edziza: Coffee Crater and Nch’kay geological source location estimations for several lithic artifacts. Similarly, the exploratory XRF sample of fine-grained volcanic (FGV) lithic artifacts also supports non-reductionist narratives of ancient lithic material circulations originating from both the Watts Point and Arrowstone Hills geological source locations to the southeast and northeast of the Discovery Islands. As I discuss in Section 6.5, disentangling direct procurement practices from down-the-line trade and Quaternary glacial

transport are difficult questions to answer without collaborative multidisciplinary research programs beyond the scope of this thesis. However, unless contradictory data are produced through the aforementioned multidisciplinary collaborations, the XRF analysis results in Chapter 6 stand as evidence of dynamic human movements, social geographies, and lithic material circulations through space and time.

In a similar vein, the thin section petrographic (TSP) analysis results shed light onto what are no less important lithic material and selection and acquisition practices even if they lack the relatively glamorous narratives invoked by the XRF data set. The diversity of lithic materials in the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) lithic assemblages identified via TSP analysis suggests innovative lithic material selection and acquisition practices with correspondingly dynamic situated learning processes. I argue that improvisational stone tool production practices operating in tandem with habituated traditions are part of the sophisticated knowledge systems of the people and communities who inhabited and thrived in the Discovery Islands study area since time immemorial. These “recursive, relational, and dynamic processes” (Grier et al. 2017:112) lived and navigated on a daily basis are partially manifested in lithic technologies made of diverse lithic materials.

Finally, the two quantitative morphometric case studies in Chapter 7 offer complementary glimpses into technological choices of stone tool production subsequent to the initial selection of what lithic material(s) to work. My first case study indicates that the hypothesized gestures, actions, and practices characteristic of people making composite slotted points with microblades inset into their lateral margin(s) are valid for the Crescent Channel (EbSh-81) microblade assemblage. These multi-material composite tools (Helwig et al. 2014; Waber 2011, n.d.; Wood and Fitzhugh n.d.) requiring considerable skill to make and use

exemplify a diversity of technological proficiencies, enriching the genealogies of technological practice that include all approaches to lithic reduction inferred throughout this thesis. The archaeological visibility of choices made along the hypothesized composite slotted point operational sequence is a promising result and a methodological insight whose full potential remains to be explored in future morphometric studies.

My second morphometric case study takes a holistic approach to quantitative data analysis rather than formally testing a hypothesis derived from a model of technological practice. Following Williams and Andrefsky (2011), I use complete debitage flake morphologies as proxies for the embodied knowledge and gestures that detached them from objective pieces. The results suggest shared gestural practices across many generations of human life and remarkable kinaesthetic coordination through space and time. The continuity of learned bodily gestures between the communities of practice who made these lithic artifacts contrasts regional culture historical sequences, examples of orthodox archaeological space-time systematics privileging change over continuity. By purposefully withholding any typological classifications more specific than “complete debitage flake,” I was able to examine the shapes of these lithic artifacts as continuous rather than categorical variables which complements the shifts in lithic technology production practices observed in the sampled assemblages. In this way, I demonstrate that archaeological taxonomic boundaries are not always as impermeable, fixed, or absolute as self-evident tautological reasoning might purport.

As in the XRF and TSP analyses discussed above and in Chapter 6, creative tensions between innovation and tradition are likely also components of the emergent communities and constellations of practice whose material culture I sample in this thesis (*sensu* Sofaer 2018). Articulations of individual agency in relation to and within contexts of situated social learning

are fundamental to the emergent processes of stone tool production and use (Lombao et al. 2017:9). Evidence of these creative tensions is found in the technological shifts observed during the macroscopic lithic analysis detailed in Chapter 5 contrasted against the gestural continuity I infer from the results of the second morphometric case study in Chapter 7. Even if discursive technological choices shifted through time, the reality that these people still produced similarly-shaped debitage assemblages shows, at the very least, that they skilfully made and used diverse forms of material culture within shared repertoires of gesture, movement, and practice that span millennia. Furthermore, my arguments remain valid even if the complete debitage flakes in the three sampled lithic assemblages were rejected in favour of alternatively-shaped flakes of unknown morphologies. Within this scenario, complete and unmodified debitage flakes are still the traces of similar and overlapping learned technological choices and depositional practices: the choice of what flakes to *not* select.

In the following chapter I state the limitations of the current study, suggest future avenues of research, and conclude this thesis.

Chapter 9: Conclusion

9.1: Limitations

Throughout this thesis I explore the findings of a diachronic analysis of three lithic assemblages from Quadra Island, British Columbia. From this, insights flow about the genealogies of technological practice and communities of skilled practitioners who inhabited the study area throughout its deep history. I use qualitative and quantitative methods including macroscopic lithic analysis, thin section petrography, X-ray fluorescence spectrometry, and morphometrics to operationalize these theoretical foundations. This suite of complementary methods and theory weaves a narrative of technological change alongside simultaneous gestural continuity for hundreds of generations. I argue this is evidence of the dynamic, sophisticated, yet enduring knowledge and practice of the ancestral inhabitants of the Discovery Islands.

As with any research program, there are limitations inherent in this work. This thesis is a dynamic text that moves away from grand narratives towards a form of discourse that incorporates incompleteness by design (Lucas 2012:252). The entire point of undertaking a pilot study to develop methodological pathways of analytically engaging with communities of (lithic) practice is to clear a path for others to follow suit. As such, I wrap up this thesis with a discussion of the limitations of this work and make recommendations for avenues of future research.

My more or less singular focus on lithic technologies throughout this thesis is understandable given the durability of stone relative to other materials. Nonetheless, it is practically certain that lithic technologies are only one component of a multi-material composite tool kit, as I touch on in the first morphometric case study in Chapter 7. Studying lithic technologies is a long standing staple of archaeological research and will likely persist. However, lithic analysts would do well to continue to remind ourselves that stone tools may or may not be

the most important components of the diverse composite technologies and material cultures of past people, particularly in environments such as the Northwest Coast where alternative materials more susceptible to taphonomic degradation such as bone and wood are readily available (Hodgetts and Rahemtulla 2001; Stewart 1984). Research programs explicitly designed to examine the ways stone tools are used to make bone and wood technologies (or vice versa) is an area of research I feel has great potential.

Throughout this thesis my fundamental units of analysis are lithic assemblages, archaeological sites, and communities of practice. In many ways these entities are appropriate given the scope and scale of my research questions. I readily admit, though, that focusing my attention upon these phenomena likely obscures more minute details other scholars may find useful in addressing their own research questions. In fact, multiscale data sets are arguably necessary in order to facilitate holistic knowledge about the people and communities who inhabited the archaeological sites sampled in this thesis. While this research takes steps in this direction, future studies would do well to consider additional and supplemental avenues of inquiry. I make several suggestions in the following section.

9.2: Future Directions

The data and knowledge I produce in this thesis are foundational baselines for future research. The sampled archaeological assemblages, components, and sites may, however, be conceptualized as palimpsests of multiple or continuous occupations. Given this, there is room to explore technological variability on a finer scale than I pursue here. For example, intra-site analyses or more detailed stratigraphic parsing of the assemblages may reveal insightful supplemental data about lithic technology production and use practices. The notion of multiple overlapping or nested communities of practice is actually quite probable given the presence of

outliers within the data sets I produce throughout this thesis. These quantitative outliers may be qualitative keystones for better understanding the characteristics, extents, and practices of the people and communities who inhabited these places and lived within the landscapes and seascapes of the Discovery Islands throughout the Holocene.

The thin section petrography (TSP) and X-ray fluorescence (XRF) spectrometry results in Chapter 6 are important findings about the lithic materials that make up the Renda Rock Shelter (EaSh-77), Crescent Channel (EbSh-81), and Village Bay Lake Island (EbSh-80) lithic assemblages. In many cases though, geological source estimations based upon the TSP and XRF data sets are preliminary. In order to more firmly estimate the movements and circulations of these lithic materials amongst and between past people and communities, better baseline data are necessary about the distribution of lithic materials and Quaternary colluvia within the vicinity of the Discovery Islands study area and the Northwest Coast more broadly. This methodological reality is not unique to the Northwest Coast, we are simply further behind than some of our peers working in other areas of the world (e.g., Shackley 2005). In Chapter 6 I propose potential geological source locations for a variety of lithic materials to serve as guiding principles for future multidisciplinary research efforts drawing upon geomorphology, geology, petrography, geochemistry, and archaeology.

Finally, the morphometric component of my research demonstrates the kinds of intimate and alternative insights about stone tool production and use practices that are attainable by quantitatively studying the shapes of lithic artifacts. However, the morphometric analyses in Chapter 7 should not be considered exhaustive. Early in this project I decided to manually record the length, width, and platform size of complete debitage flakes in the sampled lithic assemblages. This simple method proved effective for answering my morphometric research

questions. Nonetheless, these morphological attributes are only three dimensions of objects whose morphologies may require more detailed and complicated quantification depending on the morphometric research questions being posed. In these cases, alternative recording and measurement techniques such as photogrammetry and three-dimensional laser scanning would likely prove useful. These methods produce 3D point clouds that may be queried in a practically infinite fashion using GIS-based Lithic Morphometric Research (GLiMR) methods (Davis et al. 2015, 2017). Such digital approaches to measurement and quantification would likely be useful for studying the shapes of lithic artifacts, especially if new morphological attributes of interest emerge through the course of an analysis that were not foreseen during the planning stages.

Furthermore, rather than “throwing the baby out with the bathwater,” I encourage the study of aspects of the lithic technologies I did *not* examine in detail during the course of this research. Examples of potential lines of inquiry include detailed analyses of dorsal flake scar morphologies and orientations, the bipolar debitage, cores, tools, and microscopic use-wear analyses.

9.3: Departing Thoughts

I began this thesis with a statement disclosing my intentions to unpack teleological social evolutionist narratives of progressive developmentalism frequently espoused in Northwest Coast archaeological scholarship via a diachronic case study of three lithic assemblages. It should be clear by now that histories and history-making are complex processes that are, ironically, poorly characterized by orthogenetic archaeological models of progressively increasing cultural complexity throughout the Holocene (Martindale et al. 2017a:287). Rather, a growing and mobile sphere carrying space and time with it and altering worlds as it moves is perhaps a more appropriate metaphor (Lucas 2012:264). Taking inspiration from this model of ever-emergent

historical processes, I approach my research questions through multiple complementary methodologies that enable me to “surmount conventional analytical silos and eschew binaries” (Logan and Stahl 2017:1395). The diverse data sets I produced throughout the course of this research program offer insights about how multiscale and recursive relationships between histories, places, materials, and communities of practice articulate with one another within the unassuming yet ubiquitous technological practices of making and using flaked stone tools.

Using this multifaceted approach, I foreground *the people* whose material traces constitute the archaeological record and emphasize the emergent co-construction and reciprocal relationships between the makers of material culture and the things they make. The many generations that inhabit the Discovery Islands study area are composed of situated practitioners whose knowledge, skills, and technologies are continually (re)defined in relation to the translocal and transtemporal communities and constellations within which they participate and shape. A communities of practice approach informed by empirical data analyses emphasizes aspects of the past too often glossed over or ignored in archaeological research. It offers a humanistic perspective of people living their lives situated within webs of diverse relationships, accentuating “the human in objects” (Lucas 2012:262). Admittedly, the scope of this project is relatively limited compared to the intricate universe of cultural and technological practices through space and time. Nonetheless, by grounding my analyses in tangible data sets, this work helps to interrogate disciplinary assumptions and works towards redefining how we know what we know and do what we do as situated archaeological practitioners.

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Appendix A: Macroscopic Lithic Material Type Identifications and Classifications

Initial Lithic Material Type Classification	Secondary Lithic Material Type Classification and Description of Inferred Petrogenesis	Congruency of Initial and Secondary Lithic Material Type Classifications
Andesite	Pale grey colour and sugary texture. Less glassy than 'dacite' specimens. Silica-rich felsic igneous (andesite) classification.	Congruent
Banded Grey Chert	Flow-banding visible, suggesting igneous genesis. Dark inclusions visible in translucent edges, probably quartz phenocrysts or filled vesicle indicative of igneous genesis. Felsic igneous (dacite and/or rhyolite) classification.	Incongruent
Beige Quartzite	Beige colour and consistent composition, whole specimen is glassy (nearly 100% quartz).	Congruent
Black Chert	Dark purple-black colour, glassy lustre, and sugary texture. Silica-rich felsic igneous (dacite and/or rhyolite) classification.	Incongruent
Black Volcanic	Slightly sugary texture with glassy lustre and high silica content. Elongated quartz crystal or garnet phenocrysts visible. Very silica-rich felsic igneous (dacite and/or rhyolite) classification.	Congruent
Blue Rhyolite	Light blue colour, very glassy, fine-grained texture. Very silica-rich felsic igneous (rhyolite) classification.	Congruent
Contact Metamorphosed Andesite	Pale grey colour and sugary texture. Less glassy than 'dacite' specimens. Phenocrysts are milky white (rather than clear) and rectangular, likely plagioclase feldspar. Silica-rich felsic igneous (andesite) classification.	Congruent
Dacite	Very glassy, fine-grained, and grey-coloured matrix. Consistent with felsic igneous (dacite) classification.	Congruent
Dacite with Phenocrysts	Phenocrysts are milky white (rather than clear) and rectangular, likely plagioclase feldspar. Very glassy, fine-grained, and grey-coloured matrix. "Ghostly" rings/halos around the phenocrysts suggesting mild contact metamorphism which increases hardness and silica content.	Ambiguous
Dalmatian Granite, Fine	Fine-grained yet heterogeneous matrix with sugary texture. Patterning reminiscent of 'Dalmatian' coat. Moderate amount of orange-brown patina formation.	Congruent
Dark Grey Chalcedony	Smokey translucent edges, highly siliceous, dark brownish-black colour. Borderline obsidian.	Ambiguous
Dark Grey Chert	Stretched matrix (almost flow-banding) suggesting igneous genesis. Dark inclusions visible in translucent edges, probably quartz phenocrysts or filled vesicles indicative of felsic igneous (dacite and/or rhyolite) classification.	Incongruent
Dark Grey Volcanic	Dark grey colour and slightly sugary but mostly very glassy and fine-grained texture. Linear and rectangular minerals visible, probably feldspar or hornblende, supporting volcanic genesis. Very silica-rich felsic igneous (dacite and/or rhyolite) classification.	Congruent
Dark Medium-Grained Granite	Grey colour, coarser texture than 'Granite' specimens. Likely granodiorite.	Congruent
Granite	Milky tan colour due to feldspar weathering out. Likely granodiorite.	Congruent
Granite, Coarse	Milky tan colour due to feldspar weathering out and very coarse texture. Likely granodiorite.	Congruent

Initial Lithic Material Type Classification	Secondary Lithic Material Type Classification and Description of Inferred Petrogenesis	Congruency of Initial and Secondary Lithic Material Type Classifications
Granite, Fine	Milky tan colour due to feldspar weathering out and very fine-grained texture. Likely granodiorite.	Congruent
Green-Blue Rhyolite	Green-blue colour, very glassy, fine-grained texture. Very silica-rich felsic igneous (rhyolite) classification.	Congruent
Green-Grey Chert	White matrix and very translucent. Light coloured mica flakes and/or chlorite. Felsic igneous classification is probable.	Incongruent
Grey Chert	Bluey-grey colour and sugary texture. Consistent with felsic igneous (dacite and/or rhyolite) classification.	Incongruent
Grey Metasediment	Grey colour and nearly cryptocrystalline texture. Twinning/plagioclase feldspar visible, suggesting felsic igneous genesis.	Incongruent
Grey Quartzite	Very pale grey colour and homogeneous composition, whole specimen is glassy (nearly 100% quartz).	Congruent
Grey Volcanic	Light grey colour and silica-rich. Many quartz phenocrysts and dark glassy flecks, possibly smokey quartz inclusions, suggesting felsic igneous genesis.	Congruent
Ignimbrite	Pale grey colour and flattened pumice clasts surrounded by a very fine-grained matrix. Volcanic components in relation to banded microstructure suggests pycroclastic genesis followed by metamorphic reogenesis.	Congruent
Light Brown Patina I	Extensive chemical weathering results in light brown patina almost completely obscuring microstructure and mineral content(s). Slightly porphyritic although unclear whether this is the patina or the rock.	Ambiguous
Light Grey Chert	Bluey-grey colour and sugary texture. Consistent with felsic igneous (dacite and/or rhyolite) classification.	Incongruent
Light Grey Metasediment	Light grey colour and very fine-grained texture. Twinning/plagioclase feldspar visible, suggesting felsic igneous genesis.	Incongruent
Light Grey Metasediment with Quartz Inclusions	Light grey colour and very fine-grained texture. Large quartz phenocrysts present. Twinning/plagioclase feldspar visible, suggesting felsic igneous genesis.	Incongruent
Light Grey Volcanic	Light grey colour and slightly sugary but mostly very glassy and fine-grained texture. Linear and rectangular minerals visible, probably feldspar or hornblende, supporting volcanic genesis. Very silica-rich felsic igneous (dacite and/or rhyolite) classification.	Congruent
Light Tan Chert	Off-white colour, silica-rich, and cryptocrystalline texture. Pinkish patches visible, suggesting an impurity mixed into matrix during genesis.	Ambiguous
Metamorphic A	Dark grey colour and coarse texture. Well-developed parallel foliation planes suggesting metamorphic genesis.	Congruent
Metasediment	Bluey-grey colour and sugary texture. Feldspar phenocrysts, quartz phenocrysts, and flow-banding visible. Supports felsic igneous (dacite and/or rhyolite) classification.	Incongruent
Obsidian	Dark grey colour, glassy, and translucent.	Congruent
Pink Quartzite	Pale pink colour and homogeneous composition, whole specimen is glassy (nearly 100% quartz).	Congruent
Quartz	Milky colour and opacity suggests vein quartz.	Congruent

Initial Lithic Material Type Classification	Secondary Lithic Material Type Classification and Description of Inferred Petrogenesis	Congruency of Initial and Secondary Lithic Material Type Classifications
Quartz Crystal	Clear colour and opacity, like glass. Some specimens exhibit remnant hexagonal crystal morphology.	Congruent
Quartzite	Nearly 100% quartz, supporting quartzite classification. Mica flecks visible in matrix, suggesting metamorphic genesis. Slightly coarser texture than 'grey quartzite' specimen.	Congruent
Rhyolite	Grey-beige colour, very glassy, fine-grained texture. Very silica-rich felsic igneous (rhyolite) classification.	Congruent
Sandstone	Consistent texture and grain size suggests cooling magma rather than metamorphosed sand. Mica, pyroxene, and amphibole visible in matrix, suggesting a granodiorite or granite.	Incongruent
Siltstone	Brown colour and very fine-grained texture. Small black inclusions visible, possibly plagioclase and/or pyroxenes. Matrix is composed of particles of varying sizes, although all are very small, hence siltstone classification.	Congruent
Silver-Grey Chert	Silver-grey colour and sugary texture. Consistent with felsic igneous (dacite and/or rhyolite) classification.	Incongruent
Slate	Dark grey colour and very fine-grained texture. Matrix is cryptocrystalline yet extensively foliated, hence slate classification.	Congruent
Speckled Volcanic	Dark grey colour and sugary texture. Unknown dark grey mineral inclusions create speckled pattern because dispersed evenly and extensively throughout matrix, supporting igneous genesis. Very silica-rich felsic igneous (dacite and/or rhyolite) classification.	Congruent
Tan Chert	Very fine-grained, difficult to discern minerals and texture even with microscope. Totally opaque, no translucent edges. Very hard/durable matrix weathered to a milky white colour suggesting high feldspar content. Tentative classification = felsic tuff. Feldspar phenocrysts visible in some specimens, suggesting igneous genesis.	Ambiguous
Unknown	This lithic material type classification reserved for specimens that have highly irregular patination. This is the only miscellaneous unknown classification.	Ambiguous
Unknown A	Moderately coarse and degraded quartzite. Grey to tan in colour with small vugs. 1 of 5 'Unknown' lithic material types from the Renda Rock Shelter (EaSh-77).	Ambiguous
Unknown B	Dark red and brown fossiliferous material. 2 of 5 'Unknown' lithic material types from the Renda Rock Shelter (EaSh-77).	Ambiguous
Unknown Beige Patina I	Extensive chemical weathering results in beige patina almost completely obscuring microstructure and mineral content(s).	Ambiguous
Unknown Brown Patina	Extensive chemical weathering results in brown patina almost completely obscuring microstructure and mineral content(s).	Ambiguous
Unknown Brown Patina I	Extensive chemical weathering results in brown patina almost completely obscuring microstructure and mineral content(s). Darker colour than 'Unknown Brown Patina' specimen.	Ambiguous
Unknown C	Brown colour and coarse texture. Large quartz phenocrysts visible. 3 of 5 'Unknown' lithic material types from the Renda Rock Shelter (EaSh-77).	Ambiguous

Initial Lithic Material Type Classification	Secondary Lithic Material Type Classification and Description of Inferred Petrogenesis	Congruency of Initial and Secondary Lithic Material Type Classifications
Unknown Contact Metamorphosed, Coarse	Grey colour and coarse texture. Phenocrysts are milky white (rather than clear) and rectangular, likely plagioclase feldspar. “Ghostly” rings/halos around the phenocrysts suggesting mild contact metamorphism which increases hardness and silica content. Overall though material is ambiguous and doesn't have many apparent diagnostic attributes hence 'Unknown' classification.	Ambiguous
Unknown Cryptocrystalline	Milky white colour and cryptocrystalline texture. Heavy patination obscures 90% of specimen making more precise descriptions and classifications difficult.	Ambiguous
Unknown Cryptocrystalline II	Grey colour and cryptocrystalline texture. Similar to 'Unknown Cryptocrystalline' but lighter colour.	Ambiguous
Unknown Cryptocrystalline III	Silver colour and cryptocrystalline texture. Similar to 'Silver-Grey Chert' but more fine-grained texture.	Ambiguous
Unknown D	Red and brown fossiliferous material. Similar to 'Unknown B' but not as dark. 4 of 5 'Unknown' lithic material types from the Renda Rock Shelter (EaSh-77).	Ambiguous
Unknown Dark Green-Grey	Sugary texture. Regularly-spaced very glassy and dark minerals weathering out of surrounding matrix (suggests these minerals are very hard). Dark mafic minerals sit in and contrast with lighter and fine-grained felsic matrix which suggests metasedimentary genesis. However, rounded smokey quartz crystals visible suggesting specimen is a felsic igneous rock (variation on a dacite and/or rhyolite) though. Overall somewhat ambiguous material type hence 'Unknown' classification.	Ambiguous
Unknown E	Light grey matrix with black inclusions. 5 of 5 'Unknown' lithic material types from the Renda Rock Shelter (EaSh-77).	Ambiguous
Unknown III	Tan colour and coarse texture. Patina weathers to dark brown colour.	Ambiguous
Unknown IV	Heterogeneous matrix of pale tan and dark grey minerals interspersed evenly. Coarse texture reminiscent of granite. Patina weathers to a rusty red colour.	Ambiguous
Unknown IX	Silver grey colour and coarse texture. White patina remnant cortex visible. Possible contact metamorphosed phenocrysts visible elsewhere although these may also be remnant cortex.	Ambiguous
Unknown V	White colour and moderately coarse texture. Extensive garnet and/or smokey quartz along with quartz phenocrysts throughout matrix.	Ambiguous
Unknown VI	Grey colour and coarse texture (although verging on sugary texture suggesting possible igneous genesis). Patina formation obscures ~75% of specimen making more precise descriptions and classifications difficult.	Ambiguous
Unknown VII	Brown patina obscures majority of specimen although it pokes through in places. The visible portions are reminiscent of a coarse granite although insufficient data to confidently make this assessment.	Ambiguous
Unknown VIII	Light brown colour patina. Unknown underlying colour and texture due to extensive patina formation.	Ambiguous

Initial Lithic Material Type Classification	Secondary Lithic Material Type Classification and Description of Inferred Petrogenesis	Congruency of Initial and Secondary Lithic Material Type Classifications
Unknown Volcanic	Light brown colour and sugary texture suggesting igneous genesis. Extremely generic material lacking diagnostic attributes other than somewhat diagnostic texture hence 'Unknown' classification.	Congruent
Unknown Volcanic, White Cortex	Light brown colour and sugary texture suggesting igneous genesis. Extremely generic material lacking diagnostic attributes other than somewhat diagnostic texture hence 'Unknown' classification. Similar to 'Unknown Volcanic' except for remnant white cortex visible.	Congruent
Unknown Vug-Rich, Coarse	Grey colour and coarse texture with numerous vugs throughout matrix. Reminiscent of 'Unknown A' although not nearly as fine-grained texture.	Congruent
Unknown White Quartz-Rich, Coarse	White colour and sugary texture suggesting igneous genesis. Much larger gran size than other specimens with sugary texture seen thus far hence “coarse” specification. Extensive quartz phenocrysts visible throughout matrix.	Ambiguous
Unknown X	Similar to 'Unknown Dark Green-Grey' except for silver colour and more fine-grained texture. Regularly-spaced very glassy and dark minerals weathering out of surrounding matrix (suggests these minerals are very hard). Dark mafic minerals sit in and contrast with the fine-grained felsic matrix which suggests a metasediment classification. Rounded smokey quartz crystals visible suggesting specimen is a felsic igneous rock (variation on a dacite and/or rhyolite) though. Overall somewhat ambiguous material type classification hence 'unknown' classification.	Ambiguous
Unknown XI	Pinkish colour and somewhat fine-grained texture although ~90% of the specimen is obscured by heavy patina formation making more precise descriptions and classifications difficult.	Ambiguous
Unknown XII	White colour and coarse texture. Occasional garnet and/or smokey quartz phenocrysts throughout matrix. Dark grey patina formation obscures ~80% of specimen making more precise descriptions and classifications difficult.	Ambiguous
Unknown XIII	Tan colour and moderately sugary texture. Occasional garnet and/or smokey quartz phenocrysts throughout matrix. Extensive tan and pink patina formation obscures ~90% of specimen making more precise descriptions and classifications difficult.	Ambiguous
Unknown XIV	White colour and moderately coarse texture. Garnet and/or smokey quartz along with quartz phenocrysts throughout matrix. Similar to 'Unknown V' but lower density of mineral inclusions.	Ambiguous
Unknown XV	White colour and moderately coarse texture. Similar to 'Unknown V' and 'Unknown XIV' except for lack of mineral inclusions.	Ambiguous
Unknown XVI	Dark grey colour and sugary texture. Occasional garnet and/or smokey quartz phenocrysts throughout matrix. Similar to 'Unknown XIV' except for higher silica content and more sugary texture.	Ambiguous

Initial Lithic Material Type Classification	Secondary Lithic Material Type Classification and Description of Inferred Petrogenesis	Congruency of Initial and Secondary Lithic Material Type Classifications
Unknown XVII	Heavy dark brown patina distinct from other patinas seen thus far. Patina obscures 100% of specimen making more precise descriptions and classifications difficult.	Ambiguous
Volcanic with Elongated Inclusions	Tan colour and sugary texture. Extensive elongated linear mineral inclusions throughout matrix.	Congruent
Volcanic, Fine	Tan colour and very fine-grained sugary texture free of visible mineral inclusions and/or phenocrysts in matrix.	Congruent
White Chert	White colour and sugary texture. Consistent with felsic igneous (dacite and/or rhyolite) classification.	Incongruent
White Rhyolite	White colour and very fine-grained sugary texture. Occasional quartz phenocrysts dispersed throughout matrix. Similar to 'Unknown V' except more fine-grained texture and less mineral inclusions.	Congruent
White Schist	Robust foliation strongly suggests metamorphic genesis. Lots of quartz & reddish-pink smears, possibly feldspar minerals. Specimen likely started as an igneous and/or granitic rock then metamorphosed to a schist type of rock. Likely a foliated quartzite.	Ambiguous
White Volcanic, Coarse	White colour and sugary texture suggesting igneous genesis. Similar to 'Unknown White Quartz-Rich, Coarse' except lacking quartz phenocrysts throughout matrix.	Congruent

Appendix B: Thin Section Petrography Photomicrographs

This appendix is organized primarily according to archaeological site and by relative chronology of the three sampled assemblages, meaning that all photomicrographs of sub-sampled lithic artifacts from the Renda Rock Shelter (EaSh-77) appear prior to photomicrographs of Crescent Channel (EbSh-81) artifacts which appear prior to photomicrographs of Village Bay Lake Island (EbSh-80) artifacts. Photomicrographs are presented sequentially within each series according to specimen number (e.g., lithic artifact EbSh-81:1 would appear before EbSh-81:2 but after EaSh-77:99). See Table 4 for a complete list of specimens sub-sampled for thin section petrographic analysis.

Glossary of Key Terms

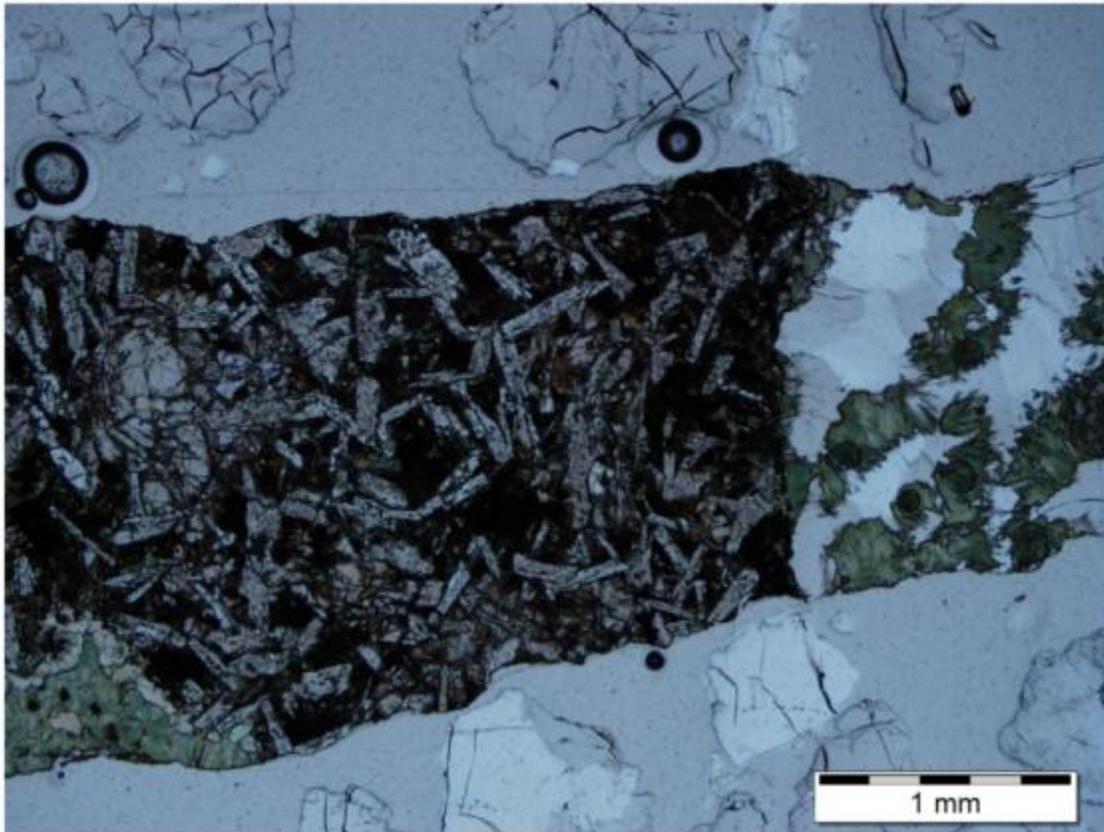
Word or Phrase	Definition
Albite	Albite is a plagioclase feldspar mineral. It is the sodium endmember of the plagioclase solid solution series. As such it represents a plagioclase with less than 10% anorthite content. Its colour is usually pure white, hence its name from Latin <i>albus</i> . It is a common constituent in felsic rocks.
Amphibole	Amphibole is an important group of generally dark-colored, inosilicate minerals, forming prism or needlelike crystals, composed of double chain SiO ₄ tetrahedra, linked at the vertices and generally containing ions of iron and/or magnesium in their structures. Amphiboles can be green, black, colorless, white, yellow, blue, or brown.
Amygdule	A vesicle in an igneous rock, containing secondary minerals.
Anhedral	Having no plane faces (of a crystal), opposite of euhedral.
Augite	Augite is a common rock-forming pyroxene mineral. The crystals are monoclinic and prismatic. Augite has two prominent cleavages, meeting at angles near 90 degrees.
Birefringent	Having two different refractive indices.
Chlorite	Chlorites are a group of phyllosilicate minerals. The great range in composition results in considerable variation in physical, optical, and X-ray properties. Similarly, the range of chemical composition allows chlorite group minerals to exist over a wide range of temperature and pressure conditions. For this reason chlorite minerals are ubiquitous minerals within low and medium temperature metamorphic rocks,

Word or Phrase	Definition
	some igneous rocks, hydrothermal rocks, and deeply buried sediments.
Clay	Soil particles with diameters less than 0.005 millimetre (finer than silts).
Cleavage angles	Cleavage is the tendency of a mineral to break along smooth planes parallel to zones of weak bonding.
Clinopyroxene	Pyroxenes that crystallize in the monoclinic system are known as clinopyroxenes.
Devitrified	Become or make hard, opaque, and crystalline.
Epidote	Epidote is a silicate mineral that is commonly found in regionally metamorphosed rocks of low to moderate grade. It occurs as replacements of mineral grains that have been altered by metamorphism.
Euhedral	Euhedral crystals are those that are well-formed, with sharp and easily recognized faces, opposite of anhedral.
Feldspar	An abundant rock-forming mineral typically occurring as colourless or pale-coloured crystals and consisting of aluminosilicates of potassium, sodium, and calcium.
Fibrous	A type of fracture/cleavage with surfaces showing fibres or splinters.
Fossiliferous	Bearing or containing fossils.
Glomerophenocryst	Aggregations of phenocrysts.
Hornblende	Hornblende is a field and classroom name used for a group of dark-colored amphibole minerals found in many types of igneous and metamorphic rocks. These minerals vary in chemical composition but are all double-chain inosilicates with very similar physical properties.
Hypabyssal	A subvolcanic rock, also known as a hypabyssal rock, is an intrusive igneous rock that is emplaced at medium to shallow depths (>2 km) within the crust, and has intermediate grain size and often porphyritic texture between that of volcanic and plutonic rocks.
Inequigranular	Having or characterized by crystals of different sizes.
Interlobate	Direct edge-to-edge contact between minerals along a relatively flat plane.
Isotropic	Dark minerals that do not affect the polarization direction of light, opposite of anisotropic.
Lapilli	Rock fragments ejected from a volcano.
Lath	A thin strip, often associated with flow-banding.
Limonite	An amorphous brownish secondary mineral consisting of a mixture of hydrous ferric oxides, important as an iron ore.
Magnetite	Magnetite is a rock mineral and one of the main iron ores, occurs in almost all igneous and metamorphic rocks. The most magnetic of all the naturally-occurring minerals on Earth.
Microdiorite	Microdiorite is a medium-grained intrusive igneous rock. It contains

Word or Phrase	Definition
	crystals that are smaller than grains of rice, which are interlocking and randomly oriented.
Monoclinic system	Crystals that form a rectangular prism with a parallelogram as its base. One of the 7 crystal systems.
Ophitic	Relating to or denoting a poikilitic rock texture in which crystals of feldspar are interposed between plates of augite.
Orthorhombic system	Crystals that form a rectangular prism with a rectangular base (a by b) and height (c), such that a, b, and c are distinct. One of the 7 crystal systems.
Orthopyroxene	Any of a series of common silicate minerals in the pyroxene family. Orthopyroxenes typically occur as fibrous or lamellar (thin-plated) green masses in igneous and metamorphic rocks and in meteorites.
Overprint	A geological process that leaves marks altering the marks of an earlier process.
Oxide	A chemical compound that contains at least one oxygen atom and one other element in its chemical formula.
Petrogenesis	The origin and formation of rocks.
Phenocryst	A large or conspicuous crystal in a porphyritic rock, distinct from the groundmass.
Plagioclase	Plagioclase is a series of tectosilicate (framework silicate) minerals within the feldspar group. Rather than referring to a particular mineral with a specific chemical composition, plagioclase is a continuous solid solution series, more properly known as the plagioclase feldspar series. Plagioclase is a major constituent mineral in the Earth's crust, and is consequently an important diagnostic tool in petrology for identifying the composition, origin and evolution of igneous rocks.
Pleochroism	An optical phenomenon in which a substance has different colors when observed at different angles, especially with polarized light.
Poikilitic	Relating to or denoting the texture of an igneous rock in which small crystals of one mineral occur within crystals of another.
Polarizer	An optical filter that lets light waves of a specific polarization pass through while blocking light waves of other polarizations. It converts a beam of light of undefined or mixed polarization into a beam of well-defined polarization (i.e., polarized light).
Porphyritic	Relating to or denoting a rock texture, typically found in volcanic rocks, containing distinct crystals or crystalline particles embedded in a fine-grained groundmass.
Pyrite	A shiny yellow mineral consisting of iron disulfide and typically occurring as intersecting cubic crystals.
Pyroxene	The pyroxenes are a group of important rock-forming inosilicate minerals found in many igneous and metamorphic rocks. Pyroxenes were so named because of their presence in volcanic lavas, where they are sometimes seen as crystals embedded in volcanic glass; it

Word or Phrase	Definition
	was assumed they were impurities in the glass, hence the name "fire strangers." However, they are simply early-forming minerals that crystallized before the lava erupted. The upper mantle of Earth is composed mainly of olivine and pyroxene. Pyroxene and feldspar are the major minerals in basalt and gabbro.
Quartz	Quartz is a mineral composed of silicon and oxygen atoms in a continuous framework. Quartz is the second most abundant mineral in Earth's continental crust, behind feldspar. Quartz crystals are chiral, and exist in two forms, the normal α -quartz and the high-temperature β -quartz.
Refractive index	The ratio of the velocity of light in a vacuum to its velocity in a specified medium.
Relief	The degree in which mineral grains stand out from the mounting medium on a prepared thin section slide, expressed as a refractive index value.
Subhedral	Having somewhat plane faces (of a crystal). Middle-ground between anhedral and euhedral.
Trachytic	Relating to or denoting a rock texture in which crystals show parallel alignment due to flow in the magma.
Vug	A small to medium-sized cavity inside rock.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 13

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown B, red/brown fossiliferous material.

Microstructure:

Plagioclase laths randomly oriented and intergrown with clinopyroxene (and orthopyroxene?) and chlorite. Crosscut by quartz and chlorite.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Epidote, quartz, chlorite.

