LITHIC ANALYSIS

Raw Materials

A variety of lithic material can be used to create stone artefacts. Knowing which types were used is important for understanding human selection and modes of acquisition. Raw materials can be classified on the basis of composition, the chemical makeup of the rock, and texture, the size, shape and organization of the particles within it. There are three fundamental types of rock that are defined based on their genesis: igneous, sedimentary and metamorphic. ***Igneous rocks*** are formed through the differential cooling of lava (molten rock on the earth's surface) or magma (molten rock below the surface). The texture of the igneous rock directly relates to the cooling rate. Slow-cooling magma tends to allow larger crystals to form, which creates macrocrystalline rocks such as granite. Alternatively, lava that is cooled quickly may not have any crystals visible with the naked eye. These microcrystalline rocks, including basalt, are better suited for stone tool production because they can be fractured conchoidally. In the case of extremely rapid cooling, a glassy texture, which has no recognizable crystals even at high magnification, can form. Obsidian, volcanic glass, is particularly prized because it is easy to knap, and create flakes with very sharp edges. The colour of an igneous rock is tied to its mineral composition, as is the case with most rock types. Igneous rocks that are dark coloured are generally rich in magnesium, iron and calcium, while those that are lighter in colour tend to be made up of silica and aluminum (Andrefsky 2005).

Sedimentary rocks are created when clastic, chemical or organic sediments are cemented together on or near the earth's surface. Those made up of clastic sediments include sandstone, siltstone and mudstone, though these were rarely used for lithic production because when flaked the fracture path tends to follow the grains of the rock. Moreover, because they are soft they cannot hold a sharp edge. Sedimentary rocks that have been silicified (impregnated with silica) are much harder and tend to fracture conchoidally (through the grains), making them much more useful. The precipitation of silica alone can also create sedimentary rocks, called ***silicates***. The silica dioxide forms one of five different tetrahedral structures (Kooyman 2000) and may contain other elements that were present during precipitation. The silica (quartz) group has a three-dimensional framework that does not contain iron or magnesium (it is nonferromagnesian). It has a basic 2:1 ratio of oxygen to silica (SiO_2) with varying amounts of extracrystalline water (Kooymann 2000). The presence of element impurities gives the mineral unique characteristics. They are grouped based on their colour and texture, which directly relate to the elements present and the size of the crystals. Crystalline quartz contains silica dioxide crystals that are visible with the naked eye. Microcrystalline and cryptocrystalline silicate minerals have crystals that are visible with a microscope (former) or by X-ray diffraction (latter), while amorphous silicates lack any crystal structure. These features are used to classify the variety of silicates found, such as basic chert, flint, jasper, agate and chalcedony, all of which are commonly used for lithic tool production.

Metamorphic rocks are sedimentary or igneous rocks that have been altered through exposure to high temperatures and pressures. The type of rock created depends on the original texture of the stone, the amounts of heat and pressure, and the fluids passing through it. In the case of quartzite, metamorphism deforms the texture of sandstone by interlocking the once individual particles of sand together. This alteration creates a much harder rock that can be fractured conchoidally, and, therefore, used for lithic production. Argillite is formed in a similar manner, though it is created when shale or siltstone is metamorphosed (Andrefsky 2005: 58). There are also a number of metamorphic rocks that can be used directly, or with slight modification, as lithic tools (as hammerstones or other similar tools), such as gneiss. Moreover, since metamorphic rocks are commonly found in Alberta, and are much harder than many other types of rock, they were used for hearth construction, in boiling features and other structures.

Raw Material Classification

The objective of raw material classification is to group lithic artefacts into defined stone types. However, it is important to note that many of the rock types grade into other forms through the processes discussed above. Moreover, there may be significant variability within a rock type. This is commonly seen in chert, for example, due to chemical mixing during precipitation. In some cases, flakes produced from a single chert nodule may be different in colour (mineral composition) and texture. For this reason, it is often difficult to classify the raw materials of the artefacts. Detailed type descriptions and an extensive reference collection are needed to make sound assignments. Both of these resources were used to identify the raw materials present in the Fincastle collection. For concrete assessments, however, the artefacts need to be chemically analyzed and linked to a referenced source. Considering that most lithic assemblages contain thousands of artefacts, it is not possible to examine the entire collection this way, not to mention the fact that some laboratory tests are destructive. Moreover, cherts are notoriously difficult to sub-classify and source because of their variability. For these reasons, only the obsidian artefacts from the Fincastle assemblage were chemically examined. The results of this laboratory analysis are reported below.

