University of Alberta

A KNIFE RIVER FLINT IDENTIFICATION MODEL AND ITS APPLICATION TO THREE ALBERTA ECOZONE ARCHAEOLOGICAL ASSEMBLAGES

By

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ABSTRACT

This study presents a reliable and economic model for achieving an accurate Knife River Flint identification, utilizing a macroscopic, microscopic and ultra-violet methodology supported by an experimental protocol. Correct identification of Knife River Flint is essential for understanding of trade and acquisition strategies involving stone tools in the Northern Plains. The identification model is applied to archaeological sites from three ecozones of southern Alberta, all dating to the Late Precontact Period. Knife River Flint decreases in size and quantity the further north the sites are found. However, the quantity of Knife River Flint from this time period is very low so that no firm conclusions about acquisition strategies or trade patterns can be established as yet.

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I wish to thank the staff at Western Heritage Inc. and at the Royal Alberta Museum for their advice and guidance.

And a very special thanks to my wife Marjorie who stood by through all the frustrations and successes of this thesis.

DEDICATION

This thesis is dedicated to all the many people of Bodo and Provost, Alberta, and the First Nations Elders who have encouraged the exploration of a shared heritage in south central Alberta.

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CH 1: INTRODUCTION

Using a macroscopic, microscopic, and ultraviolet light methodology, this thesis suggests a convenient analytical system for identifying Knife River Flint (KRF) in the field and in the archaeological field laboratory. The thesis tests this methodology through a blind test using various lithic materials of known type and origin. This methodology is then applied to the study of the relative abundance and morphological variability of Knife River Flint debitage in archaeological assemblages believed to date to the Late Precontact Period and occurring within three Alberta ecozones, namely the Prairie, the Montane and the southern Parkland.

Stone tools and the debris from stone tool manufacture have been found in archeological assemblages around the world (Kooyman 2000; Odell 2003; Andrefsky 1994, 2001a, 2001b). Since stone tends to deteriorate very slowly, stone artifacts constitute a significant portion of most archaeological assemblages, including those from the Northern Plains of North America. As a consequence, lithics provide the vast majority of material evidence of human activity at ancient sites in this region (Andrefsky 1994; Reeves 1990; Root 1992; Wormington, 1965). Ericson and Purdy (1984) estimate that at most 10% of any lithic assemblage would consist of tools, meaning that assemblages are overwhelmingly dominated by flaking debris, with most pieces often being quite small in size.

Knappers have long prized cryptocrystalline minerals, which can exhibit hardness, conchoidal fracturing, and grain sizes ideal for creating stone tools (Cotterell and Kamminga 1979, 1987; Andrefsky 1998).

Knapping, a reductive technology, often involves cherts, flints, quartzs, quartzites, obsidians and basalts amongst other lithic resources. Down-the-line trade or direct-access to the desired raw material constitute two, but not all, limiting factors in acquisition strategy (Renfrew 1972).

Obtaining better-grade stone for chipped-stone tool production has long been a priority among Native peoples on the Northern Plains (Holmes 1890; Wormington 1965; Root 1992). The Great Plains culture area which encompasses the Northern Plains, reaches from Northern Mexico through Central Alberta to the delta of the Mackenzie River on a north-south axis. This constitutes a span of approximately 4,800 km. From the Rocky Mountains in the west to the Appalachians in the east the culture area varies in width from 500 to 1200 km (Dietz and Robinson 2009).

The Northern Plains, as one subsection of this vast area is called, cover sections of North Dakota, Montana, Wyoming, Manitoba, Saskatchewan and Alberta (Ricketts et al. 1999). The boundary in the north is usually given as the interface between the fescue prairie and the boreal forest. The southern boundary is most often placed at the North Platte River in Wyoming and Nebraska (Dietz and Robinson 2009). Within Canada the respective boundaries extend north from the US border to the grass-forest interface and reach east from the aspen ranges of the Rocky Mountain foothills to western Manitoba, an area of approximately 390,000 square kilometers (Coupland 1961; Ricketts et al. 1999). In this paper the Northern Plains will include the Prairies and the Parkland ecozones (intermediate between the Boreal Plain Forest and the Prairies), which extends from the continental divide in the Rocky Mountains in the west to the Alberta-Saskatchewan border in the east. The Montane ecozone, is also included in the study area of this paper.

Locally available lithic raw materials found across Alberta vary in hardness and crystal structure. Cryptocrystalline raw materials can be found in riverine and glacial gravels throughout most of the Northern Plains (Bayrock and Reichem 1980). Quartzite is the most frequently used lithic material in most time periods in Alberta due to its local availability (Finnigan 1983), but this material is relatively brittle compared to some types of stone available elsewhere on the Northern Plains. Perhaps the best raw material for the production of chipped stone artifacts used in Alberta, other than obsidian, was Knife River Flint (KRF). Ahler (1983: 2) describes Knife River Flint as a: "[u]niform, nonporous, dark brown, translucent stone with good conchoidal fracture properties, subject to well-controlled flaking by either concussion or pressure." Furthermore, he estimates that 2,000,000 tools have been manufactured from KRF across North America, which is surely a sign of the material's high suitability for flaking.

The primary source of Knife River Flint is Dunn County, North Dakota, although trace amounts of the unchipped stone can be found across a wider area (Ahler 1986; Root 2000). KRF is widely distributed, but not common, in the southern ecozones of Alberta during some time periods (described below). The Archaeological Survey of Alberta (ASA) Heritage Resources Impact Assessment and Mitigation Reports indicate that KRF can be found in the province as far north as Fort McMurray, which is 1200 km from the primary source. It has been suggested that KRF entered Alberta through down-the-line trade (following Binford's 1979 definition), or through direct access by people journeying to the source or from the source into Alberta (Crawford 1936; Kehoe et al. 1961; Wormington 1965; Byrne 1973). Additional KRF tools have been found from British Columbia to Ohio and from the U.S. Rocky Mountains and the Northern Plains States, and to the Prairie Provinces of Canada (Clayton 1970; Fladmark 1981; Varkasis 2006). Obviously, KRF was widely desired and traded, most likely because the stone typically has all the qualities prized by knappers. For example, its hardness gives a sharp edge, while its characteristic conchoidal fracture plane means flake direction is easier to control (Kooyman 2000; Andrefsky 2001; Odell 2003).

During the Early Precontact Period, 10,500-6,000 BP, KRF was one of the predominant exotic stones being worked in Alberta (Gryba 2002; Kooyman 2003). The Middle Precontact Period has little lithic evidence available. During the Avonlea/Besant 'transitional' period, from 2,000-1,250 BP between the Late Middle Period and the Early Late Period, there is an upsurge in KRF debitage and tools manufactured from Knife River Flint. A third very minor florescence in KRF use occurs during the Late Precontact Old Women's Phase, which spans the years 1,250-250 BP (Fredlund 1970; Reeves 1983, 1985; Wald 1994; Walde et al.1985; Gregg 1987; Meyer 1988; Walde et al. 1995; Vickers 1983; Root 1992; Kehoe 1966; Kehoe et al. 1961; Forbis 1962; Peck 1996; Peck and Ives 2001; Varkasis 2006) and is evident primarily as projectile points and end scrapers.

Root (1992:3) has offered one of the few, albeit very brief explanations for this pattern: "regional exchange networks repeatedly arose on the Northern Plains in response to unpredictable and localized subsistence shortfalls." MacGregor (1965:3) commented that "(the percentage of projectile points and scrapers made from any [...] exotic materials is naturally higher the nearer one approaches their source, and therefore is higher in the south of the province." MacGregor estimated that approximately 10% of the chipped stone artifacts in the Edmonton area are KRF and only 1% consists of obsidian. He goes on to point out that the Peace River country, approximately 1900 km (1,200 miles) from the source of KRF, also has KRF artifacts.

Reeves (1983) provided one of the more thorough explanations for KRF distribution on the Northern Plains, arguing that better lines of communications and trade relations emanating from a Hopewellian westward expansion were an impetus for widespread deposition of Besant KRF artifacts. He also implies that KRF may have been an economic resource exploited by high status groups during the Besant Phase on the Northern Plains. Later disintegration of these groups may be responsible for the fewer KRF artifacts in the assemblages from the following Late Precontact period. Clark (1982) points out that down-the-line trade is on a regional basis rather than on a group basis. Correctly identifying KRF, or any other material indicator of trade, therefore is an important aspect of any field or laboratory analysis of the Northern Plains archaeological remains. Southern Alberta trade routes or direct access trails may be traced by following the morphological changes in KRF as investigations move from south to north.

Any assertions that the use of KRF rose and fell throughout the Holocene is of course entirely dependent upon the identification of the types of stone actually present in assemblages. Cryptocrystalline materials similar in appearance to KRF, for example Hand Hills Chert (R. Dawe, pers. com. 2008), are often found in Alberta archaeological assemblages. The presence of these and similar materials makes the process of material type identification particularly problematic. For example, just over four decades ago Taylor (1969:32) maintained that "[c]halcedony flakes were usually so small that Knife River 'flint' could not be safely distinguished from the local brown chalcedony" at the Fullerton site (FfPi-1). We are still faced with these same identification challenges today.

While chemical methods have been used to identify KRF with a good deal of success (Ahler 1989, 1986; Christensen 1991; Luedtke 1992; Jarvis 1996; Root 2000; Andrefsky 2000a, 2000b), they remain largely beyond the grasp of most of the province's archaeological projects. Reliable, economical, and expedient methods for identifying KRF are needed by the majority of archaeologists working in Alberta, and this thesis seeks in part to develop such a method.

The specific questions to be addressed in my thesis are:

a. Can an economical and reliable means of differentiating KRF from similar lithic materials be developed?

b. Does the archaeological record support the assumption that distance from a source results in a decline in the size of exotic lithic raw materials, in this case KRF?

c. Does change in flake size (if it occurs) by distance from the source area correspond with changing flake type?

d. What variation across ecozones of Alberta is evident in KRF artifact distribution and morphology during the Late Precontact Period (1,800 – 250 BP)?

My research will demonstrate a KRF identification methodology that involves relatively inexpensive ($200-300) analytical equipment and a high degree of reliability, even when employed by investigators with relatively limited experience in lithic identification. Secondly, my analysis will demonstrate that the KRF debitage decreases very slightly in size as the distance from the source area increases. Thirdly, examination of flake morphology will demonstrate that KRF artifacts show the later stages of lithic reduction more frequently the greater degree the distance from Dunn County. The number of KRF artifacts and morphological variability in the ecozones will be used to suggest that exotic raw materials were probably a prized resource for manufacturing tools and prestige items. It is hoped that these findings will broaden and refine the understanding of how KRF was utilized on the Northern Plains of Alberta during the last two thousand years.

In Chapter 2, I outline previous KRF research. Chapter 3 describes and evaluates my experimental methodology used for identifying KRF. Chapter 4 provides a brief description of the ecozones of Alberta as a lead up to examining the variability in KRF across southern Alberta during the Late Precontact Period. Northern Plains culture history is outlined in chapter 5. Chapter 6 concentrates on the criteria used to select the sites chosen for this analysis. Chapter 7 describes my reevaluation of the identified and ascertained KRF artifacts in these assemblages and my analysis of the morphology of KRF debitage. Chapter 8 provides a summary and conclusions of these investigations.

CHAPTER 2: KNIFE RIVER FLINT CHARACTERISTICS AND PREVIOUS RESEARCH

Schmalz (1960) defines flint as a dense, fine-grained aggregate of anhedral quartz crystals. Knife River Flint falls within this definition, as it is a cryptocrystalline, brown, translucent chert (Frodel 1962). The cortex is usually cream coloured or a chalky white. Frequently small fossil plant remains are visible within the stone. Freshly chipped surfaces exhibit a smooth, waxy lustre. Feathering is translucent up to 5 mm from the edge. Upon lengthy exposure to air and perhaps moisture, the flint may develop a bluish white patina. Bedding planes and small light coloured inclusions may be seen in the chert under low power magnification. These inclusions may include animal fossil remains. Some variation is of course present; specimens vary in colour, visible bedding planes and inclusions (Schmaltz 1960; Clayton et al. 1970; Ahler 1983, 1986; Ahler et al. 1983; Van Nest 1985; Gregg 1987; Ahler 1989; Christensen 1991; Root 1992, 2000; Luedtke 1992; Varkasis 2006).

In Alberta and elsewhere there are several lithic materials that can be mistaken for KRF, including Sand Hills Chert and several dark brown chalcedonies (Crawford 1936; Jarvis 1996; Dawe, pers. com. 2008), herein referred to as Look-Alikes (L-A). Chalcedonies, silicified wood and silicified peat can be mistaken for KRF if their colour resembles its deep brown and edge translucency. Patination can obscure the colour of the lithic sample. Patinated flakes without the parent dark brown matrix can be mistakenly identified as KRF. Heat treatment may also cause a misidentification. Samples of over heat treated KRF are frequently a stark white along the chipped edges and show laminar layering. The layering might result in the specimen being mistaken for chalcedony or silicified wood (R. Dawe, pers. com. 2008). Clearly a reliable and economical set of methods differentiating KRF from these Look-Alike materials in a field setting or during cataloguing in a laboratory would be useful.

Heritage Impact Assessments and Mitigation activities, primarily for the forestry, oil and gas industries and other commercial development, drive Alberta archaeology. Because this research is conducted as a business venture, investigators typically select methodologies that are expedient and economical. It is hoped that those searching for an efficient and non-technical means of correctly identifying this important non-local lithic material can readily implement my approach.

2.1 PREVIOUS KRF RESEARCH

Holmes (1890) is recognized as a pioneer in researching North American aboriginal mining techniques. He is perhaps the first anthropologist to study indigenous quarries in North America. He also categorized common mining features and proposed a terminology for them. McIvor (1936) mentions Knife River Flint in his early "Mineralogy Notes for Archaeologists," and Lewis Crawford first described Knife River Flint quarries in 1936. Ahler et al. (1983) described Knife River Flint procurement and established the reduction stages evident from the debitage recovered from various quarries in Dunn County, North Dakota. Ahler (1986) and his colleagues continued the study of the quarries in North Dakota in the 1980s and 1990s. The Dunn County quarries were assessed in terms of dates of use, reduction strategies, and blank preparation. Root (1992, 2000; Root et al. 2000) investigated the stone tool and debitage relationship at several KRF quarries in Dunn County. This included a lengthy set of replication experiments with non-heat treated and heat treated Knife River Flint. The replications were deemed to be within the parameters found at the Dunn County quarries. Varkasis (2006), whose dissertation focused on the Besant Phase across the Northern Plains, gives a particularly detailed account of Knife River Flint use across the region citing assemblages from Manitoba, Alberta, Saskatchewan, North Dakota, South Dakota, Wyoming and Montana.

Previous research confirms that identifying KRF is difficult (Luedtke 1992; Root 1992; Julig et al. 1992; Kooyman 2000; Akridge et al. 2001), especially outside the primary quarry areas. Alberta has a particular look-alike chert in Hand Hills Chert from Alberta, which exhibits the same dark brown coloring and whitish patina. However, Hand Hills Chert does not have the same conchoidal fracturing ease, nor the edge translucency of Knife River Flint (Root 1992; R. Dawe, pers. com. 2008).

Previously used analytical techniques for identification have included macroscopic, microscopic observations, chemical techniques (Andrefsky 2001; Kooyman 2000; Kempe and Templeman 1983; Julig et al. 1994), and carbon and oxygen isotope analyses (Christensen 1991). Other potential methods include cathodoluminescence, thermoluminescence, X-ray fluorescence, and instrumental neutron activation analysis (INAA). These more technical identification techniques are time-consuming, occasionally destructive and often expensive. Ultra-violet light irradiation, a developing technique for identifying lithic materials, including KRF (Jarvis 1996; Root 2000), is inexpensive and can be easily used in a field laboratory. The advantages and disadvantages of these methods will be described briefly below.

2.2 IDENTIFICATION TECHNIQUES: CHEMICAL

Kooyman (2000), Kempe and Templeman (1993), and Christensen (1991) discuss chemical identification techniques. Some methodological parameters to consider here are: the expenses involved, the availability of suitable laboratories, and whether the methodology is destructive or non-destructive. Trace element distribution for material types that may overlap with adjacent sources (Kooyman 2000) also can be an issue. The following brief descriptions of various identification techniques are limited to those that have been used when identifying KRF.

2.2.1 Cathodoluminescence and Thermoluminescence

Akridge and Benoit (2001) applied to KRF both cathodoluminescence (CL), a method that saturates a sample with energetic electrons to produce light emissions, and thermoluminescence (TL), which entails heating a specimen to produce light emissions. They found that KRF emitted a faint orange glow when subjected to the CL. Further examination by x-ray diffraction determined that the luminescence is probably due to calcite inclusions. Advantages of employing CL include its relative cheapness (if the necessary equipment is available) and rapid results are produced using only a very small sample. One disadvantage of CL when considering KRF is that long ground exposure of cherts leaches out carbonates, which leaves the cherts unresponsive to CL (Kempe and Templeman 1983).

Thermoluminescence methodology uses 300 mg of crushed material. Obviously, such a methodology would be undesirable when analyzing rare, delicate or small artifacts (Kooyman 2000; Kempe and Templeman 1993; Christensen 1991). Kempe and Templeman (1993) conclude that materials that were not heat treated, or materials that are heated to less than 300ºC, including flints and cherts, can be positively identified by this method. Thermoluminescence also has the advantage of giving an indication of grain size. X-ray diffraction patterns reportedly are difficult to reproduce when using TL (Akridge and Benoit 2001; Kooyman 2000; Christensen 1991).

2.2.2 X-ray Fluorescence

Trace elements in lithic materials can be identified using X-ray fluorescence. This method is precise enough to differentiate bedding planes on a section of a lithic outcrop (Christensen 1991). A small amount, 2-5 mg, of the material is required for this method. The sample is crushed, and as it is a destructive methodology, is not one recommended for use on rare artifacts (Kooyman 2000; Kempe and Templeman 1993). However, if a flat portion of an artifact can be irradiated, then the material can be analyzed without crushing, thus making the methodology essentially non-destructive. A major disadvantage is that there are relatively few facilities that have the necessary equipment and instruments (Kooyman 2000; Renfrew and Bahn 2004).

2.2.3 Instrumental Neutron Activation Analysis

Advantages of this method are that major and minor chemical components of a substance can be identified. This makes it possible for a broad suite of elements within a single sample to be investigated at the same time. Only a small amount of a sample is needed, often less than 0.1g, and if the artifact is small enough, it may be subjected to analysis as a complete object (Kooyman 2000; Renfrew and Bahn 2004).

Disadvantages are that the samples have to be cleaned and secondly, many samples are destroyed in the process of its use (Christensen 1991).

2.3 MANUAL TECHNIQUES

2.3.1 Macroscopic

Macroscopic identification of KRF depends on observation of colour, texture, translucency, lustre, and the possible presence of bedding planes with and without inclusions (Christensen 1991; Ahler 1986; Luedtke 1992; Kooyman 2000). The texture of KRF is generally perceived as a very smooth surface. Should contact with chemicals occur, the surface might become somewhat pitted. Translucency depends on the thickness of the material: the thicker the specimen being examined, the less light is transmitted through the raw material, notably on any feathered edges. Lustre is a subjective parameter and the lustre of KRF is often described as very reflective. Heat-treated KRF, on the other hand, has a waxy feel and becomes darker in appearance (Root 1992). Recently exposed facies have a brighter lustre than older facies. The lustre is affected by duration of exposure to ground water (Christensen 1991; Ahler 1986; Luedtke 1992; Kooyman 2000). Bedding planes, with and without inclusions, are occasionally evident to the naked eye (Root 2002; R. Dawe pers. comm. 2009).

Attempts at consistent reporting of lithic colour have encountered some difficulties. In the following quote, Jarvis (1996:17) demonstrates some of the attention that has been paid to this matter, and shows that no consensus on colour had been reached at the time:

"Hofman, Todd, and Collins (1991) relied on the generalized colour groups suggested by Wain (1965: 37). Luther recommends the Pantone Color System (p.c. September 1992) Robert Christensen recommend the Pantone Color System (Williams et al. 1992: 79). Church (p.c. January 1994) has used generalized, subjective colour categories, while Shockey (1993) used a system designed by AdMark. Hillsman (1992) used a subjective classification scheme based on combinations of green, yellow, orange, brown, red, blue, white, grey, and purple."

2.3.2 Microscopic

Microscopic investigation reveals the colour, texture, translucency, lustre and occasionally bedding plane structure and inclusions within KRF with better definition than macroscopic approaches. A 10x or higher magnification can differentiate between the cryptocrystalline structure of KRF and chalcedonies (Dawe 2008, pers. comm.). Incident light magnification can detect faunal and floral microfossils and frequently bedding planes (Luedtke 1992; Christensen 1991; Ahler 2001). Higher magnification, such as applied in petrographical analysis, shows the fibrous nature of chalcedonies, whereas Knife River Flint has equi-dimensional crystals. The equi-dimensional crystals versus the fibrous structures are usually not resolvable during low power microscopic investigation (Christensen 1991).

2.3.3 UV Shortwave

Munsell charts may be used to identify the colour of mineral specimens under natural or artificial light. As mentioned above this system is somewhat subjective as it depends on the amount and type of light available and whether the sample is wet or dry. Clayton et al. (1970)

reported the following colours for KRF using Munsell Charts: 10YR 2/2, 3/2 and less commonly 10YR 2/3, 2/1, and 1/1. Ahler et al. (1983) found similar results as Clayton et al. (1970) when unpatinated raw samples were held beneath the Munsell chart page. Ahler described his samples as being a more reddish 7.5YR 3/2 and less commonly 7.5YR 4/3, 4/2, 5/2, and 2.5/2. Clayton (1970) reports cortex colours registering as light grey or white: 10YR 7/2, 8/1, 8/2, 9/1, 6/2, 7/3, or 8/3. Ahler et al. (1983) found slightly different results for KRF cortex. His registered as yellowish brown and brownish yellow: 10 YR 5/4, 5/6, 6/6, 7/6, 4/4, 7/8. It is possible that Ahler's et al. specimens were stained from their matrix.

Heat-treatment clearly affects some visual characteristics of KRF. In Ahler's (1983) experiments the interior of heat-treated KRF turned a mottled grey or dark grey. Heat-treating the sample turned the yellow and brown cortex into a uniform red to reddish brown: 2.5YR4/6, 5/6, 3/4, 4/8, 5/4, or 4/4 (Ahler 1983). There is no reported change in the fluorescence of heat-treated KRF when compared to unmodified specimens (Luedtke 1992; Kooyman 2000; Root 2002). However, sometimes the KRF forms white edges and white bedding plane differentiations when heated, as was evident on and identified on R. Dawe's (2008) Royal Alberta Museum (RAM) samples. The white colour is presumably the most altered crystalline structure. Bedding planes became more visible the more over-heating occurred (Root 2002; Christensen 1991).

Root (2002) gives the following Munsell readings for heat-treated KRF in daylight: 10YR 2/1 (black), and silicified cortex: 7.5 YR 6/6 (redder). Silicified cortex produced a reading of 2.5YR 4/6 in laboratory light and cortex reflected at 10YR 7/2 (light grey). Luedtke (1992:95) points out that a smoother surface scatters less light. The lustre of heat-treated Knife River flint increases its reflectivity and likely helps to produce the changes in colour reported between heat-treated and unmodified samples.

Recognizing discrepancies that resulted with the use of natural or artificial light, others have turned to UV light sources. Root (1992) mentions that KRF fluoresces orange when subjected to UV shortwave, but gives no further details. In an inquiry to Dr Root (pers. comm. 2009), he stated "I used a Raytech brand Super Star UV lamp with Blue safety goggles (to remove the visible light UV scatter) and a view box with a matte black interior. LWUV - 3,000-4,000 angstroms, SWUV 2500 angstroms."