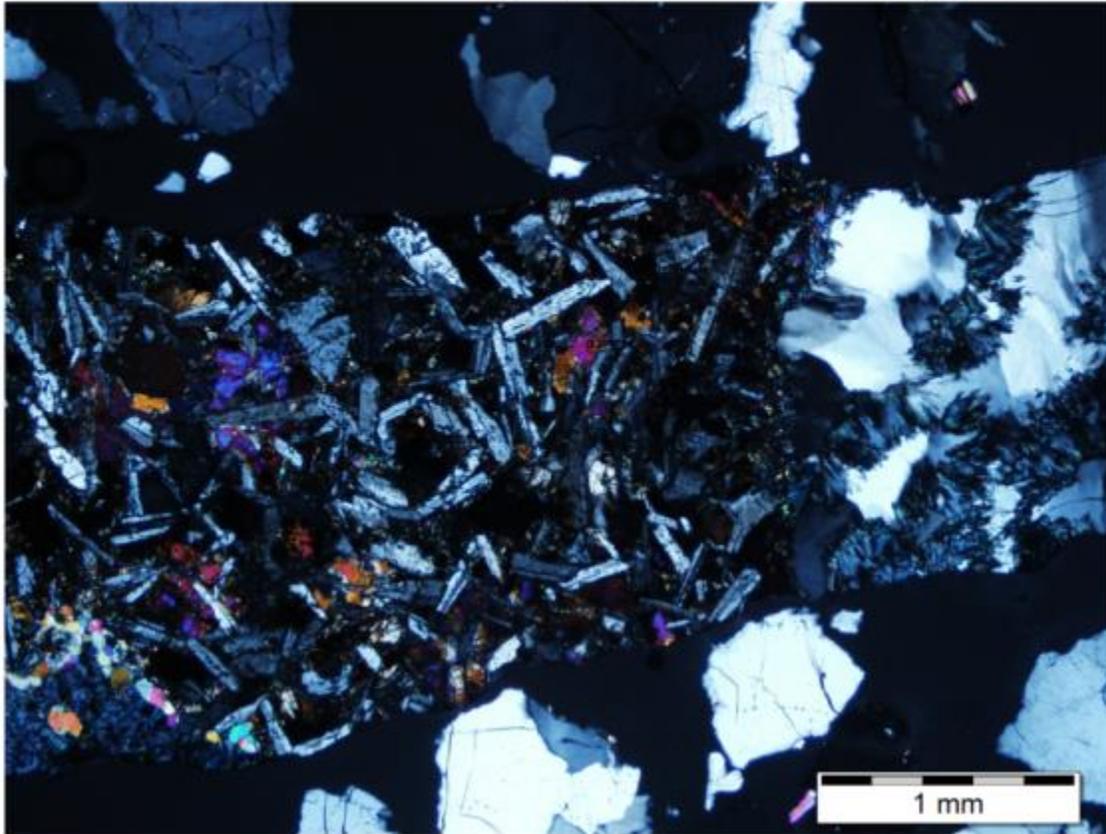
Petrographic Classification:

Altered microdiorite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 13

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:
Unknown B, red/brown fossiliferous material.

Microstructure:

Plagioclase laths randomly oriented and intergrown with clinopyroxene (and orthopyroxene?) and chlorite. Crosscut by quartz and chlorite.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Epidote, quartz, chlorite.

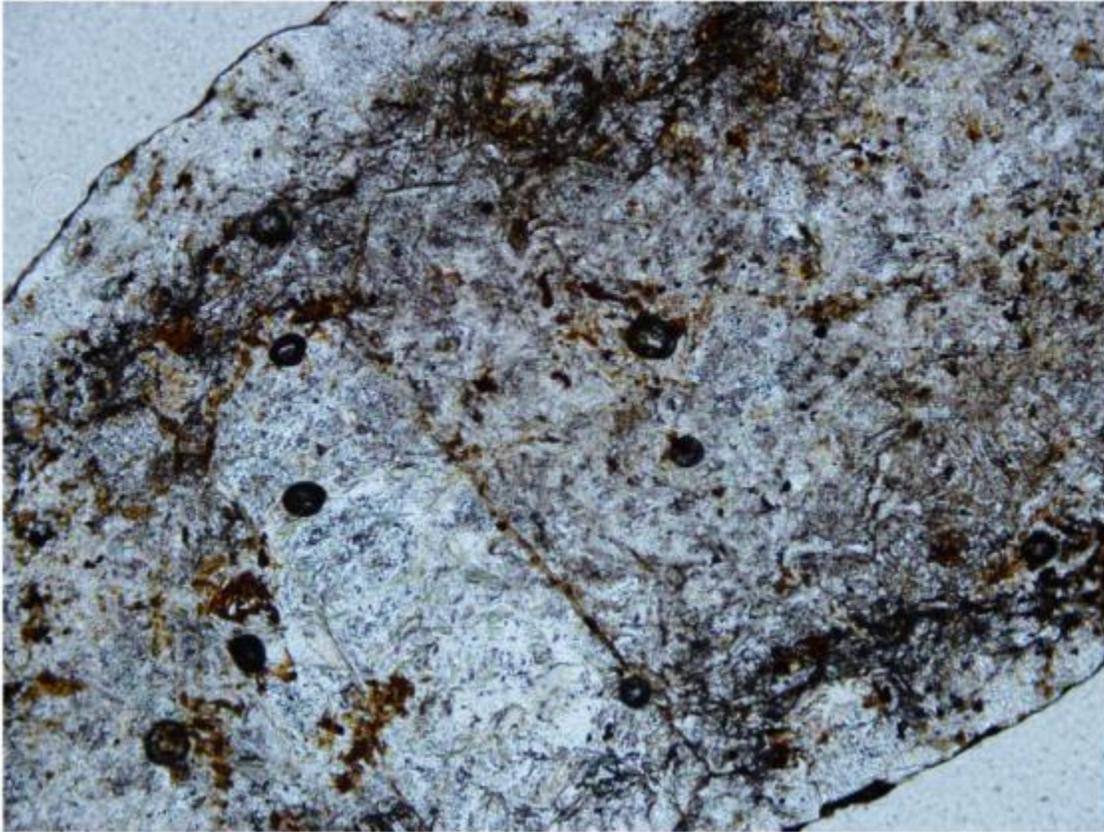
Petrographic Classification:

Altered microdiorite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 56

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown A, moderately coarse and degraded, grey to tan in colour with small vugs.

Microstructure:

Euhedral phenocrysts of feldspar immersed within a groundmass of fine-grained anhedral feldspar.

Primary Minerals:

Feldspar and perhaps plagioclase.

Alteration Minerals:

Limonitic material, epidote, and clay.

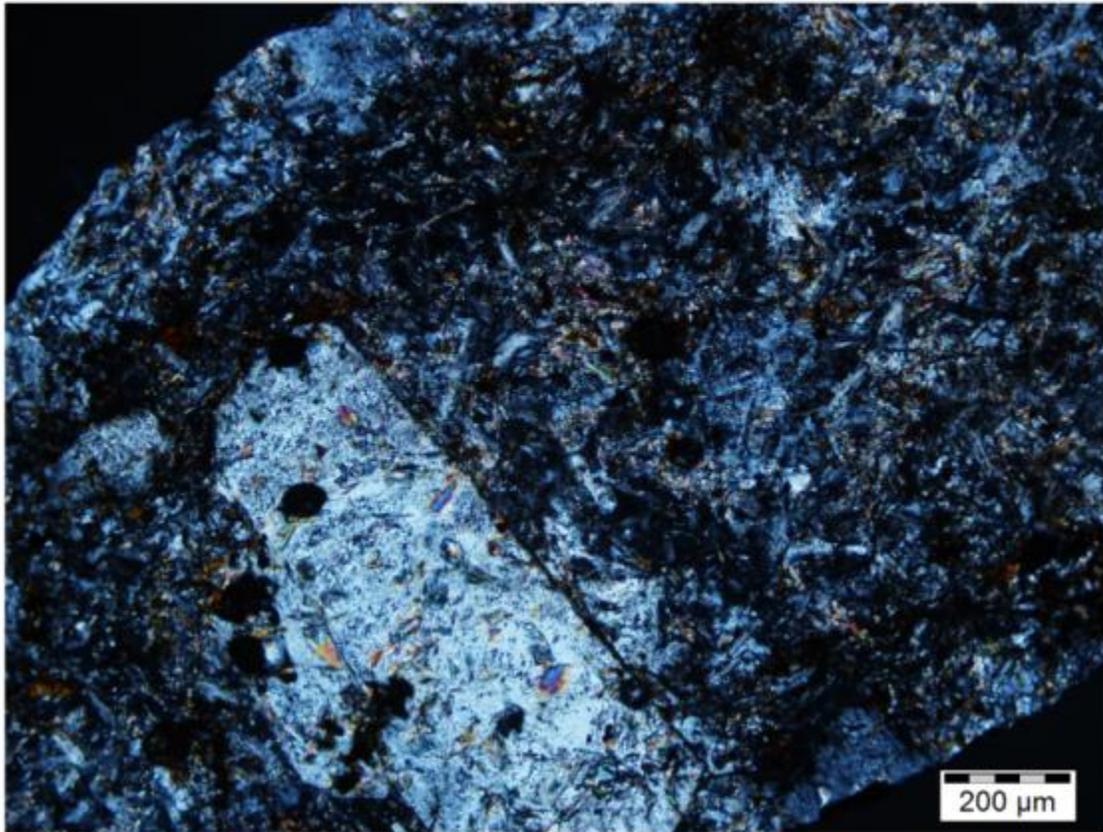
Petrographic Classification:

Altered feldspar-phyric hypabyssal rock.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 56

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Unknown A, moderately coarse and degraded, grey to tan in colour with small vugs.

Microstructure:

Euhedral phenocrysts of feldspar immersed within a groundmass of fine-grained anhedral feldspar.

Primary Minerals:

Feldspar and perhaps plagioclase.

Alteration Minerals:

Limonitic material, epidote, and clay.

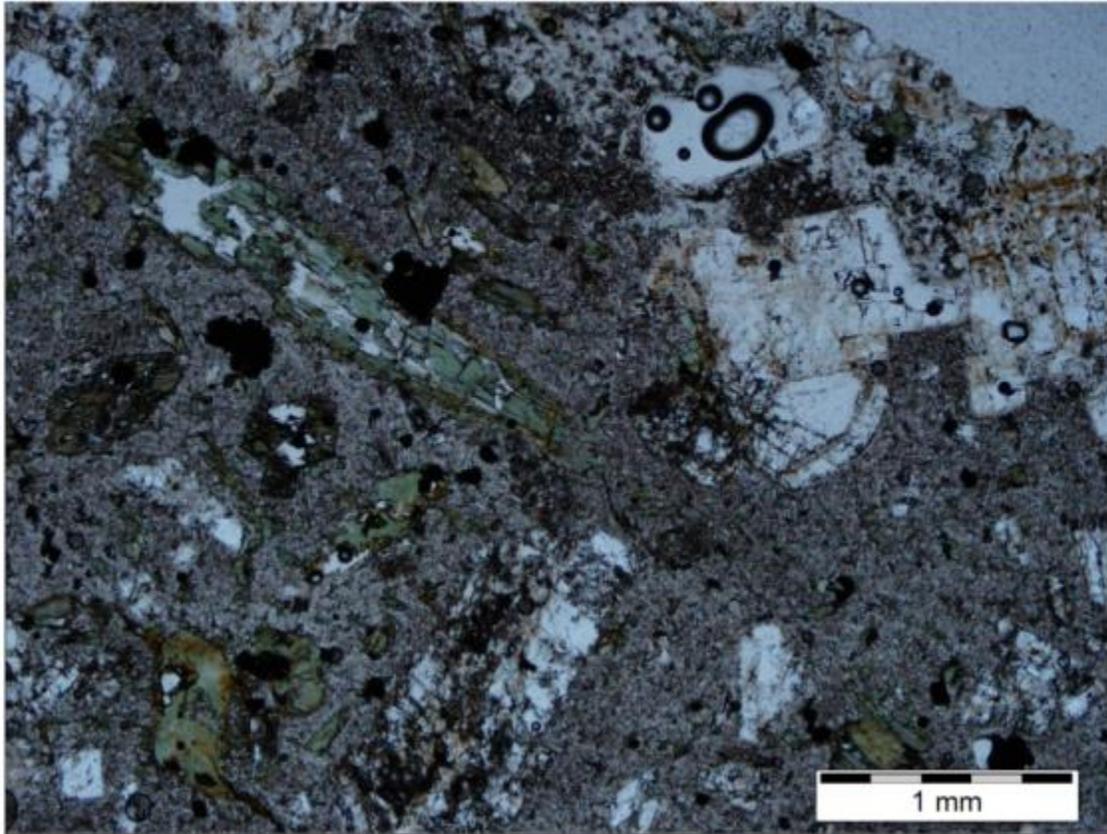
Petrographic Classification:

Altered feldspar-phyric hypabyssal rock.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 73

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Pitted white matrix with quartz and linear mineral inclusions.

Microstructure:

Euhedral phenocrysts of plagioclase and hornblende immersed within a very fine-grained and clay-altered groundmass.

Primary Minerals:

Plagioclase, hornblende, and quartz.

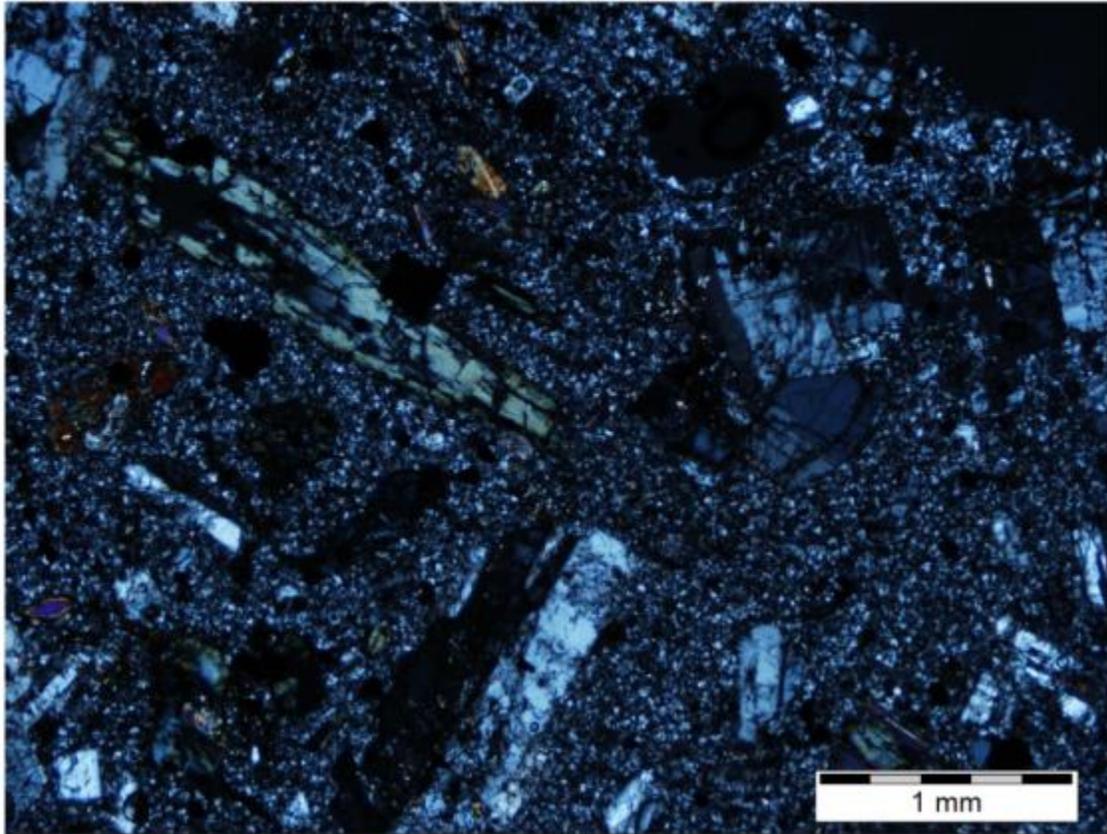
Petrographic Classification:

Hornblende-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 73

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Pitted white matrix with quartz and linear mineral inclusions.

Microstructure:

Euhedral phenocrysts of plagioclase and hornblende immersed within a very fine-grained and clay-altered groundmass.

Primary Minerals:

Plagioclase, hornblende, and quartz.

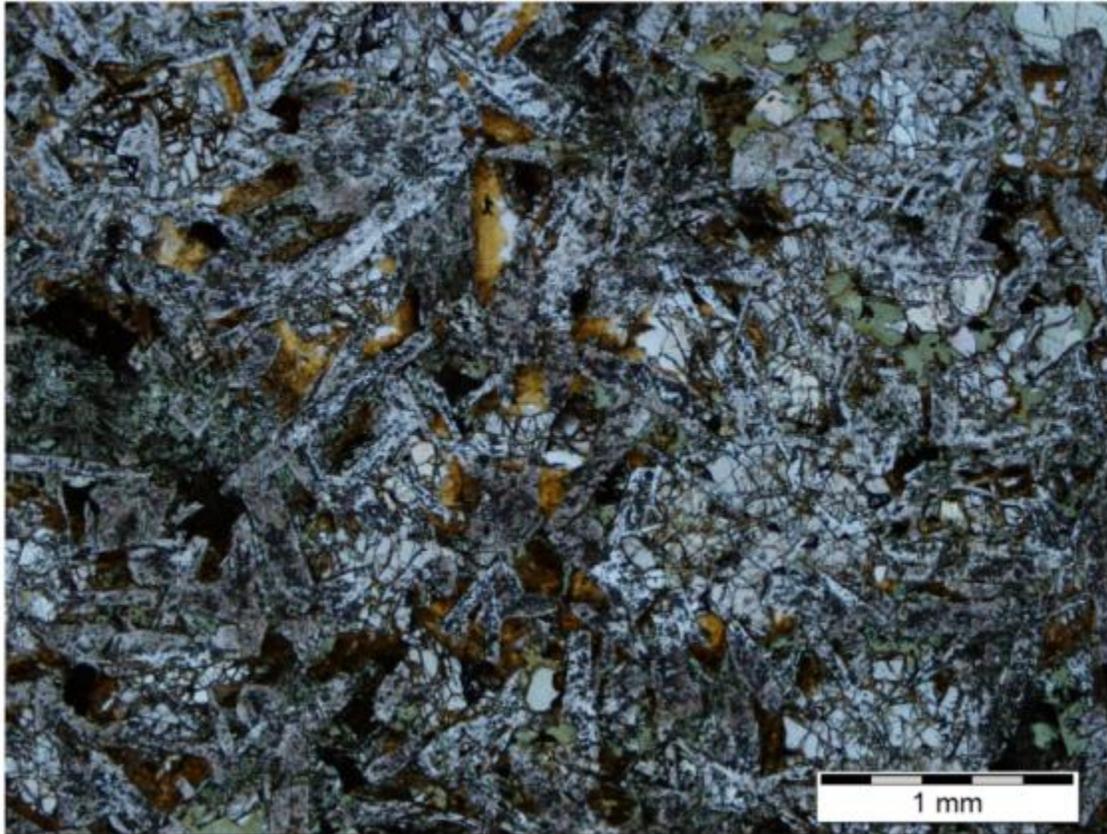
Petrographic Classification:

Hornblende-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 79

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown D, Rusty red brown siltstone with black inclusions.

Microstructure:

Ophitic microstructure defined by laths of plagioclase and pyroxenes.

Alteration Minerals:

Limonite and epidote.

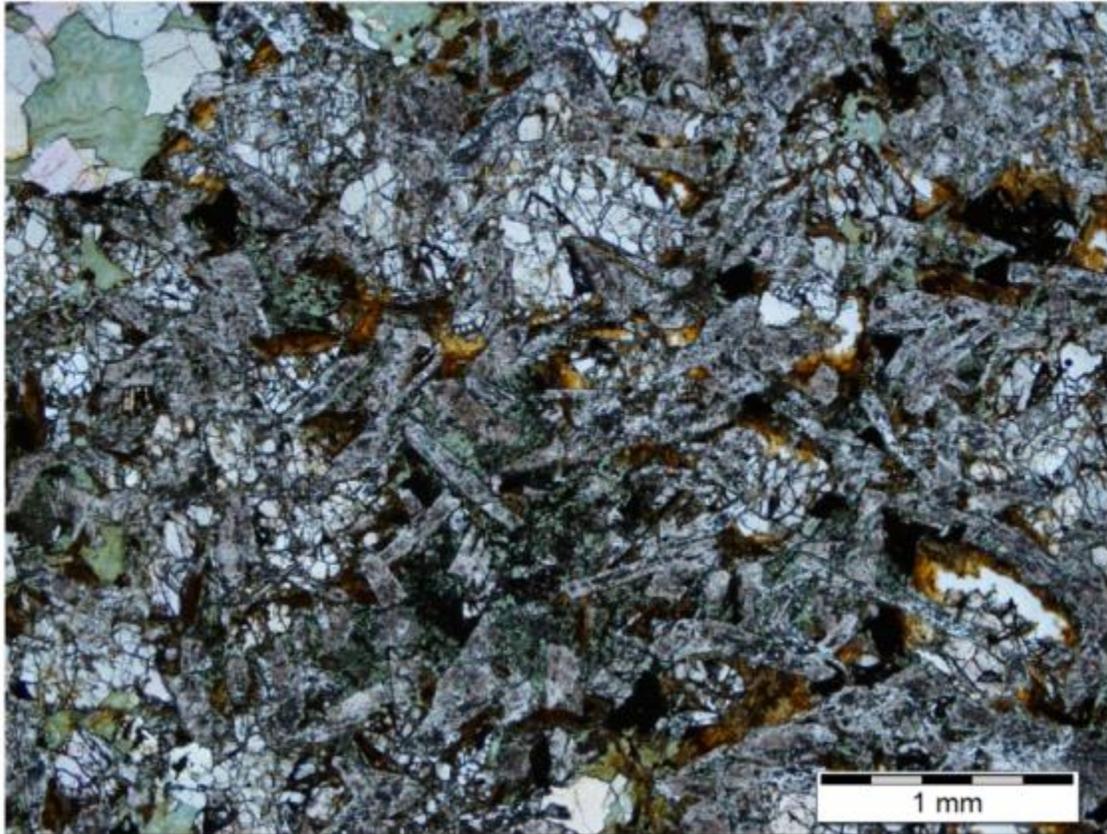
Petrographic Classification:

Microdiorite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 79

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown D, Rusty red brown siltstone with black inclusions.

Microstructure:

Ophitic microstructure defined by laths of plagioclase and pyroxenes.

Alteration Minerals:

Limonite and epidote.

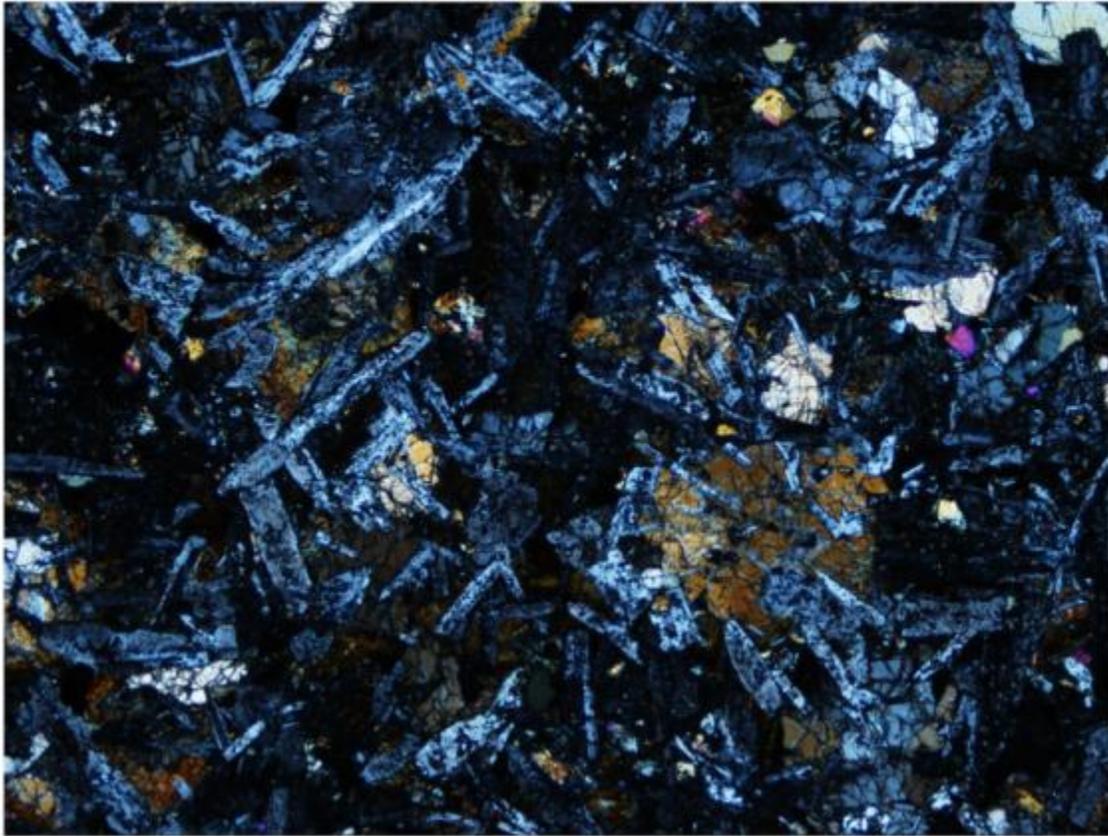
Petrographic Classification:

Microdiorite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 79

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Unknown D, Rusty red brown siltstone with black inclusions.

Microstructure:

Ophitic microstructure defined by laths of plagioclase and pyroxenes.

Alteration Minerals:

Limonite and epidote.

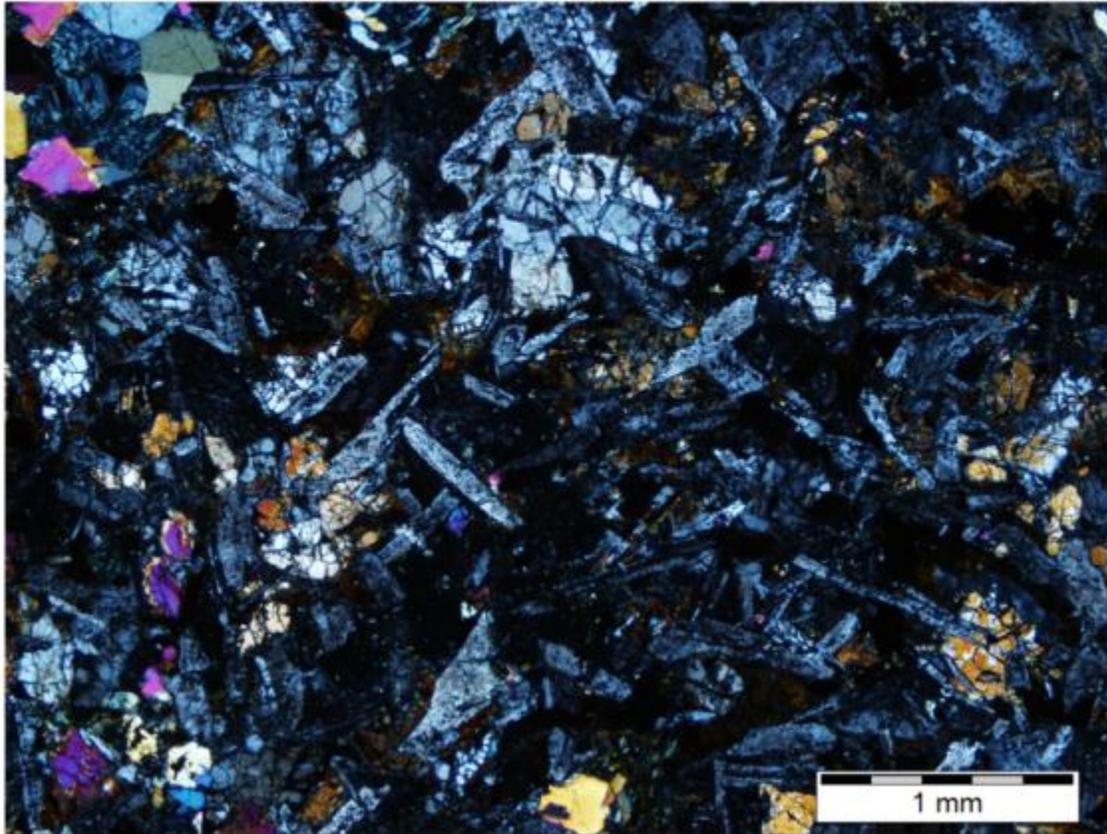
Petrographic Classification:

Microdiorite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 79

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Unknown D, Rusty red brown siltstone with black inclusions.

Microstructure:

Ophitic microstructure defined by laths of plagioclase and pyroxenes.

Alteration Minerals:

Limonite and epidote.

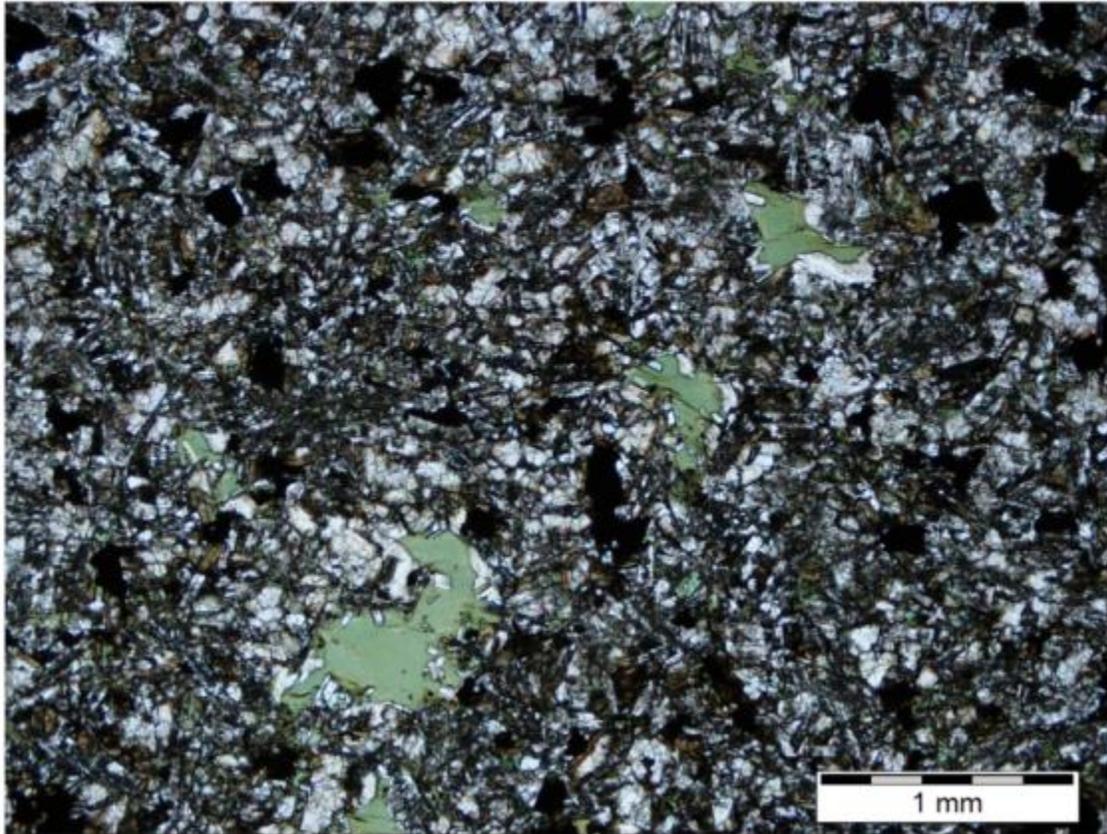
Petrographic Classification:

Microdiorite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 81

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Light grey matrix with black inclusions.

Microstructure:

Granular microstructure defined by subhedral plagioclase, anhedral pyroxene and magnetite (replaced by iron oxides).

Primary Minerals:

Plagioclase and pyroxenes.

Alteration Minerals:

Chlorite, epidote, limonite, and iron oxides

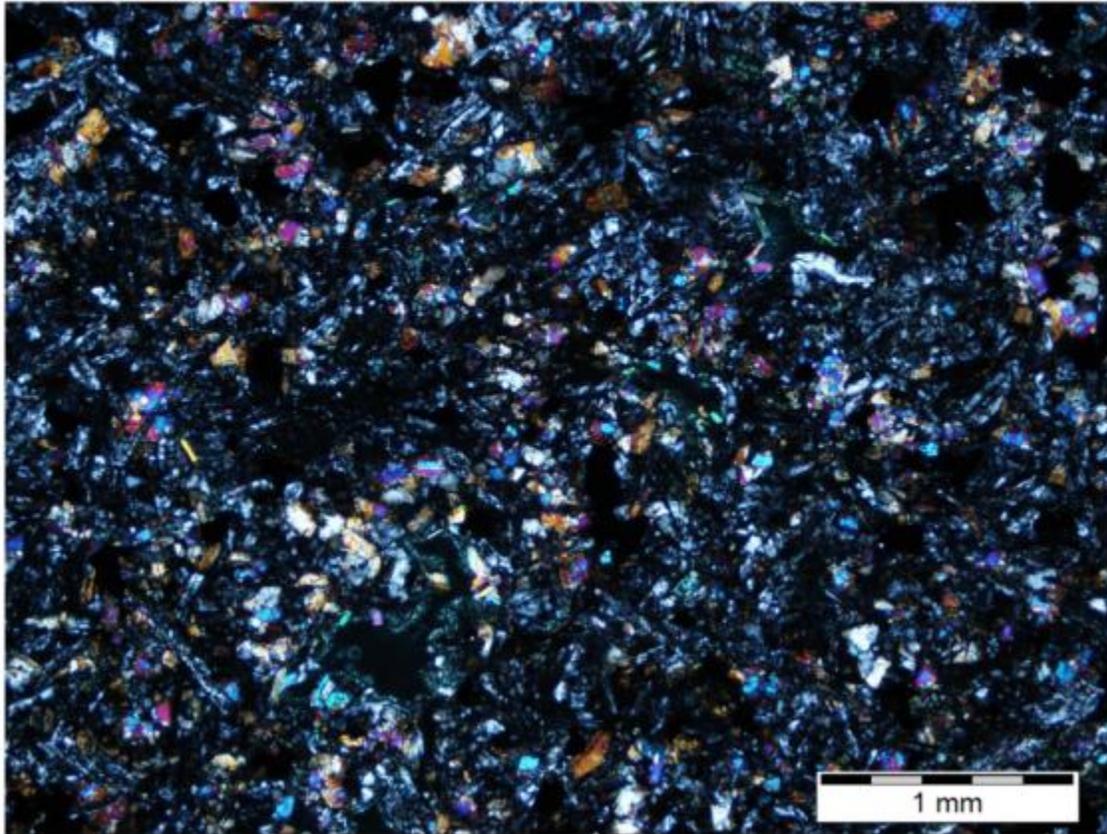
Petrographic Classification:

Altered microdiorite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 81

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Light grey matrix with black inclusions.

Microstructure:

Granular microstructure defined by subhedral plagioclase, anhedral pyroxene and magnetite (replaced by iron oxides).

Primary Minerals:

Plagioclase and pyroxenes.

Alteration Minerals:

Chlorite, epidote, limonite, and iron oxides

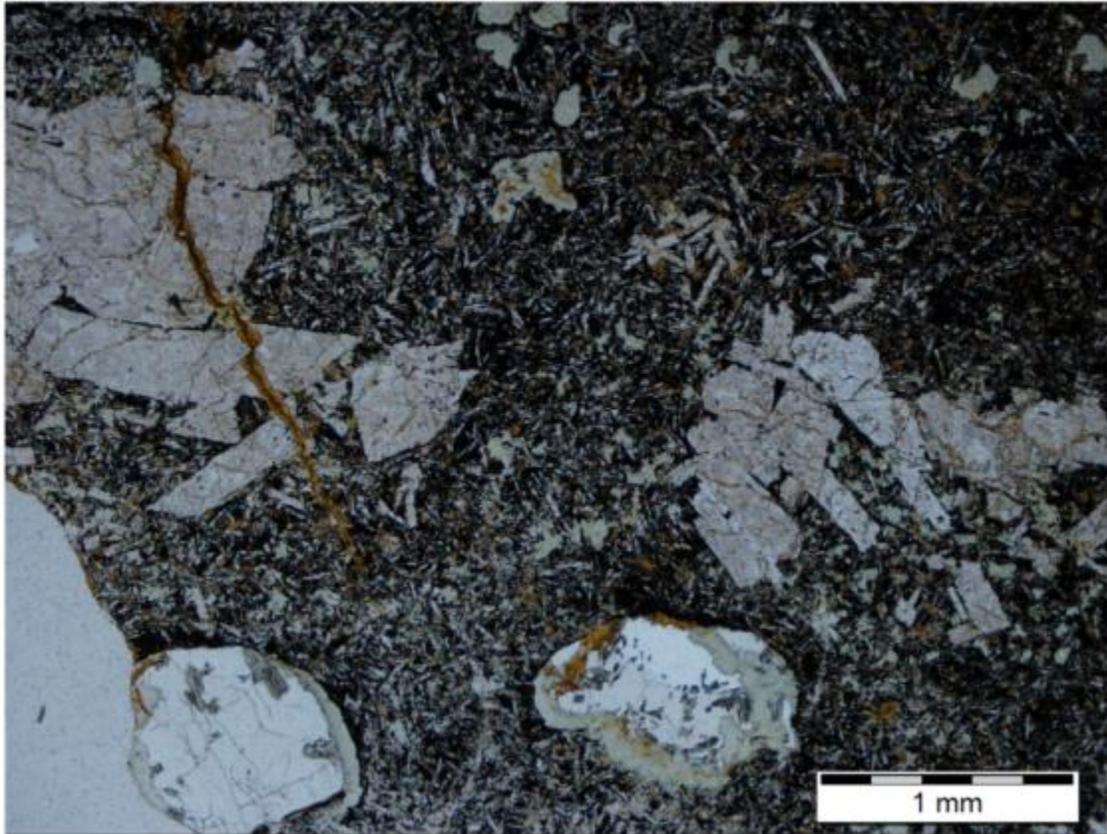
Petrographic Classification:

Altered microdiorite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 94

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown C, brownish metamorphosed sandstone with large quartz grains.

Microstructure:

Euhedral phenocrysts and glomerophenocrysts of plagioclase and sub-rounded amygdules of quartz, chlorite and epidote immersed within a fine-grained groundmass of plagioclase with interstitial alteration aggregates of clay, chlorite, and epidote.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Clay, quartz, chlorite, and epidote.

