CHAPTER 3

Primary Toolstone Sources and Pre-Contact Period Quarrying Behaviour in the Thompson River Drainage of South Central British Columbia

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Introduction and Background

Much remains to be learned about the character and natural distribution of flakable silicates and dacites on the Canadian Plateau, but some detailed published information is available (Bakewell 1991a,b; Bakewell and Irving 1994; Ball *et al.* 1998; Commisso 1999; Greenough *et al.* 2004; Kowal and Ball 1999; Leaming 1971; Mallory-Greenough and Greenough 2004; Mallory-Greenough *et al.* 2002; Richards 1988; Rousseau 2000). This chapter presents a general description and discussion of six large and abundant "primary" toolstone sources located in the Thompson River drainage of south-central British Columbia (B.C.) (Figures 3-1 and 3-2). Information presented herein is intended to serve as a basic descriptive guide to assist researchers attempting to ascertain natural toolstone quarry sources for lithic material types commonly represented in archaeological lithic assemblages at sites in south-central B.C. Also presented are reasons why some lithic material types are better suited for specific functional purposes, and thus help explain why they were selectively preferred by pre-contact period technicians.

Identification, recording and detailed archaeological investigation of natural silicate toolstone sources in southern B.C. are still in a nascent stage. I have spent considerable time examining road-cut exposures, gravel bars in streams and rivers, gravel pits, and bulldozed fields over the last 30 years, and have gradually identified at least 25 other "secondary" toolstone sources currently known within the study area, but most of these are either

Figure 3-1. Location of study area in South Central British Columbia.

highly localized or of limited areal extent, and often contain low incidences of accessible stone suitable for flaking. While these secondary sources certainly have local, regional, and inter-regional archaeological significance and importance, they are not included herein because the descriptive information alone would fill a volume.

Visual comparison and memory recognition of distinctive types of toolstone removed from known source quarries remains the easiest, simplest, and cheapest method for identifying source localities. X-ray fluorescence, petrographic analysis, and other geochemical methods (Bakewell 1991a, b;

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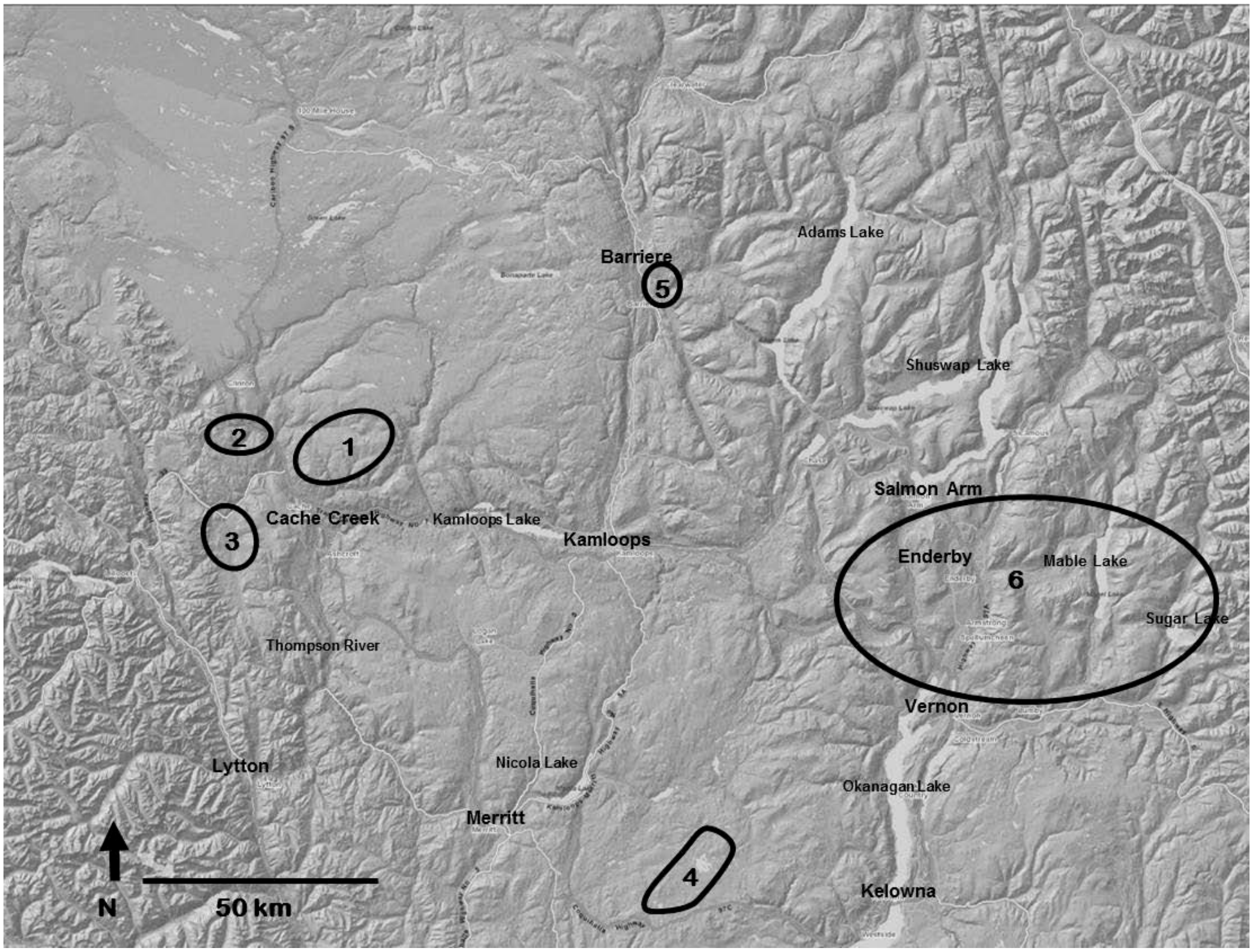

Figure 3-2. Map showing approximate locations of six primary tool stone sources in the Thompson River drainage: Source (1) Cache Creek/Arrowstone Hills dacite and silicates; (2) Maiden Creek dacite and silicates; (3) Upper Hat Creek silicates and dacite; (4) Pennask Lake/Okanagan Highland dacite; (5) Barriere chert; and (6) Shuswap banded chert. Adapted from IMAP BC map image.

Bakewell and Irving 1994; Ball *et al.* 1998; Bertin 1978; Commisso 1999; Greenough *et al.* 2004; Kowal and Ball 1999; Mallory-Greenough and Greenough 2004; Mallory-Greenough *et al.* 2002) are surely more accurate and reliable methods commonly used for identification of some stone sources, but they require specialized equipment and some expenditures of money and time that may not be practical for most lithic analyses.

The six toolstone sources presented below have a wide variety of microcrystalline and cryptocrystalline silicates with very unique sets of physical properties that allow them to be easily and accurately visually matched with their quarry source. Visual physical traits with excellent diagnostic value include considerations of weathering and patina on cortical surfaces, groundmass color(s), relative hardness, texture, lustre, internal molecular structure, inclusions, groundmass bedding or banding, perverse flawing, hinging, and general response to direct percussion and pressure flaking techniques.

Surficial and bedrock geology in the study area includes the “Cache Creek Group” and “Kamloops Group” (Campbell and Tripper 1971; Church 1982; Dawson 1896; Drysdale 1913; Duffel and McTaggart 1951; and Ewing 1981a,b; Leaming 1971). Most of the six toolstone sources presented below are known high-quality silicate sources associated with Tertiary period/age geologic deposits dating between 65 and 2 mya during the initial part of the Cenozoic Era. It was characterized by world-wide moderate to tropical climates, and in south-central B.C., Tertiary age volcanic and marine sediments are obvious by their conspicuous bright colors that commonly include true, pastel, and mixed shades of yellow, orange, red, purple, brown, green, grey and sometimes light blue. Small isolated pockets are visible along valley sides in locations where bedrock protected them from being impacted and removed by glacial and fluvial processes. These volcanic and marine floor deposits often contrast sharply with immediately adjacent glacial deposits and bedrock, and some contain chalcedonies and cherts that have formed in cavities, bubbles, seams, and buried organics (e.g., petrified wood). Plant, insect and fish fossils in fine clays and silts, and seams of coal are also sometimes directly associated with Tertiary age sediments and flakable silicates, but not always.

