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INTERPRETING GEOCHEMICAL SOURCING IN THE NORTHWEST GREAT BASIN: THE 26WA12962 SAMPLE STUDY

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INTERPRETING GEOCHEMICAL SOURCING IN THE NORTHWEST GREAT BASIN: THE 26WA12962 SAMPLE STUDY

A Thesis

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Applied Archaeology

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by

Tyler Alexander Reinholt

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ABSTRACT

Located in Northwest Washoe County Nevada along the California and Nevada border, 26WA12962 is an upland spring site consisting of habitation debris and several thousand pieces of debitage on the surface. The purpose of this research project is to interpret energy dispersive x-ray fluorescence (EDXRF) results of 80 random samples of obsidian, and fine grain volcanics such as basalt and dacite from the excavations on 26WA12962 that were conducted in 2021. This thesis will investigate if there is a preference for a specific source, as well as assisting in gathering data within a lithic landscape. To accomplish this goal, I utilized XRF test results and ethnographies to answer three research questions: 1.) Where is the obsidian and basalt coming from? Is it local or exotic? 2.) Is there a preference for a specific material? If so, which material? And 3.) Is there an explanation for the preference using Ethnographies? For the purpose of my thesis, I am defining local to be the territory of the Kamotkut or 112.6 km (70 miles) from the site (Smith 2010).

I was ultimately able to determine that 55% of the sources that were identified were local while 34% was undetermined and the remaining 16% was exotic. There also appeared to be a preference for the Bordwell spring group of obsidian. The location of material from these sources being found at the site can be attributed to the seasonal round partly. The other explanation for the material could be attributed to opportunistic gathering.

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CHAPTER ONE

INTRODUCTION

Volcanic stones have been considered important by many people since time immemorial for many reasons, including their desirable knapping qualities and unique appearance. Today, they are an important part of the way archaeologists' study various aspects of cultures of the past because it assists in understanding the way people utilized and traveled across the landscape. To help understand where the volcanic material originated, scientists use a non-destructive chemical analysis called X-ray fluorescence or XRF (Wirth and Barth 2020). One of the importances of knowing where the material came from, is to help understand land use patterns.

One of the many archaeological sites that contains tools or debitage made from volcanic material is site 26WA12962. This site is located in northwestern Nevada within the northern Great Basin. An important thing to understand about the northern Great Basin is that it is characterized by significant volcanic activity. With this volcanic activity comes obsidian and fine grain volcanic (FGV) material. For this area in particular, there are over a dozen different obsidian sources and FGV sources within 160.93km (100 miles) of 26WA12962. Because of the large amount of sources in the area, there are a lot of archaeological sites of varying nature that contain material from many of these sources. To help identify these sources, an X-ray fluorescence or X-ray fluorescence spectrometer (XRF) is used. XRF is a safe and non-destructive chemical analysis of rocks, minerals, sediments, and fluids (Wirth and Barth 2020).

This research aims to analyze and interpret XRF data collected from samples obtained at site 26WA12962, with a specific focus on determining the provenance of obsidian and basalt and discerning whether they are of local or exotic origin. Additionally, the study seeks to identify any material preferences that may be present and explore their socio-cultural implications through ethnographic analysis.

So, to answer these questions I start by providing the background of the Great Basin region, including the geologic history and a regional chronology, as a foundation and explanation for the archaeological record. From there, I discuss the theoretical framework that guided the research into volcanic material sources and the use of XRF to obtain the data. The methods chapter details what methods I utilized in my research. My results chapter displays the results that I am going to interpret for my interpretation and discussion chapter.

CHAPTER TWO

BACKGROUND

This chapter will provide background information on the archaeology, environmental settings and the different tests that can be completed with the various toolstone found at the site. The purpose of this chapter is to give a broad background on the region as well as a brief description of the different tests that were conducted on artifacts.

Environmental Setting

The focus of my research is a site called 26WA12962 located in northwestern Washoe County Nevada. Northwestern Washoe County is located in an area of the United States called the Great Basin. The Great Basin encompasses parts of Utah, Oregon, Idaho, California, and most of Nevada and is known as a high desert or even a cold desert. What this means is that most precipitation falls in the form of snow and still receives less than 25 cm or 10 in (National Park Service 2021). Due to the low amount of precipitation, the vegetation is not as dense and lush as places with more water. The vegetation that is associated with the Great Basin includes juniper (*Juniperus occidentalis & Juniperus osteosperma*), pinyon (*Pinus monophylla*), curl leaf mountain mahogany (*Cercocarpus ledifolius*), quaking aspen (*Populus tremuloides*), pines (Pinus), cottonwood (*Populus angustifolia*), sagebrush (*Artemisia tridentata,* *Artemisia nova, Artemisia arbuscula*), and greasewood (Glossopetalon spinescens). There are also numerous geophytes, food bearing shrubs, roses etc. (New World Encyclopedia Contributors 2022). A geophyte is a plant with an underground storage where it holds its water and energy. These types of plants include tubers, corms, or rhizomes with some common geophytes being carrots, ginger, potatoes, and garlic. Some of the fauna that is associated with the Great Basin include pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*), bighorn sheep (*Ovis canadensis*), mountain lions (*Puma concolor*), coyote (*Canis latrans*), jackrabbits (*Lepus spp*.), skunks (*Mephitis mephitis*), several species of trout, several species of ground squirrels, various lizards, snakes, sage grouse (*Centrocercus urophasianus*), golden eagles (*Aquila chrysaetos*), magpies (*Pica hudsonia*), and meadowlarks (*Sturnella neglecta*) (New World Encyclopedia Contributors 2022).

While all of these plants and animals are associated with the Great Basin, they are not all found at or near the site. For instance, pronghorn antelope, mule deer, ground squirrels, various birds, lizards and snakes can occasionally be seen in the area. However, since settlement of Euro-Americans, cows (*Bos taurus*) and wild horses (Equus ferus) have been introduced into the area and are competing with the native wildlife for resources. As for vegetation, the area today consists of juniper trees, low sagebrush, rabbitbrush (*Ericameria nauseosa)*, Great Basin Wild Rye (Leymus cinereus), wild rose (*Rosa woodsii*), iris (*Iris missouriensis*), various species of lupine, various species of rush, snowy thistle (*Cirsium occidentale var. candidissimum*), various bunch grasses and several other riparian type plants.

Geology

26WA12962 is located within 14.48 km (9 miles) of Duck Lake in northwestern Washoe County, Nevada in the northern Great Basin located in between Duck Flat and the Smoke Creek Desert. This section of the Great Basin is characterized by a series of valley-basins separated by northeast trending block fault mountains made of basalt and andesite (Creger 1991, 6). Surrounding block-fault mountains around the site are the Buffalo Hills to the south and southeast and the Coppersmith Hills to the northwest (Creger 1991, 6). The site itself is roughly 6,300 feet above sea level and gets on average 8 inches of precipitation a year. This precipitation comes in the form of snow. Even with the low amount of precipitation that the site obtains, it is not located in a dry barren area. There is a spring seep on site that produces quite a bit of water. As for the soil for the site and the surrounding area, it is characterized as a Redhome-Softscrabble association. This means that the soil type is described as being consisted of volcanic ash, colluvium and residuum weathered from volcanic rock (Soil Survey Staff). During the Pleistocene, both Lake Lahonton and Lake Surprise at their fullest would have flanked the site to the north with Lake Surprise and south with Lake Lahonton.

With the varying geology of the surrounding area, there are several diagnostic toolstone sources nearby. These sources are broken up by being within 16 km (10 miles), 48 km (30 miles), 80.4 km (50 miles), 112.6 km (70 miles). The sources located within 16 km include; Duck Flat (Moore 2009). The sources within 48 km include Duck Flat, Chester Lyon Spring, Cherry Mountain, Big Antelope Spring, Borwell Spring, Fox Mountain, South Warners, Rainbow Mines, Alaska Canyon, Dodge Reservoir, Sworinger Reservoir, Dolly Varden Basin, Grass Valley Spring, Buffalo Hills and Bare Creek. Sources within 80.4 km include Nellie Spring, Mahogany Mountain, Denio Camp, Coyote Sporing, Massacre Lake/ Guano Valley, Jess Valley, Grassy Ranch, Hog Ranch, Stevens Camp, South of Pinto Peak, Coleman, North Dry Valley, Fredonyer Peak, and Crabapple. The sources within 112.6 km include Plumb Valley Campground, Buck Mountain, Needles, Warner Obsidian, Harris Flat, Sugar Hill, Cold Creek, Trough Spring, Blue Spring, Mosquito Lake, Badger Creek, Chalk Spring Junction, Davis Creek, Lassen Creek, Lodgepole, Middle Fork, Needle Glass Spring Junction, Nelsson Quarry, North Cottonwood Flat, North Fork, Pink Lady, Tick Rise, Upper Ross Creek, South Hanging Rock, Summit Lake, Windmill Quarry, Mount Majuba, Poker Brown Gap, Siegfried Canyon, and the Alturas Airport. (Amick 2004; Bloomer and Jafke 2009; Ericson 1977, 1981; Ericson et al. 1976; Gates 2005; Gates and Howe 2003; Howe 2002; Hughes 1982, 1982, 1985, 1986, 2011; Hughes and Howe 2017; James 1983; Jones et al. 2003;

Kappele 1998; King 2016; LaLande 1990; LaValley 2013; Luhnow 1997; Macdonald et al. 1992; Mack 2015; Macko et al. 2005; Moore 2009; Musil and O'Neill 1997; O'Connell and Inoway 1994; Pinson 2011; Sappington 1981a, 1981b; Shackley 2018; Smith 2010a; Stueber and Skinner 2015; Young 2002).

Site Description

The site known as 26WA12962 was initially recorded in 2014 and 2016 and was described as a multicomponent site containing over 2,200 obsidian (98%), cryptocrystalline silicate (CCS) (2%), dacite and basalt flakes, 8 bifaces, 3 edge modified flakes, 17 manos, 20 metates, a pestle, a manuport, 11 projectile points (Great Basin Stemmed, Bare Creek, Elko, Eastgate, Rose Spring, Desert Side-Notched, small stemmed and large side-notched) petroglyph panels, a bedrock mortar, a bedrock milling slick, three rock stacks and a historic pit reservoir (Matthews 2016). All of these various artifacts and features that were found are evidence of habitation and resource procurement and processing. The amount of artifacts that were present at the site indicate that it has been used over and over again for thousands of years. As for the pit reservoir, it was most likely created before the 1950s, but no definitive date can be ascertained.

Indigenous Communities

People have occupied the Northwest Great Basin since time immemorial. At the time of European contact, the Northern Paiute were occupying the northern Great Basin and are associated with the Numic Spread and associated with smaller arrow sized projectile points (Hildebrandt et al. 2016, O'Connell and Inoway 1994 and O'Connell 1975). The Northern Paiute social organization was described as hunter-gatherers who would occupy seasonal villages and seasonal camps traveling from location to location following food and toolstone resources (Jones et al. 2003; Kelly 1932:75; Tiley and Rucks 2020). Unfortunately, the Kamotkut Band of the Northern Paiute have been overlooked by anthropologists and archaeologists (Tiley and Rucks 2020). Because of the Kamotkut being heavily overlooked, there is a lack of ethnographies and works that have included the communities' input and has made it rather difficult to gather more in-depth information about them.

The several indigenous communities that called this region home have varied since time immemorial. The latest group to have lived and thrived in this region and are still doing so today, are the Northern Paiute, more specifically the Kamotkut (Jackrabbit-eaters) of the Smoke Creek and Black Rock Desert (Tiley and Rucks 2020, 225). The believed ancestral territory of the Kamotkut stretched from just north of Duck Lake in Washoe county, to the Black Rock Desert to the east, just north of Pyramid Lake and just east of McDonald Peak and the

Madeline Plains in California to the west. This band territory was bordered by the Gidutokadu (Woodchuck eaters) to the north, the Hammawi Band of the Pit River in the northwest, the Wadatkut (Wada eaters) of Honey Lake to the southwest, the Agaipaninadokado (Fish Lake eaters) to the northeast, the Kupadokado (Ground squirrel eaters), and the Kuiyuidokado (Black sucker eaters) (Stewart 1939; Tiley and Rucks 2020, 226).

The Kamotkut were hunters and gatherers who occupied seasonal villages. Traveling was part of everyday life for the Kamotkut, as they followed a seasonal round that stretched all the way to a geologic formation called the Needles on the north end of Pyramid Lake Nevada. Due to the vicinity of 26WA12962 to Duck Lake, it is likely that the site was occupied during the late summer and fall by the Kamotkut.

Archaeology

Some of the earliest works that have been conducted in the region. These early works helped create and establish a chronology of the region. Some of these early works were conducted by Dr. O’Connell who focused on the Surprise Valley, Riddell and Olsen who focused on the western periphery of the Great Basin, and Melinda Leach who focused on the Massacre Lakes region (Leach 1988, O’Connell 1975, O’Connell and Inoway 1994, Riddell 1958; Riddell and

Olsen 1962). These were then built upon by Far Western for two pipeline projects in the area.