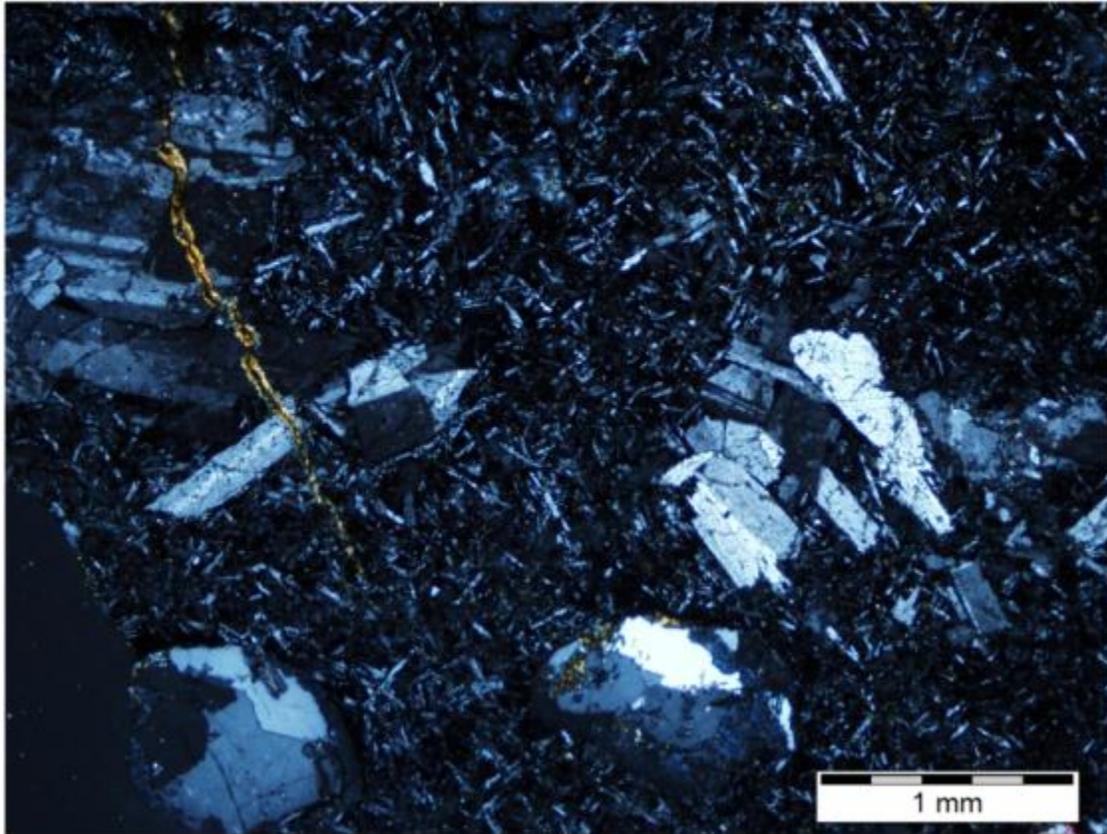
Petrographic Classification:

Plagioclase-phyric amygdalar lava/andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Renda Rock Shelter

Borden Number: EaSh-77

Specimen Number: 94

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Unknown C, brownish metamorphosed sandstone with large quartz grains.

Microstructure:

Euhedral phenocrysts and glomerophenocrysts of plagioclase and sub-rounded amygdules of quartz, chlorite and epidote immersed within a fine-grained groundmass of plagioclase with interstitial alteration aggregates of clay, chlorite, and epidote.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Clay, quartz, chlorite, and epidote.

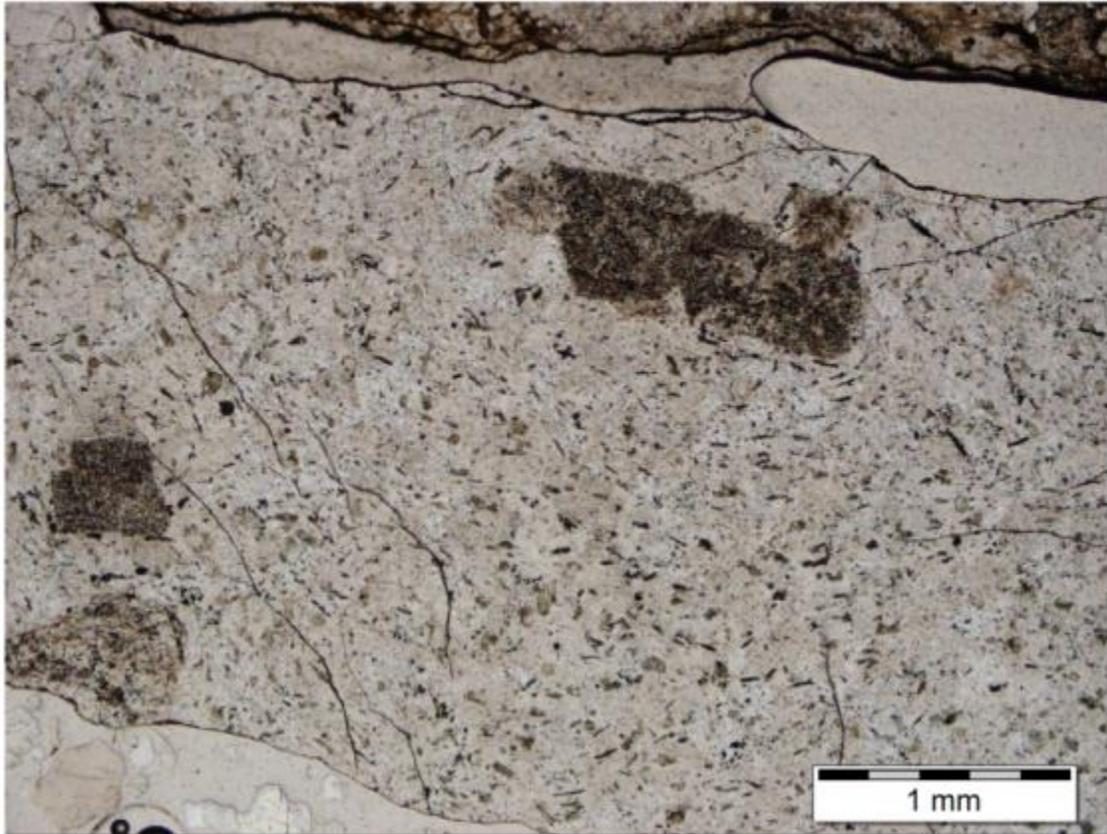
Petrographic Classification:

Plagioclase-phyric amygdalar lava/andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 20

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey dacite with phenocrysts

Microstructure:

Fine-grained interlobate aggregate of quartz or albite. Microstructural relicts of phenocrysts altered by clay.

Alteration Minerals:

Quartz or albite.

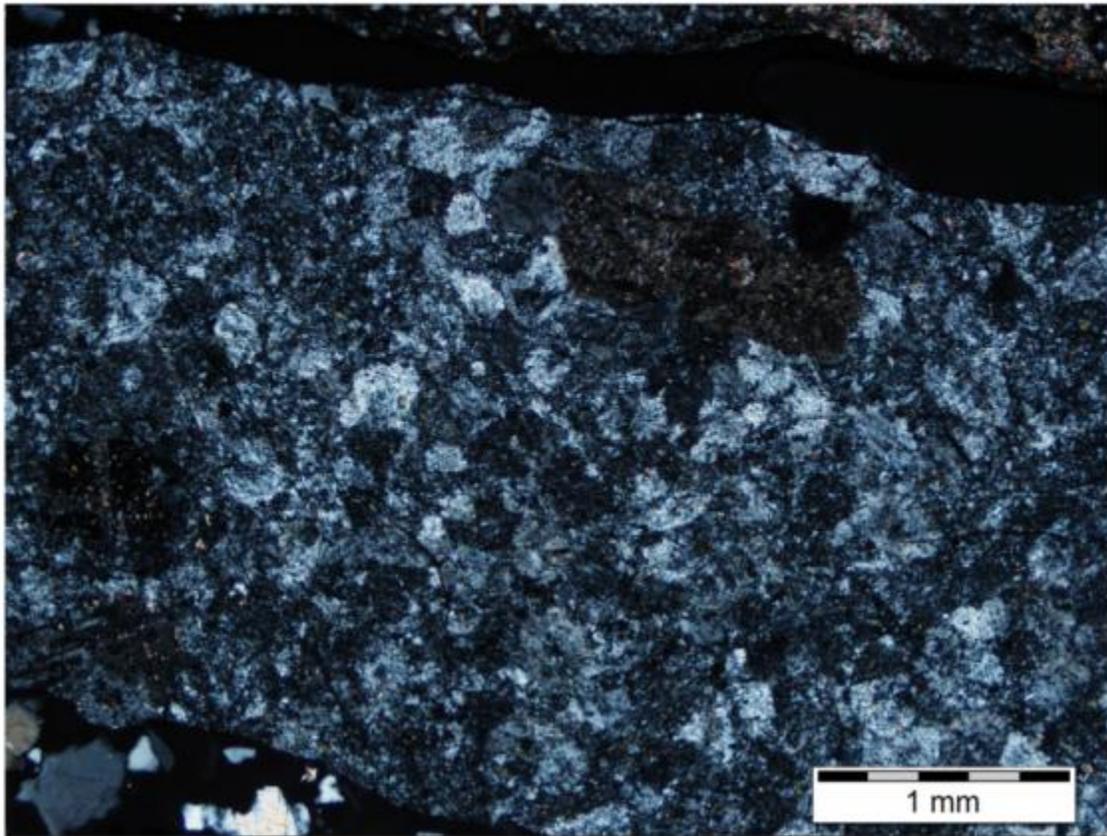
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 20

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Dark grey dacite with phenocrysts

Microstructure:

Fine-grained interlobate aggregate of quartz or albite. Microstructural relicts of phenocrysts altered by clay.

Alteration Minerals:

Quartz or albite.

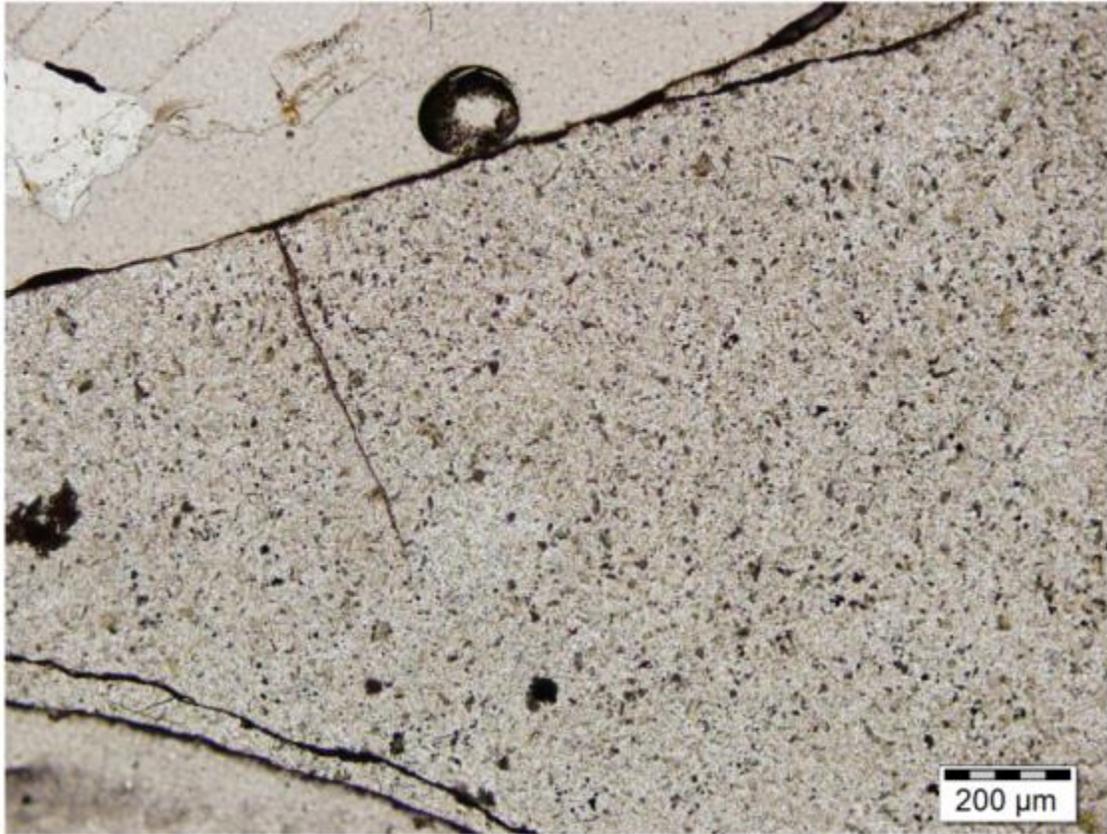
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 27

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey dacite with phenocrysts.

Microstructure:

Inequigranular isotropic aggregate of fine-grained quartz and very fine-grained unresolved material.

Alteration Minerals:

Quartz and clay.

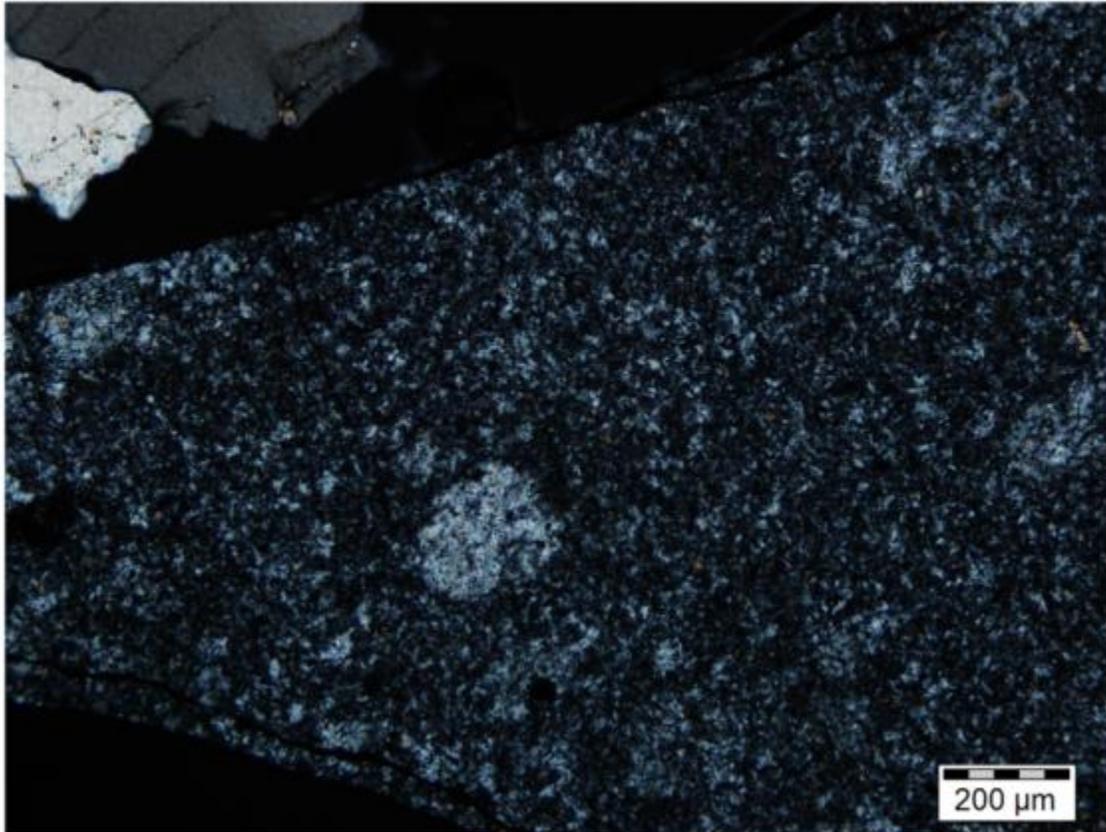
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 27

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Dark grey dacite with phenocrysts.

Microstructure:

Inequigranular isotropic aggregate of fine-grained quartz and very fine-grained unresolved material.

Alteration Minerals:

Quartz and clay.

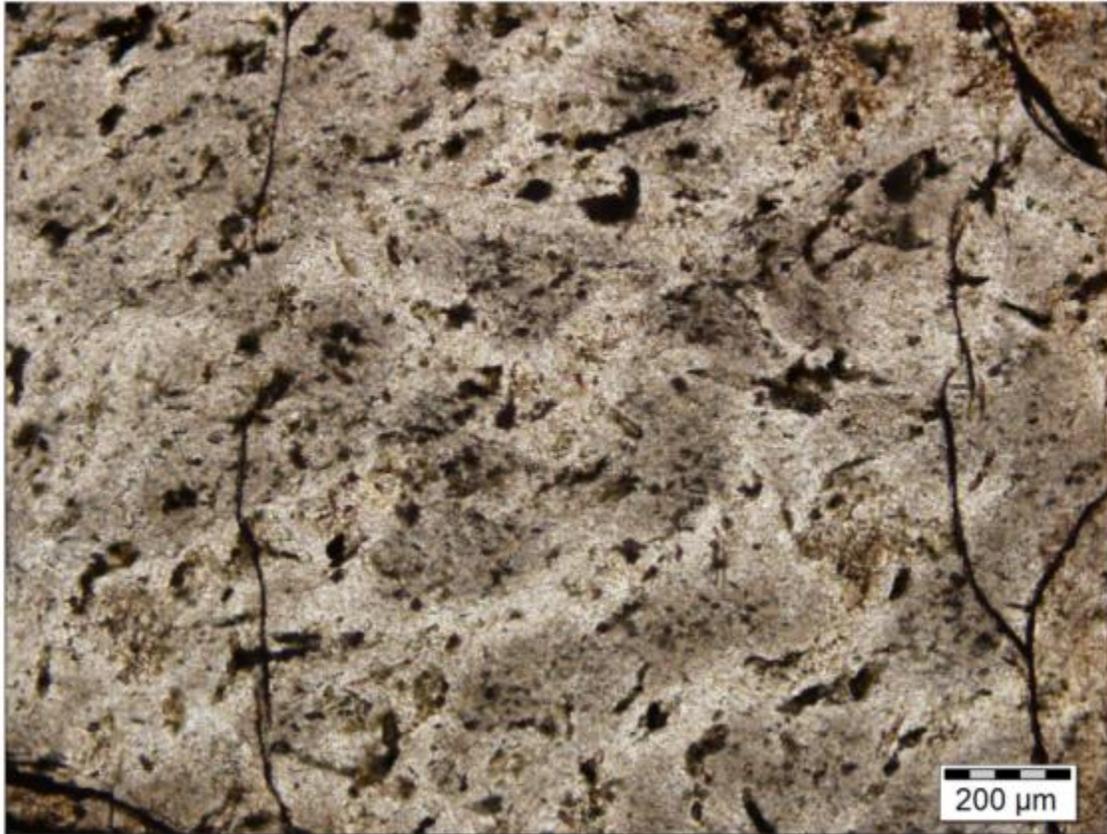
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 106

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dacite with phenocrysts.

Microstructure:

Very fine-grained.

Alteration Minerals:

Quartz.

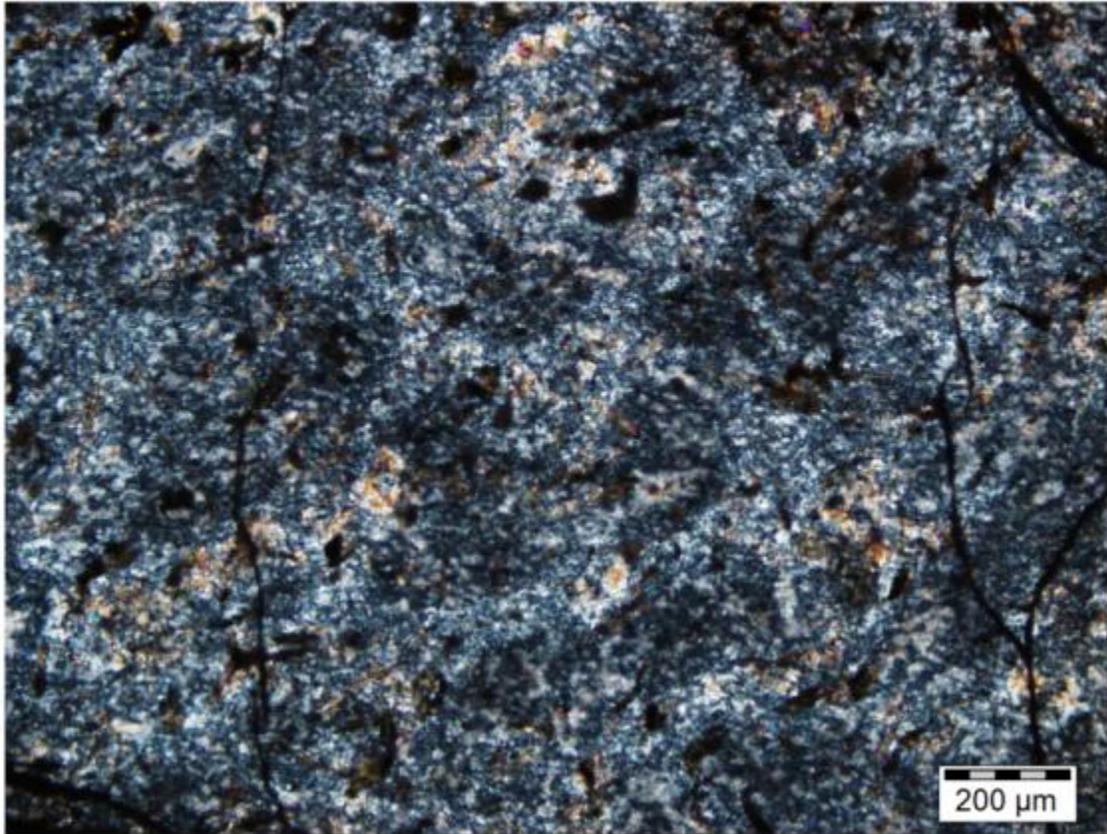
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 106

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Dacite with phenocrysts.

Microstructure:

Very fine-grained.

Alteration Minerals:

Quartz.

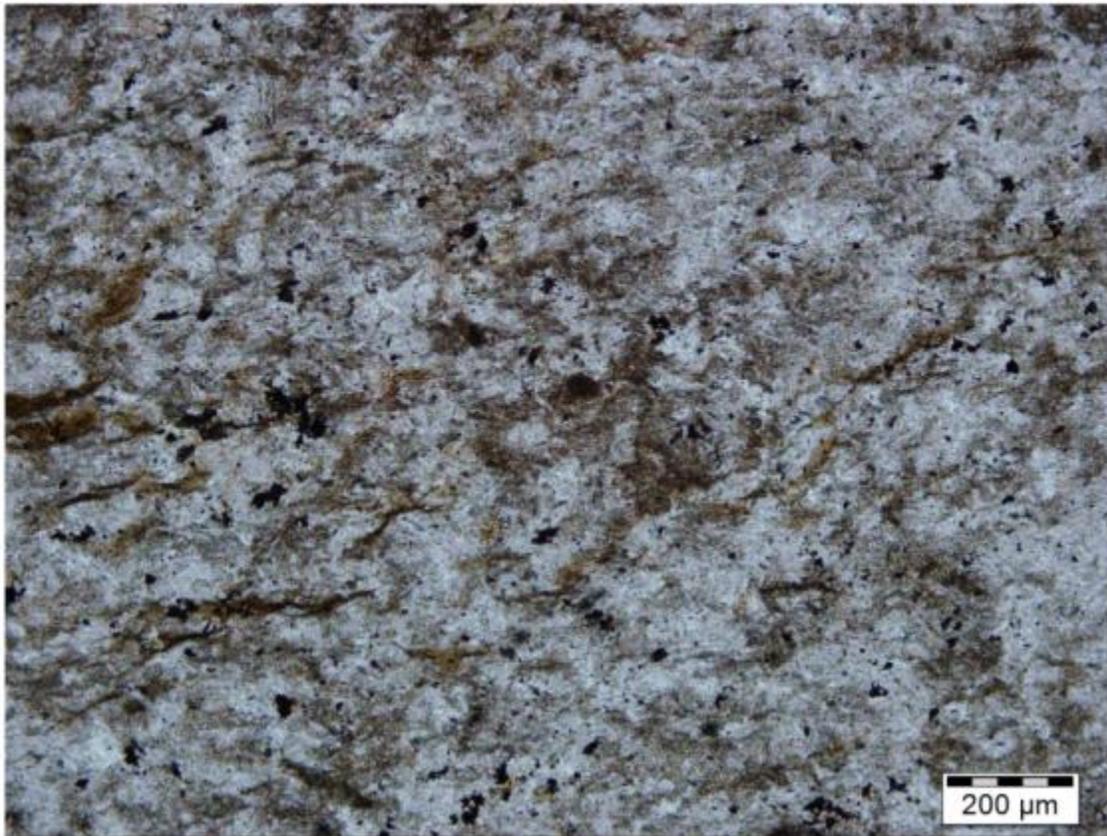
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 129

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Grey quartzite.

Microstructure:

Very fine- to fine-grained replacement aggregate of quartz and subordinate clay and iron oxides/limonitic material.

Alteration Minerals:

Quartz, clay, and limonite.

Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 129

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Grey quartzite.

Microstructure:

Very fine- to fine-grained replacement aggregate of quartz and subordinate clay and iron oxides/limonitic material.

Alteration Minerals:

Quartz, clay, and limonite.

Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 151

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Grey chert.

Microstructure:

Heterogeneous and subtly banded microstructure made up of inequigranular patches of quartz and very fine-grained dispersions of clay.

Alteration Minerals:

Quartz, clay, limonite.

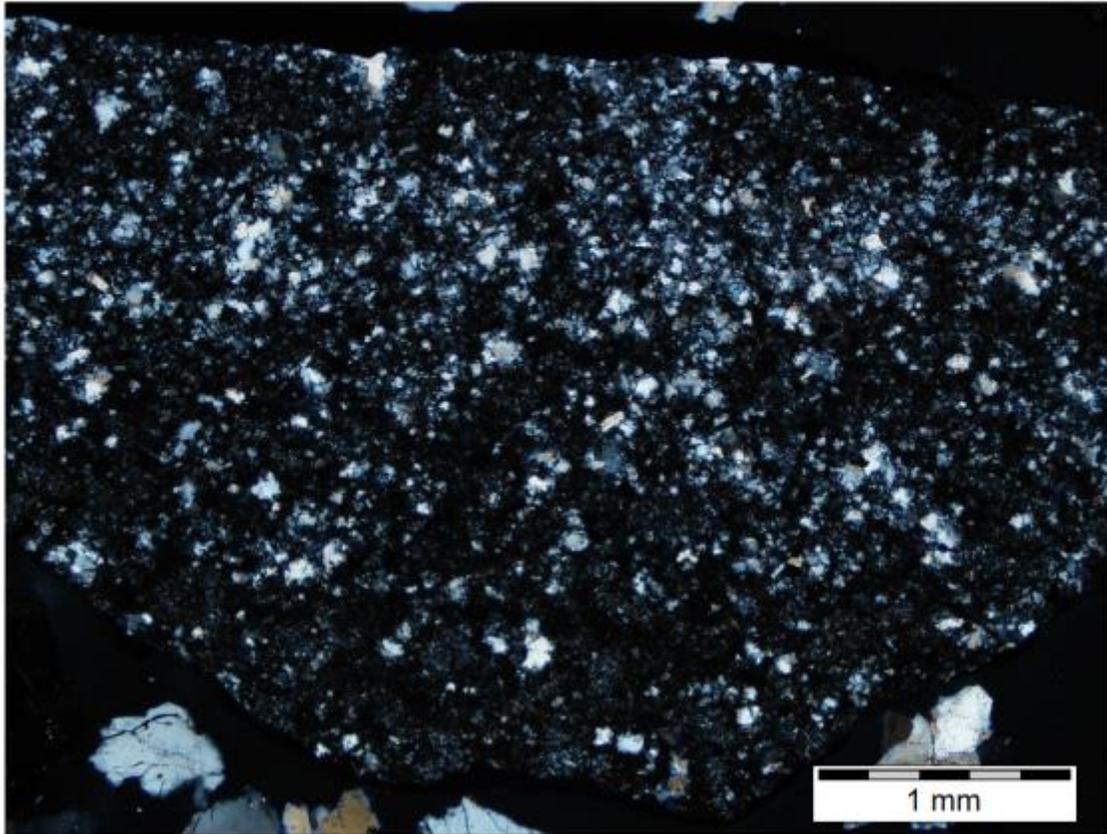
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 151

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Grey chert.

Microstructure:

Heterogeneous and subtly banded microstructure made up of inequigranular patches of quartz and very fine-grained dispersions of clay.

Alteration Minerals:

Quartz, clay, limonite.

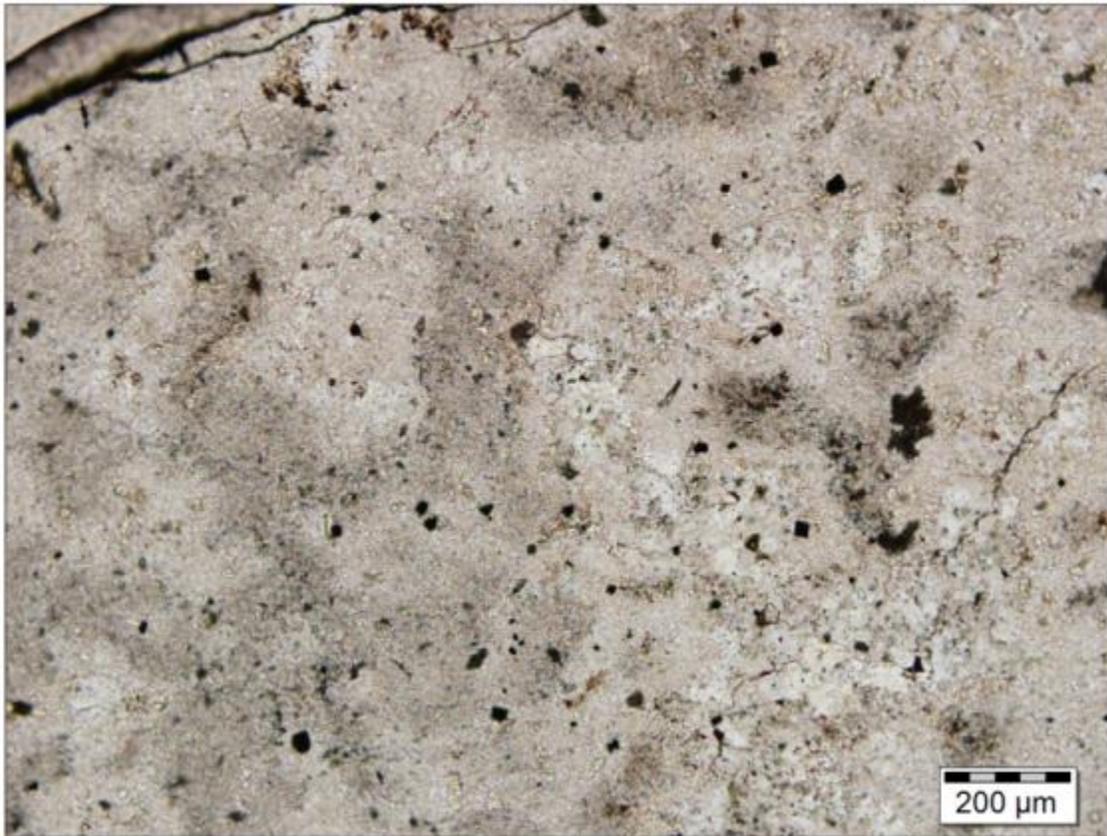
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 166

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey chert.

Microstructure:

Patchy, fine- to very fine-grained replacement aggregates of quartz.

Alteration Minerals:

Quartz.

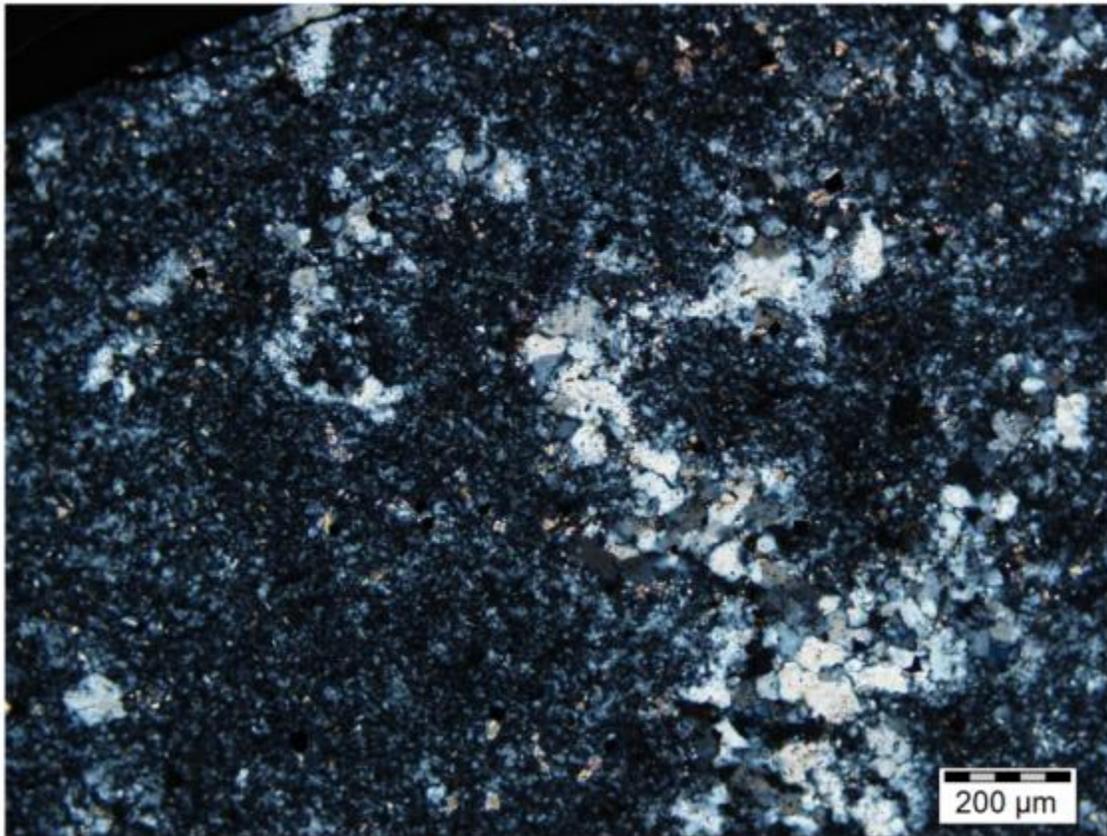
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 166

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Dark grey chert.

Microstructure:

Patchy, fine- to very fine-grained replacement aggregates of quartz.

Alteration Minerals:

Quartz.

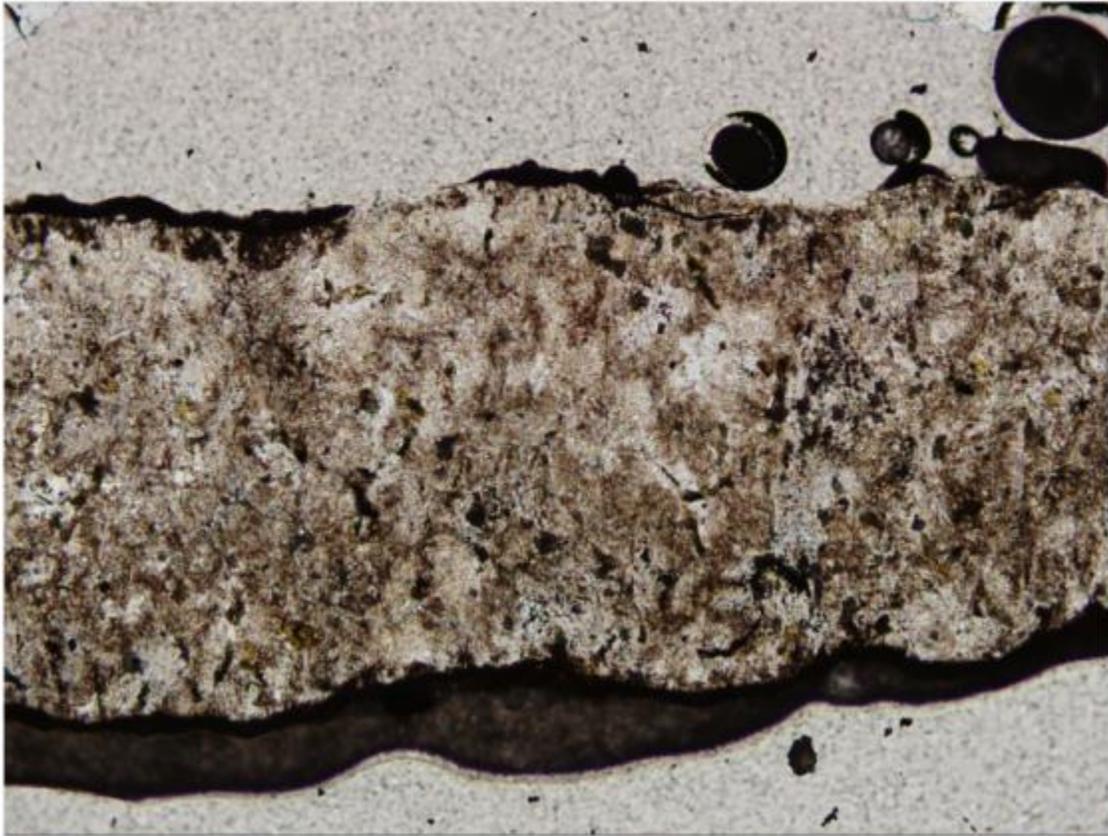
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 185

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Grey chert.

Microstructure:

Heterogeneous replacement aggregate made up of very fine- to fine-grained replacement aggregates of quartz and very fine-grained clay.

Alteration Minerals:

Quartz, clay, and limonite.

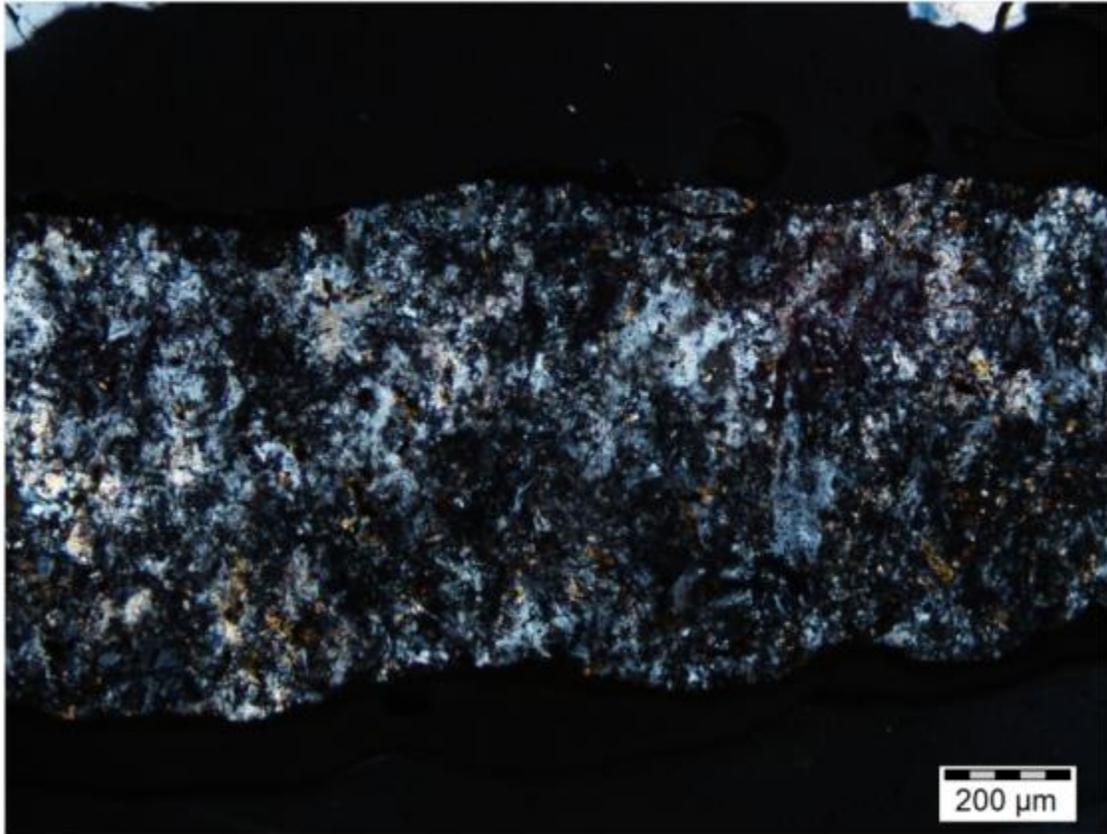
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 185

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Grey chert.

