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SPATIAL AND TEMPORAL DISTRIBUTION OF OBSIDIAN IN OKLAHOMA:

CONVEYANCE ZONES ON THE SOUTHERN PLAINS

A THESIS APPROVED FOR THE
DEPARTMENT OF ANTHROPOLOGY

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Abstract

Obsidian is an exotic lithic resource rarely found in Oklahoma, yet it still occurs in the archaeological record. This project utilized Energy Dispersive X-ray Fluorescence (EDXRF) Mass Spectrometry to geochemically source 110 obsidian artifacts from Oklahoma in various private collections and museum collections. These 110 EDXRF samples were added to the existing 220 obsidian artifacts from Oklahoma previously studied to synthesize the data. My research question is: what spatial patterning is expressed by obsidian in Oklahoma, and what do these patterns reveal about cultural interaction through time?

I utilized the interpretive framework of conveyance zones and cultural interaction patterns to interpret the results. All spatial and temporal data was process with ArcGIS to parse out the spatial and temporal distribution of obsidian in Oklahoma. The 110 EDXRF samples resulted in eight chert artifacts, which were removed from the study, leaving 102 EDXRF samples combined with the previous 220 samples totaling 322 obsidian samples in Oklahoma subjected to source characterization. The remaining 102 EDXRF samples from this study resulted in the majority of the obsidian artifacts sourcing to either the Cerro Toledo Rhyolite or Valles Rhyolite obsidian sources in the Jemez Mountains in New Mexico. Obsidian from Malad, Idaho and to a lesser extent Obsidian Cliff, Wyoming were also well represented in the 102 EDXRF samples. Outliers include obsidian from Buck Mountain, California, Timber Buttes, Idaho, and at least one unknown obsidian source.

The results of the synthesized data of the combined 322 obsidian samples from Oklahoma illuminated shifting cultural interaction patterns between the Southern Plains (Oklahoma) and adjacent regions. Until the Late Precontact Period (1,250 – 450 B.P.) and excluding the Paleoindigenous Period (prior to 7,950 B.P.), people on the Southern Plains

preferred obsidian from Malad and Obsidian Cliff overall, suggesting a cultural interaction pattern stretching northward through the Central Plains toward Idaho and Wyoming. During the Late Precontact Period those preferences and cultural interaction patterns shifted toward obsidian from the Jemez Mountains in New Mexico with Cerro Toledo Rhyolite being favored by people in the Oklahoma Panhandle, and Valles Rhyolite in western Oklahoma. During the Postcontact Period (450 – 200 B.P.) people in the past in Oklahoma preferred obsidian the Valles Rhyolite obsidian from New Mexico.

Chapter 1: Introduction

Obsidian is volcanic glass, and the process of obsidian formation locks in a number of chemical elements whose concentrations are unique to each individual lava flow. We can analyze the chemical concentrations of an obsidian artifact and "fingerprint," or source, that artifact to the lava flow it originated from (Shackley 2005). Through this process we can draw a line between the geologic source of obsidian and where the artifact was found. This can give us clues as to where and how people in the past acquired their lithic resources

Although rare, we *do* find obsidian in Oklahoma, even though there are no natural sources of obsidian in the state. The nearest obsidian-bearing formation is located in the Jemez Mountains in northeastern New Mexico, over 322 km (200 mi) away from the Oklahoma Panhandle. Despite this distance, obsidian artifacts still show up in the archaeological record across Oklahoma throughout time. This makes any obsidian artifacts found in Oklahoma all the more interesting because those artifacts had to be imported from afar.

Importing materials allow for the interaction between different groups of people, as the obsidian was either passed from hand to hand in an exchange or trade scenario, or brought directly from the geologic origin source to the object's resting place. A cultural interaction oriented perspective on spatial data allows us to incorporate social variables when looking at distance and space, or what Hughes (2011) refers to as social distance. Differences in the distribution of exotic materials, such as obsidian, indicate variations in the degree of interaction between cultural groups (Janetski et al. 2011). For the purposes of this study, I define exotic lithic resources as non-local to Oklahoma, and local lithic resources as those appearing within the state. I am interested in the nature and degree of interaction between differing groups of people on the Southern Plains and adjacent regions through time, and the possible directionality of those lines of interaction.

When studying one line of evidence such as obsidian source characterization, there will always be some contention as to whether an exotic lithic resource like obsidian was exchanged for or procured directly. I knew of this issue going in to the project, and resolved this issue in parsing out direct procurement versus exchange because the obsidian had to have made it to Oklahoma in some way or another, and human interactions drive events like this, which is the focus of this research. Conveyance zones and cultural interaction were the solutions to problems with direct procurement and exchange concerning obsidian centered research. Studying obsidian is vital to further our understanding of social boundaries, group interaction, and trade and exchange networks both within the Southern Plains and between larger regions. My research addresses the temporal and spatial distribution, and geologic source of obsidian in Oklahoma.

Oklahoma is a diverse state, both culturally and ecologically. Situated as the northern extension of the Southern Plains and amid the Southwest, Central Plains, and Southeast, Oklahoma has seen myriad different cultures utilizing its various environments in the past. In eastern Oklahoma there are large ceremonial sites associated with Southeast cultures such as Spiro (34LF40), possibly the most famous archaeological site in the state. Various cultures on the Southern Plains appear in central and western Oklahoma, and there are even some archaeological sites in the far western extension of the Oklahoma Panhandle with Basketmaker and Ancestral Puebloan influences (Lintz and Zabawa 1984). The position of Oklahoma amid all of these cultures and ecological zones makes the state a well oriented place to utilize obsidian source characterization to parse out cultural interaction patterns.

My central research question is: what spatial patterning is expressed by obsidian in Oklahoma, and what do these patterns reveal about cultural interaction through time? Answering this two-fold question will significantly contribute to our understanding of both obsidian procurement and the plausible directionality of cultural interaction patterns between different groups of people across the Southern Plains and farther.

I shall now provide a summary of the remaining chapters in this research project. Chapter 2: Environmental Background covers both past and present environments in Oklahoma. In it I discuss the shifting environments of Oklahoma from the late Pleistocene to modernity. I then briefly touch on the many lithic resources in Oklahoma and finally discuss prominent obsidian sources from the western Unites States (US) that appeared in the data and literature review. Chapter 3 is entitled Archaeological Context and is divided into two parts. In part one of Chapter 3 I discuss the theoretical ideas and mobility, cultural interaction, obsidian conveyance zones, and the nature of exchange in the archaeological record. In part two of Chapter 3 I discuss the general cultural chronology of Oklahoma. In Chapter 4: Methods I discuss my specific methodology for proceeding through my research project. Chapter 4 touches on how I assembled the list of Oklahoma sites with obsidian, how I formed my analytical sample, how I chose which artifacts to subject to Energy Dispersive X-ray Fluorescence (EDXRF), and the role of Geographic Information Systems (GIS) in the spatial analyses of the 178 obsidian sites in Oklahoma. My results are presented in Chapter 5 and include a literature review on what research has been done on obsidian in Oklahoma before this project, and the EDXRF sourcing determinations and spatial data derived from GIS. In Chapter 6: Discussion/Conclusion I discuss the results and their archaeological implications toward cultural interaction both within and between groups of people on the Southern Plains and neighboring regions. I then respond the previous hypotheses put forth by past researchers, and touch on Indigenous perspectives about obsidian. In the conclusion section of Chapter 6 I return to my research question and discuss possible future research directions.

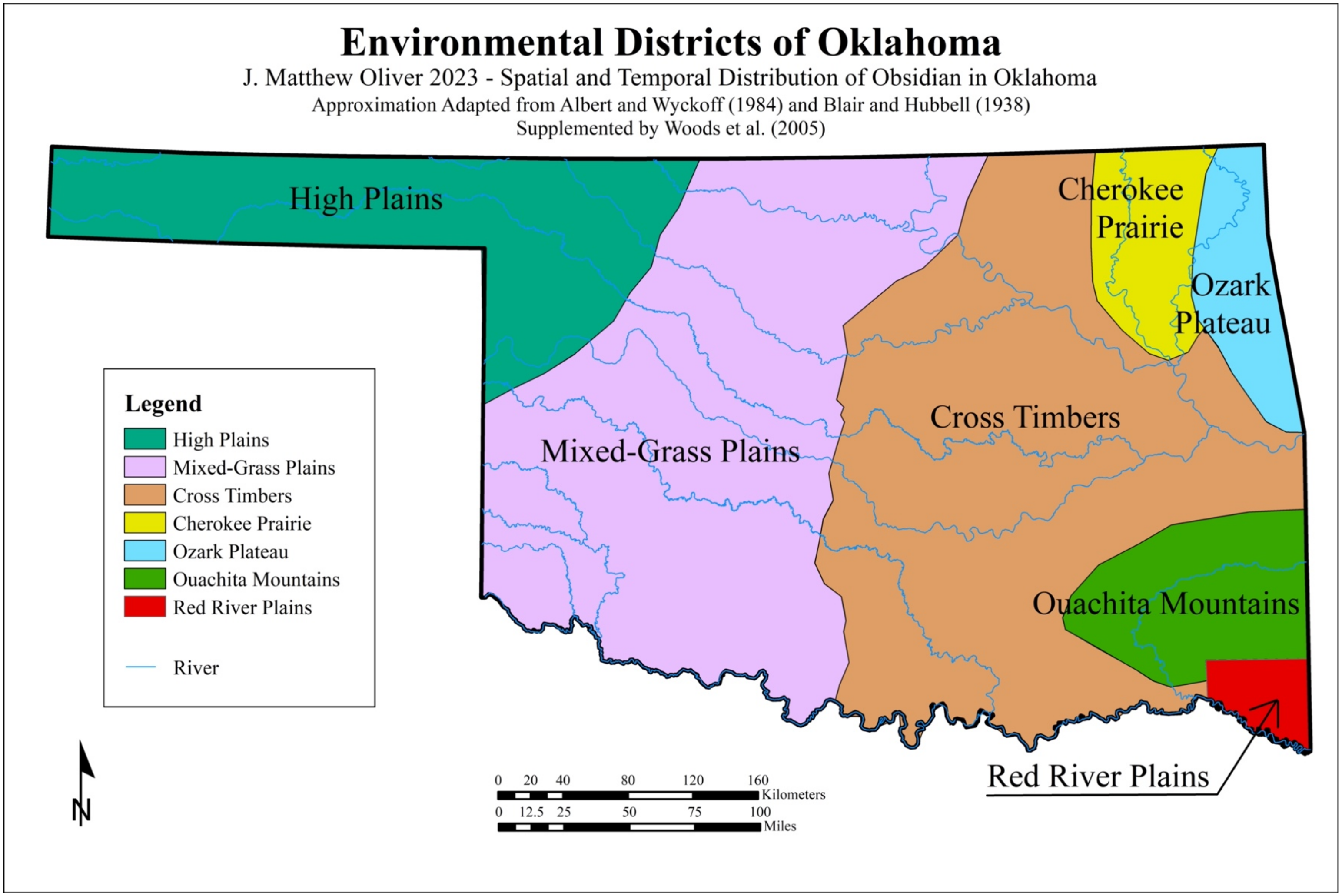
Chapter 2: Environmental Background

We can consider the entire state of Oklahoma an ecotone, which is a transition zone between multiple habitats. Just as there are a number of different environments in Oklahoma, those environments vary through time affecting the landscape, resources, organisms, and human beings. For consistency all dates are given in Calendar Years Before Present (B.P. = AD 1950) unless otherwise stated.

Oklahoma is amid the Eastern Woodlands and the Great Plains and represents the transition from the wooded Southeast US to the rolling hills and grasslands of the Great Plains. The elevation rises westward from the Little River valley, a mere 87 m (285 ft) above mean sea level (amsl) high to Black Mesa, reaching over 1,500 m (4,921 ft) amsl high in northwestern corner of Cimarron County, the westernmost county in the state (Woods et al. 2005). As the northern and eastern extension of the Southern Plains, Oklahoma stretches north toward the Central Plains, and even contains environments reminiscent of coastal lowlands in the southeastern portion of the state.

In this chapter I discuss the various past and present environments in Oklahoma, available lithic resources in Oklahoma, and the obsidian sources relevant to my study. With so much environmental diversity, I follow Albert and Wyckoff (1984) in their adaptation of Blair and Hubbell's (1938) system of Oklahoma's environmental (or biotic) districts, supplemented by the United States Geological Survey (USGS) Ecoregions Level IV poster publication by Woods et al. (2005). These districts include, from West to East, the High Plains or Short-Grass Plains, the Mixed Grass Plains, the Cross Timbers, the Cherokee Prairie, the Ozark Plateau, the Ouachita Mountains, and the Red River Plains (Figure 2.1).

Figure 2.1: Map of Albert and Wyckoff's (1984) rendition of Blair and Hubbell's (1938) Environmental Zoning System and Supplemented by Woods et al. (2005)



First, I discuss the paleoenvironment of Oklahoma starting with the Pleistocene epoch. I then move through the Holocene epoch to the present. After discussing the paleoenvironment, I turn to Oklahoma's seven modern environmental districts established by Albert and Wyckoff (1984) and Blair and Hubbell (1938). Then I briefly touch on the many lithic resources in Oklahoma, none of which are obsidian or even volcanic. Lastly I cover the various obsidian sources that have generally appeared in the archaeological record of Oklahoma and the Southern Plains.

Part One: Past Environments

Pleistocene

The Quaternary Period consists of two epochs – the earlier Pleistocene Epoch and the later Holocene Epoch. Anatomically modern humans emerged during the Pleistocene, which was largely a time of glaciation and due to a cooler period that occurred across the world around 70,000 years ago (Albert and Wyckoff 1984). The Pleistocene was also the peak of megafauna populations across the world. Approximately 17,000 years ago a glacial ice sheet covered much of the Midwestern US (Flint 1957). Paleoenvironments during this time are not well understood, especially for Oklahoma. According to Delcourt (1979) tundra existed south of the Midwestern ice sheet, spruce forests dominated the Appalachians, and both coniferous and deciduous forests covered the Southeastern United States. While little securely dated data exists for the environment of Late Pleistocene Oklahoma, it was most likely composed of boreal forests and meadows.

Based on evidence from Missouri, northeastern Oklahoma was probably covered by spruce forests (King 1973). The Late Pleistocene environment in central and western Oklahoma indicates that pine forests and meadows were more common than spruce and conducive to what

Wendorf (1975) named the “Tahoka Pluvial,” a moist and cool period within the later Pleistocene. Wendorf’s (1975) idea of the “Tahoka Pluvial” supported a variety of megafauna important to people living in the late Pleistocene, such as bison, horses, camels, and mammoths. An important example for people in Oklahoma of this portion of the Pleistocene is the Cooperton Mammoth site (34KI26) in southwest Oklahoma (Wyckoff and Brooks 1983). I provide more details on this site in the following chapter.

Approximately 16,000 years ago weather conditions became both dryer and warmer than the “Tahoka Pluvial,” and continued until about 11,500 years ago (Albert and Wyckoff 1984). Evidence from sites such as the Domebo site in southwestern Oklahoma (Leonhardy 1966) indicate that marshy environments were more common than boreal forests (Albert and Wyckoff 1984). The Younger Dryas event occurred at the end of the Pleistocene epoch about 16,000 – 10,000 years ago. The warmer and dryer climate caused radical environmental change coinciding with the extinction of many species of megafauna and Pleistocene flora ending the Pleistocene epoch and beginning the Holocene epoch (Albert and Wyckoff 1984).

Holocene

During the Holocene epoch Oklahoma environments appear rather different than what we experience today according to pollen evidence at a few important sites in southeastern Oklahoma such as the Jenkins Reilly Slough site in McCurtain County and the Ferndale Bog site in Pushmataha County. Even though the Holocene marks the development of Oklahoma environments and species that we are familiar with today, the earlier Holocene was much different – being dominated by arid grasslands. The Holocene was a period of rapid environmental fluctuation compared to the earlier Pleistocene epoch. Antev (1955) developed a classification system dividing the Holocene into three distinct climatic periods. Although

Antevs's (1955) classification on Holocene climatic periods has been debated and critiqued because his climatic periods did not happen all over North America at the same time, and often produced different effects on the flora and fauna subject to environmental flux. Despite this, his system is still applicable and used by many archaeologists today.

Antev (1955) divided the Holocene into three climatic episodes: the Anathermal, the Altithermal, and the Medithermal. The Anathermal period marked an increase in temperature and a drop in moisture beginning around 10,500 years ago and lasting until 7,000 years ago. Following the end of the Anathermal and lasting until 4,000 years ago, the Altithermal was also warm and dry, even to the point of being arid. The Medithermal period began after the Altithermal and continues to today. It is defined by relatively mild temperatures and an increase in moisture, yet drought cycles become increasingly prevalent. Dated pollen cores from the Ferndale Bog site provide us with evidence for extreme climatic changes including drought cycles and radically changing environments. It is during the Antev's (1955) Medithermal period that we begin to find evidence of modern environments and habitats in Oklahoma (Albert and Wyckoff 1984).

Part Two: Current Environments *(adapted from Albert and Wyckoff 1984 and Blair and Hubbell 1938 and supplemented by Woods et al. 2005)*

<u>High Plains</u>

The High Plains, or Short-Grass Prairie, of Oklahoma, according to Albert and Wyckoff (1984) and Blair and Hubbell (1938), lies in the northwest portion of the state and includes the panhandle and portions of the seven most northwestern Counties east of the panhandle (Figure 2.1). The climate of the High Plains is the driest, and most subject to drought, of the seven major environmental districts I discuss here. Severe weather patterns can develop quickly in this area and the High Plains generally have harsher winters than the rest of Oklahoma.

Aptly named, the High Plains of Oklahoma boast the highest elevation in the state ranging from 550 m (1,804 ft) amsl at the lowest and in the southeastern extent of the High Plains, to Black Mesa in Cimarron County stretching to over 1500 m (4,921 ft) amsl. The area displays flat to gently rolling terrain underlain by Tertiary and Pleistocene alluvial sands. These sand sands are dissected by multiple drainage systems, generally flowing west to east. In the far western part of the High Plains, again in western Cimarron County, drainage systems have formed canyons and mesas out of cretaceous sandstone (Albert and Wyckoff 1984). The only naturally occurring volcanic material in Oklahoma is the Tertiary aged basaltic lava cap covering Black Mesa (Woods et al. 2005). This is an important fact for my thesis project as it is predicated on volcanic resources being imported from afar.

The High Plains is home to typical short grasses found in similar environments. These include the buffalograss-needlegrass-gramagrass complex with yucca and sagebrush intermixed (Albert and Wyckoff 1984). Cottonwood and willow trees populate riparian environments in the area. Fauna typical to grassland environments are common in the High Plains such as bison, antelope, prairie chickens, rodents, and reptiles. In the western portion of Cimarron County, the eastern fringe of the pinon-juniper-mesa habitat exists, supporting mule deer and eagles (Albert and Wyckoff 1984; Woods et al. 2005).

<u>Mixed-Grass Plains</u>

The Mixed-Grass Plains in Oklahoma includes the Redbed Plains spreading throughout the eastern part of the region, and weathered sandstone hills in the South and West. (Albert and Wyckoff 1984). This region encompasses most of western and west-central Oklahoma including portions of 35 Counties (Figure 2.1). While the Mixed-Grass Plains receive more annual precipitation than the High Plains to the West, this precipitation rate is still considerably less than other regions in Oklahoma farther east.

The elevation for the state of Oklahoma gently rises from east to west, and for the Mixed-Grass Plains elevations grade westward from just over 300 m (984 ft) amsl to over 450 m (1,476 ft) amsl (Albert and Wyckoff 1984). The terrain in this region is dominated by gently rolling plains underlain by shales and sandstones from the Permian era. Gypsum hills also occur in the Mixed-Grass Plains (Albert and Wyckoff 1984). In the southwestern portion of the region the Wichita Mountains rise up consisting primarily of Cambrian age igneous rocks such as granite (Albert and Wyckoff 1984). In the northeastern corner of the Mixed-Grass Plains the Flint Hills extend from Kansas into Osage and Kay Counties.

Flora and fauna of the Mixed-Grass Plains are similar to those of the High Plains with the buffalograss-needlegrass-gramma grass group carpeting the western Mixed-Grass Plains. Farther east, the bluestem-grama-indiangrass group covers the landscape (Albert and Wyckoff 1984; Woods et al. 2005). As with the High Plains, cottonwood and willow trees are abundant throughout floodplains and riverine areas. Tree species belonging to the post oak-blackjack group cling to the uplands providing shelter for more eastern fauna such as the white-tail deer and coyote (Woods et al. 2005). Other fauna native to the Mixed-Grass Plains are similar to those of the High Plains. Bison historically roamed in sizeable herds in the Mixed-Grass Plains before they were nearly eradicated by colonists (Albert and Wyckoff 1984).

Cross Timbers

The Cross Timbers, or Osage Savanna, can be considered an ecotone between the drier, grass dominated environments of western and central Oklahoma and the wetter, woodland dominated environments found in eastern Oklahoma. The Cross Timbers receives more annual precipitation than both the Mixed-Grass Plains and High Plains of Oklahoma, but still considerably less rainfall than environments farther east. This region encompasses a swath of central Oklahoma stretching from north to south, and includes portions of 31 counties (Figure 2.1).

Terrain in the Cross Timbers is generally flat to rolling with patches of hills between 200 m (656 ft) amsl and 366 m (1,201 ft) amsl. The highest natural formation in the Cross Timbers are the Arbuckle Mountains, primarily consisting of Precambrian granites and Cambrian to Mississippian limestones, and reach heights near 396 m (1,299 ft) amsl (Albert and Wyckoff 1984). The eastern extension of the Redbed Plains stretches throughout the Cross Timbers. These plains are aptly named for their red Permian age formations of sandstones and shales. In the extreme eastern part of the Cross Timbers, Pennsylvanian sandstone-capped hills dominate the landscape, and in the northern part, Cuesta Plains consisting of limestone with some sandstone (Albert and Wyckoff 1984).

Floral and faunal diversity within the Cross Timbers is higher than in Oklahoma's western environments. Vegetation across the majority of the Cross Timbers is tall-grass prairie with post oak-blackjack forests clinging to the more riparian areas. Oak-hickory forests appear on hillsides. In the southeastern part of the Cross Timbers oak-pine forests dominate (Albert and Wyckoff 1984). Historically, incredibly dense forests grew along the floodplains of Oklahoma's Cross Timbers, and large bison herds roamed the grasslands (Wyckoff 1984). The density of these older forests at times made travel through the region difficult for people in the past (Wyckoff 1984). Today we find whitetail deer populating the upland forests and bottomlands of the Cross Timbers, along with multiple birds, reptiles, and rodents, especially squirrels and rabbits (Albert and Wyckoff 1984; Woods et al. 2005).

Cherokee Prairie

The Cherokee Prairie is located in northeast Oklahoma, includes portions of seven counties, and is generally considered a tall-grass prairie extension of the Central Plains into Oklahoma (Albert and Wyckoff 1984) (Figure 2.1). Weather patterns in the Cherokee Prairie include hot and dry summers and cold winters. While the Cherokee Prairie receives more annual rainfall than Oklahoma's High Plains, Mixed-Grass Plains, and Cross Timbers, it is typically drier than some of the more forested environments farther east. Topography on the Cherokee Prairie consists dissected uplands and rolling and undulating hills. These landforms are underlain by Pennsylvanian sandstones and limestones (Albert and Wyckoff 1984).

Floral and faunal diversity in the Cherokee Prairie is remarkable with grasslands covered in sideoats grama, Kentucky bluegrass, big and little bluestem, switchgrass, and Indiangrass. Miniscule pockets of post oak-blackjack forests also appear in the Cherokee Prairie (Albert and Wyckoff 1984). A multitude of rodents, fish, and reptiles live alongside larger mammals like whitetail deer, foxes, badgers, and even minks. Avian inhabitants of the Cherokee Prairie include passenger pigeons, mourning doves, meadowlarks, and birds of prey such as hawks and owls (Albert and Wyckoff 1984; Woods et al. 2005).

Ozark Plateau

The Ozark Plateau is a mountainous environment and covers the far northeastern corner of Oklahoma, including portions of six counties (Figure 2.1). The Ozark Plateau is the extension of the Ozark Mountains from Arkansas and Missouri and includes the Boston Mountains, a small mountain range south of the Ozarks spanning Sequoyah, Le Flore, and Haskell Counties. The

Ozark Plateau typically has cool and dry winters, along with hot and humid summers (Albert and Wyckoff 1984; Woods et al. 2005).

Many scholars have called the Ozarks "chert mountains," as nearly the entire mountain range consists of limestone, chert, and dolomite of Cambrian, Ordovician, and Mississippian age (Albert and Wyckoff 1984; Banks 1984, 1990). The Boston Mountains along the southern edge of the Ozark Plateau can reach heights of 244 m (800 ft) amsl. The Boston Mountains consists of Pennsylvanian age sandstones and shales (Albert and Wyckoff 1984).