Raw material types were macroscopically assessed on the basis of texture (the size, shape and organization of the particles), lustre, colour and translucency. Each of these features has a number of defined grades or categories, which are listed below.

The textural grades used in the raw material descriptions are as follows:

Very coarse-grained: Individual grains are clearly visible with the naked eye. Non-cortical facets are abrasive to the touch.
Coarse-grained: Individual grains are visible with the naked eye or a hand lens. The particles are more compacted or the voids between particles are filled in to create a less abrasive surface.
Medium-grained: Individual grains may be visible with the naked eye but a hand lens is necessary to distinguish them. A slightly abrasive surface can be felt.
Fine-grained: Individual grains are distinguishable with a hand lens. The flaked surface is smooth, though not polished-like.
Very-fine grained: Individual grains are not detectable without a microscope. The flaked surface is very smooth and feels polished.
Amorphous: A non-granular glassy texture.

The lustre of the material is defined by the way the rock surface appears in reflected light. It is connected to the texture and mineralogical constituents of the rock. It is assessed by examining a non-cortical surface of the specimen in direct light. The following categories were used to describe lustre of the raw materials present in the Fincastle assemblage:

Vitreous: Light directly reflects off the surface of the lithic remain. These rocks have the same lustre as glass.
Resinous: Some light is directly reflected off the surface of the lithic remain. These rocks have the appearance of resin or plastic.
Waxen: Most light is not directly reflected off the surface of the lithic remain. Its lustre is similar to that of wax. Heat treating the raw material often creates or accentuates a waxy lustre.
Dull: Light scatters in all directions so no reflection is seen. The rock exhibits no lustre.

Colour is directly connected to the elements present. Their concentration and texture determine the colour(s) of the raw material. Because defining colour is a subjective process, a reference collection created in conjunction with the Munsell colour system was used. Two or more researchers examined specimens that were more difficult to classify. Colour was assessed through the examination of the non-cortical aspects of the artefact, though its colour was also recorded if it was of interest. The primary colour of the artefact (the most prevalent colour) was recorded under ‘Colour’ in the database. Secondary colours were listed in the ‘Comments’ section. The following is a list of the colours identified in the Fincastle collection:

White
White – Light grey
Light grey
Brown
Orange
Yellow

Medium grey – Light grey	***Pink***
Medium grey	***Red***
Medium – Dark grey	***Purple***
Dark grey	***Blue***
Dark grey – Black	***Green***
Black	***Translucent (colourless)***

The degree to which a material can transmit light is recorded as its translucency. The following defining categories were used:

Opaque: No light is transmitted through the lithic material, no matter how thin the specimen is.
Slightly translucent: Only a limited amount of light is transmitted through the rock or mineral, often only through thin sections.
Moderately translucent: A moderate amount of light is transmitted through even thick sections of the lithic material.
Highly translucent: A high amount of light is transmitted though even thick sections of the specimen.
Translucent: The lithic material is completely translucent.

Lithic Material Types

The raw materials of the lithic artefacts recovered from the Fincastle excavations were macroscopically determined using these four features together with detailed type descriptions, collected from a number of resources, including Kooyman's (2000) and Andrefsky's (2005) lithic overviews and ?? classification system used for the ?? project. Material reference collections were also used to assign the artefacts to a previously defined type or subtype. Significant specimens were also examined microscopically to either confirm their classification or to expand the type descriptions. The 27 lithic types present in the Fincastle assemblage are described below, and are listed in Appendix ??.

Igneous Rocks

As noted above, igneous rocks are divided into extrusive (formed when lava cools) and intrusive (formed when magma cools) types. ***Basalt*** is a fine to coarse-grained, grey to black extrusive rock that can be used for lithic tool production. It is opaque and has a dull lustre. It can be distinguished from dark siltstones and chert by the presence of vesicles and small volcanic glass sherds. Basalt is the most common of the igneous rocks. It can be quarried from primary deposits in central Montana, western Idaho, Washington and British Columbia (Loveseth 1980), or can be collected from secondary deposits throughout the region.