Jarvis (1996:17) used two light sources for his fluorescent investigations. One was a Raytech Industries Versalume (PP-FLS 10-020) that emits both shortwave (2537 A) and long wave (3200 to 3650 A) ultraviolet. This unit is inexpensive (a few hundred dollars) and is battery-powered with a handle that doubles as a stand. The other was a larger, stationary, laboratory model (Raytech Model 218) that produces much more light and thus allows samples to be examined more easily.

CH 3: EXPERIMENTAL METHODOLOGY

Four experimental procedures that may accurately identify KRF flakes with an economical methodology are described in this chapter. Sources for reference samples are described and macroscopic, microscopic and UV identification results are presented. Throughout this project flakes were inspected individually rather than as a group, with one exception described below, because single items are harder to classify than groups of mixed materials.

3.1 Reference Samples

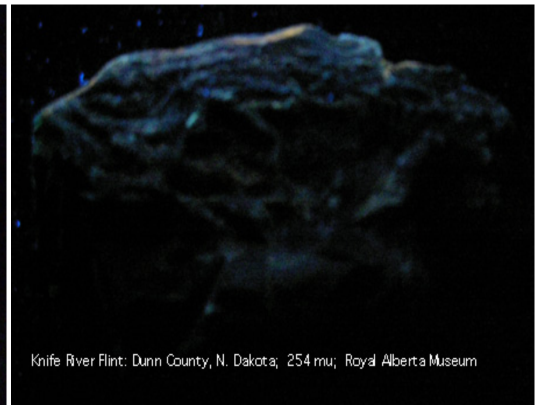
The author collected KRF samples from Dunn County, North Dakota in the fall of 2009. Robert Dawe, at the Royal Albert Museum, permitted access to identified KRF and visually Look-Alike lithic samples for comparison purposes. Freshly chipped flakes, patinated flakes and cobbles, with and without flake scars, were all used in my initial observation of the KRF characteristics.

3.2 Sampling and Methodological Procedure

A short wave UV lamp (described below) was used to irradiate the RAM specimens and an assorted sample of the author's KRF collection. Flakes to be subjected to irradiation were placed individually on a black sateen cloth, which ensured a uniform background surface for comparison purposes. The flakes were inspected individually and then in groups of up to ten specimens. Gloves and glasses are needed to protect the skin and eyes from the ultra-violet radiation. The photographs were taken with an Olympus SP-510UZ 7.4 megapixel camera. The irradiation took place in a darkened room. The following results were obtained:

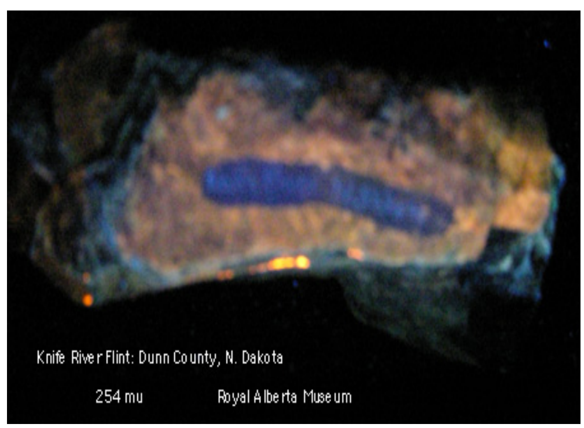
1. Unmodified cobbles, with cortex, fluoresced orange;

Photo 1a and b: KRF Cobble, a) natural light; b) UV illumination



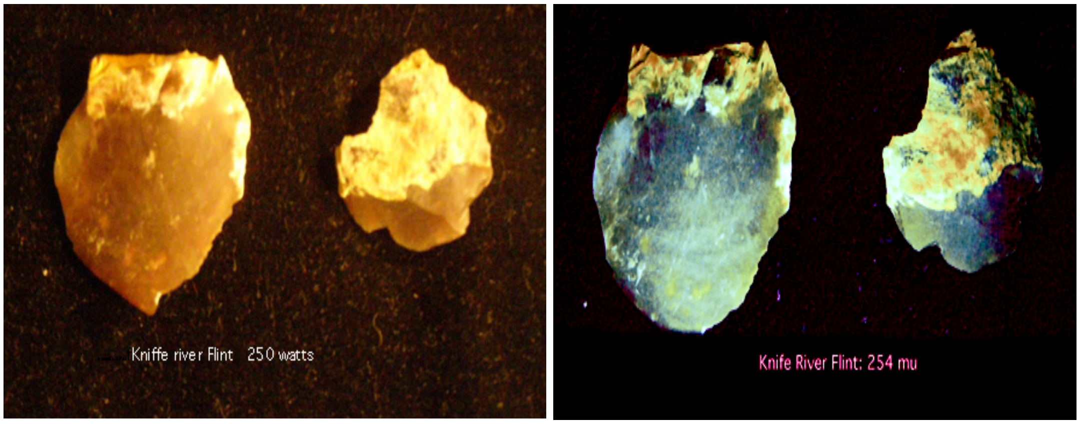
2. Geomechanically and mechanically produced flake scars on cobbles fluoresced yellowish-gray; some lightly patinated surfaces fluoresced in a faint or strong orange;

Photo 2a and b: KRF Cobble Edge, a) natural light; b) UV illumination



3. Freshly chipped flakes reflected a very light yellowish-grey colour;

Photo 3a and b: a) KRF flake natural light; b) UV illumination



4. Heat-treated Knife River Flint had a more waxy feel, had a greater lustre than un-treated specimens and fluoresces white;

5. Chalcedony and Look-Alikes remained black, or nearly non-fluorescent, under ultra-violet light exposure.

Photo 4a and b: a) Alberta L.-A. natural light; b) UV illumination

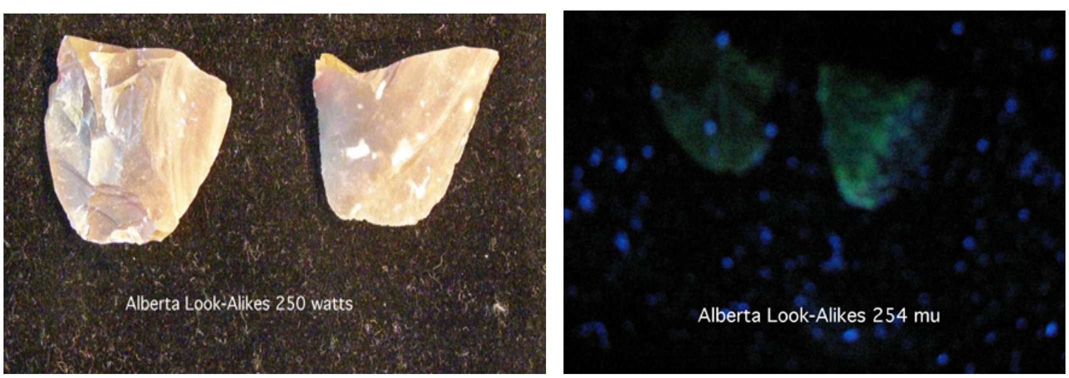


Photo 5a and b: a) Etherington Chert natural light; b)UV illumination

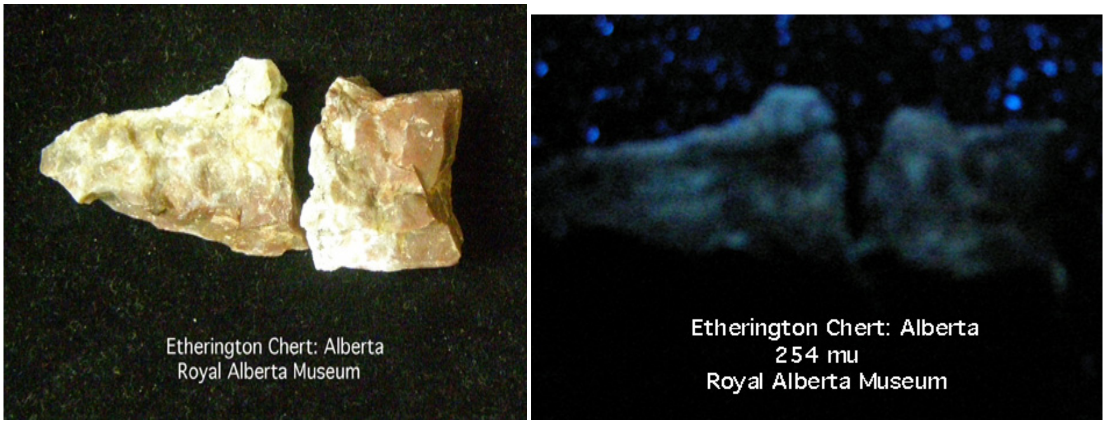


Photo 6a and b: a) Hand Hills Chert natural light; b) UV illumination

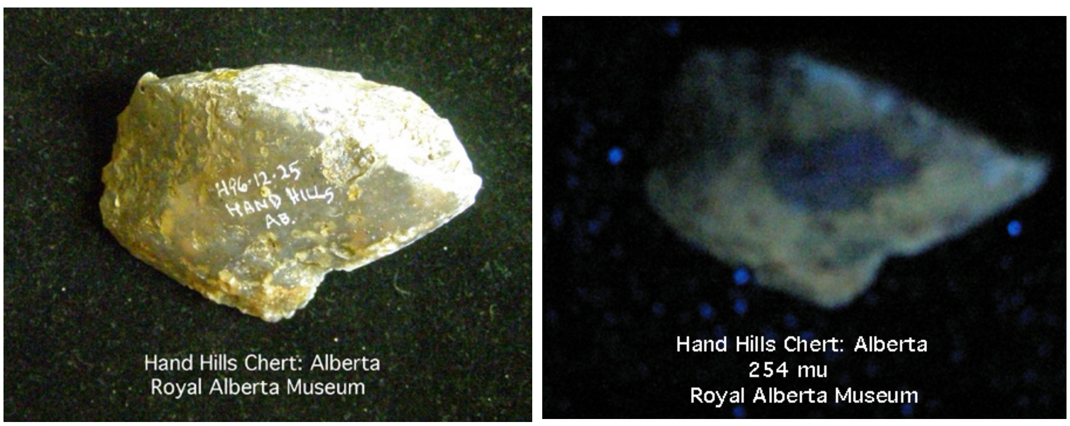
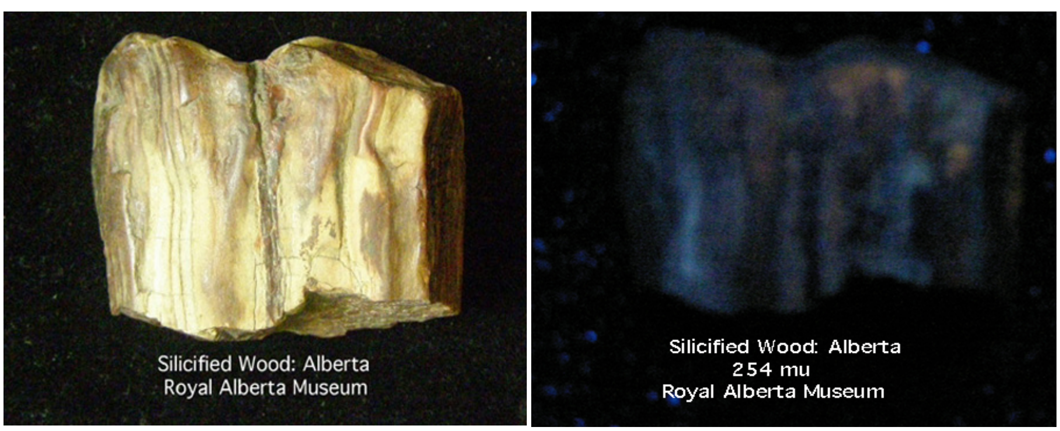


Photo 7a and b: a) Silicified Wood natural light; b) UV illumination



These results substantially reproduce the research of Clayton (1970), Ahler (1982) and Root (2002). The above set of observations was used as a reference for the blind test KRF Identification Experimental Sequences described below. Flakes that consisted only of patination were not included in this experimental study because Howard (2002) previously reported that KRF and Look-Alike patination flakes often fluoresce in the same colour range.

The methodological sequence of the blind test experiment included macroscopic unaided eye inspection, microscopic inspection with a 10x loupe, and irradiation by UV short wave light (254nm). The specific procedures for a blind test of this approach are as follows:

1. Over four hundred KRF flakes, as well as more than 400 Look-Alike flakes were struck and placed into two separately identified containers. One container was labeled 'KRF" and the second container was labeled 'Look-Alikes.' The continuous characteristics for 800 flakes specifically employed are provided in Appendix B and Appendix C.

2. Four sets of one hundred randomly chosen flakes were placed on numbered cards on three separate days. An assistant flipping a coin in a separate room, away from the author, insured a random selection of flakes. If ‘heads’ came up, a KRF flake was placed on the numbered card. If, ‘tails’ came up, a Look-Alike was placed on the numbered card. The coin-flipper recorded the one hundred flake types on a sequentially numbered tally sheet, as determined by the coin toss.

3. The author inspected the flakes individually and sequentially. The flakes were evaluated as either KRF or Look-Alikes, and recorded as such on a separate tally sheet, without returning to any specimen. Four separate identification trials were performed: unaided eye - macroscopic; loupe - microscopic; ultraviolet light irradiation; and all three methods combined. The macroscopic and microscopic runs were completed in natural lighting supplemented by fluorescent illumination, namely a desk lamp. The UV run was conducted in an otherwise completely darkened room. The combined run used natural and desk lamp lighting and a darkened room.

4. The coin flipper's recorded tally sheet was then compared to the author's tally sheet. The coin flipper calculated the accuracy for each identifying methodology.

3.3 Macroscopic Results

The KRF and Look-Alike flakes were inspected for conchoidal fracture evidence including pressure rings, radial fissures, erailleur scars, translucency, bedding planes, inclusions and lustre. If the flake exhibited these traits, it was classified as KRF. Bedding planes and inclusions were rarely evident. Any specimens showing a "grainy" surface were identified as a Look-Alike (L-A). Various lighting angles were employed during this process.

The results, outlined in Figure 3:1, confirmed the 'accepted wisdom' of local archaeological lore that the identification of KRF by unaided eye is at best a fifty-fifty percent chance for correct identification. Fifty-five samples were correctly identified as compared to forty-five incorrect identifications. A greater percentage of the Look-Alikes were correctly identified, than were the KRF flakes. In all likelihood, investigators with better familiarity with the region's lithic types might have a greater success rate. However, it seems likely that a high degree of accurate identification would still be unlikely using macroscopic investigation alone.

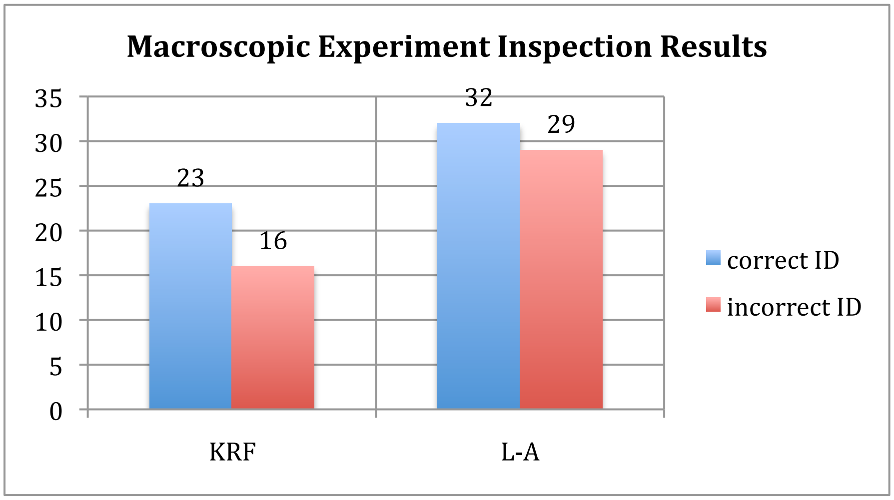


Figure 3:1 Macroscopic Inspection Results

3.4 Microscopic Results

In this experiment, a 10x Doublet loupe was used to scan the flakes. Evidence of dark brown colouration, translucency, pressure rings, eraillure and conchoidal fracture were used as evidence as identifying markers for KRF, as in the previous run. When grains or crystals were seen, the artifact was classified as a Look-Alike. As in the experiment above, various lighting angles were employed.

Employing a loupe resulted in the correct identification of 31 out of 55 KRF samples (Figure 3:2). There was also a small increase in the correct identification of Look-Alikes, with 32 out of 45 being correctly identified. In other words, roughly 2 out of 3 specimens in this experiment were correctly identified using the microscopic approach. This is a significant improvement over the macroscopic approach, which produced a success rate of approximately 50%.

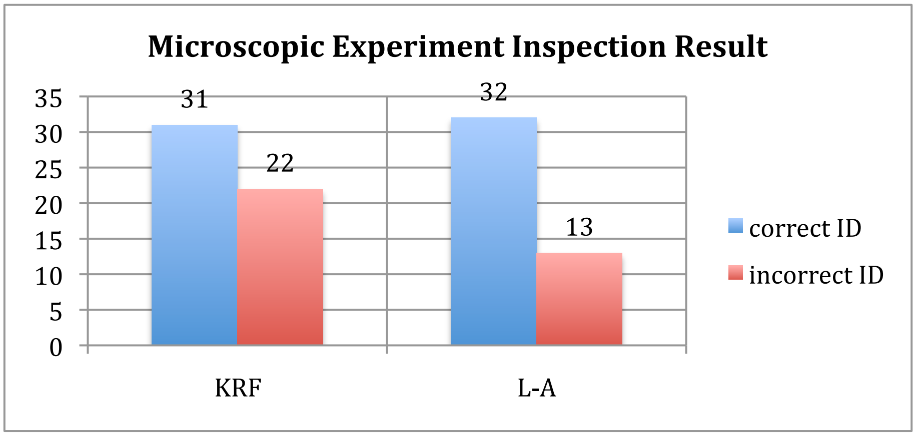


Figure 3:2 Microscopic Inspection Results

3.5 Ultraviolet Light Irradiation

In this experiment, the UV short wave light used was a hand-held 'Mineralight' Shortwave ultra-violet lamp; model UVG-54, 115 v, 60 Hz, 0.18 amps, 254 nm, manufactured by Ultra Violet Products Inc. in San Diego, California. Specimens were identified as KRF when they exhibited the characteristics seen in the KRF samples described in section 3.2 of this chapter.

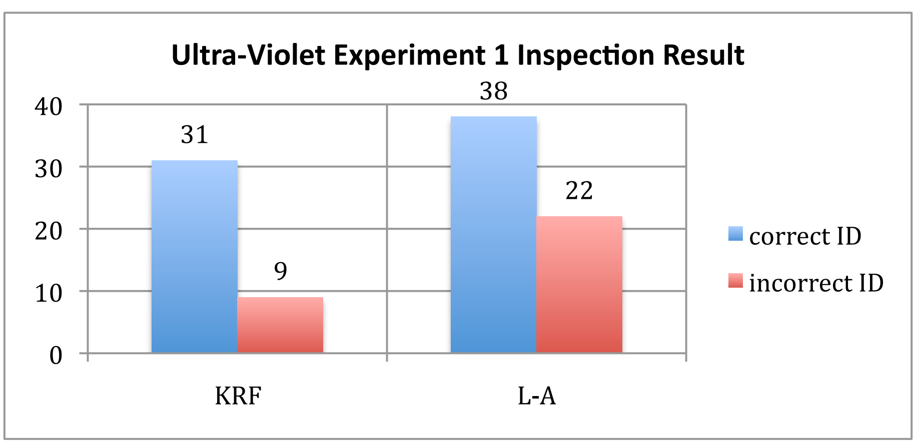


Figure 3:3:1 Ultra-Violet Run No. 1. Inspection Results

Given these rather poor results for the ultraviolet run, and this newly observed difference between the material types, I decided to perform a second run of 100 flakes. The new set was prepared and subjected to the same ultraviolet identification sequence described above.

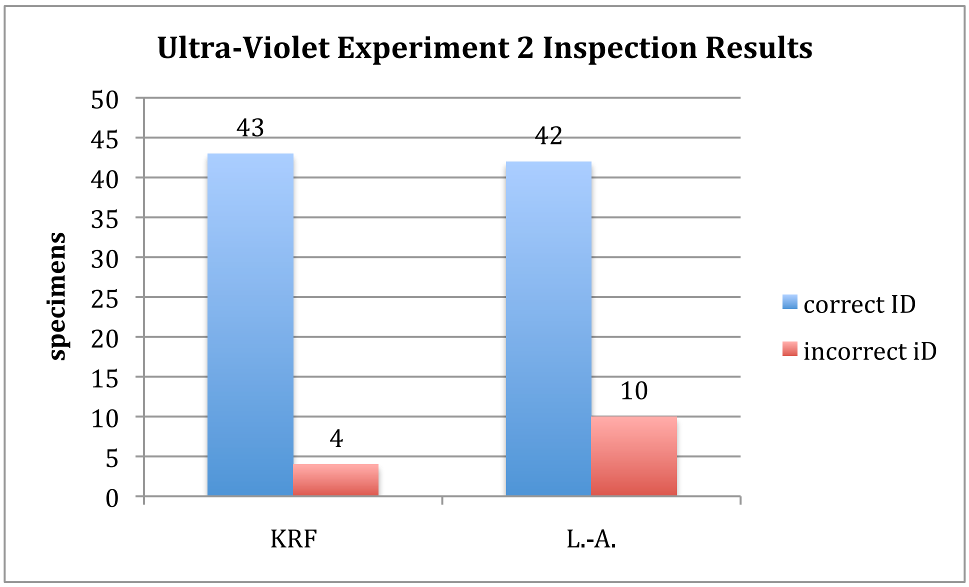


Figure 3:3:2 Ultra-Violet Run No. 2. Inspection Results

In this sequence, successful identification increased significantly, with roughly 85% of the flakes being correctly classified (Figure 3:2:2).

3.6 Macro-, Micro- and UV Inspection Results

The final experimental run consisted of a combination of unaided eye, loupe and ultraviolet irradiation. The samples were visually inspected as in the first and second experimental runs, within a room lit by daylight and a desk lamp. The ultraviolet run then commenced with the room completely darkened. Identification depended on at least two of the three inspection methods being in agreement.

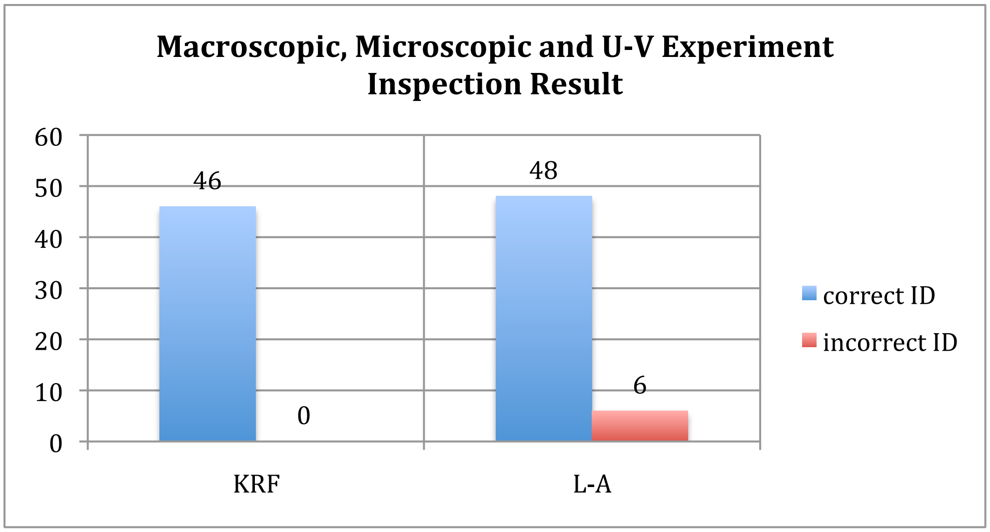


Figure 3:4 Macroscopic, Microscopic and UV Inspection Result

This methodology produced the best overall results, resulting in a 94% success rate for identifying KRF (Figure 3:4). The misidentified specimens (6%) were all Look-Alikes identified incorrectly as KRF.