The Ozark Plateau consists of dense forests, with oak-hickory forests dominating the Ozark Mountains and oak-hickory-pine forests being more prominent in the Boston Mountains. We find slightly less floral and faunal diversity in the Ozark Plateau compared to the Cherokee Prairie just west of the Ozark Plateau, yet many of the faunal species overlap. Whitetail deer, foxes, beavers, rabbits, muskrats, minks, woodchucks, and skunks typically inhabit the Ozark Plateau, along with catfish, sunfish, and a variety of birds and reptiles (Alfred and Wyckoff 1984; Woods et al. 2005).

Ouachita Mountains

The Ouachita Mountains environmental zone is a mountainous environment spreading across the southeastern part of Oklahoma and into southwestern Arkansas, and includes portions of eight counties (Figure 2.1).

The Ouachita Mountains typically have cool and dry winters, along with hot and humid summers (Albert and Wyckoff 1984, Woods et al. 2005). The mountains and valleys in the Ouachita Mountains typically stretch diagonally, from southwest to northeast and are the result of an incredibly faulted and folded uplift. Mountain peaks in this environment can reach heights of approximately 427 m (1,401 ft) amsl. Furthermore, the Ouachita Mountains consist of

Devonian age Novaculite under sandstones, shales, and minimal limestone of Pennsylvanian or Mississippian age (Albert and Wyckoff 1984).

A variety of forests dominate the Ouachita Mountains, including oak-pine forests and oak-pine-hickory forests (Albert and Wyckoff 1984; Woods et al. 2005). We also find the some post oak-blackjack forests, oak-hickory forests, and occasionally small prairie openings and meadows (Albert and Wyckoff 1984; Woods et al. 2005). Faunal diversity in the Ouachita Mountains is similar to the other environmental zones in eastern Oklahoma with the addition of more carnivorous and omnivorous mammals such as black bears, wolves, and cougars. Turkeys, herons, and quail also inhabit the Ouachita Mountains (Albert and Wyckoff 1984; Woods et al. 2005).

Red River Plains

The Red River Plains is the smallest of the seven environments in Oklahoma based on Albert and Wyckoff's (1984) adaptation of Blair and Hubbell's (1938) system (Figure 2.1). The Red River Plains is in the extreme southeastern corner of Oklahoma and covers the southern half of McCurtain County. Being a much more humid environment than the majority of Oklahoma, the Red River Plains have the state's highest temperatures during the summer and cool, mild winters (Albert and Wyckoff 1984). The Red River Plains is the northernmost extension of the Dissected Coastal Plains stretching from eastern Texas and Louisiana (Albert and Wyckoff 1984; Woods et al. 2005).

Floral habitats typically carpeting the Red River Plains include oak-pine forests along with loblolly pines, and cypress bottoms forests (Albert and Wyckoff 1984; Woods et al. 2005). Fauna that typically inhabit the Red River Plains include turkeys, woodcocks, quail, raccoons, cougars, foxes, skunks, rabbits, whitetail deer, black bears, squirrels, turtles, various snakes, gar, catfish, and in rare cases, alligators (Albert and Wyckoff 1984; Woods et al. 2005).

Part Three: Lithic Resources in Oklahoma

High quality lithic resources abound in Oklahoma. This section is necessary for a research project centered around exotic lithic resources, and particularly obsidian, to frame the research toward cultural interaction. In the following paragraphs I will touch on the known knappable lithic resource in each of the seven current environmental districts established by Albert and Wyckoff (1984) and Blair and Hubbell (1938).

<u>Lithic Resources in Oklahoma's High Plains</u>

While not nearly as rich in knappable lithic resources as the environments in the eastern part of Oklahoma, the High Plains still boasts outcroppings of Dakota quartzite, Ogallala quartzite, Tecovas jasper, and cherts from the Morrison group. Day Creek chert can also be found in limited amounts on the High Plains of Oklahoma (Banks 1984, 1990).

<u>Lithic Resources in Oklahoma's Mixed-Grass Plains</u>

Knappable lithic resources in Oklahoma's Mixed-Grass Plains are primarily from number of chert groups arising from the Arbuckle Mountains, and in the northeastern part of the Mixed-Grass Plains, we begin to find chert outcroppings associated with the Florence group (Banks 1984, 1990). Typical lithic resources local to the Mixed-Grass Plains include: Day Creek chert, Viola chert, cherts from the Arbuckle group, Wreford chert, cherts from the Foraker-Neva-Cottonwood group, and some types of the famous Florence chert (Banks 1984, 1990).

<u>Lithic Resources in Oklahoma's Cross Timbers</u>

A wide variety of knappable lithic resources are local to Oklahoma's Cross Timbers. Cherts from the Hunton, Woodford, Viola, and Simpson groups are common, along with Pinetop chert and Wapanucka/Chickachoc chert (Banks 1984, 1990). Along the eastern edge of the Cross Timbers we find knappable stone more common in Oklahoma's more mountainous environments to the east such as Johns Valley silicified shale, Frisco chert, and other cherts from the Frisco-Sallisaw group (Banks 1984, 1990).

Lithic Resources in Oklahoma's Cherokee Prairie

Oologah chert is the major local knappable lithic resource in the Cherokee Prairie (Banks 1984, 1990). Along the eastern edge of the Cherokee Prairie cherts from the Moorefield and Boone formations also appear (Banks 1984, 1990).

Lithic Resources in Oklahoma's Ozark Plateau

Knappable lithic resources in the Ozark Plateau are incredibly abundant. In fact, the Boone formation almost completely underlies this environmental region, yielding the famous Keokuk chert known throughout archaeological record of eastern Oklahoma and adjacent states (Banks 1984, 1990). Members of the Moorefield formation, such as Bayou Manard chert and Tahlequah/Peoria chert outcrop throughout much of the Ozark Plateau. Cotter Dolomite outcroppings have also been noted in Delaware and Mayes Counties, Oklahoma. In the southern part of the Ozark Plateau and in the Boston Mountains scattered outcroppings of Frisco/Sallisaw chert appear (Banks 1984, 1990).

Lithic Resources in Oklahoma's Ouachita Mountains

The Ouachita Mountains are particularly rich in knappable lithic resources (Banks 1984, 1990). In fact, the Stanley and Jackfork groups nearly cover the entire Ouachita Mountains. Other knappable lithic resources originating from the Ouachita Mountains include Arkansas Novaculite, Big Fork chert, Johns Valley silicified shale, Pinetop chert, and Wapanucka/Chickachoc chert (Banks 1984, 1990).

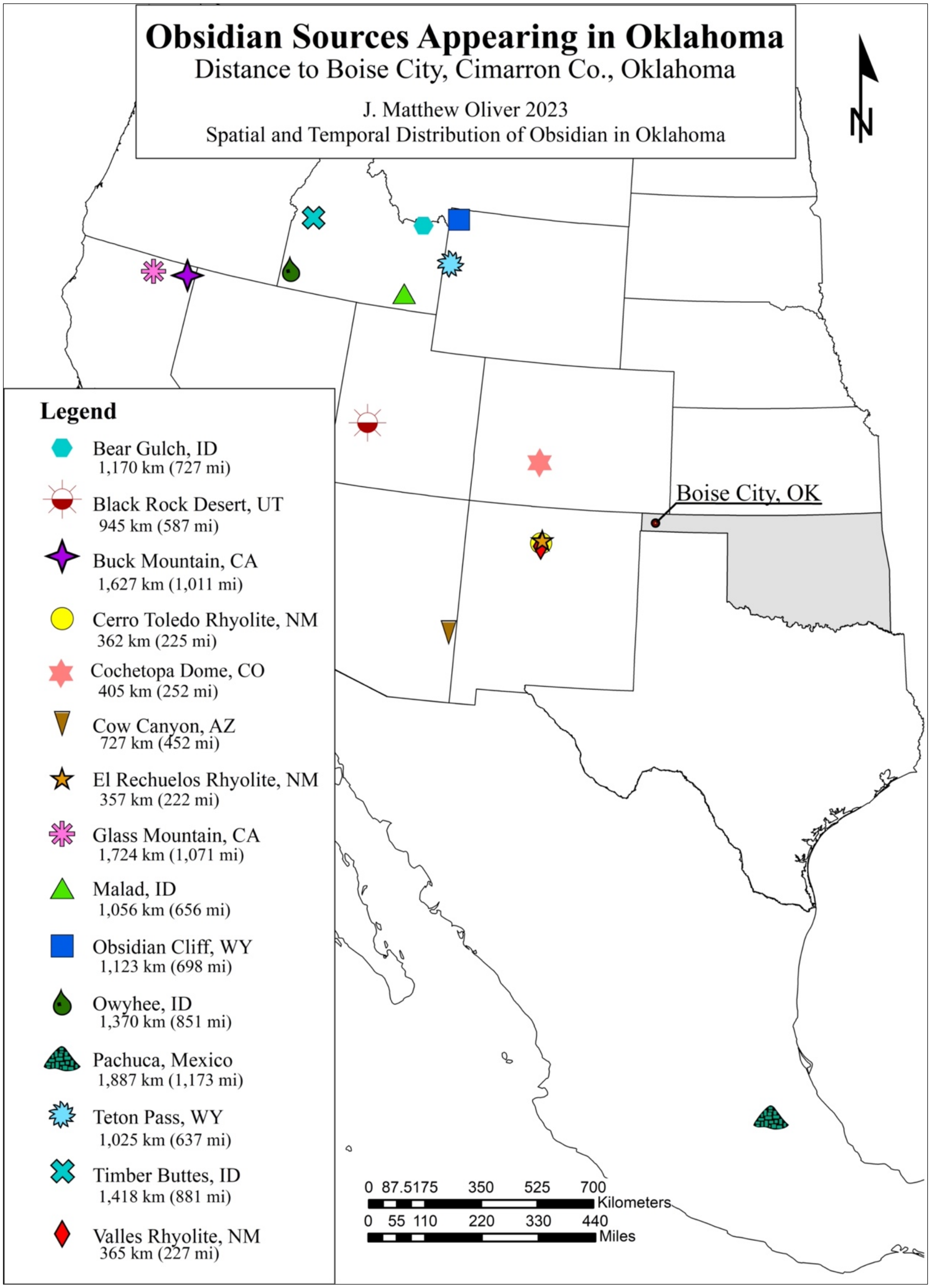
Lithic Resources in Oklahoma's Red River Plains

The Red River Plains is rather poor in knappable lithic resources as nearly the entire environmental zone is underlain by the Cretaceous age Antlers Sandstone formation. The Antlers Sandstone formation includes sandstone conglomerates, shale, and some chert (Banks 1984, 1990).

Part Four: Obsidian Appearing in Oklahoma and its Geologic Origin Source

For the remainder of this chapter I give a brief overview of the various obsidian bearing volcanic formations producing obsidian that has made its way to Oklahoma, and the Southern Plains in general. Throughout this section all distances to an obsidian source were calculated with Boise City, Cimarron County, Oklahoma as the datum for distance. I begin with Cochetopa Dome, the sole obsidian source in Colorado, then turn to the obsidian yielding volcanic formations in the Jemez Mountains in northern New Mexico, including the El Rechuelos Rhyolite formation, Cerro Toledo Rhyolite formation, and the Valles Rhyolite formation. Afterward I discuss Idaho with the Malad Rhyolite formation near Malad City, Idaho, Timber Buttes, north of Boise, Idaho, Bear Gulch in eastern Idaho, and Owyhee in southwest Idaho. Next I cover obsidian originating from Wyoming including the Obsidian Cliff formation in Yellowstone National Park, northwest Wyoming, and Teton Pass in the Grand Tetons Nation Park. Lastly, I touch on some obsidian sources found rarely in the archaeological record of Oklahoma including Buck Mountain and Glass Mountain obsidian in California, the Black Rock Desert area in Utah, Cow Canyon obsidian in Arizona, and Pachuca obsidian from the State of Hidalgo in central Mexico (Figure 2.2).

Figure 2.2: Obsidian Sources Appearing in Oklahoma



Colorado

Cochetopa Dome

Obsidian from Cochetopa Dome, a volcanic dome formation in Saguache County, southwestern Colorado is a Tertiary age formation. The obsidian outcrops some distance up the dome, and is eroding out on both the eastern and western side slopes of the dome. In the Upper Gunnison Basin Cochetopa Dome obsidian, or even obsidian in general, is rather poorly represented in archaeological sites (Stiger 2001). Stiger (2001) investigated the obsidian from Cochetopa Dome and noted that it was likely unusable by people of the past as most of the obsidian was about the size of a pebble, with some being no larger than a golf ball. Stiger (2001) also notes that, on the western side slope of Cochetopa Dome where obsidian is eroding out of the surface, there were very few pieces of debitage around. Likewise, on the eastern side slope of the dome there was no observable debitage. Dr. Bonnie L. Pitblado, an expert in Paleoindigenous Upper Gunnison Basin archaeology, confirmed that obsidian coming from the Cochetopa Dome source is very small, perhaps less than 5 cm (2 in) although she notes that collectors have shared anecdotes about the presence of larger pieces (Pitblado 2016 personal communication). The Cochetopa Dome formation is located approximately 405 km (252 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

New Mexico

Archaeologists have extensively studied obsidian coming from the rhyolite formations in the Jemez Mountains in Rio Arriba and Sandoval Counties in northern New Mexico and is well understood (cf. Shackley 2005, 2021). Three different rhyolite formations underlay the Jemez Mountains including the Cerro Toledo Rhyolite formation, the El Rechuelos Rhyolite formation, and the Valles Rhyolite formation, all of which formed during the Quaternary period.

El Rechuelos Rhyolite

The El Rechuelos Rhyolite formation is the oldest of the three obsidian bearing formations in the Jemez Mountains. Archaeologists have also referred to this obsidian as the Polvadera group. El Rechuelos obsidian generally occurs as rather small nodules, approximately one to five cm (0.4 to 2 in) in length, and is partial to hydration and devitrification (Shackley 2005). El Rechuelos obsidian has ash in its matrix and is uniformly granular. Shackley (2005) has noted that El Rechuelos obsidian was selected for in the past because of its uniformity. The El Rechuelos Rhyolite formation is approximately 357 km (222 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Cerro Toledo Rhyolite

The Cerro Toledo Rhyolite formation is younger than the El Rechuelos Rhyolite formation in the Jemez Mountains (Shackley 2005). Archaeologists have also called obsidian coming from the Cerro Toledo Rhyolite formation Obsidian Ridge and Rabbit Mountain. Cerro Toledo Rhyolite obsidian occurs in two major ash flows on the outside of the caldera rim in the Jemez Mountains. The first of these ash flows is the Toledo Embayment located on the northeast edge of the caldera rim, and the second ash flow is Rabbit Mountain, or Obsidian Ridge, which erupted near the southeast edge of the caldera rim (Shackley 2005). Both ash flows are eroding quickly, and Church (2000) has noted that the Rabbit Mountain ash flow erodes southeast along the canyons and into the Rio Grande. People have found Cerro Toledo Rhyolite obsidian nodules in and around the Rio Grande from the Jemez Mountains all the way to the state of Chihuahua in western Mexico (Church 2000). Shackley (2005) notes that Cerro Toledo Rhyolite obsidian nodules typically measure up to 10 cm (4 in) in length, often contain spherulites, and are generally aphyric (Shackley 2005). The Cerro Toledo Rhyolite formation is approximately 362 km (225 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

<u>Valles Rhyolite</u>

The Valles Rhyolite formation is the youngest of the three obsidian-bearing rhyolite formations in the Jemez Mountains and is entirely restricted within the caldera rim (Shackley 2005). Archaeologists have also called the Valles Rhyolite formation Cerro del Medio and the Tewa Group. Shackley (2005) tells us that Valles Rhyolite obsidian, similar to Cerro Toledo Rhyolite obsidian, is relatively aphyric and contains spherulites within the matrix, but to a lesser degree than Cerro Toledo Rhyolite obsidian. Valles Rhyolite obsidian nodules can measure over 30 cm, and while the matrix of the obsidian is more consistent than Cerro Toledo Rhyolite obsidian, it is slightly less consistent than El Rechuelos Rhyolite obsidian (Shackley 2005). Archaeologists have noted secondary deposits of Valles Rhyolite obsidian in and around the Jemez River and San Antonio Creek (Shackley 2005). LeTourneau et al. (1996) note that Folsom people in the Abiquiu Basin preferred Valles Rhyolite obsidian for tool manufacture over the other two Jemez Mountains obsidian types. Shackley (2005) highlights that the Valles Rhyolite formation, being entirely constricted to the caldera rim, is easily culturally controlled. The Valles Rhyolite formation is approximately 365 km (227 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Idaho

<u>Malad</u>

Obsidian generally referred to as Malad come from the Late Tertiary age rhyolite formation 15 miles (24 km) north of Malad City in Oneida County in southeastern Idaho (Asher 1965). Malad obsidian generally occurs as relatively large nodules and is a slightly transparent black with occasional hints of mahogany or red (Thompson 2004). Sappington (1981a, 1981b) notes that Malad obsidian also occurs in perlite and pumice deposits in multiple locations throughout Oneida and Bannock Counties, Idaho. Deposits of Malad obsidian can occur as nodules along Wright Creek and Dairy Creek in Oneida County, Idaho, located north of Malad City. Malad obsidian has also been called Oneida obsidian (cf. Frison et al. 1968). Malad is usually distinguished from other obsidian sources by a high barium (Ba) content (<1500 parts per million [ppm]). The rhyolite formation north of Malad City, Idaho is approximately 1,056 km (656 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

<u>Timber Buttes (Area 1)</u>

Obsidian originating from Timber Buttes (area 1) comes from a massive obsidian flow in Gem County, Idaho (Corn 2006). Timber Buttes obsidian is high in toolstone quality and does not typically appear in the archaeological record of the Southern Plains (Shackley 2005, 2021; Corn 2006). Corn (2006) noted that, geochemically, the obsidian from Timber Buttes (area 1) was significantly different from the Timber Butte Rhyolite formation. While Timber Buttes (area 1) obsidian could be part of the larger rhyolite formation, other obsidian formation processes are possible (Shackley 2005, 2021; Corn 2006). Timber Buttes (area 1) is located approximately 1,418 km (881 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

<u>Bear Gulch</u>

The obsidian-bearing Bear Gulch Rhyolite flow formation is of Pliocene and Miocene age and is located near Big Table Mountain in northeastern Clark County, eastern Idaho. The Bear Gulch obsidian source has gone by multiple names in the past and is present as multiple obsidian outcrops and quarrying pits in an approximately 28 km^2 (11 mi^2) area (Griffin et al. 1969; Willingham 1995; Park 2010). Obsidian from the Bear Gulch source is of exceptional quality and is generally black and opaque (Park 2010). The Bear Gulch obsidian source is located approximately 1,170 km (727 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Owyhee

The Owyhee obsidian source occurs in Miocene-age rhyolite deposits primarily in northwest Owyhee County, southwest Idaho. Owyhee obsidian is also found stretching into Ada County in western Idaho and Malheur County in southeast Oregon (Northwest Research Obsidian Studies Laboratory [NROSL] 2011a). In the past, Owyhee obsidian was also called Oreana, Brown's Castle, and Toy Pass obsidian (NROSL 2011b). Artifacts of Owyhee obsidian have been widely found in southwest Idaho and southeast Oregon. The obsidian from the Owyhee rhyolite formations is typically black in colour with occasional mahogany banding (Projectilepoints.net 2022a). The Owyhee obsidian source is located approximately 1,370 km (851 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Wyoming

Obsidian Cliff

Obsidian originating from Yellowstone Rhyolite Plateau in Yellowstone National Park, Park County, northwest Wyoming, is generally referred to as Obsidian Cliff obsidian (Davis et al. 1995; Schmitt 1995). Obsidian Cliff obsidian formed in the Quaternary Period, and the primary source of this obsidian is a part of the Roaring Mountain member, north of the Yellowstone Caldera and overlooking Beaver Lake and Obsidian Creek in northwest Wyoming (Obradovich 1992; Davis et al. 1995). The Obsidian Cliff locality in the Yellowstone Rhyolite Plateau is one of many rhyolite flows in the nearby area, and no other lithic source was more popular in the past, including Knife River Flint (KRF), which is actually silicified peat, and Alibates Silicified Dolomite (Davis et al. 1995).

Obsidian Cliff obsidian is generally restricted to bedrock, and was once the fabled source of obsidian anywhere east of Rocky Mountains (Davis et al. 1995). Hatch et al. (1990) noted that Hopewellian people valued obsidian from Obsidian Cliff. Typically, Obsidian Cliff obsidian is black yet can display some banding and red-brown coloration (Boyd 1961). The boundaries of Obsidian Cliff obsidian deposits stretch from Obsidian Lake and Horseshoe Hill in the North, Sofatera Creek in the East, Lake-of-the-Woods in the South, and Obsidian Creek in the West (Aaberg 1995). Obsidian Cliff is located approximately 1,123 km (698 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Teton Pass (Variety 1)

The Teton Pass obsidian source has at least three locations around the Jackson Hole Mountain Resort and Teton Village in the Grand Tetons National Park, southern Teton County, northwest Wyoming (Park 2010). There are two varieties of obsidian named “Teton Pass,” with the first being originally known as Fish Creek or Teton Pass Variety 1, and the second being also known Crescent H or Teton Pass Variety 2 (Schoen 1997; Park 2010). In Oklahoma, Teton Pass Variety 1 has been attributed to an obsidian artifact found in the Oklahoma Panhandle. Teton Pass obsidian is high in lithic toolstone quality, typically a very dark gray to black, and occasionally banded (Park 2010). The Teton Pass Variety 1 obsidian source is located approximately 1,025 km (637 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Utah

Black Rock Desert

The Black Rock Desert obsidian source is a large Tertiary-age obsidian field in the southeastern part of Millard County, southwest Utah. Other names Black Rock Desert obsidian has been called are South Twin Peak, Coyote Hills, White Mountain, and simply Black Rock obsidian (NROSL 2011c; 2011d). Obsidian in the Black Rock area of Millard County, Utah is plentiful and is typically black to a darker gray with occasional mahogany banding and phenocysts (Projectilepoints.net 2022b). The Black Rock Desert obsidian source is located approximately 945 km (587 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

California

Buck Mountain

Obsidian originating from the Buck Mountain Group, isolated by Hughes (1983), displays a tremendous amount of variation in all conceivable aspects (Shackley 2021). Buck Mountain is situated in the northeast corner of California in the Warner Mountains in Modoc County, California. Shackley (2021) notes that there are many rhyolite domes in the Warner Mountains with a multitude of different obsidian flows. The sheer amount of obsidian originating from Buck Mountain and the large nodule size (up to 80 cm [31 in]) is striking (Shackley 2021). Obsidian from the Buck Mountain source is typically black and translucent with rarer samples displaying a purple sheen or darker mahogany colors (Shackley 2021). Buck Mountain is approximately 1,627 km (1,011 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Glass Mountain

The second California obsidian source appearing in the archaeological record of the Southern Plains and Oklahoma is obsidian from Glass Mountain in Lassen County, California (Dolan et al. 2018; Shackley 2021). Glass Mountain obsidian originates from the Medicine Lake Highlands, just west of the Warner Mountains (Shackley 2021). Glass Mountain is located approximately 1,724 km (1,071 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Arizona

Cow Canyon

Obsidian originating from the Cow Canyon volcanic domes in Greenlee County, Arizona are likely of Tertiary age and are situated within a rhyolite body (Shackley 1988, 1989, 2021). The major volcanic domes of Cow Canyon are eroding heavily and rapidly resulting in secondary deposits into the Blue River to the East, the San Francisco River to the South, and the Gila River to the West (Shackley 1988, 1989, 1995). Cow Canyon obsidian generally has an aphyric matrix and displays a wide variety of colors. The nodules are small, most of which measure less than 4 cm in length, and rarely exceed 5 cm (2 in) [Shackley 1995]. A minimal amount of artifacts from the Southern Plains and Oklahoma have sourced to Cow Canyon obsidian (Shackley 2021). The Cow Canyon obsidian source is approximately 727 km (452 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Mexico

Pachuca

Pachuca obsidian originating from the Sierra Las Navajas in the state of Hidalgo, central Mexico is a well-studied obsidian source. Despite the distance, Pachuca obsidian has been reported in the archaeological record of Oklahoma and the Southern Plains (Barker et al. 2002). Pachuca obsidian is legendary with its striking green color and consistent matrix, yet this specific obsidian is from one of four lava flows in the Sierra Las Navajas. (Ponomarenko 2004).

The volcanic development of the Sierra Las Navajas is incredibly complex and spans a vast amount of time. The distinctive green 'Pachuca' obsidian is actually from the Las Minas flows and is distinguished by its unvarying chemical composition along with its accessibility, occurring as blocky deposits and actually being mined by people in the past and today (Ponomarenko 2004). Other obsidian flows in the Sierra Las Navajas produce gray, brown, and crystalline obsidian (mostly from the El Horcón flow), some of which has not been utilized by people of the past (Ponomarenko 2004). The volcanic epicenter of the Sierra Las Navajas (traditionally and colloquially known as Pachuca) is located approximately 1,887 km (1,173 mi) from Boise City in Cimarron County, Oklahoma (Figure 2.2).