The two large pipelines that traverse through the region are the Tuscarora pipeline and the Ruby pipeline. These large projects have provided a significant amount of information related to the chronology of the region. The timeline used in this paper is the Ruby Pipeline conducted by Far Western. From this project, many obsidian hydration tests were conducted that helped provide a better look into dates of sites within the Norther Tier of Nevada (Hildebrandt et al. 2016). One hypothesis that came from these tests are that in Paleo-Indian sites within Northwest Washoe County Nevada, demonstrate a favor of higher quality obsidian from far off obsidian sources versus the closer sources (McGuire and Hildebrandt 2016: 77). These sources change with the location of the sites. This preference for distant higher quality obsidian decreased over time and becomes very apparent in the Late Archaic and then increased once again in the protohistoric period (Hildebrandt et al. 2016).

Chronology

Due to trends in archaeology grouping chronologies on a regional scale to make it easier to date a site, there are a number of different chronologies that have been suggested. The one that I will be using has been suggested by Far Western as part of their book that was published on their results of the Ruby

Pipeline. The reason that I am using the publication on the results of the Ruby Pipeline is because they have created a descriptive and accurate summarization of the chronology. I know that I am not providing a date for when the site was occupied, the various time periods provide an insight into the ways toolstone was procured. Figure 1 is the chronology with dates in B.P with common projectile points typologies that will be referenced. Point typology is just one way of relatively dating a site, another way is through using generalized trends that are associated with certain cultural periods. One of these trends that help associate with a specific cultural period is toolstone acquisition. For the Pre-Clovis, Clovis, Paleoarchaic, Post-Mazama periods, there tends to be trends of nearby material versus material from further away from sites (King 2016). This trend shifts from an opportunistic collection of toolstone because of being a highly mobile people, to a more targeted collection process with the change in mobility and becoming more sedentary. Even though this trend of targeted collection is evident, the nearby sources are still being targeted over further away sources of higher quality (King 2016). This trend of nearby targeted sources continues all the way through the middle archaic and late archaic time periods but shifts in the terminal prehistoric period. According to King, this is because there was an increase in trade interaction and "disregard for the economics of transporting the material" (321).

Pre-clovis

For the Pre-clovis cultural period, evidence of biface use, debitage, cordage and butchered bones of Pleistocene megafauna. These trends were some of the samples that were found at the accepted Pre-clovis site of Paisley Cave in Nevada. One of the issues that make it hard to separate Pre-clovis sites from younger sites is the emphasis on using simple flaked tools (Hildebrandt et al. 2016: 72). It is also believed that the preference for toolstone tends to be whatever is closer versus what is a higher quality (King 2016: 310).

Clovis

Clovis or Paleoindian sites are associated with bifacial blanks, knives, scrappers, and gravers but lack milling tools and show a preference for obsidian from nearby sources and appear to be around wetland habitats (Hildebrandt et al. 2016, 72, King 2016, 310). While the Clovis culture is often thought of as large game hunters, in the Northwest Great Basin there is a different trend. This trend shows that smaller games were the focus along with marshland resources for a food source for this culture. This can be seen through the obsidian tool assemblages that are associated with small game hunting. During the Paleoindian time period, people were seen as highly mobile foragers and tend to settle around bodies of water (Hildebrandt et al. 2016: 72-73).

Paleoarchaic

The Paleoarchaic period is marked with Great Basin Stemmed projectile points, scrapers, large bifacial knives, gravers, crescents, Catlow Twinning style baskets and occasionally ground stone. There is still a focus on marshland habitats for subsistence and still rely heavily on being highly mobile (Hildebrandt et al. 2016: 76; Jones et al. 2003).

Post-Mazama

The Post-Mazama cultural period is marked by an ash layer from the erupted Mt. Mazama, now called Crater Lake, marked the end of the Paleoarchaic cultural period with a change in assemblages and trends seen at sites. During the Post-Mazama time period, Northern Side-Notched projectile points appear as well as a decrease in population due to environmental factors. For the research area, the first semisubterranean houses appeared and strengthens the argument that the people of Surprise Valley were sedentary opportunistically (Hildebrandt et al. 2016: 80; O'Connell 1975).

Early Archaic

The Early Archaic time period had a transition from semisubterranean houses to smaller brush wickiups (Creger 1991: 59). During this period, toolkits consisted of "U-Shaped grinding bowls and flat- or round-ended pestles and a greater use of the milling stone" (Hildebrandt et al. 2016: 81). This indicates that there is more of an increase is plant utilization for food. There is also a shift from a more opportunistic sedentary lifestyle to a "more residentially mobile bandlike foragers" (Hildebrandt et al. 2016: 82).

Middle Archaic

Considered the “golden age” of California and the Great Basin by many ecologists and archaeologists, the middle archaic time period can be seen as the best time to be alive in the area. The environment became cooler and wetter. Due to the environment shift, ecological sweet spots were created and at these spots, semi-sedentary occupations existed (Hildebrandt et al. 2016: 83). An increase in large game hunting also occurred during this time period and evidence of this can be seen at the Gatecliff Shelter. Because of this increase in large game hunting, there was also an increase in plant use to offset the variability in the results of hunting (Hildebrandt et al. 2016: 84).

Late Archaic

One of the largest changes that occurred in this time period is the introduction of the bow and arrow. Towards the end of this time period, the beginning of the suggested Numic Spread occurred. Evidence of this is seen in the types of basketry that is being used and created as well as mitochondrial DNA studies showing different groups between people before this time period and during (Hildebrandt et al. 2016: 89). There has also been a significant decrease in large game hunting, and “appears to have depended heavily upon the seasonal exploitation of root crops” (Hildebrandt et al. 2016: 90).

Terminal Prehistoric

The Numic Spread has occurred and the Northern Paiute traveled from the south near the Mojave Desert (Hildebrandt et al. 2016: 92). During the

Terminal prehistoric period, there was an increase in expedient tools, large unshaped block metates, an increase in milling stones and a dispersed settlement pattern. Delacorte offered the idea that there is an increase in opportunistic exploitation of local toolstone sources and reworking of older obsidian debris (Hildebrandt et al. 2016: 94).

Table 1 Chronology of the Region

Cultural Period	Date B. P	Common Projectile Points
Pre-Clovis	14,500-13,500 B. P	Pre-Clovis
Paleoindian	13,500-12,800 B. P	Clovis, Great Basin Concave Base and some Great Basin Stemmed
Paleoarchaic	12,800- 7,800 B. P	Great Basin Stemmed
Post-Mazama	7,800- 5,700 B. P	Northern Side-Notched, Humboldt, Large Corner Notch
Early Archaic	5,700-3,800 B. P	Gatecliff, Humboldt
Middle Archaic	3,800- 1,300 B. P	Elko, Gatecliff, Humboldt
Late Archaic	1,300- 600 B. P	Rosegate, Small stemmed
Terminal Prehistoric	600 B. P- contact	Desert-Side Notch, Cottonwood

X-ray Fluorescence

X-ray fluorescence or X-ray fluorescence spectrometer (XRF) is a safe and non-destructive chemical analysis of rocks, minerals, sediments, and fluids (Wirth and Barth 2020) For my thesis, the samples of the surrounding toolstone sources have already been collected by a California based Laboratory called Geochemical Lab Research run by Richard Hughes. XRF is a useful tool in helping interpret the material preference of prehistoric peoples. In an article published in 2010 by Geoffrey M. Smith, “Researchers routinely use XRF date to reconstruct prehistoric ‘lithic conveyance zones’” and mentions that some researching believe that these lithic conveyance zones represent foraging territories (Smith 2010: 866). With this idea, archaeologists can see if the material found at a site is likely from a local source or if the material or exotic. The definition of local for the purpose of this paper is no more than 112.65 kilometers (70-mile) radius from the site and is explained in my methods chapter.

There have been a number of studies done in the area that included XRF studies. Several of them include sourcing local toolstone material (Amick 2004; Bloomer and Jafke 2009; Ericson 1977, 1981; Ericson et al. 1976; Gates 2005; Gates and Howe 2003; Howe 2002; Hughes 1982, 1982, 1985, 1986, 2011; Hughes and Howe 2017; James 1983; Jones et al. 2003; Kappele 1998; King 2016; LaLande 1990; LaValley 2013; Luhnow 1997; Macdonald et al. 1992; Mack 2015; Macko et al. 2005; Moore 2009; Musil and O’Neill 1997; O’Connell and Inoway 1994; Pinson 2011; Sappington 1981a, 1981b; Shackley 2018; Smith

2010a; Stueber and Skinner 2015; Young 2002). The XRF results are the backbone of my research as they are what I am using to determine if sites are local or exotic material and if there is a preference.

CHAPTER THREE

UTILIZED THEORIES

Lithic procurement studies can be applied when there is a large quantity of material from the same source found in the same area (Jones et al. 2003). However, there are some interesting perspectives when it comes to applying theory to lithic procurement studies. For instance, there is a thought that local materials will show up further from the source in either reworked or broken stages due to its “tool-using events increases” (Jones et al. 2003). In contrast, others believe that non-local material is found at sites due to opportunistic gathering done by a highly mobile group of people (Binford 1980; Leach 1988; Smith 2010b). This research will look at lithic procurement at a landscape scale and further compare it to a small site-specific scale.

The direct historical approach can be described as “working from the known to the unknown” (Johnson 2020:68; Steward 1942; Stiles 1977). In a sense, it is just removing what we know from ethnographies and applying it to past cultures in an attempt to reinforce the data provided by the ethnographies true with archaeological evidence (Dawson 1977; Heizer 1941; Johnson 2020; Lightfoot 1995; Steward 1942; Stiles 1977). For this research, information regarding lithic preference will be taken from ethnographies and applied to artifacts from before and after the Numic spread (Kelly 1932; Kroeber 1925; Stewart 1939; Tiley and Rucks 2011, 2020). While this theory may be problematic due to not having information related to people before the Numic spread, it is an attempt to understand if there was a preference or avoidance of certain material. My research will be looking for any mention of toolstone sources in an attempt to explain why some of these sources are located at this particular site.

Due to the density of the research on the topic, I will narrow the geographical location to the Northwest Great Basin. The Northwest Great Basin consists of Northwest Nevada, Southeast Oregon, Northeast California, and a small sliver of Southwestern Idaho. In my research I will be using Human Behavioral Ecology or HBE, site catchment analysis, and lithic conveyance zones (Johnson 2020).

Resource utilization and procurement has long since been an area of study and has been improved upon with more modern-day technology such as XRF testing (Odell 2000). Within this study of resource procurement, there are several ways that it has been utilized in the past. For instance, there has been research into how to use toolstone sources to answer questions about mobility patterns (Jones et al. 2003), and land use patterns (Leach 1988). One way researchers can explain mobility patterns is by utilizing the idea of lithic conveyance zones in which indigenous peoples would return to a source on a cycle (Smith 2010). The broad site catchment theory could help answer land use patterns when paired with ethnographic research related to whether a group of people participated in a “seasonal round”. For this region, there has been an ethnography that was completed, and it does mention a seasonal round (Tiley and Rucks 2020).

Brief Summary of Archaeological History

A lot of the theories that I will be discussing are either processual or post-processual ideas. To understand what these two terms mean, I will discuss the brief history of both ways of thinking and what they stand for and how they fit into landscape archaeology. Starting off, processualism wanted to make archaeology more scientific and less about describing the past in a historical way. This can be seen with Leslie White and his ideas of looking at resource procurement in the way of thermodynamics and should be mathematically efficient (White 1949). Binford was another processualist that delineated past people into data points. Binford did not care about culture and how it evolved only about technology and models (Binford 1962). Since the inception of processual thought, it has changed dramatically with the creation of post-processualism. Processualism has slowly started to incorporate more ideas as the field of archaeology has grown and developed. The concept of agency was one of these ideas that post-processualism schools of thought have adopted and taken on as their own to look at archaeology as more than just models. Processualist Michael Schiffer suggested that archaeology would eventually turn into a field of 1,000 archaeologies (Schiffer 1988). This prophecy eventually came to fruition when post-processualism rose to prominence in the late 1980’s and 1990’s. This can be seen with gender studies, incorporating children at sites, indigenous archaeology, and archaeology of the senses are only some examples. Some of the prominent post-processual researchers are Hamilakis, Hepp et al, Joyce, and Atalay (Atalay 2006, Hamilakis 2014, Hepp at al. 2020, Joyce 2003). Even with all these new and needed areas of study, there is still some crossover between processualists and post-processualist. An example of this crossover is through the concept of agency or understanding that objects and people have relationships with their surroundings and each other (Harrison-Buck 2018, Robb 2010). The concept of agency fits rather well with the idea of lithic procurement studies and landscape archaeology.

Human Behavioral Ecology

HBE can be seen as a processualist theory and one that follows along the New Archaeology of the 1960's and 70's. Human behavioral ecology was developed from "cultural ecology" and "HBE explicitly takes ideas and models from ecological study as a whole and attempts to apply them systematically to human populations" (Johnson 2020). When a researcher looks at archaeology through the lens of HBE, they must look for an environmental reason for why cultures have adapted and changed. This is just a broad umbrella term that a lot of other ideas fall under. Some of these ideas are site catchment analysis, the study of lithic conveyance zones, actor network theory and symmetrical archaeology (Johnson 2020).