Also described as volcanic glass, ***obsidian*** is an extrusive igneous rock that cooled extremely quickly. The rapid cooling did not allow crystal growth, so the texture of obsidian is considered amorphous. Most obsidian is black, but the colour varies depending on the presence of impurities. The presence of iron and magnesium, for example, can give the obsidian a dark green, brown to orangish colour that may or may not be consistent throughout the piece. Obsidian can also be completely translucent, though this is rare. Ash particles are commonly imbedded into the stone, ranging in colour from white to black. Obsidian was used to make a variety of lithic tools since it is easy to knap and the flake edges can reach an almost molecular thinness. It is not local to southern Alberta, so was imported from a number of sources, including Obsidian Cliff in Yellowstone National Park, Glass Butte in Oregon, Bear Gulch in Idaho and British Columbia. Because each volcanic event is chemically unique, obsidian artefacts can be examined for trace elements and concentrations, and linked to a source location. This was done for all the obsidian pieces found at the Fincastle site (see below).

One of the most widely found intrusive igneous rocks is ***granite***. The slow cooling of magma allows large crystals to form, which gives granite its unique mineralogical and chemical constitute. It is predominantly made up of quartz, feldspar and mica, which creates its very crystalline character. Together with the other elements present, a variety of granite colours are created, including white, pink, orange and grey. Granite has a coarse-grained massive texture, which makes it extremely hard. For this reason it cannot be knapped, but can be used as an effective hammerstone or similar tool. Since it is locally available as cobbles in secondary deposits was also collected for use in a number features created throughout prehistory.

Massive quartz is an igneous formation of silica crystals that forms within cooling molten rock. This process builds free standing six-sided quartz crystals that are often twinned or distorted to the point that they lack obvious crystal faces, thereby appearing massive. It is normally white to translucent, though occasional tinges of pink, yellow and black can also be seen due to the presence of impurities. It is highly translucent and vitreous. Due to its mineralogical structure, it tends to be more difficult to flake; irregular fracture lines and stepped terminations are often created. That being said, nodules that are homogenous in texture can be used to create a variety of well-formed artefacts. Massive quartz is found in secondary alluvial deposits and glacial tills, but can also be quarried from outcrops in southern British Columbia (Bussey 1977) and Montana (Loveseth 1980).

Sedimentary Rocks

Sedimentary rocks created without the injection or precipitation of a significant amount of silica were rarely used for flaked tool production but were selected for other purposes. Sandstone cobbles, for example, make good hammerstones, and were often used for lining hearth features or in other constructions. ***Sandstone*** is predominantly made up of sand-sized clastic particles that were cemented together with silica. Its texture is classified as massive and is normally homogeneous though some banding may be present. Sandstone can be a number of colours, though light to medium browns and light to medium greys are the most common. It has a dull to resinous lustre and is opaque. It is readily available from a variety of secondary deposits.

Dolomite was also identified in the Fincastle assemblage. It is a sedimentary carbonate rock composed of calcium magnesium carbonate ($CaMg(CO_3)_2$). It has a fine to medium texture that is created when the carbonate crystallizes. It is normally an opaque whitish colour. Dolomite can be distinguished from limestone because it does not rapidly react with diluted (10%) hydrochloric acid (HCl).

As explained above, silicified sediments are much more conducive to lithic production. They include silt and clay deposits that have been lithified into sedimentary rock. The once individual clastic particles were cemented together with a significant amount of silica, which created a dense, knappable texture. ***Silicified siltstone*** is fine-grained but the silt particles can be seen with the naked eye or a hand lens. It is opaque and generally dark in colour (greys, browns and black) and tends to have a dull to resinous lustre. Banding is commonly present due to the originally laminated structure of the silt deposit. The unique banding (or lack of) and colour attributes have been used to identify specific outcrops, including Nordegg and Banff cherts from the Banff Formation, though all silicified siltstones have been grouped together as one type for this report, including the silt based pebble cherts. Many of the silicified siltstones used for lithic manufacture in southern Alberta probably originated from the Rocky Mountains, but was likely collected as pebbles from the drainages off these mountains.