"Primary" toolstone sources are defined as locations where fair to excellent quality silicate rocks with good flaking properties can be easily found exposed on the ground surface and exposures in medium to high densities over fairly large geographic areas. Six known primary toolstone source localities are described and discussed. They include: **(1)** Arrowstone Hills and Cache Creek locality; **(2)** Maiden Creek drainage northwest of Cache Creek; **(3)** Hat Creek Valley west of Cache Creek; **(4)** Pennask Lake locality in the Okanagan Highlands; **(5)** Barriere locality on the North Thompson River; and **(6)** the southern Shuswap Lakes locality (Figure 3-2).

Arrowstone Hills/Cache Creek Locality Dacite and Silicate Source

The best-known and most abundant toolstone quarry in south-central B.C. is the Arrowstone Hills/Cache Creek dacite source located northeast of the town of Cache Creek (Figures 3-2 and 3-3). It is associated with heavily eroded Tertiary age volcanic lava flows, ash-rain sediments and marine deposits, and terraces and pockets of associated colluvial, glacial and glacio-fluvial deposits. During the early post-contact period it was a widely known local fact that First Nations people gathered toolstone there in pre-contact period times, hence this upland was dubbed "Arrowstone Hills". Arrowstone Creek, a major confluence of Cache Creek, has dissected through a large heavily eroded extinct volcanic crater containing widespread medium to high densities of buried dacite pebbles,

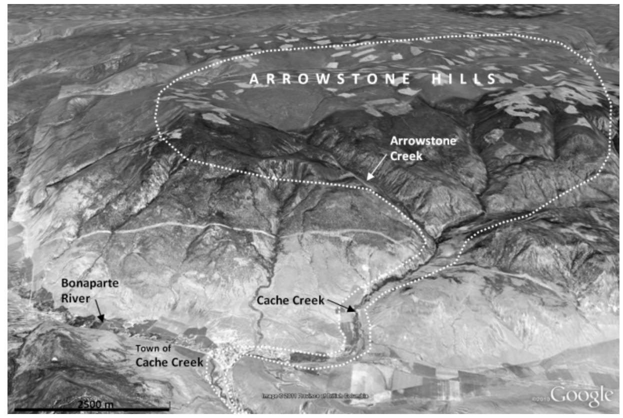

Figure 3-3. Oblique aerial view of Arrowstone Hills showing currently estimated natural surfacial distribution of Cache Creek Dacite, looking northeast. It is the most abundant and easily accessed sources of high quality dacite in south-central BC.

cobbles, and small boulders (Figure 3-3).

Prior to the early 1990s, most archaeologists referred to this toolstone as "Cache Creek basalt", and this moniker is still occasionally used today by some. Detailed petrographic studies conducted by Bakewell (1991a,b) revealed that it is actually a very high quality dacite, and this more accurate term is now acknowledged and used by most researchers. Currently, known dacite exposures at the Arrowstone/Cache Creek source encompass an area measuring approximately 100 square km (Figure 3-3). This is an estimate based on my personal familiarity with the source area, and on data secured during forestry-related impact assessment fieldwork (Ball *et al.* 1998; Kowal and Ball 1999). This conjecture of areal extent may be a bit conservative; future fieldwork may prove the source area to be somewhat larger in an eastern direction.

Extensive valley bottom fluvial gravel bar deposits and along Arrowstone and Cache Creeks, and colluviums along valley sides, are very productive for glacio-fluvial and fluvially rounded and smoothed dacite clasts of all size. Many clasts have been transported down into the town of Cache Creek where they can be found in moderate densities, and in lower densities along gravel bars and exposed banks of the Bonaparte River further downstream to the south. Despite past intensive procurement during most of the 11,000 year-long pre-contact period, in the right locations it is still easy to find up to a hundred flakable cobbles over the course of a few hours. A handful of archaeologists and hobbyist flintknappers continue to exploit parts of this source area with low regularity and impact. There can be little doubt that there are still millions of dacite clasts that remain buried throughout the Arrowstone Hills upland, and along bottoms and sides of Arrowstone and Cache Creeks.

Clasts vary greatly in form, with elongate lozenge, elliptical, discoidal, tabular, spherical, ovoid, egg-shaped, and football-shaped forms being most common (Figures 3-4 and 3-5). They typically range in size from 1 to 15 cm in maximum dimension, but small boulders ranging from 15 to 30 cm are sometimes found in localities where densities are moderate to high. Externally, many have multiple flat polygonal and elongate "fluted" facets, and are moderately to fairly angular with low to moderate degrees of surface feature rounding. Surface weathering and cortex/patina development on most clasts is commonly very thin semi-transparent, "frosty" "smoky" or "milky" white, light grey, or occasionally pale white-blue (Figure 3-4). A low proportion of clasts (usually larger cobbles and boulders) have moderate to thick "chalky" patina on one or more surface facets or sides that is precipitated calcium carbonate formed on the bottom of clasts while incorporated in alkaline glacial till deposits.

Most clasts have internal groundmasses that are jet black, black, and dark grey-black, with textures ranging from medium and fine-grained microcrystalline, to smooth cryptocrystalline. Lustres range between dull, waxy, greasy and glassy. While most groundmasses are fairly homogenous, they are not truly isotropic. Typically, internal structure of most clasts is characterized by visible lamellar or "bedded" flow planes whose orientations are accentuated and easily observed on many weathered cortical surfaces (Figure 3-4). These flow planes/lamellae are sometimes observable on fresh-struck internal surfaces as thin alternating grey-black and black parallel bands. Overall clast form is also dictated to some degree by these flow planes, with longer axes of cobbles and pebbles being oriented parallel to them. Small randomly spaced low density silicate phenocrysts and crystalline seam inclusions are sometimes present, but are more common in jet black glassy/vitreous groundmasses. Some of the grey-black medium and fine-grained groundmasses lack such inclusions, and are typically less flawed.

Figure 3-4. Selected examples of typical Cache Creek dacite pebbles and cobbles from Arrowstone Creek showing range in clast forms and cortical surface variation.

Figure 3-5. Fresh-struck flakes and chunks of Cache Creek dacite showing range of variation in groundmass textures and traits.

From a technological perspective, Arrowstone/ Cache Creek dacite is almost a perfect toolstone. Small pebbles ranging from 2 to 5 cm in maximum dimension are very abundant, and during the pre-contact period these smaller ones were commonly reduced by bipolar technique. If bipolar force is applied in parallel compliance with the lamellar structure of the groundmass, numerous usable thin, flat and sharp "shear" flakes can often be easily produced from a single pebble. Microblade cores are also easily produced from small elliptical pebbles by splitting them transversely and using resulting fracture facets as initiation platforms to very effectively remove blades oriented parallel to the internal lamellar bedding structure.

Cobbles and small boulders of this stone are also ideal for direct freehand techniques, and very large and remarkably thin flakes can be reliably produced from fine-grained dacite cobbles using both hard and soft-hammer percussion methods. The most effective means of striking medium-size and large flakes involves directing impact force loads along and parallel to, or slightly oblique to, the lamellar groundmass structure. Medium and fine-grained (i.e., non-glassy) dacites are clearly the best for successfully producing large flake blanks, as they have fairly homogenous and semi-isotropic groundmasses that are usually flaw free, allowing good flaking control and better chance of success during production of tools involving significant investments of time (e.g., formed unifaces and bifaces). They also lend themselves very well to pressure flaking, allowing production of large, thin, well-made bifaces and other complex tool forms. Medium-grained and fine-grained dacites are also more resilient and functionally durable than glassy/vitreous dacites which tend to have a greater incidence of crystalline inclusions, flaws, cracks, and cortical bruising which render them more prone to shattering, hinging, and unpredictable and erratic flaking results. While all dacite cobbles can be easily and successfully reduced into a variety of useful tool forms, after spending some time reducing the suite of groundmass types, it becomes readily apparent that medium and fine-grained dacites are technically superior to glassy/vitric clasts. This selective preference is also reflected in many lithic assemblages from archaeological sites throughout the study area.

High quality flakable dacite clasts found in the Arrowstone/Cache Creek locality provided local pre-contact period inhabitants of the region with an inexhaustible supply of excellent quality toolstone that was used for many thousands of years. The lower southern aspect of the source area would have been visited year-round, but upland areas to the north could have only been accessed from late Spring to late Fall. Archaeological sites directly associated with natural Cache Creek dacite exposures can be very large, often extending many hundreds of metres along flat and gently sloping terrace edges and stream channels. Cultural deposits at these sites are often thick (0.5 to 1.0 m below ground surface), with continuous cultural deposits at larger sites at or near clast-rich areas extending to depths of 2.0 m below surface. Cultural deposits at most sites are moderate to very high density, and comprised mostly of initial reduction stage de-cortication waste, block shatter; core preparation flakes, complete and broken/snapped tool flake blanks, a moderate to high incidence of ovate, leaf-shaped and triangular bifacial performs, and millions of hard and soft-hammer flakes resulting from their production. Some upland areas with high natural clast densities contain obvious evidence for hand-excavated pre-contact period quarry pits (adits) measuring several metres across (Bruce Ball pers. comm. 2011).