Human behavioral ecology does have its limitations that must be mentioned to get a better understanding of the theory. One of these faults is that HBE does not account for selfishness in egalitarian societies (Low and Heinen 1993). It just assumes that everyone is doing an action because it is the most efficient and will provide the most return. In a sense, it is looking at the actions of people in the laws of thermodynamics, more specifically the second law (Binford 1968; White 1949). The second law of thermodynamics can be described as

> "Heat does not flow spontaneously from a colder region to a hotter region, or, equivalently, heat at a given temperature cannot be converted entirely into work. Consequently, the entropy of a closed system, or heat energy per unit temperature, increases over time toward some maximum value. Thus, all closed systems tend toward an equilibrium state in which entropy is at a maximum and no energy is available to do useful work" (Drake 2023).

To look at this in a way that applies to humans, researchers concluded that humans were able to become the most efficient to a point where they were utilizing enough resources to offset all the energy that they were expending in the collection process (White 1949).

The study of human behavior ecology tends to look at the environment and how it is either the only factor or the main factor for cultural evolution. HBE, however, is a problematic idea, as there are more than just environmental factors that play into cultural evolution. Other factors may include communication with their neighboring tribes and the concept of free will amongst individuals. Even with its problems, HBE is an important way to help study archaeology on a landscape scale. This is mainly because utilizing site catchment analysis and lithic conveyance zones to help understand how the landscape was used by people is exactly what HBE was intended to do.

Site Catchment Analysis and Lithic Conveyance Zone

Site catchment analysis and lithic conveyance zones can be described as the brainchild of processual ideas. These look at archaeological sites as data and not as anything more. Site catchment is “based on the mapping of resources around a site. It is assumed that people will exploit the landscape ‘rationally,’ and that they will utilize resources in such a way as to maximize returns (Arroyo 2009; Johnson 2020:213; Roper 1979; Tiffany and Abbott 1982; Williams 2004). Lithic conveyance zones can be described as localities in which lithic material came from. For instance, if a large quantity of artifacts are made from the same material, then that source can be seen as a zone. The idea of lithic conveyance zones was developed from site catchment analysis, and they can go hand and hand. This idea of site catchment analysis got its start from Johann Heinrich von Thünen in 1826 (Nixon et al. 2010). Johann Heinrich von Thünen was using this theory to describe the economy of the pre-industrial revolution of Europe (Nixon et al. 2010). But it was not until Clarke (1978) and Lewis (1970) did the term “site catchment analysis” get attributed to prehistoric North America.

One specialty of site catchment theory is lithic conveyance zones or procurement areas. Lithic procurement areas (LPA) incorporate all lithic material that can be tested and because of this, cryptocrystalline silicate or CCS is going to be left out. CCS is being left out due their "complex chemical signatures and optical variability" (Jones et al. 2003). Because CCS is not testable due to its complex chemical signatures, it leaves a gap of information that cannot be answered yet. The idea of lithic conveyance zones was used by George Jones and his colleagues (Jones et al. 2003). They were writing about different ways to use the ideas of lithic conveyance zones. One way is looking at LPA on a large landscape scale. Large landscape scale LPA can be used to explain why local materials traveled further away from its source and why it was in large quantities (Jones et al. 2003). Melinda Leach (1988) suggested that this may be due to highly mobile foragers who create their projectile points at the non-local source that it is made of, while the tools were most likely made of local material (Leach 1988).

This idea does have some issues. One being difficult to determine whether the non-local material came from trade and exchange or if it it's a result of opportunistic collection while an individual or individuals were traveling. One of the main issues that LPA has is that it is also very ableist as it assumes that every member of the family could travel long distances without issues (Smith 2010).

The idea that everyone in a group could travel long distances at the same rate every day is not reasonable. Lewis Binford (1980) suggested that resource procurement was done for short bursts and on an opportunistic basis (Binford 1980). Binford, who believed that resource procurement was done on an opportunistic basis came to this conclusion after his work with the Nunamiut in Alaska (Binford 1980). During his work, Binford lived amongst the Nunamiut and recorded how they practiced resource procurement. In his study, Binford mentioned seasonal occupations that are utilized during resource collecting (Binford 1980). During this time, people would travel to a location that is rich in resources to collect and process the resources at the location that it was found. Binford suggested that there were two different types of "gathering" that past people practiced. These two types are collecting and foraging. Both the collectors and foragers practiced processing and collection of resources at the same location. The only difference, according to Binford, is that collectors produced larger archaeological sites and were apparently more organized (Binford 1980).

I plan on using HBE, LPA and landscape archaeology to help explain how the material that was found at my site traveled there. The LPA and HBE are being used in conjunction with ethnographies of the Kamotkut to help explain if people may have chosen certain toolstone sources over others. I also plan on using geospatial analysis to plot where the material that was tested came from. Once they are plotted on a map, I will look to see if they are local or exotic. Once again, I am using a boundary of 112.65 km (70 miles) as the cut off for local or exotic. This distance is being used because I believe that people were collecting material that was located within their ancestral territory. I will also be overlapping the toolstone source locations with a general route taken by the Kamotkut during their seasonal round.

CHAPTER FOUR

METHODS

The goal of this chapter is to provide the methodology that was implemented to answer whether the material found at the site was local or exotic, or if there is an ethnographic reason for why certain material may have been used over others as well as to see if there are any trends in specific sources. Some of the methodologies that will be mentioned in this chapter are the archaeological fieldwork, energy dispersive X-ray fluorescence (EDXRF) testing, and spatial analysis. A mixed method approach is being utilized for this thesis. The quantitative aspect of the research was obtained during the excavations of the site 26WA12962 in 2021. During the excavation of the site, 80 samples of obsidian and fine grain volcanics were collected and submitted for EDXRF testing at the California-based Geochemical Research Laboratory run by Dr. Richard Hughes. The results of the geochemical sourcing will be used to look for trends in the material and their locations using lithic procurement studies. I will also be utilizing a direct historical approach by reading ethnographies written about the Northern Paiute people of the region from the 1930s will be used (Kelly 1932; Stewart 1939; Tiley and Rucks 2011, 2020). I will be reading ethnographies to see if there is a mention of a preference for a specific source or if there are any specific activities that the Kamotkut practice that could help explain the toolstone source choice.

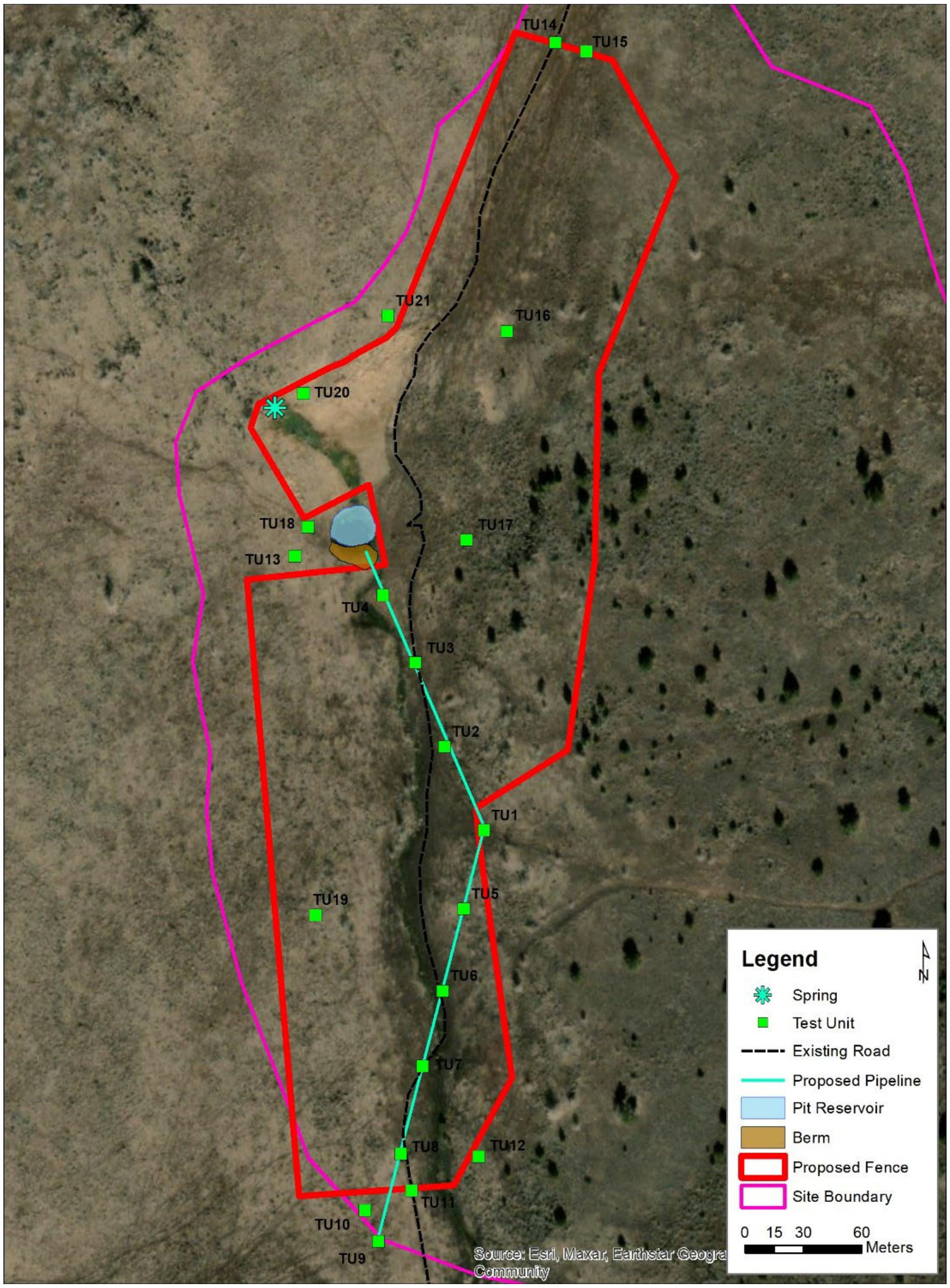

Figure 1 Test Unit Locations Courtesy of BLM (Rovanpera 2023)

Excavations

The site was excavated as part of compliance with Section 106 of the National Historic Preservation Act (1996) in 2021 due to the need of a new spring exclosure to keep the wild horses and grazing cattle out of the spring and the associated archaeological site 26WA12962. The excavations were conducted by me and the Applegate BLMs archaeologists Jennifer Rovanpera and Devin Snyder over a span of two weeks. The sampling strategy that was utilized included 50cm x 50cm units and 1m x 1m units. The smaller test units (50cm x50cm) were utilized to understand how proposed actions would affect the site while larger units (1m x 1m) were utilized to better characterize the site's cultural material and research potential. A total of 21 units were excavated throughout the site. Seventeen of the twenty-one units were 50cm by 50cm, and the remaining 4 were 1m by 1m (Figure 1). A total of 2.55 cubic meters of dirt was excavated and screened with a ¼" screen. Every unit was excavated in arbitrary 10-centimeter increments. The tools that were used to excavate were square shovels, trowels, pickaxe, and an archaeological pick. When artifacts were identified, they were taken back to the office in a labeled bag for cleaning and analysis. All units that were positive contained obsidian (TU1-3, 7, 9-14, 16-21) and units 13,16,19, and 20 contained FGV.