3.7 SUMMARY

Macroscopic examination is advantageous as a preliminary coarse step in KRF identification. A deep brown colour, conchoidal fracture and translucency in feathered edges gives a preliminary discriminatory classification result. However, the experimental data clearly show that macroscopic identification of KRF is not a reliable method when used in isolation from other approaches. The ratio of correct to incorrect identifications for KRF flakes in my macroscopic run was 3:2. The results for Look-Alikes were less successful, with over half the specimens incorrectly identified. Obviously, macroscopic identification needs to be paired with other procedures to produce results that are significantly better than could achieved merely by random chance.

Microscopic identification showed an improved success rate, with the ratio of correct to incorrect specimens being almost 2:1. This is a substantial improvement over the macroscopic run. The ability to clearly identify bedding planes and inclusions almost certainly allowed this method to produce better results than macroscopic observation alone.

The first ultra-violet irradiation experimental run had unexpectedly poor results: only just over 77% of the KRF flakes were correctly identified and just over 63% of the Look-Alikes were correctly assessed. The results engendered a re-examination of the samples and the cause for this unexpected disparity was seen to be that some Look-Alikes were perilously close to KRF in their fluorescence. This discrepancy was only made clear when the samples were inspected jointly and not separately. This later group re-evaluation of the flakes from the first UV run in groups strongly suggests that such a group evaluation can be a firm KRF identifying technique. The second UV experimental run was more successful, in large part due to recognition of the rather subtle florescence differences between the material types. With this difference taken into account, 85% of the total flakes were correctly identified, a significant improvement over the two previous methods and the first UV trial.

The combined methodology of macroscopic, microscopic and UV irradiation was the most successful in correctly differentiating KRF from the Look-Alikes materials. No KRF flake was incorrectly identified as a Look-Alike. The ratio of correctly to incorrectly identified Look-Alikes was 8:1 and the overall success rate was 94%. While this methodology does imply that some Look-Alikes would be incorrectly identified as KRF, with experience these errors could likely be reduced. I also suspect that the incorrectly identified Look-Alikes would decrease if the samples were inspected as a group. Overall, my experiment demonstrated that combining the microscopic and ultraviolet KRF identification protocols appeared to be the most reliable identification methodology.

CHAPTER 4: TERRESTRIAL ECOZONES OF ALBERTA

Canada has twenty ecozones: fifteen terrestrial and five aquatic (Ricketts et al. 1999). Six zones are present in Alberta: Taiga Shield, Taiga Plains, Boreal Shield, Boreal Pains, Montane and Prairie. The Taiga Plains are limited to Alberta's northwesterly-most corner. The Boreal Shield is to the south of Lake Athabasca on the east and the Taiga Shield is to the north of this lake. These northernmost zones have not yet yielded any Knife River Flint, from stratified sites to date, according to ASA Survey reports. The largest zone is the Boreal Plains, generally north and west of Edmonton. The Parkland subzone forms a buffer between the Montane ecozone in the west and the Boreal Plains in the north and the Prairie to the southeast. The Parkland ecozone extends into Saskatchewan and Manitoba. The Prairie ecozone occupies the east central and southern portions of Alberta. A narrow Montane ecozone is on the southwestern border, between Alberta and British Columbia (Bayrock and Reichem 1980; Wiken 1986; Ricketts et al. 1999; Hitchon 2006). My study focuses on sites found within the Prairie, Parkland, and Montane ecozones. Descriptions of these ecozones are provided below. The focus of this study is the Late Precontact (1,800 BP-250 BP) in south central Alberta. Palaeoenvironmental studies indicate that the modern ecozones were similar to this time period (Beaudoin and Oetelaar 2002).

4.1 MONTANE ECOZONE

Location

The Montane ecozone is the most diverse of Canada's fifteen terrestrial ecozones. The Montane ecozone lies along the eastern slopes of the Rocky Mountains, with a small area extending into east central

British Columbia. The northern section of the Montane ecozone is within Alberta from Banff to Jasper and is adjacent to the Kakwa area of B.C. and Alberta. The southern portion of the Montane ecozone hugs the Continental Divide and drops off to the Plains in the east (Jones et al. 2004; Harris 1987; Ricketts et al. 1999; Hitchon 2008; Bernhardt 2009).

Physical Description

The foothills of the Montane ecozone are mainly linear ridges, but plateaus and broad valleys are also present. Elevations can reach 700 to 1500 m above mean sea level. The Rocky Mountains cover most of the zone. The northern section includes the Columbia Icefields and the eastern flank of the Continental ranges. Unvegetated rocky outcrops are common and wetlands are frequently encountered, as well as icefields, snowfields and remnant glaciers (Strong 1981; Harris 1987; Ricketts et al. 1999; Gadd 1986; Bernhardt 2009).

Surficial deposits include, but are not limited to, dolomitic siltstones, dolomitic limestones, cherty limestones, shales, argillaceous limestones and sandstones. The deposits vary in colour but are predominantly black to grey; pink, purple, and green appear occasionally (Harris 1987; Bayrock et al. 1980).

Climate

Temperature is heavily influenced by altitude: the higher the elevation the cooler the air masses. Mean summer temperatures in the northern zone reach 13°C while 15°C is common in the southern areas. Winter mean temperatures have a wider range: -17.5°C in the north and -10°C in the south. Precipitation varies from 400 to 600 mm annually

(Bernhardt 20009). Permafrost occurs in isolated patches at higher elevations (Gadd 1987; Harris 1987; Phillips 1990; Rickets et al. 1999). Frequent Chinooks, especially on the eastern slopes, moderate winter temperatures. Alberta's southwestern montane zone is wetter than other sections of the Rocky Mountains (Gadd 1987; Harris 1987; Ricketts et al. 1999).

Flora and Fauna

The Alberta/British Columbia Foothills Forests are a transitional ecotone, alternating between boreal and cordilleran vegetation. Variations in seasonal precipitation are the main factor affecting forest composition. Vertical vegetation ecozones are widespread due to a greater temperature gradient as elevation increases (Gadd 1986; Harris 1987; Ricketts et al. 1999).

Lodgepole pine (*Pinus contorta*), quaking aspen (*Populus tremuloides*) and white spruce (*Picea glauca*), with balsam poplar (*P. balsamifera*), paper birch (*Betula papyrifera*) and balsam fir (*Abies balsamifera*) characterize the mixed forests of this ecozone. Aspen and open stands of lodgepole pine occur on drier sites. Black spruce (*P. mariana*) and tamarack (*Larix laricina*) are associated with wet sites (Bernhardt 2009; Ricketts et al. 1999; Gadd 1987; Rowe 1972).

The Montane ecozone exhibits a large diversity of large mammals. Bison (*Bison bison*) were sparsely scattered in the valleys of the eastern slopes during the Late Precontact (Dary 1974). Bighorn sheep (*Ovis canadensis*), elk (*Cervus elaphus*), black-tailed deer (*Odocoileus hemionus*), wolf (*Canis lupus*), grizzly and black bear (*Ursus arctos horribilis* and *U. americanus*), moose (*Alces alces*), caribou (*Rangifer *tarandus*), and mountain goat (*Oreamnos americanus*) also abound. Muskrat (*Ondatra zibethica*), snowshoe hare (*Lepus americanus*), beaver (*Castor canadensis*), wolverine (*Gulo gulo*) are representative of the smaller mammals.

The sandhill crane (*Grus canadensis*), ruffed grouse (*Bonasa umbellus*), spruce grouse (*Dendragapus canadensis*) and various waterfowl are characteristic birds of this ecozone (Gadd 1987; Banfield 1974; Ricketts et al. 1999; Sibley 200, 2003; Bernhardt 2009).

4.2 PRAIRIE ECOZONE

Location

The Prairie ecozone stretches in an arc from the Manitoba-North Dakota border in the east to south-central Alberta in the west where there is a break. Here the grasslands jump the Boreal Plains to re-appear in the northwest in the Peace River catchment area. The Prairie ecozone consists of a mixed grass zone along the western and northern edge. A second section is the tall grass prairie, which is intermediary to the short grass zone to the east and south (Jones et al. 2004; Harris 1987; Ricketts et al. 1999; Bernhardt 2009).

Physical Description

The topography here is varied due to the Pleistocene (Wisconsin) glaciation and a mainly dry seasonal climate. Potholes, rolling hills, plains, gullies, ravines and sand hills are dotted throughout the ecozone. Lithic formations consist of silty clays, silty shales, sandstones, ironstone concretionary beds, coal beds, mudstones, bentonitic beds, carbonaceous shale, and thin chert-pebble conglomerate or pebble beds with marine admixtures ((Harris 1987; Strong 1981; Ricketts et al. 1999; Carter Johnson et al. 2005; Hitchon 2006).

Climate

The mean annual temperature here is approximately 3°C. The mean summer temperature is 15.5°C, and winter temperature -10°C. The Prairie ecozone is a grassland ecoclimate with conditions of semiarid moisture conditions. Mean annual precipitation ranges from 325-450 mm. Severe droughts of various lengths commonly occur here as well (Harris 1987; Phillips 1990; Canada 2000; Ricketts et al. 1999; Carter Johnson et al. 2005).

Flora and Fauna

Grasses found here are grama (*Bouteloua gracilis*), little bluestem (*Schizachrium scoparium*), needle-and-thread (*Stipa comata*), wheatgrass (*Agropyron smithii*), sedges (*Carex ssp.),* junegrass (*Koelaria ssp.*), fescue (*Festuca diffusa*), spea (*Poa secunda)* and sweetgrass (*Hierochchloe hirta*). Willow (*Salix spp.),* scrubby aspen - cottonwood *(Populus ssp.)* are found scattered mainly in depressions and river valleys. Larkspur (*Delphinium sp*.), death camas (*Zigadenus elegans*), and wild lupine (*Lupinus sp*.) are found only in the Cypress Hills uplands (Jones et al. 2004; Strong 1981; Ricketts 1999; Bernhardt 2009).

Bison have recently re-appeared as ranch herds (Darby 1975) and were in all likelihood the predominant species here in the Late Precontact (Wormington 1965; Vickers 1986). Other species include black-tailed and white-tailed deer (*Odocoileus hemionus* and *O. virginianus*), pronghorn antelope (*Antilocapra americana*), coyote (*Canis latrans*), short-horned lizard (*Phrynosoma douglassi*), western rattlesnake (*Crotalus viridis*), rabbit (*Sylvilagus sp.*), bobcat (*Lynx rufus*), cougar (*Felis concolor*), and western rattlesnake (*Crotalus viridis*).

Representative birds are the burrowing owl *(Athene cunicularia),* chickadees (*Poecile atricapilla* and *Poecile hudsonica*), ferruginous hawk (*Buteo regalis*), sage grouse (*Centrocercus urophasianus),* Swainson's hawk (*Buteo swainsoni*), and the golden eagle (*Aquila chrysaetos*). Songbirds are seasonal visitors (Bernhardt 2009; Jones et al. 2004; Sibley 2001, 2003; Ricketts et al. 1999; Harris 1987; Strong 1981; Banfiefd 1974).

4.3 PARKLAND ECOZONE

Location

The Boreal Plains ecozone is the largest ecozone in Alberta and covers almost two-thirds of the Province. The Parkland subzone forms a transitional region of mixed aspen forest and grasslands between the Boreal Forest to the north and the Prairie to the south. The Parkland subzone has moved to the north or to the south depending on the climatological conditions over time (Ricketts et al. 1999; Beaudoin and Oetelaar 2002).

Physical Description

Pleistocene glaciation effectively flattened the surface of what is now the Boreal Plains. Numerous dunes, lakes and marshes were formed following the Wisconsin glaciation. Nearly all of the major waterways originate in the Rockies and cut northeastwards across the ecozone. Low lying plains include the Slave River Lowlands and Peace River Lowlands.

Upland zones consist of the Mid-boreal Uplands and the Western Alberta Uplands. Poorly drained fens and marshlands abound, with peat land covering up to fifty percent of the surface. The zone is mainly an undulating sandy plain. Regosols and gleysols are common in the delta areas. The rivers slope down to the northeast from the southwest into the Slave River Lowlands. Sand dunes and moraines are scattered throughout the area. Lacustrine formations, gleyey tills, fine-textured tills and sandy glacio-fluvial deposits encroach the river and lake embankments. Shales are found in thin outcrops. Elevation ranges from 300 m to over 800 m. The Uplands form large unconnected plateaus and have radial drainage. Rare patches of permafrost appear in the northern areas (Hitchon 2006; Ricketts et al. 1999; Harris 1987; Bayrock et al. 1980).

Climate

The Rocky Mountains in the west influence the climate of the Boreal Plains. Pacific moisture is blocked and warm Chinook winds form erratically. Summers are short and warm whereas winters are cold and long. The mean annual temperature ranges from 0.5°C to 2.5°C. The mean summer temperature ranges from 13°C to 16°C; and the mean winter temperature ranges from -14.5°C to -12.5°C. Mean annual precipitation ranges from 375 mm to just under 700 mm (Harris 1987; Ricketts et al. 1999; Strong 1981).

Flora and Fauna

Forest cover consists of quaking aspen, balsam poplar, white spruce, balsam fir, jack pine (*Pinus banksiana*), tamarack (*Larix laricina*), sedges (*Carex spp.*), willows (*Salix spp.*), white spruce (*Picea glauca*) and black spruce (Ricketts et al. 1999; Farrar 1999; Castner 1981; Wilkinson 1990; Royer et al. 2007; Bernhardt 2009).

Mammals include bison, plains grizzly, lynx (*Lynx ssp.*), muskrat (*Ondatra zibethica*), moose, white-tailed deer, black bear, wolf, beaver, coyote, marten (*Martes americana*), mink (*Mustela vison*), red fox (*Vulpes vulpes*), snowshoe hare (*Lepus americanus*), northern pocket gopher (*Thomomys talpoides*) and Franklin's ground squirrel (*Citellus franklinii*) (Ricketts et al. 1999; Farrar 1999; Castner 1981; Wilkinson 1990; Royer et al. 2007; Bernhardt 2009).

This ecozone includes extensive waterfowl breeding habitats. Birds include sharp-tailed grouse (*Tympahuchus phasianellus*), ruffed grouse (*Bonasa umbellus),* black-billed magpie (*Pica pica*), cormorant (*Phalacrocorax spp.*), gull (*Larus spp.*), tern (*Sterna spp.*), American white pelican (*Pelecanus*)*,* sandhill crane, red tailed hawk (*Buteo jamaicensis*), grey jay (*Perisoreus canadensis*), and many migrant bird species such as snow geese (*Chen caerulescens)* (Banfield 1974; Rickets et al. 1999; Harris 1987; Hichon 2006; Sibley 2001, 2003; Bernhardt 2009).

4.4 SUMMARY

Elevations range from 2700 m to 300 m above mean sea level in the three ecozones of this study tending from the south west to the north east. The Prairie and the Parkland ecozones are largely gently rolling hills and plains. The Montane ecozone displays large regions of bedrock exposed on cliffs and terraces, whereas bedrock outcrops in the Prairie and Parkland ecozones are relatively rare. In the latter two regions the surficial geology consist mainly of glacial gravel and fluvial deposits.

The climate is mildest in the Montane ecozones and most severe in the Prairie ecozone. In the summer droughts are frequent and occur at irregular intervals and may last a few years to a decade or more. The Montane and Prairie ecozone have warming winds, the Chinooks, during the winter.

Vegetation cover can be sparse in any one spot in the three regions depending on the drainage and amount of precipitation. Aspens, and birch provide an overstory in the Parkland ecozone and in the Prairies coulees, sloughs and riverbanks are covered by these species. Willows and rose bushes are the predominant understory in the Prairie and Parkland ecozones; in addition to these species there are alder species in the Montane ecozone. Long and short grasses in the Prairie and Parkland ecozones provide ground cover, whereas mountain species occur in the Montane ecozone.

Large mammals are found in all three ecozones, notably bison, deer, moose and elk. Smaller mammals are more varied throughout the ecozone, and most varied in the parkland ecozone. Migratory avian species follow the flyways in the eastern and central areas of the Prairie and Parkland ecozones (Sibley 2001, 2003).

CHAPTER 5: CULTURE HISTORY OF THE NORTHERN PLAINS

The culture history of Alberta's Northern Plains is reviewed in this chapter in order to give context to the studies and conclusions reached in the following chapters. The Late Precontact Period is described in more detail as this time interval is the focus of my investigations.

Humans have been living in Alberta since the Early Holocene (Wormington and Forbis 1965; Vickers 1986; Brink 2008). The vast span of human habitation of the northern Plains has been divided into three periods based on cultural changes: Early Precontact, Middle Precontact and Late Precontact. Projectile point typology is applied to identify these three main Precontact divisions (Wormington and Forbis 1965; Vickers 1986; Frison 1998; Brink 2008). Ceramic typology is an additional cultural indicator of the Late Precontact Period. Given the focus of this thesis on chipped stone technology and particularly KRF flake identification, projectile point types and material selection are highlighted in the descriptions.

5.1 Early Precontact Period: 12,000 to 7,500 BP

The sites from the Early Precontact Period typically have large projectile points, generally referred to as spear points. Clovis, Folsom, Agate Basin, Hellgap, Alberta, Scottsbluff and Eden projectile points are recognized as diagnostic projectile points from this period (Humphries 1999; Peck and Hudecek-Cuffe 2005). The length of these projectile points varies from 20 mm to over 200 mm. Seasonal camps, bison kill and butchering sites and a few burials from this period have been excavated. Knife River Flint is especially evident in assemblages that include Alberta and Eden points, with the latter being the longest projectile points

(Vickers 1986). Eden projectile points are particularly finely chipped and are nearly always manufactured from KRF (Wormington and Forbis 1966; Byrne 1973; Vickers 1986; Humphries 1999; Brink 2008).

5.2 Middle Precontact Period: 7,500 to 1,800 BP

The Middle Precontact Period has smaller projectile points than those from the Early Precontact Period. This trend in size reduction continues into the Late Precontact Period. Oxbow, McKean, Duncan, Hanna, Pelican Lake and Besant projectile points are diagnostic of this time period. These projectile points typically vary from 45 mm to 150 mm. A variety of un-notched, notched and stemmed styles are represented (Fromhold 1972; Byrne 1973; Vickers 1986; Frison 1998; Humphries 1999; Brink 2008).

On the Northern Plains, the Besant Phase, identified by its eponymous projectile point, ranges from ca. 2,200 to 1,500 BP. It is sometimes considered a transitional phase between the Middle Precontact and the Late Precontact periods (Walde et al. 1995; Walde 2006; Brink 2008). KRF is a dominant raw material for Besant projectile points (Varkasis 2006). The Oxbow, McKean, Duncan, and Hanna diagnostic projectile points are generally lanceolate to triangular in form with side-notches near the base. The Oxbow projectile point is generally a short triangular shape with a concave base (Vickers 1986, 1994; Varkasis 2006). The size of the points is considered to be indicative of atlatl and dart point weaponry (Schwimmer 1998; Kooyman 2000; Peck and Hudecek-Cuffe 2005).

5.2.1 Besant Phase: ca. 2,000 to 1,250 BP

Wettlaufer (1955) first defined the Besant Phase at the Mortlach Site in Saskatchewan. Kooyman (2000:14) notes that Besant/Sonota points were "generally between 3 and 8 cm in length." Reeves (1983) considers Besant points to be of variable workmanship, but does mention that some show much skill application. The atlatl and dart was the primary weaponry used during this phase. Some points from this period are of KRF, and Varkasis' (2006) thesis on the use of KRF in the Besant Phase is a valuable summary for this material at that time.

The Later Besant Phase was originally thought to be aceramic, but subsequent research has shown this to be incorrect. Some ceramics are indeed present during this period and appear to be similar to the Plains Woodland types (found to the east) suggesting some degree of interaction and exchange occurred between the regions (Vickers 1986; Walde and Meyer 2003). This pottery has a cord-roughened exterior, is conical, has a coarse grit temper, and is rarely otherwise decorated. Other decoration consist of punctuates and bosses near the upper portions of vessels. The Besant Phase may or may not have been ancestral to the Avonlea phase; it may have been a coeval phase (Vickers 1986; Walde and Meyer 2003; Peck and Hudecek-Cuffe 2005).

5.3 Late Precontact Period: ca.1,800 to 250 BP

Wormington and Forbis (1965) see the Late Precontact Period on the Northern Plains as bracketed between 1,800 BP and 250 BP. Diagnostic projectile points include Avonlea, Plains side-notched and Prairie side-notched projectile points and their variants. These projectile points vary from approximately 20 mm to approximately 40 mm in length

(Humphries 1999). In Alberta the Late Precontact Period has been divided into the Avonlea, the Old Women's Early Variant, Old Women's Late Variant and the intrusive One Gun or Cluny Phases; all of these Phases overlap to some extent (Wormington and Forbis 1965; Byrne 1973; Reeves 1983; Vickers 1986; Walde et al. 1995; Tischer 2000; Peck and Hudecek-Cuffe 2003; Walde and Meyer 2003).

5.3.1 Avonlea Phase: ca. 1,800 to 1,200 BP

Avonlea lithic tool kit assemblages' defining characteristics are small projectile points and split pebble technology, using locally available lithic materials, in particular Black Pebble Chert (Reeves 1970; Davis 1988). Reeves (1970) theorized that this diminution in projectile points was direct evidence of the introduction of bow and arrow technology onto the Northern Plains, as did Vickers (1994) and Walde et al. (1995). Un-notched triangular projectile points are also characteristic of Avonlea times, and also appear in the Old Women's Phase (Milne 1988). The ceramic vessels of the Avonlea Phase are usually conoid or 'coconut' shaped. The exterior is generally smooth, net-impressed, or has parallel grooved with punctuates on the rim. Knife River Flint projectile points are present in small numbers (Byrne 1973; Vickers 1994; Landals et al. 2004; Meyer and Walde 2009).

5.3.2 Old Women's Phase: ca. 1,200 to 250 BP

The Old Women's Phase in Alberta encompasses ca. 1,200 BP to 250 BP (Meyer 1988; Walde et al 1995; Young 2006; Brink 2008). Old Women's Phase sites are most commonly situated on grassland, but some are found within the southern fringe of the Boreal Plain, within the

Parkland ecozone (Meyer and Epp 1990; Ricketts et al. 1999). Old Women's Phase peoples were skilled in communal bison hunting techniques involving pounds, jumps, and sand or snow traps. New technologies included the bow and arrow and Avonlea, Plains and Prairie projectile points types. For example, variations of these types include Samantha, Timber Ridge and Triangular points (Reeves 1978; 1990; Peck and Ives 2001; Peck and Hudecek-Cuffe 2005).

Unfreed and Van Dyke (2005: 15-16) point out that there has been no strict definition of "Old Women's Phase" in the literature. The phrase has come to include all datable sites between 1,200 BP to 250 BP, between the Avonlea and the Later Late Precontact and Historic periods. Unfreed and Van Dyke (2005:23) take the position that the Old Women's Phase is a varied way of life "that was consistent with those that came before it, regardless of its cultural affiliation".