Microstructure:

Heterogeneous replacement aggregate made up of very fine- to fine-grained replacement aggregates of quartz and very fine-grained clay.

Alteration Minerals:

Quartz, clay, and limonite.

Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 198

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Tan chert.

Microstructure:

Very fine-grained replacement aggregate of quartz and clay.

Alteration Minerals:

Quartz and clay.

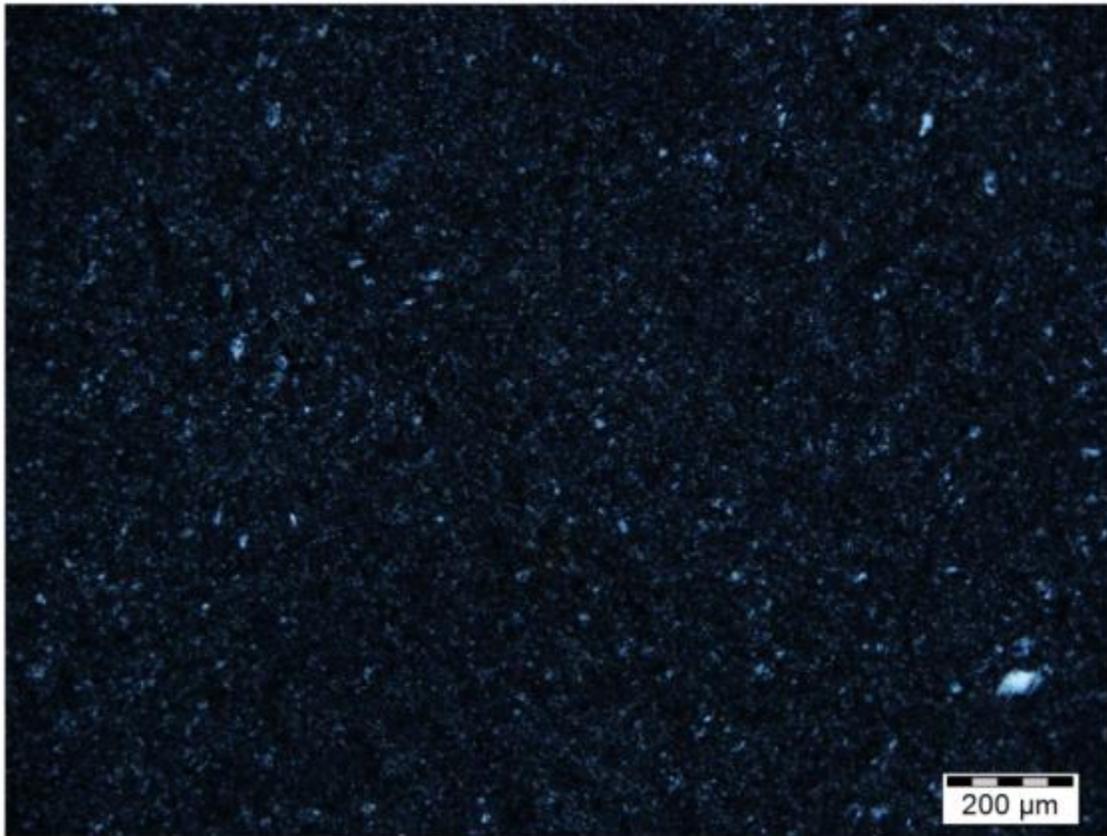
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 198

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Tan chert.

Microstructure:

Very fine-grained replacement aggregate of quartz and clay.

Alteration Minerals:

Quartz and clay.

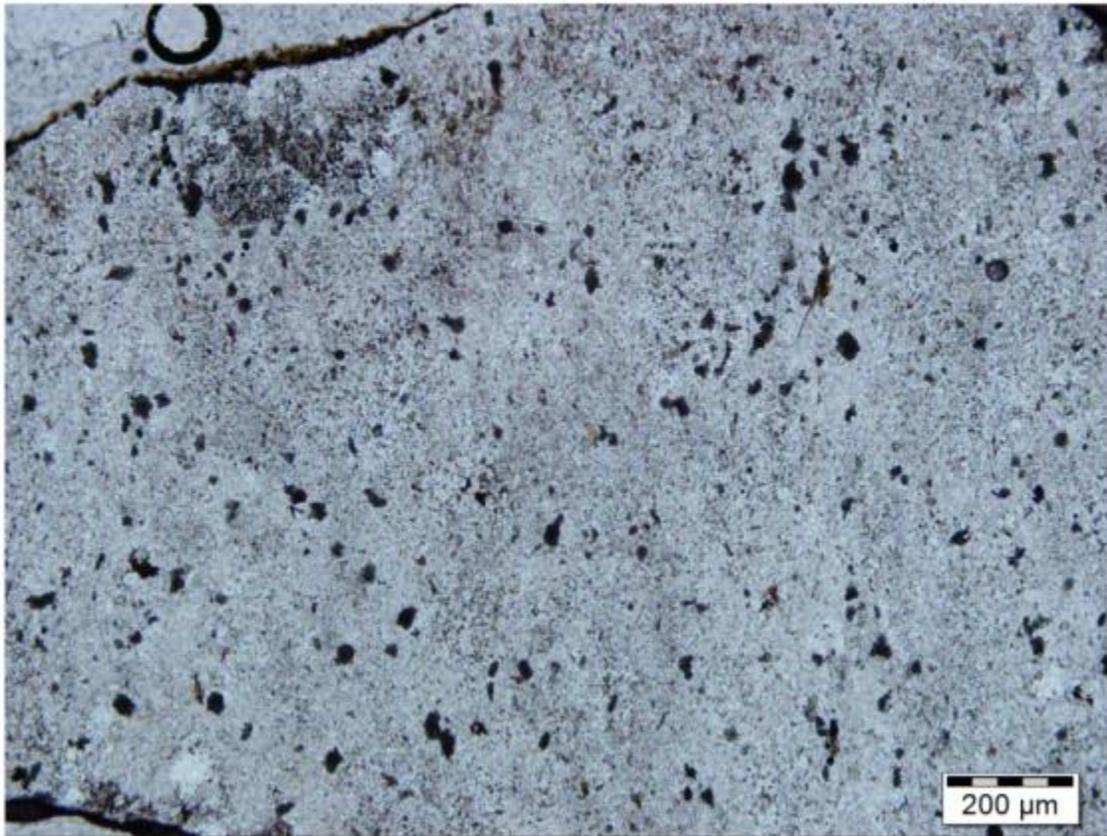
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 244

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Metasediment.

Microstructure:

Inequigranular aggregate of quartz (or albite?) overprinting a porphyritic magma.

Alteration Minerals:

Quartz and/or albite, clay, and limonite.

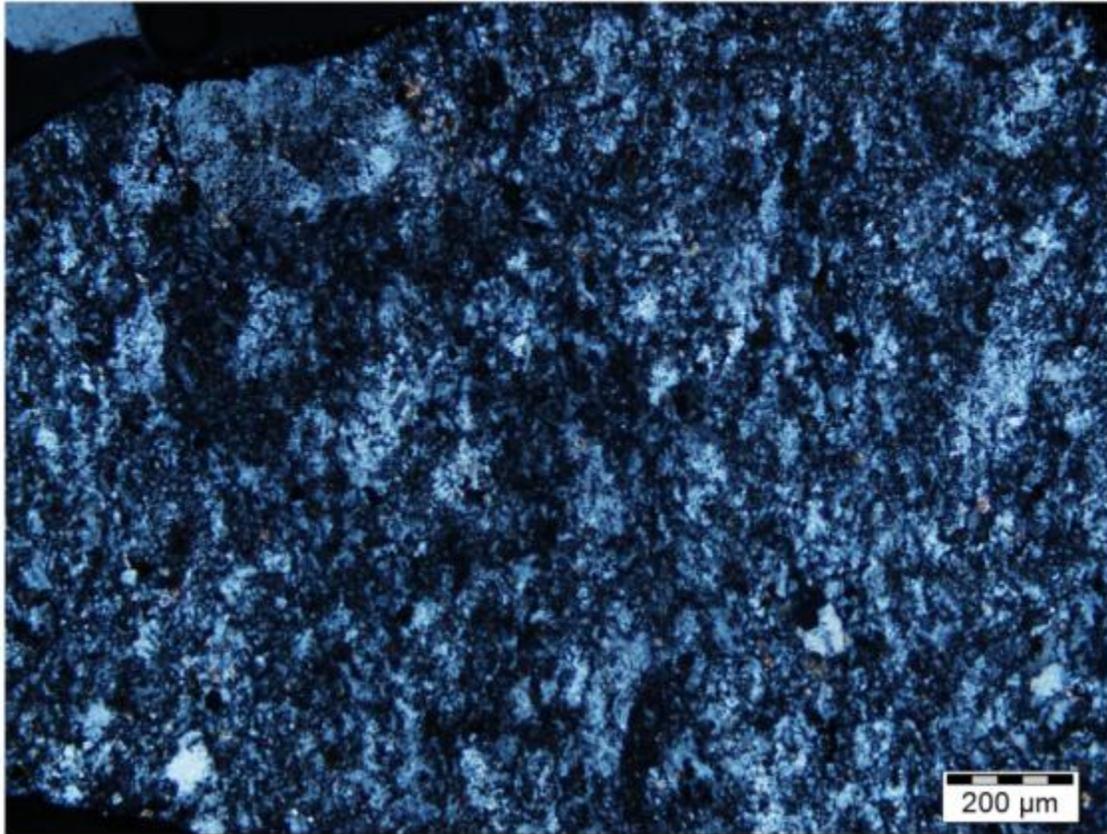
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 244

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Metasediment.

Microstructure:

Inequigranular aggregate of quartz (or albite?) overprinting a porphyritic magma.

Alteration Minerals:

Quartz and/or albite, clay, and limonite.

Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 245

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown dark green/grey.

Microstructure:

Euhedral phenocrysts of plagioclase and pyroxene within a trachytic groundmass.

Primary Minerals:

Plagioclase & pyroxene.

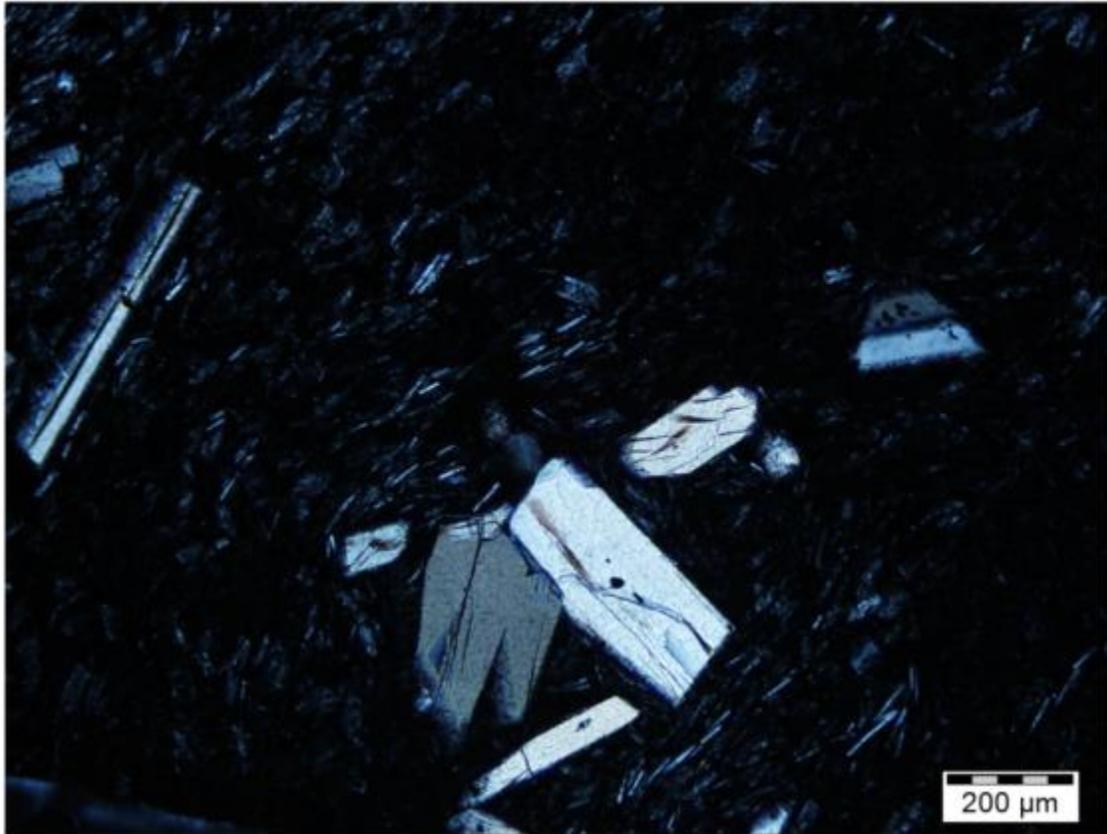
Petrographic Classification:

Pyroxene-plagioclase-phyric basalt.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 245

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Unknown dark green/grey.

Microstructure:

Euhedral phenocrysts of plagioclase and pyroxene within a trachytic groundmass.

Primary Minerals:

Plagioclase & pyroxene.

Petrographic Classification:

Pyroxene-plagioclase-phyric basalt.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 283

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Green grey chert.

Microstructure:

Very fine-grained replacement aggregate of quartz and less clay.

Alteration Minerals:

Quartz and clay.

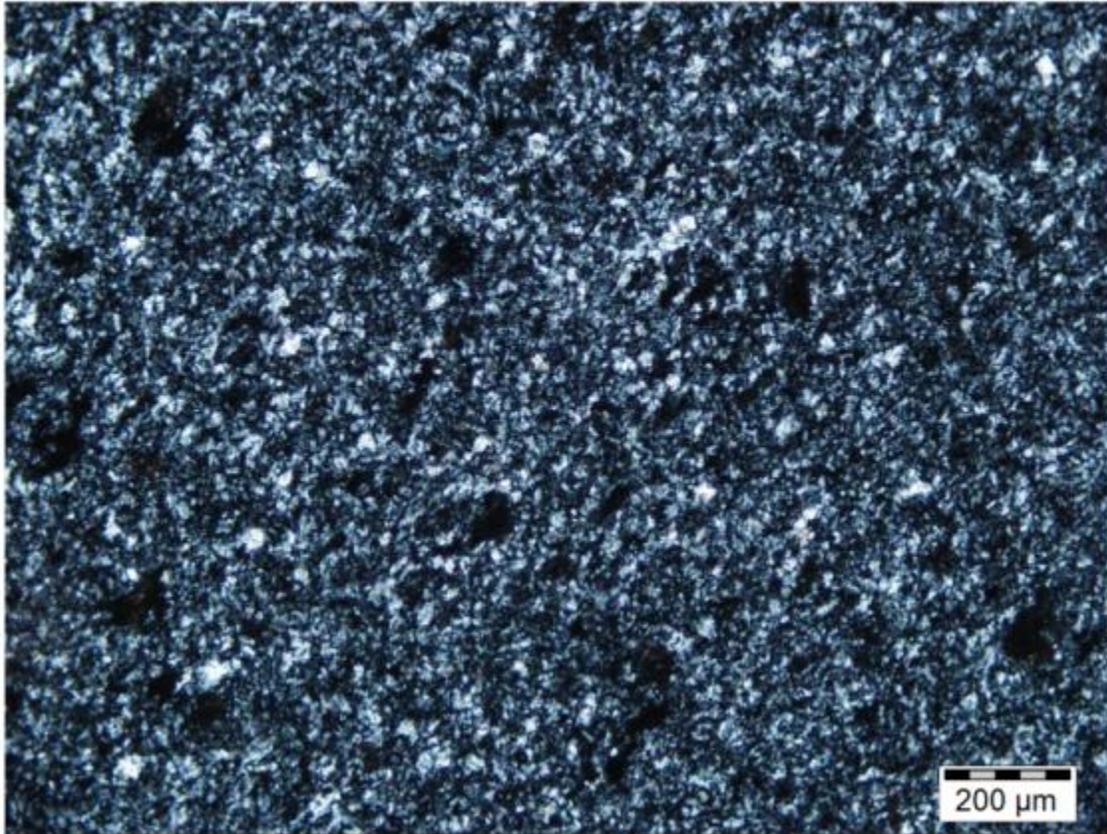
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 283

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Green grey chert.

Microstructure:

Very fine-grained replacement aggregate of quartz and less clay.

Alteration Minerals:

Quartz and clay.

Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel
Borden Number: EbSh-81
Specimen Number: 321
Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Tan chert.

Microstructure:

Very fine-grained laths of plagioclase overprinted by very fine-grained clay.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Clay.

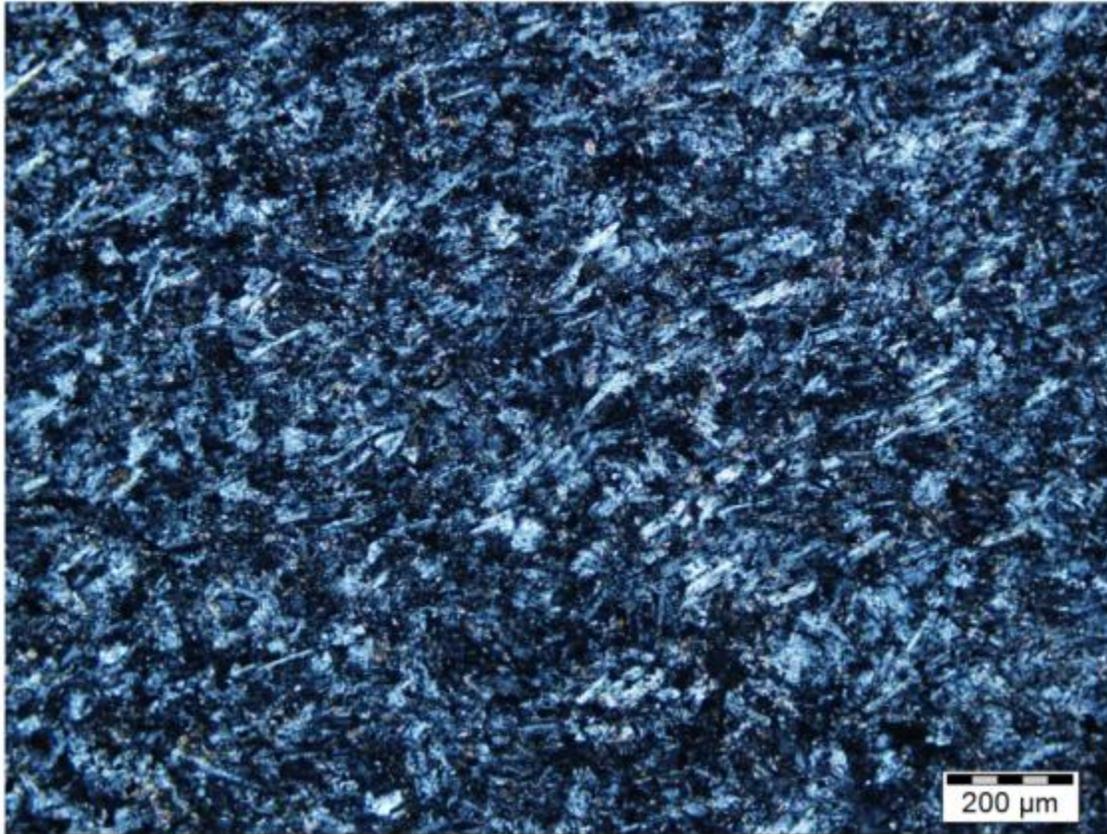
Petrographic Classification:

Altered lava.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 321

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Tan chert.

Microstructure:

Very fine-grained laths of plagioclase overprinted by very fine-grained clay.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Clay.

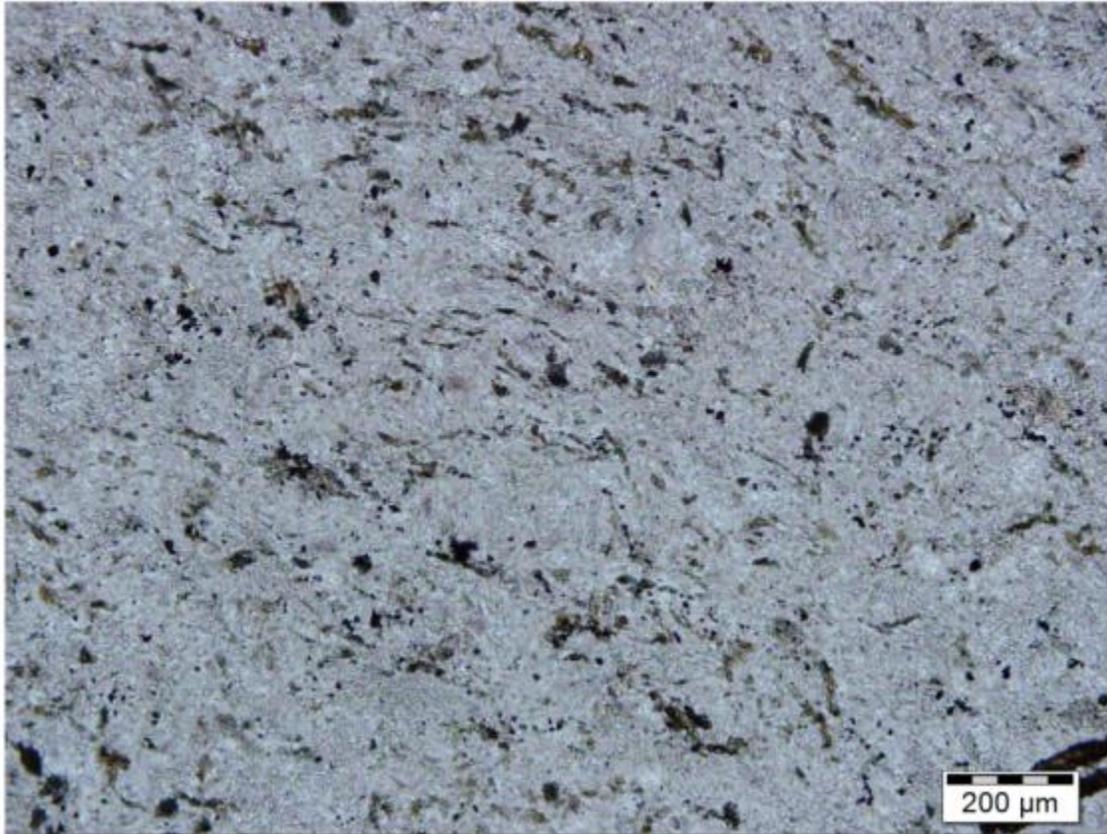
Petrographic Classification:

Altered lava.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 377

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Light grey chert.

Microstructure:

Very fine-grained replacement aggregate of quartz and less clay.

Alteration Minerals:

Quartz and clay. Possibly also iron oxides.

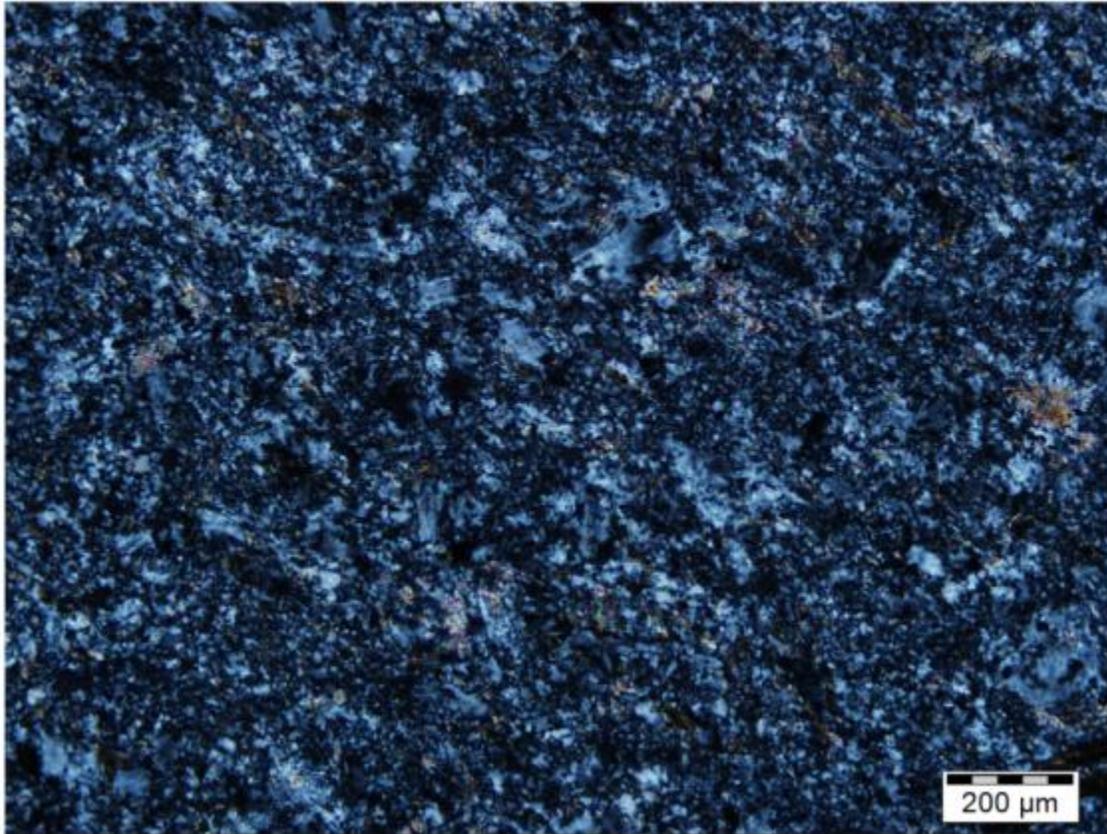
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 377

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Light grey chert.

Microstructure:

Very fine-grained replacement aggregate of quartz and less clay.

Alteration Minerals:

Quartz and clay. Possibly also iron oxides.

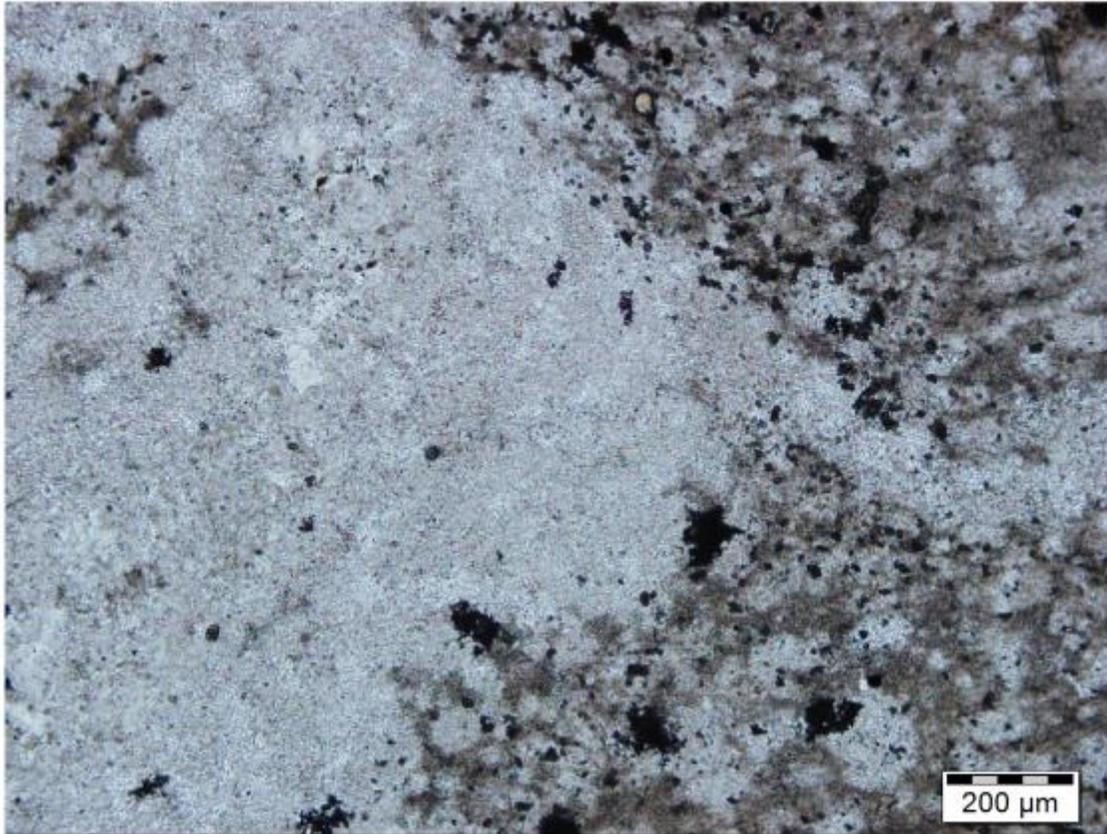
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 383

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Metasediment.

Microstructure:

Heterogeneous sample. Inequigranular aggregates of quartz overprinting irregular domains of very fine-grained clay and lesser quartz.

Alteration Minerals:

Quartz, clay, and iron oxides.

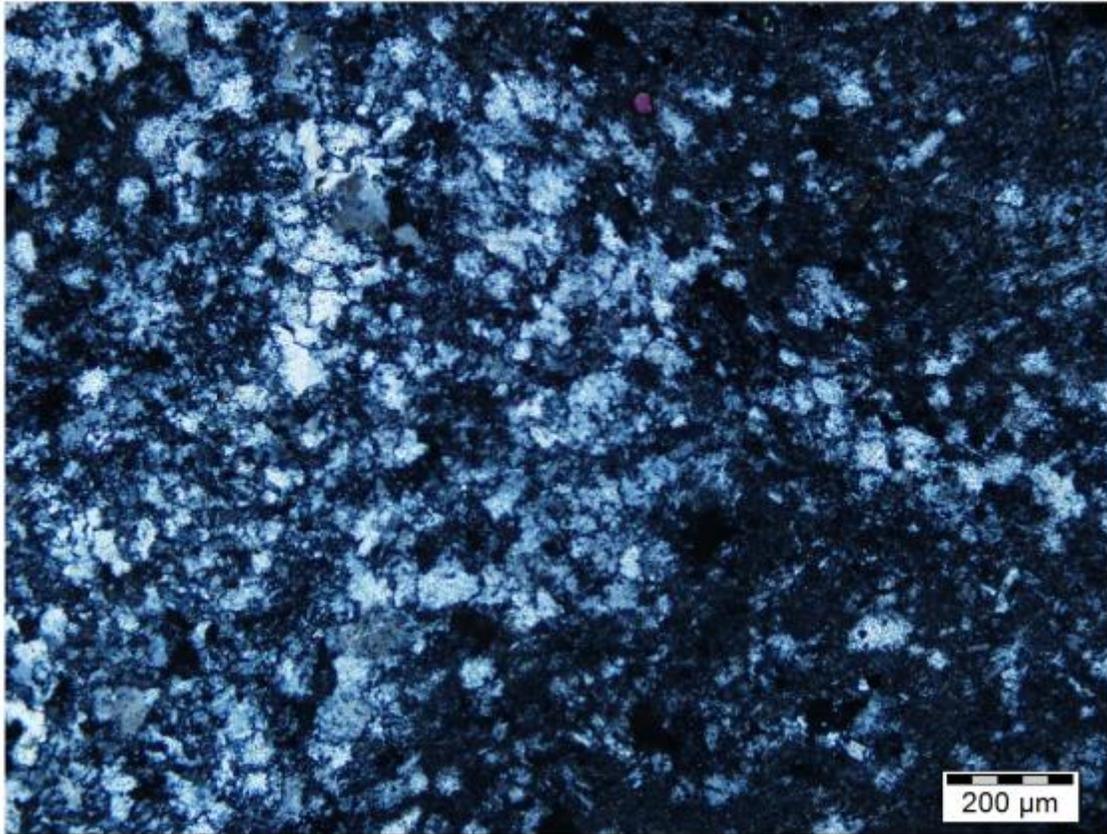
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 383

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Metasediment.

Microstructure:

Heterogeneous sample. Inequigranular aggregates of quartz overprinted irregular domains of very fine-grained clay and lesser quartz.

Alteration Minerals:

Quartz, clay, and iron oxides.

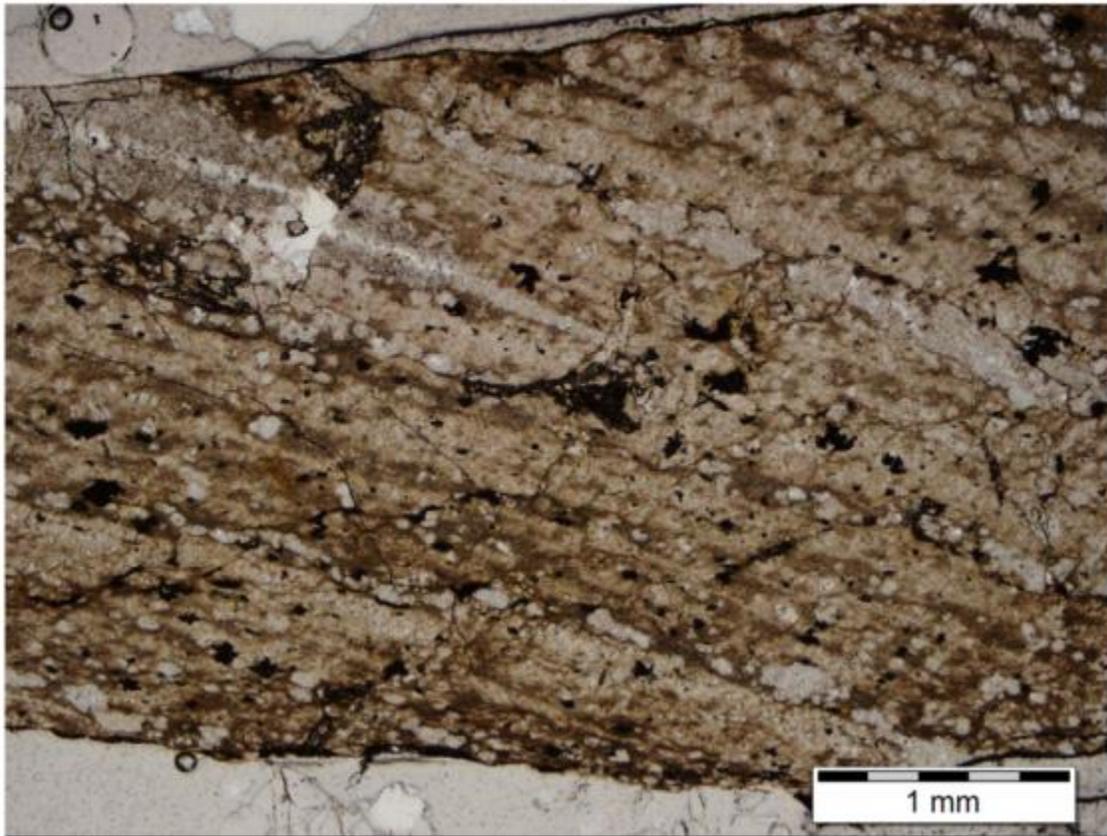
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 448

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey chert.

Microstructure:

Layered, sub-parallel domains of inequigranular quartz alternated with very fine-grained bands of unresolvable material (clay or limonite).

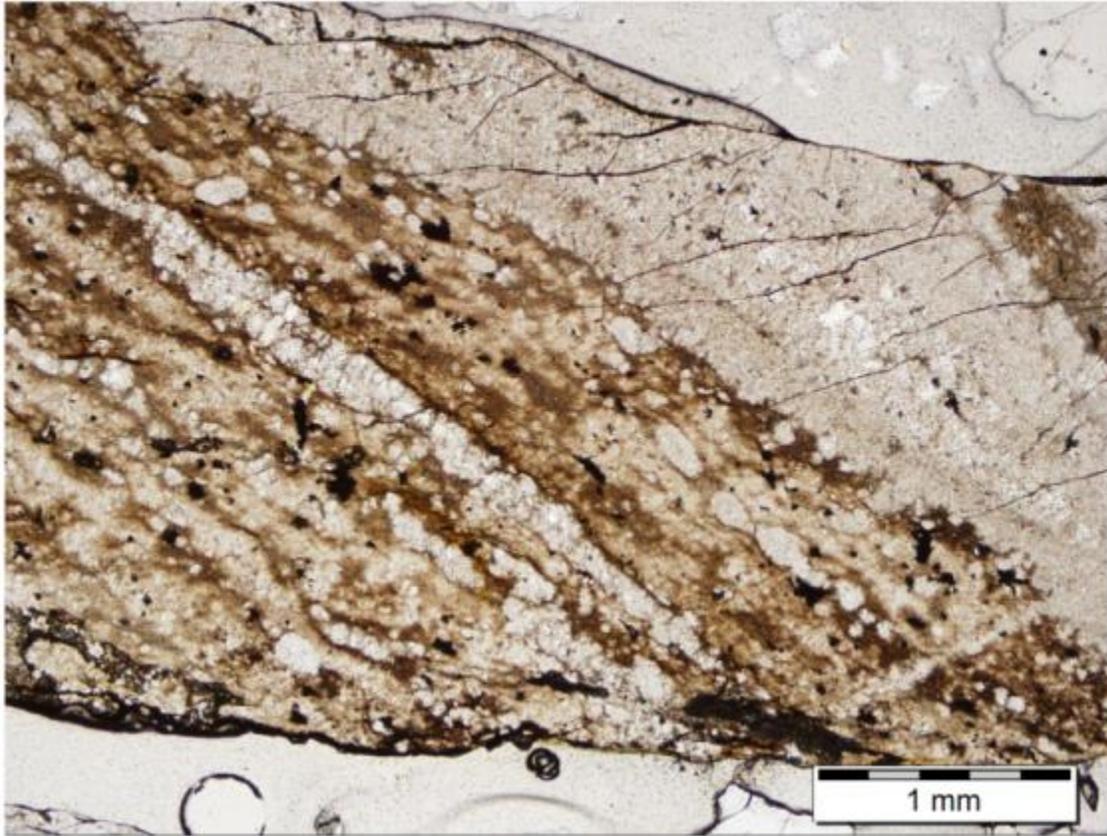
Petrographic Classification:

Alteration zone or chert, somewhat inconclusive.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 448

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey chert.

Microstructure:

Layered, sub-parallel domains of inequigranular quartz alternated with very fine-grained bands of unresolvable material (clay or limonite).