Table 2.1 below presents details on each obsidian type appearing in Oklahoma including the state the obsidian source is located in, the quality of the raw material, the maximum nodule size, how accessible the obsidian source is for procurement, and relevant citations on each particular obsidian source. I coded the "Raw Material Quality" category as "poor" for low quality obsidian, "moderate" for moderate, but not supreme, quality obsidian, and "high" for excellent quality obsidian. The "Nodule Size" category is the maximum size of observed nodules given in centimeters. The "Accessibility" category I coded as "accessible" for obsidian sources that are easy for people to access, "moderate" for obsidian sources that are not readily accessible, such as obsidian formations in bedrock people in the past had to quarry for, and "restricted" for obsidian sources that are either difficult to access or easily culturally controlled.

Table 2.1: Obsidian Source Details

Obsidian Source	State	Raw Material Quality	Nodule Size	Accessibility	Citations
Bear Gulch	Idaho	High	30 cm	Moderate	Griffin et al. 1969; Park 2010; Willingham 1995
Black Rock Desert	Utah	Moderate	10 cm	Accessible	NROSL 2011c, 2011d; Projcetilepoints.ne t 2022b
Buck Mountain	California	Moderate	80 cm	Accessible	Hughes 1983; Shackley 2021
Cerro Toledo Rhyolite	New Mexico	Moderate	10 cm	Accessible	Church 2000; Shackley 2005, 2021
Cochetopa Dome	Colorado	Moderate	5 cm	Moderate	Pitblado 2016; Stiger 2001
Cow Canyon	Arizona	High	5 cm	Accessible	Shackley 1988, 1989, 1995, 2021
El Rechuelos Rhyolite	New Mexico	Moderate	5 cm	Accessible	Shackley 2005, 2021
Glass Mountain	California	Moderate	80 cm	Accessible	Dolan et al. 2018; Shackley 2021
Malad	Idaho	High	80 cm	Accessible	Asher 1965; Sappington 1981a, 1981b; Thompson 2004
Obsidian Cliff	Wyoming	High	80 cm	Restricted	Aaberg 1995; Boyd 1961; Davis et al. 1995;

					Hatch et al. 1990; Obradovich 1992; Schmitt 1995
Owyhee	Idaho	Moderate	30 cm	Accessible	NROSL 2011a, 2011b; Projectilepoints.net 2022a
Pachuca	Hidalgo, Mexico	High	50 cm	Accessible	Barker et al. 2002; Ponomarenko 2004
Teton Pass (variety 1)	Wyoming	High	30 cm	Moderate	Park 2010; Schoen 1997
Timber Buttes (area 1)	Idaho	High	30 cm	Accessible	Corn 2006; Shackley 2005, 2021
Valles Rhyolite	New Mexico	High	30 cm	Restricted	Shackley 2005, 2021

Chapter 3: Archaeological Context

In this chapter I cover two major topics. In the first half I lay down the interpretive framework for my project. To do so I explore the concepts of cultural interaction and exchange by highlighting some issues I will face during the discussion such as being able to parse out if obsidian was obtained through exchange or direct procurement, and if there is enough data to support specific cultural interactions like exchange. After highlighting the issues I explore a handful of archaeological implications explaining the variety of ways direct procurement could occur in highly mobile groups such as those living in the in the past, regardless of their communities mobility. To remedy all of the issues concerning an obsidian centered thesis and the archaeological implications of resource acquisition I discuss the idea of a conveyance zone. I then formulate the hypothesis to match my research project. The second half of this chapter is straightforward as past archaeologists have solidified Oklahoma's cultural chronology. Lastly, I parse out four previous ideas about obsidian on the Southern Plains.

Cultural Interaction, Mobility, Exchange, and Direct Procurement

Cultural Interaction

Cultural interaction is when people belonging to two or more differing cultures meet as a result of cultural facets such as mobility and direct procurement, or during multiple kinds of events. These events can include trade, exchange, and even warfare, among others. (Earle 1982)

Mobility

The concept of mobility has been a long standing center point in archaeology of hunter-gatherers, particularly since Lee and Devore's "Man the Hunter" symposium and their idea of the "Nomadic Style," where hunter-gatherers were said to "move around a lot," (Lee and Devore 1968). In this way studies into the mobility of people in the past were focused on residential patterns, resource procurement, and subsistence activities. Mobility is so much more than those three things, as it is about movement itself, and not only of people around a landscape, but also of ideas and information (Leary 2014). In this way mobility is tied up with cultural interaction and social relationships, which we could also consider the movement of not only objects between people, but also ideas as well. In this section I explore the concept of mobility in archaeology jumping off from Lee and Devore's idea of mobility (Lee and Devore 1968) and touch on more nuanced theories on mobility that push the theoretical envelope past residential patterns, subsistence activities, and resource procurement.

Traditionally, mobility is thought to be a decisive factor in the lifeways of people of the past in that it is opposed to sedentism, which is thought to be an organizing factor for agrarian people, thus setting up a dichotomy. However, all humans are mobile, even those of us living a highly sedentary lifestyle, at least to some degree, and the opposition between mobile hunter-gatherers and sedentary farmers obscures the universality of mobility (Kelly 1992). Throughout most of the 20th century, archaeologists operating under the processual paradigm focused on hunter-gatherer relationships to the environment, ecology, optimization of resources, and energy costs. In fact, one guiding factor in the study of mobility among hunter-gatherers in the archaeological record is the idea of how much energy it would cost to obtain certain resources and how much energy it would cost to not only residentially move, but also to move objects and equipment (Kelly 1992). These ideas extend into modern archaeological practices as well. In a study published in 2010 on the microlith technology and mobility of hunter-gatherers in the Honshu region of Japan, Sano concludes that microlith technology was utilized by the prehistoric inhabitants of the Honshu region because of their low energy cost in procurement and production, which was conducive to a high level of mobility (Sano 2010).

The focus on energy costs and mobility is far from leaving the field of archaeology, though we should not get rid of it entirely as it is inevitably one of many factors.

Binford set the tone for this era of mobility studies in archaeology through his ethnoarchaeological work with the Nunamiut people (Binford 1980). Here Binford delineates two types of mobility strategies: residential mobility among foragers and logistical mobility among collectors. Residential mobility is where foragers go out from their residential base to gather resources and then return. This type of mobility is characterized by the lack of investment in any particular place and the ability of the group to move camp when needed and often (Binford 1980). On the other side we have collectors who employ a different type of mobility – logistical mobility. This is where collectors will go out to collect resources and engage in some measure of storage activities (Binford 1980). Logistical mobility among collectors is characterized by a lower degree of residential moves and a variety of different site types, such as cache sites where certain goods are stored (Binford 1980). While Binford may have intended these categories to be heuristic in nature, they were later taken up as a dichotomy for studying mobility patterns among people in the archaeological record.

Mobility is so much more than what drives settlement systems and subsistence regimes as mobility can also have important political and social dimensions (Kelly 1992). In fact, people will often employ mobility for social reasons such as to sate curiosity and form social ties outside of whatever group they live within (Kelly 1992). In his 1992 review article on mobility and sedentism, Robert Kelly shows us that the dichotomy between mobility and sedentism is not useful because all people are in some way mobile (Kelly 1992). While mobility studies in archaeology have traditionally focused on the energy management and subsistence patterns of people of the past, these alone cannot fully explain the degree of variability we see in the archaeological record and we must consider social variables as well as environmental ones (Politis 1996). Politis's (1996) study of the mobility strategies of the Amazonian Nukak people in that they residentially move more often than their subsistence pattern demands to care for their environment by moving more often than they have to so that they do not deplete any particular area of resources (Politis 1996).

Archaeologists have been pushing theories surrounding mobility past environmental factors, such as Sassaman's discussion on the mobility patterns of the Mexican Kickapoo (Sassaman 2001). Within the discussion, Sassaman reveals that mobility is used politically by the Mexican Kickapoo to maintain their autonomy and to show their freedom as individuals (Sassaman 2001). Again, because we have primarily centered mobility studies on resources and the environment, there is a need to reinvent our concepts of mobility so that we can better approach what mobility has to do with the social environment (Weig 2015). Another recent theory that challenges the environment-resource lens of mobility is Weig's concept of *motility*, which is a human being or group's capacity for mobility before the fact (Weig 2015). To establish the concept of motility, Weig looks at the Baka people's mobility patterns and claims that approaches with an environmental focus would have been inadequate in explaining the variation and reasons observed Baka mobility patterns (Weig 2015). The concept of motility allows us to approach shifts in mobility patterns as well as the social factors that drive them (Weig 2015). Because motility is the capacity for movement, it becomes a tool that helps one operate within a social environment and the utilization of this theoretical concept allow us to get past the limitations of an environmental or ecologically oriented approach.

Mobility and exchange are interrelated, and in fact, exchange relationships require a degree of mobility to even exist. Lovis and his co-authors state that when studying people in the past, we often focus on one aspect of their lives, but that everything is inevitably intertwined (Lovis et al 2006). In order for us to understand the relationship between mobility and exchange among people in the past, and ultimately to isolate why we consider one of these and not the other at times, we must consider both simultaneously. Beyond that, Leary states that "mobility cannot be taken on its own," (Leary 2014) and that there is a complex interplay between mobility and a variety of other social aspects that need to be examined.

Exchange and Direct Procurement

In this section, I discuss what exchange and direct procurement are as strategies for resource acquisition, pore over a number of models that can explain specifically the manner of resource acquisition, and formulate hypotheses to fit my project. My intent with the entire project is simply to show a web of large scale cultural interaction patterns between people living in Oklahoma during the past and where they obtained their obsidian from through cultural interaction, whatever form that cultural interaction took. There will always be some question as to whether people in Oklahoma's past obtained obsidian from an exchange scenario or from direct procurement, which is a consistent problem for archaeologists as a whole. With a scope this large, however, it does not necessarily matter how a person in the past obtained obsidian because the mere fact that they did implies a directionality to that particular obsidian source. These lines between artifact and source are what make the web of large scale cultural interaction I am revealing. In the following paragraphs I discuss exchange as an idea and cover some types of exchange scenarios that can explain how obsidian found its way to Oklahoma, both of which will inform the hypothesis for my thesis.

Exchange is defined by Earle (1982) as the distribution through space of material culture between social groups or between individuals. Exchange can have many exciting implications for social interaction, social networks, and alliances. This definition is important as the past, like today, is full of people and their doings. Exchange gives us a unique window into the past because exchange relations can link two (or more) groups of people together. Earle's (1982) also highlights that exchange is "a transfer with strong individual and social aspects." We must remember that during an exchange of goods, information, and ideas between individual people, those people are making choices that may be driven by factors other than rationality and utility.

Earle (1982) tells us that to parse out exchange we must complete three tasks: (1) to source the objects being exchanged; (2) to examine the spatial and temporal patterns that emerge; (3) and to reconstruct the organizational system occurring through the exchange (i.e. down-the-line, etc.). Malinowski's writings on the Trobriand Islanders and Kula Rings are one of our most seminal examples of exchange relations between groups of people (Malinowski 1922). Exchanging of gifts and ideas strengthens the ties two groups of people have together through reciprocal obligation (Mauss 1950).

We can consider obsidian in Oklahoma an exotic lithic material. Exotic lithic materials are defined as non-local lithic materials appearing in the archaeological record. Obsidian does not form in Oklahoma, which is an area particularly rich in high quality lithic materials (cf. Banks 1982, 1990). Obsidian was likely brought to Oklahoma through cultural interaction patterns and followed other goods, information, and the movements of groups of people throughout the Southern Plains and adjacent regions.

<u>Archaeological Implications of Resource Acquisition</u>

I cover three specific archaeological implications of resource acquisition next, most of which I have pulled from Fertelmes (2014:59) dissertation on Hohokam exchange or procurement of basalt for groundstone implements. Direct Procurement is a strategy of resource acquisition in which the group of people that travelled to and acquired the resource at its source were the people that used the resource (Fertelmes 2014). Direct Exchange is the idea that one group of people enter into exchange relations with another group, typically a neighboring settlement, without any other groups in between (Kooyman 2000; Fertelmes 2014). Another type of exchange scenario is down-the-line exchange, which is the movement of resources over long distances in which each group that partakes in down-the-line exchange takes a bit the resource before passing it along to their neighbors living farther from the source (Kooyman 2000; Fertelmes 2014). In a down-the-line exchange scenario there will be a decline in the amount of the resource the farther it is moved from its source (Renfrew 1977; Sahlins 1972). There are a number of other strategies utilized to explain long-distance resource acquisition (Hofman and Blackmar 2012; Jodry 1999; Amick 1994; Binford 1978, 1980, 1983; Thomson 1939, 1949; Veth 2006; Wood 1980;) which I will now discuss.

Specialized Long-Distance Resource Acquisition Strategies

The *Walkabout* strategy was typically utilized by single individuals and was much like a rite-of-passage journey or quest (Hofman and Blackmar 2012). People utilizing the *Walkabout* strategy may have done so to form social connections, out of mere curiosity, or to amass information about the landscape (Hofman and Blackmar 2012). The *Walkabout* strategy allows individuals within a group a larger measure of *motility* than their peers who did not engage in the *Walkabout* strategy and could account for the presence of exotic materials within a person's community.

The *Long Distance Ranger* strategy is where a handful of individuals seek out and procure a resource that is quite far out of the normal mobility range of the community those individuals belong to (Hofman and Blackmar 2012; Jodry 1999). People in the past could have employed the *Long Distance Ranger* strategy to acquire exotic resources regardless of how sedentary their community was (Jodry 1999).

The *Lewis and Clark* strategy is where a handful of individuals embark on a information-seeking journey to initiate an preserve contact with other groups of people, and gather information and resources well outside the normal mobility range of their communities (Binford 1978, 1980; Hofman and Blackmar 2012). This type of resource acquisition strategy was exploratory and occurred among certain Plains Village people along the Missouri River (Hofman and Blackmar 2012; Holder 1973; Wood 1980).

The *Rendezvous* strategy is where varying groups of people in the past met at a previously agreed upon place and time (Hofman and Blackmar 2012; Hofman 1994; Shott 2004; Whallon 2006). People could have employed the *Rendezvous* strategy for many reasons, such as communal bison hunting activities, marriage contracts, rites-of-passage, information sharing, and forming social ties with other groups (Bamforth 1988; Bement 1999; Hayden 1981). People in the past that engaged in the *Rendezvous* strategy would have been exposed to a variety of exotic resources, some of which they likely brought back to their home communities. With the *Rendezvous* strategy, like the other long-distance resource acquisition strategies, the concept of *motility* (Weig 2015) allows for certain individuals in highly sedentary communities to employ long-distance mobility that is outside of the normal range for their home community.

The *Random Repeated Encounters* strategy occurs when two groups of people, usually mobile people or sedentary people employing one of the strategies I have outlined above, meet another group whose territorial ranges slightly overlap (Hofman and Blackmar 2012, Thomson 1939, 1949; Veth 2006). These *Randomly Repeated Encounters* did not have to be planned, and likely were not to some degree. Unplanned encounters between certain groups of people may have been more common than at first glance (Hofman and Blackmar 2012). During an event such as the *Random Repeated Encounter*, people in the past would have had the opportunity to share news, information, resources, and other facets of life from afar (Hofman and Blackmar 2012). Like the other long-distance resource acquisition strategies, people in the past could have employed the *Random Repeated Encounters* strategy to acquire exotic resources will outside of their typical mobility range.

The *Oversized Patterned Land Use* strategy is where a communities residential mobility pattern covers an extremely large area (Amick 1994; Binford 1983). For instance, there is ethnographic evidence for the Ancestral Comanche and Ancestral Shoshone employing the *Oversized Patterned Land Use* strategy to maintain social connections from the Southern Plains, over the Rocky Mountains, and into the Great Basin (Hofman and Blackmar 2012; Gunnerson 1956, 1969; Wallace and Hoebel 1952). This *Oversized Patterned Land Use* strategy could account for exotic materials appearing in both past highly mobile and sedentary communities.

In the following paragraphs I formulate two hypotheses based on what archaeological implications for resource acquisition we should see with the many types of resource acquisition strategies I discussed above.

Hypothesis and Underlying Assumptions

The hypotheses I propose for my thesis project is: obsidian procurement choices and their archaeological implications changed over time in Oklahoma. There are a number of underlying assumptions with the hypothesis and archaeological implications (direct procurement, direct exchange, and down-the-line exchange) that prove to be problematic. First, all three are largely predicated on human beings acting rational and concentrating on energy preservation, and we know that this is not always the case (Politis 1996). Second, all three archaeological implications are linked to subsistence strategies and varying degrees of mobility (i.e. hunter-gatherers would have a high degree of mobility and sedentary people would have a low degree). As Wieg (2015) and Sassaman (2001) show us, especially with the concept of *motility* (Weig 2015), the capacity for a group or individual's mobility before the fact, mobility does not necessarily have to be connected with subsistence strategies. In combination with the six strategies for resource acquisition I discussed above, the concept of *motility* can be applied to both a group of people, or *any potential* individual in that group. This way mobility and *motility* make it plausible that certain people with certain roles within a group, even a highly sedentary group, could have travelled extremely far and brought back exotic resources like obsidian to Oklahoma.

With a research project centered on obsidian, and obsidian sourcing no less, it turns out that the data in my project do not support *how* varying groups of people in the past acquired their obsidian. They could have acquired it via any of the six long-distance resource procurement strategies I detailed above, regardless of time period. Therefore, the data in my research project can support *when* and *where* people in the past in Oklahoma obtained their obsidian, and their varying choices throughout time.

Conveyance Zones

To remedy this issue I chose to utilized *conveyance zones* to parse out the directionality of cultural interaction between where obsidian has been found in Oklahoma and its geologic origin point. We typically define conveyance as a cyclical geographic area where lithic artifact assemblages show a similar geologic source (Seeman 1994; Jones et al. 2012). In other words, a conveyance zone is the radial distance of lithic artifact distribution spreading out from its geologic origin point. Within the idea of a conveyance zone I am concerned with people and their relations with others across space and time, not simply the movement of objects. So a conveyance zone in this project specifically means a plausible direction of cultural interaction between where an obsidian artifact came to rest and what volcanic formation that piece of obsidian formed at.

Typical conveyance zones are radial and surround the geologic origin point. As I am looking at obsidian found within Oklahoma, I created partial conveyance zones as they pertain to Oklahoma (i.e. unidirectionally). The total conveyance zone for whatever particular obsidian source at any given time will be much larger than what I depicted in this project. In other words, I can show one radial direction from the center of a conveyance zone (the source of obsidian) and where that obsidian came to rest in Oklahoma. These radial conveyance zones show the directionality of cultural interaction between people in the past in Oklahoma and between adjacent regions, and at times, even farther (Seeman 1994; Jones et al. 2012).

Cultural Chronology

With the hypothesis configured and cultural interactions, exchange, direct procurement, and conveyance zones explained, I now turn to cultural chronology of Oklahoma. In each of the five time periods I will touch on these hypotheses again and note any exceptions or other issues. Table 3.1 presents the archaeological sequence of Oklahoma.

Table 3.1: Cultural Chronology for Oklahoma

Cultural Period	Timeframe in Years Before Present (B.P*.)
Pre-Clovis Period	Prior to ca. 13,050 B.P.
Paleoindigenous Period	Ca. 13,050 – 7,950 B.P.
Archaic Period	Ca. 7,950 – 1,950 B.P.
Woodland Period	Ca. 1,950 – 1,050 B.P.
Late Precontact Period	Ca. 1,250 – 450 B.P.
Postcontact Period	Ca. 450 – 200 B.P

*Calendar Years Before Present = AD 1950

Pre-Clovis Period (Prior to ca. 13,050 B.P.)

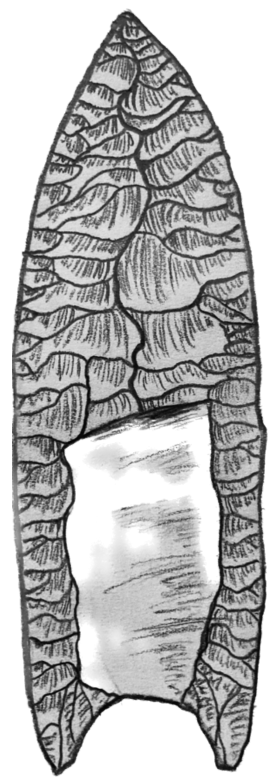
In relatively recent years, archaeology has seen growing acceptance of the body of evidence for Pre-Clovis occupations in the North America. In Oklahoma specifically, at least two sites contribute to our knowledge about the activities of these First Americans. The Burnham Site (34WO73) in Woods County (Wyckoff et al. 2003) holds the remains of an ancient species of bison (either *B. cheneyi* or *B. alleni*). Archaeologists uncovered stone tool fragments and debitage in context with these remains. A radiocarbon date (in calendar years) for this site is between 37,138 – 34,299 B.P. (Wyckoff and Carter 2003). It should be noted that Wyckoff himself is cautious about the Burnham Site's Pre-Clovis attribution (Wyckoff and Cater 2003; Pitblado 2023 personal communication).

The second site from Oklahoma with evidence for Pre-Clovis occupation is the Cooperton Mammoth site (34KI26) in Kiowa County. At Cooperton, archaeologists recovered the remains of a Columbian mammoth dated between 25,733 – 23,732 B.P. (Anderson 1975). Bell (1967) and Bonfield (1975) inferred human interaction with the mammoth through the presence of green-bone fractures, the physical arrangement of the remains, and the presence of two possible hammerstones (Gettys 1984). The Cooperton Mammoth site is compelling but remains controversial (Anderson 1975; Bell 1967; Bonfield 1975; Gettys 1984).

Paleoindigenous Period (Ca. 13,050 – 7,950 B.P.)

Following Pitblado (2022) and Steeves (2021), I will refer to the late Pleistocene era as "Paleoindigenous" rather than "Paleoindian." The oldest accepted Paleoindigenous cultural complex in Oklahoma is the Clovis Complex, generally dating between 13,050 – 12,750 B.P. (Waters et al. 2020). Clovis projectile points/knives (PPKs) are lanceolate spearpoints with definitive fluting flakes emanating from the base (Figure 3.1).

Figure 3.1: Conceptualization of a Clovis Point (13,050 – 12,750 B.P.), illustrated by the author



Clovis Complex people were highly mobile and typically associated with mammoths (Gettys 1984). In Oklahoma, the earliest Clovis Complex site is the Domebo site (34CD50). Archaeologist recovered two complete Clovis points and one Clovis midsection together with the remains of an Imperial mammoth (Leonhardy 1966). Leonhardy obtained six radiocarbon dates from Domebo with the oldest being between 14,546 – 11,818 B.P. (Leonhardy 1966). Mammoth populations dwindled and eventually became extinct, and people began to focus more on bison in the west and deer and other small game in the east part of the state. Ferring (1989) questions archaeologist's ideas on Paleoindigenous people exclusively subsisting on megafauna and posits more diversity in the subsistence practices of Paleoindigenous people.

The shift in hunting specialization from mammoth to bison coincided with a shift in lithic technology (Wyckoff and Brooks 1983). The latter half of the Early Paleoindigenous period is represented by the appearance of the Folsom Complex between 12,900 – 12,740 B.P. (Buchanan et al. 2022). Interestingly, Buchanan et al. (2022) showed that there was an approximately 200 year overlap between the beginning of Folsom and the end of Clovis. Like Clovis, Folsom people utilized fluting technology and were highly mobile. Evidence for Folsom occupations in Oklahoma occur throughout the Oklahoma Panhandle and the western part of the state (Baker et al. 1957; Bell 1948, 1954, 1977; Bement 1997, 1999). The Cooper site (34HP45) in Harper County is a bison kill site where archaeologists found many unused Folsom points and a bison skull with a lightning bolt symbol painted on it, indicating ritualistic activity (Bement 1997, 1999).

Late Paleoindigenous people were just as mobile as their predecessors and had a sophisticated tool kit, but they no longer fluted their PPKs. A number of lanceolate and stemmed points represent the Late Paleoindigenous period obsidian in Oklahoma (Table 3.2; Figure 3.2 – 3.4).