Prairie side-notched and Plains side-notched projectile points dominate lithic assemblages in the Old Women's Phase. The Prairie side-notched points are characteristically thin, have little finishing and the side-notches are not standardized. The side-notches are large and the base is usually convex (Fromhold 1972; Meyer 1988; Peck 1996; Humphries 1999; Peck and Ives 2001). Plains Side-notched points are well made with fine flaking, but thinner than Prairie side-notched projectile points and more uniform. Well-defined side notches on these points are parallel to the base (Reeves 1983). Both projectile point types vary between 15 mm to 30 mm in length. Split pebble bipolar reduction technology predominated in stone tool manufacturing of scrapers, drills and other tools (Reeves 1983; Humphries 1999).

The Old Women's Phase diagnostic projectile points have been further divided into 'Prairie Side-notched', 1,200 BP to 700 BP and 'Plains Side-notched', 700 BP to 250 BP (Kehoe 1966). Peck, (1996), using discrete and continuous attributes, classifies 'Late Side-notched' points as Cayley Series points and 'Mortlach Group' points. Early Cayley (1,250 BP to 650 BP) are found in Saskatchewan and Alberta, while Late Cayley (650 to 250 BP) points are found only in the western portions of Alberta. The Mortlach Group is found in Saskatchewan and appears after 650 BP (Peck 1966; Peck and Ives 2001).

A. B. Kehoe (1959) was the first to categorize the ceramics of the Northern Plains and suggested the term "Ethridge" for the styles south of the North Saskatchewan River ranging into north central Montana. "Wascana" ware ranges from roughly the same time period and is mainly confined to Saskatchewan drainage basin. Byrnes (1973) introduced the term "Saskatchewan Basin Complex" for the same regional types, with an Early and a Late Variant, along with the intrusive One Gun and Cluny complex. The One Gun and Cluny Complex Phases are limited to the Late Precontact and continue into the Protohistoric (450-250 BP) period.

Manufacturing techniques involved paddle and anvil procedures. Vessel interiors show anvil impressions, while exteriors vary with cord-roughened, paddled, and textile impressions. Decorative motifs, mainly on lips, necks and shoulders, include punctates, incised lines, as well as finger and nail pinching marks (A. B. Kehoe 1959; Byrne 1973; Walde et al. 1995).

Byrne (1973) defines the Cluny and the One-Gun ceramic phase in his study and believes the two terms are synonymous. Also, he proposes that the Cluny Phase is an intrusion from the south. The Later Late

Precontact One Gun Phase is named for a respected Sitsika (Blackfoot) Elder and Historian who maintained that there is more than one 'Cluny' type village in this south central Alberta Region, none of which have yet been identified. Forbis (1977), who studied the Cluny Fortified Village, concludes that the intrusion most likely came from the Middle Missouri, at approximately 250 BP (1,700-1,750 AD). The Middle Mississippian travelers could have taken a route through the KRF source region. Taylor (1969) was the first to note that there was a lack of KRF 'waste flakes' from this time period in Southern Alberta. Taylor did not define 'waste flake' but it is clear this term did not refer to tools.

CHAPTER 6: SITE DESCRIPTIONS

Excavation reports preceding the Alberta Historic Resources Act of 1973 have certain shortcomings. Excavation reports and artifacts from university and museum campaigns from this era are mostly not available for analysis due to misplaced assemblages or uncurated collections. The ASA reports from 1973 to the mid 1980s often lack artifact catalogues. Furthermore, the early reports are scanty on artifact descriptions, provenience information, and other parameters that are considered standard requirements for archaeological reports today. Later reports include the descriptions and designation of site type, culture history, palaeo-environment, palaeo-climate, flora and fauna territorial ranges, as well as relative and radiocarbon dating for the sites being investigated.

Knife River Flint morphological and distribution descriptions in the ASA reports are dependent on the correct identification of material type in these original reports. In my reading of ASA reports, some investigators acknowledge some level of doubt about material type identification. For example, when in doubt as to the artifacts' material being KRF, the investigators most frequently describe the raw material as chalcedony. Reports abound with descriptions of 'chalcedony, brown', 'chalcedony, brown, translucent', or again ' chalcedony, brown KRF?' Collector bias is evident in the reports in that some KRF was observed on the surface, some collected others not collected, and more importantly, not ascribed to any artifact category or culture history period. In addition, sampling strategies are dependent on pre-selected developmental areas such as pipeline concessions and access corridors – site boundaries often extend beyond the project area, resulting in very selective sampling. Beck et al. (1989) cautions that site analyses must consider the following factors:

a) Heavy machinery use: limits micro-debitage recovery

b) Shovel testing is often shallow and limited in many sites

c) Observed, but uncollected Knife River Flint artifacts and debitage is recorded

d) Sites are mostly unsieved

e) Screens mesh sizes are often 1/4 inch (~6mm) or larger

f) Geographical bias: many investigations and surveys occur in developmental areas, which are themselves distributed unevenly across the landscape

g) Some investigated sites remain unreported or archived by the Survey or the Museum

h) Limited amount of detailed assemblage descriptions

These limitations were taken into account when considering the artifacts available for this study. However, for my purposes, wrongly identified KRF is possibly the most problematical issue, but also potentially the most resolvable of those described above.

6.1 Site Selection Criteria

Site descriptions used in this study range from the earliest ASA reports in 1973, to the latest additions, up to and including 2010. The ASA archives a series of Site Reports, Final Reports and a Site Database. The RAM archives the various site assemblages including any available artifact catalogues pertaining to the sites. These resources are the basis of my KRF distribution and morphological investigations in the three southern Alberta ecozones (Figures 6:1 and 6:2) during the Late Precontact period.

The ASA provided a list of sites in which KRF was present and a topographical map showing the sites' location. A second map placed the sites in Alberta's ecozones. The first step in limiting the site list that included a total of 182 sites to a more manageable proportion was to eliminate KRF sites that were identified as:

a) Isolated surface finds; these artifacts can rarely be placed into a space-time context with any accuracy.

b) Surface collections in private hands. My inspection of private donations of lithics to the Royal Alberta Museum (many of which are only available as photographs) determined that these collections consist exclusively of projectile points and other tools with practically no provenience other than legal land descriptions. Thus, little in the way of space and time context for these objects is available.

c) Surface collections in museums. Many of these collections are private donations to the RAM and the same parameters apply to them as described for the items above.

d) Materials noted but not collected. Noted lithic and faunal material was inspected ‘on-the-spot’ and therefore not subjected to any further analysis. The lithic material therefore is only provisionally categorized. Ceramics may give a Late Precontact period context, but a more specific time-space assignation would be desirable.

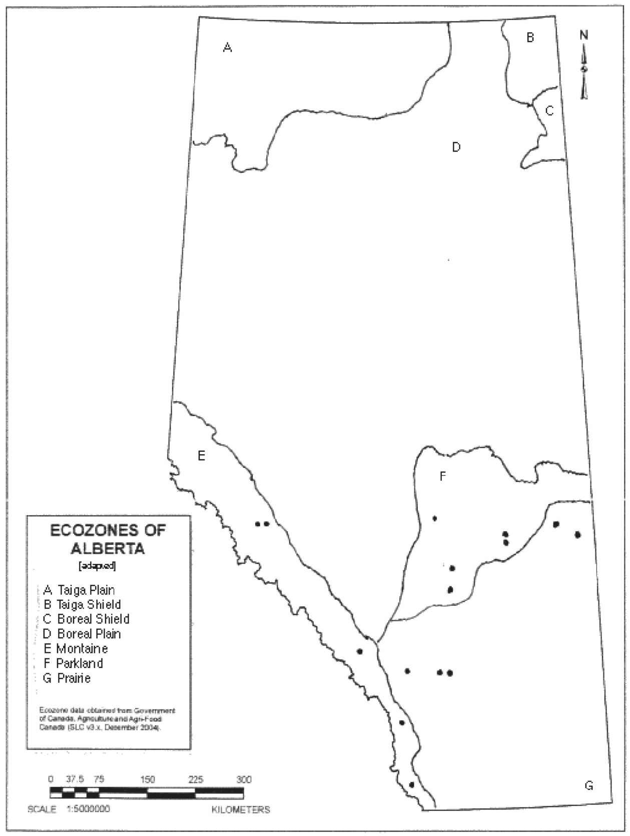


Figure 6:1 Alberta Ecozones

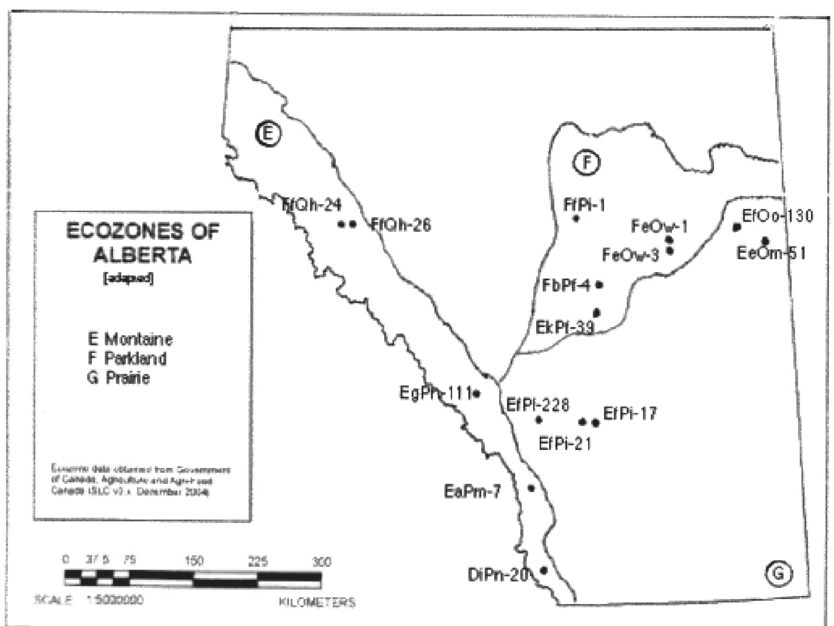


Figure 6:2 Southern Alberta Ecozones with the Sites Investigated for this study

e) Plow zone recoveries only. Plow zone depth is generally considered to be 10-15 cm. Plowing generally scatters any artifacts over a wider area each time the plow crosses a site. This considerably confuses any cultural and temporal context.

f) Site Reports mentioning KRF from sub-surface contexts thus were the main set from which my study sites were selected. Following this, Report summaries were used to find sites that contained KRF and that had relative dating or radiocarbon dating for assemblages. However, even within this subset, some sites eventually proved not to meet the above outlined selection criteria. For example, the Reports may have had misleading dating, or may have had inaccurate KRF identification. These sites are indicated below.

The sites deemed to fit the parameters of this study were then categorized within the remaining ecozones, including 19 total sites from the Montane zone, with 10 being suitable for analysis; 42 total sites from the Prairie ecozone, with 11 being suitable for analysis; and finally, 27 total sites from the Parkland ecozone, with 10 being suitable for analysis. Five sites from each of the three ecozones were selected using a random number generator (Randon.org 2008) and these 15 total sites formed the final database for my thesis. Figure 6:1 summarizes the total number of KRF sites in each Ecozone said to contain KRF, and the number of these sites meeting the above-mentioned criteria.

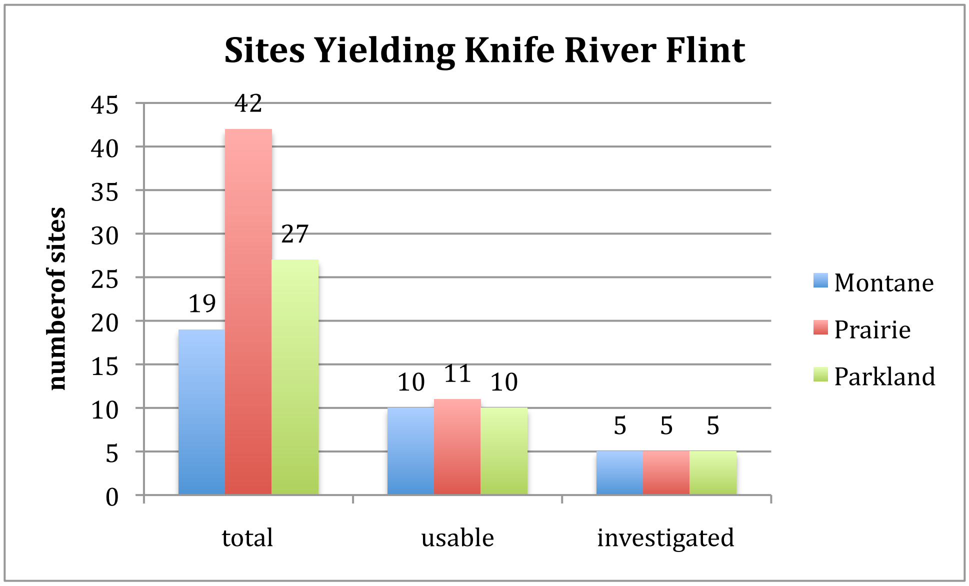


Figure 6.3 KRF sites in Montane, Prairie and Parkland ecozones

6.2 Analytical Methodology

The potential Late Precontact Period KRF assemblages were identified based on the typological assessments of pottery and projectile points as well as radiocarbon dates where available, as provided by the original investigators. Projectile point typology (Forbis 1962; Burley 1985; Head 1985; Byrne 1973; Meyer 1988; Peck and Hudecek-Cuffe 2003; Walde et al. 1995; Wormington and Forbis 1965; Humphries 1999) was accepted as designated in the ASA Reports. This provided a cultural historical outline for placing projectile points into a time continuum. The ceramic typology used is that of the original site investigators and as based on Byrne (1973) and as modified by Walde and Meyer (2003).

Sullivan and Rozens' (1985) tripartite flake typology as well as Andrefsky's (1994, 2001a, 2001b) and Kooyman's (2000) categories were used to analyze and describe the flake morphology. For each site listed below, I provide information on the setting, the chronology of occupation, the total number of lithics recovered, and the number of these objects identified as being of KRF. I begin with sites in the Mountain ecozone, and then describe those in the Prairie and Parkland ecozones. Three of my chosen sites eventually proved to have no artifacts available for re-assessment. Circumstances conspired to have some artifacts misplaced, lost, out for analysis, and some have never been submitted to the Royal Alberta Museum.

6.3 MONTANE ECOZONE SITES

DiPn-20: campsite and kill site

The site is located on a broad terrace on the north side of Beaver Mines Creek (Figure 6:3). It is located immediately north of a valve site (Head 2002; Turney et al. 2003). Geologically, the site is within the Rocky Mountain Foothills and is a Cordilleran physiographic subdivision of the Porcupine Hills Formation. The bedrock is folded and faulted and generally slopes to the east and northeast. Surficial geology is the result of glaciation and its several retreats and advances. Glacial tills are found in lower areas and colluviums on the higher slopes. Kames and kame terraces are frequent (Bayrock and Reichen 1980; Gadd 1986; Turney et al. 2003). The site was probably flooded several times by a small tributary to the Beaver Mines Creek, thus laying down sediments that preserved the cultural material and some stratigraphy (Turney et al. 2003).

Most archaeological materials were found in the plow zone. Eight shovel tests were excavated and resulted in cultural material being found *in situ* (Head 2002) consisting of various lithic types (Appendix Figure 18). This was a follow-up upon the discovery of KRF artifacts on the surface, in association with an unidentified bone (Head 2002). All shovel tests yielded archaeological material, but no further KRF artifacts were recovered. Later, Turney and Head (2003) excavated 37 square meters at the site. Diagnostic artifacts included one Hanna and one Pelican Lake (Appendix Figures 18, 19, 20) projectile point. Two occupation periods were evident, one from the Middle Precontact Period and one from the Late Precontact Period on the surface and in the plow-zone. No radiocarbon dates are available. This site is included since KRF was initially identified although follow-up excavations failed to recover other KRF samples. I was able to examine the recovered lithic artifacts extracted by Head (2002) and Turney and Head (2003) from this site.

EaPm-7: scatter and campsite

The site faces south on a small terrace on the upper Trout Creek drainage basin. It is on a pro-glacial terrace or bench at the head of Honey Coulee (Bayrock and Reichen 1980). The site spans 40 m on a north-south axis and 30 m on an east-west axis (Vivian et al. 2006). Recovered artifacts include fire-cracked rock, faunal remains and debitage. Eight shovel tests were excavated and two produced archaeological materials (Ronaghan 1987). A further six 1 m x 1 m units were excavated, all of which yielded cultural materials.

Diagnostics projectile points consist of a Hanna, a Pelican Lake, a Kootenay and an Avonlea projectile point. Exotic lithic material was identified as obsidian, KRF, Swan River Chert and Helena chert. Three KRF artifacts were recorded; one is a wedge and the other two are retouched flakes (Vivian et al. 2006). No radiocarbon dates are available. I was able to examine the artifacts recovered from this site.

EgPn-111: campsite, scatter, stone feature and kill site

This site was misidentified in the ASA records as EgPm-111 rather than EgPn-111. The site is on an upper valley edge south of the Elbow River. It is located on the down slope of the valley edge and is situated above the EgPn-108 bison kill site. Bedrock geology consists of horizontal sedimentary rock beds. Limestones, sandstones and shales predominate. Surficial geology reflects a glacial history of ice contact lacustrine sand and silt deposits (Bayrock and Reichen 1980; Head 1989; Head et al. 2002).

Quigg et al. (1974) collected no artifacts during their survey of the site of 1974. Quigg et al's. report (1974) is unavailable, but is quoted by Van Dyke (1980). Eight shovel tests were conducted by Head (1989a) who described the site as 'significant' and recommended additional excavation due to diagnostic Besant projectile points being present. Knife River Flint artifacts excavated included partial and complete projectile points, a core and some debitage. Diagnostic artifacts recovered were one Pelican Lake and one Samantha projectile point (Head et al. 2000).

Laboratory #	Uncalibrated age BP at two sigma
BETA 127231	1480 +/- 70
BETA 127232	1410 +/- 60
BETA 127233	1370 +/- 60

Table 6:1 Radiocarbon Dates: EgPn-111

Head et al. (2000) argue that the three radiocarbon dates (Table 6:2) indicated that this was a single event site. Faunal assemblage analysis by Head et al. (2002) established a fall occupation. The Final

Report suggests that the site should be assigned to the Besant phase, towards the end of the Middle Precontact, though later occupations could not be ruled out (Head et al. 2002). I was able to assess the 171 lithic flakes from this site. No flakes or tools were identified as KRF and were described as KRF in the reports but were listed as chalcedony in the catalog.

FfQh-24: scatter and campsite

This campsite is located on a twenty-meter bench or terrace that overlooks Harris Creek and is 200 m upstream of its confluence with the MacLeod River. The terrace consists of fine non-glacial sediment, probably overlying coarser alluvium (Bayrock and Reichen 1980). Some of the stratigraphy is compressed: 11,000 years is represented in only 30 cm of soil profile.

Landals et al. (1995) excavated 26 shovel tests, which revealed a distinct buried palaeosol. Cultural material was recovered from above and below this palaeosol. Landals et al. assigned the lower cultural material to the Early Precontact Period. Meyer (et al. 2007) classified the site as an Aeolian conflated site. Diagnostic projectile points present range from the Cody Complex of the Early Precontact, including some KRF projectile specimens, to the McKean Phase of the Middle Precontact (Meyer et al. 2007). Later occupations, however, cannot be ruled out. No radiocarbon dates are available. Site FfQh-24 yielded 113 flakes from all excavations and I examined all of these items.

FfQh-26: campsite

The campsite is on a 'knob' on a twenty-meter bench overlooking the Harris Creek-McLeod River confluence (Meyer et al. 2007). Fine colluvial deposits underlie soils, which may cover coarser colluviums (Bayrock et al. 1980). Landals et al. (1995) excavated four shovel tests which yielded 55 lithic artifacts, some of which were recorded as chalcedony.

Diagnostic artifacts recovered represent a time span from Early Precontact Period to Late Precontact occupations. There is no stratification present (Meyer et al. 2007). Knife River Flint artifacts (N=376) are mostly associated with an Early Precontact Clovis and Cody Complex occupations. Five Middle Precontact points were recovered. One Middle large dart point or a Late Precontact large arrow projectile point is present (Meyer et al. 2007). Meyer et al. (2007) speculated that Knife River Flint acquisition is thought to be by direct access since the population density would be low in this time frame.

One uncorrected radiocarbon date of 3,050 +/-50 BP (BETA 213458) was established from a charcoal sample. The sample was associated with the site's lowest level. The dates suggest a Mummy Cave Phase occupation, during the Middle Precontact (Meyer et al. 1995). The lithic assemblage was available for re-assessment.

6.4 PRAIRIE ECOZONE SITES

EeOm-51: stone feature

The southern portion of the site is on a small bluff overlooking the South Saskatchewan River. The northern portion is on an alluvial terrace on the east side of the river (Bayrock and Reichen 1980). An alluvial fan or terrace forms the east side of the site. Native prairie covers the surface (Green et al. 2000).

Green et al. (2000) excavated six shovel tests, of which three yielded cultural material, including bone fragments and a buried stone ring, while a further two shovel tests yielded fire cracked rock. Stage 1-mitigation excavations, spanning 11 square meters, uncovered two or possibly three components (Green et al. 2000, 2001). The upper and lower components had no diagnostic artifacts. The middle component included a buried stone circle. Twenty square meters were examined as part of Stage 2 Mitigation (Kozakavich 2001). Kozakavich (2001) combines Permits ASA 00-179 and ASA 01-53 and the latter Permit has yielded a catalogue.

Diagnostic artifacts from the middle component include two KRF Besant projectile points and one Avonlea projectile point (Green et al. 2000). Stage 2-mitigation excavations recovered one Besant and one brown chalcedony Avonlea projectile point, as well as eight chert triangular points and one chert non-diagnostic point tip. Debitage included 15 chalcedony flakes consisting of one primary decortification flake, one secondary decortification flake, eight secondary flakes, one tertiary flake, three flake fragments and one piece of shatter. One non-diagnostic side-notched projectile point fragment is manufactured from KRF. Twelve diagnostic projectile points were recovered from the lower levels in the excavation. Five finished chalcedony tools found included four projectile points and one biface. This lowermost assemblage is less than one percent of the total lithics recovered (Green et al. 2000; Kozakavich 2001).

No radiocarbon dates are available. I investigated the lithic assembly consisting of 2711 flakes, extracted by Green et al. (2000) and Kozakavich (2001.

EfOo-130: campsite, stone feature and workshop

This site is on a terrace on the south side of the Red Deer River on a level bench. The surficial geology is hummocky moraines of glacial till, commonly called pot-and-kettle country (Bayrock and Reichen 1980; Hudecek 1988). Two seasonal drainage ditches are on the northeast and the southwest of the site (Clark 2000; Tisher et al. 2006).

Investigations have been extensive: Reeves (1976, 1977), Adams (1975), Hudacek (1988) and Tischer et al. (2006) all conducted projects at the site. Five of six reports are available, with ASA 99-35 being the lone absentee. The site consists of tipi rings, adjoining work places and other living areas.

The site is dated to the Late Avonlea-Early Old Women's Phase based on diagnostic projectile points, 18 ceramic shards, split pebble technology and four radiocarbon dates (Reeves 1976, 1983; Hudecek 1988; Tisher 2006). Clarke (et al. 2000) obtained four radiocarbon dates Table 6:3) that places the site firmly within the Late Precontact Avonlea Period to Old Women's Phase.

Laboratory #	Uncalibrated age BP at two sigma
BETA 141284	1190 +/- 40 BP
BETA 141285	1160 +/- 40 BP
BETA 141286	1350 +/- 120 BP
BETA 141287	1040 +/- 70 BP

Table 6:2 Radiocarbon Dates: EfOo-130

Diagnostic projectile points include Avonlea, Triangular, Timber Ridge Side-notched, and Plains- and Prairie Side-notched specimens. A small number of KRF artifacts are present within a lithic assemblage of mainly local lithic materials (Reeves 1976). Ten chalcedony debitage artifacts are listed in the catalogue as well as 14 KRF flakes. One KRF end scraper was recovered (Reeves 1976). All stages of tool production debitage are present. Tisher assigns the pottery shards to the Avonlea Phase. None of the site remained when last revisited in 2006 (Tisher et al. 2006). The debitage assemblage was available for inspection.