Unit 1 (TU1) is a 50 cm x 50 cm unit, situated at the southeast of the proposed exclosure. A total of three levels were excavated with the surface level [0-10 cm below ground surface (BGS)] being level 1. Unit 2 (TU2) is a 50 cm x 50 cm unit, situated along the proposed water pipeline located in the central section of the spring exclosure. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 3 (TU3) 50 cm x 50 cm is in the middle of an existing two-track road that bisects the site and spring exclosure. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 4 (TU4) is a 50 cm x 50 cm unit, situated in the center of the spring exclosure just east of a drainage created from the overflow of a historic pit reservoir. A total of two levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 5 (TU5) is a 50 cm x 50 cm unit, situated along the proposed water pipeline traveling from the eastern most point (TU1) southwest to outside the spring exclosure and the site boundary. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 6 (TU6) is a 50 cm x 50 cm unit, situated along the proposed water pipeline and located just east of the existing two-track road. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 7 (TU7) is a 50 cm x 50 cm unit, situated along the proposed water pipeline and located just west of the existing two-track road. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 8 (TU8) is a 50 cm x 50 cm unit, situated along the proposed water pipeline and is located just west of the existing two-track road. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 9 (TU9) is a 50 cm x 50 cm unit, situated at the terminus of the proposed water pipeline and is also the southern boundary of the site. A total of four levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 10 (TU10) is a 50 cm x 50 cm unit, situated just inside the southern boundary of the site to determine deposition. A total of four levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 11 (TU11) is a 50 cm x 50 cm unit, situated along the southern boundary of the proposed exclosure. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 12 (TU12) is a 50 cm x 50 cm unit, situated just outside of the proposed exclosure in the southeast section. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 13 (TU13) is a 50 cm x 50 cm unit, situated outside of the exclosure in the northwest of the site boundary. It is west of the historic pit reservoir and was placed to determine the deposition of the site and to determine possible damage from cattle and horses. A total of four levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 14 (TU14) is a 50 cm x 50 cm unit, situated along the northern boundary of the spring exclosure and is within the two-track road. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 15 (TU15) is a 50 cm x 50 cm unit, situated along the northern boundary of the spring exclosure and is just east of TU 14. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 16 (TU16) is a 1 m x 1 m unit, situated within a concentration of milling features located in the center of the northern section of the project. This unit was placed to determine deposition of the site in a surface concentration. A total of four levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 17 (TU17) is a 1 m x 1 m unit, situated within the center of the proposed project. This unit was placed due to the presence of a surface concentration as well as the presence of a petroglyph panel. A total of three levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 18 (TU18) is a 50 cm x 50 cm unit, situated just northeast of TU 13, it is located just outside of the exclosure, and was used to determine site deposition and possible impact to resources. Unit 19 (TU19) is a 1 m x 1 m unit, situated on a bedrock outcrop and near a large bedrock milling slab in the southwest section of the project. This location was picked due to the proximity of the bedrock milling slab. A total of six levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 20 (TU20) is a 1 m x 1 m unit, situated within the current spring exclosure in the western section of the project. This location was chosen due to its proximity to the spring seep. A total of six levels were excavated with the surface level (0-10 cm BGS) being level 1. Unit 21 (TU21) is a 50 cm x 50 cm unit, situated on the outside of the project boundary on the northwest side. A total of nine levels were excavated with the surface level (0-10 cm BGS) being level 1.

Table 2 Unit Breakdowns

Unit	Size	Total Levels	Total artifacts	Cubic Meters
TU1	50 cm x 50 cm	3	2	0.05
TU2	50 cm x 50 cm	3	6	0.05
TU3	50 cm x 50 cm	3	4	0.05
TU4	50 cm x 50 cm	2	0	0.025
TU5	50 cm x 50 cm	3	0	0.05
TU6	50 cm x 50 cm	3	0	0.05
TU7	50 cm x 50 cm	3	2	0.05
TU8	50 cm x 50 cm	3	0	0.05
TU9	50 cm x 50 cm	4	10	0.075
TU10	50 cm x 50 cm	4	9	0.075
TU11	50 cm x 50 cm	3	1	0.05
TU12	50 cm x 50 cm	3	2	0.05
TU13	50 cm x 50 cm	4	73	0.075
TU14	50 cm x 50 cm	3	2	0.05
TU15	50 cm x 50 cm	3	0	0.05
TU16	1 m x 1 m	4	80	0.3
TU17	1 m x 1 m	3	450	0.2
TU18	50 cm x 50 cm	3	6	0.05
TU19	1 m x 1 m	6	1270	0.5
TU20	1 m x 1 m	6	48	0.5
TU21	50 cm x 50 cm	9	109	0.2

X-Ray Fluorescence Spectrometry

X-ray fluorescence or X-ray fluorescence spectrometry (XRF) is a safe and non-destructive piece of equipment that provides the chemical analyses of rocks, minerals, sediments, and fluids (Del Hoyo-Meléndez 2017; Wirth and Barth 2020). This XRF test is done by taking a sample of the material and exposing it to X-ray waves. The mineral composition will be expressed in the results due to each material reacting differently. These results are then interpreted and then can be compared to known compositions of other toolstone sources (Wirth and Barth 2020). XRF is a useful tool in helping interpret the material preference of prehistoric peoples. According to Smith (2010), “Researchers routinely use XRF data to reconstruct prehistoric ‘lithic conveyance zones’” and mentions that some researchers believe that these lithic conveyance zones represent foraging territories (Smith 2010b). With this idea, archaeologists can see if the material found at a site is likely from a local source or an exotic source. As stated in my theory section, I am using a boundary of 112.65 km (70 miles) as the cut off for local or exotic.

Spatial Analysis

Spatial analysis has been invaluable to researchers due to the ability to look at a region on a scale ranging from landscape to site specific (Ebert 2004; Fitzjohn 2007; Fletcher and Robinson 2003; Gillings 2012; Hritz 2014; McCoy and Ladefoged 2009; Rennell 2012; Sharon et al. 2004; Turner and Taylor 2003; Whitley and Hicks 2003). Many archaeologists have used programs and tools that help with spatial analysis. One of the main tools used is Geographical Information Systems (GIS). With ESRI ArcMap being the most commonly used GIS program. This program is used to create site location maps and sketch maps for site records. Many agencies have used the program to create models that assist in the management of the land and its cultural resources (Ebert 2004; Fletcher and Robinson 2003). While these are not the only uses for ArcMap, these are the most common. Some of the other ways that ArcMap is used, is in application of lidar results as well as helping interpret trade and travel routes

(Fitzjohn 2007; Gillings 2012; Hritz 2014; McCoy and Ladefoged 2009; Whitley and Hicks 2003).

Due to my thesis focusing on the where the material found at the site originated from, I utilized ESRI ArcMap Pro. This program was used to create maps as well as provide spatial data to various toolstone sources that was gathered from several works (Amick 2004; Bloomer and Jafke 2009; Ericson 1977, 1981; Ericson et al. 1976; Gates 2005; Gates and Howe 2003; Howe 2002; Hughes 1982, 1982, 1985, 1986, 2011; Hughes and Howe 2017; James 1983; Jones et al. 2003; Kappele 1998; King 2016; LaLande 1990; LaValley 2013; Luhnow 1997; Macdonald et al. 1992; Mack 2015; Macko et al. 2005; Moore 2009; Musil and O'Neill 1997; O'Connell and Inoway 1994; Pinson 2011; Sappington 1981a, 1981b; Shackley 2018; Smith 2010a; Stueber and Skinner 2015; Young 2002). Utilizing GIS, I made a map and a list of the various known toolstone sources at varying distances around 26WA12962. I first started with a 10-mile buffer and exported the list of toolstone sources within that 10-mile buffer. I then replicated the process for 16 km (10 miles), 48 km (30 miles), 80.4 km (50 miles), 112.6 km (70 miles). Table 3 shows the breakdown of the material types within these buffers. I should note that the totals shown do not have the duplicates from the smaller buffer. With this list of toolstone sources and their distance from 26WA12962, they were then compared to the ancestral lands of the Kamotkut provided by Stewart, Kelly, and Tilly and Rucks to see if the toolstone sources fall within the boundaries(Kelly 1932; Stewart 1939; Tiley and

Rucks 2011, 2020). To do this, I utilized the landmarks described in these ethnographies to see if the locations of the various sources fall within these landmarks.

Table 3 Number of Toolstone Sources and Their Distances from Site

Distance from 26WA12962 (Kilometers)	Obsidian	Fine-grain Volcanic	Total
16	4	0	4
48	93	1	95
80	113	14	127
112.65	236	24	260

Summary

I conducted excavations in 2021 as part of my job working with the BLM Applegate Field office. After the excavations were completed, artifacts were cleaned, analyzed and a random sample of 80 obsidian and fine-grained volcanics were sent to the Geochemical Laboratory for XRF testing. I created a list and count of toolstone sources within a 16 km (10 miles), 48 km (30 miles), 80.4 km (50 miles), 112.6 km (70 miles) buffer of 26WA12962 within GIS using the buffer tool. This was done to show the large number of sources that could have been collected from and where they are located in relation to the seasonal round conducted by the Kamotkut.

CHAPTER FIVE

RESULTS

As stated in the previous chapter, an EDXRF machine was able to determine the chemical composition of the samples that were submitted for testing. From these chemical compositions, a total of seven sources were identified by Dr. Richard Hughes (Hughes 2022). Dr. Richard Hughes was able to determine the source of the material by comparing the chemical composition of the test samples to source compositions. These sources are: Bordwell Spring (BS), Buffalo Hills, Fox Mountain (FM), Gold Lake Basalt, Pinto Peak (PP), South Warners, unknown dacite (Hughes 2022). It should be noted that the unknown dacite is three different sources reported as unknown dacite/basalt, unknown dacite I and unknown dacite, but their locations are unknown at this time. The results from the EDXRF test measured for Strontium (S), Yttrium (Y), zirconium (Zr), Niobium (Nb), Barium (Ba), Titanium (Ti), Manganese (Mn), and Iron (Fe) in parts per million (ppm) (Hughes 2022). To show that the materials are different, the best method of reading the results are through comparing Zr and the Y/Sr ratio and Zr/Rb ration by Fe/Mn ratio (Figure 1 and Figure2) (Hughes 2022).It can be seen that Bordwell Spring, Pinto Peak and Fox Mountain either overlap or are grouped very closely depending on the ratios being interpreted. This overlap may be explained due to the age and material being from the same lave flow but were shaped and deposited by the Pleistocene lakes (Young 2002:80). For this research, I will refer to them individually except for the mapping purposes. The main reason that BS/PP/FM are being grouped together for the mapping is because a majority of the location data that I have access to, do not differentiate between the three and just call them BS/PP/FM.

My research will analyze energy dispersive X-ray fluorescence (EDXRF) results. EDXRF is faster than XRF and only takes roughly 30 seconds per sample to get results. Unfortunately, the test is not as effective when testing smaller samples (Hughes 2022; Mandal et al. 2003; Shackley 1991). The EDXRF results will then be compared to see which source the sample is from. The samples of the surrounding toolstone sources have already been collected by California-based Geochemical Research Laboratory run by Dr. Richard Hughes. This is the same location where the samples were sent for testing. A total of 80 randomly selected samples were sent for testing. These samples consisted of tools and debitage that came from the surface and several test units throughout the site. Most of the tools that were submitted came from the surface except for very few that were uncovered in various test units. As for the debitage, they were selected randomly from different units and levels, as we did not collect from the surface for these, to best provide a random sample of material use throughout the site.

> "The obsidian was analyzed by a "QuanX-EC™ (Thermo Electron Scientific Instruments Corporation) EDXRF spectrometer equipped with a

silver (Ag) x-ray tube, a 50 kV x-ray generator, digital pulse processor with automated energy calibration, and a Peltier cooled solid state detector with 145 eV resolution (FWHM) at 5.9 keV. The X-ray tube was operated at differing voltage and current settings to optimize excitation of the elements selected for analysis. In this case, analyses were conducted for the elements rubidium (Rb Kα), strontium (Sr Kα), yttrium (Y Kα), zirconium (Zr Kα), and niobium (Nb Kα), and to generate iron vs. manganese (Fe Kα/Mn Kα) ratios. Barium (Ba Kα) and iron (as $Fe_2O_3^T$) composition estimates were generated for certain artifacts, and x-ray tube current was scaled to the physical size of each specimen" (Hughes 2022).

Some of the projectile points that were tested can be seen in Figure 2.

Figure 2 Projectile Point Photos Recovered from 26WA12962

Table 4 XRF Results of Small Artifacts (Hughes 2022)

		Element Intensities							Element Ratios						Source
Site	**Cat. no.**	**Rb**	**Sr**	**Zr**	**Σ Rb,Sr,Zr**	**Rb%**	**Sr%**	**Zr%**	**Fe/Mn**	**Rb/Sr**	**Zr/Y**	**Y/Nb**	**Zr/Nb**	**Sr/Y**	**(Chemical Type)**
26WA12962	045h	356	157	304	817	0.436	0.192	0.372	19.8	2.3	7.1	1.0	6.9	3.7	South Warners
26WA12962	047b	363	208	391	962	0.377	0.216	0.406	10.6	1.8	5.2	1.5	7.5	2.7	Buffalo Hills
26WA12962	047c	381	279	462	1122	0.340	0.249	0.412	12	1.4	6.3	1.5	9.2	3.8	Buffalo Hills
26WA12962	050i	243	2	848	1093	0.222	0.002	0.776	55.5	121.5	7.5	2.7	20.2	<.1	Bordwell Spring
26WA12962	051f	338	7	1245	1590	0.213	0.004	0.783	60.6	48.3	7.2	2.6	18.6	<.1	Bordwell Spring
26WA12962	055f	381	218	409	1008	0.378	0.216	0.406	10.9	1.8	5.5	1.4	7.4	2.9	Buffalo Hills
26WA12962	055g	354	267	447	968	0.366	0.173	0.462	13.4	2.1	6.7	1.6	10.4	2.5	Buffalo Hills