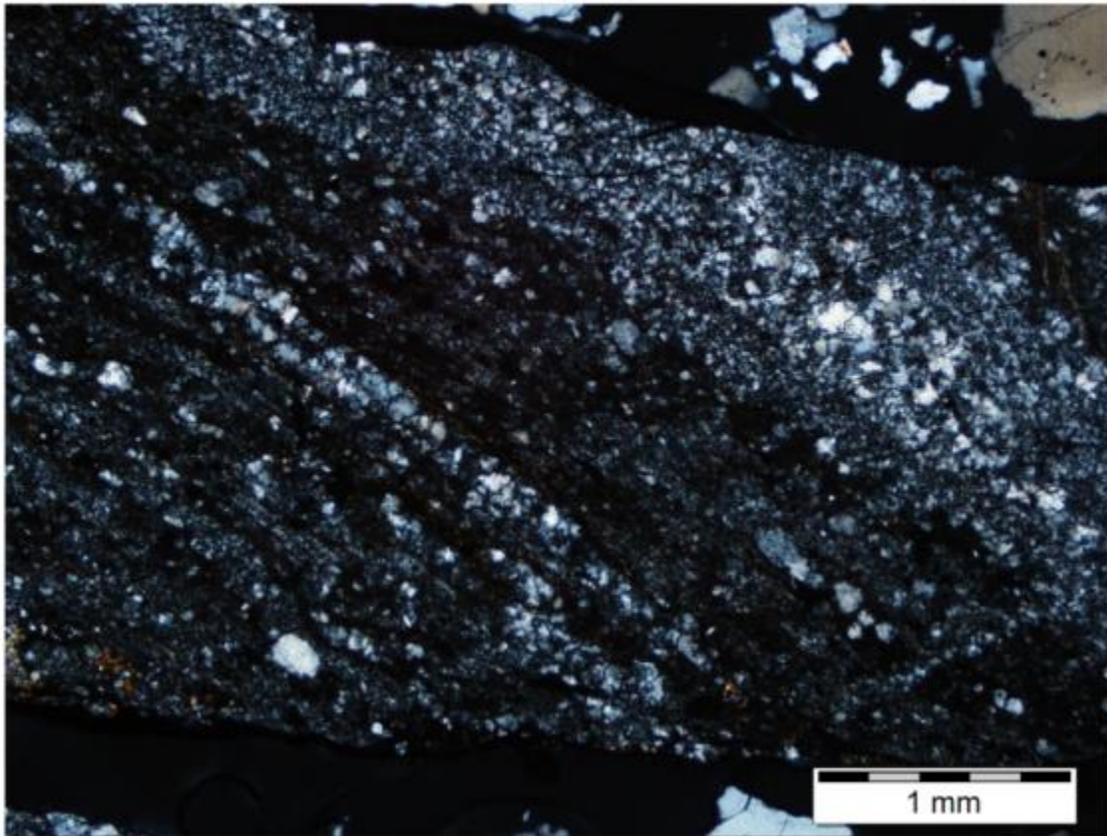
Petrographic Classification:

Alteration zone or chert, somewhat inconclusive.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 448

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Dark grey chert.

Microstructure:

Layered, sub-parallel domains of inequigranular quartz alternated with very fine-grained bands of unresolved material (clay or limonite).

Petrographic Classification:

Alteration zone or chert, somewhat inconclusive.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 465

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey volcanic.

Microstructure:

Euhedral phenocrysts immersed within a trachytic microstructure.

Primary Minerals:

Plagioclase, hornblende, & magnetite.

Alteration Minerals:

Clay.

Petrographic Classification:

Porphyritic lava (andesite or basalt).

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 465

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey volcanic.

Microstructure:

Euhedral phenocrysts immersed within a trachytic microstructure.

Primary Minerals:

Plagioclase, hornblende, & magnetite.

Alteration Minerals:

Clay.

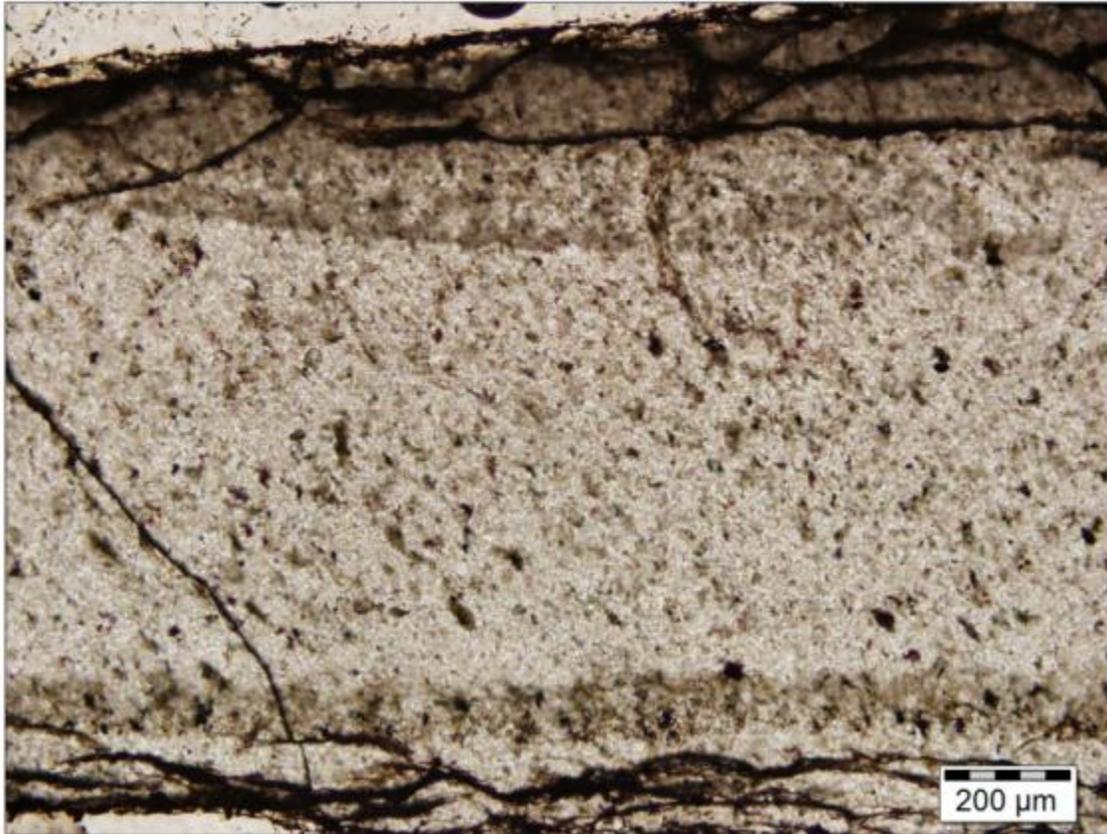
Petrographic Classification:

Porphyritic lava (andesite or basalt).

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 535

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey chalcedony.

Microstructure:

Very fine-grained.

Alteration Minerals:

Quartz.

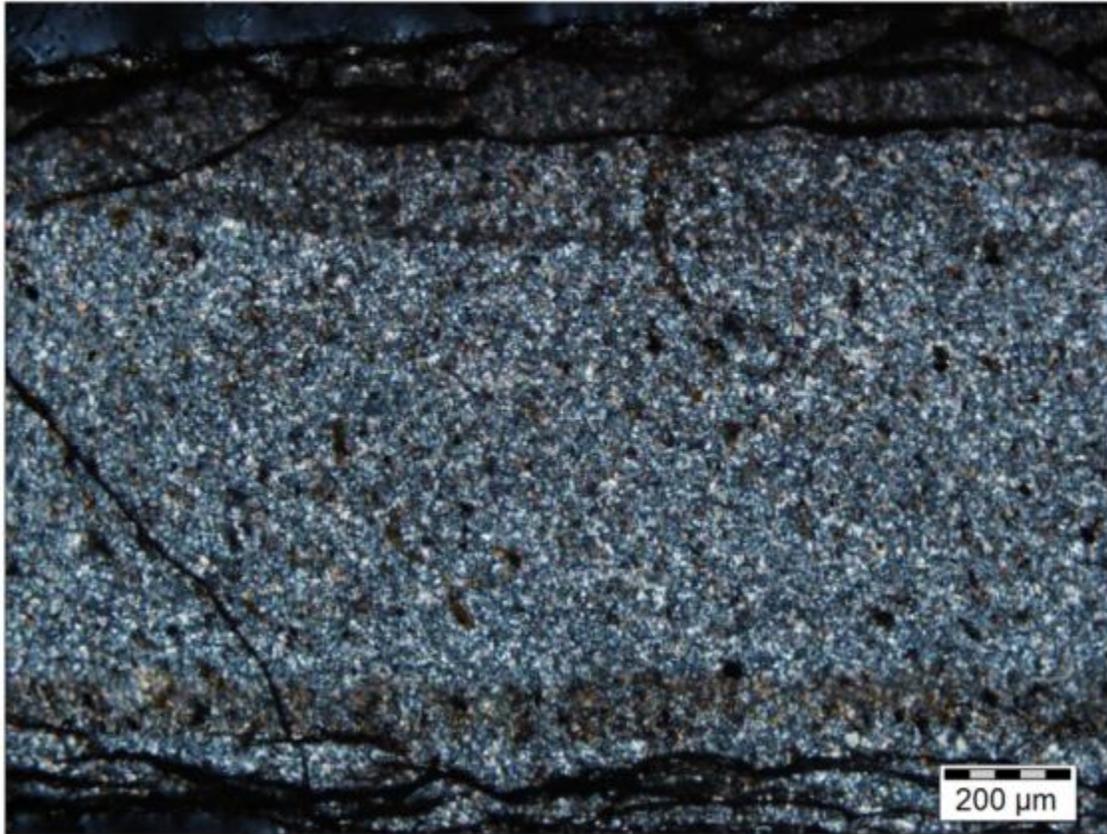
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 535

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Dark grey chalcedony.

Microstructure:

Very fine-grained.

Alteration Minerals:

Quartz.

Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 554

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Black Volcanic.

Microstructure:

Euhedral phenocrysts immersed within a trachytic microstructure.

Primary Minerals:

Plagioclase, hornblende, & magnetite.

Alteration Minerals:

Clay.

Petrographic Classification:

Porphyritic lava (andesite or basalt).

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 554

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Black Volcanic.

Microstructure:

Euhedral phenocrysts immersed within a trachytic microstructure.

Primary Minerals:

Plagioclase, hornblende, & magnetite.

Alteration Minerals:

Clay.

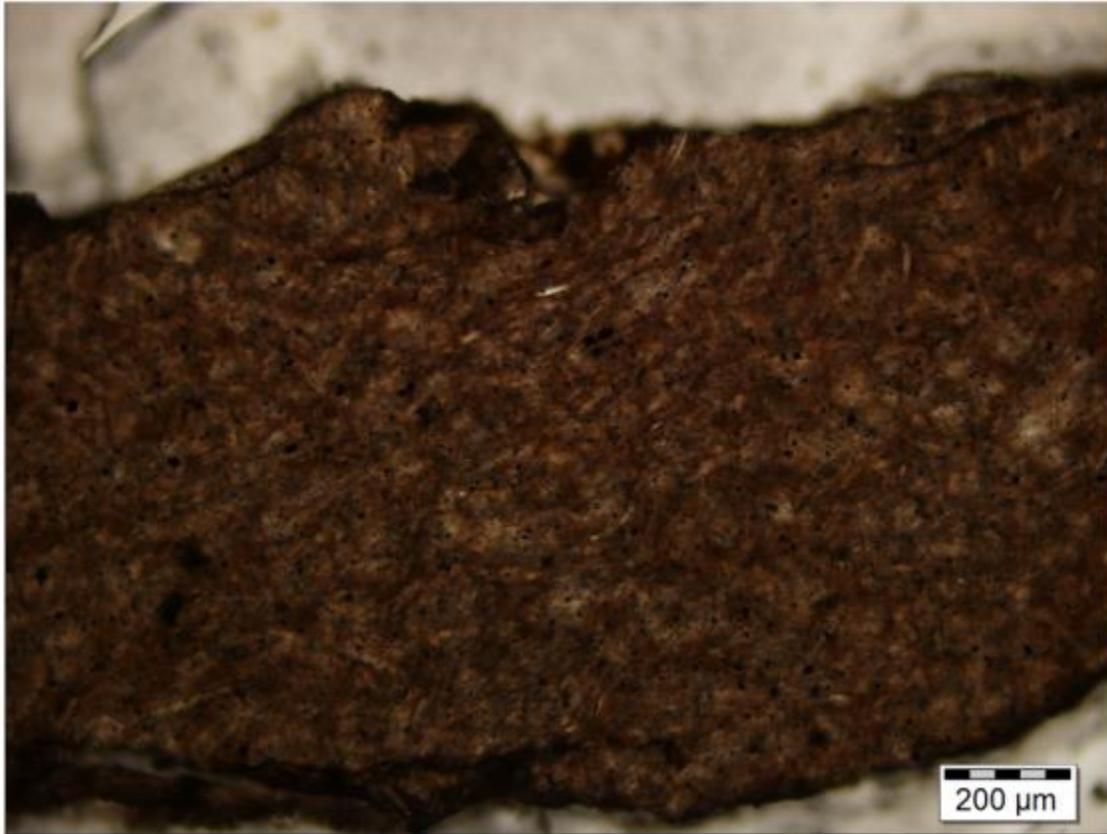
Petrographic Classification:

Porphyritic lava (andesite or basalt).

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 558

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Black volcanic.

Microstructure:

Homogeneous.

Alteration Minerals:

Clay.

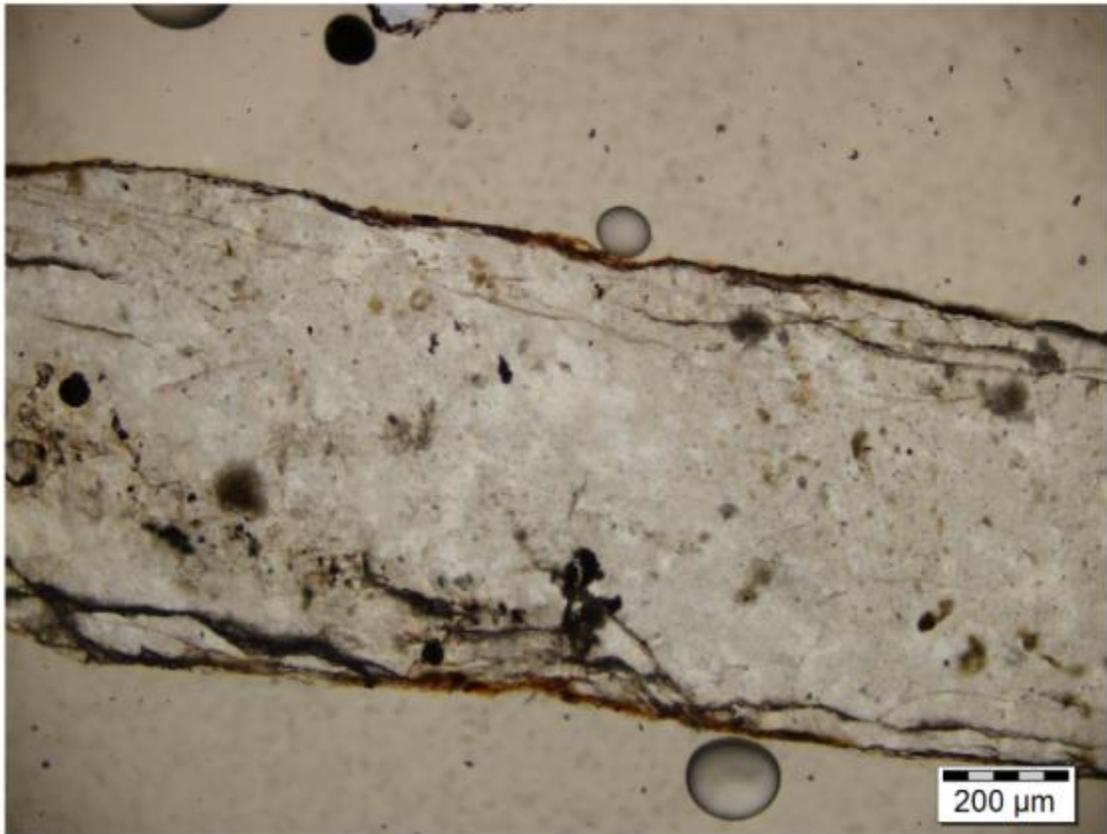
Petrographic Classification:

Lava.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 560

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Black Chert.

Microstructure:

Inequigranular isotropic aggregate of fine-grained quartz and very fine-grained unresolved material.

Alteration Minerals:

Quartz and clay.

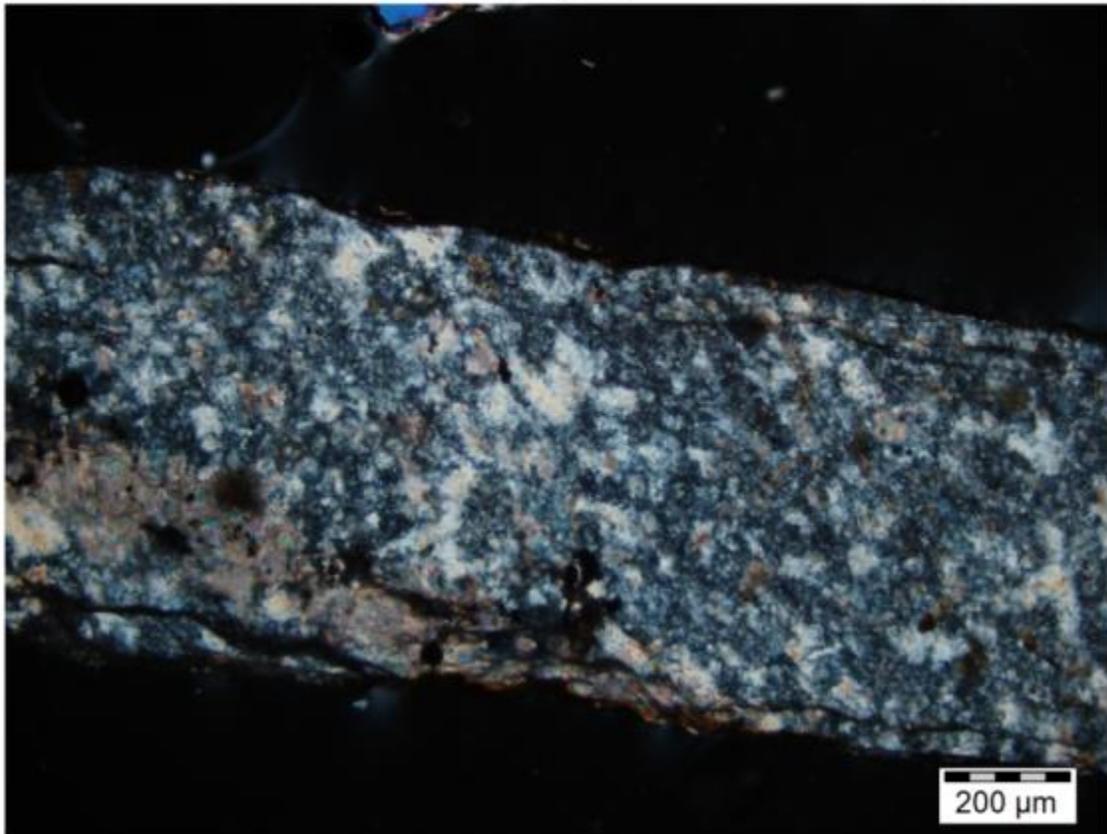
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 560

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Black Chert.

Microstructure:

Inequigranular isotropic aggregate of fine-grained quartz and very fine-grained unresolved material.

Alteration Minerals:

Quartz and clay.

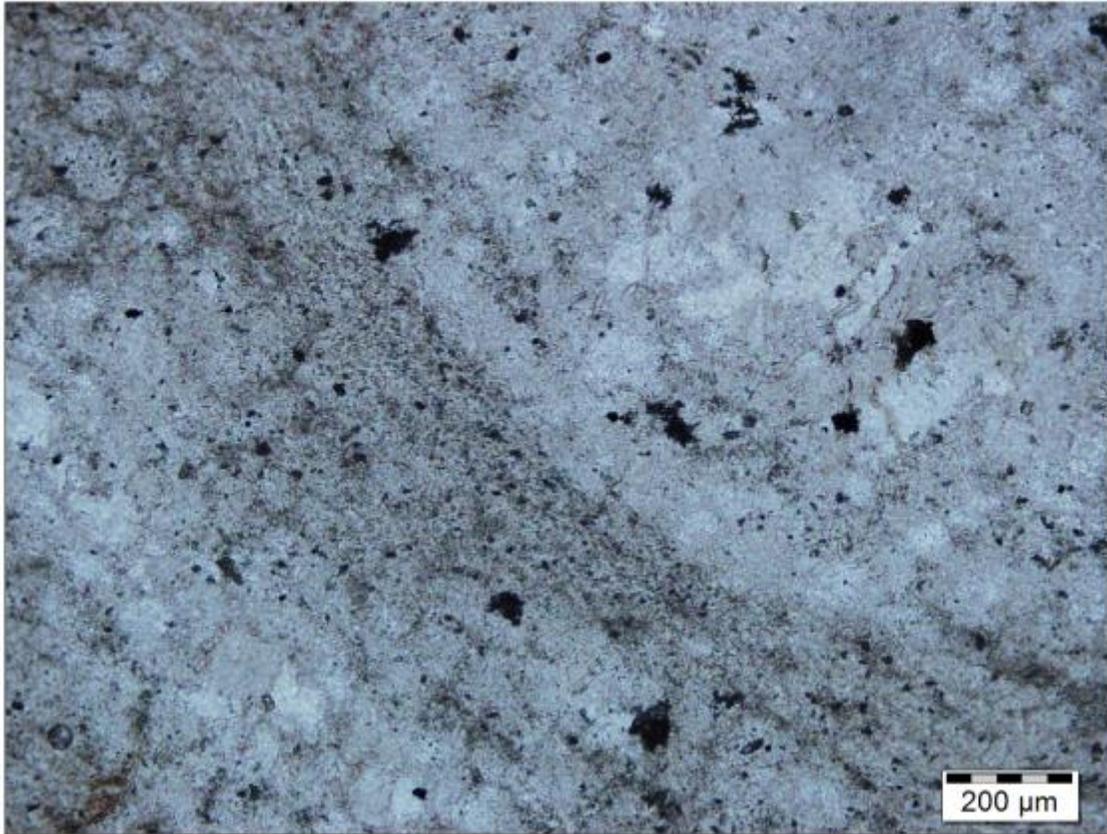
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 564

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Green grey chert.

Microstructure:

Banded microstructure with fine-grained domains of quartz and very fine-grained domains of quartz and subordinate clay.

Alteration Minerals:

Quartz, possibly clay too.

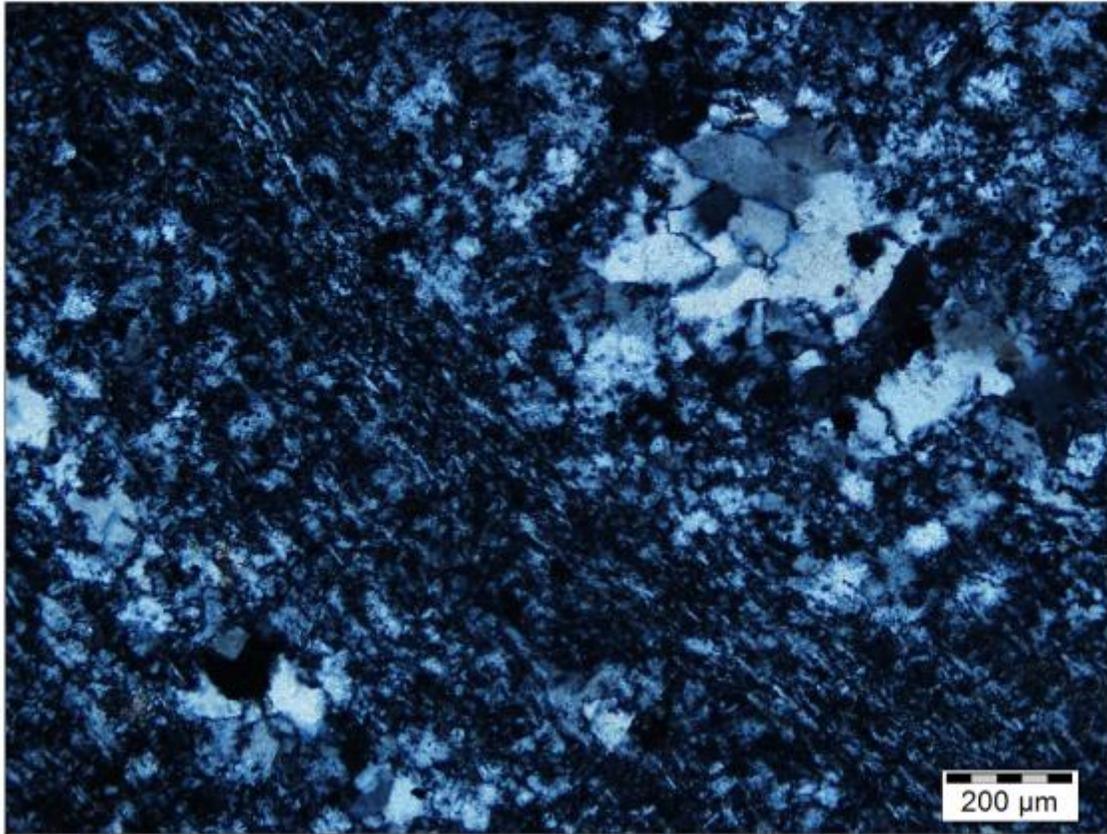
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 564

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Green grey chert.

Microstructure:

Banded microstructure with fine-grained domains of quartz and very fine-grained domains of quartz and subordinate clay.

Alteration Minerals:

Quartz, possibly clay too.

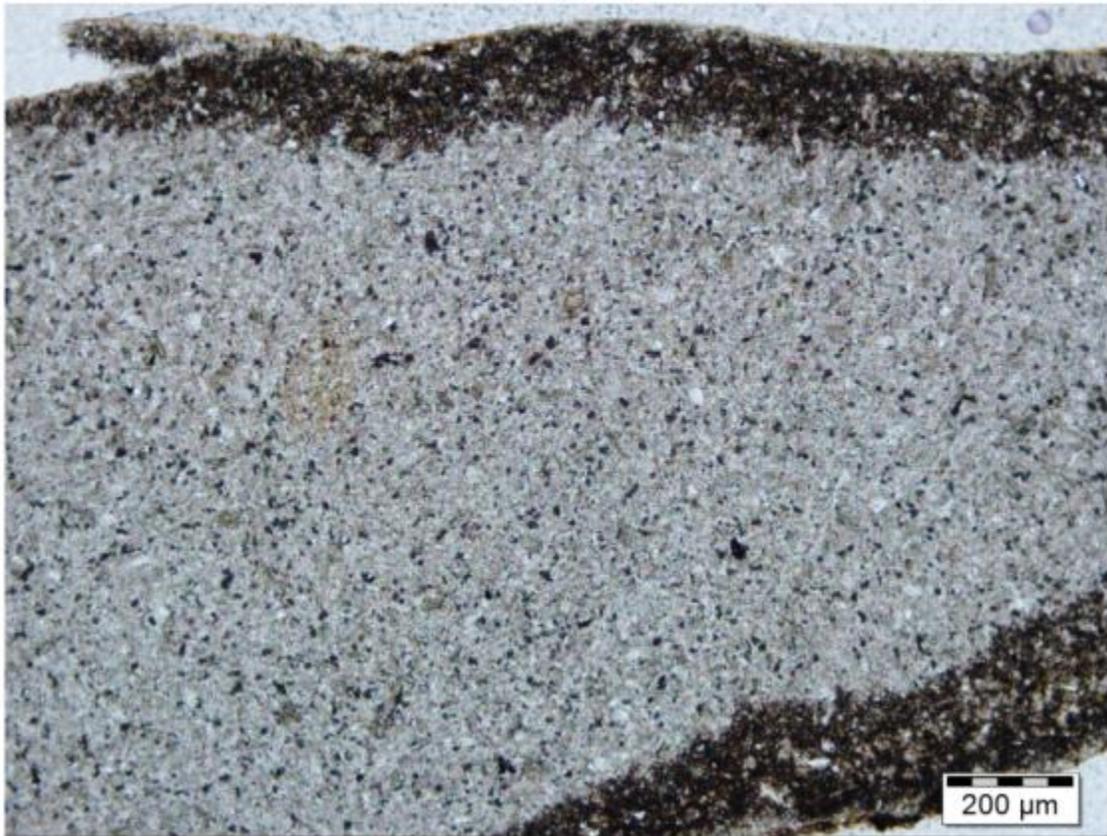
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel
Borden Number: EbSh-81
Specimen Number: 565
Light Transmission: Plane Polarized

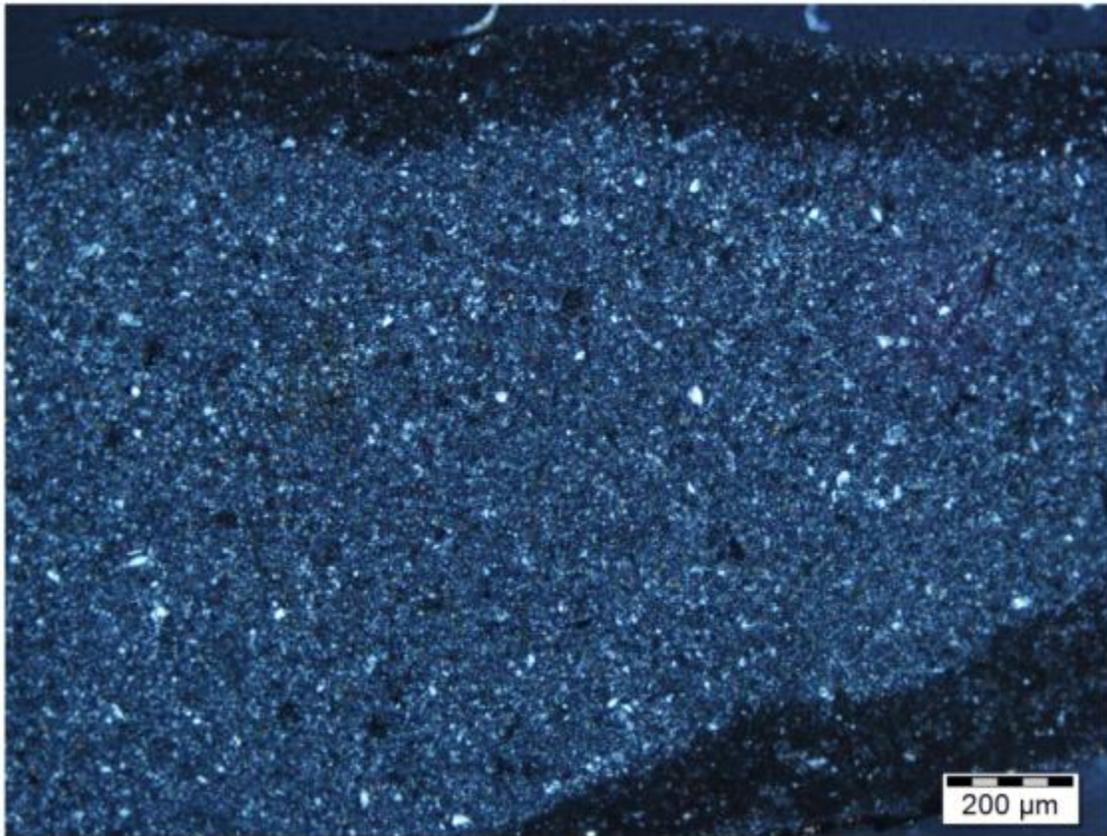
Surficial Attributes Material Type Classification:
Green grey chert.

Microstructure:
Very fine-grained replacement aggregate of quartz.

Petrographic Classification:
Quartz alteration zone.

Geological Suite:
Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel
Borden Number: EbSh-81
Specimen Number: 565
Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:
Green grey chert.

Microstructure:
Very fine-grained replacement aggregate of quartz.

Petrographic Classification:
Quartz alteration zone.

Geological Suite:
Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 601

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey volcanic.

Microstructure:

Euhedral phenocrysts immersed within a trachytic microstructure.

Primary Minerals:

Plagioclase, hornblende, magnetite.

Alteration Minerals:

Clay.

Petrographic Classification:

Porphyritic lava (andesite or basalt).

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 601

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey volcanic.

Microstructure:

Euhedral phenocrysts immersed within a trachytic microstructure.

Primary Minerals:

Plagioclase, hornblende, magnetite.

Alteration Minerals:

Clay.

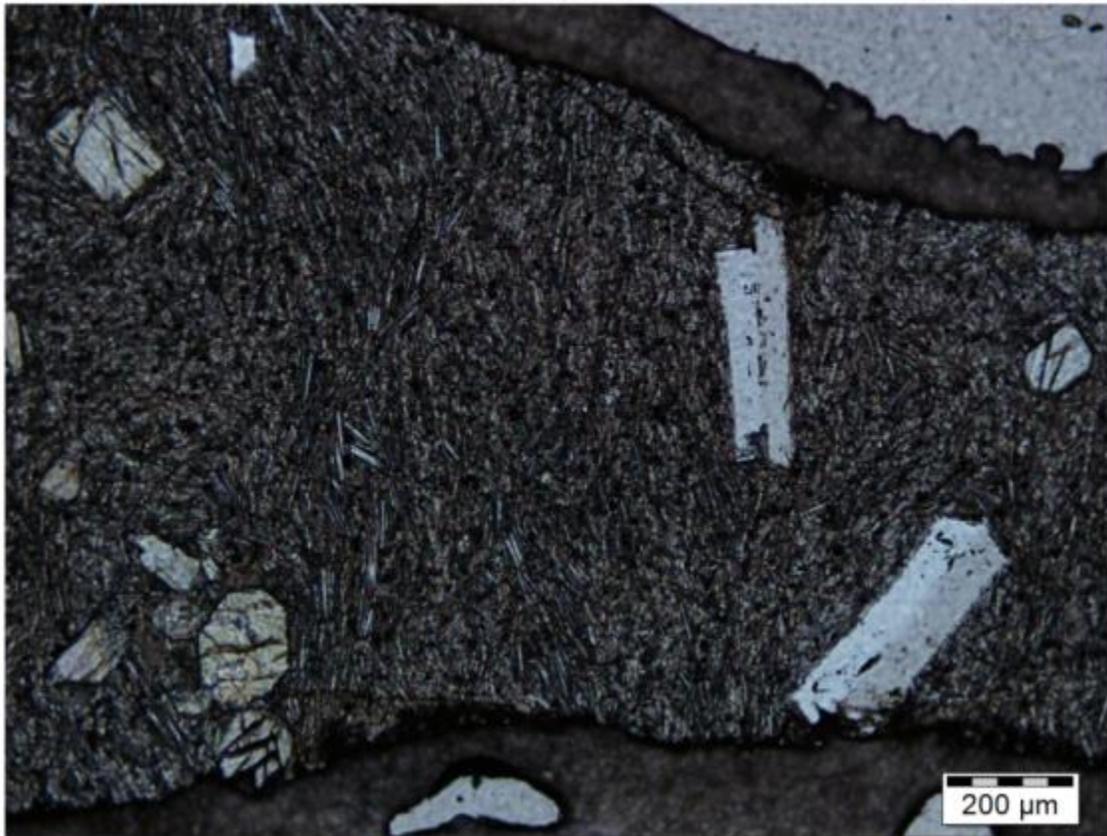
Petrographic Classification:

Porphyritic lava (andesite or basalt).

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 607

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Metasediment.

Microstructure:

Euhedral phenocrysts of plagioclase and pyroxene within a trachytic groundmass.

Primary Minerals:

Plagioclase, pyroxene.

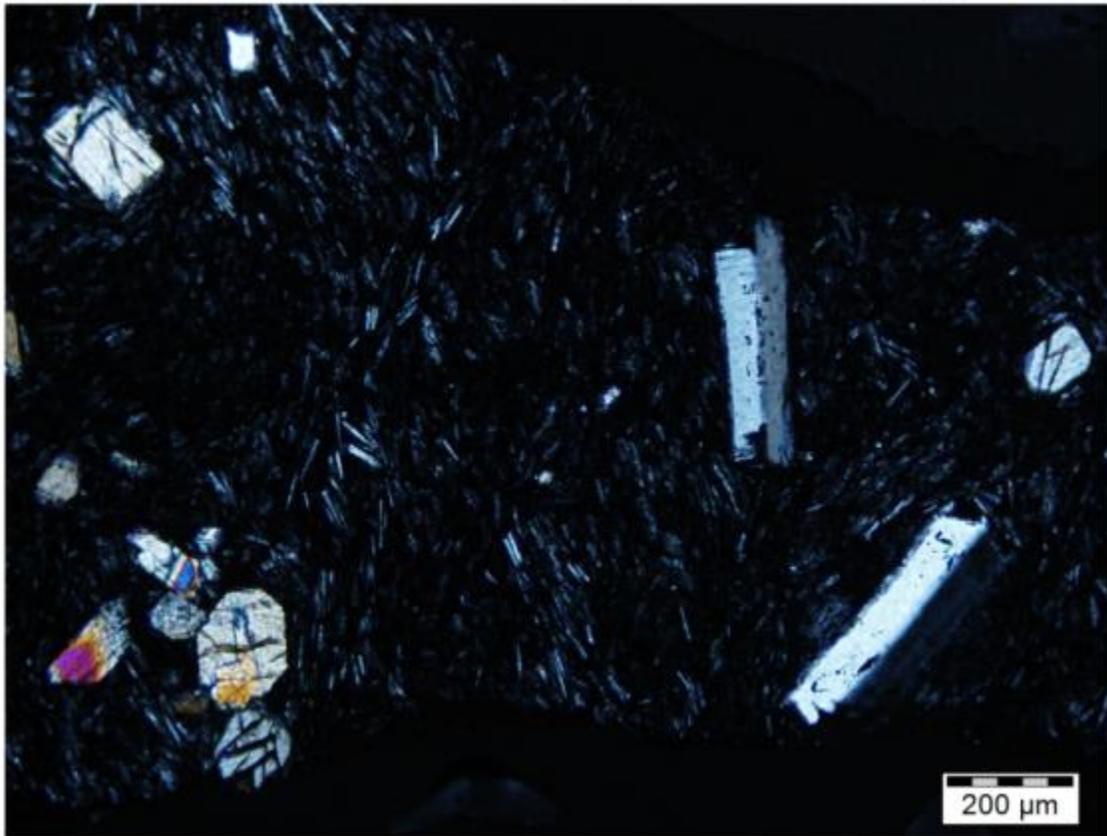
Petrographic Classification:

Pyroxene-plagioclase-phyric basalt.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 607

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Metasediment.

Microstructure:

Euhedral phenocrysts of plagioclase and pyroxene within a trachytic groundmass.

Primary Minerals:

Plagioclase, pyroxene.