EfPi-17: campsite

Site EfPi-17 is a multi-component, stratified site (Hanna 2000, 2002b). This site is situated on a bluff overlooking the Bow River. Alluvial deposits of coarse and fine lacustrine deposits formed the terraces. The surficial geography is hummocky (Shetson 1990).

Three cultural components were distinguished by a 15cm or more separation of sterile soils (Hanna 2000, 2002b). Four shovel tests and cut-bank examination disclosed two distinct components, with the possibility of additional deeper components. The upper component contained fire cracked rock, debitage and a few bone fragments. The lower component has a similar composition (Hanna 2000, 2002b). One side/end scraper was listed as KRF. The west block upper component had one complete flake and one scraper assigned to chalcedony. One KRF Scottsbluff and one KRF Eden point represent the Early Precontact. One Pelican Lake and four Avonlea points represent the Middle Precontact. Four small side-notched point fragments suggest a Late Precontact occupation. The fragments are not large enough for definitive cultural assignment. Three shards were also recovered. These ceramics are considered to be consistent with an Avonlea occupation (Hanna 2000, 2002b).

A single calibrated radiocarbon assay gave an uncalibrated date of 3,120 +/-40 BP (BETA157613). The investigators suggest that this date is too recent for the Cody Complex and Pelican Lake materials found in association with the dated ungulate long bone. This bone was located just above a gravel bed at ~45 cm below surface (Hanna 2000, 2002b).
I inspected the lithic assemblage retrieved by Hanna (2000, 2002b).

EfPi-21: campsite

The site is on a terrace overlooking the Bow River on the northeast side of the Bow River valley. The surficial geography consists of "lacustrine deposits, coarse and fine fractions, draped massive stagnation moraines, hummocky land between 3-15 meters in elevation, and ice thrust moraine deposits" (Shetson 1987[online map]).

Hanna (2000, 2000b) considered this site to be the remaining portion of a larger campsite. The site has Highway 24 to the east and has a gravel quarry on the other three sides producing is a steep cut-bank on the north, west and east margins. These exposures exhibit 50 cm of sandy silt over gravel deposits. Several pieces of debitage and fire broken rock were embedded in the road-cut; rodent castings have bared more. Four shovel test pits produced artifacts (Hanna 2000, 2000b). Undisturbed cultural stratigraphy was evident under a shallow plow zone and the majority of the cultural material was in these undisturbed deposits (Hanna 2000a). Two palaeosols yielding artifacts were discerned. The first occupation yielded a large side-notched point, possibly an Early

Precontact Period Mummy Cave Complex specimen (Hanna 2000a). The upper occupation may consist of two compressed cultural layers (Hanna 2000, 2002b). Two KRF formed tools and one projectile point base were recovered. No radiocarbon dates are available. The debitage assemblav ge was available for re-assessment.

EfPl-228: scatter

The site is on a terrace on the northeast side of the Bow River valley. The terrace slopes towards the river. Fine floodplain alluvial gravels probably overlie coarser gravels (Ramsey 2004, 2005; Bayrock and Reichen 1980).

Oetelaar and Gillespie (2001) identified EfPi-228 as a multi-component site. Ramsey (2004, 2005) concurs in this analysis. A 'low density' occupation is present starting below the tillage zone. Ramsey (2005) proposes that there may be two occupations conflated in an upper palaeosol.

Artifacts recovered included a large number of debitage, consisting mainly of quartzite and siltstone bifacial reduction flakes. The first occupation, found below a Mazama ash layer and dated to 7,700 BP (Zdanowicz et al. 1999), yielded a large side-notched point, a possibly an Early Precontact KRF Mummy Cave Complex specimen. Two non-diagnostic side-notched projectile point fragments were also recovered. The Middle Precontact is represented by one Oxbow and one possible Avonlea point. One Prairie and one Plains side-notched projectile point, typologically consistent with the Late Precontact Old Women's Phase also were excavated. A total of three KRF artifacts are catalogued (Ramsay 2004, 2005) including one KRF projectile point fragment and two pieces of debitage. Three non-diagnostic pottery shards also were excavated (Ramsay 2004, 2005).

Measured radiocarbon dating gave a result of 1,830 +/- 40 BP (BETA 215590) from a bone. The date falls within the Besant Phase in the later Middle Precontact. However, the radiocarbon dates suggest a Besant occupation post-dating the ash layer. I inspected the lithic assemblages collected by all of the various investigators.

6.5 PARKLAND ECOZONE SITES

EkPf-39: scatter, campsite and workshop

The site is situated on flat to hummocky coarse lacustrine deposits consisting of coarse fluvial gravel and silt deposits, some of which have been reshaped by wind. The result is a set of rolling hills (Beaton 2006; Shetson 1990). The site has indeterminate boundaries due to a trail or road, a water pipeline and a fence-line cutting through and bordering the area.

This site is a 'lithic workshop with a campsite component' (Beaton 2006) and is part of a cluster of six sites. Twenty-one shovel tests out of forty-one yielded cultural material. Site stratigraphy suggests the presence of multiple components, but no diagnostic artifacts were recovered. One hundred artifacts were recovered and six of these were expedient and possibly unfinished tools. One KRF artifact was characterized as a piece of 'non-orientable debris' (Beaton 2006). No radiocarbon dates are available. I examined the lithic assemblage from this site.

FbPf-4: scatter and campsite

The site is on a sandy ridge approximately five kilometers south of Erskine on the east side of a gravel road. The site is an accumulation of fine and coarse floodplain gravels (Shetson 1990). The site spans 10 m on an east-west and 30 m on a north-south axis.

The site is badly disturbed. The site spans approximately Light (2010) screened the matrix from 30 square meters through a 6 mm mesh. Head (1989b) screened (6 mm mesh) the matrix from five shovel tests. All recovered cultural material was in the disturbed, upper, tilled stratum of the site. Artifacts were concentrated in one area of approximately 30 square meters, and a thin scatter of artifacts covered the remainder of the tilled field (Head 1989b). Head (1989b) recovered one KRF end scraper from the surface. One Middle Precontact Pelican Lake projectile point and one possible Late Precontact point were recovered by (Head 1989b). Head (1988b) provides a catalogue, but unfortunately the artifacts have not been curated, therefore there are no artifacts for analysis. No radiocarbon dates are available. My assessment of the lithic assemblage from this site involved only the lithics recovered by Head 1989b) as presented in his catalogue as no artifacts were available for examination.

FdOt-9: campsite

This site is on an outwash terrace below a hilltop overlooking Hardisty Lake (McCullough and Fedirchuk 1987). The surface geology consists of coarse sediment intermixed with fine sand, silt and clay. The conglomerate may be the result of a thrust moraine (Shetson 1990).

Quigg (1977) recovered on a total of 725 lithics of which 518 were flakes (71% of the total assemblage). One KRF flake was identified (0.01% of the total assemblage). One Plains side-notched brown chert projectile point was catalogued. Quigg also listed 23 brown chalcedony artifacts, of which 11 were flakes.

McCullough and Fedirchuk (1987) placed the site as within the Parkland ecozone, at the Battle River Crossing. Two possible components were hypothesized. They retrieved 85 artifacts of which 65 were from the surface. Eighteen artifacts were lithics (21.1% of the total assemblage), including 15 flakes (83.3% of the lithic assemblage). They identified one KRF flake (5.5% of the total). McCullough and Fedirchuk speculate that this site represents a Bitterroot culture campsite, a variation of the Besant late Middle Precontact.

Stuart (1988) excavated 1020 artifacts. A total of 1014 lithics were collected (40.9% of the total assemblage) of which 417 were flakes (40% of the total assemblage). Sixteen identified KRF artifacts were retrieved from a sub-surface context. Fifteen KRF flakes were identified. One KRF scraper was retrieved from Level 1. No radiocarbon dates are available. My lithic assessment encompassed all the recovered lithics by McCullough and Landals (1987).

FeOs-37: campsite

The site has coarse sand and gravel substrates mixed with finer sand, silt and clay (Shetson 1990), and is located on a sand dune. Wind ablation has destroyed much of the stratigraphy (McCullough and Landals 94). A single McKean projectile point base was the only diagnostic item found and was recovered from the surface (McCullough and Landals 1995). McCullough and Landals identified no KRF artifacts.

Kulle and Landals (1995) sank 23 shovel tests of which three proved positive for cultural material. The matrix was screened by means of a set of 6 mm and 3 mm meshes. A total of 68 cultural items were recovered of which 64 were debitage (94.1% of the assemblage) including 41 flakes (60.2% of the assemblage). Three brown chalcedony flakes were indicated in Kulle and Landals' catalog. Kulle and Landals (1996) identified one partial Pelican Lake KRF projectile point.

Wondrosek et al. (2000) recovered 122 lithic specimens (97.1% of the total assemblage) employing a 3 mm screen during field recovery. Flakes constituted 110 specimens (98.2% of the total assemblage). No KRF was specified in the catalogue; brown chalcedony was specified as a lithic raw material identification. No radiocarbon dates are reported. I re-assessed the lithic assemblages excavated by both sets of investigators from this site.

FfPi-1

FfPi-1 (the Fullerton site) abuts a sand quarry in a rolling prairie. The surficial geology consists of fine and coarse till (Shetson 1990). The site is on a late glacial lakebed with lacustrine deposits reworked into sand dunes (Gillespie 2003). This site is on a sloping surface, and wind erosion has compressed the surface archaeological deposits (Gibson 1987). This sand hill (dune) site has been cut by development, which has truncated the site. Neither the 1964 nor the 1966 reports concerning this site are available. Taylor (1969) continued to investigate this site and provides a précis of the earlier research. The site has a compressed stratigraphy, which makes cultural and temporal sequencing problematical.

Seven levels were excavated, in arbitrary intervals of 10 cm and were termed levels A to G (Taylor 1969). Level A is reported to span 1,000 BP to the present. Pottery shards (N=24) and one diagnostic Late Precontact Period Avonlea projectile point date some use of the site to the Late Precontact Old Women's Phase. However, this upper level is disturbed and may represent more than one broad period of occupation. Taylor also recovered a KRF Scottsbluff, an Alberta, a Prairie side-notched and a Plains side-notched projectile point from Level F.

Excavation by Gibson (1987) produced one non-KRF Avonlea projectile point from Level A, which is a disturbed zone that may have held screened sand from earlier excavations. Deeper excavations proved to hold cultural materials, though none were temporally diagnostic. Gillespie (2003) drilled ten auger holes to a depth of 2 m, using a bucket auger. The auger matrix was screened with a 1/4-inch (6 mm) mesh. Auger Hole #1 produced an Oxbow projectile point in its upper section. Some sub-samples were screened with a 2 mm mesh nested in a 500-mu sieve. Gillespie (2003) determined that the Fullerton site is multi-component, but did not specify any cultural contexts.

Taylor (1969) cites an uncalibrated radiocarbon date 1,230 +/- 130 BP (GSC 641 NMC98) based on bone fragments recovered from a hearth in Level 2. Roots reaching this level may have contaminated the bone sample. The radiocarbon date firmly places the occupation in the Late Precontact period. Unfortunately none of the lithic assemblages excavated from this site were available for re-assessment.

CHAPTER 7: KRF ASSESSMENT RESULTS

This chapter presents the results of my re-assessments of the KRF flakes, shatter and tools excavated from the sites mentioned in chapter. All available lithic material from the RAM collections of the selected sites was inspected for KRF artifacts. Methodology followed the protocol described in Chapter 3 using the combined macro- , micro-inspection and UV illumination in artificial light and a darkened room as needed. The results of my analyses of the identified KRF artifacts from the selected sites are given below. Results are presented by site and begin with those located in the Montane, followed by the Prairie and lastly the Parkland ecozone. Projectile point typology and ceramic assignments mentioned in this paper are based on the identification by the site investigators and by the RAM staff. The following lithic terminology as used in this paper is based on definitions Rozen and Sullivan (1985), Andrefsky (2001, 2004), Root (2004) Odell (2003) and Kooyman (2000). Specific definitions are as follows:

Flake: has a point of impact or platform and a bulb of percussion, with or without percussion rings and exhibits feathering

Primary flake: cortex covers the entire dorsal surface

Secondary flake: cortex covers up to 50% of the dorsal surface

Tertiary flake: small flakes lacking any cortex with any number of dorsal flake scars

Split flake: is a flake that is broken longitudinally on it long axis, thus one margin is missing

Medial flake fragment: a flake with unbroken margins but not having proximal and distal features

Flake fragment distal: no platform or bulb of percussion

Flake fragment proximal: flake with bulb of percussion, but lacking point tip

Retouched flake: any intentional modification of a lithic artifact

Shatter: irregularly shaped lithic, on which no dorsal or ventral surfaces can be discerned, and which lack any flake characteristics

Cortex: the skin or patination on lithics

Core: a piece of lithic material from which other pieces have been struck for purposes of obtaining a flake for further shaping

7.1 MONTANE ECOZONE SITES

DiPn-20

Head's 2002 excavations at this site produced ninety-two lithic pieces (no tools were present). Turney and Head's (2003) excavations yielded 42 lithic tools (9.6% of the total) from a total of 258 lithic items. Forty-three percent of the total lithics are from below the plow-zone. Turney and Head (2003) identified KRF as a raw material for some of the artifacts at the site, but all cherts were lumped under 'chalcedonies' in the final reports. Turney and Head's identification of nine flakes as chalcedony is in my assessment correct. Four of their chalcedony flakes were incorrectly identified, as my assessment identified them as KRF. Two flakes from the plow-zone were initially identified as chalcedony, but were identified as KRF in my analysis. One KRF tool, a wedge, was recovered and my analysis agreed with the raw material assessment.

cat #	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	# dfs	notes
151	1			√	13.8	12.8	2.5	0.6	4	lat. edge damage
170	1			√	11.1	8.8	1.9	0.1	5	distal flake fragment,
135	4			√	28.3	18.7	4.4	1.7	7	flake
157	5			√	29.7	15.4	2.6	1.8	4	flake

Table 7:1 DiPn-20: Knife River Flint artifacts from DiPn-20
(dfs - dorsal face scars; cat # - catalogue number; primary – primary flake; secondary - secondary flake; tertiary - tertiary flake)

The split flake and whole flakes, #s 151and 157, (Table 7:1), both have a minimum of four dorsal face scars. The flake fragment, #170, exhibits five dorsal flake scars. Flake #135 has seven dorsal flake scars. The large number of flake scars suggests that these latter three pieces were produced during maintenance, reshaping, or resharpening activities.

EaPm-7

The total lithic assemblage consisted of 94 pieces, all from the later two technological reduction stages. Twenty-nine stone tools (30.8% of the total assemblage) were identified in this assemblage, including seven lithic artifacts that were identified as KRF (7.4% of the total). Four diagnostic projectile points (4.2% of the total assemblage) were recovered, including diagnostic Middle Precontact points (Vivian et al. 2006). The artifacts from this site were not available for assessment. The metrics here were derived from the artifact catalogue at the Royal Alberta Museum.

cat #	level	primary	secondary	tertiary	length mm	width mm	mm	weight g	# dfs	notes
104	20-30BS			√	8.5	13.8	2.1	0.3	n/a	retouched flake
137	surface		√		30.1	30.1	4.6	3.5	n/a	retouched flake

Table 7:2 Knife River Flint artifacts from EaPm-7

One KRF flake, #137, (Table 7:2) is from the surface. Its size, 30 mm long by 30 mm wide, implies its production during a primary or secondary reduction stage. The right and left lateral pressure flaking scars are evidence that it was struck from a piece that was being reworked. The other KRF flake (#104) was judged to be from the later states of reduction. The KRF wedge was recovered from Level 2 (Vivian et al. 2006).

EgPn-111

The site yielded a lithic assemblage of 453 artifacts. Debitage totaled 357 pieces (78.8% of the total assemblage) and 96 tools (21.1% of the total) were also identified, of which 34 (7.5% of the total assemblage) were projectile points or point fragments, including seven (1.9%) of KRF. One KRF core fragment and one KRF flake were also recovered (Head et al. 2000).

I was able to assess the 171 lithic flakes from this site. No flakes were identified as KRF in the site catalogue and my assessment agreed with this. The flake identified by the investigators as KRF appears to have been misidentified; my assessment determined it was not KRF, but rather a brown chert Look-Alike. Projectile points and point fragments were, in my assessment, correctly identified as KRF. Diagnostic projectile points suggest that the site was occupied between the Middle Precontact Period and the Late Precontact Period. The KRF core, correctly identified, does suggest that some tool fashioning transpired. One diagnostic point suggests a Late Precontact Period Old Women's Phase occupation. However, all the correctly identified KRF proved to be from a Middle Precontact context and are not included in my summaries below.

FfQh-24

Landals et al. (1995) excavated 14 lithic artifacts from this site. A further 170 lithic artifacts were retrieved by Meyer et al. (2007), for a total of 184 lithic artifacts of which 174 (94.5% of the total assemblage) were debitage, and 3 (1.7% of the total assemblage) consisted of KRF.

I assessed the debitage and noted that two of the KRF flakes were correctly identified and one misidentified. For those that were assessed as KRF, flake #30 (Table 7:3) has 4 dorsal flake scars and the flake fragment, #95, exhibits 3 dorsal flake scars.

cat #	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	# dfs	notes
30	2		√		12.1	10.0	1.8	0.2	4	flake
95	2		√		12.3	12.6	1.6	0.3	3	flake fragment

Table 7:3 Knife River Flint artifacts from FfQh-24

Both are secondary flakes and show some cortex. In addition, flake fragment #95 has a high number of dorsal face scars suggesting that resharpening may have been taking place at this site. Both flakes are from a context (Early Precontact) that precluded them being further included in my analyses.

FfQh-26

Landals et al. (1995) excavated 55 lithic pieces. The single KRF artifact present was a heavily patinated Scottsbluff point that came from the surface. Meyer et al. (2007) recovered 6857 lithic artifacts of which 5373 are debitage (78.3% of the total assemblage). Stone tools and cores (N=160+) and thirteen diagnostic projectile points were identified. KRF flakes (N=376) constituted 5% of the total assemblage. Meyer et al. (2007) placed nearly all the KRF debitage in an Early Precontact context. Two secondary flakes and two flake fragments are from the surface and thus display no convincing temporal assignation. Table 7:4 tabulates the KRF flakes from the Late Precontact context at this site. All the KRF flakes from this Late Precontact context proved to be correctly identified by the initial investigators.

KRF flakes are most frequently found in Level 2 (Table 7:4). Level 2 has two flakes with two dorsal flake scars: #2298a, a flake fragment, and complete flake #2383c. Flake #2277 has three dorsal flake scars and a ground platform. Flake (#2382a) from Level 2 also exhibits three dorsal flake scars. Four dorsal flake scars are present on distal flake fragment #1410; aswell as on #2278, a flake with a ground platform; and on #2288, a split flake fragment. Five dorsal flake scars are present on #2289b and six dorsal flake scars are found on #2382b. Level 3 has two notching flakes, #1946 and #1428a. One flake #1968, from Level 3, has as many as nine dorsal face scars. Finally a patinated KRF Scottsbluff projectile point was recovered from the surface and recorded as KRF by Landals et al. (1995) and was confirmed by my re-assessment.

cat #	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	# dfs	notes
1410	2			√	10.9	14.9	2.6	3.0	4	step frac. distal
2277	2			√	9.1	6.8	1.3	0.0	3	ground platform
2278	2			√	10.3	12.6	1.8	0.2	4	ground platform
2288	2			√	11.2	9.4	1.0	1.0	4	medial lateral frag.
2289a	2			√	9.5	8.3	1.0	0.1	2	flake fragment
2289b	2			√	7.0	11.2	1.4	0.1	5	flake
2382a	2			√	16.4	8.9	1.5	0.2	3	flake
2382b	2			√	11.8	10.4	1.6	0.1	6	flake
2382c	2			√	10.2	7.2	1.0	0.1	2	flake
1496	3			√	7.5	7.7	0.6	0.0	n/a	notching flake
1913	3			√	7.2	7.8	1.3	0.1	3	flake fragment
1968	3			√	18.7	18.4	2.6	0.8	9	step frac. centre
1999	3			√	9.1	11.6	1.6	0.2	6	medial fragment
1428a	3			√	8.6	8.6	1.2	0.0	n/a	notching flake
1428b	3			√	10.2	6.2	1.4	0.0	n/a	lost

Table 7:4 Knife River Flint artifacts from FfQh-26
frac. -fracture

The high number of dorsal flake scars on the KRF artifacts suggests that tool resharpening and maintenance was occurring. The notching flakes from Level 3 suggest that notching was being performed at this site. The small amount of KRF debitage (5% of the total assemblage) in this assemblage is consistent with the small quantity of this raw material excavated from similar sites in the Prairie ecozone. The excavators propose a Late Precontact occupation. One small Late Middle Precontact dart point or Early Late Precontact large projectile point is the basis for this conjecture. The radiocarbon dates (Chapter 6) suggest occupation(s) from the Middle Precontact to the Late Precontact. Clearly though, the lack of stratification at the site and the clear evidence for earlier dating materials makes it impossible to give a precise assignment to time period of the items described here.

7.2 PRAIRIE ECOZONE SITES

EeOm-51

A total of 2,762 lithics were recovered, (19.5% of the total artifact assemblage). Debitage comprises 2711 pieces (98.1% of the total lithic assemblage).

cat #	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	# dfs	notes
1584	5			√	14.8	18.2	2.9	0.6	3	4 scars on platform
7486	5			√	5.4	6.7	0.7	0.0	1	fine screening, flake
7532	5		√		10.0	15.0	6.1	0.8	n/a	fine screening, shatter
7619	5		√		9.7	9.5	3.9	0.4	4	fine screening, flake
13818	5			√	n/a	11.6	4.6	0.6	7	medial flake
12932	6		√		10.6	8.4	2.8	0.2	3	flake, step frac. on plat.

Table 7:5 Knife River Flint artifacts from EeOm-51

Thirty-eight tools (1.3% of the total lithic assemblage) and 13 cores (0.4% of the total lithic assemblage) were recovered. Nineteen artifacts were recorded as chalcedony flakes, (< 1% of the total) were recovered.

Six of these artifacts proved to be KRF on my re-assessment. Thirteen are chalcedony, or Look-Alikes, though there was no attempt by the investigators to differentiate the chalcedony into lithic categories.

Level 5 matrix material underwent screening (1/4” mesh [6 mm]) producing one secondary KRF flake #7619 (Table 7:5) with four dorsal flake scars, one tertiary proximal flake fragment (#7619) having one dorsal flake scar and one piece of KRF shatter(#7532). One tertiary KRF flake, #1584, has three dorsal flake scars and one tertiary flake (#13818) has seven dorsal flake scars. Level 6 has one KRF secondary flake (#12932) with 3 dorsal flake scars.

Three occupations are present in this assemblage, based on diagnostic projectile points. One Oxbow projectile point was recovered from Level 6, as well as one possible Besant point basal fragment. One KRF Avonlea projectile point was retrieved from Level 5 along with one KRF non-diagnostic projectile point base. Level 7 produced one KRF Prairie side-notched projectile point with one shoulder missing. This typological inversion suggests that the levels and the materials in them cannot be taken as discrete cultural historical/temporal units. Eight Triangular projectile points were recovered, four from levels 5 and four from level 6 (Kozakavich 2000, 2001). Clearly, the KRF Besant projectile point indicates a Middle Precontact Period date and some use of KRF at that time. The KRF Avonlea projectile point dates to the Late Middle Precontact Period or Early Late Precontact Period. One KRF Prairie side-notched projectile point is evidence of a Late Precontact occupation at this site. The secondary and tertiary KRF flakes, all from the deeper levels, suggest that maintenance or manufacturing processes were taking place at this site.