Table 3.2: Late Paleoindigenous Projectile Points from Oklahoma

Projectile Point	Age	Reference
Dalton	Ca. 10,000 – 5,000 B.P.	Bell 1958
Scottsbluff	Ca. 9,600 – 9,000 B.P.	Ray 2016
Plainview	Ca. 9,000 – 2,000 B.P.	Bell 1958
Meserve	Ca. 9,000 – 4,000 B.P.	Bell 1958
Agate Basin	Ca. 9,450–8,950 B.P.	Perino 1968

Figure 3.2: Conceptualization of a Dalton Point (ca. 10,000 – 5,000 B.P.), illustrated by the author

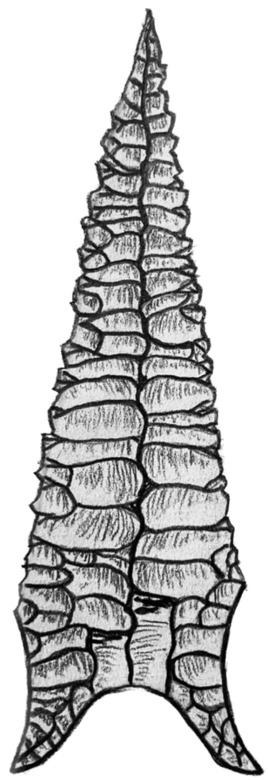
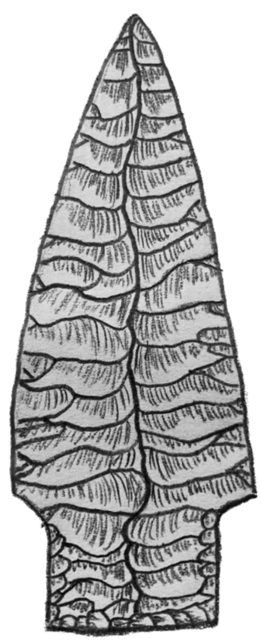


Figure 3.3: Conceptualization of an Agate Basin Point (ca. 9,450 – 8,950), illustrated by the author

Figure 3.4: Conceptualization of a Scottsbluff Point (ca. 9,600 – 9,000 B.P.), illustrated by the author



Scholars began to note cultural differences across space at this time with Dalton points (10,000 – 5,000 B.P.) [Bell 1958] appearing primarily in eastern Oklahoma and Plano Complex points (10,200 – 7,500 B.P.) [Marcum-Heiman et al. 2016] dominating western Oklahoma. The Plano Complex describes the material culture of extremely mobile people that lived at the end of the Paleoindigenous Period and made unfluted, yet rather sophisticated, PPKs (Marcum-Heiman et al. 2016). Gettys (1984) noted a bias towards kill sites in western Oklahoma and camp sites in eastern Oklahoma.

<u>Archaic Period (7,950– 1,950 B.P.)</u>

Lifeways similar to those of the Late Paleoindigenous people continue at the start of the Archaic period in Oklahoma. Archaic people essentially lived a lifestyle centered around hunting and gathering with an increasing reliance on locally available resources (Wyckoff and Brooks 1983). People lived in larger groups, established seasonal camps, and were rather mobile similar to Paleoindigenous people. Toward the end of the Archaic Period, there is evidence for increasing populations, warfare, and exchange (Brooks and Cleland 2015), as well as the beginnings of agriculture (Wyckoff and Brooks 1983). The Archaic Period is traditionally divided into the Early (7,950 – 5,950 B.P.), Middle (5,950 – 3,950 B.P.), and Late Archaic (3,950 – 1,950 B.P.) (Prewitt 1981). In this section, I discuss the Archaic period in Oklahoma through these subdivisions.

Early Archaic Period (7,950 – 5,950 B.P.)

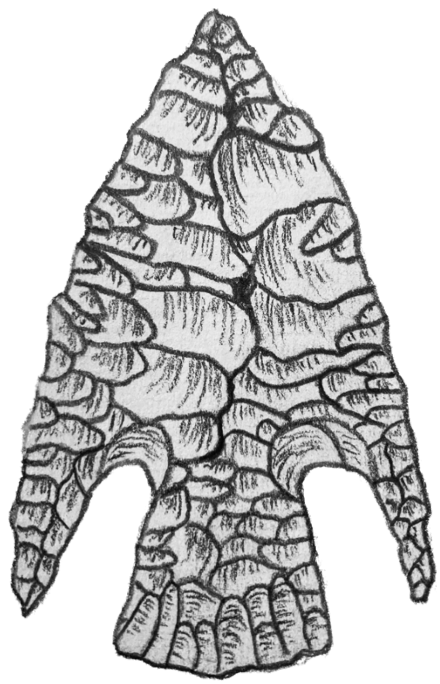
The Early Archaic Period is not well understood for Oklahoma. People were likely living in similar ways to their Late Paleoindigenous predecessors. In fact, Wyckoff and Taylor (1971) note a number of attributes on lanceolate points found in Early Archaic contexts that point toward a continuation of Late Paleoindigenous technology. During this time people used a diverse tool kit including lanceolate, stemmed, and notched projectile points as well as flake tools, clear fork gauges, and gravers (Hughes 1984). Early Archaic people seemed to have a preference for quartzite, although artifacts made from locally available chert are not uncommon (Hughes 1984).

Two sites yielded most of what we know about the Early Archaic Period in Oklahoma – the Gore Pit Site (34CM131) in Comanche County and the Nall Site (34CI134) in Cimmaron County, Oklahoma. Hammat (1976) produced a radiocarbon at the Gore Pit Site, dating it to ca. 8,447 – 7,564 B.P. Most of the artifacts from the Gore Pit Site are made of Ogallala quartzite and include a variety of side-notched and stemmed projectile points. The Nall Site is a multicomponent Late Paleoindigenous/Early Archaic site in the Oklahoma panhandle. Surface artifacts and both notched and stemmed dart points indicate an Early Archaic presence here (Baker et al. 1957).

Middle Archaic Period (5,950 – 3,950 B.P.)

Like the Early Archaic Period, we know little about the Middle Archaic Period in Oklahoma, although one Middle Archaic cultural complex, the Calf Creek complex (5,960 – 5,700 B.P.) [Lohse et al. 2021] has been extensively studied. Calf Creek people were specialized bison and antelope hunters with distinctive, expertly crafted basally notched PPKs (Figure 3.5) [Brooks and Cleland 2015].

Figure 3.5: Typological concept of a Calf Creek Point (ca. 5,960 – 5,700 B.P.), illustrated by the author



Calf Creek, Bell, and Andice PPKs (5,960 – 5,700 B.P.) [Loshe et al. 2021] are all large basally notched bifaces associated with the Calf Creek complex (Barlett and O'Shea 2014). Calf Creek people preferred high-quality lithics, and Calf Creek PPKs reported from Oklahoma are made of Alibates silicified dolomite, Ogallala quartzite, Florence-A chert, Frisco chert, and other high-quality lithics (Benefield and Duncan 2021; Duncan 1995; Powell 1995; Rhoton 1995; White 1995). Heat treatment of lithic raw material and caching activities were also practiced by Calf Creek people (Lohse et al. 2021; Wyckoff 1995).

Late Archaic Period (3,950 – 1,950 B.P.)

During the Late Archaic Period populations increased and settlements grew larger and more numerous. The first evidence for exchange relationships and warfare also appear (Brooks and Cleland 2015). In western Oklahoma, Late Archaic people depended more on large mammals, such as bison and antelope, than their counterparts did farther east (Brooks and

Cleland 2015). An increase in plant-processing tools, including groundstone implements, indicates a growing reliance on locally available plant resources in addition to bison and antelope. People engaged in communal bison hunts resulting in a number of kill sites such as the Certain Site (34BK46) in Beckham County in southwestern Oklahoma (Bement and Buehler 2000).

Archaeologists established the Summers Complex from work at the Summers Site (34GR12) in Greer County in southwestern Oklahoma, and contributed much of what we know about the Late Archaic Period (Hughes 1984). At the Summers Site, Leonhardy (1966b) produced a suite of radiocarbon dates falling between 3,061 – 2,926 B.P. The majority of tools were made from Ogallala quartzite with fewer tools made from Alibates silicified dolomite, Edwards chert, and Tecovas jasper. Summers Complex projectile points include a variety of corner-notched, side-notched, and stemmed points. Figures 3.6 – 3.10 are typological concept illustrations of Late Archaic PPKs relevant to my study on obsidian in Oklahoma including the Marcos PPK (2,600 – 1,800 B.P.), the Pandale PPK (6,000 – 4,000 B.P.), the Frio PPK (4,950 – 450 B.P.), a general side-notched PPK (3,950 – 1,950 B.P.), and a general corner-notched PPK (3,950 – 1,950 B.P.) [Bell 1958, 1960; Hughes 1984].

Figure 3.6: Conceptualization of a Marcos Point (ca. 2,600 – 1,800 B.P.), illustrated by the author

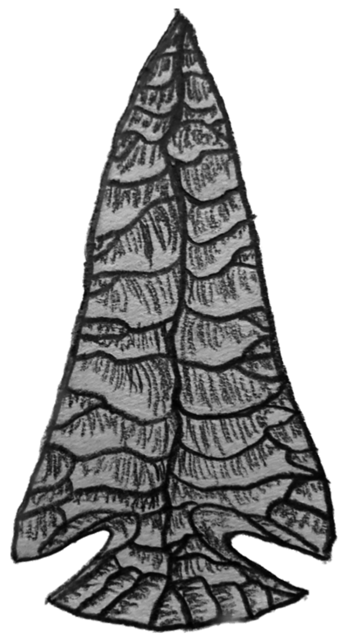


Figure 3.7: Conceptualization of a Pandale Point (ca. 6,000 – 4,000 B.P.), illustrated by the author

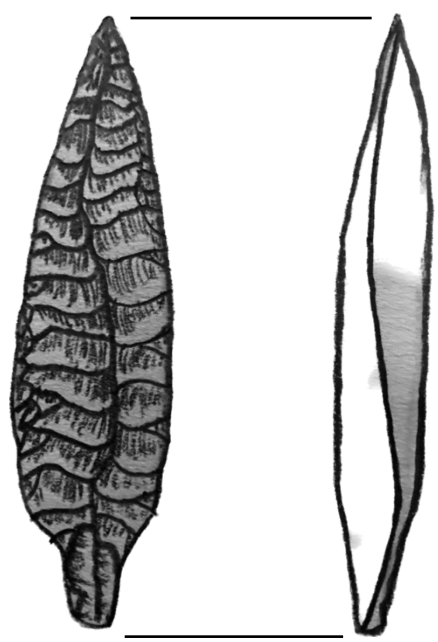


Figure 3.8: Conceptualization of a Frio Point (ca. 4,950 – 450 B.P.), illustrated by the author

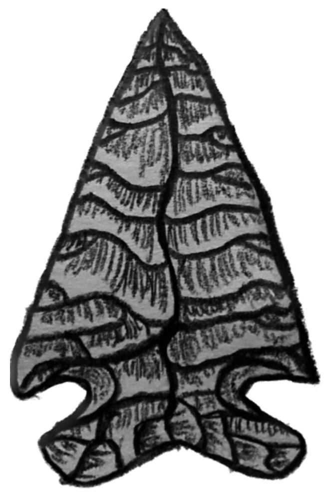


Figure 3.9: Conceptualization of a generalized Side-notched Dart Point (ca. 3,950 – 1,950 B.P.), illustrated by the author

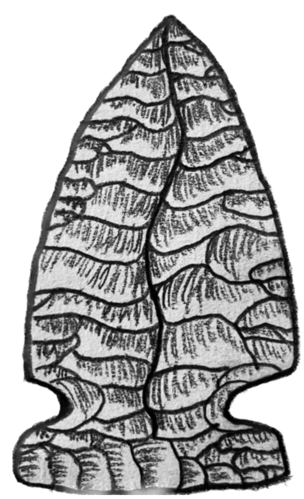
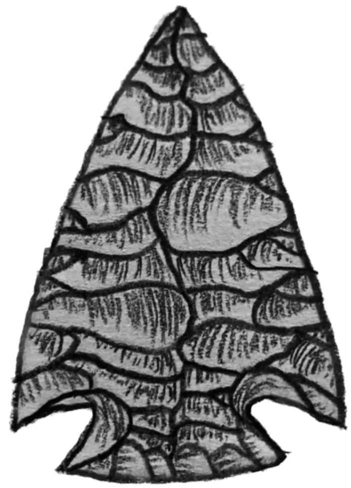


Figure 3.10: Conceptualization of a generalized Corner-notched Dart Point (ca. 3,950 – 1,950 B.P.), illustrated by the author



The presence of Alibates silicified dolomite and chert from the Edwards Plateau indicate exchange relationships between the people in Oklahoma during the Late Archaic Period with those of central Texas and the Texas Panhandle (Hughes 1984).

Woodland Period (1,950 – 1,050 B.P.)

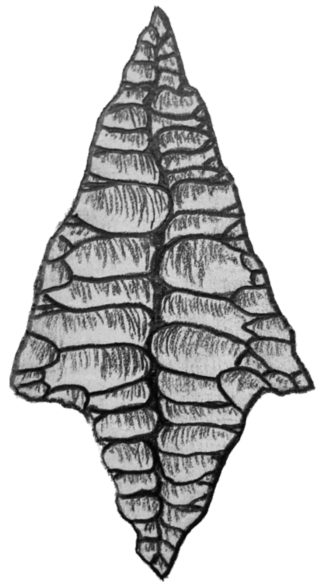
Throughout North America the Woodland Period is generally marked by the presence of ceramic artifacts and the appearance of bow and arrow technology, referring to smaller PPKs that can truly be called arrowheads (Hoffman and Brooks 1989). The most well-known Woodland manifestation in North America is the Hopewellian culture centered in the Southeastern US (Caldwell 1964). In Oklahoma, archaeologists define Woodland Period occupations as Eastern Woodland, in reference to Woodland Period manifestations in the Southeast, and Plains Woodland, generally considered an extension of Eastern Woodland cultures.

Woodland Period people engaged in lifeways similar to those of the preceding Archaic Period including a reliance on hunting and residential mobility (Marcum-Heiman et al. 2016). Gathering intensified to support this mobile lifeway and in many cases Woodland period people began cultivating plants such as squash, sunflower, and corn (Wyckoff and Brooks 1983). Sedentism also increased during this Period, as evidenced by the appearance of ceramics, semi-permanent camps, and horticulture (Marcum-Heiman et al. 2016). Plains Woodland Period structures are rare in Oklahoma, but the few that archaeologists have uncovered are circular semi-subterranean structures (Drass 1985).

Technological developments include an increase in groundstone technology such as the mano and metate, and a shift towards smaller projectile points. Woodland period projectile points are typically corner-notched, such as the Scallorn PPK (1,750 – 800 B.P.) [Figure 3.11] {Duncan et al. 2007} or stemmed as in the Gary PPK (3,950 – 950 B.P.) [Figure 3.12] {Suhm and Krieger 1954; Bell 1958}. Archaeologists also find lithic artifacts related to horticultural activities such as the hoe. Pottery is typically plain or chord-marked with conically shaped bases (Vehik 1984).

Figure 3.11: Conceptualization of a Scallorn Point (ca. 1,750 – 800 B.P.), illustrated by the author

Figure 3.12: Conceptualization of a Gary Point (ca. 3,950 – 950 B.P.), illustrated by the author



Both Plains Woodland and Eastern Woodland people primarily utilized locally available lithic resources (Vehik 1984). Outside of Eastern Oklahoma, little evidence exists for external exchange relationships between Woodland period people in Oklahoma and their contemporaries (Vehik 1984), yet there is evidence of interaction between Plains Woodland and Eastern Woodland people within Oklahoma as certain chert types, such as Keokuk, appear in a number of Plains Woodland sites (Drass 1985).

Fourche Maline/Eastern Woodland period (2,250 – 950 B.P.)

The most well understood Woodland Period archaeological culture in Oklahoma is the Fourche Maline phase (2,250 – 950 B.P.) derived from the Fourche Maline Creek of the southern Arkansas River basin (Leith 2011). Galm provided a date range from 1,650 – 1,150 B.P. for the Fourche Maline phase (Galm 1984), but Leith's recent reevaluation of the Fourche Maline phase expanded that date range significantly to ca. 2,250 – 950 B.P. (Leith 2011). Archaeologists consider the Fourche Maline to be the formative period to Late Precontact cultural manifestations in eastern Oklahoma (Leith 2011).

In contrast to Plains Woodland occupations farther to the West in Oklahoma, Fourche Maline people relied less on hunting larger game and supplemented their subsistence patterns with increased plant cultivation and a more sedentary lifestyle. Hopewellian-like ceramic artifacts recovered at certain Fourche Maline sites indicate that exchange relationships existed between southeastern Oklahoma and the people living throughout the southeastern US (Galm 1984).

Plains Woodland (1,950 – 1,050 B.P.)

The Plains Woodland Period (1,950 – 1,050 B.P.) is not well understood on the Southern Plains, and many sites are not distinguished between the Late Archaic Period and the Plains Woodland period (Drass 2003). This discrepancy may be related to material continuity between Late Archaic and Plains Woodland assemblages (Marcum-Heiman et al. 2016). Similar to other Woodland Period occupations, Plains Woodland cultures are marked by the appearance of pottery and bow and arrow technology. Plains Woodland people engaged in a mobile hunting and gathering lifestyle supplemented by horticultural activities. In western Oklahoma, Plains Woodland people primarily focused on bison hunting, which may have shifted to a preference for deer around ca. 1,450 B.P. (Drass 2003).

The lithic resources utilized by Plains Woodland people in Oklahoma were mostly local (Vehik 1984). Exchange relationships are evident with Eastern Woodland people in Oklahoma (Drass 1985). Farther west in the Texas Panhandle, Hughes (1991) defined the Palo Duro complex as belonging to the Plains Woodland Period. Mogollon Brownware sherds occur at Palo

Duro complex sites, indicating westerly exchange relationships between Southern Plains Woodland groups and people living in the Southwest (Drass 2003).

Late Precontact Period (1,250 – 450 B.P.)

Western and Central Oklahoma (1,250 – 450 B.P.)

The Late Precontact Period (1,250 B.P. – 450 B.P.) in western and central Oklahoma is marked by intensified agriculture and the establishment of small farming communities around river valleys and their tributaries (Marcum-Heiman et al. 2016; Wyckoff and Brooks 1983). This time period has also been called the Plains Village period by many archaeologists. Architectural features are typically evident Late Precontact sites and are generally rectangular in structure, but can vary to ovoid or round (Marcum-Heiman et al. 2016). The primary cultigens include squash, beans, and corn. Late Precontact lifestyles revolved around agriculture and hunting in western and central Oklahoma.

Ceramic technology increased during the Late Precontact period and we find both smooth and chord-marked pottery (Marcum-Heiman 2016; Wyckoff and Brooks 1983). Ceramic figurines and increased pottery decoration also occurs including appliques. Groundstone artifacts become more abundant than during the Woodland period and artifacts such as manos and metates are common.

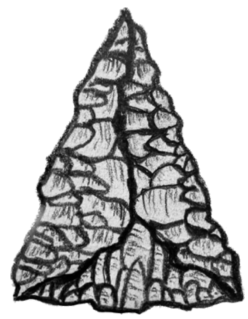
Projectile points are typically small triangular arrow points that are either side-notched, such as the Washita PPK (900 – 200 B.P.) [Figure 3.13] or Harrell PPK (900 – 200 B.P.) [Figure 3.14], basally-notched like the Deadman's PPK (1,450 – 450 B.P.) [Figure 3.15], or unnotched like the Fresno PPK (750 – 250 B.P.) [Figure 3.16] {Duncan et al. 2007}. During the earlier portion of the Late Precontact Period archaeologists still find contracting-stem dart points such as the Gary PPK (3,950 – 950 B.P.) [Bell 1958; Suhm and Krieger 1954] and corner notched arrow points like the Scallorn PPK (1,750 – 800 B.P.) [Duncan et al. 2007].

Figure 3.13: Conceptualization of a Washita Point (ca. 900 – 200 B.P.), illustrated by the author

Figure 3.14: Conceptualization of a Harrell Point (ca. 900 – 200 B.P.), illustrated by the author

Figure 3.15: Conceptualization of a Deadman's Point (ca. 1,450 – 450 B.P.), illustrated by the author

Figure 3.16: Conceptualization of a Fresno Point (ca. 750 – 250 B.P.), illustrated by the author



Important lithic resources utilized by Late Precontact period people in central and western Oklahoma include Kay County (Florence-A) chert, Alibates silicified dolomite, and Frisco chert (Bell 1984; Hofman 1984). Knappable cobbles occurring in many drainages in western Oklahoma were utilized as well.

As the Plains Villagers lived a more sedentary lifestyle than their predecessors and mobility decreased, but there is ample evidence for exchange relationships both between the Late Precontact people in western and central Oklahoma. The presence of obsidian from the Jemez Mountains in New Mexico and Olivella shell from the Pacific Coast at a number of Late Precontact sites in central and western Oklahoma indicates a westerly exchange relationship (Bell 1984; Hofman 1984). Additionally, Kay County chert indicates relationships to the North.

Eastern Oklahoma (1,250 – 450 B.P.)

The Late Precontact Period (1,250 – 450 B.P.) in eastern Oklahoma emerged from the Fourche Maline manifestations during the Woodland period. Late Precontact period people in eastern Oklahoma were agriculturalists that lived in small hamlets on the Ozark Plateau and the Ouachita mountains, areas that are both rich in natural resources (Wyckoff and Brooks 1983). The cultigens they utilized include sunflower, corn, gourds, beans, and squash (Singleton and

Reilly III 2020). During this period, people were sedentary, yet still hunted both small and large game to support their agricultural lifestyle.

Late Precontact people in eastern Oklahoma constructed large mounds and ceremonial centers, and are generally considered to be the far western extension of a widely interconnected Mississippian world with similar ideologies and ceremonial complexes (Singleton and Reilly III 2020). Their society was a complex hierarchy centered around ceremonialism, and we find many artifacts linked to dress and ornamentation that reflect social status such as earspools.

Groundstone artifacts typical of Late Precontact people in eastern Oklahoma include items such as celts and pipes, as well as agricultural implements. Ceramics were diverse and often highly decorated. Chipped stone technology follows that of the broader Mississippian cultures in the Southeast with PPKs being small, and generally either side-notched or unnotched (Singleton and Reilly III 2020). There is a greater variety of PPK types in Late Precontact Period assemblages in eastern Oklahoma than their contemporary assemblages in western and central Oklahoma. The lithic resources utilized by people in eastern Oklahoma during the Late Precontact Period were primarily locally available cherts from the Ozark and Ouachita plateaus (Brown 1984). In addition to these, Kay County chert, Alibates silicified dolomite, and even Dover chert from Tennessee appear at Late Precontact sites in eastern Oklahoma (Brown 1984).

Exchange and interaction networks for Late Precontact groups in eastern Oklahoma were vast. Items such as copper and Dover chert indicate relationships with people living in the Midwestern US during this time (Brown 1984). Conch shell and other materials link people in eastern Oklahoma during the Late Precontact Period to the broader Southeast (Singleton and Reilly III 2020). The presence of Alibates silicified dolomite links Late Precontact Period people in eastern Oklahoma to the Southern Plains, even though Alibates cobbles do appear in the Arkansas River and its associated drainages (Brown 1984).

Postcontact Period (450 – 200 B.P.)

The Postcontact Period in Oklahoma was a time of dynamic social interaction and radical cultural change brought on by European colonists in the 16th century. The influx of Europeans in North America brought new technology along with a slew of new and detrimental problems such as disease and a strikingly different ideology. By 415 B.P., new diseases brought by European colonists began to decimate Native American populations (Vehik 1994). After European contact, the horse was reintroduced in North America where it had previously been extinct. Metal tools swiftly replaced lithic technology, yet some archaeological sites exist during this period where stone tools were found. Projectile point types remain relatively the same as in the Late Precontact Period and we see small side-notched or unnotched projectile points such as the Washita PPK (900 – 200 B.P.), Harrell PPK (900 – 200 B.P.), and Fresno PPK (750 – 250 B.P.) [Figures 3.13, 3.14, and 3.16] {Duncan et al. 2007}. Examples of these are the Deer Creek site (34KA3), or Fernandino, in Kay County, north-central Oklahoma and the Edwards I site (34BK2) in Beckham County, southwest Oklahoma (Baugh 1982; Wyckoff 1964).

Previous Arguments about Obsidian on the Southern Plains

Reviewing previous research on obsidian was necessary to frame the direction of my research. It is important to note that, with the exception of Baugh and Nelson (1987), all previous research on obsidian in Oklahoma has been isolated and very few theories or hypotheses have been put forth.

Baugh and Nelson (1987) provide the first published synthesis, and this included less than ten sites. Through Baugh and Nelson's (1987) synthesis, they concluded that exchange networks existed between the Southern Plains and the Central Plains in the Late Precontact period (Baugh and Nelson 1987). After contact, Baugh and Nelson hypothesized that interaction networks shifted toward the Southwest (Baugh and Nelson 1987).

Another hypothesis has been posited by Oklahoma archaeologists about obsidian and exchange networks through time. Based on evidence from site 34CU40, the Hodge site, a Custer Phase (1,150 – 700 B.P.) [Drass 1999] Late Precontact site Cojeen and Burkhalter (2004) dispute this dichotomous split between obsidian from distant northern sources appearing earlier in time, and obsidian from the Southwest appearing later. Cojeen and Burkhalter (2004) based this summation on a Scallorn-like PPK (1,750 – 800 B.P.) [Duncan et al. 2007] base sourcing to Malad, Idaho and a flake linked to the Valles Rhyolite formation in New Mexico.

Likewise, Dr. Robert Brooks presented a paper at the 72nd Annual Plains Anthropological Society conference in 2014 on obsidian in Oklahoma. He put forth a number of impressions such as obsidian being limited in eastern Oklahoma simply because eastern Oklahoma is farther away from any known obsidian formations than the Oklahoma Panhandle or the western and central parts of the state (Brooks 2014). Brooks (2014) also noted that only archaeological sites in the Oklahoma Panhandle have more than a handful of obsidian, and that two distinct routes of obsidian moving into Oklahoma, being a northwesterly route toward more distant, northern sources in Idaho and Wyoming, as well as a westerly route to the Jemez Mountains. In his 2014 paper presentation, Brooks had three final points to make: 1) the majority of obsidian from precontact sites outside of the Oklahoma Panhandle comes from the northwesterly route; 2) there is a strong connection between the Oklahoma Panhandle and the Jemez Mountains in the Late Precontact Period; and 3) the Jemez Mountains provide all obsidian in Oklahoma during the Postcontact Period.