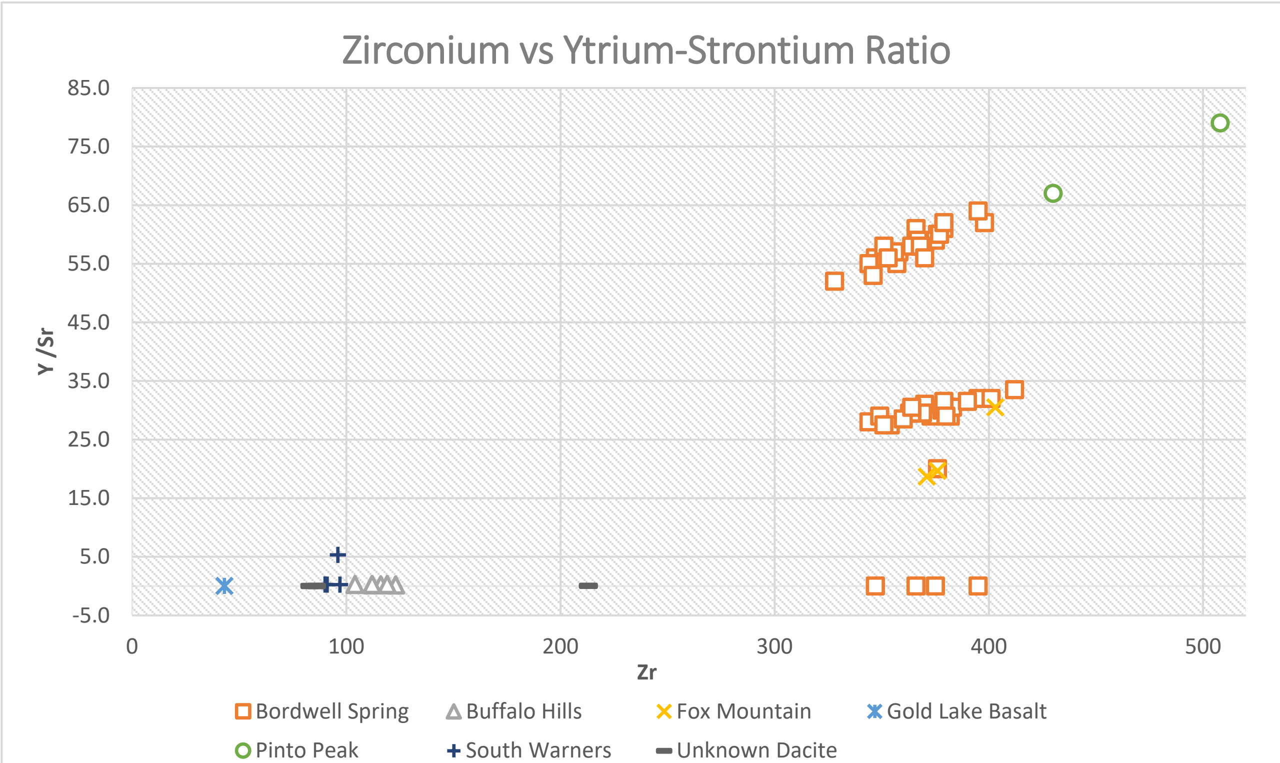

Figure 3 Zr vs Y/Sr Ratio

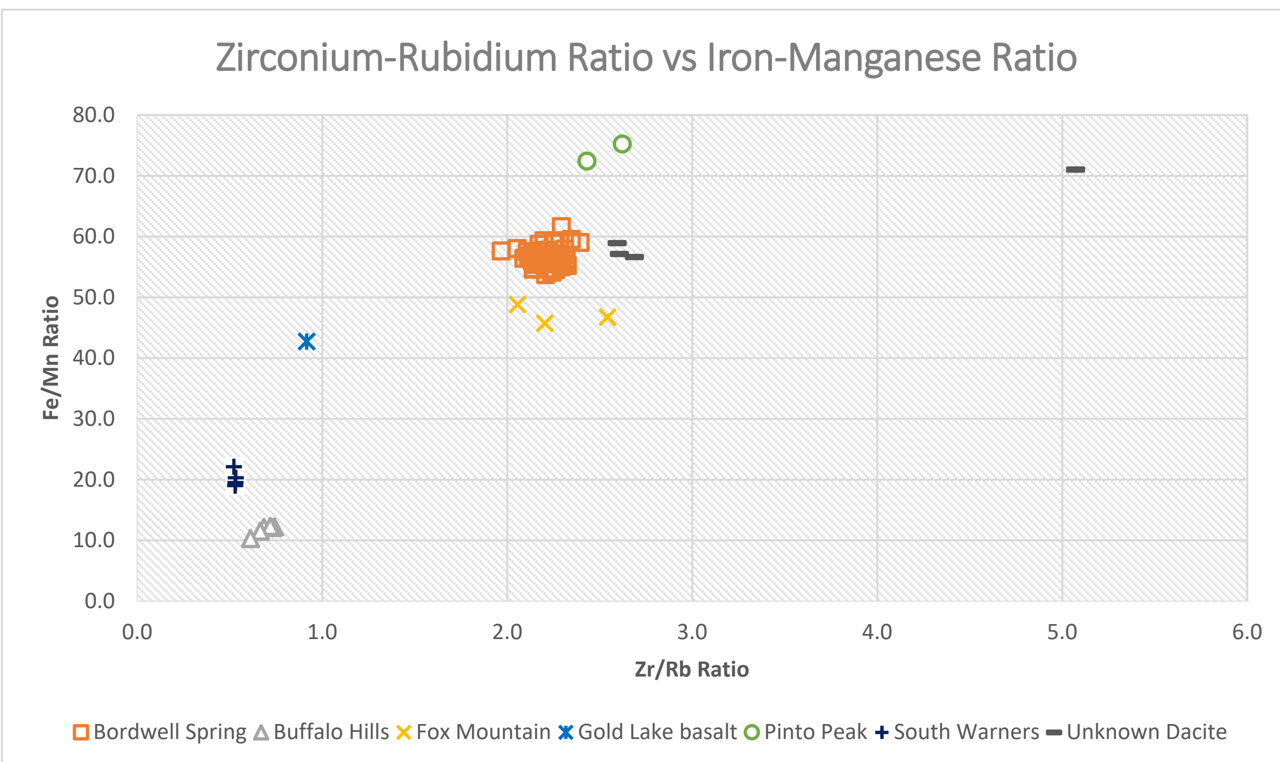

Figure 4 Zr/Rb vs Fe/Mn Ratios

Out of the eighty samples, fifty-four were from Bordwell Spring, eleven were from the Buffalo hills source, five are from the South Warners source, four were an unknown Dacite, three are from Fox Mountain, two from Pinto Peak and one was from the Gold Lake Basalt source (Table 5) (Hughes 2020).

Out of the seven sources that were identified, only six had recorded locations where the material can be found. Five out of the six source locations had an average distance of less than 48 km (30 miles) from the site and three being less than 32.18 km (20 miles). The remaining source location was the Gold Lake Basalt source that is located 148.22 km (92.1 miles) away from the site. Because of the grouping of BS/PP/FM, the average distance from the source to the site is skewed as many of the sources are labeled as the group rather than the individual source itself. Due to the data available, the Pinto Peak source has been lumped into BS/PP/FM and the distance from the Pinto Peak will be 38.37 km (23.84 miles). I have also included the distances from the locations labeled as BS/PP/FM in my chart to demonstrate the distance from all sources identified (Figure 3 and Table 2) (Amick 2004; Bloomer and Jafke 2009; Ericson 1977, 1981; Ericson et al. 1976; Gates 2005; Gates and Howe 2003; Giambastiani 2007; Howe 2002; Hughes 1982, 1985, 1986; Hughes and Howe 2017; James 1983; Jones et al. 2003; Kappele 1998; Kelly 1932; King 2016; LaLande 1990; LaValley 2013; Luhnow 1997; Macdonald et al. 1992; Mack 2015; Macko et al. 2005; Moore 2009; Musil and O'Neill 1997; O'Connell and Inoway 1994; Pinson

2011; Sappington 1981a, 1981b; Skinner et al. 1997; Smith 2010; Stueber and Skinner 2015; Young 2002)

Table 5 Toolstone Source Totals

Source	Number of samples	% of total
Bordwell Spring	54	67.5%
Buffalo Hills	11	13.75%
Fox Mountain	3	3.75%
Gold Lake Basalt	1	1.25%
Pinto Peak	2	2.5%
South Warners	5	6.25%
Unknown Dacite	4	5%

Out of the seven sources that were identified, only six had recorded locations where the material can be found. Five out of the six source locations had an average distance of less than 48 km (30 miles) from the site and three being less than 32.18 km (20 miles). The remaining source location was the Gold Lake Basalt source that is located 148.22 km (92.1 miles) away from the site. Because of the grouping of BS/PP/FM, the average distance from the source to the site is skewed as many of the sources are labeled as the group rather than the individual source itself. Due to the data available, the Pinto Peak source has been lumped into BS/PP/FM and the distance from the Pinto Peak will be 38.37 km (23.84 miles). I have also included the distances from the locations labeled as BS/PP/FM in my chart to demonstrate the distance from all sources identified (Figure 3 and Table 2) (Amick 2004; Bloomer and Jafke 2009; Ericson 1977, 1981; Ericson et al. 1976; Gates 2005; Gates and Howe 2003; Giambastiani

2007; Howe 2002; Hughes 1982, 1985, 1986; Hughes and Howe 2017; James 1983; Jones et al. 2003; Kappele 1998; Kelly 1932; King 2016; LaLande 1990; LaValley 2013; Luhnow 1997; Macdonald et al. 1992; Mack 2015; Macko et al. 2005; Moore 2009; Musil and O'Neill 1997; O'Connell and Inoway 1994; Pinson 2011; Sappington 1981a, 1981b; Skinner et al. 1997; Smith 2010; Stueber and Skinner 2015; Young 2002)

Table 6 Source Distance from 26WA12962

Source	Average distance (miles)	Average distance (Kilometers)
Bordwell Spring	19.63	31.59
Buffalo Hills	14.15	22.77
Fox Mountain	19.6	31.54
Gold Lake Basalt	92.1	148.22
Pinto Peak	23.84	38.37
South Warners	27.48	44.22
Unknown Dacite	N/A	N/A

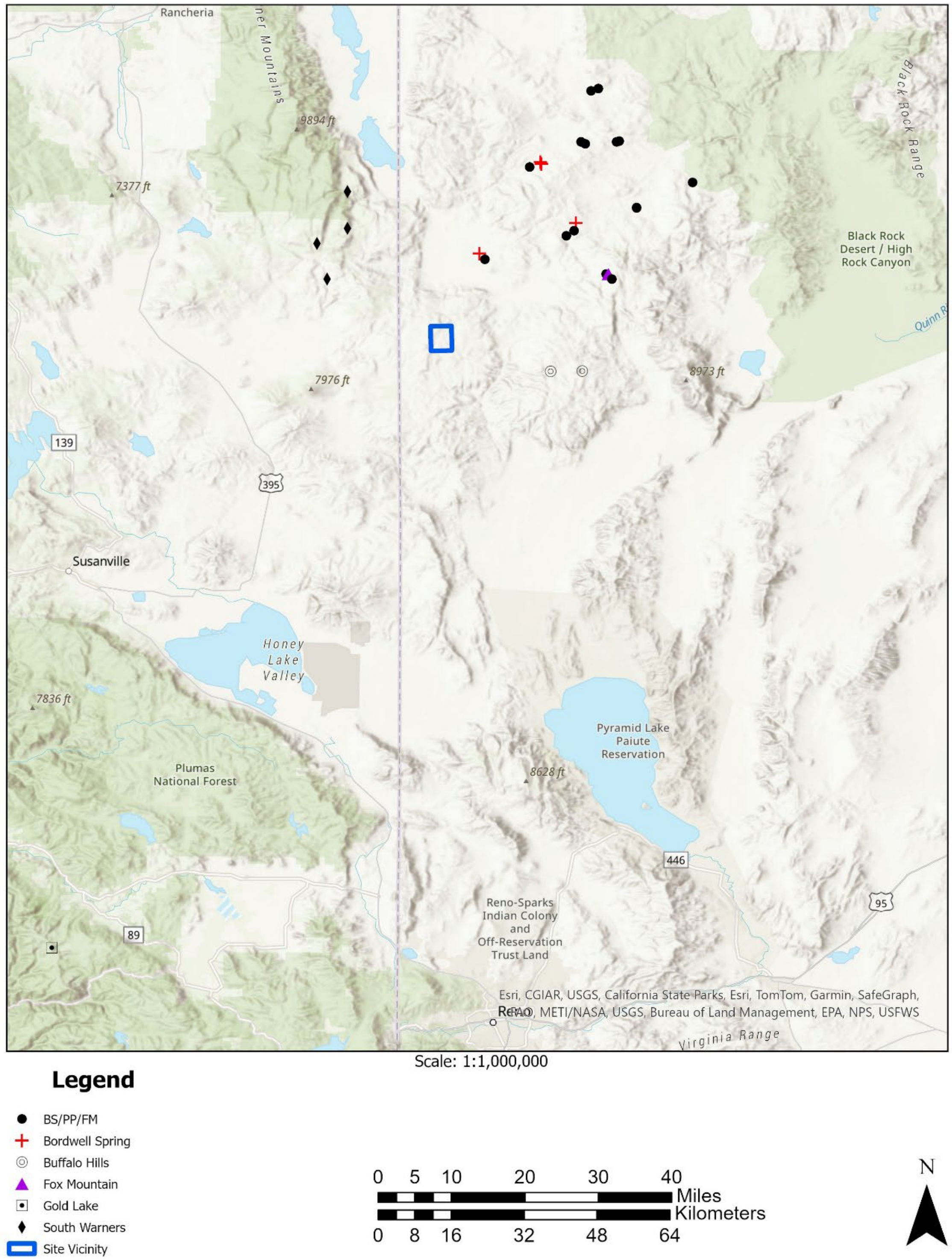

Figure 5 Toolstone Sources in Relation to 26WA12962

CHAPTER SIX

INTERPRETATION/DISCUSSION

The purpose of this thesis was to interpret the toolstone sources that were located at 26WA12962, a site located along the seasonal round that was conducted by the Kamotkut band of the Northern Paiute (Tiley and Rucks 2011, 2020). With 26WA12962 being located near so many toolstone sources, it gives a rather important picture into what toolstone may have been seen as more valuable than others. Looking at the results, we can see that out of the 80 samples, 54 were from Bordwell Spring, 11 were from the Buffalo Hills source, 3 were from the Fox Mountain source, 1 from the Gold Lake Basalt source, 2 were from the Pinto Peak source, 5 from the South Warners source and 4 were from an unknown dacite or basalt source (Table 5). Out of all of these sources, the furthest away is the Gold Lake Basalt source, which is 148.22 kilometers (92.1 miles), while the closest source was Buffalo Hills which is 22.77 kilometers (14.15 miles) from the site.