EfOo-130

Reeves (1976) reported one KRF end-scraper. Adams (1976) mentions the presence of some KRF debitage at this site as well. Hudacek (1988) lists four end-scrapers, one distal point tip, one retouched utilized flake, one piece of shatter and 14 retouched/reused flakes for a total of 21 KRF artifacts. The 21 artifacts represent 0.08% of the total lithic collection. Clarke (et al. 2000) provides a catalogue of 10,444 artifacts. Lithic artifacts totaled 3894 (37.2% of the total assemblage) and debitage amounted to 3008 pieces (28.8% of the total assemblage or 77.2% of the total lithic assemblage). Tools accounted for the remaining 886 lithic artifacts (8.4% of the total). Clarke's group also screened all excavated materials, (which produced no KRF), through nested sieves, but does not give mesh sizes.

cat #	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	# dfs	notes
365		√			10.7	13.5	4.7	0.5	5	distal frag.
1299a	1			√	18.08	11.2	4.6	0.7	11	flake

Table 7:6 Knife River Flint artifacts from EfOm-130

My analysis of the lithics revealed that only two flakes out of the 14 recorded as KRF in the catalogue were correctly identified; twelve seem to be brown chalcedony Look-Alikes. One KRF distal flake fragment, #365, (Table 7:6) is a primary piece and has five dorsal flake scars. There is no provenience mentioned. The second KRF artifact #1299a, from Level 1, is a complete tertiary flake with eleven dorsal flake scars.

The large number of flake scars on flake #1229a suggests that tool maintenance or resharpening was occurring at this site. Tool kit expansion is implied by two main reduction stages evident in the debitage. Diagnostic projectile points suggest that the site was a Late Precontact Old Women's Phase habitation. Four radiocarbon dates (Chapter 6) support a Late Precontact occupation for this site.

EfPi-17

The total lithic assemblage numbered 972 artifacts. Debitage amounted to 572 pieces (58.8% of the total). Hanna (2002a) retrieved two KRF flakes but does not provide provenience information for them (Table 7:7). Two screened soil samples (2 mm mesh) from Levels 4a and 4b yielded four KRF flakes or flake fragments. Chalcedony artifacts (N=83) represent 39% of the total lithic assemblage of the central block. Fourteen KRF flakes are identified as such in the catalogue. My reassessment confirmed only six correctly identified KRF flakes. The remaining eight flakes seem to be Look-Alikes.

cat #	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	# dfs	notes
103		√			8	5.9	1.4	0	n/a	cortex, prox. frag.
393			√		18.7	20.4	6.4	1.8	4	flake, cortex on plat
soil sample	4a	√			4.8	5.8	0.9	0	n/a	flake cortex
soil sample	4a	√			8	5.4	1	0	2	split flake
soil sample	4a			√	5.5	2.4	0.7	0	4	split flake
soil sample	4a			√	8	5.4	1	0	2	flake

Table 7:7 Knife River Flint artifacts from EfPi-17

KRF flake #103 has cortex covering its dorsal surface and therefore has no dorsal face scars that can be ascertained. Flake #393 has cortex on the platform and the specimen has four dorsal flake scars. The dorsal flake scar count of the two KRF split flake fragments from the soil sample level 4a is incomplete, since only one lateral edge is present on either artifact. One artifact has two dorsal flake scars and the other specimen has four flake scars. One soil sample complete KRF flake fragment from Level 4a has two dorsal flake scars.

The recovered KRF flake fragments suggest tool or blank production, resharpening or reshaping events – all three major reduction stages are represented, and dorsal flake scar counts range from zero to four. Unfortunately, the KRF is found from Level 4 and below making it unlikely that they constitute a component of the Avonlea or later phases of the Late Precontact Period.

Diagnostic projectile points suggest a Late Precontact Old Women's Phase occupation. A corrected radiocarbon date (Chapter 6) also points towards the Avonlea Phase.

EfPl-21

The lithic assemblage consists of 815 pieces of which 651 are debitage (79.8% of the total assemblage). My assessment of the flakes in this lithic assemblage (from Hanna 2000, 2000b) agreed with that of the excavators--no KRF flakes are present. Eighteen expedient tools (2.2% of the total assemblage), and three KRF tools (0.4% of the total assemblage) are listed. The two KRF formed tools (0.2% of the total assemblage) were recovered from Level 2 and consist of a wedge and a heavily patinated bifacial drill/awl, both of which have cortex. The third KRF tool is a projectile point fragment.

Hanna (2002a) dates the site to the Late Precontact based on one fragmentary side-notched projectile point that is deemed consistent with the Late Precontact Old Women's Phase. This site is included because the ASA database recognized 'Old Women's Phase' as a prerequisite for this pilot study.

EfPl-228

My re-assessment of the lithic flake assemblages (from Zdanowicz et al. 1999; Ramsay 2004, 2005; Oetelaar and Gillespie 2001), agrees with their entries in their resulting catalogue. No KRF flakes were present in the assemblage. Of the 425 lithic artifacts listed, 201 are flakes (47.2% of the total assemblage) and 24 are tools (5.6% of the total assemblage). One Plains side-notched projectile point is listed as chalcedony and my analysis confirmed this identification. One KRF scraper (1.4% of the total assemblage) and two KRF artifacts, a marginally retouched stone tool from Level 8 and an end scraper from Level 10 were considered as being in a deep disturbed context related to observed rodent activity (Ramsey (2005). Ramsey (2005) reported one KRF scraper from the lower palaeosol, Level 10, below a Mazama Ash layer.

Soil samples were screened (6 mm mesh), but no KRF artifacts were recovered. The single radiocarbon date suggests a Besant occupation bordering on the onset of the Late Precontact. Recovered diagnostic projectile points suggest site use in the Late Precontact Period Old Women's Phase. All recovered KRF artifacts come from the lower levels and are most likely from time periods not include in this study.

7.3 PARKLAND ECOZONE SITES

EkPf-39

My assessment of the lithic assemblage of 99 total artifacts of which 93 were flakes (from Beaton 2006) agrees with the excavator's assertion that no KRF flakes were retrieved. Beaton identified one piece of shatter (1% of the total assemblage) from Level 1 as KRF (#40, Table 7:8). Re-assessment confirmed this identification.

cat #	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	# dfs	notes
40	1				25.0	9.6	9.2	2.4	n/a	shatter

Table 7:8 Knife River Flint artifacts from EkPf-39

Six expedient tools (6% of the total assemblage) are formed on flakes and are in an unfinished state. No diagnostic cultural material was identified. Therefore there is no means of assigning the chronology of the site occupation (Beaton 2006). The shatter comes from the disturbed tillage stratum of the site, namely Level 1, although Beaton is not clear in his report on this point. The presence of the KRF shatter caused this site to be included in the ASA database from which sites were selected.

FbPf-4

The combined excavations by Head (1989b) and by Light (2010) yielded 385 artifacts of which 363 (94.2% of the total assemblage) were lithic debitage. According to the original investigator, one KRF end scraper was recovered from the surface (Light 2010) and according to my analysis this identification is correct. My analysis also confirmed that no KRF debitage is present in the assemblage. The ASA Report mentions one Middle Precontact pelican lake point and one possible Late Precontact projectile point.

One unprovenienced KRF flake, incorrectly identified, was recovered from the tillage zone. The incorrectly identified flake and the KRF scraper caused the site's inclusion in this pilot study.

FdOt-9

A total of 1020 artifacts comprise the lithic assemblage. Debitage numbers 1014 specimens (99.4% of the total assemblage) and flakes comprise 417 artifacts (41.1% of the total debitage assemblage).

My re-assessment of the lithic assemblage encompassed all the lithics recovered by McCullough and Landals (1987). Within the assemblage, they identified 16 brown chalcedony flakes. My investigations identified 2 KRF flakes from this subset. Stuart (1988) identified 14 flakes as KRF, but these artifacts were not available for assessment.

My analysis of the lithic artifacts retrieved by the investigators determined that only four artifacts from 14 listed KRF artifacts were correctly identified. These included the scraper from Level 1 (Table 7:9), two surface collected flakes #3274 with 4 dorsal flake scars and # 3312 with five scars, and the flake #3219 from Level 5 with three scars.

Nine flake artifacts catalogued as brown chalcedony yielded two KRF flakes on my re-assessment, which included flake #3219 from level 3 with five dorsal flake scars, and one KRF flake fragment, #3067 with three scars from Level 2. The large number of dorsal flake scars, ranging between three and five, suggests tool refurbishing.

# cat.	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	#dfs	notes
3274	surface			√	14.5	10.4	3.1	0.3	4	flake
3312	surface			√	16.7	11.4	2.1	0.4	5	flake
3067	2			√	12.5	11.4	2.3	0.3	3	flake frag. prox.
3219	3			√	15.6	8.3	2.1	0.3	4	flake
3222	5			√	11.4	9.4	2.1	0.1	3	flake

Table 7:9 Knife River Flint artifacts from FdOt-9

One McKean projectile point fragment from this site indicates a Middle Precontact occupation. The Plains side-notched projectile point suggests a Late Precontact occupation. However, wind ablation has disturbed the stratification to such an extent that a firm chronological placement of the KRF artifacts at the site is impossible. The Plains side-notched point is included in the Late Precontact points and tools totals below for this study.

FeOs-37

Wondrosek et al. (2000) recovered 122 lithic specimens (97.1% of the total assemblage) employing a 3 mm screen. Flakes constituted 110 specimens (98.2% of the total assemblage). No KRF was specified in the catalogue; brown chalcedony was specified as a lithic raw material identification. Kulle and Landals (1995) and Wondrosek et al. (2000) listed brown chalcedony in the final catalogue without specifying KRF artifacts. Nine flakes were listed as ‘brown chalcedony. My re-assessment of the lithic artifacts (Table 7:10) determined that two pieces of shatter and one flake consisted of KRF. The two specimens of shatter are from Levels 1 and 2. The third KRF artifact is a complete flake(#32) (Table 7:10), (0.9% of the total) and comes from Level 2. It has three dorsal flake scars suggesting that tool refurbishing was taking place. The two pieces of shatter, #33 and #46, provide some evidence for this speculation.

# cat.	level	primary	secondary	tertiary	length mm	width mm	thickness mm	weight g	#dfs	notes
33	1				22.9	19.7	7.3	3.8	n/a	shatter
32	2			√	4.1	6.2	1	<0.1	3	flake
46	2				22.9	19.1	7.3	3.8	n/a	shatter

Table 7:10 Knife River Flint artifacts from Fe0s-37

FfPi-1

Taylor's (1969) excavations yielded 17,242 lithic artifacts of which 11,506 are flakes (66.7% of the total assemblage) and 1029 (5.9% of the total assemblage) are stone tools. Only 844 (82.0% of the total assemblage) stone tools are plotted by level; the rest are surface finds or from disturbed contexts. Twenty 'waste' flakes (Taylor 1969:37) were identified as KRF (0.2% of the total assemblage) and come from the lower levels. Stone tools of KRF comprise 15 artifacts (1.5% of the total tool assemblage). Taylor (1969:37) concludes that FfPi-1, the Fullerton site, is 'rather anomalous with its small quantity' of KRF when compared to other sites in southern Alberta. Taylor assigned none of the flakes or KRF tools to the Late Precontact Old Women's Phase, but to the previous Besant Phase or earlier. Notably few sites were known at the time and later investigations elsewhere support the lack of KRF artifacts in the Late Precontact of this region. Taylor's assemblage is not available for analysis.

However, Gibson's and Gillespie's assemblages from this site were available for examination. Gibson (1987) retrieved 178 lithic artifacts from this site, of which 172 (96.6% of the total assemblage) were debitage. None of these artifacts are made of KRF based on my analysis. Three 'brown chalcedony flakes' recovered from Level A in Gibson's excavations were correctly identified according to my analysis. Gillespie (2000) excavated a total of 55 lithic artifacts. Of this total, 43 (78.1% of the total assemblage) were debitage. Three brown chalcedony flakes proved to be as described based on my analysis. No KRF debitage was recovered at any level.

7.4 SUMMARY

The following summary includes only those KRF flakes that have been rather firmly identified as coming from a Late Precontact context. Several sites that proved to have KRF flakes only from earlier cultural contexts are excluded in this summary.

In my re-assessment, the five Montane ecozone sites have produced 17 KRF flakes (Figure 7:12) out of a total of 7,623 flakes (0.001% of the total) analyzed. Two sites in the Montane ecozone, FfQh-24 and FfQh-26, are almost as far north as FfPi-1 in the Parkland ecozone. Site FfQh-24 yielded one KRF flake fragment and one complete KRF flake. Site FfQh-26 yielded 15 KRF flakes, all from tertiary stages of reduction.

Site DiPn-20 is closest to the KRF source in North Dakota and yielded two complete KRF flakes and two KRF flake fragments and all are tertiary reduction flakes. EaPn-7 produced two KRF flakes, a secondary and a tertiary flake. EgPn-111 failed to yield KRF flakes from the time period under consideration. Primary KRF flakes were not found in any of the sites examined from the Montane ecozone. Secondary flakes were found in EaPm-7 and FfQh-24 in the Montane ecozone and tertiary flakes are found in DiPn-20, EaPm-7 and FfQh26.

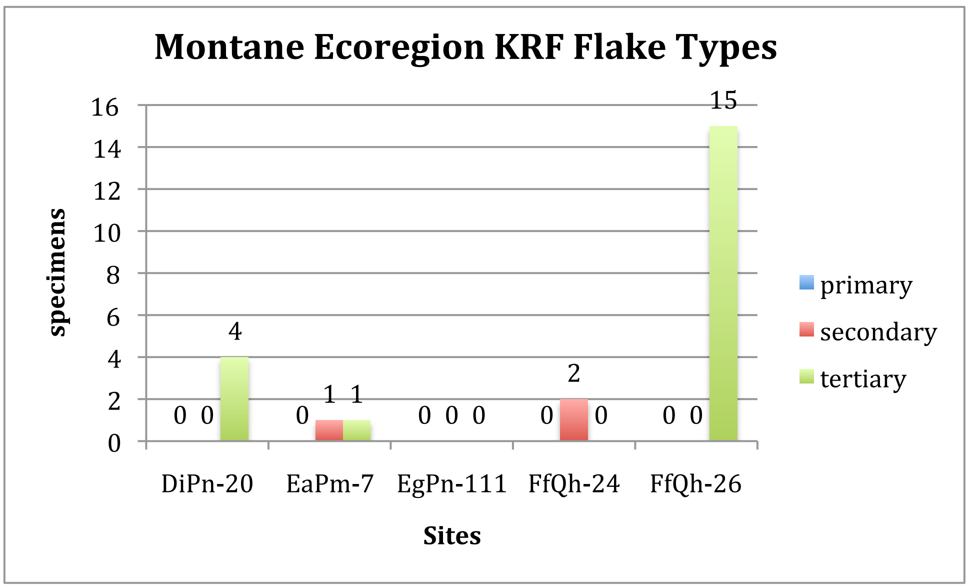


Figure 7:1 Knife River Flint Flake Types in the Montane Ecozone

The mean length of the KRF flakes in the Montane ecozone (Table 7:12) is 12.9 mm. and the mean width here is 11.8 mm. The mean thickness is 1.8 mm and the mean weight is 0.6 g. The mean number of dorsal face scars is 4.3 per flake.

MONTANE ECOZONE	length mm	width mm	thickness mm	weight g	# dfs
mean	12.9	11.8	1.8	0.6	4.3
stdev	6.8	5.1	1.3	0.9	1.7

Table 7:12 Montane Ecozone Flake Means and Standard Deviations
Stdev - standard deviation

The Prairie ecozone sites yielded 36 KRF flakes out of a total assemblage of 7,143 pieces of debitage (0.005% of the total assemblage) and 14 KRF flakes are judged to be from the Late Precontact Period (0.0001% of the total assemblage). Primary KRF flakes (Table 7:2) were found EfOo-130 with one specimen and at EfPi-17 which held three specimens. Secondary KRF flakes were found in EfOm-51 with three specimens while EfPi-17 yielded one specimen. Three sites yielded KRF tertiary flakes, EfOm-51 with three specimens, EfOo-130 with one specimen and EfPi-17 with two specimens. Two sites, namely EfPi-21 and EfPl-228 had no KRF flakes from the time period of interest in this study.

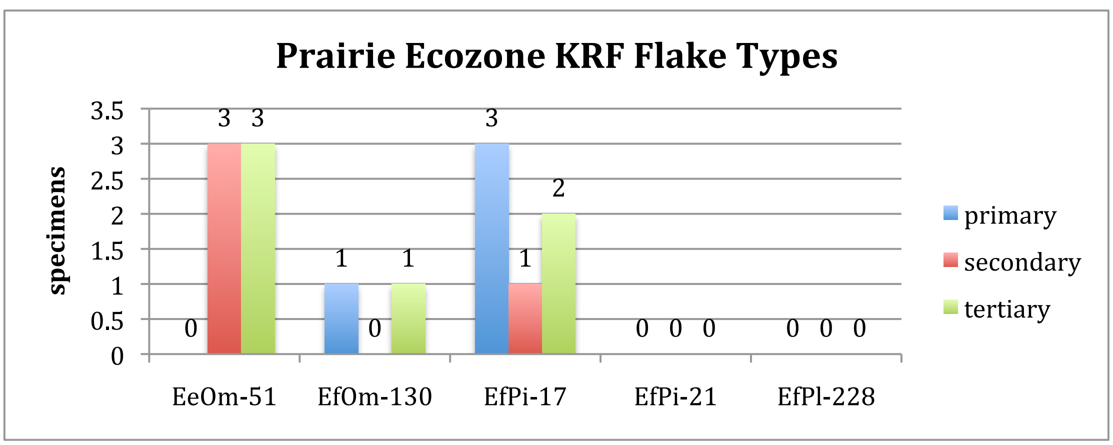


Figure 7:2 Knife River Flint Flake Types in the Prairie Ecozone

The mean length (Figure 7:13) of the KRF flakes in the Prairie Ecozone is 13.9 mm, the mean width is 12.8 mm, and the mean thickness is 4.3 mm whereas the mean weight is 0.8 g. The mean number of dorsal weight scars is 5. Standard deviations for each mean are listed in Table 7:2.

PRAIRIE ECOZONE	length mm	width mm	thickness mm	weight g	# dfs
means	13.9	12.8	4.3	0.8	5
stdev	5.3	6	2.1	0.7	4.5

Table 7:13 Prairie Ecozone KRF Flake Means and Standard Deviations

The Parkland ecozone has a paucity of KRF flakes (Figure 7:2) from the Late Precontact as determined in this pilot study. Specifically ony two sites contained KRF flakes, namely FdOt-9, with five specimens and FfPi-1, with one specimen. In both all were tertiary KRF flake.

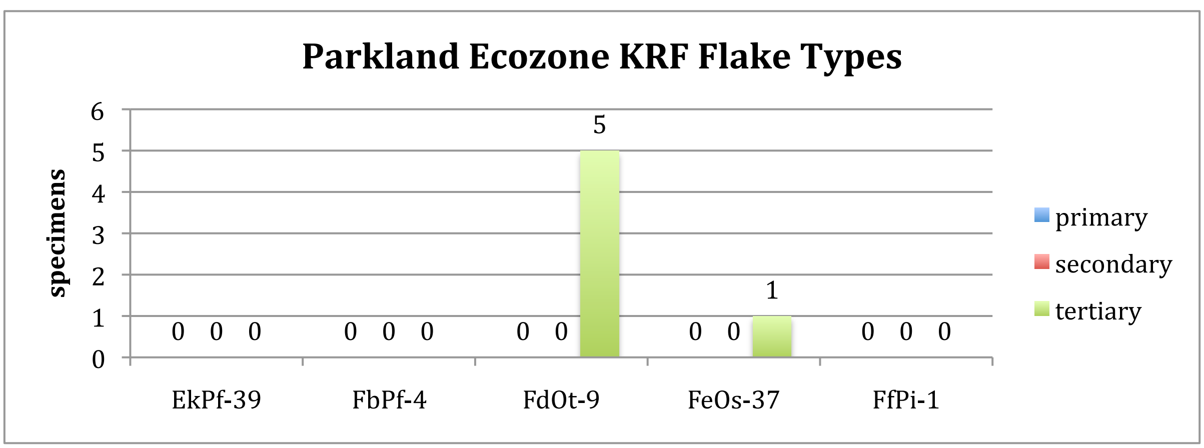


Figure 7:3 Knife River Flint Flake Types in the Parkland Ecozone

The mean length (Table 7:14) of the Parkland KRF flakes is 12.4 mm, the width is 6.5 mm, and thickness is 2.1 mm and the weight is0.2 g. The mean for the number of face scars is 3.6. The standard deviation for each are also presented in Table 7:13

PARKLAND ECOZONE	length mm	width mm	thickness mm	weight g	# dfs
mean	12.4	9.5	2.1	0.2	3.6
stdev	4.5	2	0.6	0.1	0.8

Table 7:14 Parkland Ecozone KRF Flake Means and Standard Deviations

Avonlea and Old Women's Phase occupations in the three ecozones are supported by the retrieval of the Avonlea, Triangular, Prairie side-notched and Plains side-notched points. The Montane ecozone produced only two Late Precontact Period projectile point types made of KRF, namely an Avonlea and an undifferentiated side-notched specimen. The Prairie ecozone yielded Avonlea, Prairie, Plains side-notched, Timber Ridge, Triangular and undifferentiated side-notched points of KRF. The Parkland ecozone produced Prairie side-notched and Plains side-notched projectile points of KRF.

CHAPTER 8: DISCUSSION AND CONCLUSIONS

This study was initiated in an attempt to develop an inexpensive and reliable methodology for identifying KRF in the field and in the laboratory. An experimental methodology that combines macroscopic, microscopic and ultraviolet irradiation to highlight Knife River Flint's unique physical characteristics and properties has proven successful in experimental studies and was subsequently applied to archaeological assemblages in Alberta.

Fifteen sites in Alberta were re-assessed for KRF identification. The Montane, prairie and Parkland Ecozones each provided five sites. The resulting analysis is compiled in Figure 8:1.

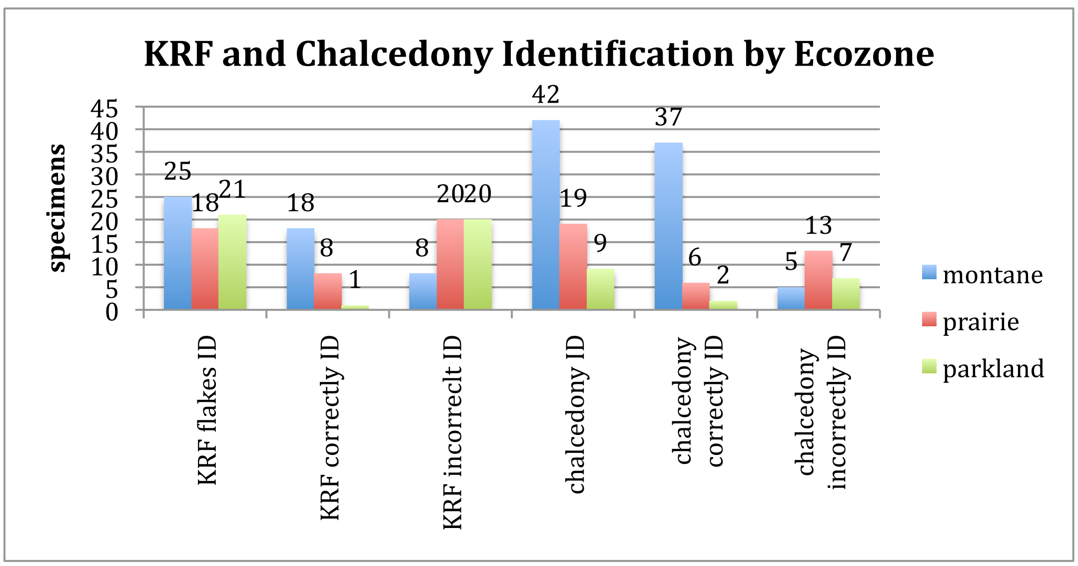


Figure 8:1 Knife River Flint and Chalcedony Flake Identification

Sixty-four flakes (Figure 8:1) were identified as KRF by other investigators of which only 28 (43.7%) were assessed as being correctly identified by applying the study's methodology. Seventy flakes were identified as brown chalcedony of which 45 (64.2%) were judged originally correctly identified. Nearly all of the previous investigators had applied only a macroscopic approach when identifying lithic types. My experimental results suggest that such a methodology for differentiating KRF and chalcedony has perhaps only a fifty-percent chance for correct identification, which is no better than guessing. My reassessments of the archaeological materials seems to confirm my experimental trials and leads me to believe that perhaps nearly half of the brown chalcedony and KRF flakes in the province could be incorrectly identified. These results appear to be a strong argument for adopting my methodology.