In Kansas, based on the 2008 article written by Dr. Robert J. Hoard, C. Tod Bevitt, and Janice McLean, the story obsidian sourcing and exchange networks tell is strikingly similar to the data and interpretations I have brought forth for this project. There was no Paleoindigenous evidence for obsidian in Kansas, and two obsidian artifacts were analyzed for the Archaic Period, both of which matched the geochemical concentrations of obsidian from the Valles Rhyolite formation in the Jemez Mountains, New Mexico. Hoard et al. (2008) discussed obsidian source characterization for their Early Ceramic Period (2,000–1,000 B.P.), which roughly correlates with Oklahoma's Woodland Period (1,950–1,050 B.P.), stating that Kansas was the southern fringe of a down-the-line exchange network involved with the Hopewell, and all of the obsidian from this time period sourced to the distant northern sources in Idaho and Wyoming.

Moving forward in time to the Middle Ceramic Period (1,000–500 B.P.), which roughly correlates with Oklahoma's Late Precontact Period (1,250–450 B.P.), Hoard et al. (2008) demonstrated that obsidian was much more frequent in the archaeological record during this time, and all of the obsidian samples from southern Kansas sourced to the Jemez Mountains with obsidian from the Cerro Toledo Rhyolite formation being the most prominent. The authors also note that obsidian from the north half of Kansas primarily sourced to more distant northern sources in Idaho and Wyoming, but most of these artifacts were surface finds and lacked strict temporal integrity (Hoard et al. 2008).

During Kansas's Late Ceramic Period (500–250 B.P), which equates to Oklahoma's Postcontact Period (450–200 B.P.), that obsidian was even more common in Kansas than during the Middle Ceramic Period, and that the vast majority of samples sourced to the Jemez Mountains but with obsidian from the Valles Rhyolite formation being most prominent (Hoard et al. 2008). The authors went a little farther in time than I did for this project and covered Kansas's

Historic American Indian Period (250–150 B.P.), for which all of the obsidian in Kansas dating to the Historic American Indian Period sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico (Hoard et al. 2008).

In this chapter I discussed the interpretive framework I utilized to work through the research project along with all of the underlying assumptions and issues with a research project focused on obsidian. The cultural chronology of Oklahoma was delineated and I gave a brief overview of previous ideas on obsidian on the Southern Plains. In the next chapter I discuss the details of the specific methodological practices I utilized to complete the research project.

Chapter 4: Methods

In this chapter I detail the methodology I used to conduct my study on obsidian in Oklahoma. First I discuss the dataset and archaeological sites. Next I discuss the assemblage and the collections that formed the assemblage. Then I turn to the projectile point/knife (PPK), biface attributes, and typology I utilized. It is important for the reader to note that I specifically focused on PPKs and bifaces in the assemblage. Following the PPK/biface attributes, I detail the methods of obsidian source characterization and X-ray fluorescence (XRF) mass spectrometry. I then go over the spatial analysis methods I used, choices I made when deciding which artifacts from the assemblage to subject to XRF, and conclude the chapter.

Dataset and Archaeological Sites

To keep the dataset manageable I chose to curtail my study spatially by utilizing the arbitrary political border of the state of Oklahoma rather than the Southern Plains in general. This political border is completely arbitrary and has existed for over a century. Another reason I limited my project to Oklahoma is that obsidian artifacts coming from within the state have been previously analyzed by archaeologists, yet no studies have been published that comprehensively address the entire state. Dr. Robert Hoard et al. (2008) have published a similar study to my thesis covering obsidian in Kansas. This article was the primary inspiration for my thesis and provided the basic framework.

My process in tracking down sites in Oklahoma with obsidian began with a database compiled by Dr. Robert Brooks (2014), former Oklahoma State Archaeologist, and Christopher Lintz, a prominent Southern Plains archaeologist and retired scholar now working with the Center for Archaeological Studies at Texas State University in San Marcos. They passed the project along to me and I significantly added to the already existing data. One of the first tasks I completed for this study was to review nearly all previously recorded archaeological sites in Oklahoma and parse out which sites had obsidian reported from the Oklahoma Archeological Survey's (OAS) site file database. There were several thousands of previously recorded archaeological sites in Osage and McCurtain Counties and my review of the recorded sites in these two counties did not fit into the timeframe of this project.

Afterward, I pored over the references attached to many of the site forms that had obsidian reported and used those references to bolster the list of obsidian sites in Oklahoma. I also met with and interviewed many prominent Oklahoma archaeologists to discuss obsidian in the state including Dr. Bonnie Pitblado, Dr. Robert Brooks, Dr. Scott Brosowske, Dr. Don Wyckoff, Dr. Richard Drass, Dr. Leland Bement, Dr. Marjorie Duncan, and Dr. Christopher Lintz. All of these archaeologists were incredibly helpful and assisted me with knowledge and ideas on how to further build the list of obsidian sites in Oklahoma. When I began my search, over 33,000 archaeological sites have been recorded in Oklahoma, yet 114 sites have yielded any obsidian (Brooks 2014; Lintz 2015 personal communication).

Assemblage and Collections

The next step after constructing the list of archaeological sites in Oklahoma with obsidian was to assemble an assemblage to study and analyze. The assemblage consists of 2,140 artifacts and was consolidated from 23 different collections including those from various museums, private collectors, and government agencies such as the OAS. Of those 2,140 artifacts, 110 were selected for XRF analysis and were sent to Dr. M. Steven Shackley for obsidian source determination. For clarity, the dataset for this research project consists of the 110 obsidian samples I selected for XRF analysis in addition to previous research on obsidian in Oklahoma.

My network of practicing archaeologists was pivotal in meeting and working with private collectors. In all respects, I gave my best effort to follow the ethical guidelines put forth by Dr. Bonnie Pitblado et al. (2014, 2022) in her articles on ethical practices when working with collectors. Dr. Don Wyckoff introduced me to Towana Spivey, a private collector living in Duncan, Oklahoma. Dr. Bonnie Pitblado introduced me to Jim Cox, a prominent private collector in Central Oklahoma. Dr Scott Brosowske of Courson Archaeological Research (CAR) was integral in my introduction to most of the private collectors I collaborated with. I contacted Dr. Brosowske shortly after beginning this project and he graciously introduced me to his netwok of private collectors in the Oklahoma Panhandle, many of whom had obsidian artifacts in their collections. Dr. Brosowske introduced me to many collector's in the Oklahoma Panhandle who were already a part of his archaeological network including Rick Williams, Bill Ramsey, Russell Tibbetts, Harold Kachel, Kimmie Karber, and Bob Kerns. Dr. Brosowske also introduced me to the curators at the No Man's Land Museum (NMLM) in Guyman, Oklahoma and the Cimarron County Heritage Center (CCHC) in Boise City, Oklahoma.

Overall, my interactions with private collectors throughout this project was positive and formative. Most collectors were excited to talk about and show me their collections, and to talk about archaeology in general. When working with private collectors there is always the issue of verity and provenience data for their particular artifacts. I approached the collectors with a sense of trust when inquiring about the provenience of their particular obsidian artifacts. In other words, if a collector told me that a certain artifact came from a previously known archaeological site, I trusted that this information was true and incorporated it into this project. Some private collectors kept rigorous records and location data, including coordinates, of all of their finds, and at times even knew the trinomial or site name where they found an artifact. Others knew the drainage, county, or at worst, that a particular artifact came from Oklahoma with no other provenience information. Regardless, if the information was there, I point-plotted private collector finds spatially on maps of Oklahoma in a similar fashion to the way I point-plotted previously recorded archaeological sites.

During my time assembling the assemblage multiple artifacts from various sites were involved in the Native American Graves Protection and Repatriation Act (NAGPRA). These artifacts were promptly removed from the study and returned to their owners to avoid any future issues. Throughout the data collection process, I encountered a number of artifacts that were not obsidian. These were also removed from the study. The exception is if a non-obsidian artifact passed my preliminary examinations and was included as an XRF sample (i.e. I thought the artifact was obsidian). I refer the reader to Appendix A for the comprehensive artifact inventory, Appendix B for Dr. M. Steven Shackley's (2021) report on the 110 XRF samples, and Appendix C for a comprehensive list of archaeological sites in Oklahoma with obsidian. Table 4.1 below shows all of the collections I utilized to form the assemblage.

Table 4.1: Collections in the Assemblage

Catalog Numbers	Artifacts	Owner	Collection
1-7	7	Courson Archaeological Research	Goodner
45	1	Courson Archaeological Research	Unknown
8-17	10	Harold Kechal	Harold Kechal
18-24	7	Russell Tibbetts	Russell Tibbetts
26-43	18	Bob Kerns	Bob Kerns
46	1	Rick Williams	Rick Williams
48-53, 1734-1735	8	Bill Ramsey	Bill Ramsey
47, 54-1468	1416	Kimmie Karber	Kimmie Karber
1494	1	No-Man's Land Museum	Unknown
1495-1496	2	No-Man's Land Museum	Duckett
1497-1498	2	No-Man's Land Museum	Billy Baker

Catalog Numbers	Artifacts	Owner	Collection
1499-1500, 1504-1662	161	Cimmaron County Heritage Center	Kenneth Saunders
1501-1502	2	Cimmaron County Heritage Center	Hutchinson
1503	1	Cimmaron County Heritage Center	Max Vamleer
1470-1493, 1768-1773	30	Oklahoma Archeological Survey	Unknown
1663-1665	3	Oklahoma Archeological Survey	Timothy Baugh
1766	1	Oklahoma Archeological Survey	34KA5 Spring Excavations
1742-1743	2	Panhandle-Plains Historical Museum	Unknown
1764-1765	2	Museum of the Great Plains	Unknown
1736-1737	2	Towana Spivey	Towana Spivey
1738-1741, 1749-1763	19	Jim Cox	Jim Cox
1666-1668, 1689-1698	13	Sam Noble Oklahoma Museum of Natural History	Unknown
1744-1748	5	Sam Noble Oklahoma Museum of Natural History	Unknown
1774-1937	164	Sam Noble Oklahoma Museum of Natural History	Unknown
1938-1988	51	Sam Noble Oklahoma Museum of Natural History	Hemmingway
1989-2199	211	Sam Noble Oklahoma Museum of Natural History	Unknown

Projectile Points, Bifaces, and Typology

A typology is necessary to understand changes in obsidian source and tool form through time. Artifacts from excavated contexts associated with solid dates provide a better grasp on the time depth of obsidian use in Oklahoma, but these are scarce in my study's assemblage. Typologies are classification schemes consisting of types, which are artifacts similar enough to each other to be classified under the same group (Andrefsky 2005). The hallmark of typologies are that they signify a timeframe for a specific type, such as a characteristic projectile point (Ford 1954; Andrefsky 2005).

There are a number of issues with the concept of typologies in archaeology. One is that the typological classification of hafted-bifaces generally consider them unchanging and give little regard to the concept of resharpening (Flenniken and Wilke 1989). Resharpening will inevitably change the morphological characteristics needed for classification (Flenniken and Wilke 1989; Andrefsky 2005). While resharpening may throw a wrench in temporal typological schemes, there is always the question of whether resharpened tools will differ enough from their parent tools to skew timeframes for certain types (Bettinger 1991). Typologies are still necessary in archaeology as they provide us with shared language to discuss artifacts and archaeology (Whittaker 1994). I must also note that this project is not a typological study, and I use a typology to provide a timeframe.

I performed biface metrics on obsidian artifacts I chose to fill the 110 XRF samples sent to Dr. Shackley. These were rigorous, sub-millimeter measurements on every conceivable metric with the idea that I may be the last or sole person to take these data points for each artifact. The specific attributes, both qualitative and quantitative, I collected data from are available by request to the author at jmatthewoliver@gmail.com. I did not include these data in an appendix because of the sheer size of the data tabulations.

There is no current typology covering the geographical expanse of Oklahoma, and there are significant differences between the material culture of eastern and western Oklahoma, especially after the Woodland period (ca. 1,950 – 1,050 B.P). To remedy both of these issues I have utilized five different typologies focusing exclusively on hafted biface forms that are typically found in Oklahoma. Amassing a detailed typology for Oklahoma is a thesis or dissertation in its own right, and I do not intend to do that here. I have, however, constructed a simple typology based on the PPKs appearing in the XRF assemblage for this study (n = 110) and other obsidian PPKs appearing in Oklahoma that have been studied by previous researchers. To designate PPK types I primarily compared the general outline of the PPK, supplemented by defining attributes, to basic existing typologies for the region. Table 4.2 presents the five works I utilized for a typology for my thesis project. Table 4.3 details the specific typology I utilized for my project drawn from the resources presented in Table 4.2 and others as a supplement.

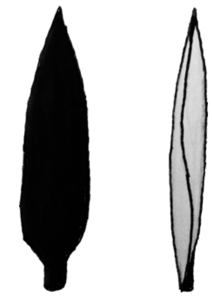
Table 4.2: Typological Works Utilized

Typology	Date/Authors
The O'Shara Tradition: Origins of Anasazi Culture	1973 Cynthia Irwin Williams
Guide to the Identification of Certain American Indian Projectile Points, Volumes 1—4	1958—1971 Robert E. Bell and Gregory Perino
Projectile Point Types in Missouri and Portions of Adjacent States	2016 Jack H. Ray
Southern Plains Lithics: The Small Points	2007 Marjorie Duncan, Larry Neal, Don Shockey, Don Wyckoff, Michael Sullivan, and L. M. Sullivan
Seedskadee Project: Remote Sensing in Non-Site Archeology (High Plains Typology)	1986 Dwight L. Drager and Arthur K. Ireland

Table 4.3: Specific Typology Utilized for Obsidian in Oklahoma

Projectile Point	Approximate Date Range	General Time Period	Reference	General Outline
Clovis	13,050–12,750 B.P.	Paleoindigenous	Waters et al. 2020	
Scottsbluff	9,600–9,000 B.P.	Paleoindigenous	Ray 2016	

Agate Basin	9,450–8,950 B.P.	Paleoindigenous	Perino 1968	
Dalton	10,000–5,000 B.P.	Paleoindigenous	Bell 1958	
Calf Creek	5,960–5,700 B.P.	Archaic	Loshe et al. 2021	

Pandale	6,000–4,700 B.P.	Archaic	Bell 1958	
Frio	4,950–450 B.P.	Archaic	Bell 1960	
Marcos	2,600–1,800 B.P.	Archaic	Bell 1958	
General Side-Notched Dart Point	3,950–1,950 B.P.	Archaic	Hughes 1984	

General Corner-Notched Dart Point	3,950–1,950 B.P.	Archaic	Hughes 1984	
Scallorn	1,750–800 B.P.	Woodland	Duncan et al. 2007	
Deadman’s	1,450–450 B.P.	Late Precontact	Duncan et al. 2007	
Washita	900–200 B.P.	Late Precontact & Postcontact	Duncan et al. 2007	
Harrell	900–200 B.P.	Late Precontact & Postcontact	Duncan et al. 2007	

Fresno	750–250 B.P.	Late Precontact & Postcontact	Duncan et al. 2007	

When putting together a large scale typology it is important to review the credibility of the authors of its various pieces. Irwin-Williams is a Southwest archaeologist who has done work at Los Alamos National Laboratories and Princeton University. Robert E. Bell was foundational in Oklahoma archaeology and has held positions in the University of Oklahoma Anthropology Department, the Sam Noble Museum of Natural History (SNOMNH), and the OAS. Gregory Perino spent time at the Thomas Gilcrease Institute of American History and Art and was one of the founders of the Illinois State Archaeological Society. Jack H. Ray is the Assistant Director for Archaeological Research at the Center for Archeological Research of Missouri State University and has received a number of distinguished awards. Marjorie Duncan recently retired from her position as Assistant State Archaeologist of the OAS. Dwight L. Drager worked on the Chaco Mapping Project (Drager 1985) and *The Seedskadee Project* (Drager and Ireland 1986) for the National Park Service. Likewise, Arthur K. Ireland worked on the same *Seedskadee* project as Drager (Drager and Ireland 1986). The authors of these typologies are well suited to contribute to an overall typology of Oklahoma because of their distinguished careers and ethical treatment of the archaeological discipline. I will refrain from describing the hundreds upon hundreds of PPK types described in these five typologies, and will instead encourage the reader to review each typology itself as a reference to the PPK types I assigned in my thesis's assemblage.

Obsidian Source Characterization and X-Ray Fluorescence (XRF) Mass Spectrometry

One of the most appealing features of obsidian is the great variety in the relative frequencies of trace elements resulting from a multitude of factors in its formation, which allows us to source an artifact or nodule to its supposed geologic origin point, as long as the origin point is known and exists in a comparative sample.

For the most part, sourcing lithic artifacts analyze the frequencies of trace elements present in a sample. This is desirable for a number of reasons. For example, if a flake of obsidian was collected at a site and sourced, we can draw a line from the source to the place where the flake was found. By proxy of the obsidian artifact, this analysis indicates some type of movement, whether it be from trade, mobility, or some other process such as procurement. Regardless, *someone* had to have brought the artifact to its resting place. Beyond that, multiple sourcing data can reveal mobility patterns, obsidian conveyance zones, trade and exchange routes, and lithic resource procurement strategies.

There are many techniques for geochemically sourcing obsidian. I chose to use XRF over other techniques because of its non-destructive nature and the specific trace elements XRF techniques identify are the trace elements present in obsidian that we use to compare different geologic origin points.

The XRF technique can be either destructive or non-destructive, depending on if the analyst wishes to analyze the surface of a sample, or the entire thing (Andrefsky 2005). In the latter case the sample is crushed so that the X-rays can penetrate beyond the surface of the sample. In this sourcing method fluorescent X-rays are emitted by the sample, and each element will produce a different wavelength which can be analyzed to determine the concentration of said element (Andrefsky 2005). In comparing XRF to Neutron Activation Analysis (NAA), XRF is quicker, more accessible, and more cost effective than NAA, as well as being more non-destructive than NAA in relative terms (Glascock et al. 1998). There are a few variations of XRF, such as energy dispersive X-ray fluorescence (EDXRF) and wavelength dispersive X-ray fluorescence (WXRF). With modern technological improvements, EDXRF can isolate nearly as many elements as NAA, making a stronger case for this method and accounting for its popularity

(Shackley 2011). Another iteration of XRF technology is the portable version (PXRF), which was developed to analyze samples in the field or those that have been curated (Liritzis and Zacharias 2011). We should remember, however, that PXRF machines should always be appropriately calibrated or the effectiveness of the analysis may be lost.

We need to be careful when talking about sourcing – as Hughes points out, a source refers to a location, whereas a geochemical group refers to a particular chemical association (Hughes 1998). When one undertakes a sourcing study, it is always a good thing to remember that these techniques are not infallible and should be used in conjunction with other methods to produce a more reliable and robust argument.

I chose to use the EDXRF method over NAA because of EDXRF's ease of access, lower cost, and non-destructibility. I sent 110 artifacts to Dr. M. Steven Shackley's EDXRF laboratory in Albuquerque, New Mexico for obsidian source characterization. I chose to use Shackley's lab for consistency as many previous researchers analyzing at obsidian in Oklahoma also used Shackley's lab. The criteria I used to decide which 110 artifacts to subject to EDXRF are presented in a flow chart (Figure 4.1). When the assemblage was exhausted based on the criteria in the flow chart, I passed the assemblage through the flow chart once more to reach 110 samples.

Figure 4.1: Flow Chart of EDXRF Sampling Decisions

1) Artifacts that have not been subjected to geochemical source characterization

↓

2) At least one artifact from every collection

↓

3) Diagnostic artifacts (primarily projectile points)

↓

4) Non-diagnostic artifacts from excavated contexts

↓

5) Non-diagnostic artifacts from archaeological sites with no obsidian artifacts sourced

↓

6) Non-diagnostic artifacts from archaeological sites in the main body of Oklahoma rather than the panhandle

I designed the flow chart (Figure 4.1) to maximize the measure of time and space in my project. For instance, step 1) ensures that I did not subject an artifact to EDXRF that had already been geochemically studied. Step 2) ensures that I utilized at least one artifact from every collection I worked with, and so that none of the collectors that assisted me in this project were left out. Step 3) ensures some measure of temporal control in focusing on diagnostic artifacts. When no additional diagnostic artifacts remained that satisfied steps 1) – 3), I moved to step 4) which allows for more temporal control. Once step 4) was exhausted, as in, there were no more artifacts from excavated contexts left in the total assemblage (n = 2,140) to fill out the EDXRF sample set (n= 110), I utilized step 5) to maximize the spatial extent of my study by focusing on archaeological sites recorded in Oklahoma with obsidian, but never studied before with geochemical techniques. I put step 6) in place at the end of the flow chart to serve a similar function as step 5), meaning that I intended to study an obsidian artifact from as many different spatial contexts in Oklahoma as possible. Most of the evidence we have from previous researchers is on obsidian in Oklahoma's panhandle. Step 6) bolsters the data in the main body of Oklahoma as opposed to the panhandle. Once my entire assemblage (n = 2,140) passed through the flow chart, I passed all of the artifacts through the flow chart again to fill out the EDXRF sample set (n = 110) as long as every artifact met the first criteria (step 1)).

Spatial Analysis and Mapping

Spatial analysis is important to archaeology, as conducting spatial analyses can reveal patterns that could be overlooked by normal archaeological inquiry (Hodder and Orton 1976). Spatial analysis is not infallible, and does have some considerable issues. Subjective interpretations of spatial analysis are also a problem, and it is important for us to use rigorous spatial analysis methods to retain some measure of objectivity (Hodder and Orton 1976). When considering site densities, survey bias becomes an issue, meaning that there will appear to be more sites in geographic areas that have been intensely surveyed, and fewer sites in geographic areas that have not been surveyed. It is vital that we also know the boundaries of these surveyed areas, or the spatial representation of the data could skew (Ebert et al. 1996).

Many spatial analysis tests attempt to identify clusters. Identifying clusters provides insight into certain aspects of social life, such as settlement patterns and variations in artifact distributions. Likewise, Ducke (2015) points out that clustering reveals spatial and temporal aspects of cultural processes. The research I present in this thesis looks for clustered and dispersed spatial patterns of sites in Oklahoma containing obsidian to approach cultural interaction on the Southern Plains and between adjacent regions.

The spatial analyses I performed show where in Oklahoma obsidian is concentrated, which indicates a degree of interaction between prehistoric people living in that particular area of the state with other nearby cultural groups that either had access to the obsidian sources, or were involved in some sort of interactive process. The exploratory mapping component of this research involves assessing the geologic sources of certain obsidian artifacts, and the directionality of interaction revealed through this process spatially and temporally. For instance, obsidian sourcing to the Jemez Mountains in northern New Mexico indicate a western-oriented directionality of interaction, meaning that people in Oklahoma's past were likely interacting with other groups of people to the west, such as those in the Texas panhandle or northeast New Mexico.

To reveal any spatial patterning between the Oklahoma obsidian sites, I used exploratory mapping to analyze the data to support directionality for possible directionality of cultural interaction between groups of people living in the Southern Plains, the area near a particular obsidian source, and all of the areas in between. Environmental Systems Research Institute's (ESRI) ArcGIS suite was the program I used to complete these analyses. Exploratory data analysis, such as exploratory mapping, can be used to assess trends within a dataset, and if approached in a problem oriented way, can be productive (Maschner 1996).

To do so, I assigned specific symbology to represent each obsidian type (source) found in the state and plotted the datapoints on maps of Oklahoma. I utilized a teal hexagon for Bear Gulch, Idaho; a dark red sun symbol for Black Rock Desert, Utah; a purple four-pointed start for Buck Mountain California; a yellow circle for Cerro Toledo Rhyolite, New Mexico; an orange-pink six-pointed star for Cochetopa Dome, Colorado; a brown upside-down triangle for Cow Canyon, Arizona; an orange five-pointed start for El Rechuelos Rhyolite, New Mexico; a pink asterisk for Glass Mountain, California; a green triangle for Malad, Idaho; a blue square for Obsidian Cliff, Wyoming; a dark green teardrop for Owyhee, Idaho, a malachite-green hill-shape for Pachuca, Mexico; a light blue buzzsaw-shape for Teton Pass, Wyoming; a turquoise "X" for Timber Buttes, Idaho; and a red diamond for Valles Rhyolite, New Mexico (see Figure 2.2)

I calculated the point-plotted data utilizing Universal Transverse Mercader (UTM) coordinates for a centroid to create the data point. Information about the various obsidian sources was widely available online, and I utilized data from the Northwest Research Obsidian Studies Laboratory (NROSL), Shackley's 2005 publication on obsidian, and his Geoarchaeological X-ray Fluorescence Laboratory website (swxrflab.net) to calculate the UTMs needed for plotting obsidian sources on maps in ArcGIS. I created a different map per time period (i.e. Paleoindigenous, Archaic, etc.). If a site had more than one obsidian artifact sourcing to different geologic origin points, I created an inset within the map to show the variability within the site.