1.Where do the obsidian and fine grain volcanics located in the site originate? Are they local or exotic?

The obsidian and the fine grain volcanics that were found at the site come from a variety of sources. These sources include: Bordwell Spring, Buffalo Hills, Fox Mountain, Gold Lake Basalt, Pinto Peak, South Warners, Unknown

Dacite/Basalt, Unknown Dacite I, Unknown dacite. Out of the nine sources that were identified, 55 percent of the sources (Bordwell Spring, Buffalo Hills, Fox Mountain, Pinto Peak, South Warners) are within a 112.65 km (70 mile) buffer which is the distance that I am using to define local versus exotic (Jones et al. 2003). Eleven percent of the source locations are exotic (Gold Lake Basalt), and the remaining 34 percent are undetermined due to the locations being unknown (Hughes 2022). This data is not really surprising as over half of the sources that were identified are considered local. The one surprising source was the Gold Lake Basalt source. The reason that this is so surprising is the fact that the environment that the site is located in has several basalt sources that can be considered high enough quality to use as a tool. The explanation for this material traveling so far, is that the Lake Tahoe is close enough to the path of the seasonal round, that either opportunistic gathering occurred to make a projectile point or trade occurred (Tiley and Rucks 2011, 2020).

When I was first thinking about where the material found at the site would be exotic or local, I expected them to be all local material due to the number of sources nearby. However, with the results, I saw that my initial thoughts were correct in the sense that there was only 1 source that was not local. This could be explained by the different resource procurement methods that occurred throughout time as well as how the sources were deposited whether it be secondary or by humans. There is evidence of toolstone from several of these sources have a secondary deposition that occurred naturally (McGuire et al. 2002, 82-83).

2. Is there a preference for a specific material? If so, which material?

There does appear to be a preference for a specific material. The preferred material appears to be obsidian from the Bordwell Spring source. This was determined by looking at the XRF results, 67.5% of 80 samples came from the Bordwell Springs source (Table 5). Preference is determined by the amount of material that was found at the site and by the fact that this is not the closest source to the site. The Bordwell Spring obsidian source is located 19.63 miles or 31.59 kilometers northeast of the site, while the closest obsidian source is the Buffalo Hills source that is only 14.15 miles or 22.77 kilometers from the site (Amick 2004; Bloomer and Jafke 2009; Ericson 1977, 1981; Gates 2005; Gates and Howe 2003; Giambastiani 2007; Howe 2002; Hughes 1982, 1985, 2011; Hughes and Howe 2017; James 1983; Jones et al. 2003; Kappele 1998; Kelly 1932; King 2016; LaValley 2013; Luhnow 1997; Macdonald et al. 1992; Mack 2015; Moore 2009; Musil and O'Neill 1997; O'Connell and Inoway 1994; Pinson 2011; Sappington 1981a, 1981b; Shackley 2018; Skinner et al. 1997; Smith 2010a; Stueber and Skinner 2015; Young 2002).

3.Is there an explanation for the preference using Ethnographies?

Due to the Kamotkut being one of many groups that seemed to have been overlooked by anthropologists, there is a lack of ethnographies and a lack of works that included the communities input (Tiley and Rucks 2020). This has posed some difficulties in acquiring the information that would help answer this question. Because there is a lack of references, the explanation for this preference for material is only hypothetical. My explanation for why the Bordwell Spring source was in higher concentration compared to the closer source is because of the Seasonal Round that the Kamotkut conducted every year (Tiley and Rucks 2011, 2020), as well as it being related to hunting (Madsen 2007; Smith 2010a). Since I am using the seasonal round as an answer for why the Bordwell Spring obsidian source was a preference, it needs to be described. The seasonal round is described as

> "starting sometime in February, and by March, people were moving from Granite (Fly and Granite Creek ranches) to Pyramid Lake for trade at the Needles. They came to the Needles area to trade and rest up… People traveling from Granite stopped at Deep Hole, where the hot springs are not too hot, but warm enough for a bath. Bonham Hot Springs are also on the route to the Needles. From here, elders and others too frail to go on the big loop—little kids and pregnant women—could cut across to Secret Valley and Honey Lake Valley along where Flannigan is today… From Deep Hole, (Granite Mountains) was the main route to Duck Lake. Duck Lake was a very important resource area and crossroads and

another place people gathered from all over…From Duck Lake, travelers could go around the south end to Leadville, straight over the mountains into Grass Valley Ranch and then eventually to Granite." (Figure 6) (Tiley and Rucks 2011, 2020). When analyzing this seasonal round, it starts in Granite creek near the Black Rock Desert, and they travel to the southeast to Pyramid Lake and then south to Needles. From Needles, they travel back to the north towards the Granite Mountains and to Duck Lake.

A majority of the material found at the site are located northeast of the site and are along the Fall and Winter paths of the seasonal round with the exception of the Gold Lake Basalt and the South Warner sources (Tiley and Rucks 2020: 229). Due to the proximity of the site to Duck Lake and the season for when people would arrive at Duck Lake, hunting before the winter would be necessary. With hunting comes the use of tools, and these tools were made from stone, likely from obsidian. I believe that the Bordwell Spring obsidian source was within an area that contained more game to hunt compared to the Buffalo Hills source which was closer. On top of possible game presence being higher, I also believe that the Bordwell Spring source was, and still is larger than the Buffalo Hills source. The proximity of the sources to the site may also represent that people were opportunistically gathering when needed, versus targeting a particular source.

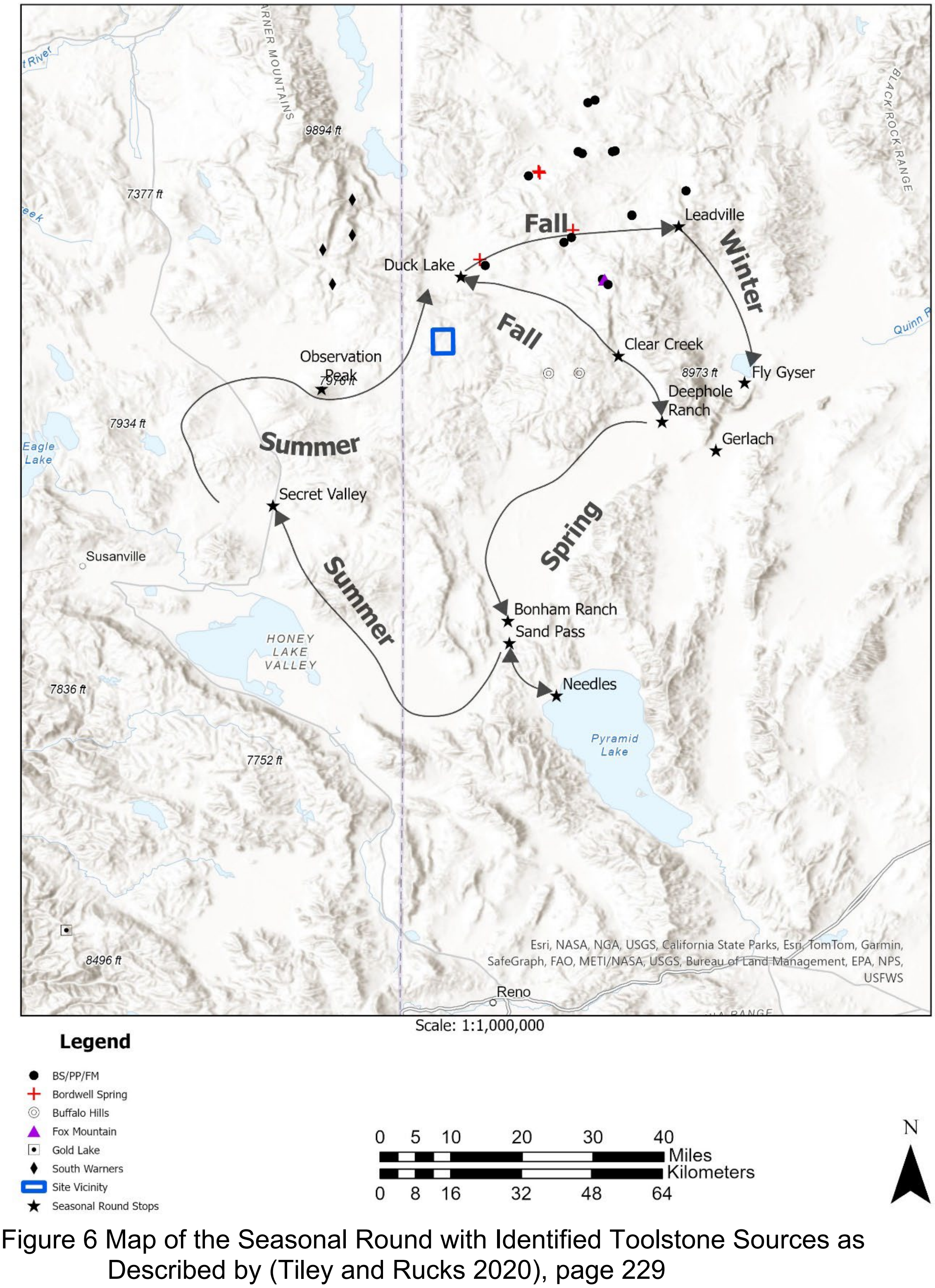

Figure 6 Map of the Seasonal Round with Identified Toolstone Sources as Described by (Tiley and Rucks 2020), page 229

Discussion

While completing a thesis, everyone has the moment where they ask themselves “what does this mean?”. For me, my research helps identify lithic procurement strategies that occurred at a highly dynamic site that was utilized by people for thousands of years. It also provides future researchers with a small amount of data that they can compare their XRF results with to help identify a source. Hopefully this research will promote more people to try and perform non-destructive XRF testing on sites in its entirety.

While conducting my research, there were several issues that I ran into. One of these issues is that there were still 3 separate dacite sources that are still unknown in location and name. This was a challenge because material from these three sources made up 5% of my total results. This does not seem like a lot, but if these sources had known locations, it would help us understand resource procurement just a little bit more.

Another issue that I encountered while conducting my research was not having enough ethnographies about the Kamotkut or the Northern Paiute as a whole in the region. While I understand that every band may have interacted with their environments differently, it would at least help understand what the neighbors are the Kamotkut were doing. Unfortunately, due to the lack of ethnographies done in the region, I had to rely heavily on old, outdated sources to help in my interpretations. This included what the ancestral territory of the

Kamotkut was and who their neighbors were. Most of these sources were conducted in the 1930s when anthropology was very focused on viewing Native Americans through a Western Lens. If there were more works on Northern Paiute as a whole, there may have been explanation on if there were specific toolstone sources that were avoided or used exclusively.

As with all master's theses, there is the potential for future work. One suggestion that I can make for future research would be to incorporate hydration data. A researcher could look to see if there are any trends in lithic procurement throughout the time period of the region.