In my experimental studies, initial macroscopic identification was based on characteristics such as conchoidal fracture, colour, lustre and translucency. However, in my experiments, macroscopic inspection alone achieved a successful identification rate of approximately 50%. Coupling macroscopic and microscopic investigations increased the success rate to 69%. A combination of microscopic, macroscopic and Ultra-violet methods, when used successively, accurately identified at least 95% of the KRF artifacts. This combined methodology is convenient and inexpensive and has proven successful in Identifying the KRF and Look-Alike experimental flakes and shatter discussed in this study. Perhaps most importantly, the high success rate was obtained by an investigator with very little previous training or experience in lithic identification, suggesting that it will be of use to a wide variety of investigators.

Accurate KRF debitage counts can help in determining the quantity of exotic raw material being utilized in relation to other exotic and local raw materials (See Appendix A for specific quantities of material types identified). Employing the tri-partite methodology on the fifteen sites of my analysis has demonstrated that the numerical count and relative percentage of KRF artifacts in the Late Precontact Period is comparatively small. While it proved extremely difficult in my sample sites to confidently assign debitage to specific time periods, those assemblages clearly belonging to the Late Precontact Period clearly contained only small numbers of KRF flakes. Varkasis (2006:186) has shown that in the immediately preceding Late Middle Precontact Period Besant Phase, KRF was much more common, accounting for 44% of the projectile points. My data provides at least some indication that KRF was far less commonly in use during the Late Precontact.

What variation is evident in KRF distribution and morphology across the three Alberta ecozones closest to Dunn County? The relative abundances, variability in the size, and other primary characteristics of KRF flakes in the Montane, Prairie, and Parkland ecozones were used to address this question. The Montane ecozone has no KRF primary decortification flakes, but has yielded secondary flakes in two sites and tertiary flakes in three sites. The Prairie ecozone sample included two sites that yielded KRF primary decortification flakes, two sites with KRF secondary flakes and three sites with KRF tertiary flakes. The Parkland ecozone has yielded only two sites with KRF flakes, both with tertiary flakes only.

The relative abundance and type of KRF flakes dating to the Late Precontact period, from the fifteen sites described above (Chapter 7), strongly suggest that the closer the site to Dunn County, the more likely it is that there will be all three flake types present. The Prairie ecozone, closest to the KRF source, yielded primary, secondary and tertiary flakes. Furthermore, his ecozone yielded the largest KRF flakes by size and weight. The Montane ecozone, more distant from the source area, has two sites with secondary KRF flakes and three sites with tertiary KRF flakes. Also, their overall size was smaller than those in the Prairie ecozone. Two sites in the Parkland ecozone, the ecozone furthest from Dunn County, yielded only tertiary flakes.

Using the KRF flakes under investigation, it would seem that those from the Prairie ecozone are slightly wider (mean of 12.75 mm) than the Montane and Parkland ecozone (means of 12.53 and 9.5 mm respectively). The Prairie ecozone flakes also are thicker (mean of 4.28 mm, Montane at 2.1 mm and Parkland at 2.1 mm), weigh more (mean of 0.75 g, Montane at 0.48 g and Parkland at 0.2 g) and have more dorsal face scars (mean of 5.0 and Parkland at 3.6, and Montane at 3.2) than KRF flakes from the Montane and Parkland ecozone. Overall, these patterns suggest: 1) KRF reduction activities were more variable in the Prairie ecozone than elsewhere in the study sample; 2) larger KRF pieces were available for reduction in the Prairie ecozone than elsewhere; 3) more early stage reduction occurred in the Prairie ecozone than in the other sample areas; 4) KRF constituted a slightly greater proportion of the total lithic material being flaked in the Prairie ecozone than seen elsewhere in the southern Alberta ecozones.

The means for the number of dorsal face scars seems to deviate from this broader pattern, namely the Prairie ecozone has a mean of 5.0, while both the Montane (mean of 3.2) and Parkland (3.6 scars) have less flake scars on average. One might expect that further from the source, found KRF pieces would be more extensively flaked (have more flake scars), as by the time they had reached this distance they would have been used and reused many times. However, the number of flake scars observable is clearly linked to the size of the object under consideration—

smaller flakes simply have less space for scars than do larger pieces. Perhaps the much larger flakes found in the Prairie ecozone show more flake scars on average than the other ecozones simply because they are larger than those seen elsewhere in the study.

The significance of these variations between the ecozones would likely change somewhat if more sites had been included in my analyses. Another consideration is that the Montane ecozone stretches southeast to northwest and only the study sites at its northern end yielded KRF, counter to the expectation that distance to source plays a major role in KRF relative abundance. The Parkland ecozone has yielded the fewest KRF flakes from the time period of interest despite being nearly the same linear distance from the source region.

The reasons for this KRF use-variation between the ecozones are not clear from the dataset at hand, but clearly distance to source surely is not the only factor involved. For example, Vickers (1986) has shown that warfare was a deterrent to wide-scale travel in the latter part of the Late Precontact Period. He also demonstrates that alliances among the groups on the Canadian Northern Plains shifted over time, which could alter access to trade materials. Thus political factors may enter be a large determining cause in the spread or reduction of exotic materials.

Direct access to the source most likely does not explain the patterns discerned. If this were the case, then three ecozones would have similar KRF assemblages, both in terms of the relative abundances of KRF and the types of flakes present. The fact that there is a discrepancy in the number and type of reduction flakes present in the three ecozones indicates that down-the-line trade is more likely. Those groups more distant from the source area were likely receiving KRF objects that were already extensively worked. The lack of pieces bearing cortex in the sites most distant from the source support this, as does the small size of the debitage in these regions. Those groups closest to the source region received less extensively worked pieces, which they flaked and utilized and later passed on to more distant groups. The presence of some cortical flakes and the slightly larger flake sizes in the southern portion of the province likely evidence these activities. Regardless, the overall abundance of KRF in any southern Alberta ecozone is very small and suggests the material was not a major item of trade and exchange during the Late Precontact period.

Access to local abundant and high quality stone also may have played a role in structuring the trade in KRF across the province. Late Precontact sites further north in the Taiga Plains, Taiga Shield and Boreal Shield have not yielded any KRF artifacts at least according to the ASA database (2008). Fenton and Ives (1990) have clearly shown that Beaver River Sandstone, a fine cryptocrystalline chert, is a widely dispersed lithic material in the Boreal Plains. Perhaps the ready availability of such high quality material meant that exotics such as KRF were not valued and thus not an item of trade with peoples to the south.

A total of 2554 tools (Table 8:1) were recovered in the fifteen selected sites. The investigators identified thirty-seven KRF tools, exclusive of projectile points. All KRF tools were correctly identified as KRF material.

The Montane ecozone produced 6 KRF tools, which constituted 1.3% of the total assemblage. The Prairie ecozone yield 13 KRF tools, also 1.3 % of the total assemblage. The Parkland ecozone surrendered 18 KRF tools, or only 1.5% of the total assemblage. These figures show that the

Parkland region has a very slightly higher relative abundance of KRF tools (albeit statistically insignificant), yet it yields the fewest KRF flakes of the three ecozones. More importantly, KRF constitutes a larger proportion of the non-projectile point tool material than seen among the debitage in these same sites. This suggests to me that perhaps mostly fully formed KRF non-projectile point tools were entering the region, and these were less reworked than those made of other material types.

ECOZONE	# of tools	# of KRF tools	KRF %
Montane	430	6	1.3
Prairie	984	13	1.3
Parkland	1140	18	1.5

Table 8:1 KRF Tools by Ecozones

A total of 113 Late Precontact projectile points (Figure 8:2) were retrieved in the fifteen sites of this study, and ten point types are represented. Many are fragments and some bases and medial portions are too fragmentary to be able to assign them to any specific type other than to the Late Precontact. The notches used for typological assignations in these specimens are within the small size range typical of the Late Precontact. The triangular style is the largest identified group with 44 specimens, constituting 38.9% of the total. They are only encountered in the Prairie ecozone. This ecozone also has the largest variety of points. Fifteen undifferentiated points (13.2% of the total) are the largest group in the Montane ecozone. Four point types are present in the Montane ecozone and the Parkland ecozone yielded three point types.

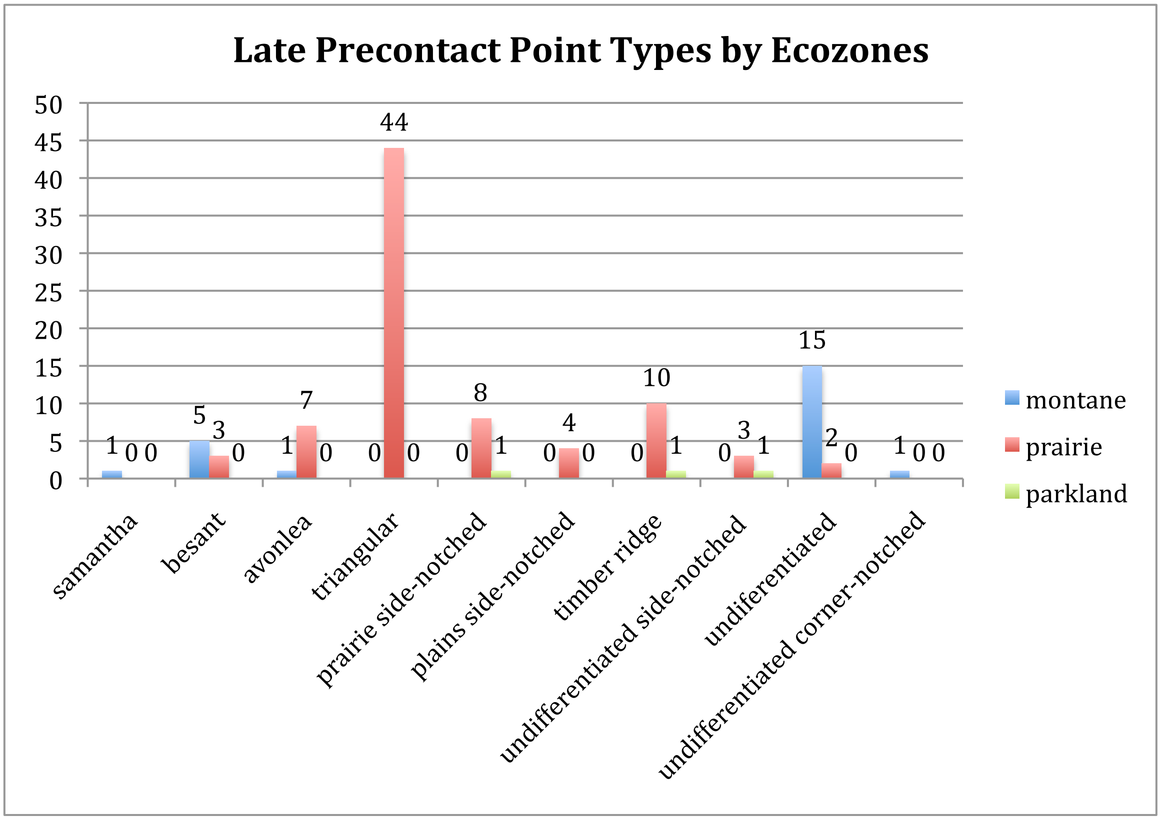


Figure 8:2 Late Precontact Point Types by Ecozone

In my sample, 17 points are made of KRF, constituting 15% of the total point assemblage. The Montane region exhibits the largest collection with nine KRF points, or 52.9% of the total. The Prairie ecozone follows with seven specimens, or 41.1% of the total. The Parkland ecozone has the smallest KRF point assemblage with one specimen, or 5.8% of the total. As seen with the non-projectile point tools, points made of KRF are relatively far more abundant than would be suggested by the general paucity of KRF debitage at the sites. Again, this suggests that KRF points were mostly arriving to the region fully formed and that very few if any were locally shaped. Down-the-line trade of arrows might account for such a pattern.

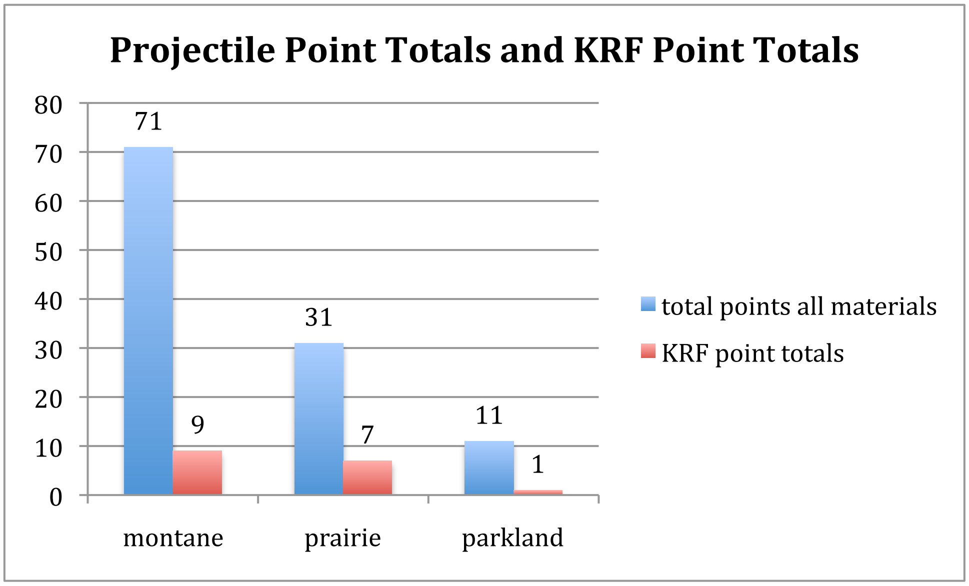


Figure 8:3 Projectile Point Totals and KRF Point Totals

Some insights about the greater abundances of KRF points relative to flakes might be sought within the oral history of the peoples whose ancestors produced these ancient tools and flakes. Bison hunting conferred prestige on the hunters in the Northern Plains and sacrificing a prized possession might lead to greater hunting success. Knife River Flint, as an exotic and rare raw material, may have been used preferentially for tasks such as hunting. This could explain the number of projectile points at kill and processing sites and the relative dearth of KRF flakes. Crystal John, (pers. comm. 2010) reported that Cree Elders explained to her that projectile points used in hunting and killing buffalo are considered to be on sacred ground once the buffalo has been dispatched, and that therefore the projectile points were not re-claimed and re-used. These practices would increase the number of KRF projectile points at kill and primary processing sites and at the same time restrict the number of reworked KRF points.

Conversely, Gard (1968) mentions that the women who processed a fallen bison would retrieve any arrows and return them to their owners. This practice would also increase the number of points being reworked. Used points tend to have impact fractures at the tip, or be split, or even break laterally. Reworking would be needed to refurbish these returned points and more flakes would therefore be present. Unfortunately Gard does not mention how the arrows were identified, nor does he mention the specific First Nation(s) involved. My research suggests though that very few KRF projectile points underwent such retrieval and reworking. Perhaps only locally produced arrows and points received such treatment, while those obtained from afar were more often left behind as described by Crystal John.

While the relatively small numbers of KRF flakes found in my study have inhibited me making many inferences about past human behavior, the tri-partite methodology of macroscopic, microscopic and short wave ultraviolet illumination methodology developed here should be a valuable contribution towards further understanding the story of KRF. Second, this study does to some degree support the assumption that distance of a raw material from its source is reflected in a diminishing size and the later production stages of the debitage of the raw material. Clearly though, more than distance to source is at work in shaping Knife River Flint distribution in Alberta during the Late Precontact period. Better understanding of the relevant factors will only be possible with a larger dataset.

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APPENDIX A

Lithic Types by Site

Site/lithics	DiPn-20	EaPm-7	EgPn-111	FfQh-24	FfQh-26	EaOm-51	EfOo-130	EfPi-17	EfPi-21	EfPl-228	EkPf-39	FfPi-1	FbPf-4	FdOt-9	FeOs-37		totals
agate												*					1
argillite, grinell									*								1
argillite, kootenay		*															1
basalt		*				*	*										3
beaver river sandstone														*			1
chalcedony	*			*	*	*	*	*	*	*		*		*	*		11
chert, avon														*			1
chert, helena		*															1
chert, montana										*					*		2
chert, paskapoo				*	*						*						3
chert, top of the world		*			*							*					3
chert, unidentified	*	*	*	*	*	*	*	*		*		*	*	*	*		13
granite						*											1
ironstone												*					1
jasper												*					1
KRF	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		15
limestone						*											1
mudrock										*							1
nordegg sil. siltstone				*	*												2
obsidian		*	*				*		*			*		*	*		7
ochre												*					1
pebble chert							*										1
petrified wood			*		*				*			*		*			5
porcellanite						*			*			*			*		4
quartz								*							*		2
quartzite		*	*	*	*	*	*	*	*	*	*	*	*	*	*		14
quartz crystal		*															1
sandstone										*		*					2
shale												*					1
silicified peat						*		*				*					3
siltstone				*	*				*	*							4
silicified sandstone											*						1
silicified siltstone		*		*	*	*	*								*		6
silicified wood							*			*					*		3
swan river chert		*					*						*		*		4
totals	**3**	**11**	**5**	**8**	**10**	**10**	**10**	**6**	**8**	**9**	**4**	**15**	**4**	**8**	**11**		**122**

APPENDIX B: KRF
Experimental Metrical Data

#	l mm	w mm	th mm	wt g	cortex
1	17	11	7	1.5	
2	14	19	3	0.6	
3	14	6	4	1.1	
4	13	15	2	0.5	ˆ
5	13	17	3	1.9	
6	21	22	4	2.6	
7	13	17	1	0.3	
8	13	8	2	0.2	
9	15	7	4	0.9	
10	22	14	11	4.3	
11	13	9	5	0.5	
12	19	11	2	0.2	
13	12	11	3	0.4	
14	12	8	1	0.1	
15	9	14	1	0.1	
16	14	19	5	1.5	
17	21	22	7	1.9	
18	30	21	4	2.5	
19	19	14	9	3.3	ˆ
20	15	13	10	1.8	ˆ
21	17	22	7	3.2	ˆ
22	10	19	6	0.7	ˆ
12	12	13	4	0.4	
24	14	11	5	0.7	
25	5	16	3	0.2	ˆ
26	10	9	6	0.4	ˆ
27	14	13	7	1.4	
28	14	21	5	1.8	
29	10	21	6	1.0	
30	13	20	3	0.8	
31	20	19	7	2.1	ˆ
32	11	5	5	0.2	
33	13	27	5	1.4	ˆ
34	28	25	6	4.2	ˆ
35	10	9	5	0.4	
36	11	14	3	0.5	
37	17	17	3	0.5	ˆ
38	17	19	9	2.7	ˆ
39	6	5	1	0.1	
40	7	12	2	0.1	
41	13	19	4	0.8	
42	16	21	7	2.5	
43	7	9	6	0.5	
44	12	16	3	0.6	ˆ
45	25	34	3	2.5	ˆ
46	13	25	6	1.7	ˆ
47	11	8	5	0.3	
48	12	9	3	0.2	
49	7	4	2	0.1	ˆ
50	7	16	4	0.4	ˆ
51	13	9	4	0.3	
52	10	14	2	2.4	
53	9	11	2	0.1	ˆ
54	15	22	3	1.3	
55	6	11	2	0.1	ˆ
56	16	8	3	0.4	
57	9	20	4	0.5	
58	23	16	7	1.6	ˆ
59	15	18	4	0.7	ˆ
60	12	6	2	0.1	
61	11	15	3	0.3	
62	12	11	4	0.3	
63	11	10	4	0.4	
64	6	15	3	0.3	
65	14	7	7	0.6	
66	10	13	2	0.2	ˆ
67	10	15	4	0.6	
68	11	8	3	0.2	
69	13	16	3	0.4	
70	17	10	11	1.8	
71	16	12	4	0.7	
72	12	19	10	1.9	ˆ
73	12	14	5	0.7	
74	18	11	8	1.3	
75	9	10	2	0.1	
76	12	10	4	0.4	
77	15	22	3	0.9	
78	8	10	2	0.1	ˆ
79	14	10	5	0.4	ˆ
80	9	13	2	0.2	
81	9	10	3	0.1	
82	9	13	3	0.2	ˆ
83	8	17	4	0.4	ˆ
84	10	10	3	0.2	
85	12	14	3	0.3	
86	12	12	4	0.5	ˆ
87	12	10	8	0.8	
88	22	18	4	0.9	ˆ
89	18	21	3	1.3	ˆ
90	12	30	4	1.4	ˆ
91	19	25	4	1.6	
92	27	24	5	3.3	ˆ
93	12	21	5	1.1	
94	13	17	8	1.4	ˆ
95	16	8	4	0.4	
96	10	7	3	0.1	ˆ
97	9	12	2	0.2	
98	7	19	5	0.7	
99	12	14	8	1.5	
100	12	18	6	0.9	ˆ
101	10	13	2	0.2	ˆ