For the previously recorded archaeological sites I pulled the centroid UTM coordinates from the OAS's site form pertaining to that particular site and symbolized each based on where the obsidian from that particular site sourced to (i.e. a green triangle for Malad, Idaho). To plot data I gathered from private collectors, I plotted the locations they gave me if they were spatially tight. At times collector's knew the site name or trinomial where the artifact came from. In such a case, I trusted that they were correct and plotted the data point based on the central UTM for that particular site. Some of the collectors I worked with during this project had coordinates, yet most knew of the drainage where an artifact was found rather than a specific location. In that case, I did not plot a spatial data point for a collector's specific artifact, but noted throughout the study that it was found in whichever county they informed me of. Rarely, a collector would tell me an anecdote and indicate a specific place where they found the artifact (i.e. four miles west of Lindsay, OK). In that case, I plotted the spatial point as accurately as I could and utilized it in the mapping process. I calculated the distance between each locality (either a previously recorded site or information given by a private collector) and obsidian source linked to the artifact(s) from that locality utilizing the "measure" tool in ArcGIS.

To remove as many unknown data points as possible I attributed each site into a specific time period (i.e. Woodland, Late Precontact, etc.) based on the information within the OAS's site form and other publications that discussed the particular site. For multicomponent sites, I reviewed where the obsidian was found and attributed it to the appropriate temporal component, again based on the site form or other publications regarding the site in question. Many of the obsidian artifacts from previously recorded archaeological sites were obsidian flakes found on the surface when the site was recorded. In this case, if the site was a multicomponent site, I considered how much obsidian has already been analyzed in Oklahoma based on the time period, and selected a time period for the obsidian artifact based on the likelihood of the obsidian being from that time period. For example, in Oklahoma most of the obsidian is from either the Archaic Period or the Late Precontact Period, a moderate amount is from the Postcontact Period, and a minimal amount is from either the Paleoindigenous Period or the Woodland Period. Therefore if I had a multicomponent site with significant Archaic Period and Woodland Period occupations, but one obsidian flake from the surface, I considered the obsidian flake to be of Archaic Period age simply based on the amount of obsidian in Oklahoma from the Archaic Period versus the Woodland Period that we already know about.

To frame the discussion at the end of this thesis, I used the online tool Windrose.xyz available from https://windrose.xyz to generate Wind Rose diagrams that depict the connections of a given obsidian source spatially throughout the state based on time period, and the directionality of obsidian movement that suggests cultural interaction patterns. Wind Rose diagrams are radial bar charts, typically used to depict wind direction and speed over time. Wind

Rose diagrams can also show the direction and the amount of something (whether it is wind, or obsidian). This idea came from Dr. Bonnie Pitblado's (2003:153) book on Late Paleoindigenous occupations in the Rocky Mountains, wherein she used Wind Rose diagrams to show the directionality and intensity of Paleoindigenous people utilizing various lithic resources in the western US. To create these, I coded Obsidian Cliff and Teton Pass, Wyoming, along with Bear Gulch, Idaho as North-Northwest; Malad, Timber Buttes, and Owyhee, Idaho as Northwest; Glass Mountain and Buck Mountain, California, Black Rock Desert, Utah, and Cochetopa Dome, Colorado as West-Northwest; El Rechuelos Rhyolite, Cerro Toledo Rhyolite, and Valles Rhyolite, New Mexico as West; Cow Canyon, Arizona as Southwest; and Pachuca, Mexico as South. The Wind Rose diagrams were calculated by the number of artifacts per time period.

I also created conveyance zone maps depicting the western US, the various obsidian sources where the obsidian, and the archaeological sites and localities where that particular type of obsidian has been found in Oklahoma. I utilized the "draw polygon" tool in ArcGIS to depict a buffer around all of the sites and localities in Oklahoma with obsidian from that particular source. The buffer-shapes I created this way are not normal conveyance zone ellipses, which typically depict an ellipse centered on the obsidian source and drawn around the source to include all of the archaeological sites where that particular type of obsidian was found. I chose to create buffer-shapes within Oklahoma to avoid suggesting that certain types of obsidian appeared in Oklahoma where they did not. I chose to depict these buffer-shapes with 50% transparency so that I could display them on one map (per time period). To depict the amount of obsidian from each source found in Oklahoma I utilized different line styles on a sliding scale. For a single obsidian artifact from Oklahoma I utilized a 6:6 thin dashed line. For two to five artifacts I utilized a 6:1 thin dashed line. For six to 15 artifacts I utilized a thin solid line. For 16 to 25 artifacts I utilized a thick solid line. For 26 to 55 artifacts I utilized a thick solid line with a border. For 56 to 99 artifacts I utilized a thicker solid line with a border and centerline.

Methodology discussions are critical for archaeological studies for verity and so the study may be replicated, if necessary. In this chapter I discussed the specific methods of data collection, choices, and analysis I utilized to study obsidian in Oklahoma. I now turn to Chapter 5: Results, which will detail the results of these methods and the research project.

Chapter 5: Results

In this chapter I pore over the results of my research on the spatial and temporal distribution of obsidian in Oklahoma. First, I present the results of the list of obsidian sites in Oklahoma along with an associated table and map. Second, I present the detailed spatial and temporal data of obsidian distribution throughout the state including a literature review on work completed with obsidian in Oklahoma prior to my project and the results of my 110 X-ray Fluorescence (XRF) samples. I organized the results of my project around the five broad time periods in the archaeological sequence.

Obsidian Sites in Oklahoma

In total I parsed out an 61 archaeological sites in Oklahoma with obsidian, bringing the total number of known archaeological sites with at least one obsidian artifact spread around the state of Oklahoma to 178 sites in 44 counties. The results of my search for obsidian sites in Oklahoma are depicted on a map of Oklahoma (Figure 5.1) and detailed in its preceding table (Table 5.1; Appendix C). The sites depicted in Figure 5.1 are coded as either red for a site with obsidian that has not been studied, blue for a site with obsidian that was studied before this research project, and green for a site with obsidian that was included in this research project.

Figure 5.1: Obsidian Sites in Oklahoma

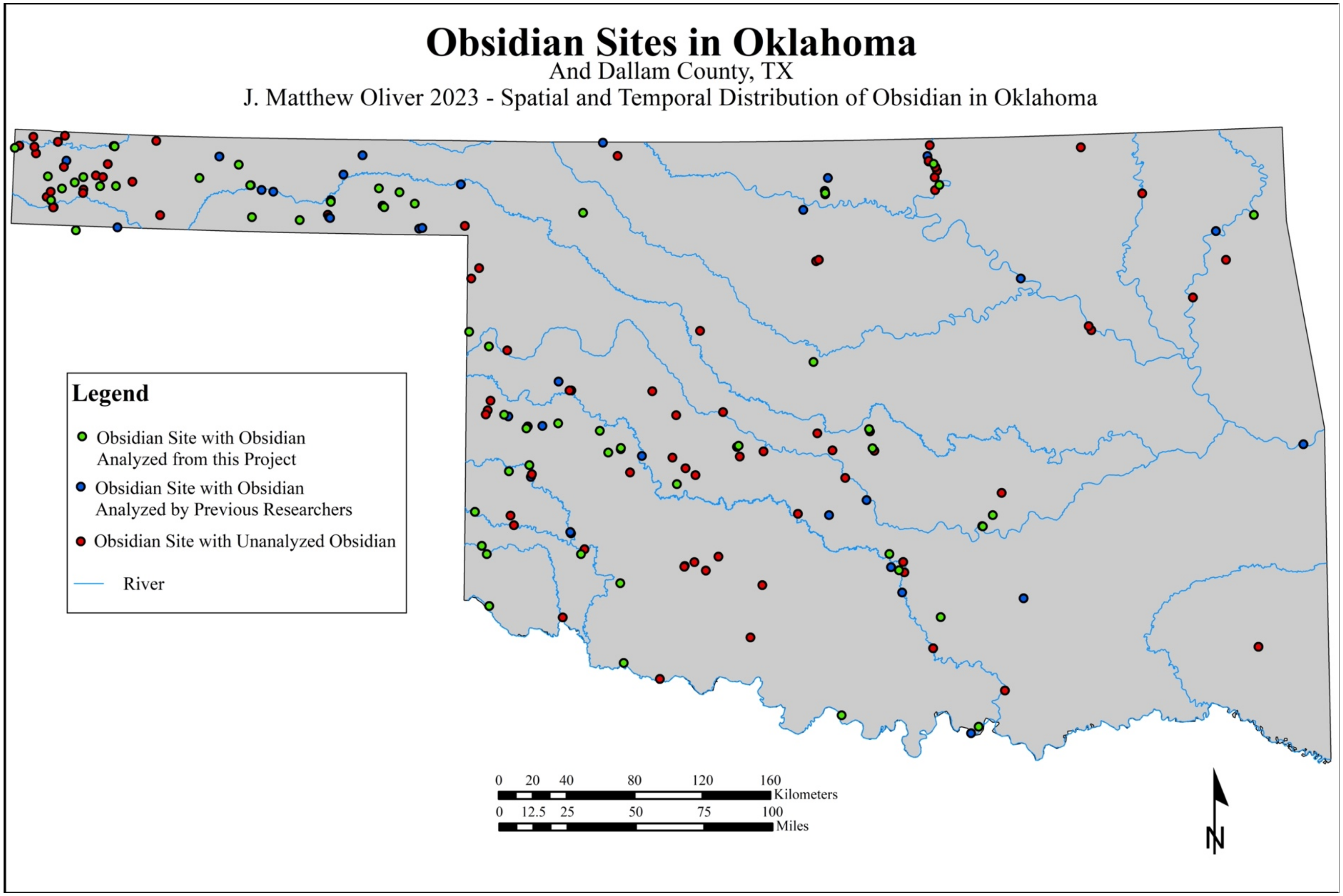


Table 5.1: Obsidian Sites in Oklahoma

County	Total Sites	Paleoindigenous	Archaic	Woodland	Late Precontact	Postcontact	Multicomponent	Unknown
Beaver	17				6		11	
Beckham	7				6		1	
Blaine	2				2			
Bryan	1						1	
Caddo	3	1		1	1			
Canadian	3							
Carter	1						1	
Cimarron	31		1		17	1	3	9
Cleveland	3		1					2
Coal	1			1				
Comanche	5			1				4
Cotton	1							1
Custer	5				4	1		
Delaware	1				1			
Ellis	5				5			
Garfield	2							2
Garvin	6				3		3	
Grady	2				1			1
Grant	5			1	3		1	
Greer	6				1	2	2	1
Harmon	3		1		2			
Jackson	3						1	2
Jefferson	1					1		
Kay	10		1	4	2	1	2	
Kiowa	1					1		
Le Flore	1				1			
Marshall	2		1				1	
Mayes	3			1			2	

County	Total Sites	Paleoindigenous	Archaic	Woodland	Late Precontact	Postcontact	Multicomponent	Unknown
McClain	3				2		1	
McCurtain	1						1	
Murray	1					1		
Nowata	1						1	
Oklahoma	2		1				1	
Pawnee	1							1
Roger Mills	9	1			3	1	2	2
Seminole	4		1		1		2	
Stephens	1				1			
Texas	10				7		2	1
Tillman	2				2			
Tulsa	2					1		1
Washington	1			1				
Washita	6		1		2	1	1	1
Woods	2				2			
Woodward	1						1	

I submitted 110 samples of carefully chosen obsidian artifacts from various sites and localities to Dr. M. Steven Shackley of the Geoarchaeological X-Ray Fluorescence Spectrometry Laboratory in Albuquerque, New Mexico for XRF analysis and obsidian source characterization. Shackley's utilized the Energy Dispersive X-ray Fluorescence (EDXRF) technique to parse out the elemental concentrations of my 110 samples. Shackley's (2021) report for these 110 samples has been appended to my thesis as Appendix B. Unfortunately, eight of the 110 samples turned out be a deceptively dark, waxy, and slightly translucent chert. These artifacts were removed from the study. From this point forward, I will refer to the 110 EDXRF samples as the 102 EDXRF samples. My obsidian source characterization results and associated spatial and temporal data appear in Table 5.2. Figure 5.2 is a map displaying the XRF results spatially throughout Oklahoma. Figure 5.3 is a map depicting how many artifacts I included in the 102 EDXRF samples per location. In Figure 5.3 I utilized numerals to depict artifacts I submitted for EDXRF analysis that had loose spatial associations (n = 4 for Cimarron County, n = 3 for Beaver County, n = 2 for Texas County, and n = 7 for Oklahoma in general).

Table 5.2: EDXRF Results of 102 Samples

Key

Symbol	Meaning
?	Unknown
BM	Buck Mountain Obsidian Source
CTR	Cerro Toledo Rhyolite Obsidian Source
ERR	El Rechuelos Rhyolite Obsidian Source
M	Malad Obsidian Source
OC	Obsidian Cliff Obsidian Source
VR	Valles Rhyolite Obsidian Source
CNDP	Corner-Notched Dart Point
PPK	Projectile Point/Knife
SNDP	Side-Notched Dart Point

Catalog#	Site	County	Artifact	Age	Source
1	N/A	N/A	Harrell	Late Precontact	?
2	N/A	N/A	CNDP	Archaic	M
3	N/A	N/A	Fresno	Late Precontact	M
4	N/A	N/A	Washita	Late Precontact	VR
8	N/A	Beaver	Washita	Late Precontact	VR
10	N/A	Beaver	Pandale	Archaic	ERR
11	N/A	Beaver	Scallorn	Woodland	M
12	N/A	Beaver	Marcos	Archaic	ERR
16	N/A	Beaver	Washita	Late Precontact	OC
18	34BV104	Beaver	Eccentric/Biface	Late Precontact	VR
26	34BV171	Beaver	Frio	Archaic	VR
27	34BV171	Beaver	CNDP	Archaic	VR
28	34BV171	Beaver	SNDP	Archaic	VR
45	N/A	Kingfisher	PPK Fragment	Unknown	CTR

Catalog#	Site	County	Artifact	Age	Source
46	N/A	Texas	Fresno	Late Precontact	CTR
47	34BV100	Beaver	Washita	Late Precontact	CTR
49	N/A	Kiowa	Scallorn	Woodland	?
50	N/A	Cimarron	Scallorn	Woodland	CTR
51	N/A	Cimarron	CNDP	Archaic	M
52	N/A	Washita	Fresno	Late Precontact	VR
55	34BV111	Beaver	CNDP	Archaic	M
56	34TX135	Texas	Washita	Late Precontact	OC
63	34BV100	Beaver	Washita	Late Precontact	CTR
64	34BV100	Beaver	Fresno	Late Precontact	CTR
73	34BV100	Beaver	Fresno (large)	Late Precontact	CTR
91	34BV99	Beaver	Fresno	Late Precontact	CTR
92	34BV99	Beaver	Fresno	Late Precontact	CTR
94	34BV99	Beaver	Fresno	Late Precontact	CTR
95	34BV99	Beaver	Fresno	Late Precontact	CTR
96	34BV99	Beaver	Fresno	Late Precontact	CTR
1475	34JK22	Jackson	Flake	Archaic	M
1487	34MR10	Murray	Flake	Postcontact	VR
1488	34BK8	Beckham	Flake	Late Precontact	M
1489	34BK9	Beckham	Flake	Late Precontact	VR
1490	34TI1	Tilllman	Flake	Late Precontact	CTR
1492	34TX32	Texas	Flake	Late Precontact	VR
1494	34CL76	Cleveland	Frio	Archaic	VR
1495	N/A	N/A	Scallorn	Woodland	CTR
1496	N/A	N/A	Scallorn	Woodland	VR
1601	34WA2	Washita	Flake	Postcontact	CTR
1602	34CI240	Cimarron	Flake	Unknown	M

Catalog#	Site	County	Artifact	Age	Source
1604	34WA2	Washita	Flake	Postcontact	VR
1607	34CI215	Cimarron	Flake	Late Precontact	CTR
1609	CI214	Cimarron	Flake	Late Precontact	?
1610	N/A	Cimarron	CNDP	Archaic	ERR
1612	34CI161	Cimarron	Flake	Archaic	VR
1616	34CI216	Cimarron	Flake	Late Precontact	VR
1623	34CI236	Cimarron	Flake	Late Precontact	VR
1629	34CI248	Cimarron	Flake	Late Precontact	M
1632	34CI204	Cimarron	Flake	Unknown	CTR
1734	N/A	Cimarron	Scallorn	Woodland	CTR
1735	N/A	Dallam, TX	Agate Basin	Paleoindigenous	CTR
1738	34CL76	Cleveland	Core	Archaic	TB
1742	34BK51	Beckham	Flake	Late Precontact	VR
1743	34BK51	Beckham	Scraper/Modified Flake	Late Precontact	VR
1749	34MA41	Marshall	Biface Fragment	Late Precontact	BM
1750	34OK71	Oklahoma	Flake	Archaic	M
1755	34CL76	Cleveland	Flake	Archaic	M
1763	N/A	N/A	Eccentric/Biface	Unknown	M
1765	34JF1	Jefferson	Biface Fragment	Postcontact	OC
1769	34WD5	Woodward	Flake	Late Precontact	CTR
1772	34CU27	Custer	Flake	Late Precontact	VR
1773	34CU27	Custer	Flake	Late Precontact	CTR
1775	34TX39	Texas	Deadman's	Late Precontact	VR
1776	34TX39	Texas	Washita	Late Precontact	VR
1786	34RM208	Roger Mills	Flake	Archaic	M
1787	34KA119	Kay	Flake	Archaic	CTR
1788	34HR60	Harmon	Flake	Late Precontact	VR

Catalog#	Site	County	Artifact	Age	Source
1789	34SM7	Seminole	PPK Mid-section	Archaic	BM
1791	34KA72	Kay	Flake	Woodland	M
1792	34KA72	Kay	Flake	Woodland	OC
1793	34SM20	Seminole	Flake	Archaic	M
1794	34GV108	Garvin	Flake	Woodland	CTR
1796	34GV25	Garvin	Flake	Late Precontact	M
1797	34DL28	Delaware	Flake	Late Precontact	OC
1798	34BK1	Beckham	Biface Fragment	Late Precontact	CTR
1799	34BK1	Beckham	Biface Fragment	Late Precontact	CTR
1802	34EL12	Ellis	Flake	Late Precontact	VR
1803	34EL12	Ellis	Flake	Late Precontact	VR
1806	34RM94	Roger Mills	Flake	Late Precontact	VR
1807	34HR36	Harmon	Flake	Archaic	?
1809	34CI199	Cimarron	Flake	Archaic	CTR
1814	34GT6	Grant	Shatter	Late Precontact	OC
1815	34KA62	Kay	Flake	Woodland	VR
1816	34KA62	Kay	Flake	Woodland	M
1827	34WA6	Washita	Small PPK fragment	Late Precontact	VR
1830	34HR1	Harmon	Biface Fragment	Late Precontact	M
1831	34HR1	Harmon	Flake	Late Precontact	M
1836	34TX31	Texas	Flake	Late Precontact	CTR
1845	34TX45	Texas	Biface Fragment	Late Precontact	VR
1859	34BK8	Beckham	PPK Base	Late Precontact	CTR
1860	34BK8	Beckham	PPK Base Fragment	Late Precontact	VR
1869	34MR10	Murray	Fresno	Postcontact	VR
1870	34MR10	Murray	Flake	Postcontact	VR
1897	34CN24	Canadian	PPK Base Fragment	Late Precontact	VR

Catalog#	Site	County	Artifact	Age	Source
1898	34CN24	Canadian	Flake	Late Precontact	VR
1944	34WA2	Washita	Fresno	Postcontact	VR
1948	34WA2	Washita	Fresno	Postcontact	VR
1951	34WA2	Washita	Fresno	Postcontact	VR
2010	34RM14	Roger Mills	Harrell	Late Precontact	VR
2075	34RM14	Roger Mills	Fresno	Late Precontact	VR
2097	34RM14	Roger Mills	Harrell	Late Precontact	VR

Figure 5.2: Map of EDXRF Results

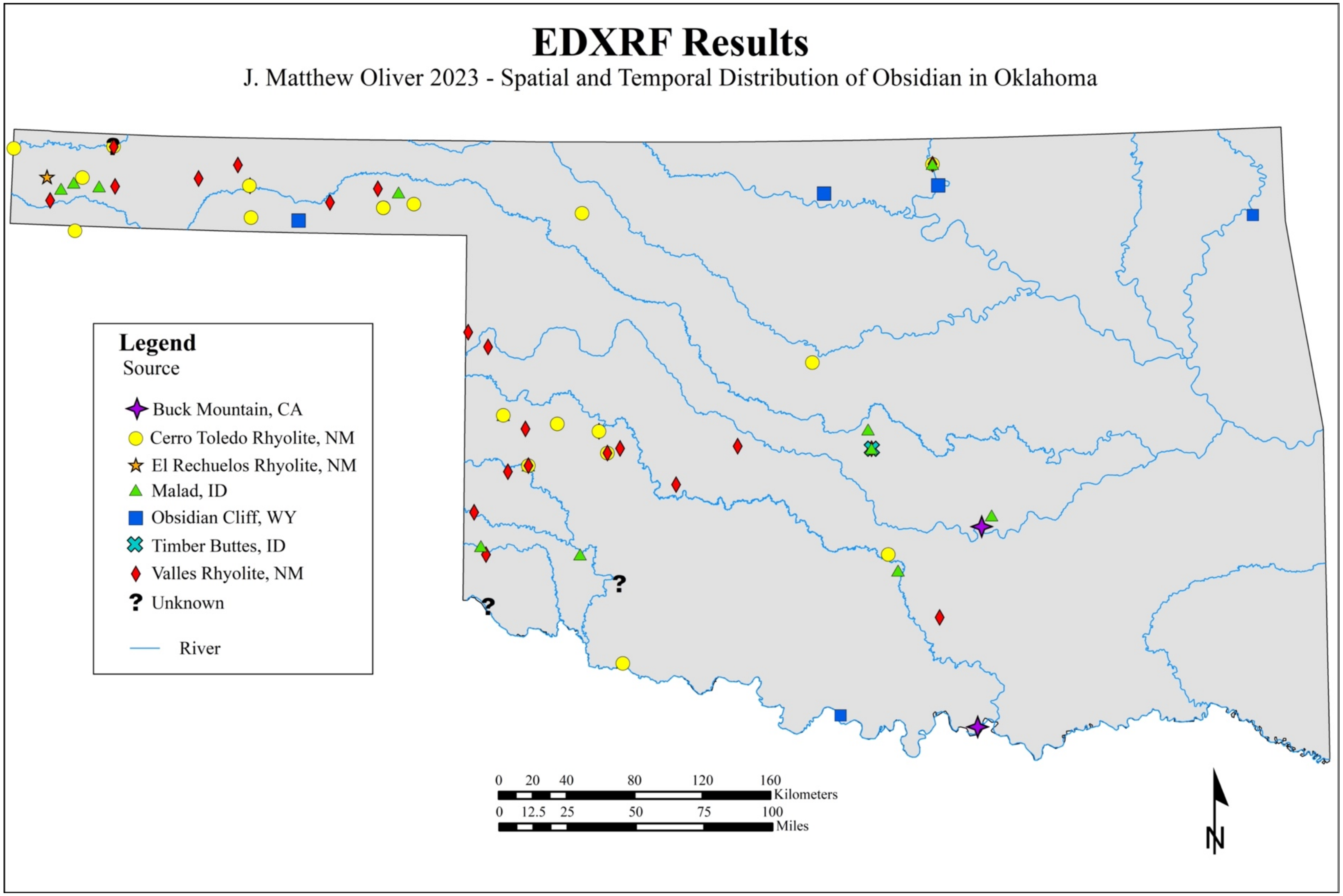
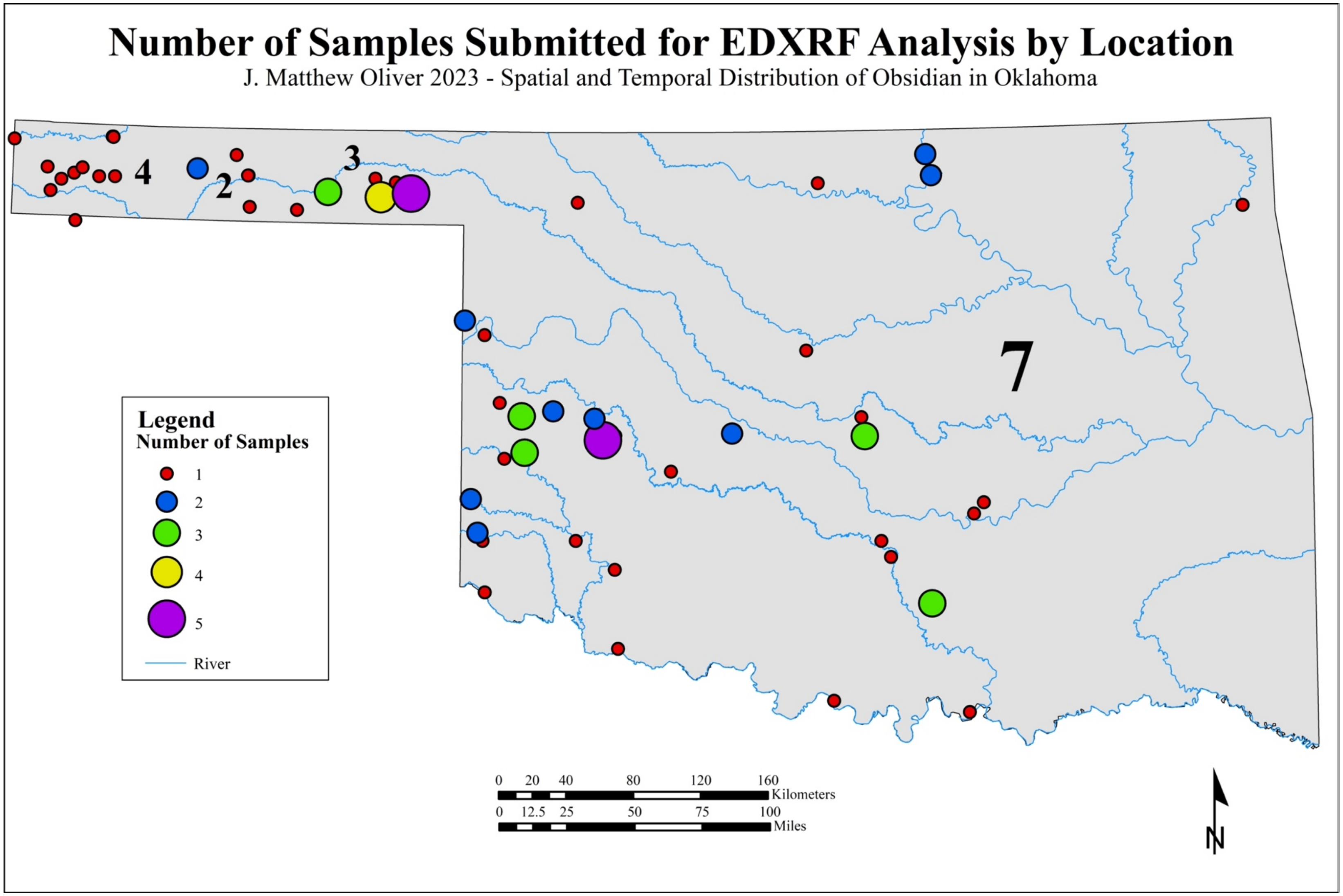


Figure 5.3: Map of Number of Samples Submitted for EDXRF Analysis by Location

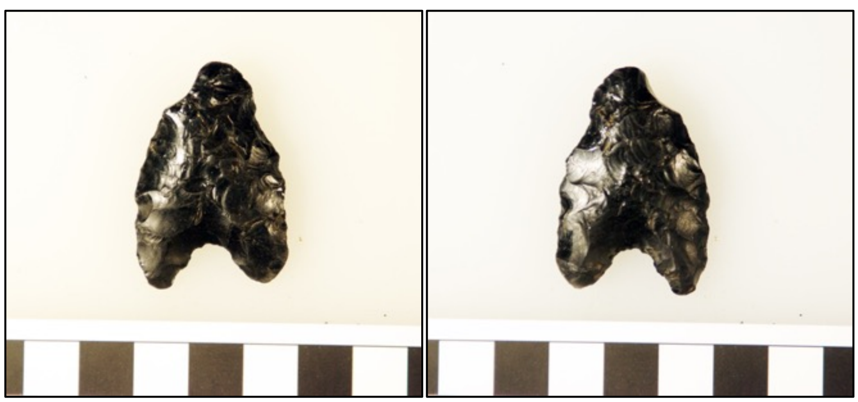


Paleoindigenous Period (Ca. 13,050 – 7,950 B.P.)