APPENDIX A

XRF TABLE OF RESULTS OF LARGE ARTIFACTS (HUGHES 2022)

		Trace and Minor Element Composition									Ratio	Obsidian Source
Site	**FS. No.**	**Rb**	**Sr**	**Y**	**Zr**	**Nb**	**Ba**	**Ti**	**Mn**	**$Fe_2O_3^T$**	**Fe/Mn**	**(Chemical Type)**
26WA12962	001	152	2	56	344	15	nm	nm	nm	2.38	56.4	Bordwell Spring
26WA12962	002	167	0	60	366	15	nm	nm	nm	2.71	56.5	Bordwell Spring
26WA12962	003	169	68	18	90	12	382	nm	nm	0.97	20.3	South Warners
26WA12962	004	162	1	61	366	18	nm	nm	nm	2.53	54.5	Bordwell Spring
26WA12962	005	155	96	24	112	13	1138	nm	nm	1.00	12.1	Buffalo Hills
26WA12962	006	161	2	58	373	17	nm	nm	nm	2.42	55.5	Bordwell Spring
26WA12962	007	42	613	24	213	10	1106	nm	nm	10.35	71.0	Unknown dacite/basalt
26WA12962	008	165	1	59	367	17	nm	nm	nm	2.55	57.7	Bordwell Spring
26WA12962	010	154	1	56	347	17	nm	nm	nm	2.40	56.8	Bordwell Spring
26WA12962	011	156	1	55	357	16	nm	nm	nm	2.35	57.0	Bordwell Spring
26WA12962	012	152	83	23	104	12	1084	nm	nm	0.88	12.1	Buffalo Hills
26WA12962	013	33	1412	16	86	3	1089	nm	nm	8.31	57.1	Unknown dacite I
26WA12962	014	146	3	56	371	17	nm	nm	nm	2.24	46.7	Fox Mountain
26WA12962	017	32	1427	16	83	5	1156	nm	nm	8.67	58.9	Unknown dacite I
26WA12962	022	172	2	58	382	19	nm	nm	nm	2.60	54.6	Bordwell Spring
26WA12962	039	169	0	55	347	15	nm	nm	nm	2.55	58.0	Bordwell Spring
26WA12962	060	47	501	10	43	7	1090	nm	nm	4.58	42.7	Gold Lake basalt
26WA12962	061	151	96	22	112	12	1147	nm	nm	0.95	12.2	Buffalo Hills
26WA12962	063	182	1	57	358	19	nm	nm	nm	2.46	57.6	Bordwell Spring
26WA12962	066	159	95	22	116	11	1114	nm	nm	0.98	12.1	Buffalo Hills
26WA12962	068	175	0	61	375	17	nm	nm	nm	2.77	56.3	Bordwell Spring
26WA12962	072	171	1	60	376	18	nm	nm	nm	2.29	59.3	Bordwell Spring
26WA12962	073	151	1	56	351	17	nm	nm	nm	2.24	55.2	Bordwell Spring
26WA12962	074	32	1336	14	86	3	1162	nm	nm	7.65	56.6	Unknown dacite
26WA12962	075	172	72	17	91	12	372	nm	nm	1.07	19.0	South Warners
26WA12962	112	167	2	62	370	17	nm	nm	nm	2.61	55.5	Bordwell Spring
26WA12962	113	209	1	79	508	19	nm	nm	nm	2.27	72.4	Pinto Peak
26WA12962	045a	153	1	55	344	16	nm	nm	nm	2.27	58.9	Bordwell Spring
26WA12962	045b	165	1	59	375	19	nm	nm	nm	2.55	55.6	Bordwell Spring
26WA12962	045c	157	1	58	364	18	nm	nm	nm	2.37	56.2	Bordwell Spring
26WA12962	045d	171	2	59	369	20	nm	nm	nm	2.61	55.8	Bordwell Spring
26WA12962	045e	178	2	61	380	18	nm	nm	nm	2.14	56.0	Bordwell Spring
26WA12962	045f	184	0	62	395	19	nm	nm	nm	2.81	55.4	Bordwell Spring
26WA12962	045g	171	118	24	123	13	1039	nm	nm	1.07	12.3	Buffalo Hills
26WA12962	047a	179	1	61	379	18	nm	nm	nm	2.82	56.8	Bordwell Spring

26WA12962	050a	164	1	67	430	18	nm	nm	nm	1.90	75.2	Pinto Peak
26WA12962	050b	161	2	59	363	16	nm	nm	nm	2.43	54.6	Bordwell Spring
26WA12962	050c	158	2	58	349	16	nm	nm	nm	2.39	56.9	Bordwell Spring
26WA12962	050d	173	2	60	378	20	nm	nm	nm	2.61	56.5	Bordwell Spring
26WA12962	050e	174	2	61	379	18	nm	nm	nm	2.70	55.6	Bordwell Spring
26WA12962	050f	159	1	57	356	17	nm	nm	nm	2.49	56.0	Bordwell Spring
26WA12962	050g	179	96	25	119	12	990	nm	nm	1.05	11.5	Buffalo Hills
26WA12962	050h	172	2	59	364	17	nm	nm	nm	2.70	56.7	Bordwell Spring
26WA12962	051a	162	2	59	363	17	nm	nm	nm	2.45	54.1	Bordwell Spring
26WA12962	051b	151	1	52	328	15	nm	nm	nm	1.98	58.7	Bordwell Spring
26WA12962	051c	160	2	59	364	17	nm	nm	nm	2.43	57.1	Bordwell Spring
26WA12962	051d	175	1	58	369	18	nm	nm	nm	2.52	57.5	Bordwell Spring
26WA12962	051e	167	1	58	368	17	nm	nm	nm	2.60	57.7	Bordwell Spring
26WA12962	051g	183	92	24	112	13	956	nm	nm	1.07	10.3	Buffalo Hills
26WA12962	051h	185	2	64	395	19	nm	nm	nm	2.74	56.4	Bordwell Spring
26WA12962	055a	154	1	53	346	16	nm	nm	nm	2.39	55.8	Bordwell Spring
26WA12962	055b	160	2	61	383	18	nm	nm	nm	2.46	59.0	Bordwell Spring
26WA12962	055c	191	2	67	412	19	nm	nm	nm	2.71	56.7	Bordwell Spring
26WA12962	055d	177	2	63	379	19	nm	nm	nm	2.64	54.6	Bordwell Spring
26WA12962	055e	186	77	18	97	13	383	nm	nm	1.03	22.1	South Warners
26WA12962	069a	152	1	58	351	18	nm	nm	nm	2.39	57.9	Bordwell Spring
26WA12962	069b	154	2	55	354	17	nm	nm	nm	2.17	55.2	Bordwell Spring
26WA12962	069c	176	3	60	376	18	nm	nm	nm	2.52	55.9	Bordwell Spring
26WA12962	069d	154	1	56	353	17	nm	nm	nm	2.32	61.6	Bordwell Spring
26WA12962	069e	176	1	60	377	18	nm	nm	nm	2.52	57.3	Bordwell Spring
26WA12962	069f	162	2	58	380	17	nm	nm	nm	2.06	59.5	Bordwell Spring
26WA12962	069g	183	2	61	403	17	nm	nm	nm	2.33	45.7	Fox Mountain
26WA12962	071a	179	2	63	390	18	nm	nm	nm	2.26	56.1	Bordwell Spring
26WA12962	071b	183	3	59	376	18	nm	nm	nm	2.28	48.8	Fox Mountain
26WA12962	077a	188	2	64	401	19	nm	nm	nm	2.68	57.0	Bordwell Spring
26WA12962	077b	164	2	57	360	18	nm	nm	nm	2.31	56.1	Bordwell Spring
26WA12962	077c	162	1	56	370	18	nm	nm	nm	2.36	59.3	Bordwell Spring
26WA12962	077d	159	2	55	351	17	nm	nm	nm	2.56	53.7	Bordwell Spring
26WA12962	077e	181	3	16	96	13	363	nm	nm	1.07	19.5	South Warners
26WA12962	081a	186	1	62	398	18	nm	nm	nm	2.14	54.7	Bordwell Spring
26WA12962	081b	159	2	61	364	19	nm	nm	nm	2.52	55.0	Bordwell Spring
26WA12962	081c	173	1	62	379	19	nm	nm	nm	2.81	57.6	Bordwell Spring
26WA12962	082a	189	1	64	395	18	nm	nm	nm	2.22	56.4	Bordwell Spring

APPENDIX B

SUSANVILLE INDIAN RANCHERIA PERMISSION LETTER

CALIFORNIA STATE UNIVERSITY SAN BERNARDINO

Tyler Reinholt <008088685@coyote.csusb.edu>

response to your letter

1 message

Chris Lamarr <clamarr@susanvilleindianrancheria.onmicrosoft.com> Tue, Sep 26, 2023 at 5:32 PM

To: "tyler.reinholt8685@coyote.csusb.edu" <tyler.reinholt8685@coyote.csusb.edu>

Tyler,

I appreciate you contacting the Susanville Indian Rancheria regarding your efforts at Duck Lake. Our THPO office supports your non-destructive testing efforts and would appreciate reviewing your project thesis. Good luck with your efforts and feel free to contact me if you have any questions.

Thanks,

Chris LaMarr, J.D.

Tribal Historic Preservation Officer/NAGPRA Coordinator

Natural Resource Department

Susanville Indian Rancheria

C: 530-250-6636

APPENDIX C

BLM PERMISSION LETTER

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Applegate Field Office
708 W. 12th Street
Alturas, CA 96101
www.blm.gov/office/applegate-field-office

In Reply Refer To:
8100 (P) LLCAN020

April 3, 2023

Mr. Tyler Reinholt
2601 Barstow Road
Barstow, CA 92311

Dear Mr. Reinholt,

The Bureau of Land Management, Applegate Field Office, grants you the use of the data collected from the Rowland Spring site (26WA12962) gathered in July 2021 by BLM staff. These data include the artifact catalog produced for the Rowland Spring site, Geographical Information System (GIS) data collected at the site, photographs and unit forms, and subsequent analyses obtained through outside labs: the geochemical sourcing (XRF) completed by Geochemical Research Laboratory (Letter Report 2021-43) and the obsidian hydration analysis completed by Origer's Obsidian Laboratory (March 2022).

Permission to use these data is based on two conditions: 1) sensitive information regarding the site 26WA12962 is not released to the public; and 2) the BLM Applegate Field Office Archaeologist receives a copy of your thesis upon its acceptance for the office's records.

Please email the BLM Applegate Field Office archaeologist, Jen Rovanpera, at jrovanpera@blm.gov if you have further questions.

Sincerely,

Elias Flores
Supervisory Natural Resources Specialist
BLM Applegate Field Office

REFERENCES

Amick, Daniel S.
2004 A Possible Ritual Cache of Great Basin Stemmed Bifaces from the Terminal Pleistocene - Early Holocene Occupation of Nw Nevada, USA. *Lithic Technology* 29(2):119–145.

2022 Great Basin. *New World Encyclopedia*. https://www.newworldencyclopedia.org/entry/Great_Basin#Flora_and_fauna, accessed December 29, 2023.

Arroyo, Ana Belén Marín
2009 The Use of Optimal Foraging Theory to Estimate Late Glacial Site Catchment Areas from a Central Place: The Case of Eastern Cantabria, Spain. *Journal of Anthropological Archaeology* 28(1):27–36. DOI:10.1016/j.jaa.2008.11.001.

Binford, Lewis R.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4–20. DOI:10.2307/279653.

Bloomer, William W., and Denise Jafke
2009 A High Sierran Nexus: Hot Obsidian Data from Donner Memorial State Park. *Proceedings of the Society for California Archaeology* 21:109–115.

Broughton, Jack M., and James F. O'Connell
1999 On Evolutionary Ecology, Selectionist Archaeology, and Behavioral Archaeology. *American Antiquity* 64(1):153–165. DOI:10.2307/2694351.

Dawson, K.C.A.
1977 An Application of the Direct Historical Approach to the Algonkians of Northern Ontario. *Canadian Journal of Archaeology / Journal Canadien d'Archéologie*(1):151–181.

Del Hoyo-Meléndez, Julio M.
2017 X-Ray Fluorescence (XRF) Spectrometry. In *Digital Techniques for Documenting and Preserving Cultural Heritage*, edited by Anna Bentkowska-Kafel and Lindsay MacDONALD, pp. 257–262. Arc Humanities Press.

Ebert, David
2004 Applications of Archaeological GIS. *Canadian Journal of Archaeology / Journal Canadien d'Archéologie* 28(2):319–341.

Ericson, Jonathon E.
1977 Evolution of Prehistoric Exchange Systems: Results of Obsidian Dating and Tracing. Unpublished Ph. D, University of California, Los Angeles, California.

1981 *Exchange and Production Systems in Californian Prehistory: The Results of Hydration Dating and Chemical Characterization of Obsidian Sources*. BAR Publishing.

Ericson, Jonathon E., Timothy A Hagan, and Charles W Chesterman
1976 Prehistoric Obsidian in California II: Geologic and Geographic Aspect. In *Advances in Obsidian Glass Studies: Archaeological and Geochemical Perspectives*, edited by R. E Taylor, pp. 218–239. Noyes Press, Park Ridge, New Jersey.

Fitzjohn, Matthew
2007 Viewing Places: GIS Applications for Examining the Perception of Space in the Mountains of Sicily. *World Archaeology* 39(1):36–50.

Fleming, Andrew
2012 The Future of Landscape Archaeology. In *Landscape Archaeology between Art and Science*, edited by S.J. Kluiving and E.B. Guttmann-Bond, pp. 461–470. From a Multi- to an Interdisciplinary Approach. Amsterdam University Press.

Fletcher, Richard, and E. G. D. Robinson
2003 A Simple GIS Method for Archaeological Survey. *Mediterranean Archaeology* 16:125–135.