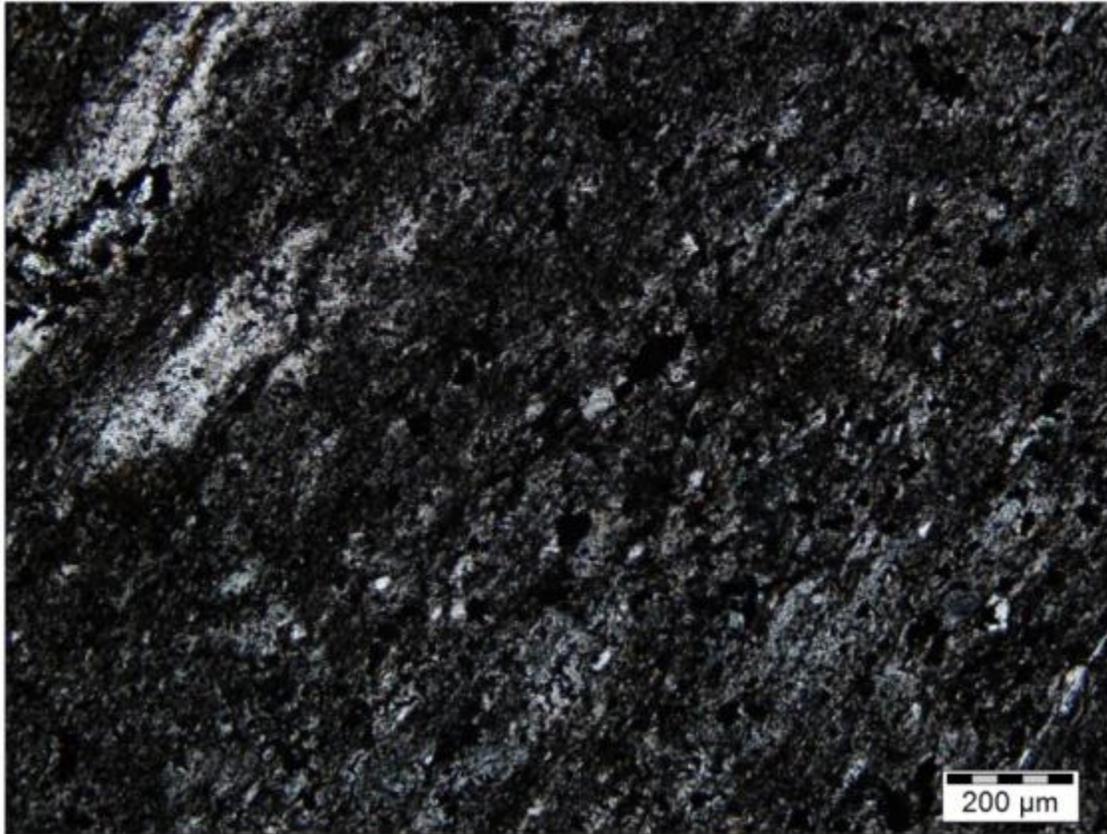
Petrographic Classification:

Pyroxene-plagioclase-phyric basalt.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 633

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Green grey chert.

Microstructure:

Earthy and banded.

Alteration Minerals:

Quartz, pyrite, limonitic material.

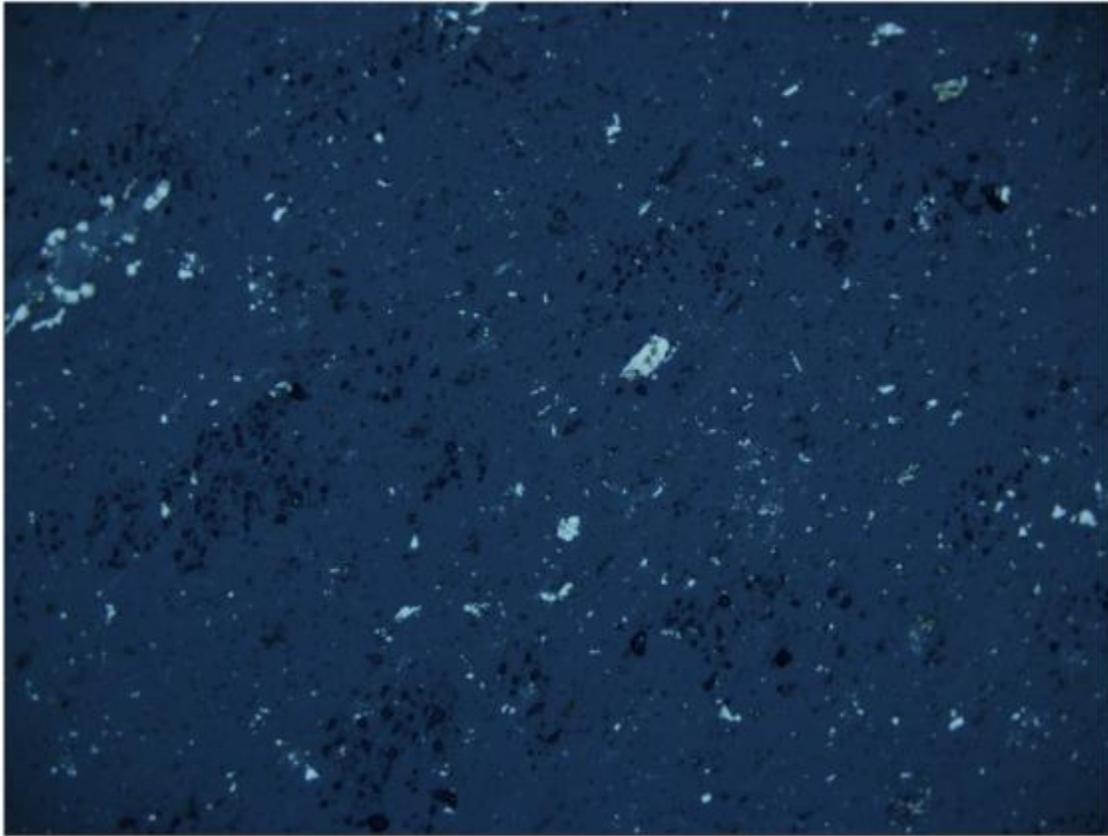
Petrographic Classification:

Altered lava or chert.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 633

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Green grey chert.

Microstructure:

Earthy and banded.

Alteration Minerals:

Quartz, pyrite, limonitic material.

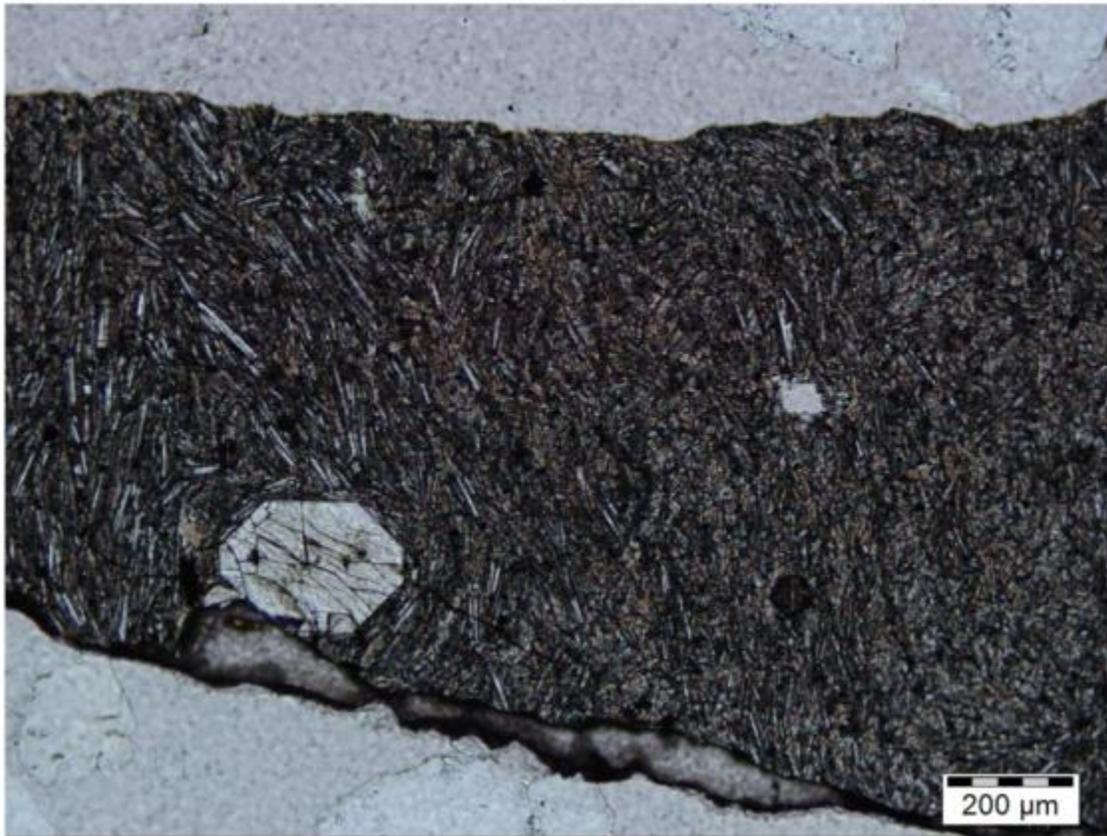
Petrographic Classification:

Altered lava or chert.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 935

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Grey volcanic.

Microstructure:

Euhedral phenocrysts immersed within a trachytic microstructure.

Primary Minerals:

Plagioclase-pyroxene.

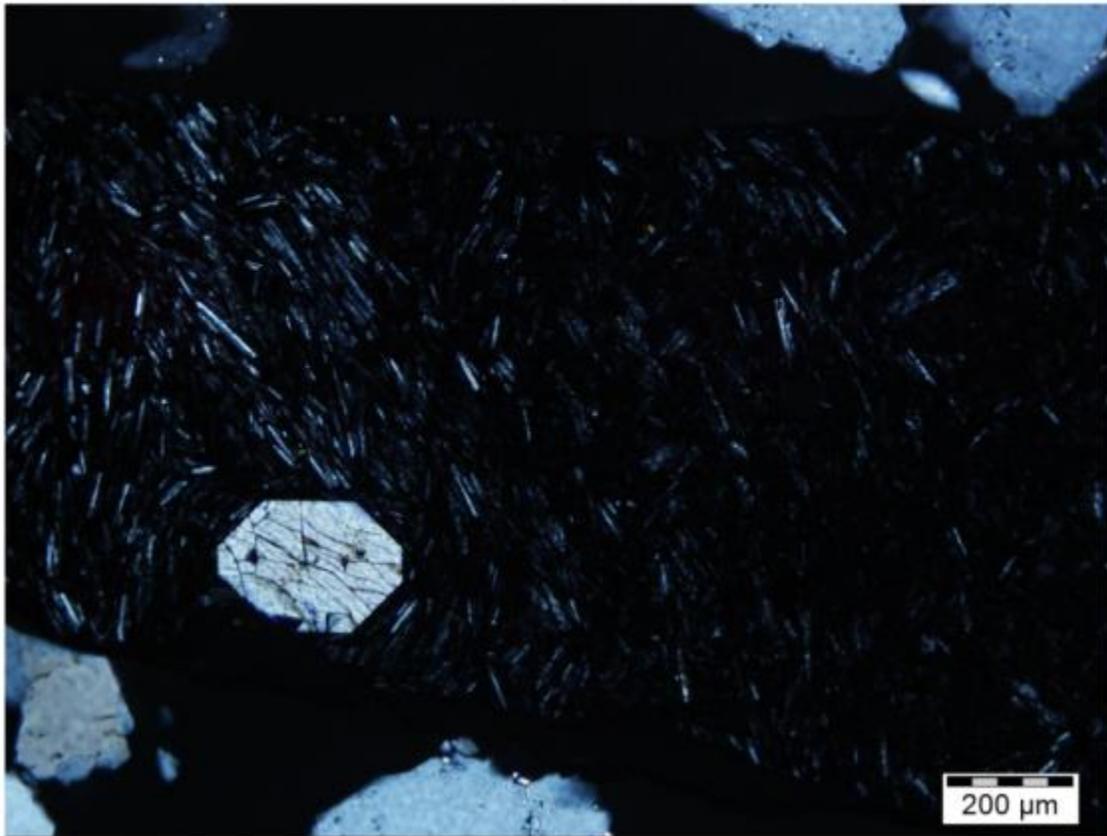
Petrographic Classification:

Pyroxene-phyric basalt.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 935

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Grey volcanic.

Microstructure:

Euhedral phenocrysts immersed within a trachytic microstructure.

Primary Minerals:

Plagioclase-pyroxene.

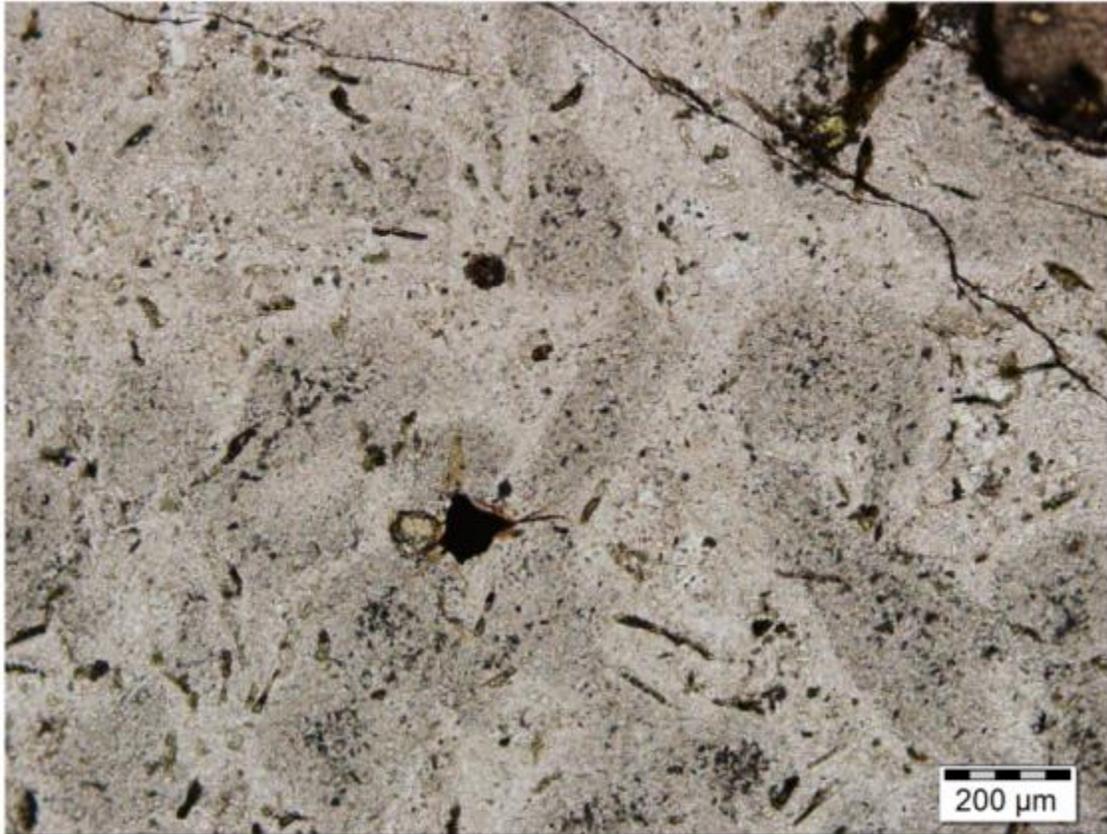
Petrographic Classification:

Pyroxene-phyric basalt.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 1027

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Dark grey volcanic.

Microstructure:

Patchy fine- to very fine-grained replacement aggregates of quartz.

Alteration Minerals:

Quartz.

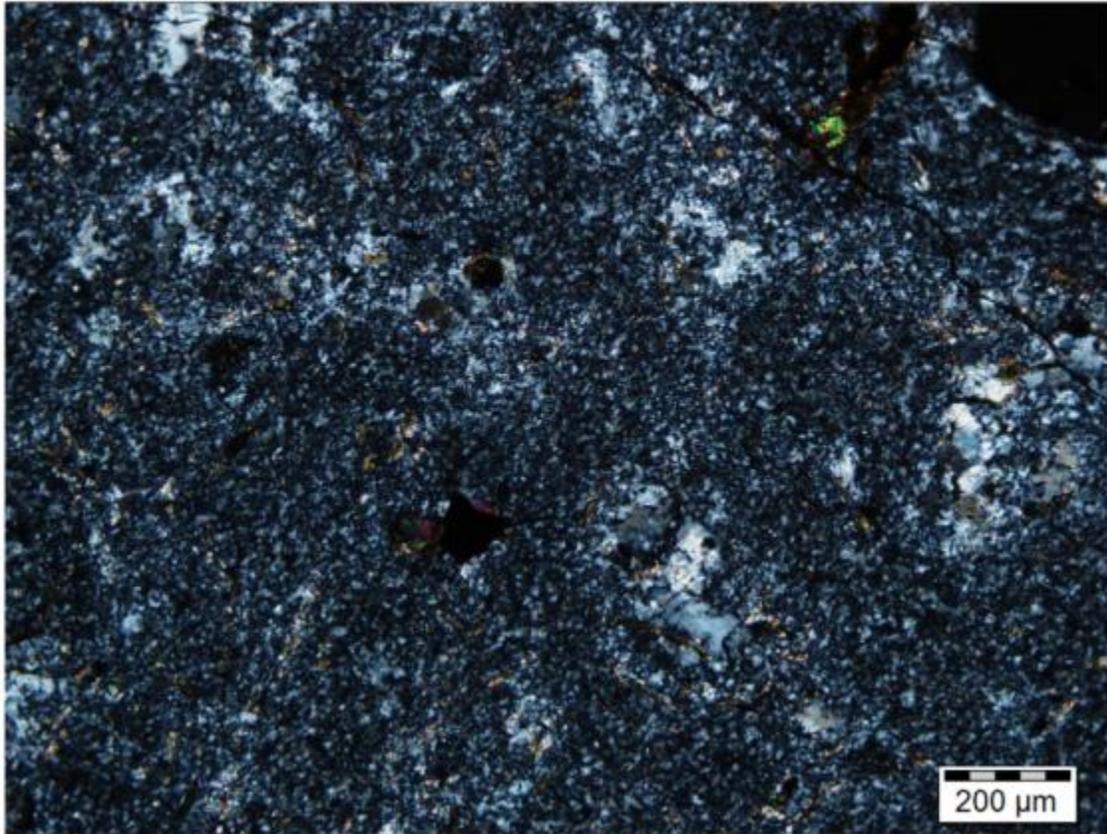
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 1027

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Dark grey volcanic.

Microstructure:

Patchy fine- to very fine-grained replacement aggregates of quartz.

Alteration Minerals:

Quartz.

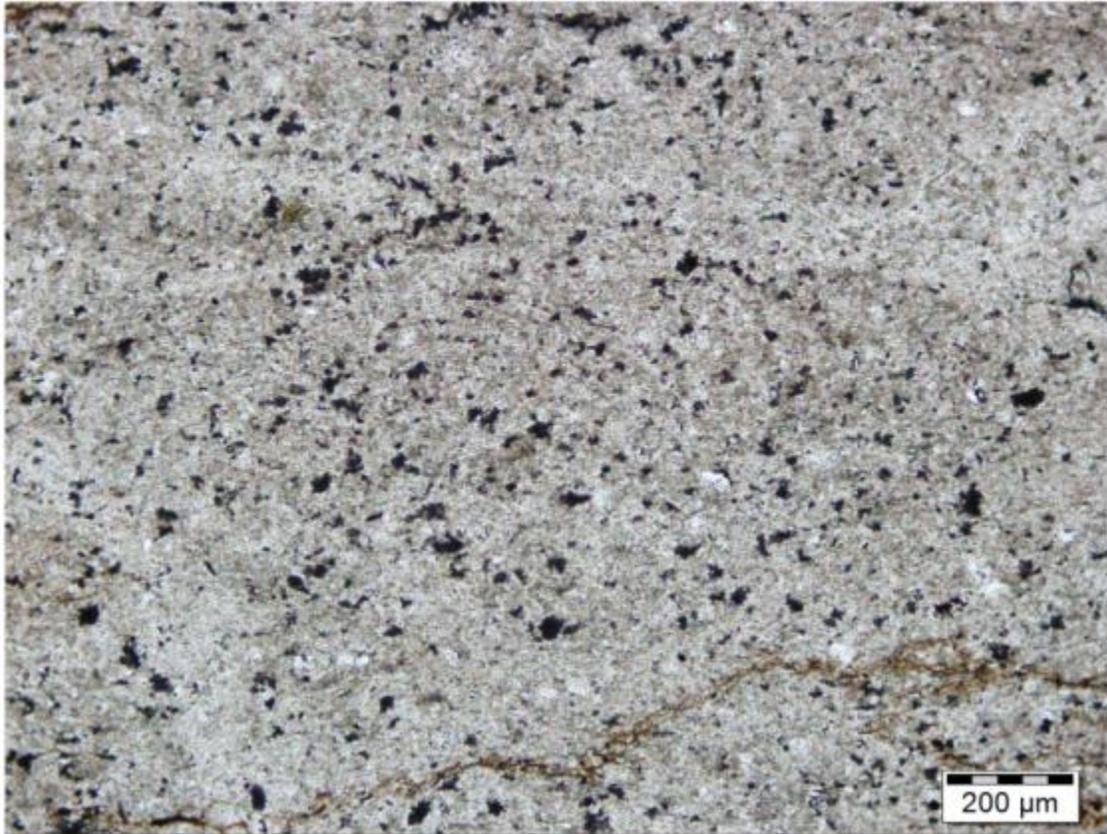
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 1042

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Tan chert.

Microstructure:

Fractured and slightly heterogeneous very fine-grained replacement aggregate of quartz and clay.

Alteration Minerals:

Quartz, clay, and an unknown limonitic material.

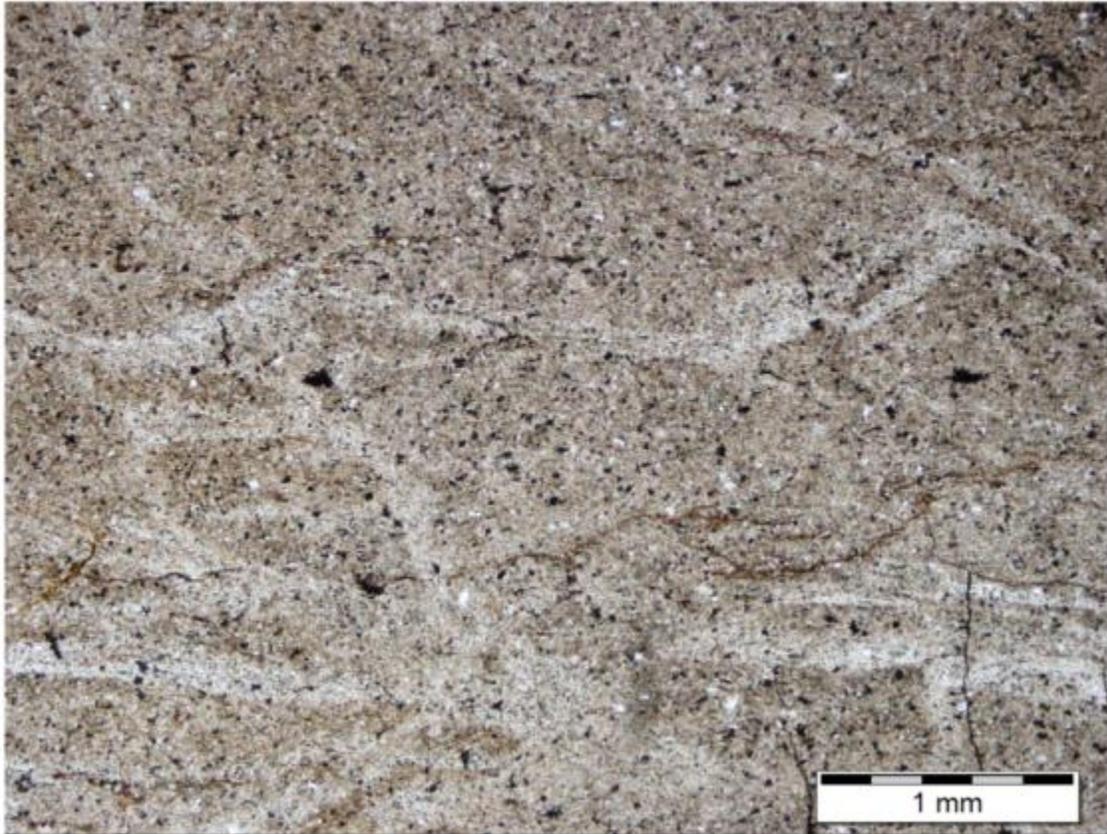
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 1042

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Tan chert.

Microstructure:

Fractured and slightly heterogeneous very fine-grained replacement aggregate of quartz and clay.

Alteration Minerals:

Quartz, clay, and an unknown limonitic material.

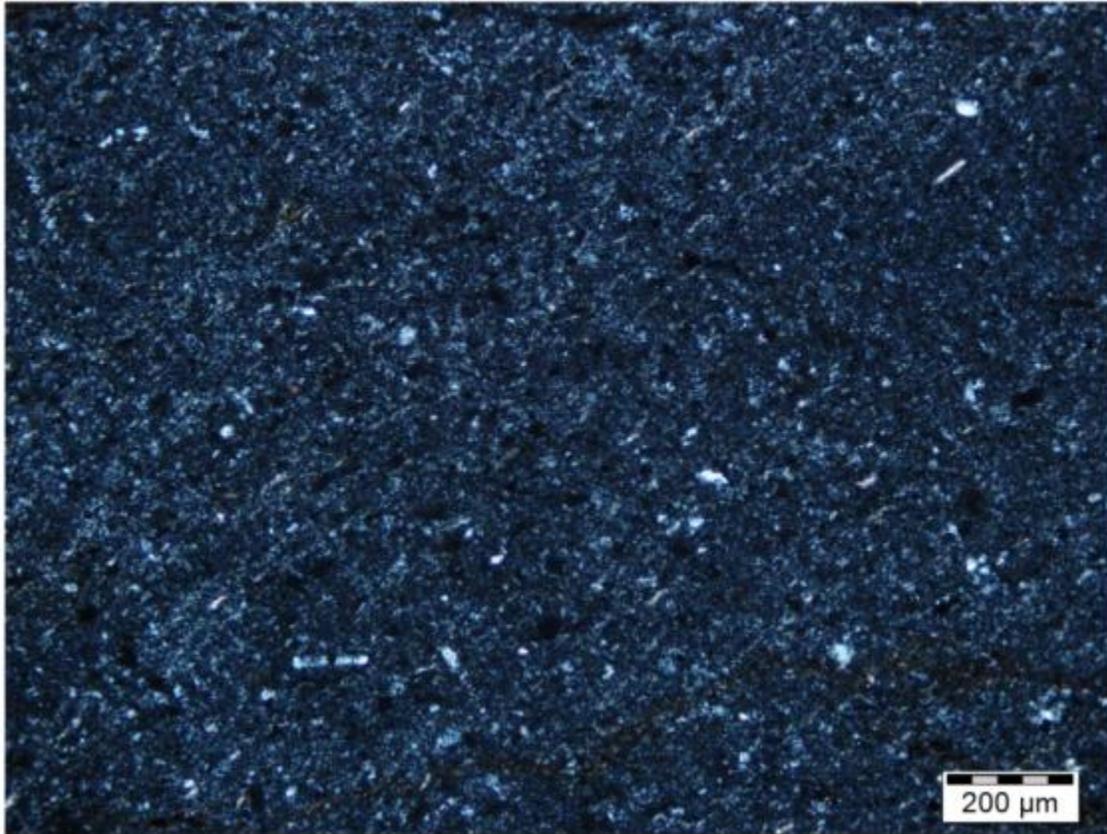
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Crescent Channel

Borden Number: EbSh-81

Specimen Number: 1042

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Tan chert.

Microstructure:

Fractured and slightly heterogeneous very fine-grained replacement aggregate of quartz and clay.

Alteration Minerals:

Quartz, clay, and an unknown limonitic material.

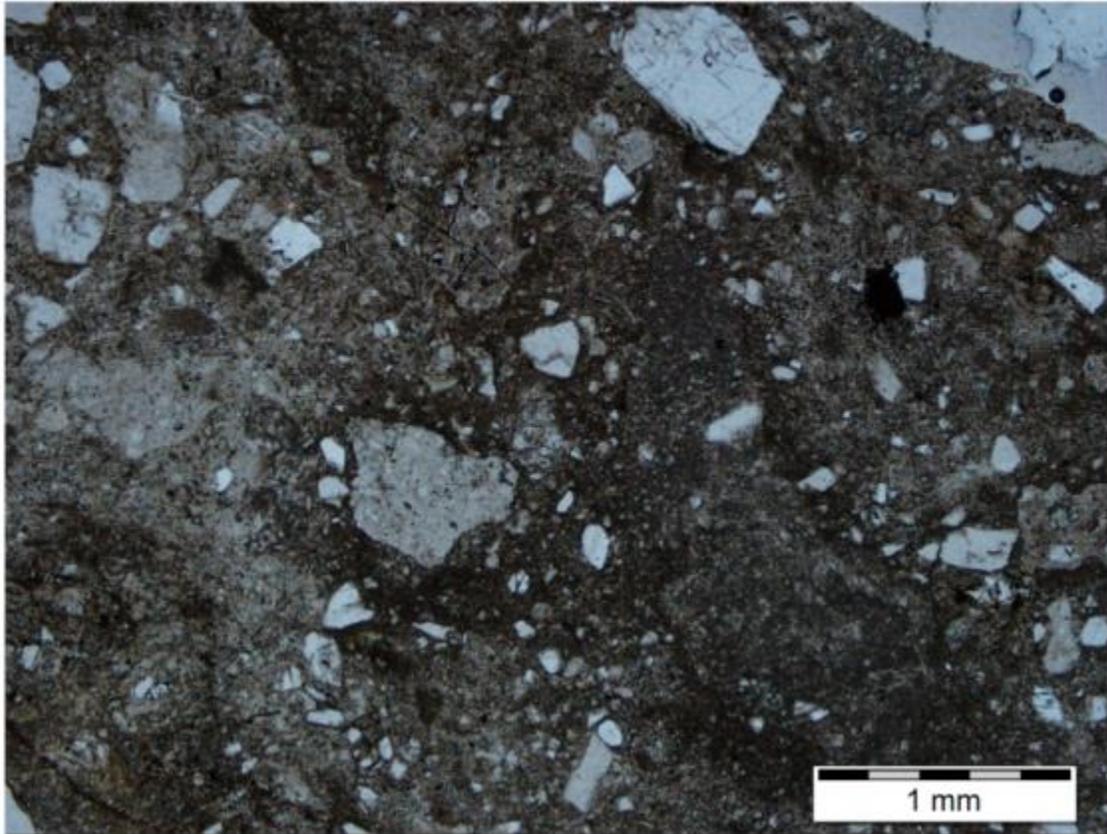
Petrographic Classification:

Quartz alteration zone.

Geological Suite:

Quartz alteration.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 145

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown V

Microstructure:

Fragmental microstructure made up of angular crystal fragments of plagioclase and clay-altered lithic fragments (likely lapilli).

Primary Minerals:

Plagioclase, hornblende, and magnetite.

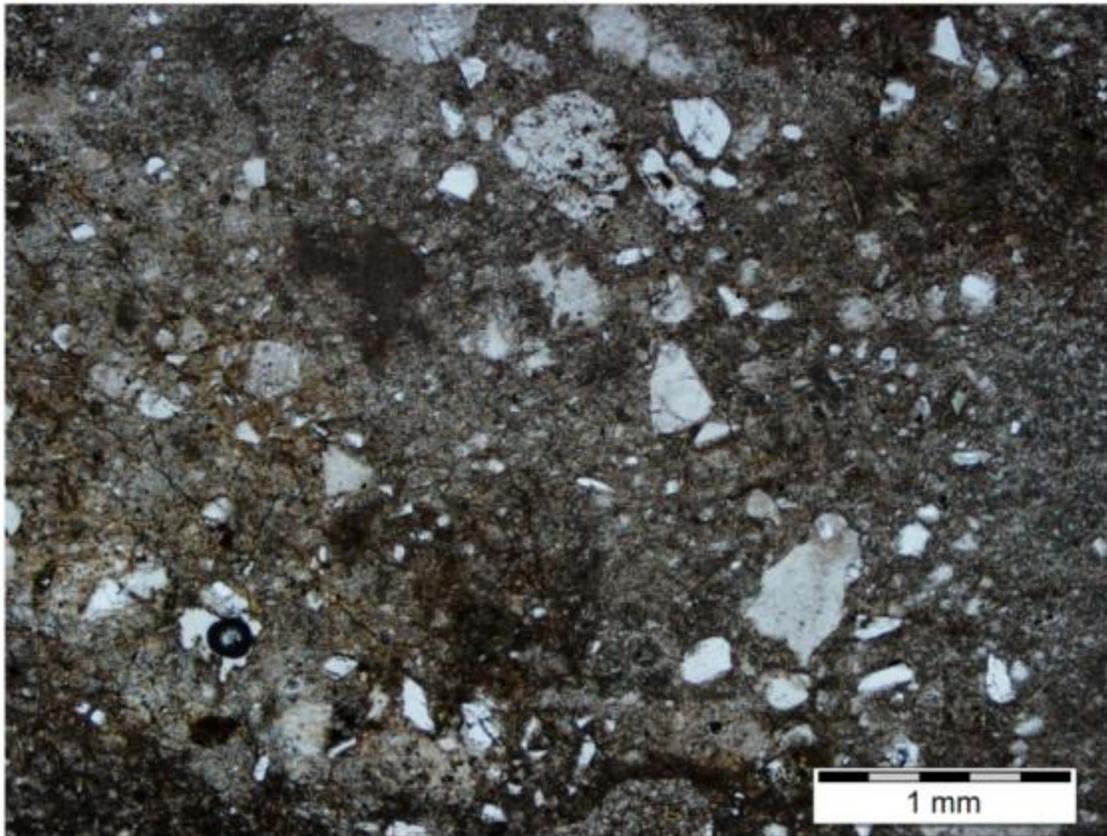
Petrographic Classification:

Tuff.

Geological Suite:

Volcaniclastic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 145

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown V

Microstructure:

Fragmental microstructure made up of angular crystal fragments of plagioclase and clay-altered lithic fragments (likely lapilli).

Primary Minerals:

Plagioclase, hornblende, and magnetite.

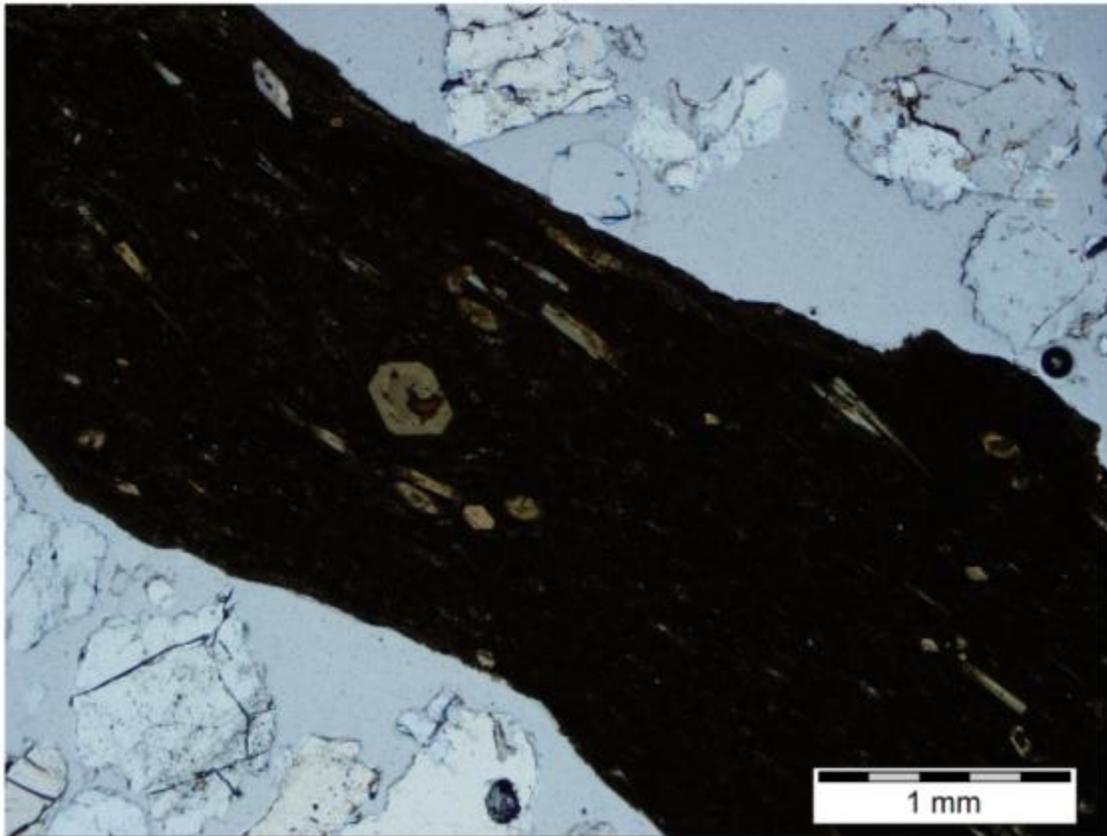
Petrographic Classification:

Tuff.

Geological Suite:

Volcaniclastic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 152

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Volcanic with elongated inclusions.

Microstructure:

Phenocrysts of amphibole showing a preferred dimensional orientation.

Primary Minerals:

Hornblende.

Alteration Minerals:

Clay.

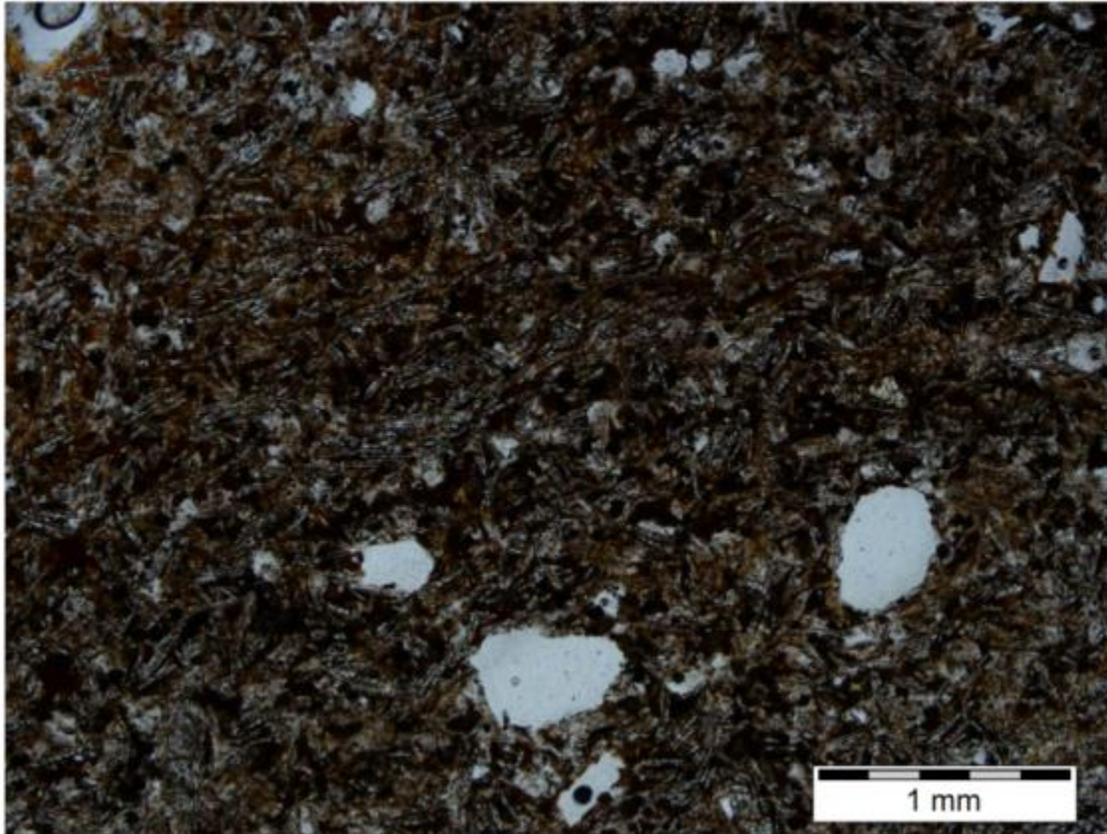
Petrographic Classification:

Hornblende-phyric lava.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 161

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Volcanic, fine.