Previously Reported Paleoindigenous Obsidian in Oklahoma

The earliest examples of obsidian use in Oklahoma (n = 5) comprise two isolated projectile points/knives (PPKs) from Oklahoma, another PPK from site 34WA41, and two obsidian flakes from site 34RM439. The first example has been called the Blankenship Clovis (Figure 5.4) [13,050 – 12,750 B.P.] {Waters et al. 2020}. This artifact displays basal grinding, concave basal thinning, and fine workmanship. The projectile point was heavily retouched, having been worked down to a short and stout form, and it has a beveled edge near its tip (Figure 5.4). This artifact sourced to Cochetopa Dome in the Gunnison Basin, Colorado, over 716 km (445 mi) from the northwest corner of Roger Mills County, Oklahoma, which is what we can consider the northwesternmost edge of southwest Oklahoma [Shackley 2015a].

Figure 5.4: Blankenship Clovis from Southwest Oklahoma



There are two potential problems associated with the Blankenship Clovis and its source attribution: 1) the spatial context attached to the Blankenship Clovis is weak (as in, the collector was unwilling to share more specific spatial data other than southwest Oklahoma); 2) the Blankenship Clovis fingerprinted to the Cochetopa Dome obsidian formation in southwest Colorado, yet this geochemical source determination is suspect because the obsidian described as coming from Cochetopa Dome is typically as rather small nodules with the largest observed being about the size of a golf ball (Stiger 2001). Dr. Bonnie Pitblado, an expert in Paleoindigenous archaeology in the Gunnison Basin, confirmed that all of the obsidian nodules she has observed from Cochetopa Dome were 5 cm (1.97 in) at the largest, although she notes that collectors have shared anecdotes about the presence of larger pieces (Pitblado 2016 personal communication). Additionally, no Clovis sites or even isolated PPKs have been found in the Gunnison Basin itself, and that region has been studied extensively by archaeologists (Pitblado 2016 personal communication).

The second example is an obsidian Dalton-like PPK base (10,000 – 5,000 B.P.) [Bell 1958] from the Jim Cox Collection (Figure 5.5). The object Jim Cox has in his collection is a plastic cast of the Dalton-like PPK base and it exhibited much of the attributes Dalton PPKs typically do. No one I was in contact with could find where the actual artifact had gone, so it was unavailable for geochemical sourcing.

Figure 5.5: Plastic Cast of the Obsidian Dalton-like PPK Base from the Jim Cox Collection

Hofman and Blackmar (2012) reported the third instance of obsidian utilized by Paleoindigenous people in Oklahoma in their discussion of the Flaming Site, 34WA41. Archaeologists found two spearpoints at Flaming, including an obsidian Scottsbluff PPK (9,600 – 9,000 B.P.) [Ray 2016]. Hofman and Blackmar (2012) sent the obsidian Scottsbluff PPK to Ray Kunselman at the University of Wyoming for EDXRF analysis, who determined that the most probable obsidian source was Wright Creek, southeastern Idaho, over 1,415 km (879 mi) from 34WA41 (Hofman and Blackmar 2012). Wright Creek obsidian is another name for Malad obsidian.

Taylor-Montaya and others (2006) reported the fourth and final example of previously researched Oklahoma obsidian dating to the Paleoindigenous period. They used EDXRF to source two obsidian flakes from 34RM439, the Charley Terrace site, a Late Paleoindigenous site in western Oklahoma using EDXRF. One flake matched to the Cerro Toledo Rhyolite formation in the Jemez Mountains, northern New Mexico, over 609 km (378 mi) from 34RM439, and the other to Cow Canyon in Arizona, over 915 km (569 mi) from 34RM439 (Taylor-Montoya et al. 2006).

<u>EDXRF Results: Paleoindigenous Period</u>

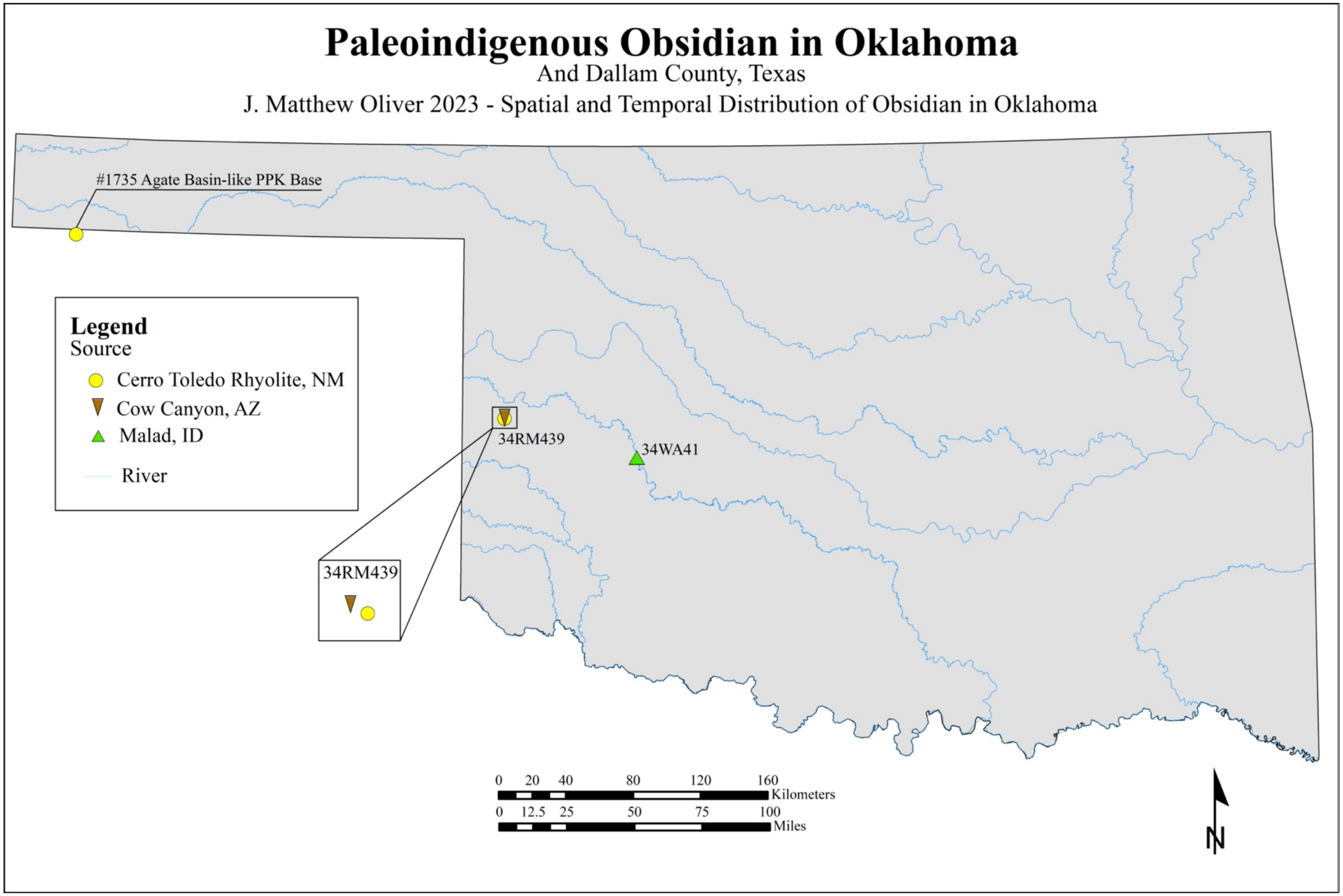
Evidence from the 102 EDXRF samples in my study for Paleoindigenous obsidian utilization is consistent with the literature review in that there is very little evidence for it in Oklahoma. The Paleoindigenous sample (#1735) is an obsidian Agate Basin-like PPK base (9,450–8,950 B.P.) from the Bill Ramsey Collection (Perino 1968) [Figure 5.6].

Figure 5.6: Obsidian Agate Basin-like PPK from the Bill Ramsey Collection

Technically, this artifact was not found within the political border of Oklahoma, but approximately 6.4 km (4 mi) south of the Texas-Oklahoma border in Dallam County, Texas.

Normally I would have excluded this artifact as it was not found within Oklahoma. I made an exception and included it as there is almost no evidence for Paleoindigenous obsidian utilization in Oklahoma, and the artifact was found in close proximity to Cimarron County. The Agate Basin-like PPK base sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountain, New Mexico, over 352 km (219 mi) from where Bill Ramsey found the artifact (Table 5.2; Figure 5.7; Appendix B). Figure 5.6 is a synthesized map detailing results for obsidian in Oklahoma during the Paleoindigenous Period spatially.

Figure 5.7: Paleoindigenous Obsidian in Oklahoma and Dallam County, Texas



Archaic Period (Ca. 7,950 – 1,950 B.P.)

<u>Previously Reported Archaic Period Obsidian in Oklahoma</u>

Compared with the earlier Paleoindigenous period, evidence for obsidian utilization increased during the Archaic Period in Oklahoma (n = 65). There is no evidence for obsidian utilization in Oklahoma during the Early Archaic Period (7,950 – 5,950 B.P.). Middle Archaic (5,950 – 3,950 B.P.) obsidian utilization is represented by an obsidian Calf Creek PPK (5,960 – 5,700 cal. B.P.) from 34JK22, the Ralph Winters site, in southwest Oklahoma (Perino 1968; Lohse et al. 2021). In a report prepared for the OAS, Shackley (2015b) identified the specimen as obsidian originating from the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 666 km (414 mi) from 34JK22 (Figure 5.8).

Figure 5.8: Obsidian Calf Creek PPK from 34JK22 (grid = 1 cm)

A second example of Middle Archaic obsidian utilization is Sean Dolan and supporting researcher's (2018) article on 34ML168, the Hayhurst Farm site and the Calf Creek biface cache. A single piece of obsidian debitage was found with the Hayhurst cache bifaces and its chemical signature matched obsidian from Glass Mountain in northeast California, over 2,231 km (1,386 mi) from 34ML168 (Dolan et al. 2018). This example carries the most distance between obsidian source and provenience of the artifact in Oklahoma.

The Oklahoma Panhandle has yielded more documented obsidian sites than any other part of the state. Bement and Brosowske (2001) sourced 12 obsidian artifacts from 34BV171, the Obsidian Hill site, a multicomponent site with archaeological evidence from the Late Paleoindigenous Period (9,950 – 7,950 B.P.) to the Late Archaic Period (2,950 – 1,950 B.P.) (Bement and Brosowske 2001). Three of the artifacts from 34BV171 are Late Archaic PPKs. The PPKs, along with three bifaces, were linked to the Obsidian Cliff formation in northwest Wyoming, over 1,120 km (696 mi) from 34BV171. The other six artifacts matched chemical signatures of the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 506 km (314 mi) from 34BV171 (Bement and Brosowske 2001).

As part of the same project, Bement and Brosowske (2001) also analyzed three Late Archaic PPKs from private collections. Two of the three PPKs sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 500 km (311 mi) from the southwest corner of Beaver County, Oklahoma, with the final PPK linked to the El Rechuelos Rhyolite formation in the Jemez Mountains, New Mexico, over 494 km (307 mi) from the southwest corner of Beaver County, Oklahoma (Bement and Brosowske 2001).

Kristen Carlson et al. (2014) discovered another site with obsidian in the Oklahoma Panhandle during a survey. Site 34CI487, the Sharp Ranch Camp 11 site, is associated with a Late Archaic manifestation, and Shackley (2014b) reported that two flakes from 34CI487 match the Valles Rhyolite (over 356 km [221 mi] from 34CI487) and El Rechuelos Rhyolite (over 348 km [216 mi] from 34CI487) formations in the Jemez Mountains, New Mexico.

Contract archaeologists from the United Research Services (URS) corporation found evidence for Archaic people utilizing obsidian in central Oklahoma while conducting excavations at 34CO29, the Foreman site (Margolis et al. 2014). Site 34CO29 is a transitional

Late Archaic/Plains Woodland site with multiple radiocarbon dates clustering around 3,000 B.P. and 850 B.P. for separate occupations (Margolis et al. 2014). The archaeologists recovered one obsidian flake from 34CO29 and sent it to Christopher Stevenson of the Diffusion Laboratory, Pennsylvania for geochemical tracing. Stevenson concluded that the flake sourced to Government Mountain in northern Arizona, but that not all of the trace elements matched (Margolis et al. 2014). Because of this discrepancy Margolis and colleagues had Shackley analyze the artifact afterward. Shackley concluded that the flake actually was of Malad obsidian, southeast Idaho, over 1,646 km (1,022 mi) from 34CO29 (Margolis et al. 2014).

Mark Latham and Edwin Hajic, along with other archaeologists with Burns & McDonnell Engineering Company, Inc. and Oklahoma Department of Transportation (ODOT) recovered much evidence for obsidian utilization during the Archaic period in central Oklahoma (Beale et al. 2022; Latham 2016; Latham and Hajic 2023, in review). Latham and colleagues conducted excavations at a transitional Late Archaic/Plains Woodland site 34SM87, the Jumper Creek site, and uncovered 22 obsidian flakes. PPK data indicates that the site was occupied for an extended period of time from the Early Archaic Period (7,950 BC – 5,950 B.P.) through the Plains Woodland Period (1,950 – 1,050 B.P.). Radiocarbon dates suggest repeated occupations situated between 4,400 and 2,400 B.P. (Beale et al. 2022). The researchers sent the 22 obsidian flakes to Shackley (2016, 2017a, 2017b) for EDXRF analysis. Eight of the artifacts sourced to the Obsidian Cliff formation in northwest Wyoming, over 1,618 km (1,005 mi) from 34SM87, and the remaining 14 artifacts to the Malad formation in southeast Idaho, over 1,601 km (995 mi) from 34SM87.

John Bybee (2015) and archaeologists with Amec, Foster, and Wheeler, Inc. conducted microwear analysis and geochemical fingerprinting on a refitted obsidian blade from site

34MY312, a multicomponent site in northeast Oklahoma. The archaeologists found the obsidian blade in the deeper Late Archaic component of 34MY312. This component dates to 2,006 B.P. (Bybee et al. 2015). Bybee and colleagues contracted Craig Skinner of the Northwest Research Obsidian Laboratory, who matched the geochemical signature of the specimen with the Obsidian Cliff formation in northwest Wyoming, over 1,607 km (998 mi) from 34MY312 (Skinner 2015).

The final example of obsidian from the Archaic Period in Oklahoma is an interesting one. A private collector found an obsidian eccentric at 34MA2, the Buncombe Creek site, a single-component Late Archaic site in south-central Oklahoma (Bell 1954). The artifact is a discoidal biface with nine notches encircling the circumference of the artifact. Shackley (2015c) sourced the eccentric to the Bear Gulch formation in southeast Idaho, over 1,765 km (1,096 mi) from 34MA2.

Overall, archaeologists have reported 46 artifacts from nine different Archaic sites. Twenty-three of the Archaic artifacts sourced to the distant northwest with 15 artifacts from Obsidian Cliff, Wyoming, 17 from Malad in Idaho, and one from Bear Gulch, Idaho. A single artifact matched with Glass Mountain, California in the far west-northwest. The remaining ten artifacts sourced to the comparatively nearby Jemez Mountains in northern New Mexico. The majority of these artifacts (n=10) are obsidian from the Valles Rhyolite formation with the other two from the El Rechuelos Rhyolite formation. Table 5.3 summarizes the literature review research I discussed in this section.

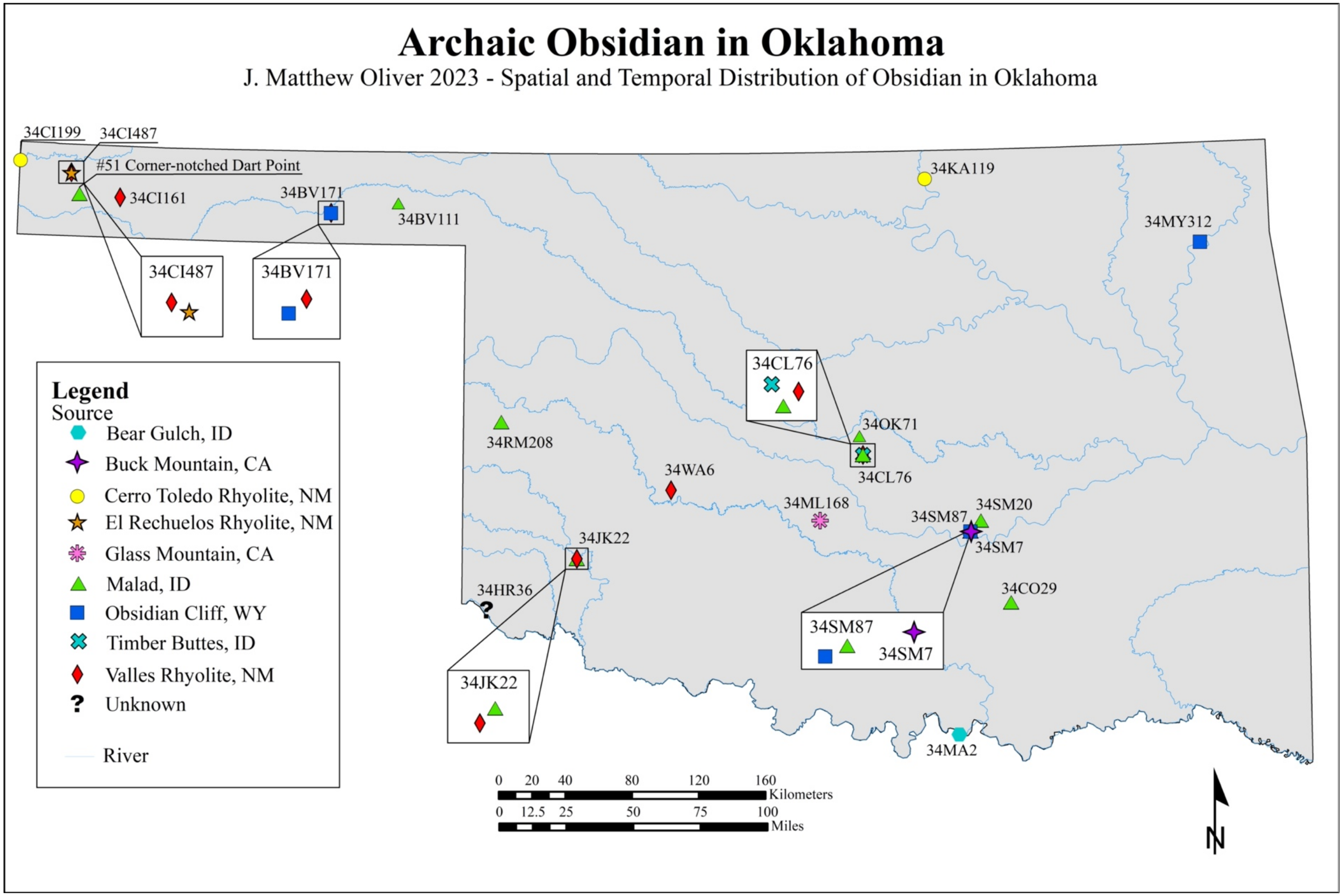
Table 5.3: Previously Researched Archaic Period Obsidian in Oklahoma

Site	Artifact	Source	
34JK22	Calf Creek PPK	Valles Rhyolite	
34BV171	Multiple	Obsidian Cliff	Valle Rhyolite
Private Collection	PPKs	Valle Rhyolite	El Rechuelos Rhyolite
34CI487	Flakes	Valles Rhyolite	El Rechuelos Rhyolite
34CO29	Flake	Malad	
34SM87	Flakes	Malad	Obsidian Cliff
34MY312	Blade	Obsidian Cliff	
34MA2	Eccentric	Bear Gulch	
34ML168	Debitage	Glass Mountain	

EDXRF Results: Archaic Period

There is much more evidence for people utilizing obsidian in Oklahoma during the Archaic Period as opposed to the preceding Paleoindigenous Period and the following Woodland Period. Twenty-one of the 102 EDXRF samples align with the Archaic Period. Figure 5.9 is a synthesis map of Archaic Period obsidian in Oklahoma including information from my literature review and the 102 EDXRF samples.

Figure 5.9: Archaic Obsidian in Oklahoma



Five of these 21 Archaic samples have loose spatial data associated with them. A corner-notched dart point (#2) from the Goodner Collection with no provenience other than coming from Oklahoma sourced to the Malad formation in southeast Idaho (Table 5.2; Figure 5.9; Appendix B). A Pandale-like PPK (#10) [6,000–4,700 B.P.] and a Marcos-like PPK (#12) [2,600–1,800 B.P.] {Bell 1958} from the Harold Kachel Collection from Beaver County, Oklahoma sourced to the El Rechuelos Rhyolite formation in the Jemez Mountains, New Mexico, over 500 km (311 mi) from the northwest corner of Beaver County, Oklahoma (Table 5.2; Figures 2.2, 5.9, and 5.10; Appendix B) [Bell 1958].

Figure 5.10: Artifact #10 a Pandale-like PPK from the Harold Kachel Collection

A corner-notched dart point (#1610) [3,950 – 1,950 B.P.] {Hughes 1984} from a collection housed at the No Man's Land Museum (NMLM) sourced to the El Rechuelos Rhyolite formation in the Jemez Mountains, New Mexico, over 358 km (222 mi) from the center of Cimarron County, Oklahoma (Table 5.2; Figure 5.9; Appendix B). Artifact #1610 most likely came from Cimarron County, or at least the Oklahoma Panhandle. The final EDXRF sample from the Archaic Period with loose spatial data is another corner-notched dart point (#51) [3,950 – 1,950 B.P.] {Hughes 1984} found in Cimarron County from the Bill Ramsey Collection that sourced to the Malad formation in southeast Idaho, over 1,059 km (658 mi) from the center of Cimarron County, Oklahoma (Table 5.2; Figure 5.9; Appendix B).