While it is not widely known or acknowledged, the Arrowstone/Cache Creek area source also contains isolated patches of low to medium density cryptocrystalline silicates. Small to medium size (4 to 10 cm) nodules and blocky clasts of translucent chalcedony, multi-coloured (mostly red, brown and yellow) cherts, and sometimes opal, can be found with dacite clasts in low density associated with Tertiary Age volcanic basalt flows and related isolated pockets of marine sediments, and also incorporated in glacial till and steam deposits. Petrified/silicified wood is also present in some areas, notably in the northwest aspect of the source area. Archaeological sites lying within and near this source indicate that these less abundant silicates were also being sought and reduced, but they typically only represent less than 2 percent of most quarry-related assemblages.

Maiden Creek Dacite and Silicate Sources

The Maiden Creek dacite quarry and its nearby companion silicate source are located northwest of the town of Cache Creek between the Bonaparte River and Mid-Fraser River region (Figures 3-2 and 3-6). These medium to high density sources have been previously presented in Rousseau (2000:177-181), and their more salient traits are presented and summarized below. This very abundant dacite source area occupies about 20 square kilometres in upper Maiden Creek drainage basin. Pebbles, cobbles and small boulders of good to excellent quality dacite can be very easily found in moderate

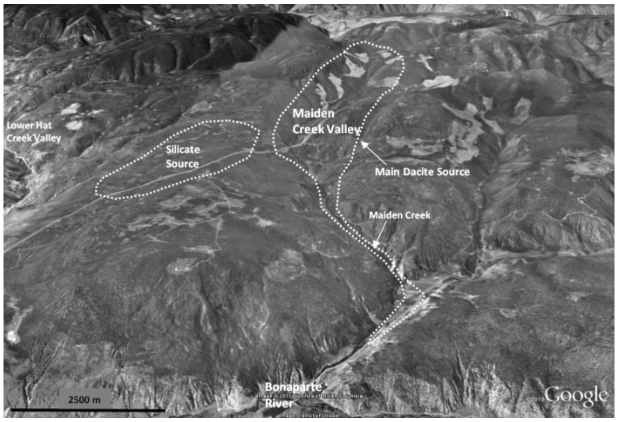

Figure 3-6. Oblique aerial image of the Maiden Creek dacite and silicate sources, looking west.

Figure 3-7. Cobbles and pebbles of Maiden Creek dacite showing range of clast forms and typical cortical surfaces.

Figure 3-8. Examples of fresh-struck surfaces of Maiden Creek dacite showing range in groundmass textures.

to high densities within exposed glacial till deposits, stream banks and channels in the upper drainage area, and in lesser concentrations to the east along Maiden Creek valley bottom down to the Bonaparte River. Dacites from this source are generally similar in structure and appearance to those found at the Arrowstone/Cache Creek source to the east, but there are some significant visually evident physical differences that allow them to be differentiated from each other with a fair degree of certainty.

Dacite clasts from Maiden Creek vary in size from small pebbles up to small boulders, and many are discoidal, elliptical, trapezoidal, elongated, tabular and blocky (Figure 3-7). On average they tend to be thicker than those from the Arrowstone/Cache Creek source, and outer surfaces of many have several intersecting flat polyhedral and elongate “channel-like” facets. Cortex/patina development is usually moderate to pronounced, and while some are thin and semi-translucent, most are opaque medium to light grey or white. Grey clast surfaces commonly have a faint graphite-like metallic sheen. On some larger blocky clasts, cortex development is very thick, especially on those with distinctive flat “rippled” and “corrugated” facets that are always oriented parallel to internal groundmass flow planes (Figure 3-8; lower right). This “corrugation” trait is very rarely present on Arrowstone/Cache Creek clasts. In some extreme cases the cortex development resembles chalky patinas similar to those found on English or Texas flint nodules. There is an abundance of bedrock limestone (Marble Canyon) surrounding the western edge of this dacite source, and thick calcium carbonate precipitates on some specimens may be attributed to direct contact with this geologic unit and/or groundwater with high concentrations of dissolved limestone.

Relatively homogenous groundmasses range in colours from jet black, dark to medium grey-black, medium grey, and occasionally even light grey (Figure 3-8). The lighter grey hues have semi-translucent and diaphanous properties that have caused some researchers to mistakenly identify them as grey chert. In contrast, dacite clasts from the nearby Arrowstone/Cache Creek source to the east are most always jet black to dark grey-black. Groundmass textures are generally rough medium-grained to smooth fine-grained microcrystalline, with fewer numbers of clasts being smooth and slightly vitric. Lustres commonly vary between dull, waxy, and greasy, but shiny glassy dacite clasts are far less common here than in the Arrowstone Hills Cache Creek source to the east. A high incidence of Maiden Creek dacite groundmasses also have faintly visible to obvious lamellar flow plane banding characterized by thin, ribbon-like bands of alternating black and dark grey-black lamellae that displays an interesting "candy cane" or "zebra stripe" appearance when flaked obliquely through the flow plane bedding axes. Fresh-struck internal textures mostly range from medium to fine-grained microcrystalline. Internal phenocrysts and other inclusions are also present, but are less common than those in dacite clasts from the Arrowstone/Cache Creek source.

Maiden Creek Dacite is also an excellent toolstone, and is easy to flake using hard and soft-hammer techniques. Removal of very large and exceptionally thin hard-hammer flakes is most easily accomplished when percussive force is initiated slightly obliquely or parallel to the internal flow planes. Such large flakes are ideal for successfully producing flake blanks to make a variety of formed bifacial knives and projectile points, formed unifaces, and other simple tool forms. Internal flawing and perverse fracturing are not as common in the Maiden Creek dacites as they are with clasts from the Arrowstone/Cache Creek source. Attempts to successfully remove flakes at angles set acutely or perpendicular to the bedding planes is rewarded with some success, but is sometimes seriously hindered by random internal fractures, perverse fracturing and shattering, and abrupt stepped and hinged flake terminations.

Numerous archaeological sites have been identified within the upland aspect of the Maiden Creek dacite source area during routine forestry-related projects over the last two decades. Most of them are directly related to quarrying activity and contain moderate to extremely high densities of primary and secondary reduction waste extending to depths of 1.0 m below surface, attesting to long term continuous exploitation of this stone spanning several millennia. Many assemblages from archaeological sites between the Bonaparte River and the Fraser River to the west contain high proportions (60 to 90 percent) of Maiden Creek dacite. However, the main high density dacite concentration lies in the upland western aspect of the source area, requiring considerable expenditures of energy to access, find, reduce, and transport the toolstone to be used at valley bottom sites. Because it is not as readily accessible as the Arrowstone Hills/Cache Creek source, Maiden Creek dacites may be less common in regional site assemblages, and not as widespread. There is good evidence indicating this dacite was sought and used for the last 5000 years. The greatest intensity of exploitation of dacite from the Maiden Creek source area probably occurred during the Plateau horizon (ca. 2400 to 1200 BP) of the Late Prehistoric Period.

A short distance south of the main Maiden Creek dacite source area there is a widespread surficial scatter of low to medium density clasts of multi-coloured microcrystalline and crypto-crystalline silicates. The most common are small pebbles and cobbles of semi-translucent and opaque yellow, yellow-orange, orange, orange-brown and brown chalcedonies and cherts visually similar to those commonly found throughout much of Upper Hat Creek valley about 20 km to the south (see below). Cobble sizes range between 5 to 10 cm in diameter, and some contain both semi-translucent chalcedony and multi-coloured opaque cherts on the same piece of stone. Cortical surfaces commonly have a dull or frosted appearance, and fresh-struck groundmass surfaces have smooth textures and pearly or waxy lusters. Overall flakability of most of these hard cherts and chalcedonies is considered poor to fair, as they commonly have groundmasses with high incidences of cracks and flaws, and crystalline inclusions and seams that significantly hinder successful production of usable flake blanks larger than 3 cm.