Microstructure:

Fine-grained laths of plagioclase associated with a strongly altered groundmass. Sub-rounded cavities heterogeneously dispersed within this lava.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Epidote and clay.

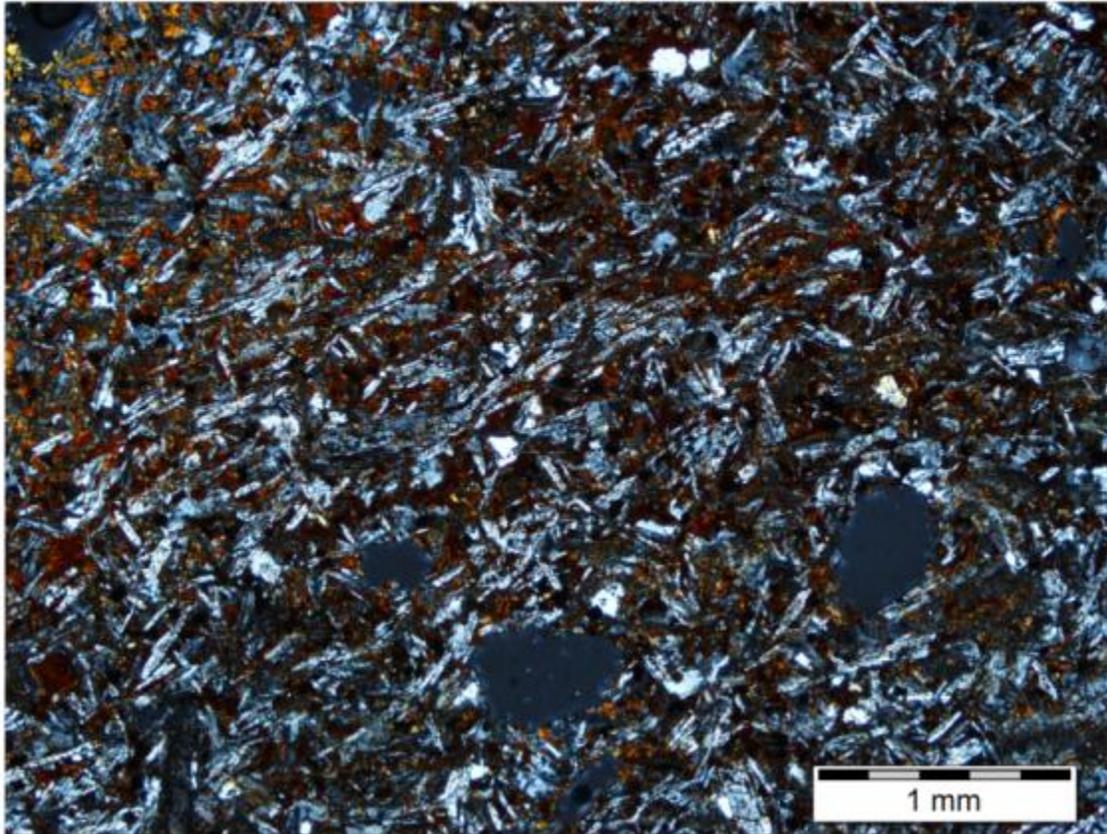
Petrographic Classification:

Andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 161

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Volcanic, fine.

Microstructure:

Fine-grained laths of plagioclase associated with a strongly altered groundmass. Sub-rounded cavities heterogeneously dispersed within this lava.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Epidote and clay.

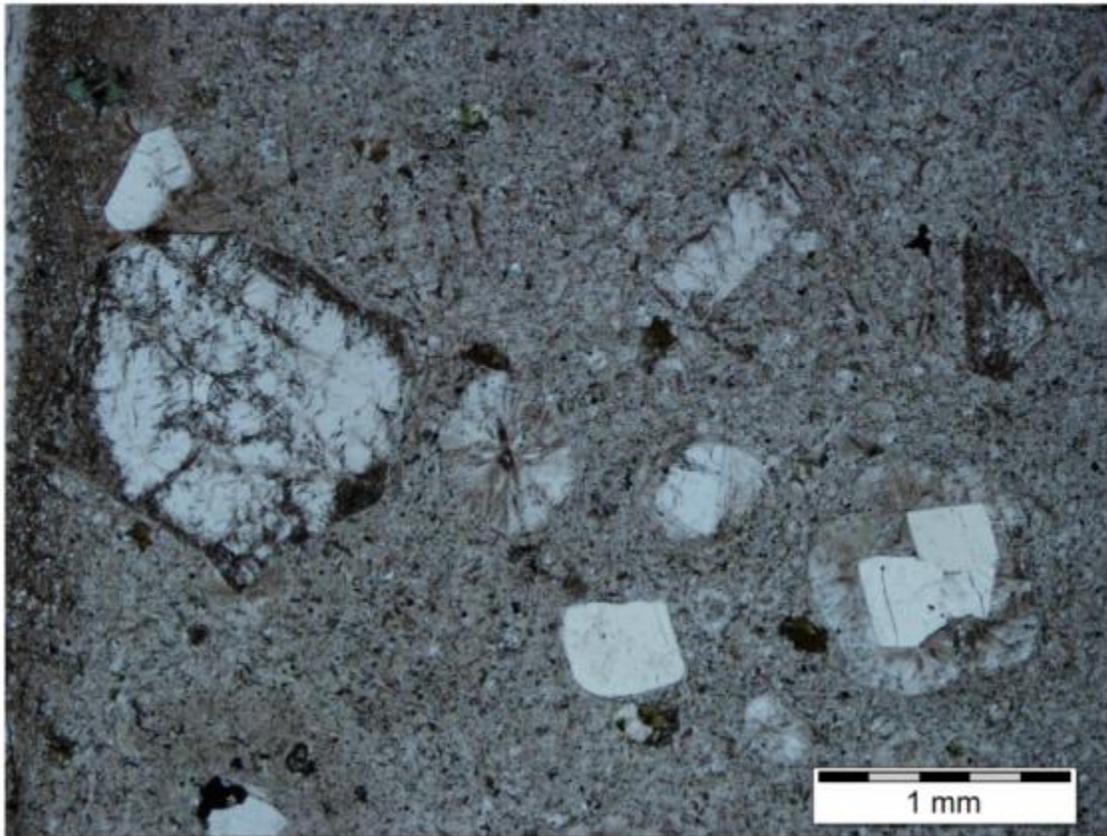
Petrographic Classification:

Andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 173

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

White rhyolite.

Microstructure:

Subhedral phenocrysts of quartz, plagioclase, and fibrous amygdules filled by low relief and low birefringent material immersed within a very fine-grained unresolved matrix.

Primary Minerals:

plagioclase and quartz.

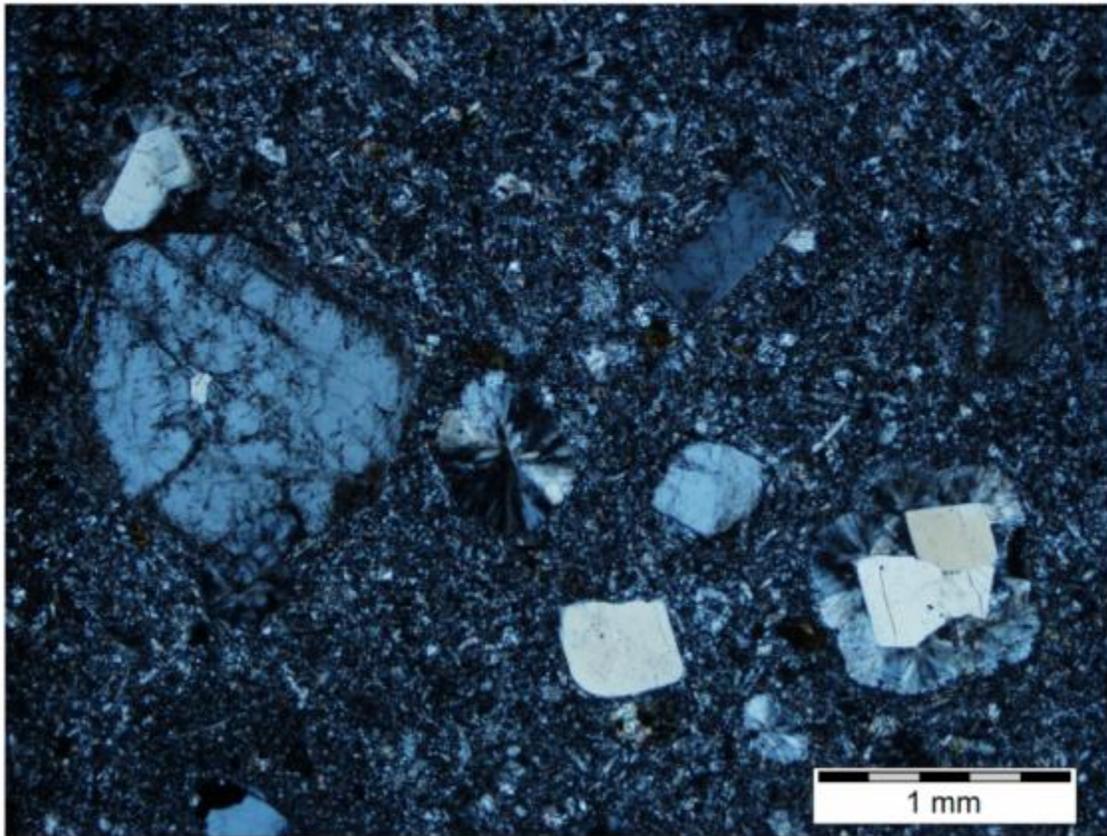
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 173

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

White rhyolite.

Microstructure:

Subhedral phenocrysts of quartz, plagioclase, and fibrous amygdules filled by low relief and low birefringent material immersed within a very fine-grained unresolved matrix.

Primary Minerals:

plagioclase and quartz.

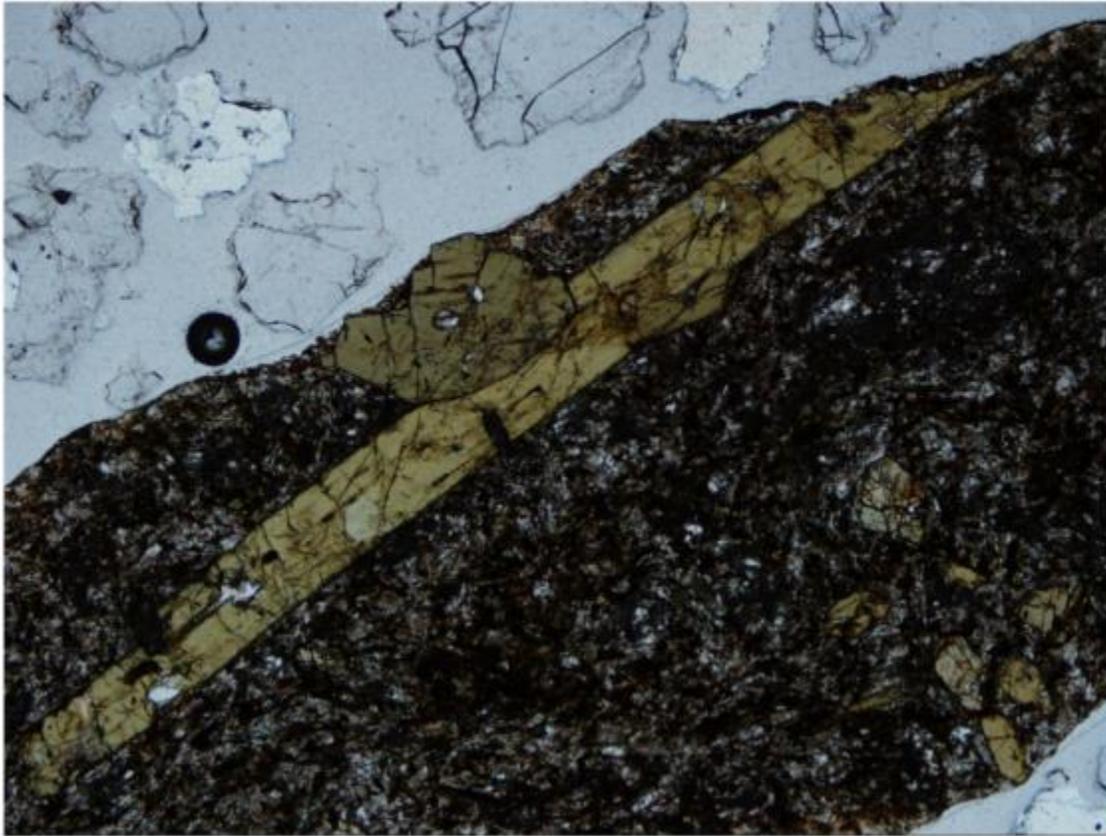
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 174

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown VII.

Microstructure:

Amphibole and plagioclase phenocrysts within a strongly altered groundmass.

Primary Minerals:

Hornblende & plagioclase.

Alteration Minerals:

Limonitic material, iron oxides.

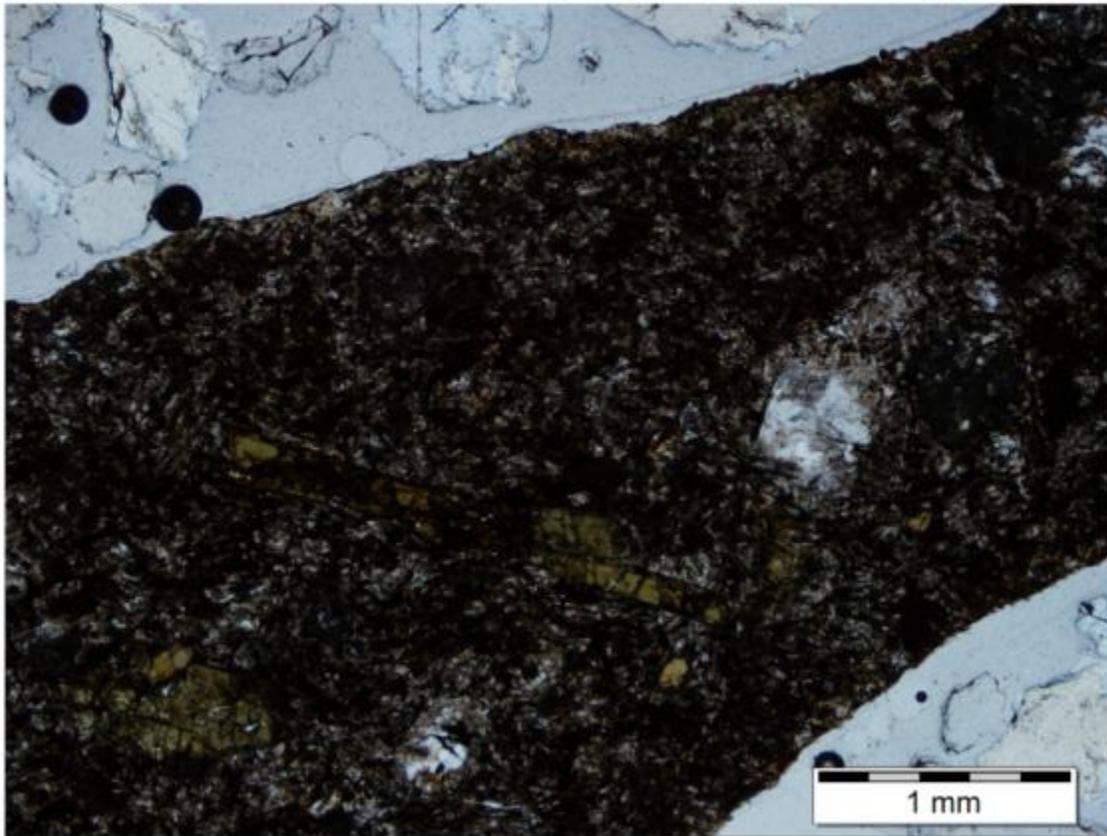
Petrographic Classification:

Plagioclase-hornblende-phyric lava.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 174

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Unknown VII.

Microstructure:

Amphibole and plagioclase phenocrysts within a strongly altered groundmass.

Primary Minerals:

Hornblende & plagioclase.

Alteration Minerals:

Limonitic material, iron oxides.

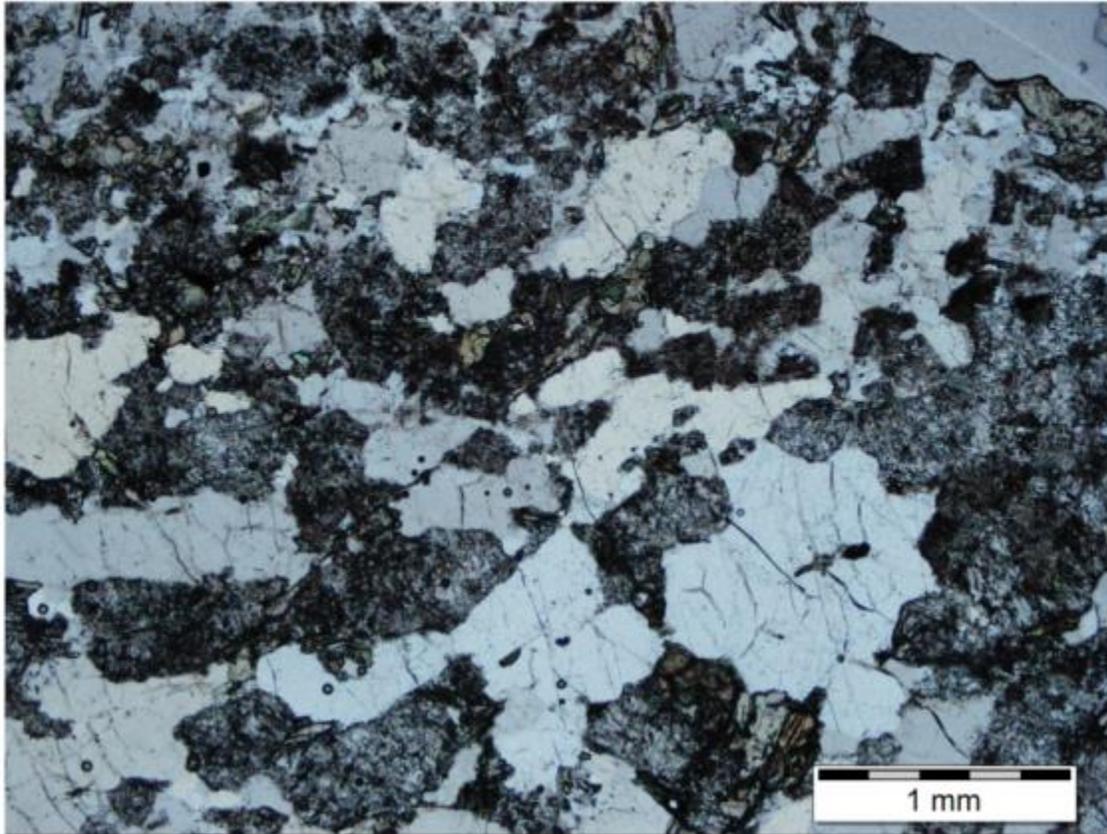
Petrographic Classification:

Plagioclase-hornblende-phyric lava.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 176

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Quartzite.

Microstructure:

Granular microstructure defined by quartz and altered plagioclase.

Primary Minerals:

Quartz and plagioclase.

Alteration Minerals:

Clay and epidote.

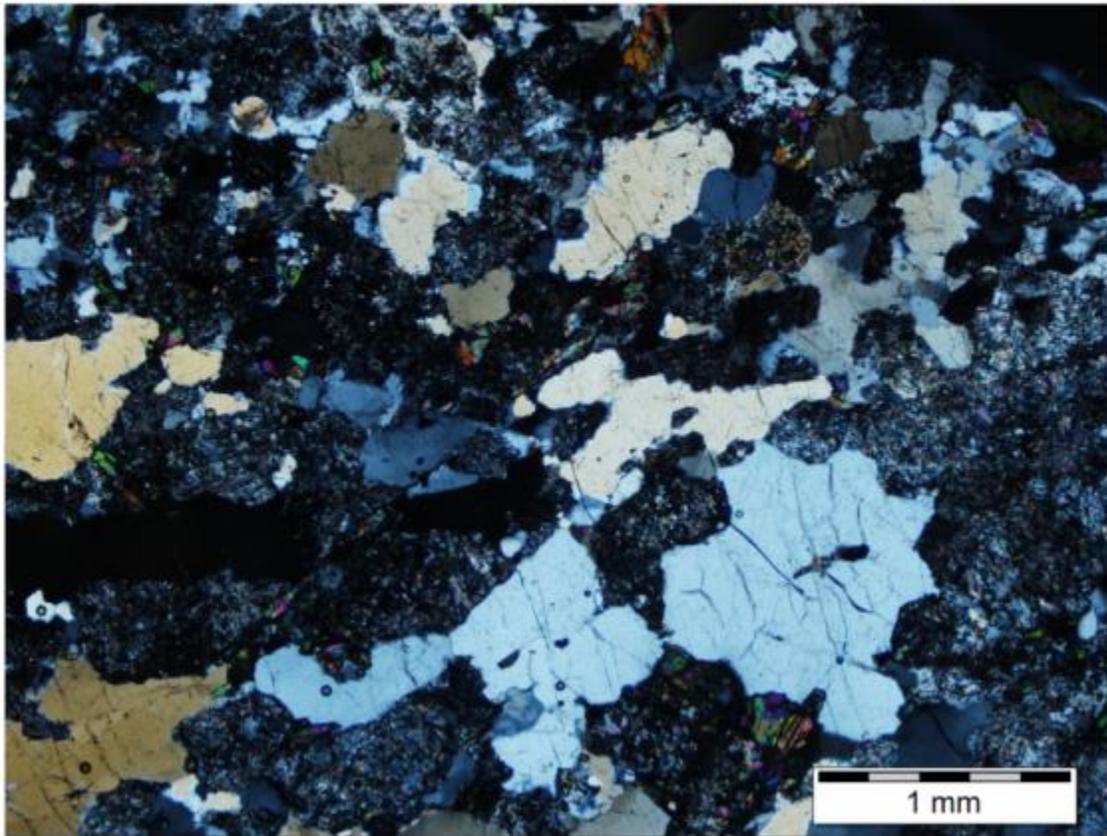
Petrographic Classification:

Granitoid.

Geological Suite:

Granitoid.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 176

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Quartzite.

Microstructure:

Granular microstructure defined by quartz and altered plagioclase.

Primary Minerals:

Quartz and plagioclase.

Alteration Minerals:

Clay and epidote.

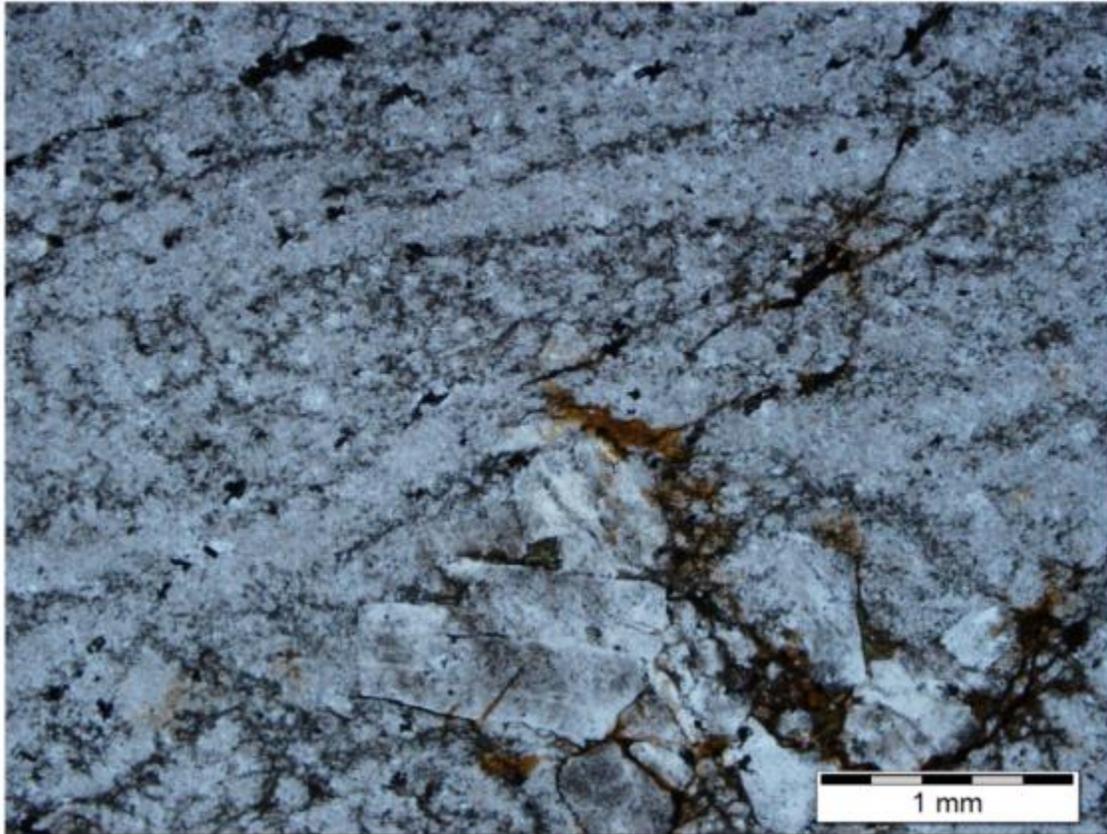
Petrographic Classification:

Granitoid.

Geological Suite:

Granitoid.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 187

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

White rhyolite.

Microstructure:

Euhedral phenocrysts of plagioclase immersed within a very fine-grained clay-altered groundmass.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Clay.

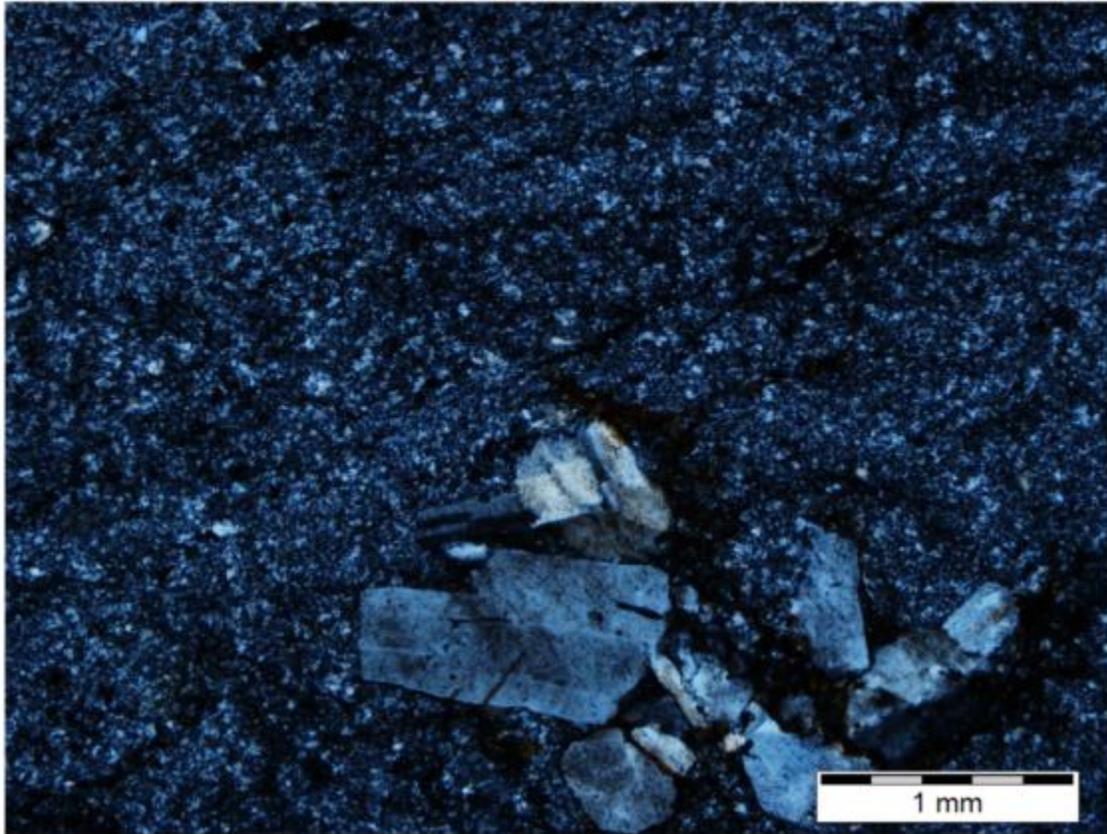
Petrographic Classification:

Plagioclase-phyric lava, probably andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 187

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

White rhyolite.

Microstructure:

Euhedral phenocrysts of plagioclase immersed within a very fine-grained clay-altered groundmass.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Clay.

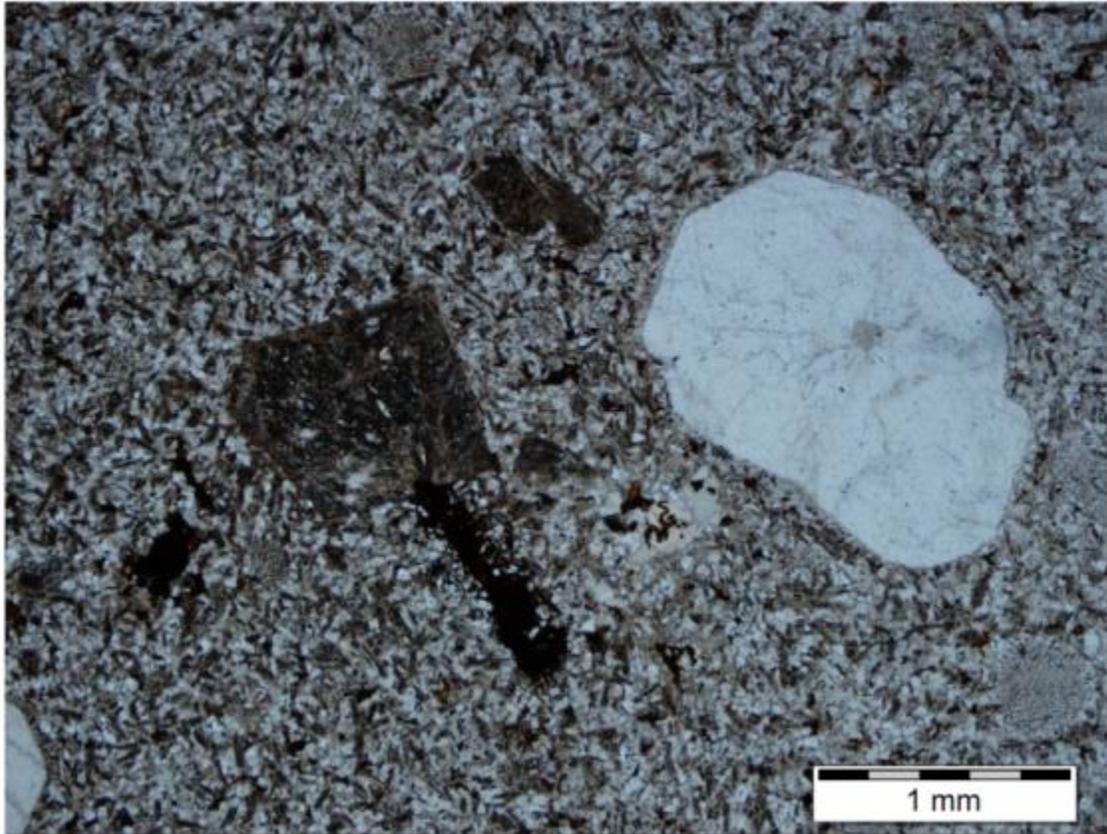
Petrographic Classification:

Plagioclase-phyric lava, probably andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 200

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Light grey metasediment.

Microstructure:

Subhedral quartz and plagioclase phenocrysts and plagioclase glomerophenocrysts immersed within a fine-grained groundmass of quartz and plagioclase.

Primary Minerals:

Plagioclase and quartz.

Alteration Minerals:

Clay and epidote.

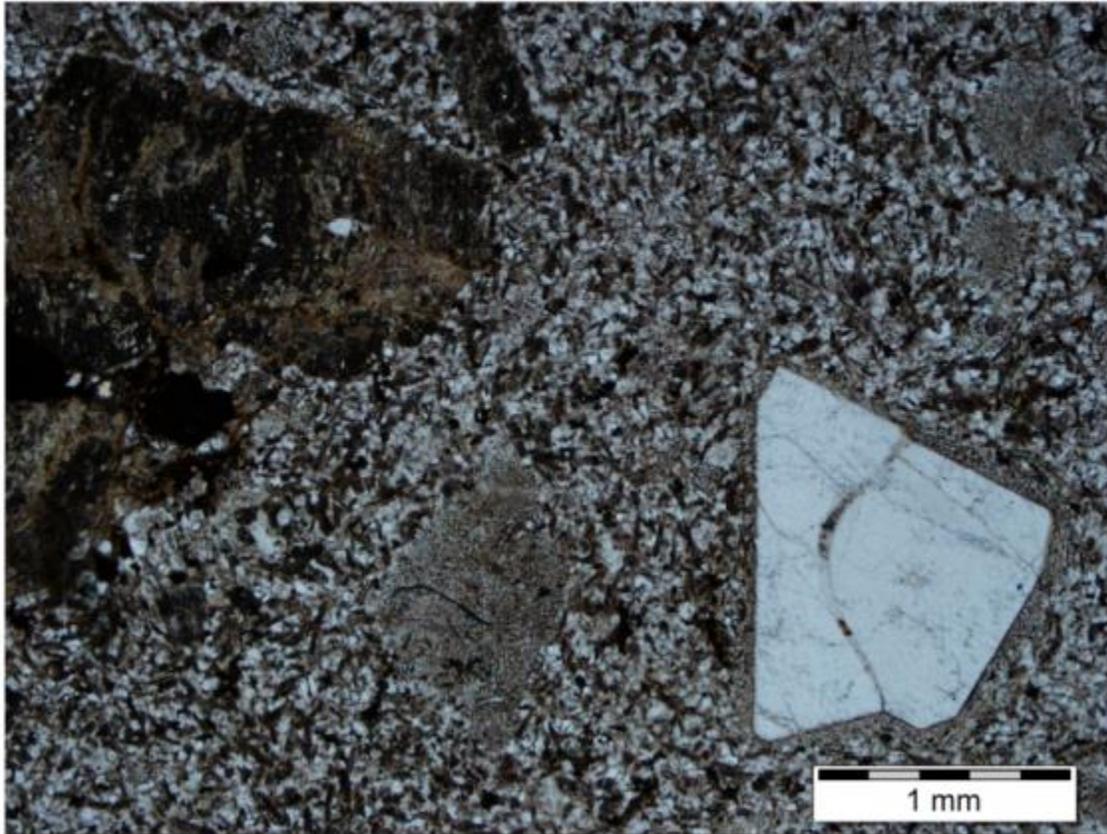
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 200

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Light grey metasediment.

Microstructure:

Subhedral quartz and plagioclase phenocrysts and plagioclase glomerophenocrysts immersed within a fine-grained groundmass of quartz and plagioclase.

Primary Minerals:

Plagioclase and quartz.

Alteration Minerals:

Clay and epidote.

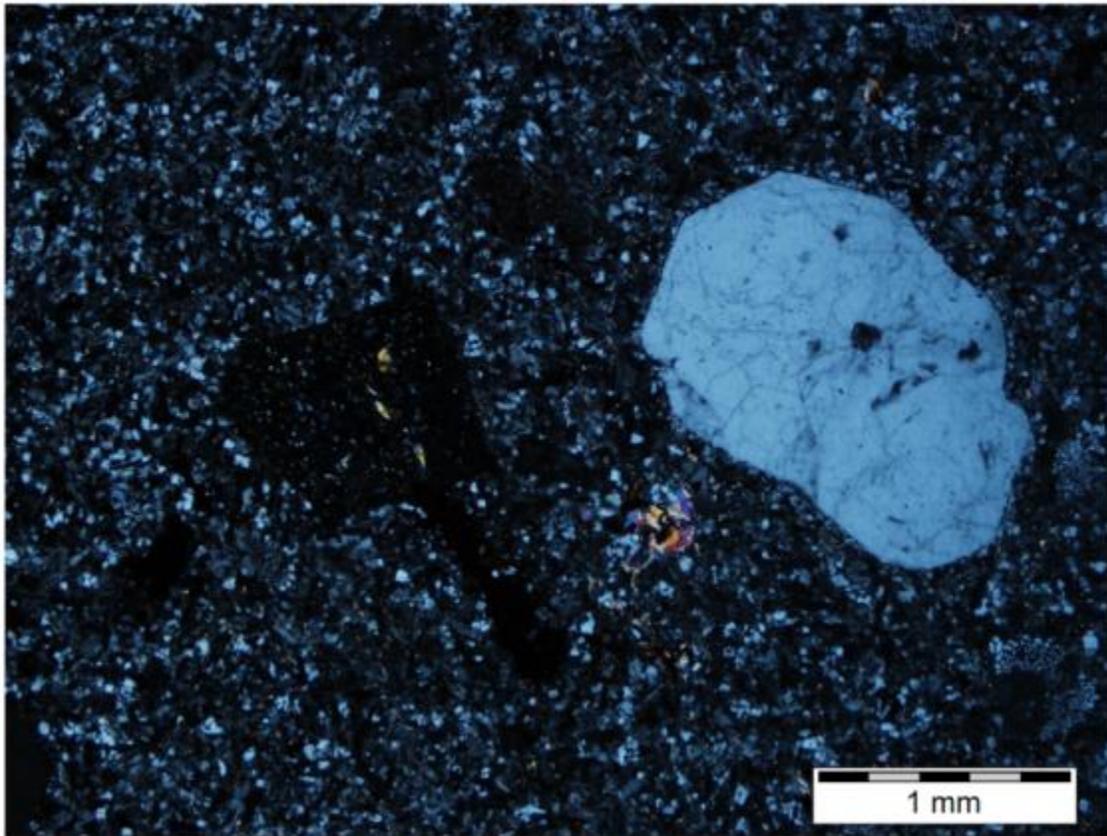
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 200

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Light grey metasediment.

Microstructure:

Subhedral quartz and plagioclase phenocrysts and plagioclase glomerophenocrysts immersed within a fine-grained groundmass of quartz and plagioclase.

Primary Minerals:

Plagioclase and quartz.

Alteration Minerals:

Clay and epidote.