Gates, Gerald R
2005 A Thematic Evaluation of Small Prehistoric Foraging and Logistical Locations on a Portion of the Modoc Plateau of Northeastern California. *Proceedings of the Society for California Archaeology* 18:70–75.

Gates, Gerald R, and Mark L. Howe
2003 Heritage Resources Inventory of the Blue Fire Warner Mountain Ranger District, Modoc National Forest. Edited by Donna A. Day, Sharon A Waechter, Katy Coulter, David Doyle, and Gregory White. *Proceedings of the Society for California Archaeology* 16:159–164.

Giambastiani, Dayna Tinsley
2007 Late Archaic and Ethnohistoric Pinyon Exploitation in Slinkard Valley, an Upland Environment in the Western Great Basin. Unpublished M.A., University of Nevada, Reno, United States -- Nevada.

Gillings, Mark
2012 Landscape Phenomenology, GIS and the Role of Affordance. *Journal of Archaeological Method and Theory* 19(4):601–611.

Heizer, Robert F.
1941 The Direct-Historical Approach in California Archaeology. *American Antiquity* 7(2):98–122. DOI:10.2307/276058.

Howe, Mark L.
2002 Obsidian Sources of the Modoc National Forest - Distribution and Trade Patterns in Prehistoric Site presented at the Denver Annual Meeting of the Geological Society of America, 2002, Denver.

Hritz, Carrie
2014 Contributions of GIS and Satellite-based Remote Sensing to Landscape Archaeology in the Middle East. *Journal of Archaeological Research* 22(3):229–276.

Hughes, Richard
1982 Age and exploitation of obsidian from the Medicine Lake Highland, California. *Journal of Archaeological Science* 9(2):173–185. DOI:10.1016/0305-4403(82)90048-6.

1985 Obsidian Sources. In *Nightfire Island: Later Holocene Lakemarsh Adaptation On the Western Edge of the Great Basin*, pp. 245–267. Anthropological Papers 1. University of Oregon, Eugene, Oregon.

1986 *Diachronic Variability in Obsidian Procurement Patterns in Northeastern California and Southcentral Oregon*. Vol. 17. Anthropology. University of California Press, Berkeley.

2022 *Energy Dispersive X-ray Fluorescence Analysis of Obsidian from Four Archaeological Sites Located Within the Home Camp Riparian Project, Washoe County, Nevada*. Geochemical Research Laboratory. Report on file at the Applegate Office Bureau of Land Management, Cedarville on Behalf of the Bureau of Land Management.

Hughes, Richard E
2011 *Perspectives on prehistoric trade and exchange in California and the Great Basin*. Salt Lake City : University of Utah Press.

Hughes, Richard, and Mark L. Howe
2017 Jess Valley: An Archaeologically Significant Obsidian Source in the

Southern Warner Mountains of Northeastern California. *Journal of California and Great Basin Anthropology* 37(1):62–69.

James, Steven R
1983 Surprise Valley Settlement and Subsistence: A Critical Review of the Faunal Evidence:21.

Johnson, Matthew
2020 *Archaeological Theory: An Introduction*. 3rd ed. Blackwell Publishing, Hoboken, NJ.

Jones, George T., Charlotte Beck, Eric E. Jones, and Richard E. Hughes
2003 Lithic Source Use and Paleoarchaic Foraging Territories in the Great Basin. *American Antiquity* 68(1):5–38. DOI:10.2307/3557031.

Kappele, William A.
1998 *Rockhounding Nevada*. Falcon Publishing, Guilford, Connecticut.

Kelly, Isabel
1932 Ethnography of the Surprise Valley Paiute. *American Archaeology and Ethnology* 31(3):67–210.

King, Jerome
2016 Obsidian Conveyance Patterns. In *Prehistory of Nevada's Northern Tier: Archaeological Investigations Along the Ruby Pipeline*, edited by William R. Hildebrandt, Kelly R. McGuire, Jerome King, Allika Ruby, and D. Craig Young, 101:pp. 303–327. American Museum of Natural History.

Kroeber, A L
1925 *Handbook of the Indians of California*. Bulletin (Smithsonian Institution. Bureau of American Ethnology), 78. Government Printing Office, Washington.

LaLande, Jeff
1990 *Summary Report on the 1989 Obsidian-Sourcing Project*. Report prepared for the Rogue River National Forest, Medford, Oregon.

LaValley, Stephen J
2013 Late Holocene Toolstone Procurement and Land-Use Strategies in the Black Rock Desert and High Rock Country of Northwest Nevada:296.

Leach, Melinda
1988 Subsistence Intensification and Settlement Change Among Prehistoric Hunters and Gatherers of the Northwest Great Basin. Unpublished PhD, University of California, Los Angeles.

Lightfoot, Kent G.
1995 Culture Contact Studies: Redefining the Relationship between Prehistoric and Historical Archaeology. *American Antiquity* 60(2):199–217. DOI:10.2307/282137.

Luhnow, Glennda Gene
1997 An Examination of the Ethnographic Boundary Shared by Gumbatwas and Kokiwas Modoc Tribeletes, Northeastern California. Sonoma State University.

Macdonald, Ray, Robert L. Smith, and John E. Thomas
1992 Chemistry of the Subalkalic Silicic Obsidians. *U. S Geological Survey Professional Paper 1523*. accessed June 17, 2023.

Mack, Joanne M
2015 Upper Klamath River Obsidian Use Frequencies: Distance-To- Source and Additional Variables. In *Toolstone Geography of the Pacific Northwest*, edited by Terry L. Ozbun and Ron L. Adams, pp. 234–242. Archaeology Press.

Macko, Michael E., Jeffrey S. Couch, and Henry C. Koerper
2005 Implications of Ritual Biface Caches from the Irvine Site. *Journal of California and Great Basin Anthropology* 25:93–108.

Madsen, David
2007 The Paleoarchaic to Archaic transition in the Great Basin. *Paleoindian or Paleoarchaic: Great Basin Human Ecology at the Pleistocene-Holocene Transition*:3–20.

Mandal, A. C., S. Santra, D. Mitra, M. Sarkar, and D. Bhattacharya
2003 EDXRF as a Routine Tool for Numismatic Studies. *Current Science* 85(2):134–135.

Matthews, J
2016 *26WA12962*. Site record on file at the Bureau of Land Management, Applegate Field Office, Alturas California.

McCoy, Mark D., and Thegn N. Ladefoged
2009 New Developments in the Use of Spatial Technology in Archaeology. *Journal of Archaeological Research* 17(3):263–295.

McGuire, Kelly R., and William R. Hildebrandt
2016 Cultural Context of the Northern Tier. In *Prehistory of Nevada's Northern Tier: Archaeological Investigations Along the Ruby Pipeline*, 101:pp. 71–95. American Museum of Natural History.

McGuire, Kelly R., William R. Hildebrandt, Jerome H King, Kelly R. McGuire, Michael G Delacorte, Kimberley L Carpenter, Sharon A Waechter, and D. Craig Young
2002 *Boundary Lands: Archaeological Investigations Along the California-Great Basin Interface*. Nevada State Museum Anthropological Papers 24. Nevada Department of Cultural Affairs Division of Museums and History, Carson City, Nevada.

Moore, Joe
2009 *Great Basin Tool-Stone Sources: The NDOT Obsidian and Tool-Stone Sourcing Project: 2002 Progress Report.* Nevada Department of Transportation, Carson City.

Musil, Robert R., and Brian O'Neill
1997 Source and Distribution of Archaeological Obsidian in the Umpqua River Basin of Southwest Oregon. In *Contributions to the Archaeology of Oregon: 1995-1996*, edited by Albert Oetting, pp. 123–1662. Association of Oregon Archaeologists Occasional Papers 6. Eugene, Oregon.

National Park Service
2021 Deserts - Great Basin National Park (U.S. National Park Service). *Great Basin National Park Nevada*. https://www.nps.gov/grba/learn/nature/deserts.htm, accessed December 29, 2023.

O'Connell, James F.
1975 *The Prehistory of Surprise Valley*. Ramona, Calif.: Ballena Press.

O'Connell, James F, and Cari M Inoway
1994 Surprise Valley Projectile Points and Their Chronological Implications:38.

Pinson, Ariane O.
2011 The Clovis Occupation of the Dietz Site (35lk1529), Lake County, Oregon, and Its Bearing on the Adaptive Diversity of Clovis Foragers. *American Antiquity* 76(2):285–313.

Rennell, Rebecca
2012 Landscape, Experience and GIS: Exploring the Potential for Methodological Dialogue. *Journal of Archaeological Method and Theory* 19(4):510–525.

Roper, Donna C
1979 The Method and Theory of Site Catchment Analysis: A Review:23.

Rovanpera, Jennifer
2023 *Phase II Testing at Four Springs in the Home Camp, Wall Canyon West, and Tuledad Grazing Allotments, Washoe County, Nevada*. Cultural Resource Report on file at the Bureau of Land Management, Applegate Field Office, Alturas, CA.

Sappington, R. L
1981a A Progress Report on the Obsidian and Vitrophyre Sourcing Project. *Idaho Archaeologist* 4:4–17.

1981b Additional Obsidian and Vitrophyre Source Descriptions from Idaho and Adjacent Areas. *Idaho Archaeologist* 5(1):4–8.

Shackley, M. Steven
1991 Tank Mountains Obsidian: A Newly Discovered Archaeological Obsidian Source in East-Central Yuma County, Arizona. *Kiva* 57(1):17–25.

2018 *Source Provenance of Obsidian Paleoarchaic Bifaces from the Great Basin*.

Sharon, Ilan, Yehuda Dagan, and Gilah Tzionit
2004 The [awful?] truth about GIS and Archaeology. *British School at Athens Studies* 11:151–162.

Skinner, Craig E., Jennifer J Thatcher, and Kathleen M. Davis
1997 *X-Ray Fluorescence Analysis and Obsidian Hydration Rim Measurement of Artifact Obsidian from 35-DS-193 and 35-DS-201, Surveyor Fire Rehabilitation Project, Deschutes National Forest, Oregon*. Northwest Research Obsidian Studies Laboratory, Oregon.

Smith, Geoffrey M.
2010 Footprints Across the Black Rock: Temporal Variability in Prehistoric Foraging Territories and Toolstone Procurement Strategies in the Western Great Basin. *American Antiquity* 75(4):865–885. DOI:10.7183/0002-7316.75.4.865.

Steward, Julian H.
1942 The Direct Historical Approach to Archaeology. *American Antiquity* 7(4):337–343. DOI:10.2307/275399.

Stewart, Omer C
1939 The Northern Paiute Bands. *Anthropological Records* 2(3):127–149.

Stiles, Daniel
1977 Ethnoarchaeology: A Discussion of Methods and Applications. *Man* 12(1):87–103. DOI:10.2307/2800996.

Stueber, Daniel O, and Craig E Skinner
2015 Glass Buttes, Oregon: 14,000 Years of Continuous Use. In *Toolstone Geography of the Pacific Northwest*, edited by Terry L. Ozbun and Ron L. Adams, pp. 193–207. Archaeology Press, Simon Fraser University, Burnaby, British Columbia.

Tiffany, Joseph A, and Larry R Abbott
1982 Site-Catchment Analysis: Applications to Iowa Archaeology. *Journal of Field Archaeology* 9(3):313–322.

Tiley, Shelly, and Penny Rucks
2011 *Ethnographic Syntheses of the Eagle Lake Field Office: Bureau of Land Management, Susanville, CA*. Rucks Ethnographic Services.

2020 Hiding in Plain Sight: An Ethnohistory of the Kamotkut Paiute. In *Cowboy Ecologist: Essays in Honor of Robert L. Bettinger*, edited by Roshanne S. Bakhtiary, Terry L. Jones, and Michael G Delacorte, pp. 225–237. CARD 19. Center for Archaeological Research at Davis, Davis, California.

Turner, Matthew D., and Peter J. Taylor
2003 Critical Reflections on the Use of Remote Sensing and GIS Technologies in Human Ecological Research. *Human Ecology* 31(2):177–182.

Whitley, Thomas G., and Lacey M. Hicks
2003 A Geographic Information Systems Approach to Understanding Potential Prehistoric and Historic Travel Corridors. *Southeastern Archaeology* 22(1):77–91.

Williams, Marikka Lin
2004 Interpreting Prehistoric Patterns: Site Catchment Analysis in the Upper Trinity River Basin of North Central Texas.:316.

Wirth, Karl, and Andy Barth
2020 X-Ray Fluorescence (XRF). *Geochemical Instrumentation and Analysis*. https://serc.carleton.edu/research_education/geochemsheets/techniques/XRF.html, accessed October 16, 2022.

Young, D. Craig
2002 Part 6. Secondary Obsidian Sources of the Madeline Plains: Paleolandscapes and Archaeological Implication. In *Boundary Lands: Archaeological Investigations Along the California-Great Basin Interface*, edited by K. R. McGuire, pp. 75–84. Nevada State Museum Anthropological Papers Number 24, Carson City, Nevada.