The Maiden Creek silicate source also has at least one locality where angular chunks of "opal" can be found on the ground surface in association with eroding basalt bedrock. Most colours range from pale yellow, light yellow, light green, light green-blue, light green brown, bright orange, blood red, and occasionally iridescent white and pinkish-white. Opal groundmasses typically have very smooth to glassy textures, a semi-opaque to diaphanous translucency, and fresh surfaces have waxy to greasy lustres. It is a relatively soft and very brittle stone, and most specimens are fraught with extensive cracking that result in a high incidence of block shatter and large amounts of waste when being flaked. This opal was not commonly sought for producing stone tools because its flaking qualities are poor, and because it is soft and brittle, most tools produced from it would have short use-lives. While there was some direct evidence for pre-contact period reduction of small amounts of this opal in the immediate source area, it is rarely found at archaeological sites surrounding this source area.

Small to large chunks of petrified (opalized) wood from the trunks and branches of large trees are also found scattered throughout the Maiden Creek silicate source area. The internal structure of the wood can be easily seen on most specimens, which vary in colours that include opaque white, light grey, light brown, medium brown, and dark brown. Some pieces with high silica content are fairly translucent and slightly iridescent. Patination is usually well developed on weathered surfaces. As a general rule, this material does not respond well to flaking, as it has a tendency to shatter and fracture into elongate chunks and blocky flakes that conform to the internal wood-grain structure. It flakes more predictably and easily when force is applied parallel to the internal elongate structural axis of the wood. Flaked petrified wood is sometimes represented in very low frequency (less than 1 percent of lithic assemblages) at Late Period archaeological sites throughout the study area, where it is found as small waste flakes, and occasionally projectile points, scrapers, or simple flake tools were made from it.

Upper Hat Creek Silicate and Dacite Sources

Upper Hat Creek Valley is located southwest of the town of Cache Creek between the Fraser River to the west, and Thompson and Bonaparte Rivers to the east (Figures 3-2 and 3-9). It has long been a destination for rock and gemstone collectors, and geologists and archaeologists conducted detailed investigations there during the 1970s (Leaming 1971; Pokotylo *et al.* 1982; Rousseau 2000:171-174). Various chalcedony and cherts are available as randomly distributed low density float on the ground surface, in the hummocky glacial ablation terrain that occupies most of the valley bottom, and in stream embankments, channels, and gravel bars throughout the source area. Most of the scattered silicate materials are found in randomly localized

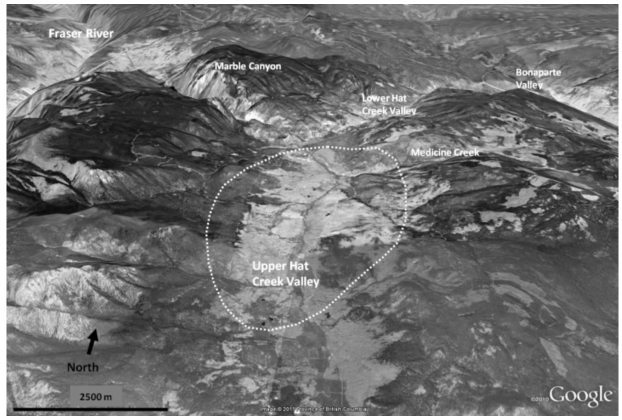

Figure 3-9. Oblique aerial view of Upper Hat Creek Valley showing estimated extent of chert and dacite source area, looking north.

low to medium density concentrations in the northern aspect of this source.

The most common silicates are polychrome chalcedonies and cherts with colours ranging from pale yellow, light and medium yellow-brown, medium brown, and occasionally dark green, dark brown, red-brown and red (Figure 3-10). This general suite of silicates has long been called “Hat Creek chert” by archaeologists, but it also includes translucent and semi-translucent chalcedonies with the same basic colours. Clast size varies considerably, from small pebbles to boulders up to 1 metre in diameter. Those contained in the glacial till and glacio-fluvial deposits are often amorphous, angular and blocky with irregular surfaces; those from creek channel contexts more rounded and smooth. Polychrome mottling, convolutions, and “mosaic” patterns are very common, and many clasts exhibit variable silica content and admixtures of several colours and textures.

Typical Hat Creek chert clast groundmasses are irregular in internal consistency, and are rife with numerous cracks and flaws that cause a moderate to high incidence of perverse fracturing when being hard-hammer flaked. Nevertheless, some larger pieces have portions that are relatively homogenous and isotropic, and large thick flake blanks can be successfully removed. It is a very hard and durable stone, and in pre-contact period times it was actively sought and employed to make curated and specialized tools requiring long use lives (e.g., simple flake knives, unifacial scrapers, shavers, planers, gravers, perforators, etc.). Its hardness makes soft-hammer and pressure flaking difficult; high force loads are required to successfully detach

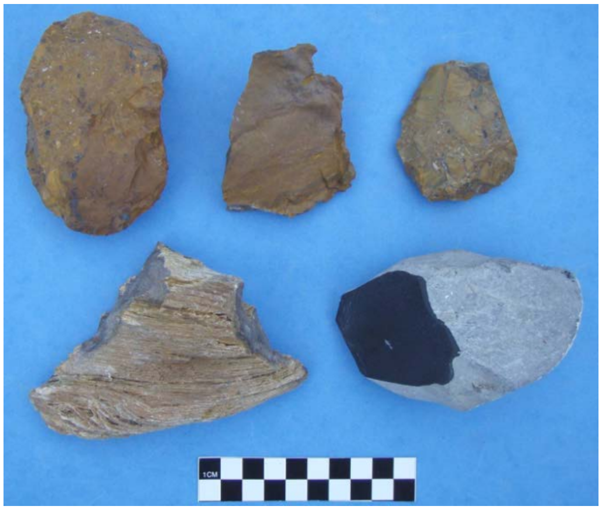

Figure 3-10. Examples of Hat Creek yellow-brown chert, a piece of flakable petrified wood, and a dacite cobble with fresh flake scar from Upper Hat Creek.

flakes. Consequently, well-formed bifaces made from this suite of cherts and chalcedonies are rarely found at archaeological sites, whereas simpler formed and unformed unifaces sometimes are.

There are many recorded and investigated sites within the immediate source area that contain significantly high proportions of Hat Creek chert, lending ample testament for extensive pre-contact period use. Large quantities of highly localized lithic reduction waste suggest that flake blanks were commonly produced from these silicates with intent to transport them to other locations. This toolstone is found in low frequencies at archaeological sites within a 50 km radius, and is best represented at sites to the west on the east side of the Mid-Fraser, and in the east within the Bonaparte and lower Thompson River valleys.

Other flakable toolstone found scattered throughout the Upper Hat Creek source in low clast numbers include pebbles and cobbles of transparent, pale grey and pale yellow chalcedony (agate). Chunks and bits of petrified wood (Figure 3-10) are also found incorporated in glacial till in several locations, but it is generally of poor quality and unsuited for successful lithic reduction. Low densities of pebbles and small cobbles of good-quality dacite can also be found randomly distributed in the local glacial till deposits and creek beds. Some of these dacite clasts may have originated from the Maiden Creek source area a few kilometres north, having been carried southward by glaciers. However, typical Hat Creek dacite cobbles are a bit different in appearance from those of the Maiden Creek and Cache Creek sources. Most are elongate, discoidal, and elliptical, moderate to well-rounded, and have a heavily smoothed and weathered appearance. Cortical surfaces are usually opaque and moderately to relatively thick, with light and medium grey patina colours being most common. A slight dull graphite-like metallic sheen is common on most clasts. Groundmasses are jet black and relatively homogenous with very few tiny random inclusions, and most often medium and fine grained with moderately dull to waxy lustres. Highly vitreous clasts are rare. Like dacites from other sources in the study area, it has a lamellar flow-plane structure that allows easy and effective removal of large thin flakes when hard-hammer force is applied parallel or slightly offset to the flow planes. It pressure flakes very well, and is ideal for making large thin bifaces, unifaces, and simple flake tools.