Silicified mudstone is differentiated from siltstone on the bases of texture and colour. A silicified mudstone was once a clay deposit, so is more fine grained (the clastic particles cannot be seen with the naked eye), and is generally more homogeneous in texture and colour (banding is less common). It has slightly better knapping qualities than silicified siltstone because of these traits. It is opaque and has a dull to resinous lustre. Pebbles made of silicified mudstone are commonly found in alluvial deposits across the northern Plains. Distinguishing between chert and silicified mudstone is very difficult without laboratory testing. For this reason, very dark grey/black chert classification types often include silicified mudstone or vice verse. Because the lustre of the black raw material was more vitreous than resinous, the ***Black chert*** label was used for this project, with the knowledge that this classification category may contain silicified mudstone specimens.

Silicified wood (*petrified wood*) is created when carbonaceous sediment (wood) is fossilized by its replacement with silica. The structure of the stone generally remains somewhat wood-like, however, so flaking may be adversely affected as a consistent conchoidal fracture is unlikely. The fractures tend to follow the wood grain, which produces tabular-like flakes and stepped terminations. The texture of silicified wood is predominantly microcrystalline. Colours can range, even within one piece, but yellows, browns, reds and greys are common. It can be opaque to translucent, dull to vitreous. It is relatively common in secondary till deposits in southern Alberta.

Chert is broadly defined as a cryptocrystalline or amorphous silicate that forms in the cavities of other rock. It is a silicate that is found as nodules or veins in its original context, or as weathered gravel in secondary deposits. Chert can be sub-classified into a number of types based on its colour and texture, several of which have been sourced to the northern Plains. Of specific interest to this project is Swan River chert from southeastern Manitoba and Madison Formation chert from Montana.

Swan River chert outcrops in the Swan River Valley in southwest Manitoba, but it can also be found in limited quantities in Laurentide gravel deposits as far west as southeastern Alberta (Kooyman 2000). Its colour and texture are highly variable. Nodules can be mottled with white, grey, yellow, brown, orange, pink, red and purple, but its curdled-milk appearance is its signature characteristic, along with the presence of numerous small vugs (cavities within the rock) or microfossil inclusions. Campling (1980) identified the coloured mottles as aggregates of quartz grains, which can be peg-shaped, feather-like or needle-like. Swan River chert can be opaque to moderately translucent, and have a dull to vitreous lustre. It ranges from very fine-grained to coarse-grained, often within a single nodule, which is why it was regularly heated before it was flaked. Heat treaded specimens tend to take on a more waxy pink to reddish-orange hue (Kooyman 2000), and have a more consistent granular texture.

Chert originating from layers within the Madison Limestone Formation in Montana was mined as early as 5,100 years ago (Rapp 2009). It is highly variable in colour and can range from opaque to highly translucent. Though many researchers separate this chert into subgroups based on colour, as was done for this project, it is often grouped together as ***Montana chert*** for analysis. The opaque varieties (yellow, red, green, white and grey) are the most commonly recognized of the Montana chert types. They are all very fine grained and vitreous. They can be homogeneous in colour, or have banding, dendrites and mottling.

Chalcedony is more translucent than most chert because it has fewer impurities and more extracrystalline water. It tends to be lighter in colour for these reasons as well. Its often has a distinctive fibrous, radiating texture that is quite visible microscopically (Rapp 2009). It can be cyptocrystalline or amorphous. Chalcedony is sub-classified based predominantly on colour and the presence or absence of banding, dendrites and mottling.

Though better defined as a chalcedony because of its texture, ***Knife River flint*** was one of the most widely used raw materials on the northern Plains (Clayton et al. 1970; Gregg 1987). It was surface collected and mined from secondary alluvial deposits in the counties of Dunn and Mercer in North Dakota, and made its way into assemblages found hundreds of km away. It was used and traded as early as the Paleoindian period, though its peak use was by the Hopewellian people some 2000 years ago (Kooyman 2000). Unfortunately, solidly confirming that the brown chalcedony artefacts found at a site were made from Knife River flint is not yet possible because the chemical signature of this material has not been determined (Clayton et al. 1970). This is partly because the alluvial deposits in North Dakota are not the primary bedrock source of the stone. The primary deposit has been either eroded away or not yet located. The greater challenge, however, is chemically differentiating Knife River flint from other brown chalcedonies.