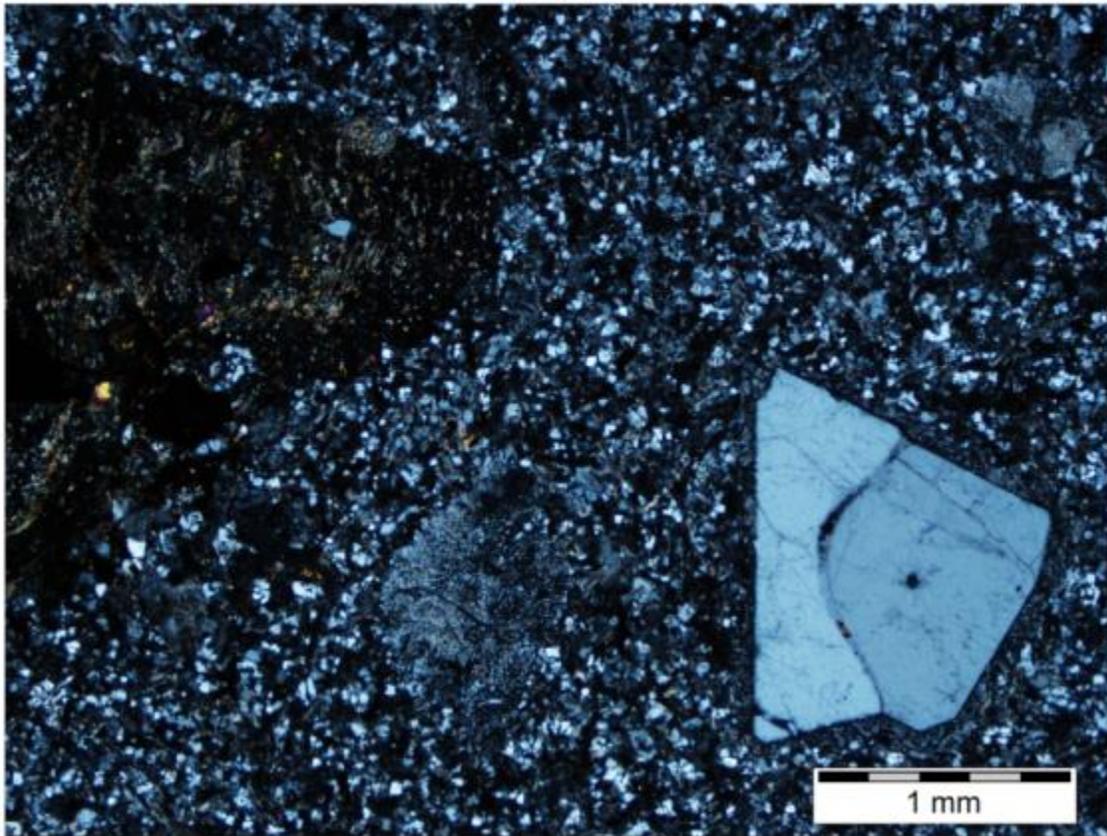
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 200

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Light grey metasediment.

Microstructure:

Subhedral quartz and plagioclase phenocrysts and plagioclase glomerophenocrysts immersed within a fine-grained groundmass of quartz and plagioclase.

Primary Minerals:

Plagioclase and quartz.

Alteration Minerals:

Clay and epidote.

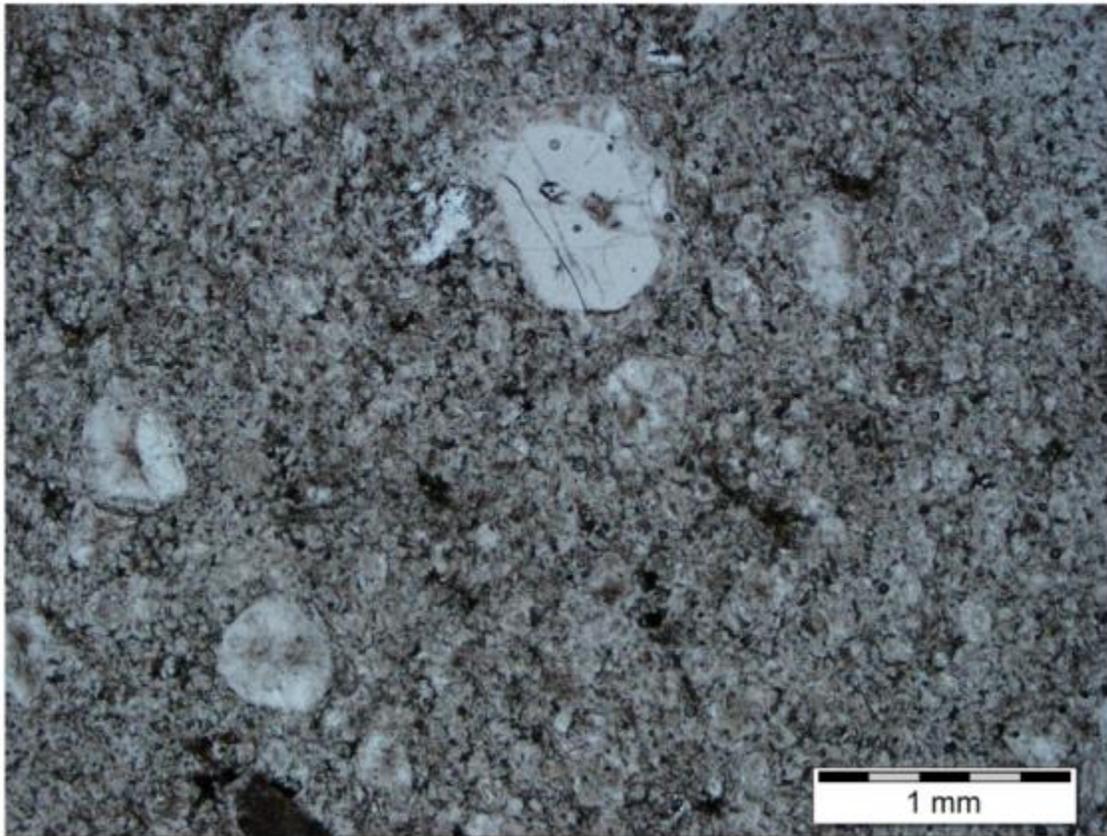
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 260

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Grey quartzite.

Microstructure:

Subhedral phenocrysts of quartz, plagioclase, and fibrous amygdules filled by low relief. Low birefringent material are immersed within a very fine-grained unresolved matrix.

Primary Minerals:

Plagioclase and quartz.

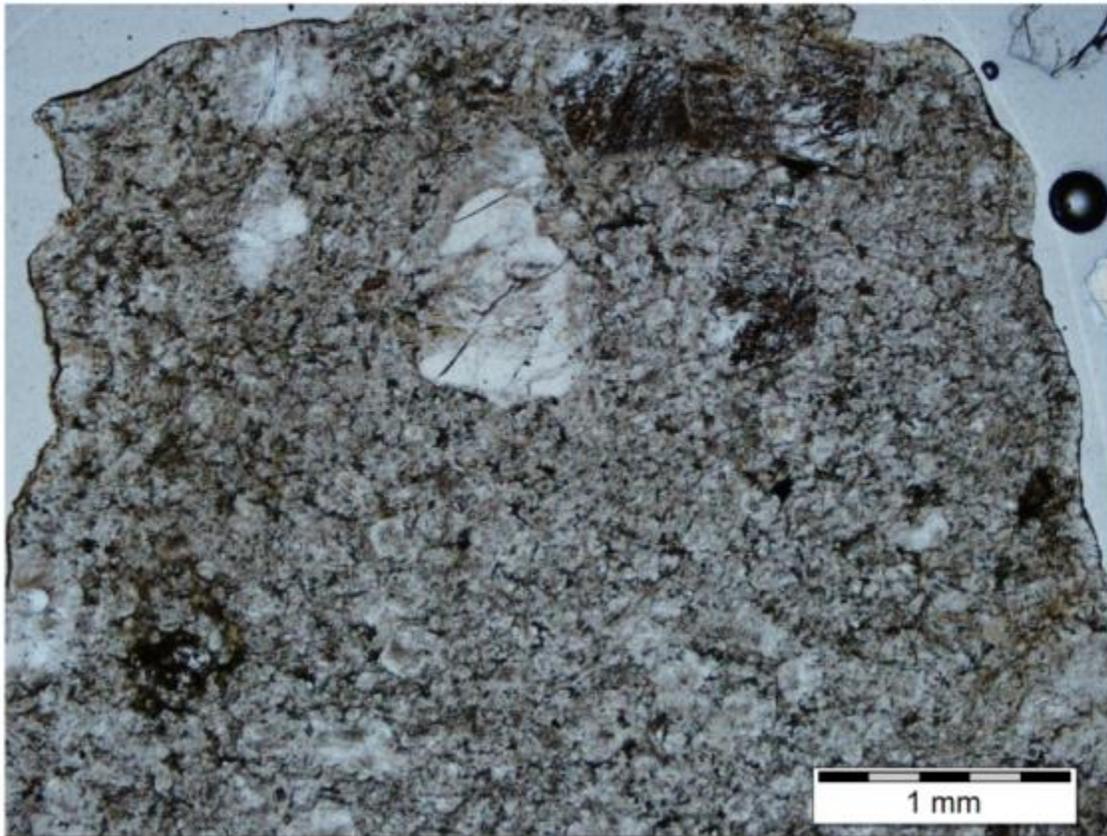
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 260

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Grey quartzite.

Microstructure:

Subhedral phenocrysts of quartz, plagioclase, and fibrous amygdules filled by low relief. Low birefringent material are immersed within a very fine-grained unresolved matrix.

Primary Minerals:

Plagioclase and quartz.

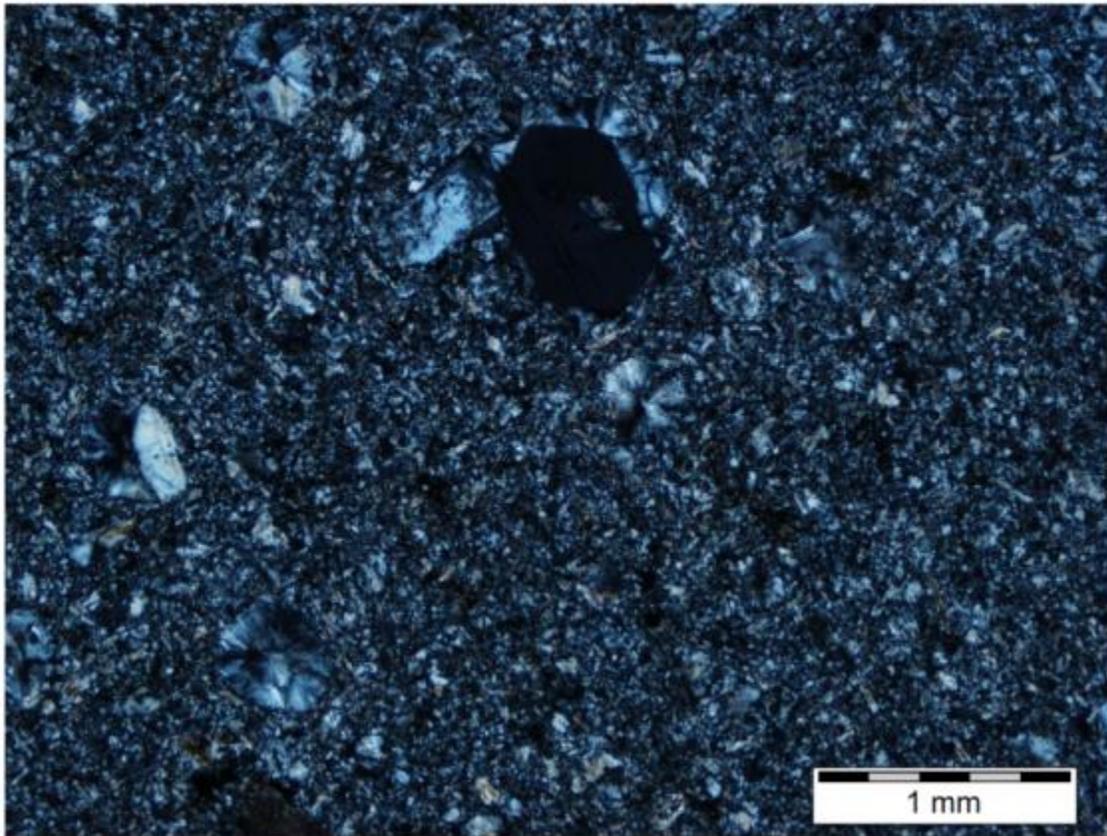
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 260

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Grey quartzite.

Microstructure:

Subhedral phenocrysts of quartz, plagioclase, and fibrous amygdules filled by low relief. Low birefringent material are immersed within a very fine-grained unresolved matrix.

Primary Minerals:

Plagioclase and quartz.

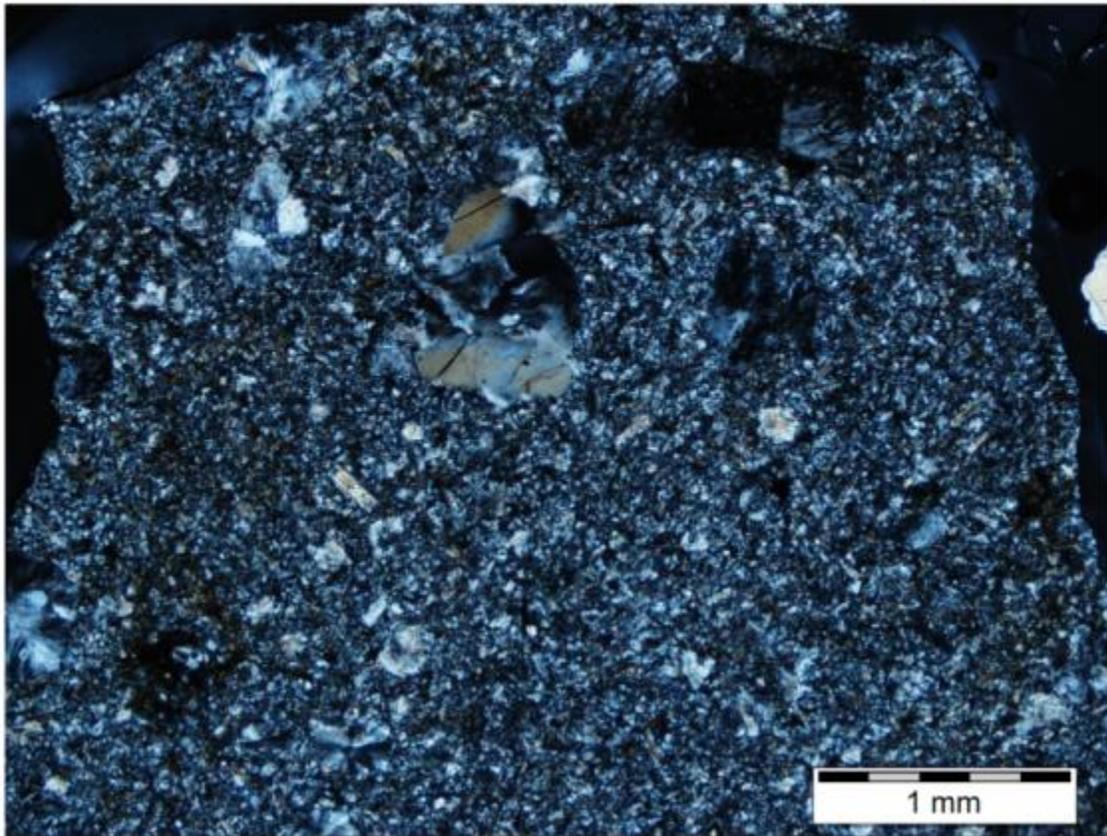
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 260

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Grey quartzite.

Microstructure:

Subhedral phenocrysts of quartz, plagioclase, and fibrous amygdules filled by low relief. Low birefringent material are immersed within a very fine-grained unresolved matrix.

Primary Minerals:

Plagioclase and quartz.

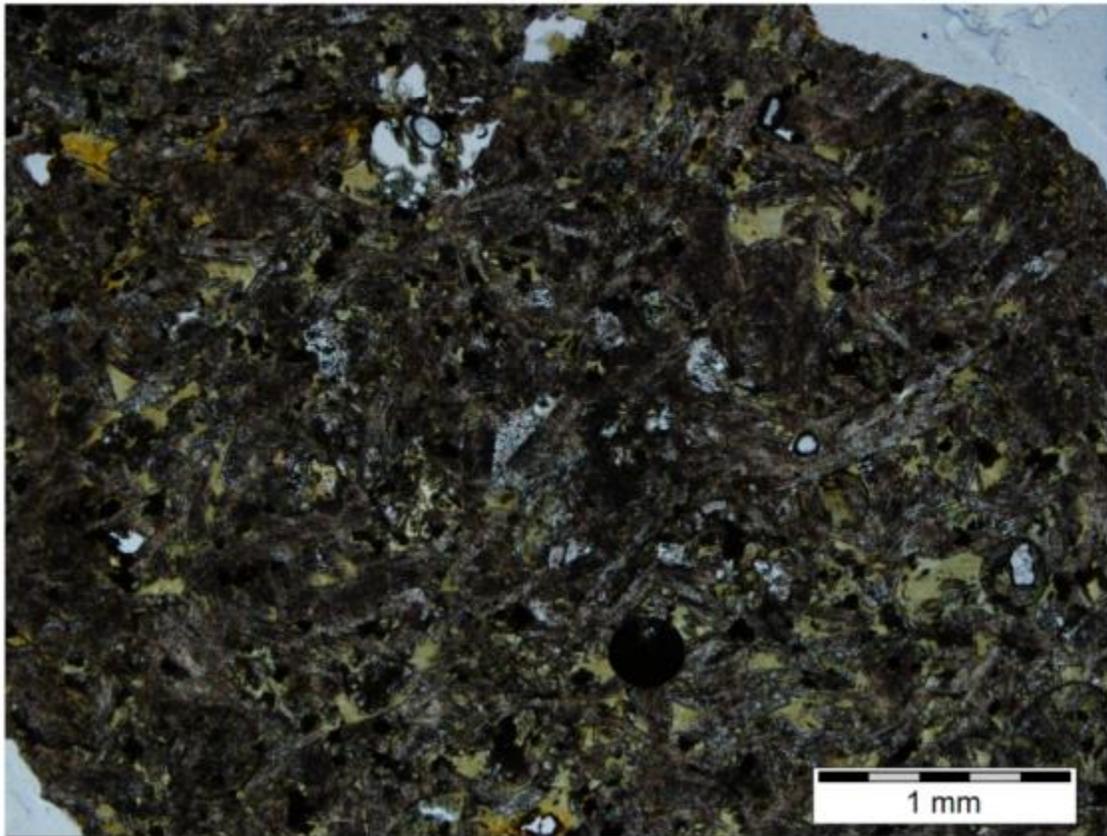
Petrographic Classification:

Quartz-plagioclase-phyric andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 261

Light Transmission: Plane Polarized

Surficial Attributes Material Type Classification:

Speckled volcanic.

Microstructure:

Elongate laths of plagioclase are randomly oriented and dominate the composition of this lava. Chlorite and rare quartz occupy some of the interstices between the plagioclase.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Clay, chlorite, quartz, and epidote.

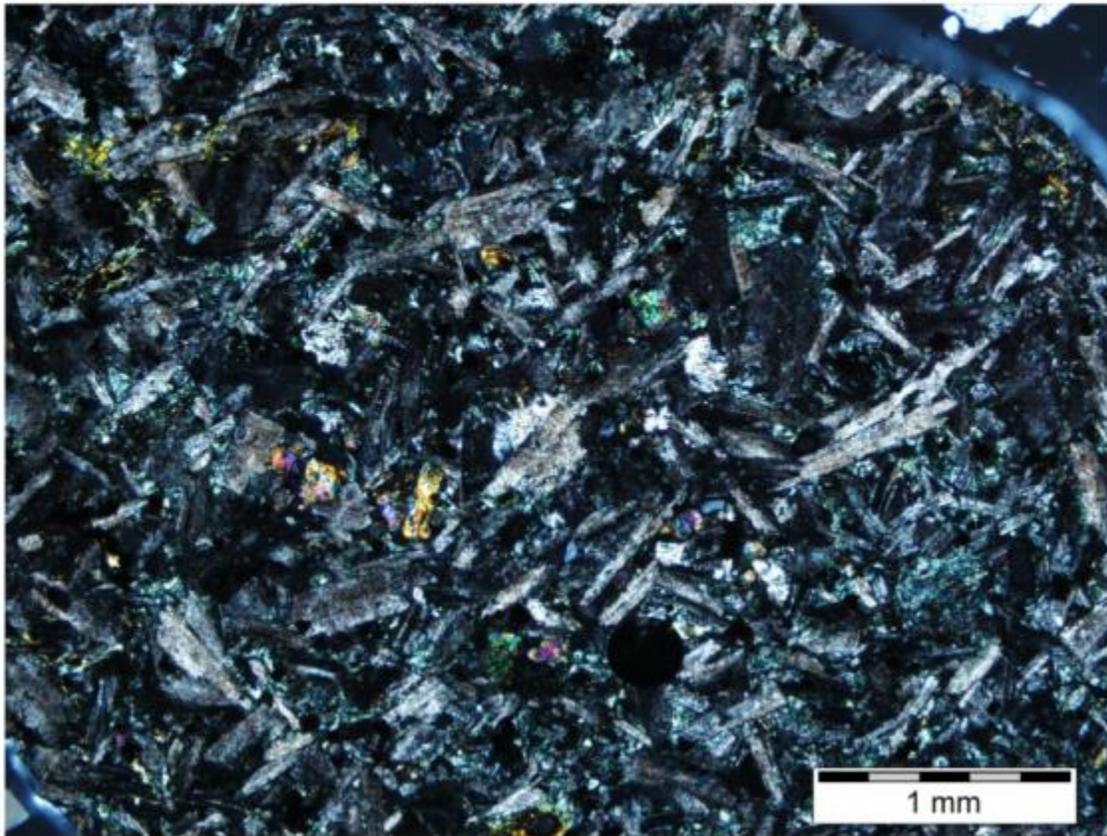
Petrographic Classification:

Altered andesite.

Geological Suite:

Andesitic.

Thin Section Petrography Photomicrograph



Archaeological Site: Village Bay Lake Island

Borden Number: EbSh-80

Specimen Number: 261

Light Transmission: Crossed-Nicols Polarized

Surficial Attributes Material Type Classification:

Speckled volcanic.

Microstructure:

Elongate laths of plagioclase are randomly oriented and dominate the composition of this lava. Chlorite and rare quartz occupy some of the interstices between the plagioclase.

Primary Minerals:

Plagioclase.

Alteration Minerals:

Clay, chlorite, quartz, and epidote.

Petrographic Classification:

Altered andesite.

Geological Suite:

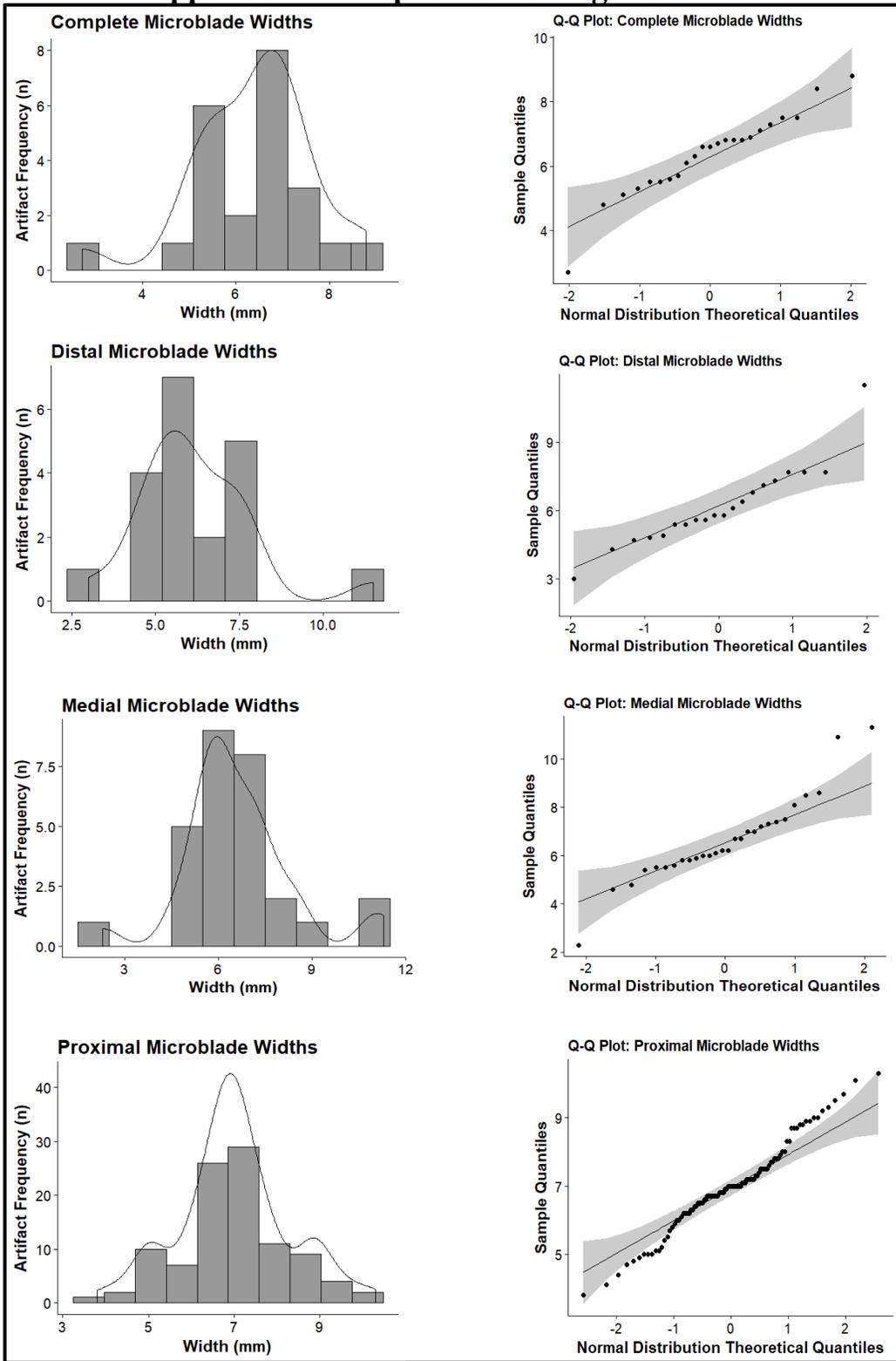
Andesitic.

Appendix C: X-Ray Fluorescence Spectrometry Elemental Composition Data

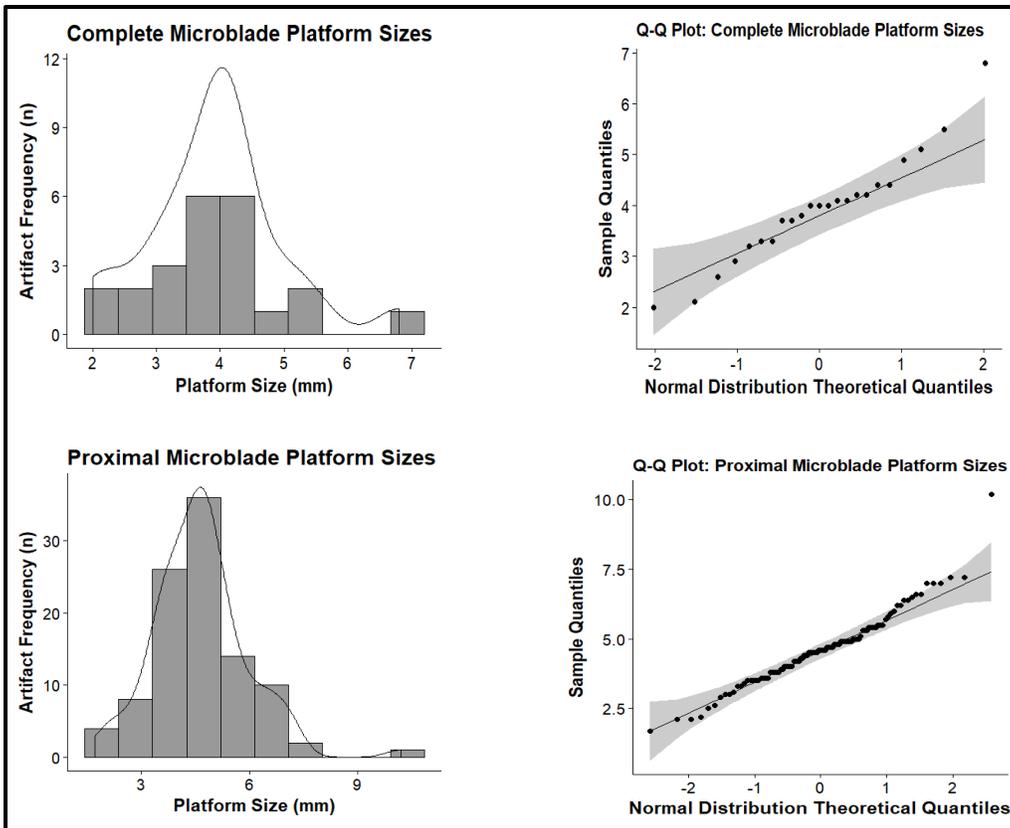
Macroscopic Lithic Material Type Identification and Classification	Specimen Number	Geological Source Location Estimation	Elemental Composition (ppm)									
			Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Black Volcanic	EbSh-81:554	Watts Point	566	30588	81	14	1	26	1033	12	165	2
Black Volcanic	EbSh-81:558	Watts Point	715	36969	83	12	2	36	1062	13	159	3
Dark Grey Volcanic	EbSh-81:545	Unknown	917	32537	92	14	0	15	876	13	143	4
Dark Grey Volcanic	EbSh-81:601	Watts Point	780	39022	70	11	0	33	1164	13	167	2
Grey Volcanic	EbSh-81:128	Unknown	667	25267	128	17	0	20	336	17	108	6
Grey Volcanic	EbSh-80:340	Unknown	509	24883	139	18	2	28	510	22	131	5
Grey Volcanic	EbSh-80:352	Unknown	650	36034	128	15	9	117	665	12	241	10
Grey Volcanic	EbSh-80:369	Unknown	517	20911	931	65	3	45	371	19	85	5
Grey Volcanic	EbSh-81:935	Unknown	840	41519	91	11	0	20	1429	15	189	6
Obsidian	EbSh-80:27	Kingcome	903	17707	96	17	11	117	22	35	306	43
Obsidian	EbSh-80:33	Kingcome	683	26572	158	18	16	142	3	68	730	48
Obsidian	EbSh-80:38	Kingcome	577	22431	134	18	10	119	2	65	686	49
Obsidian	EbSh-80:39	Kingcome	548	23663	163	20	10	114	9	58	602	41
Obsidian	EbSh-80:40	Kingcome	566	26250	190	18	12	130	5	60	649	44
Obsidian	EbSh-80:45	Kingcome	499	21880	139	19	11	119	4	63	672	47
Obsidian	EbSh-80:46	Kingcome	520	23662	141	18	6	118	26	63	662	46
Obsidian	EbSh-80:50	Kingcome	349	22248	131	18	11	132	2	63	697	47
Obsidian	EbSh-80:51	Kingcome	547	24051	160	20	5	129	7	61	706	51
Obsidian	EbSh-80:55	Kingcome	591	25897	166	20	10	129	15	58	626	42
Obsidian	EbSh-80:65	Kingcome	430	23579	140	19	12	131	2	63	694	48
Obsidian	EbSh-80:66	Kingcome	760	33196	220	18	12	148	3	62	739	54
Obsidian	EbSh-80:67	Kingcome	519	22874	138	18	12	124	10	57	637	43
Obsidian	EbSh-80:68	Kingcome	812	28237	202	19	10	134	6	59	624	44
Obsidian	EbSh-80:74	Kingcome	443	22195	119	17	8	118	5	61	638	43
Obsidian	EbSh-80:75	Kingcome	550	23543	147	18	8	122	1	61	627	44
Obsidian	EbSh-80:78	Kingcome	390	20540	132	19	6	119	3	64	678	50
Obsidian	EbSh-80:79	Kingcome	430	20328	114	18	9	118	3	64	662	46
Obsidian	EbSh-80:107	Kingcome	555	20131	134	19	6	120	3	61	686	50
Obsidian	EbSh-80:108	Kingcome	472	22702	117	18	6	123	3	57	664	44
Obsidian	EbSh-80:117	Kingcome	625	32460	232	18	14	148	10	60	664	46
Obsidian	EbSh-80:339	Kingcome	485	23529	144	19	8	139	2	69	721	48
Obsidian	EbSh-80:342	Kingcome	442	19874	187	22	8	121	7	59	623	47
Obsidian	EbSh-80:343	Kingcome	492	21480	121	18	10	125	4	67	691	46
Obsidian	EbSh-80:346	Kingcome	495	28553	285	25	11	144	2	66	715	50
Obsidian	EbSh-80:351	Kingcome	502	20178	118	18	9	114	4	58	639	46
Obsidian	EbSh-80:353	Kingcome	449	23778	211	23	10	134	2	65	714	50
Obsidian	EbSh-80:354	Kingcome	527	24576	180	21	10	133	3	64	697	47
Obsidian	EbSh-80:355	Kingcome	525	26420	296	27	11	138	4	65	692	49
Obsidian	EbSh-80:356	Kingcome	666	26853	257	24	12	138	3	72	722	44
Obsidian	EbSh-80:358	Kingcome	519	19446	136	19	11	121	2	61	661	49
Obsidian	EbSh-80:359	Kingcome	479	23844	188	21	8	132	4	70	710	48
Obsidian	EbSh-80:360	Kingcome	628	24547	197	22	10	135	3	65	731	51
Obsidian	EbSh-80:361	Kingcome	356	21556	187	22	10	121	4	58	655	43
Obsidian	EbSh-80:362	Kingcome	457	22534	155	20	12	148	2	64	713	48
Obsidian	EbSh-80:363	Kingcome	578	27296	264	22	13	147	4	59	698	48
Obsidian	EbSh-80:364	Kingcome	602	25041	220	23	12	141	4	71	711	49
Obsidian	EbSh-80:365	Kingcome	475	21008	143	19	10	128	4	67	687	48
Obsidian	EbSh-80:366	Kingcome	324	20325	147	19	5	109	3	60	613	44
Obsidian	EbSh-80:367	Kingcome	455	25890	235	24	9	135	2	68	686	47
Obsidian	EbSh-80:368	Kingcome	819	33969	366	20	19	156	5	66	735	51
Obsidian	EbSh-80:370	Kingcome	523	22817	190	22	7	116	10	62	658	48

Macroscopic Lithic Material Type Identification and Classification	Specimen Number	Geological Source Location Estimation	Elemental Composition (ppm)									
			Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Obsidian	EbSh-80:371	Kingcome	473	22897	160	20	8	130	2	65	719	52
Obsidian	EbSh-80:372	Kingcome	493	27002	247	21	14	142	5	68	722	50
Obsidian	EbSh-80:373	Kingcome	414	25364	207	22	10	122	10	62	681	47
Obsidian	EbSh-80:374	Kingcome	671	26185	272	26	4	112	3	49	567	41
Obsidian	EbSh-80:375	Kingcome	749	26500	235	23	7	115	9	56	607	43
Obsidian	EbSh-80:379	Kingcome	368	21017	146	20	9	114	4	58	657	44
Obsidian	EbSh-80:380	Kingcome	539	26178	214	21	10	141	3	63	704	49
Obsidian	EbSh-80:381	Kingcome	479	22112	156	20	10	125	4	62	670	46
Obsidian	EbSh-80:382	Unknown Central Coast B	615	19782	194	23	13	145	22	48	380	52
Obsidian	EbSh-80:383	Kingcome	367	23689	169	20	7	124	6	58	661	46
Obsidian	EbSh-80:384	Kingcome	491	21373	260	27	12	127	3	55	622	41
Obsidian	EbSh-80:385	Kingcome	455	20107	144	20	9	118	2	64	669	48
Obsidian	EbSh-80:386	Kingcome	456	22864	210	22	10	146	5	62	660	44
Obsidian	EbSh-80:387	Kingcome	459	23426	154	20	11	130	2	71	737	47
Obsidian	EbSh-80:388	Kingcome	435	22902	204	23	12	148	5	66	686	48
Obsidian	EbSh-80:389	Kingcome	457	19762	122	19	7	116	3	56	648	45
Obsidian	EbSh-80:390	Kingcome	427	19346	117	18	5	111	3	61	618	43
Obsidian	EbSh-80:391	Kingcome	614	24663	337	30	13	127	5	55	629	44
Obsidian	EbSh-80:392	Kingcome	442	25200	251	25	7	136	3	67	690	47
Obsidian	EbSh-80:393	Unknown Central Coast B	721	23727	278	27	15	161	23	45	368	51
Obsidian	EbSh-80:394	Kingcome	383	23361	152	19	10	128	5	65	717	50
Obsidian	EbSh-80:395	Kingcome	356	21410	150	20	8	139	4	62	678	47
Obsidian	EbSh-80:396	Kingcome	484	24688	236	24	11	123	6	55	638	45
Obsidian	EbSh-80:397	Kingcome	525	26345	269	26	13	148	1	63	734	46
Obsidian	EbSh-80:398	Kingcome	546	26115	287	25	10	141	6	67	700	45
Obsidian	EbSh-80:399	Unknown Central Coast B	537	23269	286	28	7	131	33	38	336	47
Obsidian	EbSh-80:400	Kingcome	569	25967	224	23	10	130	3	62	703	48
Obsidian	EbSh-80:401	Unknown Central Coast B	494	19037	196	22	7	139	22	45	367	48
Obsidian	EbSh-80:402	Kingcome	401	21763	210	23	4	117	6	61	649	46
Obsidian	EbSh-80:403	Kingcome	534	25654	219	23	12	135	8	66	708	47
Obsidian	EbSh-80:404	Kingcome	449	22398	173	21	11	129	4	65	682	47
Obsidian	EbSh-80:405	Kingcome	406	22669	157	20	10	131	3	62	721	49
Obsidian	EbSh-80:406	Kingcome	693	27878	319	28	18	152	3	67	696	49
Obsidian	EbSh-80:407	Kingcome	534	21100	130	19	11	118	4	65	699	46
Obsidian	EbSh-80:408	Kingcome	590	23408	158	20	10	128	3	63	695	47
Obsidian	EbSh-80:409	Kingcome	559	24371	226	23	8	131	6	68	679	49
Obsidian	EbSh-80:410	Kingcome	555	21394	152	20	11	123	2	63	676	50
Obsidian	EbSh-80:411	Kingcome	496	22528	174	21	7	115	15	58	642	46
Obsidian	EbSh-80:412	Kingcome	451	21458	353	32	9	122	5	59	628	40
Obsidian	EbSh-80:413	Kingcome	573	24192	242	23	10	130	4	66	679	47
Obsidian	EbSh-80:414	Kingcome	397	22473	187	22	9	126	2	64	706	49
Obsidian	EbSh-80:415	Kingcome	372	20683	126	19	7	115	4	59	648	42
Obsidian	EbSh-80:416	Kingcome	431	22366	178	20	7	117	2	62	663	46
Obsidian	EbSh-80:417	Unknown Central Coast B	609	18956	169	20	10	158	17	46	389	56
Obsidian	EbSh-80:418	Kingcome	650	27100	175	19	13	153	3	73	764	54
Obsidian	EbSh-80:419	Mount Edziza: Coffee Crater	743	32068	313	11	19	181	2	81	1238	107
Obsidian	EbSh-80:420	Kingcome	405	19220	138	20	11	116	2	62	644	48
Obsidian	EbSh-80:422	Unknown Central Coast B	577	16869	350	33	12	113	32	41	303	44
Obsidian	EbSh-80:428	Nch'kay	469	13119	56	15	3	69	275	17	188	11
Obsidian	EbSh-80:429	Kingcome	492	21480	121	18	10	125	4	67	691	46
Obsidian	EbSh-81:429	Unknown Central Coast B	430	16170	89	17	9	128	19	48	357	56

Appendix D: Morphometric Diagnostic Plots



Diagnostic Plots of Crescent Channel (EbSh-81) Microblade Width Samples



Diagnostic Plots of Crescent Channel (EbSh-81) Microblade Platform Size Samples