There is a documented highly localized source of multi-coloured cherts on lower Medicine Creek (Leaming 1971; Rousseau 2000:173-174) where it intersects through a glacial debris lobe at the valley floor/wall juncture (Figures 3-9 and 3-11). Local rock collectors visit this location on a regular basis to seek high quality silicates that range in color from orange-yellow, orange-red, red, purple-red, dark purple, and sometimes black. These pebbles and cobbles are found predominantly in the stream bed during low water, and also eroding out of a high vertical glacial till exposure on the north side of the creek. Specimens I have seen from this source have groundmasses similar to those described above for the yellow-brown Hat Creek cherts and chalcedonies, being typically fraught with flaws and irregularities. However, some clasts have relatively homogenous and flaw-free portions that are well-suited for making small and medium-size flakes and tools. There is archaeological evidence for reduction of stone from this source along the creek, but rock collectors have removed most archaeological cores and waste flakes from the ground surface. I suspect that this specific location still contains a low to moderate incidence of chert and chalcedony clasts buried in the glacial deposits on the north side of Medicine Creek, and medium density buried lithic reduction scatters in the overlying aeolian silts.

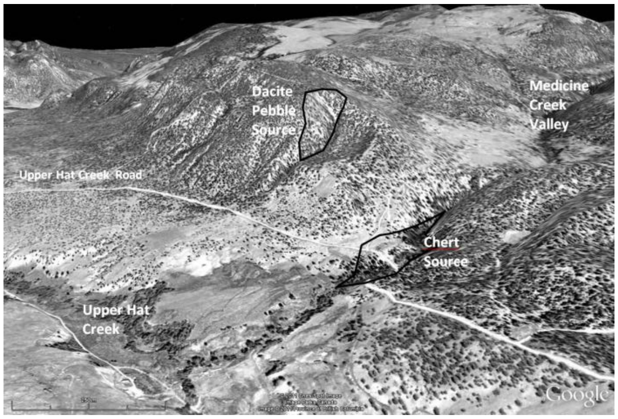

Figure 3-11. Oblique aerial view showing locations of highly localized Medicine Creek chert and nearby high density dacite pebble sources in Upper Hat Creek Valley, looking northwest.

There is an abundant and highly concentrated exposure of very small dacite pebbles located about 1 km northeast of the intersection of Upper Hat Creek road and Medicine Creek (Figure 3-11). Thousands of dacite pebbles are eroding out of a steep prominent talus slope at the southwestern side of a ridge, which is a steeply uplifted section of a soft Tertiary-age marine sediment deposit. All clast outer surfaces have a smooth rounded and weathered appearance. Clast forms range from elliptical, discoidal, lozenge-shaped, egg-shaped, football-shaped, and occasionally spherical. Dacite at this highly localized source is unique from that found at other large dacite sources (i.e., Arrowstone Hills, Maiden Creek, Pennask Lake) in that the vast majority of pebbles range only between 2 and 5 cm in maximum dimension, and they have a very distinctive well-developed light grey to medium grey metallic matte patina that makes them appear as if they were coated with a semi-translucent or opaque layer of graphite or lead. Groundmasses exhibit textures that range from fine-grained to vitreous, and have dull, waxy, and sometimes glossy lustres. These pebbles also have a lamellar flow-plane internal structure that allows them to be very easily reduced by bipolar technique to produce small thin flakes when force is applied compliant to the flow plane lamella axes. There is an abundance of archaeological evidence for pre-contact period exploitation of these small dacite clasts at the base of the talus slope, where it is obvious that intensive bipolar reduction occurred for a very long time. Clasts from this source may have also been used to produce microblades, since their size and form are ideal for making reliable microblade cores, but this remains to be conclusively shown. Because most clasts from this dacite source are so small, it is unlikely that they were actively sought for involvement in any intentional exchange or transport outside of this immediate source locality.

Pennask Lake/Okanagan Highlands Dacite

This large source is situated between the towns of Merritt and Peachland on a high altitude undulating plateau known as the Okanagan Highlands (Figures 3-2 and 3-12). Dacite pebbles, cobbles, and small boulders of varying shapes are found in low to moderate densities in glacial till exposures surrounding Pennask Lake and in stream and creek channels leading in and out of it. These clasts have properties that are visually quite similar to those of the Maiden Creek source, although they appear to have experienced a greater degree of surface fluvial processes. Many clasts have a moderate to well-developed dull grey patina much like the larger dacite cobbles found in Upper Hat Creek. Typical groundmasses are mostly always dark grey-black, and textures range from medium to very fine-grained, with most fresh-struck flakes having dull to slightly waxy surface lustres. Glassy/vitreous groundmasses are very rare. Internal flaws and cracks are few, but small randomly distributed crystalline silica phenocryst inclusions are sometimes present. Groundmasses are relatively homogenous, and like the Arrowstone/Cache Creek, Maiden Creek and Upper Hat Creek dacites, they too have obvious lamellar flow-plane internal structure. Of all the dacites, I consider those from Pennask Lake to be the most granular and “platy”. Dacite from the Pennask Lake source has several excellent toolstone properties. Relatively homogenous and flaw-free groundmasses permit easy production of large and medium-sized flake blanks using hard and soft-hammer techniques. Clasts flake best when force is applied parallel or just slightly oblique to the internal flow-plane lamina, and extraordinarily large and thin flakes can be produced that are ideal for successful production of large, thin, well-made bifaces, formed and unformed unifaces, and simple flake-tools. However, attempts to remove flakes by applying

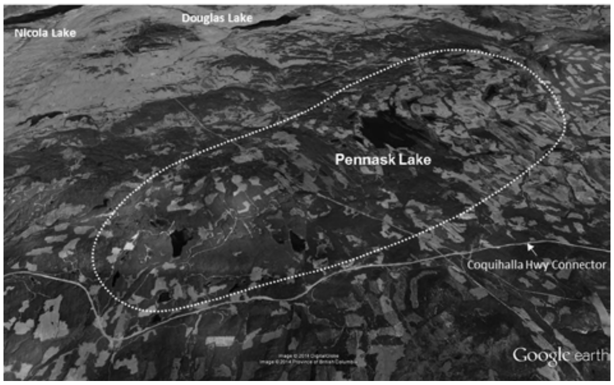

Figure 3-12. Oblique aerial image of the Pennask Lake locality showing estimated extent of natural dacite source, looking north.

force perpendicular to the internal flow planes are often less successful, resulting in high incidences of shattering, stepping and perverse fracturing. Pressure flaking that is more-or-less compliant with the lamellar structure of the groundmass consistently allows very long thin flakes to be detached across flake and tool surfaces.

Since this dacite source is located in a fairly high altitude context that is generally snow-locked during winter and late spring, it could only have been visited during late spring to early fall during pre-contact period times. Numerous high density dacite scatters containing mostly primary lithic reduction waste flakes are located on Pennask Lake shorelines and islands (Figure 3-12). Test excavations at some of these sites have revealed continuous high density primary reduction lithic waste extending to 1 metre below surface, making it clear that dacite was regularly and intensively quarried and reduced in this locality for a very long time.

Because this dacite source lies midway between the Nicola Valley to the west, and Okanagan Valley to the east, inhabitants of both regions made regular use of this abundant source of high quality stone during the pre-contact period. My many years of experience in the Okanagan Valley leads me to conclude that most of the dacite represented at sites there probably originates from the Pennask Lake source. Many Middle and Late period site assemblages in the Nicola Valley contain dacite that likely originates from the Arrowstone Hills /Cache Creek source to the northwest, but it is highly likely they made greater use of the Pennask Lake source. The excellent flaking properties of this stone would have been particularly beneficial to Early Period big-game hunter-gatherers, since large bifaces made from it could be reliably produced and easily maintained. Middle Period inhabitants of the adjacent valleys visited the Pennask Lake source during seasonal upland hunting and trout fishing forays, returning to valley bottom base camps where it was used regularly by resident groups and casually distributed. During the Late Prehistoric Period this stone continued to be collected and transported during seasonal subsistence forays. It may have also been quarried and distributed via organized formal inter-regional exchange systems, but this seems unlikely given the high altitude context, low surface visibility due to thick vegetation cover, and significant expenditures of energy required to move any significant quantities of this stone for valley bottom site consumption.

Barriere River Chert

The Barriere River chert source encompasses most of the small town of Barriere located north of Kamloops in the middle of the North Thompson River Valley (Figures 3-2 and 3-13). It is documented as a frequent rock collector destination in Leaming (1971). Blocky, tabular, angular, and slightly to moderately rounded pebbles, cobbles, and small boulders of this very distinctive lithic material are found in low to moderate frequencies within fluvial sand and gravel deposits comprising the large valley-bottom delta at the confluence of the Barriere and North Thompson Rivers. During the pre-contact period these clasts were collected from exposed banks and gravel bars along the river during low water levels, and they can still be found in low to moderate abundance in these same contexts today. My inspections suggests clasts are most common in the eastern aspect of the source area, and are likely being derived from a more concentrated source contained in the slightly higher glacial outwash terraces and colluvial deposits flanking the eastern valley floor-wall juncture.