Despite the chemical similarities, many researchers macroscopically identify Knife River flint by its deep brown to amber colour, though the colour can be homogenous or mottled. It is generally vitreous and slightly translucent, but the dark brown patches may be opaque, and the colourless areas completely translucent. Heating the material to improve its knapping qualities can result is a slightly reddish colour and greasier lustre, as well as pronounced flake scar attributes, including enhanced ripple marks (Brink and Dawe 1989). Artefacts covered in a white patina often have a bluish tint. It is one of the rare types of chalcedony that is not fibrous. Instead, organics, most likely peat, can be occasional seen microscopically, which is one of the defining characteristics of Knife River flint. Technically, one cannot classify specimens that do not contain recognizable fossil plant fragments as sourced Knife River flint. For this reason, many archaeologists choose to label this type of material as ***brown chalcedony***, especially since some researchers (??) have suggested that a number of separate brown chalcedonies may be present in the northern Plains. This more cautious label has been used for this project. Artefacts heavily patinated were grouped together as ***patinated brown chalcedony***.

As noted above, brown chalcedony is commonly connected with Knife River flint deposits as is patinated brown chalcedony. Upon examining the Fincastle debitage it became clear that the ***translucent chalcedony*** in this assemblage also came from the same source. Though most of these fragments can be described as clear chalcedony marked with dark brown fibrous inclusions with some black to brown or reddish mottling, several specimens evidenced this translucent material grading directly into brown chalcedony.

Yellow and ***red chalcedony*** types were also recognised in the collection as they likely originated from a different source than the brown and translucent chalcedony. Though they are more translucent and lighter in colour than the opaque yellow and red cherts connected with Montana chert deposits, they are probably connected to them, much the same way the translucent chalcedony is to Knife River flint. They are very fine-grained and have a vitreous lustre. Banding, dendrites and mottling are common in these types.

Miscellaneous chert is a broad classification type that includes chert artefacts that do not easily fit into a known sourced type, such as Swan River chert, or a separate rock group, such as chalcedony. Because chert outcrops, and even the nodules themselves, can be highly variable, it is likely that much of the raw material placed in this category does, in fact, belong to one of the above types. However, without chemical testing, which is also not completely reliable for chert, a more specific assignment was not possible. This group does not include ***jasper***, an opaque cryptocrystalline silicate that is typically red to brown, or ***agate*** a moderately translucent chalcedony that, through the mixing of silica dioxide and some opal, has a unique moss-like appearance, in a variety of colours. Neither of these types were identified in the assemblage.

Metamorphic Rocks

Porcellanite is made up of a mixture of silty clay and calcareous matter that was silicified with a large amount of opaline silica (Rapp 2009). It can be created a number of ways, but is often found on the floor and roof of burned out coal seams (Fredlund 1976). The heat produced when the coal seam burned metamorphically altered the sedimentary rock to create fused shale. It is recognizable by its fine-grained unglazed ceramic-like texture, which is dull to slightly vitreous. It is generally a single opaque colour, greyish or reddish, but can contain small, irregular vesicle inclusions and/or tiny holes discernible with a hand lens. It is less hard, dense and vitreous than chert. Most of the porcellanite used at Alberta sites likely originated from southern Montana where large outcrops of high quality material occur (Clark 1985).

Argillite is a weakly metamorphosed siltstone (shale) or mudstone that is very similar to porcellanite. It too has a solid opaque colour that can be reddish to brownish or greyish to greenish. It is also fine-grained though its texture can be slightly coarser and platy. This and its more vitreous lustre are used to identify this raw material. Argillite found in secondary deposits in southern Alberta and northern Montana likely originated from one of the large bedrock outcrops in the Rocky Mountains. ***Kootenay argillite*** is thought to come from the Kootenay region of southeastern British Columbia. It is light green to grey in colour, and is very fine grained.

Metamorphic ***quartzite*** was commonly used for lithic manufacture throughout prehistory. The metamorphic alteration of the texture of sandstone allows it to be fractured through the quartz grains rather than around them, though its grainy structure limits the ability to create thin flakes. For this reason, quartzite tools tend to be more expedient (such as hammerstones and choppers), although many well-formed tools have also been made using this material. Quartzite cobbles, rounded through alluvial weathering, are found throughout Alberta, in a variety of colours (brown, yellow, red, purple, green and grey). When heated, their colour can change to become pink, red or purple depending on the minerals present and the degree of heating. Having said this, Dawe (1984) reported that the knappability of Alberta quartzite is not improved when heated, which explains why the pieces of heat-altered quartzite in the Fincastle assemblage are all fire-broken rock.