KRF METRICAL DATA con'd

#	l mm	w mm	th mm	wt g	cortex
102	9	12	8	0.6	ˆ
103	12	7	5	0.4	ˆ
104	14	13	9	1.6	
105	8	14	4	0.4	
106	6	13	5	0.3	
107	14	8	5	0.4	
108	10	17	4	0.6	
109	17	21	8	2.2	ˆ
110	13	12	5	0.9	
111	12	11	3	0.4	
112	15	9	3	0.3	
113	14	16	5	0.8	ˆ
114	10	18	2	0.1	
115	9	13	2	0.2	
116	12	18	7	1.4	
117	12	14	2	0.4	
118	6	10	2	0.1	
119	10	15	5	0.7	ˆ
120	9	12	2	0.2	
121	10	18	3	0.3	
122	11	10	5	0.4	ˆ
123	7	13	3	0.2	ˆ
124	8	15	4	0.5	ˆ
125	8	10	2	0.1	
126	21	25	5	2.6	ˆ
127	24	24	4	3.3	ˆ
128	13	19	7	1.8	ˆ
129	14	14	7	1.2	ˆ
130	11	9	5	0.5	
131	14	22	5	1.3	ˆ
132	9	14	3	0.3	ˆ
133	24	19	8	3.6	
134	20	17	11	3.6	ˆ
135	9	12	5	0.5	ˆ
136	9	15	8	1.1	ˆ
137	12	10	1	0.1	ˆ
138	22	18	4	1.5	
139	13	20	4	1.2	ˆ
140	11	18	5	0.9	
141	12	9	5	0.5	ˆ
142	10	8	1	0.1	
143	10	18	12	2.1	
144	7	12	2	0.1	
145	11	10	2	0.1	ˆ
146	5	14	1	0.1	
147	13	12	3	0.3	
148	11	15	4	0.6	ˆ
149	10	8	5	0.2	
150	10	9	4	0.3	
151	9	16	4	0.4	
152	14	18	4	0.8	ˆ
153	11	15	10	1.5	
154	9	12	2	0.1	
155	11	8	2	0.1	
156	10	13	3	0.2	ˆ
157	7	10	1	0.1	
158	24	26	7	3.8	ˆ
159	13	24	7	1.8	ˆ
160	12	11	7	0.9	ˆ
161	12	10	6	0.7	
162	14	11	2	0.4	
163	14	14	3	0.5	
164	16	23	5	2.1	
165	10	14	3	0.3	ˆ
166	13	16	7	1.7	
167	11	19	7	1.1	ˆ
168	11	26	11	3.6	ˆ
169	17	9	3	0.2	
170	11	13	2	0.2	
171	9	10	3	0.2	
172	10	12	3	0.2	ˆ
173	16	12	10	2.1	ˆ
174	22	22	3	1.2	ˆ
175	8	15	6	0.7	
176	17	14	7	1.2	ˆ
177	14	12	6	0.8	ˆ
178	18	11	9	1.7	ˆ
179	11	15	5	0.6	ˆ
180	14	15	5	1.0	ˆ
181	18	12	4	0.7	
182	19	10	3	0.3	
183	10	10	3	0.4	
184	11	9	0.9	0.4	
185	12	9	9	0.8	
186	16	14	4	1.0	
187	12	10	2	0.1	ˆ
188	13	9	5	0.7	ˆ
189	15	6	4	0.2	ˆ
190	11	9	2	0.1	ˆ
191	10	12	12	1.7	
192	11	21	9	1.6	
193	19	16	8	2.9	
194	31	13	3	0.6	
195	15	17	4	1.1	ˆ
196	21	23	3	1.0	
197	15	12	4	0.5	
198	12	18	5	0.6	
199	12	12	3	0.3	ˆ
200	11	9	4	0.4	ˆ
201	10	9	6	0.4	
202	17	13	2	0.2	
203	13	20	9	2.9	ˆ
204	11	16	2	0.3	

KRF METRICAL DATA con’d

#	l mm	w mm	th mm	wt g	cortex
205	9	13	2	0.2	
206	17	32	10	3.2	
207	13	6	5	0.4	
208	11	13	4	0.5	
209	16	15	5	1.1	ˆ
210	14	9	2	0.1	
211	13	16	4	0.7	ˆ
212	20	12	5	0.8	ˆ
213	11	18	11	2.0	ˆ
214	11	15	6	0.9	
215	11	7	2	0.1	
216	20	10	9	2.0	ˆ
217	9	14	3	0.3	
218	23	30	4	1.7	
219	11	8	2	0.2	
220	22	17	7	1.6	ˆ
221	13	7	2	0.1	
222	15	23	13	4.4	ˆ
223	9	13	3	0.3	
224	17	9	2	0.2	
225	12	8	5	0.4	
226	11	8	5	0.5	ˆ
227	10	8	3	0.2	
228	10	9	7	0.8	
229	16	9	3	0.4	
230	12	11	2	0.3	ˆ
231	6	11	2	0.1	ˆ
232	11	15	4	0.5	ˆ
233	12	5	3	0.1	
234	7	17	8	1.0	ˆ
235	9	14	5	0.6	ˆ
236	9	9	4	0.2	
237	11	13	4	0.4	
238	10	12	6	0.6	
239	7	14	2	0.1	ˆ
240	14	12	4	0.4	ˆ
241	11	12	3	0.2	ˆ
242	11	8	7	0.7	
243	10	9	2	0.1	
244	9	19	9	1.1	
245	10	12	5	0.4	
246	21	21	5	2.0	ˆ
247	10	25	3	0.9	
248	12	8	4	0.3	
249	10	16	3	0.4	
250	13	20	3	0.6	
251	7	12	3	0.2	
252	15	13	6	1.1	
253	14	17	6	1.1	ˆ
254	12	11	7	0.9	ˆ
255	10	17	3	0.4	ˆ
256	7	14	7	0.6	ˆ
257	10	8	2	0.1	
258	6	12	4	0.3	ˆ
259	11	15	3	0.4	
260	7	13	2	0.1	ˆ
261	15	9	2	0.2	ˆ
262	16	8	3	0.3	ˆ
263	8	12	4	0.3	ˆ
264	12	9	3	0.2	
265	14	18	4	1.1	ˆ
266	13	16	6	0.9	ˆ
267	9	13	4	0.4	
268	16	7	2	0.2	
269	12	16	5	1.0	ˆ
270	10	12	3	0.3	
271	13	9	3	0.3	
272	10	11	3	0.3	ˆ
273	7	14	7	0.5	ˆ
274	11	10	4	0.2	
275	14	20	8	2.4	ˆ
276	14	24	5	1.7	ˆ
277	15	23	4	0.9	ˆ
278	13	10	6	0.7	
279	16	20	5	1.3	ˆ
280	12	18	7	1.6	
281	13	18	3	0.9	ˆ
282	15	15	3	0.7	
283	11	12	3	0.4	
284	17	15	6	1.8	ˆ
285	12	15	5	0.6	
286	9	11	5	0.4	
287	2	8	7	0.9	
288	10	9	3	0.8	
289	12	12	3	0.3	
290	9	13	4	0.4	
291	19	9	5	1.0	
292	8	11	6	0.4	ˆ
293	8	13	5	0.4	ˆ
294	9	7	2	0.1	ˆ
295	10	11	7	0.7	ˆ
296	9	7	2	0.1	ˆ
297	7	7	2	0.1	
298	10	7	7	0.1	
299	9	8	2	01	
300	12	14	10	2.2	ˆ
301	14	11	3	0.2	
302	10	13	2	0.2	
303	13	11	9	1.2	ˆ
304	15	17	8	1.9	ˆ
305	14	11	8	0.9	ˆ
306	10	11	4	0.3	
307	9	10	3	0.2	
308	8	14	2	0.2	ˆ

KRF METRICAL DATA con’d

#	l mm	w mm	th mm	wt g	cortex
309	37	24	8	4.3	ˆ
310	12	10	2	0.2	
311	6	15	4	0.3	
312	16	11	7	1.4	
313	19	7	4	0.6	
314	13	13	4	0.4	
315	13	11	8	0.1	
316	9	14	17	2.2	
317	13	14	2	0.2	
318	10	20	10	1.5	
319	11	6	2	0.1	ˆ
320	12	9	7	0.7	
321	12	11	2	0.2	ˆ
322	12	8	3	0.2	
323	10	7	3	0.2	
324	9	12	2	0.1	
325	15	11	7	0.9	
326	10	17	9	2.0	
327	29	31	6	4.4	
328	11	13	5	0.7	ˆ
329	22	12	11	2.4	
330	12	14	5	0.3	
331	14	17	3	0.5	ˆ
332	32	15	9	3.3	ˆ
333	10	18	7	0.9	ˆ
334	12	28	7	2.2	ˆ
335	14	7	1	0.1	
336	21	26	5	2.6	
337	16	32	9	4.4	ˆ
338	15	14	10	1.7	
339	19	21	5	1.2	ˆ
340	9	15	4	0.4	ˆ
341	12	20	5	0.7	ˆ
342	17	15	14	2.2	ˆ
343	17	16	14	3.9	
344	12	10	3	0.3	
345	11	8	2	0.1	ˆ
346	10	20	5	0.8	
347	8	10	2	0.2	
348	9	9	2	0.1	
349	8	11	5	0.3	ˆ
350	24	31	10	4.9	
351	12	14	8	0.6	
352	24	15	11	3.9	
353	19	14	12	3.7	ˆ
354	10	14	4	0.6	
355	11	10	4	0.3	
356	12	12	2	0.2	
357	11	13	3	0.2	ˆ
358	12	6	6	0.3	
359	12	12	8	1.2	ˆ
360	15	8	7	0.8	
361	12	21	7	1.2	
362	17	12	4	0.7	
363	15	6	3	0.2	ˆ
364	8	8	3	0.2	
365	6	13	3	0.2	ˆ
366	9	11	4	0.2	
367	11	14	4	0.5	ˆ
368	14	12	4	0.6	
369	16	14	4	0.9	ˆ
370	14	6	4	0.3	
371	9	12	3	0.2	
372	10	15	6	0.6	ˆ
373	9	11	2	0.1	
374	13	23	8	1.7	ˆ
375	11	10	6	0.4	
376	8	11	3	0.1	
377	13	9	5	0.5	ˆ
378	13	9	9	0.9	
379	13	7	6	0.4	
380	12	7	2	0.1	
381	9	12	2	0.1	
382	22	16	8	2.6	
383	17	14	3	0.6	ˆ
384	17	23	19	1.8	ˆ
385	28	20	3	2.1	
386	12	11	3	0.3	ˆ
387	18	13	9	1.7	
388	17	15	4	0.9	ˆ
389	13	10	2	2.2	
390	11	14	5	0.6	
391	10	8	5	0.4	
392	11	9	4	0.3	ˆ
393	12	9	3	0.3	
394	14	18	5	1.3	
395	15	25	4	1.3	
396	7	16	3	0.3	ˆ
397	13	9	3	0.1	
398	9	15	3	0.3	
399	12	12	1	0.1	
400	6	10	2	0.1	
MEAN	12.8	14.3	4.7	0.9	
ST DEV	4.6	13.2	2.6	0.9	

APPENDIX C: Look-Alikes Experimental Metrical data

#	l mm	w mm	th mm	wt g	cortex
1	8	12	3	0.2	
2	13	10	5	0.4	
3	16	12	2	0.3	
4	21	31	6	3.2	ˆ
5	12	6	6	0.4	ˆ
6	9	18	6	1.3	
7	16	14	14	3.9	ˆ
8	14	22	3	0.8	
9	10	13	6	0.8	
10	12	13	3	0.4	ˆ
11	19	18	12	2.3	ˆ
12	11	19	12	1.6	
13	8	11	3	0.2	
14	10	8	3	0.2	ˆ
15	10	14	4	0.3	
16	7	11	2	0.1	
17	10	14	6	0.8	
18	15	18	9	1.6	ˆ
19	9	16	5	0.4	
20	9	14	3	0.3	
21	15	11	4	0.6	ˆ
22	12	7	3	0.2	
23	10	18	8	1.2	
24	12	9	2	0.1	
25	9	9	1	0.1	
26	16	13	8	1.6	
27	10	9	2	0.2	ˆ
28	7	13	3	0.1	
29	8	14	3	0.3	
30	10	11	7	0.8	
31	8	11	2	0.1	
32	9	12	7	0.6	
33	9	22	5	0.5	ˆ
34	11	18	7	0.8	
35	16	7	2	0.1	
36	12	22	8	1.6	
37	12	9	5	0.3	
38	15	7	4	0.4	
39	9	12	6	0.6	
40	11	6	5	0.2	
41	15	30	9	4.5	ˆ
42	8	12	6	0.5	
43	7	11	3	0.2	
44	8	13	2	0.1	
45	8	8	9	0.6	
46	8	17	5	0.5	ˆ
47	2	7	6	0.2	
48	7	12	3	0.1	
49	7	10	4	0.2	
50	18	27	5	2.1	
51	19	15	12	3.8	ˆ
52	17	15	9	1.5	ˆ
53	23	18	4	1.5	ˆ
54	16	24	5	1.6	ˆ
55	7	12	4	0.3	
56	8	13	7	0.8	
57	9	15	5	0.7	
58	20	14	2	0.7	
59	18	19	5	1.3	
60	15	11	6	1.0	ˆ
61	11	8	6	0.5	
62	20	10	3	0.4	
63	15	14	9	1.4	
64	13	9	9	0.7	ˆ
65	10	14	9	1.2	ˆ
66	12	10	4	0.4	ˆ
67	11	8	6	0.4	
68	18	9	3	0.5	ˆ
69	18	17	5	0.7	
70	17	17	9	1.4	
71	25	14	5	1.3	ˆ
72	13	12	6	0.5	
73	16	16	5	1.0	
74	14	13	12	2.5	
75	12	8	5	0.4	
76	15	9	5	0.5	ˆ
77	13	10	5	0.6	
78	8	13	4	0.2	
79	9	17	3	0.3	ˆ
80	12	16	6	1.1	
81	7	15	6	0.5	ˆ
82	11	10	6	0.6	
83	7	13	2	0.1	
84	6	10	3	0.1	
85	10	7	2	0.1	
86	12	10	4	0.2	
87	16	9	6	0.5	ˆ
88	10	14	3	0.3	ˆ
89	10	8	7	0.6	
90	10	12	5	0.3	
91	11	6	3	0.1	
92	15	6	4	0.3	
93	7	8	5	0.1	
94	11	10	4	0.4	
95	13	9	8	0.5	
96	10	12	6	0.6	
97	6	14	2	0.2	
98	8	14	4	0.2	
99	12	9	5	0.6	ˆ
100	13	15	8	1.2	
101	8	15	4	0.4	
102	13	9	3	0.2	
103	10	8	2	0.1	

LOOK-ALIKES METRICAL DATA con'd

#	l mm	w mm	th mm	wt g	cortex
104	14	11	5	0.6	ˆ
105	8	10	2	0.1	
106	8	8	5	0.2	
107	7	10	2	0.1	
108	6	8	2	0.1	
109	8	13	2	0.2	
110	8	11	3	0.2	
111	5	11	2	0.1	
112	9	6	4	0.1	
113	7	11	4	0.2	
114	13	12	11	1.6	
115	8	13	6	0.5	
116	12	10	9	0.7	
117	7	14	4	0.3	
118	14	7	3	0.3	ˆ
119	7	16	5	0.3	ˆ
120	9	4	2	0.1	ˆ
121	11	5	3	0.1	ˆ
122	10	6	5	0.2	
123	12	11	1	0.1	
124	13	5	2	0.1	
125	10	15	4	0.5	
126	15	7	7	0.6	
127	9	14	2	0.3	
128	9	10	3	0.2	
129	10	12	6	0.6	
130	11	17	3	0.4	
131	19	9	5	0.5	ˆ
132	5	9	1	0.0	
133	7	9	2	0.1	
134	10	11	2	0.3	
135	15	14	3	0.7	ˆ
136	12	15	7	1.2	
137	12	7	5	0.3	
138	8	11	2	0.1	
139	6	9	3	0.1	ˆ
140	14	12	4	0.5	ˆ
141	10	7	4	0.2	
142	8	10	3	0.1	
143	16	6	5	0.4	ˆ
144	17	17	7	1.4	
145	12	10	6	0.7	
146	6	9	5	0.2	
147	9	11	5	0.4	ˆ
148	15	8	6	0.8	ˆ
149	9	9	4	0.1	
150	10	5	3	0.1	
151	19	9	6	0.7	
152	6	16	5	0.4	
153	8	10	3	0.1	ˆ
154	8	11	4	0.2	ˆ
155	9	4	3	0.1	
156	9	4	3	0.1	
157	6	10	4	0.2	
158	8	7	5	0.2	
159	12	4	3	0.1	ˆ
160	8	5	4	0.1	
161	20	20	6	2.2	ˆ
162	11	17	11	2.6	ˆ
163	12	15	4	0.5	
164	12	13	7	0.9	
165	14	12	5	0.5	
166	11	15	4	0.7	ˆ
167	12	12	7	0.7	
168	8	12	3	0.2	
169	12	12	7	0.8	
170	11	8	6	0.4	
171	4	10	5	0.1	
172	9	11	4	0.3	ˆ
173	5	9	4	0.2	ˆ
174	8	10	4	0.2	
175	10	6	1	0.1	
176	9	6	3	0.1	
177	9	5	4	0.1	ˆ
178	10	4	3	0.1	ˆ
179	10	6	2	0.1	
180	10	7	2	0.2	ˆ
181	8	9	6	0.4	ˆ
182	8	5	3	0.1	ˆ
183	5	7	2	0.1	
184	11	15	6	1.1	
185	16	18	8	1.8	
186	15	12	6	0.7	
187	13	12	9	1.1	ˆ
188	12	24	5	1.0	ˆ
189	19	26	8	3.3	
190	8	15	7	0.9	ˆ
191	10	15	7	0.7	
192	15	7	6	0.4	ˆ
193	12	10	6	0.6	ˆ
194	18	7	6	0.8	
195	11	6	4	0.2	
196	8	8	6	0.3	
197	12	12	4	0.7	
198	16	12	3	0.6	ˆ
199	7	7	4	0.1	
200	7	5	4	0.1	
201	9	12	3	0.2	
202	6	8	2	0.1	
203	13	9	2	0.2	
204	8	8	3	0.1	
205	8	6	5	0.1	
206	11	6	2	0.1	ˆ
207	13	4	3	0.1	

LOOK-ALIKES METRICAL DATA con’d

#	l mm	w mm	th mm	wt g	cortex
208	6	6	2	0.1	
209	6	5	2	0.0	
210	5	9	4	0.1	
211	11	9	4	0.3	
212	6	6	5	0.1	
213	14	9	6	0.7	
214	8	6	4	0.2	
215	9	5	2	0.0	
216	11	11	4	0.3	ˆ
217	13	13	6	1.2	ˆ
218	10	5	3	0.1	
219	8	7	5	0.2	
220	11	18	6	0.6	
221	8	8	7	0.4	
222	10	9	5	0.4	
223	8	13	5	0.3	ˆ
224	8	10	4	0.2	
225	15	12	7	1.0	ˆ
226	16	10	7	1.2	
227	9	5	5	0.2	
228	7	5	5	0.1	
229	6	9	5	0.2	
230	9	5	4	0.1	
231	9	7	2	0.1	ˆ
232	8	10	2	0.1	
233	7	9	3	0.2	ˆ
234	7	7	3	0.1	
235	7	8	2	0.1	
236	5	6	1	0.0	
237	12	5	3	0.1	
238	4	5	2	0.1	ˆ
239	6	8	1	0.1	ˆ
240	6	7	2	0.1	
241	6	5	2	0.1	
242	12	6	3	0.1	ˆ
243	6	6	2	0.7	
244	16	11	6	0.7	ˆ
245	12	9	6	0.7	ˆ
246	18	7	6	0.7	
247	14	5	5	0.2	
248	8	10	5	0.4	ˆ
249	12	7	6	0.4	
250	15	8	5	0.4	ˆ
251	15	15	11	1.6	ˆ
252	11	9	5	0.3	
253	7	11	4	0.3	
254	10	7	6	0.4	
255	9	8	2	0.1	
256	11	4	3	0.1	ˆ
257	9	4	5	0.1	ˆ
258	8	5	2	0.8	ˆ
259	8	7	1	0.4	
260	8	4	3	0.1	
261	9	3	2	0.0	
262	8	4	3	0.1	
263	11	9	4	0.3	
264	5	7	1	0.0	
265	8	6	5	0.2	
266	8	4	1	0.1	
267	5	16	6	0.3	ˆ
268	14	7	3	0.3	
269	16	9	7	1.1	ˆ
270	12	9	4	0.3	
271	18	11	6	1.0	
272	10	10	7	0.5	
273	10	12	4	0.4	ˆ
274	11	8	3	0.2	
275	11	15	4	0.4	ˆ
276	6	7	3	0.1	
277	7	5	2	0.1	
278	10	8	3	0.1	
279	10	12	5	0.5	
280	10	5	4	0.1	
281	7	9	5	0.2	
282	7	11	2	0.1	
283	9	13	3	0.2	ˆ
284	6	9	3	0.1	
285	7	12	1	0.1	ˆ
286	6	6	4	0.1	
287	11	24	7	1.1	
288	14	8	4	0.4	
289	7	11	8	0.5	
290	7	10	3	0.2	
291	6	17	4	0.3	ˆ
292	10	8	6	0.3	
293	4	6	3	0.1	
294	10	11	7	0.5	
295	7	8	2	0.1	ˆ
296	7	8	6	0.1	
297	3	17	2	0.1	ˆ
298	6	7	2	0.1	
299	7	13	7	1.3	ˆ
300	14	13	10	1.4	
301	11	18	6	0.6	
302	8	9	6	0.4	
303	7	9	4	0.2	ˆ
304	8	13	4	0.3	
305	3	9	4	0.1	
306	9	12	8	0.7	
307	12	13	10	0.9	
308	7	10	2	0.1	
309	9	14	3	0.3	ˆ
310	9	4	2	0.1	
311	8	4	3	0.0	

LOOK-ALIKES METRICAL DATA con’d

#	l mm	w mm	th mm	wt g	cortex
312	6	10	1	0.0	
313	6	8	1	0.1	
314	16	9	8	0.7	
315	8	16	4	0.3	
316	10	10	4	0.2	ˆ
317	10	6	5	0.2	
318	9	9	7	0.5	ˆ
319	17	7	5	0.6	
320	8	8	3	0.3	ˆ
321	7	5	2	0.1	
322	6	8	2	0.1	
323	8	6	2	0.1	ˆ
324	13	8	2	0.2	ˆ
325	9	7	3	0.1	ˆ
326	10	17	3	0.5	ˆ
327	9	7	5	0.2	
328	11	11	4	0.2	
329	7	5	3	0.1	
330	20	12	9	1.8	ˆ
331	8	6	6	0.2	
332	12	5	4	0.2	
333	14	8	3	0.1	
334	20	12	3	0.5	
335	7	6	6	0.2	
336	10	7	7	0.2	
337	6	13	2	0.1	
338	7	10	3	0.1	ˆ
339	10	11	2	0.2	
340	10	8	4	0.3	
341	13	15	3	0.4	
342	13	13	3	0.5	
343	7	10	2	0.1	
344	15	31	8	3.0	ˆ
345	25	11	5	0.9	
346	10	8	3	0.2	
347	13	8	4	0.3	
348	8	9	5	0.3	ˆ
349	14	20	13	3.0	
350	12	8	2	0.1	
351	31	18	10	4.6	ˆ
352	15	13	3	0.8	ˆ
353	14	17	6	1.1	ˆ
354	13	12	13	3.6	
355	11	13	3	0.4	
356	6	9	4	0.1	
357	16	14	5	1.0	
358	11	11	8	0.8	ˆ
359	10	10	5	0.3	ˆ
360	8	15	4	0.3	
361	9	14	4	0.3	
362	19	21	6	1.8	
363	5	7	5	0.1	
364	22	17	10	4.0	ˆ
365	17	17	8	1.8	
366	8	24	6	0.7	ˆ
367	14	13	5	0.8	
368	22	10	5	1.1	ˆ
369	11	12	4	0.3	ˆ
370	13	8	2	0.1	
371	22	24	5	1.6	
372	10	19	10	2.2	ˆ
373	16	10	7	1.4	
374	11	14	4	0.5	ˆ
375	8	13	2	0.1	
376	12	11	3	0.4	ˆ
377	14	19	7	1.5	ˆ
378	10	16	9	1.3	ˆ
379	13	12	9	1.3	ˆ
380	13	12	10	1.5	
381	13	15	5	1.7	
382	7	10	6	0.3	
383	9	9	6	0.4	
384	13	9	4	0.4	ˆ
385	12	8	4	0.2	
386	11	9	3	0.3	
387	15	12	5	0.4	ˆ
388	25	7	6	0.7	ˆ
389	22	10	6	1.7	ˆ
390	21	11	6	1.3	
391	15	10	5	0.7	
392	18	17	7	1.4	
393	13	6	6	0.5	
394	13	8	7	0.6	ˆ
395	10	5	3	0.1	
396	12	6	4	0.2	
397	15	12	7	1.0	ˆ
398	10	11	7	0.5	ˆ
399	8	17	4	0.6	
400	13	15	4	0.5	
MEAN	10.8	10.7	4.6	0.5	
STA.DEV	4.1	4.6	2.3	0.7	