These highly distinctive metamorphosed “limestone” cherts are represented in a suite of colours including pastel shades of white, cream, beige, light brown, light to medium grey, grey-green, light green, pink, pink-purple, red-purple, and red-brown (Figures 3-14 and 3-15), with the most common colours being greys and greens.

Figure 3-13. An oblique aerial view of the town of Barriere showing estimated extent of the Barriere chert source in the North Thompson River Valley, looking northeast.

Figure 3-14. Selected cobbles and small boulders of Barriere chert showing clast formal variation and common external and internal colours.

Polychrome clasts with several separate and intermixed colours are quite common. Cortex formation on most specimens is very thin and transparent, allowing internal groundmass colours and structural features to be easily seen (Figure 3-14). Most cortical surfaces are just a bit lighter in colour compared to their groundmass. Small lunate and crescentic conchoidal impact fracture pock-marks are occasionally evident on the surface of better-quality clasts that have been transported down the Barriere River. Typical groundmass textures vary from dull to "frosted" microcrystalline to smooth cryptocrystalline, and fresh-struck surface lustres vary between dull, pearly and waxy. Good quality clasts often exhibit multicoloured and multidirectional striations, veins, and ribbon-like bands that are wavy, contorted and sometimes disjointed, giving the stone an interesting and aesthetic appearance. High incidences of internal flaws and cracks have resulted from metamorphic distortion, and from clasts being transported downstream in high-energy glacio-fluvial and fluvial contexts.

While most Barriere chert groundmasses are very dense, brittle, and often fraught with numerous random intersecting cracks, flaws, and distortion irregularities, a fair number of the larger and more siliceous clasts have fairly homogenous portions that are well-suited for successful production of simple chipped stone tools. Collectively considered, the overall flakability of these cherts ranges from poor to fair. Internal flaws and unpredictable reduction results contribute to production of large quantities of shatter and blocky waste. It is also a very hard and resilient stone, requiring large force loads to detach medium and large flakes using direct hard-hammer technique. It is also often difficult to effectively execute simple secondary retouch and pressure flaking control. Many formed tools found at archaeological sites indicate sparing use of unifacial or bifacial retouch, probably for this latter reason. Despite the technical and physical shortcomings of Barriere chert, its superior hardness and durability are well-suited for creating very sharp and long-lasting tool edges, thus simple unmodified and unifacially retouched flake tools were commonly produced from it.

Occupants of the North Thompson River valley regularly made extensive use of dacites obtained from the Arrowstone Hills/Cache creek source to the west, but there are numerous sites in Barriere and surrounding localities that also contain medium to high proportions of Barriere chert. It has also been found in low frequencies at sites throughout the North Thompson River valley and its lesser tributaries and adjacent uplands between Kamloops and Blue River. There does not appear to have been any intentional organized formal effort to export it beyond the North Thompson River valley for use in other adjacent regions. This is not surprising, since this stone is clearly technically inferior to the abundant dacites and other high quality silicates available in the southern aspect of the study area. Regular local exploitation of Barriere chert probably began during the Middle Prehistoric Period, but this remains to be supported by excava-

Figure 3-15. Fresh-struck flakes of Barriere chert showing typical groundmass traits.

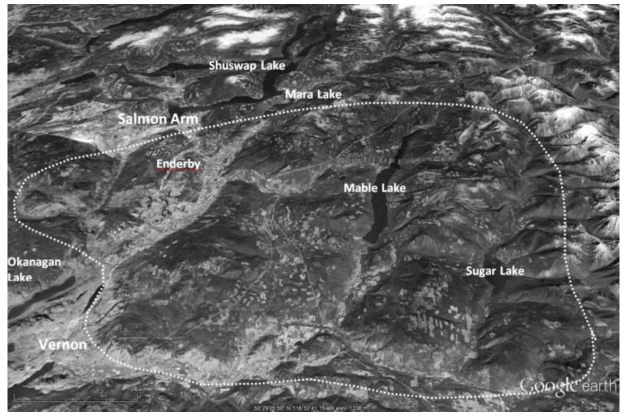

Figure 3-16. Oblique aerial view of the southern Shuswap area showing the currently known extent of widely scattered low-density Shuswap banded chert cobbles that are occasionally found in exposed glacial till deposits on the sides of valleys, and in valley bottom creeks and rivers, looking north. A suspected "mother lode" of this material remains to be identified.

tion data. Its local and regional popularity was greatest during most of the Late Period, particularly over the last 2,400 years.

Shuswap Banded Chert

"Shuswap banded chert" is a very distinctive medium to high quality silicate toolstone long known to archaeologists but rarely acknowledged or discussed. It is sometimes found in low to moderate frequencies (20 to 40 percent) in lithic assemblages secured from investigated and observed archaeological sites surrounding Shuswap Lake, Mara Lake, Mable Lake, and Sugar Lake; at many sites along the South Thompson River to Kamloops; along the shores of Kamloops Lake and west along the Thompson River to Ashcroft; in the Enderby and Falkland localities; and occasionally at sites in the North Okanagan as far south as Kelowna (Figures 3-2 and 3-16). This general area is well known to rock collectors, and contains many heavily eroded Tertiary-age volcanoes, lava flows, and marine sediments that are known to yield a variety of chalcedony and chert silicates.

Despite its common and sometimes relatively abundant appearance at many archaeological sites in the southern Shuswap region, a localized moderate to high density concentration or "mother lode" of this toolstone remains to be found and recorded by archaeologists. Over the last three decades I have made several intentional efforts to find a concentrated source, but have only succeeded in recovering a few isolated pebbles and cobbles in very low densities incorporated in colluviums, glacial tills and glacio-fluvial gravel exposures in road-cuts, stream and river channels, and gravel quarries between Vernon and Sugar Lake, and in the Enderby and Falkland localities (Figure 3-16). It currently appears to have a fairly widespread and low-density natural distribution, probably resulting from the original formation source of this stone being heavily impacted, diluted, and subsequently spread randomly over the landscape by late Pleistocene glacial processes. However, I remain convinced that there is a localized medium to high density source of this stone somewhere south and/or southeast of Shuswap Lake, as it appears in moderate frequencies with a high incidence of waste in some site assemblages in that general locality. My diligent search for a dense concentration will continue.

Shuswap Banded chert is a hard, dense and resilient toolstone with medium to high colloidal silicate content. It can be readily visually identified by a unique constellation of physical traits, and is most commonly found as small tabular and blocky rounded pebbles and cobbles varying between 5 and 15 cm in maximum dimension. Cortical surfaces are generally tan or light grey coloured, moderately to heavily weathered, and flaked surfaces oxidize fairly rapidly to form patinas that are much lighter than their groundmasses (Figure 3-17). Groundmass textures vary from fine-grained microcrystalline to smooth and vitreous crypto-crystalline. Lusters vary between dull, pearly, waxy, greasy and glossy. Most clast groundmasses are opaque, but better quality and lighter coloured examples of this stone are slightly diaphanous along thin flake margins when held against a strong light source. It varies in a range of colours, with pastel and natural shades of tan, beige, light grey, light brown, light pink-brown, light grey-brown, medium grey-brown, medium grey-purple, medium brown, medium brown-purple, dark brown and black-brown being the most common. It is not unusual to have several colours evident on one piece of stone. Fresh-struck internal surfaces are darker in colour compared to their cortex.

The most obvious and diagnostic visual trait is the presence of numerous very thin, closely spaced, parallel micro-stratigraphic lamina that alternate in colour throughout the groundmasses. These ribbon-like lamina are often straight, wavy, randomly distorted, contorted, discontinuous, disjointed and/or "re-healed", and appear to be the result of very thin alternate (possibly seasonal) sediment bedding that underwent some distortions prior to being impregnated and solidified with colloidal silica. As a result, flaws, cracks, microcrystalline inclusions and seams, and other inconsistencies are common in many clast groundmasses, causing them to often respond unpredictably when percussed. However, some pieces can be quite homogenous and relatively flaw-free, and lend themselves well to being easily and successfully formed using soft and hard-hammer reduction and pressure flaking. Collectively considered, I regard this toolstone to have fair to good overall flakability.