Quartzite can be divided into sub-types that reflect the texture of the stone. ***Coarse-grained quartzite*** has a coarse to very coarse texture because the sand particles within the stone are large. Artefacts made using this material are normally one homogeneous colour, and are opaque to slightly translucent. They can be dull to vitreous, but are often described as having a sugary to sparkling lustre (Kooymann 2000). ***Medium/Fine-grained quartzite*** is made up of fine to medium grained sand particles so has a finer texture, though the sand particles are still visible with the naked eye or by using a hand lens. Cobbles of this material also range in colour and are generally homogeneous, but some banding may be present. They can be opaque to moderately translucent, and have the same lustre as the coarse-grained quartzite artefacts. Finer-grained quartzites are better for lithic projection in most cases because they tend to have a greater amount of silica cement to grain volume (Kooymann 2000), which is more conducive to conchoidal fracturing.

As the particles of igneous and sedimentary rocks are exposed to more heat and pressure their texture is altered. In most cases, these factors cause mineral grown and their potential alignment within the rock, which is referred to as foliation. ***Slate***, for example, was once shale (a fine-grained clastic sedimentary rock made of a mixture of clay and silt-sized particles that were aligned into parallel bedding planes) that was subject to the metamorphic process. The heat and pressure altered the shale parent rock into a harder, fine-grained, foliated stone. Slate is typically grey but can be green, orange or purple depending on the clay minerals within. As the metamorphic factors of heat and pressure increase, different types of rocks are created. ***Phyllite*** represents a gradation in the degree of metamorphism between slate and schist. It is a more foliated and coarsely grained rock than slate, but still has a platy texture. It is normally grey to black. ***Schist***, formed from slate or basalt, is also a foliated rock, but because it was exposed to higher temperatures and more pressure, shows more mineral growth and alignment, and is coarser grained than phyllite. It is classified as a medium-grade metamorphic rock. It is similar in colour to slate, phyllite and basalt. ***Gneiss*** is the highest grade (the most altered) metamorphic rock. The extreme heat and pressure not only cause the foliation of the newly formed minerals, but their banding as well. It is considered coarser grained than schist, and is easily identified by the compositional banding layers. It is generally significantly harder than any of the sedimentary rocks.

Slate, phyllite, schist and gneiss outcrops can be found across the Canadian Shield and in the Rocky Mountains. Most of these rocks collected for artefact use in southern Alberta likely came from secondary deposits, including alluvial beds and glacial tills. Due to the platy textures of the first three rocks they were rarely used for flaking purposes. Gneiss is also not suitable for this activity, but its exceptional hardness is conducive for its use as a hammerstone or the like. These metamorphic rocks may have also been used in hearths, boiling features or other structures.

Heat Treatment

Heat treating certain stone types can increase its workability for lithic manufacture. Knapping improvement occurs in cases where the molecular structure of the raw material is positively altered. In some stones the tensile strength is reduced to about one-half (Olausson 1983), which allows longer flakes to be detached from the core when the same knapping force is applied. In other materials the particles are vitrified, thereby creating a smoother, more consistent texture. The creation of microcracks in the stone's texture when intracrystallic water is released can also improve flaking (Price et al. 1982). Crabtree and Butler (1964) and Whittaker (1994) noted that slowly heating chert to temperatures between 300°C and 450°C and then slowly cooling the stone before flaking it improved its knappability. In contrast, Johnson (1980) concluded that heating chalcedony to temperatures between 260°C and 315°C yielded an ideal change in the material, but temperatures higher than 315°C caused the material to fracture. Alternatively, heating some high quality materials does not seem to improve flaking quality, and in some cases can have a negative effect. Heating obsidian, for example, is detrimental as the material often shatters or explodes because of the release of water from its molecular structure.

Identifying heat treated material is often based on lustre. Some stone types that were originally dull develop a greasy lustre when heated (Crabtree and Butler 1964), while others become vitreous (Purdy and Brooks 1971). The surface of the specimen may also have a 'soapy' feel (Whittaker 1994). A colour change is often noted as well, due to an alteration of the oxidation state of the iron impurities in the material (Purdy and Brooks 1971) or other chemical changes (Patterson 1984). Colour change is especially apparent in Swan River chert, as are other features, such as the waxy lustre and the smoother texture. Changes in chert and chalcedony tend to be more subtle, but colour and lustre differences can be detected in most material.