Shuswap banded chert was clearly given frequent attention and selective preference during pre-contact period times. While it was used to produce a wide variety of tool types, it appears to have been employed for making reliable unformed and formed unifacial flake tools primarily intended for moderate to heavy load cutting and scraping activities, and for hafted tools intended to have long use-lives. This is likely because it is hard and durable, and thus a good choice for these concerns. Medium-size and large bifacial knives, well-formed scrapers, and gravers were produced from this stone in moderate numbers, as were low numbers of projectile points, and microblades. The relatively high incidence of this lithic material at sites in the eastern half of the Thompson River drainage area indicates that it was regularly exploited and widely distributed in this area on a fairly consistent basis. Excavation data from many sites firmly indicate it was known and used with low regularity starting around 6000 years BP. Its use persists through time, appearing in low frequencies (5 to 10 percent) of lithic assemblages at some Middle Prehistoric Period sites, with larger proportions (10 to 30 percent) in Late Prehistoric Period sites.

Figure 3-17. Selected examples of Shuswap banded chert showing typical range of cortex and groundmass variation.

Pre-Contact Period Quarrying and Toolstone Distribution

The culture-historical framework used to discuss quarrying and stone tool production behaviour through time follows that outlined for the Canadian Plateau by Richards and Rousseau (1987), Rousseau (2004, 2008), and Stryd and Rousseau (1996). For the sake of descriptive simplicity, the information and interpretations are presented and discussed using the three basic temporal periods: the *Early Period* (ca. 11,500 to 7000 years BP), the *Middle Period* (ca. 7000 to 3500 years BP), and the *Late Period* (3500 to 200 years BP). Specific cultural manifestations within these periods are also mentioned and discussed where deemed pertinent.

Early Period (ca. 11,500 to 7000 years BP)

Not much is known about toolstone quarrying due to the paucity of excavation data for the Early

Period. Early pioneers surely had first choice of a wide variety of flakable microcrystalline and cryptocrystalline silicates exposed and strewn across barren landscapes by glacial and glacio-fluvial processes. Large dacite, chalcedony and chert clasts would have been available in variable densities throughout much of the study area, notably in upland plateau contexts. Since these early people were highly mobile in pursuit of big game, good quality silicates were incidentally collected as fortuitously encountered while travelling or during the course of daily subsistence tasks. Silicates used by these Early Period people were often carried great distances before eventually being deposited at archaeological sites. Therefore, some of the earliest sites in the study may contain silicates derived from sources many hundreds of kilometres away (notably from the Columbia Plateau to the south), and conversely, sites in distant regions may have silicates that were originally obtained from within the Thompson drainage system.

Putatively early bifaces and projectile points found in the study area (Rousseau 1993; Rousseau 2008:221-225; Stryd and Rousseau 1996: 179-185) are made from medium-grain and fine-grained dacites, and high quality chalcedonies that were well-suited for their big-game hunting needs (Rousseau 1993, 2008). Currently, the earliest solid evidence for use of dacite and Hat Creek chert is from the basal component of the Landels site (EdRi 11) south of Cache Creek where a radiocarbon date on associated bone found below Mazama tephra dated to around 8400 years BP (Rousseau 1991, 1993; Rousseau *et al.* 1991). This indicates knowledge of the Hat Creek and probably Arrowstone/Cache Creek sources by this time. Although there is currently no direct evidence for it, initial exploitation of the Arrowstone Hills/Cache Creek dacite source likely began during the beginning of the Early Period. Exposed dacite clasts would have been abundant, obvious, and very easily obtained in both the upland and lower aspects of this source area.

Middle Period (ca. 7000 to 3500 years BP)

Middle Period archaeological sites are quite common in the study area, and numerous excavated components have yielded excellent lithic assemblages containing readily identifiable toolstone from sources mentioned here. There is ample supportive evidence for regular exploitation of most primary toolstone sources, and several less-important secondary sources. People exploiting these quarries during non-winter months had relatively easy access to an abundance of dacites and other flakable silicates, allowing them to be somewhat more selective with respect to stone quality. Direct acquisition from natural toolstone sources was the main mode of toolstone procurement, and involved physically fit individuals belonging to mobile residential groups and participating in upland subsistence forays. There is no direct archaeological evidence for any organized lithic exchange; most of the raw materials represented in Middle Period lithic assemblages can be assigned to known local or regional sources.

Regional human populations during the Middle Period were relatively low compared to the Late Period, thus there was much less exploitation pressure on primary quarries. However, investigated and observed sites within or in close proximity to the Cache Creek/Arrowstone Hills, Maiden Creek, and Pennask Lake dacite sources suggests that a major proportion (about 20 to 30 percent) of the primary stage reduction assemblages were deposited in these localities during the Nesikep Tradition (Rousseau 2004:3-12). Archaeological sites within and surrounding Arrowstone Hills and Maiden Creek dacite sources are numerous, extensive, and extremely high density, often containing many tons of lithic reduction waste associated with diagnostic biface forms that can be related to the *Early Nesikep Period* (ca. 7000 to 6000 years BP), and *Lehman Phase* (ca. 6000 to 4500 years BP) (Rousseau 2004, 2008; Stryd and Rousseau 1996:185-197). The primary objective at these quarry sites was production of large flake blanks using hard-hammer technique, and soft and hard-hammer flaking of medium-size to large triangular, oval, elipitical and tear-shaped bifaces that were later intended for flake cores, bifacial and unifacial knives, and other more complex tools. Moderately mobile local and regional inhabitants commonly made frequent intentional and/or “embedded” visits to this source area to replenish toolstone as needed. Dacite from this source was also transported and casually exchanged inter-regionally by these fairly mobile groups, and it is well represented in assemblages at major Middle Period sites within and adjacent to the Mid-Fraser, Thompson, North Thompson, South Thompson, and Shuswap River valleys.

Middle Period lithic technicians actively sought and used dacite on a regular basis, and while they had easy access to all grades of it, they seemed to prefer medium and fine-grained microcrystalline groundmasses over those that were crypto-crystalline and glassy. This is probably because many glassy clasts are more brittle, and rife with internal flaws, cracks, and random phenocryst inclusions that reduce its technological value and reliability. Many Middle Period formed bifaces typically range from medium-size to quite large (up to 15 cm long) and most are remarkably thin and very well-made. This is especially true of the ***Early Nesikep Period*** (ca. 7000 to 6000 years BP) and ***Lehman Phase*** (ca. 6000 to 4500 years BP) when technicians were actively taking advantage of lamellar dacite groundmasses to produce large thin flake blanks by applying force loads parallel or slightly obliquely to, their internal bedding planes. This "directional compliancy" afforded by the internal lamellar structure of medium and fine-grained dacites is key to understanding how pre-contact period lithic technicians most successfully and effectively reduced cores and produced large flake blanks from them. Pressure flaking was executed with the same conscious consideration of this lamellar structure, allowing removal of very long and thin flakes extending up to and sometimes beyond the longitudinal mid-line on many bifaces.

During the ***Lochnore Phase*** (ca. 5000 to 3500 years BP), dacite still dominates most lithic assemblages (70 to 80 percent), however, many components contain stone from a wide variety of nearby secondary sources (20 to 30 percent), and from gravel bars and exposures (10 percent) in close proximity to base camps and established villages. This reflects the fact that people participating in this cultural manifestation were less preoccupied with exploiting upland resources, and more focussed on riverine and valley bottom environments for most of their food, stone and textile needs. Very small quantities of obsidian, usually in the form of small secondary retouch or pressure flakes, occasionally appear in *Lochnore Phase* assemblages. A small number of X-ray fluorescence analyses show that some originate from Anahim Peak in northwestern B.C., and from the Whitewater Ridge and Glass Buttes source localities in eastern Oregon. The paucity of obsidian should be viewed as being the result of occasional obsidian tools or small clasts making their way into the study area via low-level, informal, familial or inter-regional exchange systems.

Late Period (ca. 3500 to 250 years BP)

Current excavation data for the ***Shuswap Horizon*** (ca. 3500 to 2400 years BP) indicates that people participating in this cultural pattern most commonly exploited toolstone that was gathered incidentally within a few kilometres of valley bottom villages and most base and field camps during the course of daily subsistence activities. As a result, extensive use was made of a wide variety of locally available, poor to good quality siltstones, quartzites, rhyolite, chalcedonies and cherts. Dacite typically comprises about 50 to 75 percent of lithic assemblages, and most of it is medium to fine-grained, suggesting that the abundant Arrowstone Hills/Cache Creek, Maiden Creek, and Pennask Lake sources were being regularly visited and used with low to moderate intensity. Well-organized formal inter-regional commodity exchange networks involving toolstone did not exist during the *Shuswap Horizon*, but small quantities of dacite may have been intentionally moved from west to east by way of casual inter-group or inter-family exchange. Good to high quality extra-local cryptocrystalline silicate stones typically constitutes only a small part of most lithic assemblages (less than 5 percent), with colourful cherts and translucent chalcedonies being the most prevalent "exotics".

The beginning of the ***Plateau Horizon*** (ca. 2400 to 1200 years BP) is coeval with the emergence of a highly organized formal exchange system and interaction sphere that involved many large villages and networked extensively throughout major valleys of the Canadian Plateau. There is ample evidence to suggest that fair to excellent quality flakable silicate lithics were being regularly exploited and moved over fairly large distances on a regular long-term basis. By far, the most common lithic raw material quarried, exported and used throughout the study area during the *Plateau Horizon* are dacites from the Arrowstone Hills/Cache Creek and Maiden Creek source areas. The Pennask Lake dacite source was of lesser inter-regional importance, and was frequented during the non-winter months primarily by groups occupying the Nicola and Okanagan Valley regions to the west and east respectively.

There is an obvious high selective preference for dacites during the *Plateau Horizon*, and they usually comprise about 70 to 90 percent of most lithic assemblages deposited in valley bottom sites. The collective abundance of this lithic material at sites of this age throughout the study area is staggering, and can only be explained by continuous large-scale importation from the primary dacite sources. It is realistic to envision small groups and entrepreneurs targeting and transporting large quantities of raw dacite pebbles, cobbles and small boulders, as well as processed flake blanks and bifacial tool preforms. A person or dog can easily carry 10 to 15 kilos of stone over fairly long distances, and it is likely that most of this dacite (and small quantities of other good quality silicates) were gathered and carried down to the valley bottoms by small groups, and then transported by canoes along major waterways to villages and camps along the lower Thompson River, Kamloops Lake, North Thompson and South Thompson River, and Shuswap Lake regions.

By about 2000 years BP, the *Plateau Horizon* reached a cultural climax, and human populations reached their maximum throughout most southern B.C. (Richards and Rousseau 1987; Rousseau 2004). At this time, most primary and secondary toolstone source areas were well-known to occupants of the Thompson River drainage, and were regularly visited and exploited by lithic technicians to gather good quality stone for personal, inter-familial, inter-village and intra-village socio-economic purposes. High demand for toolstone during this population maximum saw serious depletion of some of the more readily accessible low-altitude dacite exposures, forcing technicians to venture into mid- and upland areas to target smaller and lower density secondary toolstone sources that were repeatedly visited and exploited during the course of organized subsistence forays for other nearby upland resources. Greater familiarity with small secondary silicate sources in adjacent highlands resulted in a regular infusion of fair to good quality silicates (i.e., chalcedonies and cherts) into the lithic consumption at valley bottom sites, and late *Plateau Horizon* lithic assemblages commonly contain 10 to 30 percent "exotic" silicates. Many of these silicates are hard and resilient, and they were commonly used to produce tools with intended long-term use-lives, and/or for use on medium to hard contact materials. Small amounts of obsidian from sources in the distant north (Anahim Peak) and south (Oregon/Glass Buttes) are sometimes found at large village sites, but constitute less than 0.5 percent of assemblages.

During the ***Kamloops Horizon*** (ca. 1200 to 250 years BP), there was a greater reliance on stone secured by direct personal acquisition, and/or casual, semi-formal, or familial exchange systems. Although regular movement of good quality stone via organized intra-regional exchange networks persisted during this time, it was less organized and less extensive than during the previous *Plateau Horizon,* and less stone was quarried and transported. Dacite continued to be the most sought-after toolstone (80 to 95 percent of assemblages), and was commonly used to produce the majority of chipped stone tool types. Some sites contain assemblages with low to medium densities of poor to fair local flakable lithic materials gathered from within catchment areas, presumably to offset periods when better quality dacites were scarce. Also, *Kamloops Horizon* pithouse village sites often contain a high incidence of lithic raw material recycling, and it is not unusual to find artifacts and waste from earlier cultural manifestations that have been brought back into service, reworked into other tool forms, or reduced by bipolar technique to create usable flakes. This suggests periodic shortages or restricted access to better quality stone during the winter months. Various kinds of "exotic" silicates were still in common use during the *Kamloops Horizon*, but they are less commonly employed compared to the *Plateau Horizon,* often comprising only about 5 to 10 percent of typical excavated lithic assemblages. This may be the result of heavy exploitation and eventual depletion of some of the more obvious and readily accessible silicate sources during the preceding *Plateau Horizon*. A less intensive inter-regional formal exchange network during the *Kamloops Horizon* may also be partly to blame.

Directions for Future Toolstone Source Investigations

Although one cannot argue against the certainty provided by more precise "scientific" analysis methods, simple visual identification of toolstone sources from artifacts and lithic waste in archaeological assemblages is still the easiest, quickest, most practical and cheapest means. Experienced lithic analysts familiar with character traits of various types of stone from primary and secondary sources in their study area and peripheral regions could probably attain a fairly high degree of accuracy and confidence in correct source identification (e.g., from 75 to 90 percent), thereby allowing greater certainty and support for any post-analysis behavioural inferences drawn from them. While accurate toolstone type differentiation and correct respective natural source assignations are easiest where high levels of visual/physical trait variability exists between stone from known sources (e.g., localized and isolated exposures of polychrome cherts and chalcedonies), this task is made much more difficult and less certain in areas with numerous widespread and easily accessible sources yielding stone with identical or very similar visual and physical properties (e.g., ubiquitous common exposures of obsidians, basalts and dacites).

Archaeologists should familiarize themselves with the nature, context, and distribution of local geologic formations and exposures that are already known to contain toolstone, and be vigilant for them while in the field. Geologists and petrologists should be consulted whenever possible, as they can more accurately identify and classify toolstone types, provide insights into their physical and technical traits, and help identify geologic contexts where they can be found. Surficial geology maps sometimes provide information leading to source identification, as do local and regional prospecting and rock collecting publications. Rock-hound and lapidary groups are ubiquitous, and their members can sometimes provide a wealth of oral information.

Be aware that many other smaller “secondary” flakable toolstone sources have been identified in the Thompson River drainage and surrounding regions, and most have one or more types of stone with unique visual diagnostic physical and technical traits that permit fairly easy and certain source identification in archaeological lithic assemblages. I submit that all secondary sources should be recorded and documented, no matter how small or seemingly insignificant. Many source locations are directly associated with archaeological lithic deposits relating to initial reduction stage activities, and they should be recorded on site forms and registered. Efforts should be made to determine approximate horizontal extents of all toolstone source areas, and to provide a general account of relative clast size and abundance; tasks that may be fairly simple and quick for secondary sources, but more difficult and time-consuming for extensive primary sources where clast size and relative abundance can vary greatly across the landscape. For each source, representative clast reference collections should be gathered, catalogued, described and stored at an institution or facility accessible to lithic researchers. Eventually, this accumulated data will provide a comprehensive descriptive accounting of visually and chemically distinct toolstones types and their known natural source distributions, creating a solid basis for advancing insights and inferences about past quarrying behaviours, lithic technological systems, annual and seasonal subsistence and settlement patterns, group mobility and catchment territory, and the nature and extent of casual, informal, and formal intra- and inter-regional exchange systems and networks.

Use of X-ray fluorescence and/or other geochemical means to fingerprint toolstone samples from sources should continue to be a major research focus. Much like obsidian, dacites lend themselves well to being fingerprinted, and samples analyzed from different source areas often have individual compositional signatures that allow them to be differentiated from each other with high levels of certainty. This may be true for other toolstone types as well, and these possibilities should be explored using this method. Academic institutions should be encouraged to purchase X-ray fluorescence guns, and allow researchers access to them for lithic source cataloguing and archaeological assemblage analyses.

Lastly, we need to continue studying and refining our understanding of the complex and myriad inter-relationships existing between toolstone physical traits, patterns of preferential lithic material type selection, technical traits and flakability, reduction methods and strategies, suitable task/functional applications, microwear/use-wear patterns, and artifact recycling/reworking behaviour. Stone tool replication and controlled experimental use involving different lithic types applied to various contact materials are very useful research endeavours that result in considerable technical and functional intimacy with specific toolstone types, and consequently help elucidate why and how they were selectively collected, transported, reduced, modified and employed by pre-contact period people. Results of these studies, and any behavioural inferences that can be derived from them, should be conveyed to other researchers orally and via publications.

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