The 16 Archaic Period samples remaining are from previously recorded archaeological sites that the recorders deemed belonging to the Archaic period solely or multicomponent sites with a significant Archaic Period component. Three PPKs in the Bob Kerns Collection were found at site 34BV171 in Beaver County. These include a Frio-like PPK (#26) [4,950–450 B.P.] {Bell 1960}, a corner-notched dart point (#27) [3,950 – 1,950 B.P.] {Hughes 1984}, and a side-notched dart point (#28) [3,950 – 1,950 B.P.] {Hughes 1984}, all of which sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 506 km (314 mi) from 34BV171 (Table 5.2; Figure 5.9; Appendix B). Another corner-notched dart point (#55) [3,950 – 1,950 B.P.] {Hughes 1984} found at site 34BV111 from the Kimmie Karber collection sourced to the Malad formation in southeast Idaho, over 1,208 km (751 mi) from 34BV111 (Table 5.2; Figure 5.9; Appendix B).

Three artifacts, including #1494, a Frio-like PPK (Figure 5.11) [4,950 – 450 B.P.] {Bell 1960}, a core (#1738), and a flake (#1755) from the Jim Cox Collection found at site 34CL76 in Cleveland County surprisingly sourced to three different obsidian-bearing formations.

Figure 5.11: Artifact #1494 a Frio-like PPK from the Jim Cox Collection

The Frio-like PPK (4,950 – 450 B.P.) [Bell 1960] sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 825 km (513 mi) from 34CL76 (Table 5.2; Figure 5.9 and 5.11; Appendix B). The core sourced to Timber Buttes obsidian source in southwestern Idaho, over 1,890 km (1,174 mi) from 34CL76 (Table 5.2; Figure 5.9; Appendix B). The flake sourced to the Malad formation in southeastern Idaho, over 1,522 km (946 mi) from 34CL76 (Table 5.2; Figure 5.9; Appendix B). Another obsidian flake (#1750) from the Jim Cox Collection was found at site 34OK71 in Oklahoma County, Oklahoma. Artifact #1750 sourced to the Malad formation in southeast Idaho, over 1,514 km (941 mi) from 34OK71 (Table 5.2; Figure 5.9; Appendix B).

A flake (#1475) from site 34JK22 in Jackson County, Oklahoma belonging to a collection held at the OAS sourced to the Malad formation in southeastern Idaho, over 1,425 km (885 mi) from 34JK22 (Table 5.2; Figure 5.9; Appendix B). A second flake (#1612) found at site 34CI161 belonging to the Kenneth Saunder's Collection held at the Cimarron County Heritage Center (CCHC) sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 382 km (237 mi) from 34CI161 (Table 5.2; Figure 5.9; Appendix B). A third flake (#1786) found at site 34RM208 in Roger Mills County, Oklahoma belonging to the Sam Noble Oklahoma Museum of Natural History (SNOMNH) Collection sourced to the Malad formation in southeastern Idaho, 1,337 km (831 mi) from 34RM208 (Table 5.2; Figure 5.9; Appendix B). A fourth flake (#1787) found at site 34KA119 in Kay County, Oklahoma from the SNOMNH Collection sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 859 km (534 mi) from 34KA119 (Table 5.2; Figure 5.9; Appendix B).

A fifth flake (#1793) found at site 34SM20 in Seminole County, Oklahoma from the SNOMNH Collection sourced to the Malad formation in southeastern Idaho, over 1,603 km (996 mi) from 34SM20 (Table 5.2; Figure 5.9; Appendix B). A sixth flake (#1807) found at site 34HR36 in Harmon County, Oklahoma from the SNOMNH Collection could not be matched to any known obsidian source (Table 5.2; Figure 5.9; Appendix B). A seventh flake (#1809) from site 34CI199 in Cimarron County, Oklahoma from the SNOMNH Collection sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 325 km (202 mi) from 34CI199 (Table 5.2; Figure 5.9; Appendix B). An obsidian PPK mid-section (#1789) found at site 34SM7 in Seminole County, Oklahoma, and coming from a collection at the SNOMNH sourced to the Buck Mountain obsidian source in northeast California, over 2,213 km (1,375 mi) from 34SM7 (Table 5.2; Figure 5.9; Appendix B). The temporal evidence from site 34SM7 is tenuous and circumstantial, yet artifacts belonging to collectors in the area and other archaeological sites in the vicinity of Jumper Creek (34SM87) suggest that site 34SM7 is likely a transitional Late Archaic to Woodland site (Briscoe 1993). Because of this information, I classified site 34SM7 as an Archaic Period site based on previous obsidian data in the surrounding region.

Woodland Period (Ca. 1,950 – 1,050 B.P.)

<u>Previously Reported Woodland Period Obsidian in Oklahoma</u>

Two occurrences of Woodland Period obsidian have been reported in Oklahoma before my project. Archaeologists working for ODOT (Bartlett and O'Shea 2014) found the first evidence during mitigation for a bridge replacement in north-central Oklahoma. There, Bartlett and O'Shea (2014) uncovered one obsidian flake from excavations at 34GT47, the Cralley Frederick site. Site 34GT47 is a transitional Plains Woodland/Late Precontact site dating to ca. 960 B.P. (Bartlett and O'Shea 2014). According to Shackley's (2013) analysis, the obsidian flake sourced to the Obsidian Cliff formation in northwest Wyoming, over 1,411 km (877 mi) from 34GT47 (Bartlett and O'Shea 2014).

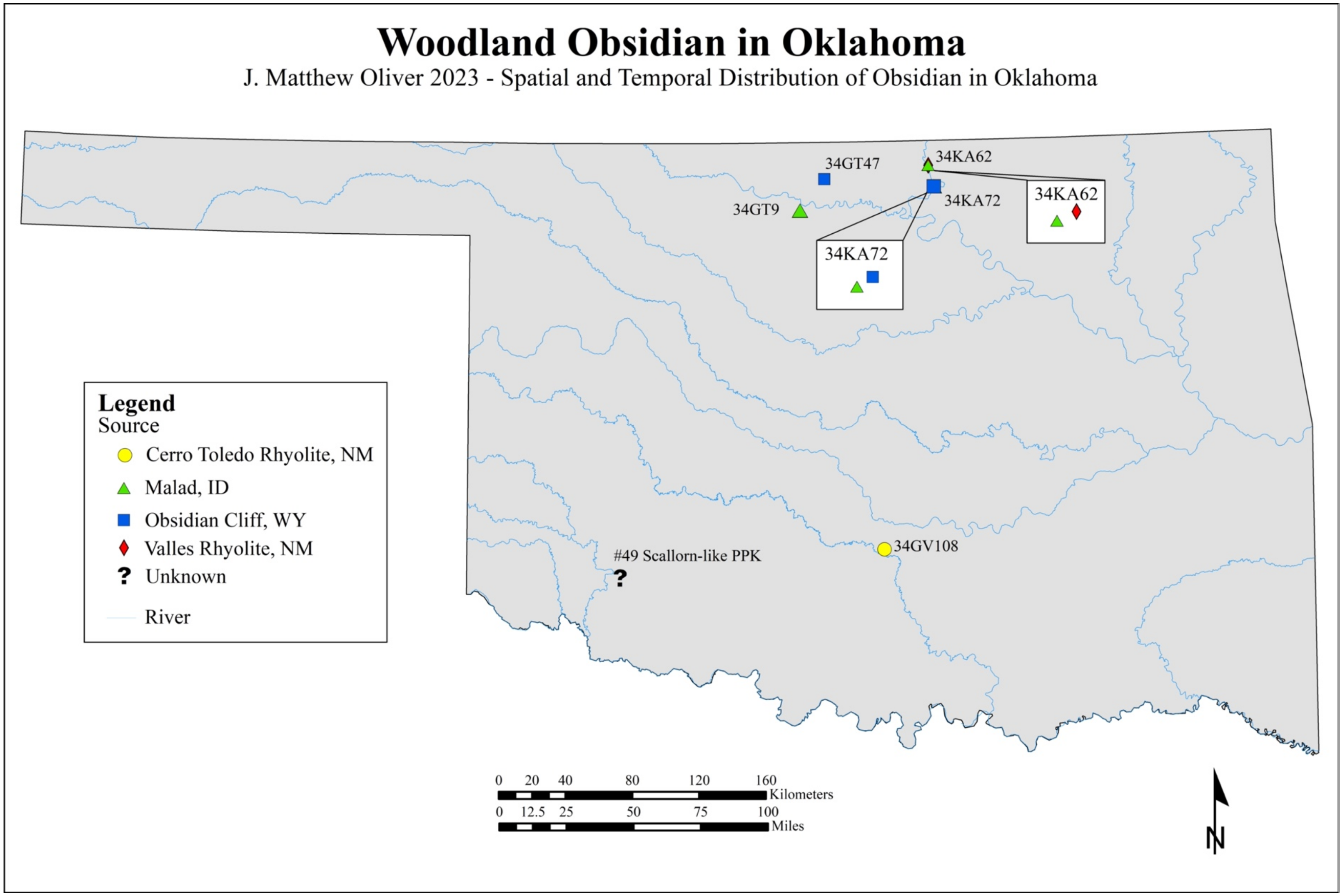
Brooks and Cleland (2015) conducted the second study of Woodland period obsidian in Oklahoma as part of the analysis of material from 34GT9, the Stalker site, excavated in 1981–

1982 by Glen Rose. Site 34GT9 is a transitional Plains Woodland/Late Precontact site with radiocarbon dates indicating a relatively short occupation situated around ca. 1,060 B.P. (Brooks and Cleland 2015). Brooks and Cleland (2015) found three obsidian flakes within the material from this site, and sent one of them to Shackley, who matched it to the Malad obsidian formation in southeast Idaho, over 1,410 (876 mi) from 34GT9 (Brooks and Cleland 2015).

EDXRF Results: Woodland Period

Similar to the Paleoindigenous Period, evidence for obsidian utilization during the Woodland Period in limited (n = 11). I linked eleven of the 102 samples submitted for EDXRF analysis and obsidian source characterization to the Woodland Period in Oklahoma. Figure 5.12 is a synthesis map of my EDXRF results for the Woodland Period and the literature review.

Figure 5.12: Woodland Obsidian in Oklahoma



Six of these eleven samples are Scallorn-like PPKs. Scallorn-like PPKs are generally considered a Woodland manifestation and have a date range of 1,750 – 800 B.P. (Duncan et al. 2007). This date range spills over into the early portions of the Late Precontact Period, and along these lines, many archaeologists consider Scallorn-like PPKs tenuously diagnostic at best (Duncan et al. 2007). The first of these six Scallorn-like PPKs (#11) belongs to the Harold Kachel Collection, was likely found in Beaver County in the Oklahoma Panhandle, and sourced to the Malad formation in southeast Idaho, over 1,154 km (717 mi) from the northwest corner of Beaver County, Oklahoma (Table 5.2; Figure 5.12; Appendix B).

Three of the six Scallorn-like PPKs (#49, #50, and #1734) belong to the Bill Ramsey Collection. Two of Bill Ramsey's Scallorn-like PPKs (#50 and #1734) were found in Cimarron County with one of the artifacts (#50) bearing spatial data recorded by Bill Ramsey himself, and sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 360 km (224 mi) from the center of Cimarron County, Oklahoma (Table 5.2; Figure 5.12; Appendix B). The remaining Scallorn-like PPK (#49) from the Bill Ramsey Collection was found in Kiowa County with Bill Ramsey recording the spatial data here as well. The EDXRF results show that artifact #49 is definitively obsidian, but does not match any known source (Table 5.2; Figure 5.12 and 5.13; Appendix B).

Figure 5.13: Artifact #49 Obsidian Scallorn-like PPK (1,750 – 800 B.P.) from the Bill Ramsey Collection

Two more Scallorn-like PPKs (#1495 and #1496) belonging to the Duckett Collection housed at the NMLM were found in Oklahoma and respectively sourced to the Cerro Toledo Rhyolite formation, over 453 km (281 mi) from the center of Texas County in the Oklahoma Panhandle (#1495) and the Valles Rhyolite formation, over 457 km (284 mi) from the center of Texas County in the Oklahoma Panhandle (#1496) [Table 5.2; Figure 5.12; Appendix B]. I was not able to assess any veritable spatial data for artifacts #1495 and #1496 other than that they are from Oklahoma.

I located and analyzed two obsidian flakes (#1815 and #1816) found at site 34KA62 in Kay County, Oklahoma from the collections housed at the SNOMNH. Artifact #1815 sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 861 km (535 mi) from 34KA62 (Table 5.2; Figure 5.12; Appendix B). In contrast, artifact #1816 sourced to the Malad formation in southeast Idaho, over 1,464 km (910 mi) from 34KA62 (Table 5.2; Figure 5.12; Appendix B). Wyckoff (1964) stated that there was not enough evidence to align 34KA62 with any particular time period, but Rohrbaugh (1974) argued for a Woodland Period occupation after assessing the results of excavation that took place at 34KA62.

Three obsidian flakes (#1791, #1792, and #1794) hailing from two different archaeological sites in Oklahoma with strong Woodland Period cultural associations provided the remainder of the obsidian utilization evidence for the Woodland Period. All three of these flakes belong to a collection housed at the SNOMNH. Artifacts #1791 and #1792 were found at site 34KA72 and respectively sourced to the Malad formation in southeast Idaho, over 1,473 km (915 mi) from 34KA72 (#1791), and the Obsidian Cliff formation in northwest Wyoming, over 1,463 km (909 mi) from 34KA72 (#1792) [Table 5.2; Figure 5.12; Appendix B]. The final obsidian flake (#1794) associated with the Woodland Period was found at site 34GV108 and sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 844 km (524 mi) from 34GV108 (Table 5.2; Figure 5.12; Appendix B).

Late Precontact Period (Ca. 1,250 – 450 B.P.)

Previously Reported Late Precontact Period Obsidian in Oklahoma

In stark contrast to the previous Woodland Period, the Late Precontact Period has yielded the most evidence for obsidian utilization in Oklahoma (n = 149). This may be, at least in part, because Oklahoma archaeologists have studied the Late Precontact Period more than any other time period. Dr. Timothy Baugh (1986) geochemically analyzed one artifact from 34BK6, the Fowler site, a Late Precontact occupation in southwest Oklahoma. Baugh (1986) conducted XRF analysis on this artifact and matched it to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 630 km (391 mi) from 34BK6.

A year later, Baugh and Nelson (1987) fingerprinted eight obsidian flakes from five Late Precontact sites: one from 34WO43, the Omey Site in northwest Oklahoma, three from 34RM72, the Zimms site, in western Oklahoma, one from 34GV22, the Currie site, in south-central Oklahoma, two from 34ML1, the Allcorn site, in central Oklahoma, and one from 34BV55, the

Skull Springs site, in the Oklahoma Panhandle. The study included data on obsidian from both Late Precontact and Postcontact sites. I discuss the Late Precontact Period obsidian here and return to the Postcontact Period material later in this chapter.

The artifacts from 34WO43 and 34GV22 matched the geochemical fingerprint for the Malad formation in southeast Idaho, over 1,290 km (802 mi) from 34WO43, and over 1,586 km (985 mi) from 34GV22 (Baugh and Nelson 1987). Both artifacts from 34ML1 sourced to the Black Rock Desert obsidian source in west-central Utah, over 1,448 km (900 mi) from 34ML1 (Baugh and Nelson 1987). The single artifact from 34BV55 matched trace element concentrations in the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 580 km (360 mi) from 34BV55 (Baugh and Nelson 1987). Site 34RM72 produced the most interesting results because two of the flakes matched the Malad obsidian formation in southeast Idaho, over 1,350 km (839 mi) from 34RM72, whereas the other flake sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 638 km (396 mi) from 34RM72 (Baugh and Nelson 1987).

In addition to the Archaic Period artifacts sourced by Bement and Brosowske (2001), they also analyzed five artifacts from four Late Precontact sites and localities in the Oklahoma Panhandle. A flake from 34BV116, the Porcupine site, a multicomponent site with an extensive Late Precontact occupation, sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 553 km (344 mi) from 34BV116. Bement and Brosowske (2001) also scrutinized artifacts from 34BV157, the Kerns #7 site, a Late Precontact site with Washita PPKs (900 –200 B.P.) [Duncan et al. 2007] and several obsidian flakes. Bement and Brosowske (2001) sent two flakes from 34BV157 to Shackley for EDXRF analysis, who reported that the obsidian originated from the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 504 km (313 mi) from 34BV157. Bement and Brosowske (2001) analyzed an artifact from 34TX34, the Clawson site, but the results did not match any known obsidian source. Finally, Bement and Brosowske (2001) fingerprinted a final Washita PPK (ca. 900 –200 B.P.) [Duncan et al. 2007] from a private collection to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 545 km (339 mi) from the center of Beaver County in the Oklahoma Panhandle.

The most intriguing instance of Late Precontact Period, or any other, obsidian in Oklahoma is the Odessa-Yates site (34BV100), located in Beaver County in the Oklahoma Panhandle. This site has produced over 2,000 obsidian flakes and a significant number of tools (Brosowske 2005). Fieldwork at the site led Dr. Brosowske to write his dissertation (2005) on the shift in Southern Plains exchange relationships before and through the Middle Ceramic Period (700 – 450 B.P.). Brosowske (2005) sent 73 artifacts from 10 Late Precontact sites in Texas and Beaver Counties, Oklahoma, to Shackley for source attribution. Of the 73 artifacts, 45 came from 34BV100 and 38 of those sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 534 km (332 mi) from 34BV100. Of the remaining artifacts from 34BV100, one sourced to the Fish Creek obsidian source, which is actually a part of the Teton Pass obsidian source, in northwest Wyoming over 1,158 km (720 mi) from 34BV100, two sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico over 536 km (333 mi) from 34BV100, two did not match any known obsidian source, and two proved not to be obsidian at all (Brosowske 2005).

Brosowske (2005) also discussed 19 obsidian flakes from seven sites in Beaver County in the Oklahoma panhandle. Three flakes were from 34BV97, the Campbell Creek site, and one of those sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 532 km (331 mi) from 34BV97, while the other two originated at Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 535 km (332 mi) from 34BV97 (Brosowske 2005). The Sprague site (34BV99) contained four obsidian flakes, all of which matched the geochemical signature for the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 552 km (343 mi) from 34BV99 (Brosowske 2005). A single flake from 34BV104, the Spangler site, originated at the Malad formation in southeast Idaho, over 1,197 km (744 mi) from 34BV104 (Brosowske 2005). Another flake, this one from 34BV93, the Coldwater #1 site, also sourced to the Malad formation in southeast Idaho, over 1,171 km (728 mi) from 34BV93, with two more flakes from 34BV93 matching the Cerro Toledo Rhyolite obsidian source in the Jemez Mountains of New Mexico, over 525 km (326 mi) from 34BV93. Brosowske (2005) analyzed one flake from 34BV122, the Gilger site, and determined that it came from the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 555 km (345 mi) from 34BV122. He analyzed three flakes from 34BV172, the Pierce site, with one matching to Cerro Toledo Rhyolite formation (over 503 km [312 mi] from 34BV172) and two to Valles Rhyolite formation (over 506 km [314 mi] from 34BV172), both in the Jemez Mountains, New Mexico. From 34BV14, the Roy Smith site, four flakes sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 512 km (318 mi) from 34BV14, one to the Valles Rhyolite formation, over 515 km (320 mi) from 34BV14, and one to the Obsidian Cliff formation in northwest Wyoming, over 1,212 km (753 mi). In a private collection, three flakes from either 34BV99 or 34BV100 (the collector was unsure which) matched obsidian from the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico (Brosowske 2005). The Cerro Toledo Rhyolite formation, New Mexico, is over 534 km (332 mi) from 34BV100 and over 552 km (343 mi) from 34BV99. The Valles Rhyolite formation, New Mexico, is over 536 km (333 mi) from 34BV100, and over 555 km (345 mi) from 34BV99. Both 34BV100 and

34BV99 are near each other and were not always differentiated as separate localities by collectors in the area.

Brosowske (2005) analyzed three flakes from 34TX1, the Stamper site, a Late Precontact site in the Oklahoma panhandle. Results showed one flake matched the geochemical signature for the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 463 km (288 mi) from 34TX1, and another to the Owyhee obsidian source, southwestern Idaho, over 1,474 km (916 mi) from 34TX1 (Brosowske 2005). The third flake was actually black chert. Finally, Brosowske (2005) sourced one flake from 34TX113, the Tharp site, determining that the artifact could be traced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 445 km (276 mi) from 34TX113. Brosowske's (2005) study in the Oklahoma Panhandle revealed that during the Late Precontact period, Southwest obsidian dominated assemblages, with 55 samples sourcing to the Cerro Toledo Rhyolite formation and eight to the Valles Rhyolite formation, both in the Jemez Mountains of New Mexico. Five samples matched more distant sources, but obsidian from other areas such as Idaho and Wyoming was present nonetheless. Table 5.4 below summarizes Brosowske's (2005) work.

Table 5.4: Obsidian from Brosowske (2005)

Site	Artifact	Source		
34BV100	Multiple	Cerro Toledo Rhyolite	Valles Rhyolite	Teton Pass
34BV97	Flakes	Cerro Toledo Rhyolite	Valles Rhyolite	
34BV99	Flakes	Cerro Toledo Rhyolite		
34BV104	Flake	Malad		
34BV93	Flakes	Malad	Cerro Toledo Rhyolite	
34BV122	Flake	Cerro Toledo Rhyolite		
34BV172	Flakes	Cerro Toledo Rhyolite	Valles Rhyolite	
34BV14	Flakes	Cerro Toledo Rhyolite	Valles Rhyolite	Obsidian Cliff
Private Collection	Flakes	Cerro Toledo Rhyolite		
34TX1	Flakes	Cerro Toledo Rhyolite	Owyhee	
34TX113	Flake	Valles Rhyolite		

Archaeologists at the OAS instigated additional studies of Late Precontact obsidian research. Dr. Richard Drass and Dr. Leland Bement submitted obsidian flakes from two Late Precontact sites, 34GV34, the Paul site, in south-central Oklahoma and 34PW128, a site in north-central Oklahoma, to Shackley (Drass 2016 personal communication) for obsidian source analysis. All four artifacts matched the Malad obsidian source in southeast Idaho, over 1,572 km (977 mi) from 34GV34, and over 1,542 km (958 mi) from 34PW128. Shackley (2014b) analyzed obsidian artifacts from four additional Late Precontact sites. Two artifacts from 34HR1, the Welden #1 site, in southwestern Oklahoma matched the Malad obsidian source in southeast Idaho, over 1,378 km (856 mi) from 34HR1, and a flake from 34CI303, a site in the Oklahoma Panhandle, originated from the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 376 km (234 mi) from 34CI303 (Shackley 2014b). Additionally, Shackley (2014b) also assigned another obsidian artifact from 34GT5, the Spoon site, in north-central Oklahoma to the Malad obsidian source in southeast Idaho, over 1,417 km (880 mi) from 34GT5.

Another instance of Late Precontact Period obsidian in Oklahoma emerged during test excavations for an oil well pad in Custer County, southwest Oklahoma. Archaeologists with Cojeen Archaeological Services, LLC recovered a Scallorn-like (1,750 – 800 B.P.) [Duncan et al. 2007] obsidian base fragment from an area just outside of 34CU40, the Hodge site, a Late Precontact site of the Custer Phase (1,150 – 700 B.P.) [Cojeen and Burkhalter 2004; Drass 1999]. They submitted the obsidian Scallorn-like base fragment as well as a previously recovered obsidian flake from 34CU40 to the Berkeley Geoarchaeological X-Ray Fluorescence Laboratory. The PPK base fragment sourced to the Malad formation in southeast Idaho, over 1,359 km (844 mi) from 34CU40, and the flake to the Valles Rhyolite formation in the Jemez Mountains of New Mexico, over 646 km (401 mi) from 34CU40 (Cojeen and Burkhalter 2004).

Obsidian is all but absent in the more forested areas of eastern Oklahoma during the Late Precontact Period; however, there is one known obsidian artifact associated with an eastern Oklahoma Late Precontact site: a scraper from 34LF40, the Craig Mound portion of the Spiro Mounds complex. Spiro Mounds is in Le Flore County in east-central Oklahoma and is the most well-known site in the state. During 1935 Works Progress Administration (WPA) excavations, J. G. Braecklein recovered an obsidian scraper from a looter tunnel in Craig Mound (Barker et al. 2002). Years later, Barker and colleagues (2002) conducted EDXRF analysis on this artifact and showed that it sourced to the Pachuca obsidian source in central Mexico, over 1,735 km (1,078 mi) from 34LF40. This was an indication of a possible link between Mesoamerica and the Late Precontact Period in Oklahoma (Barker et al. 2002).

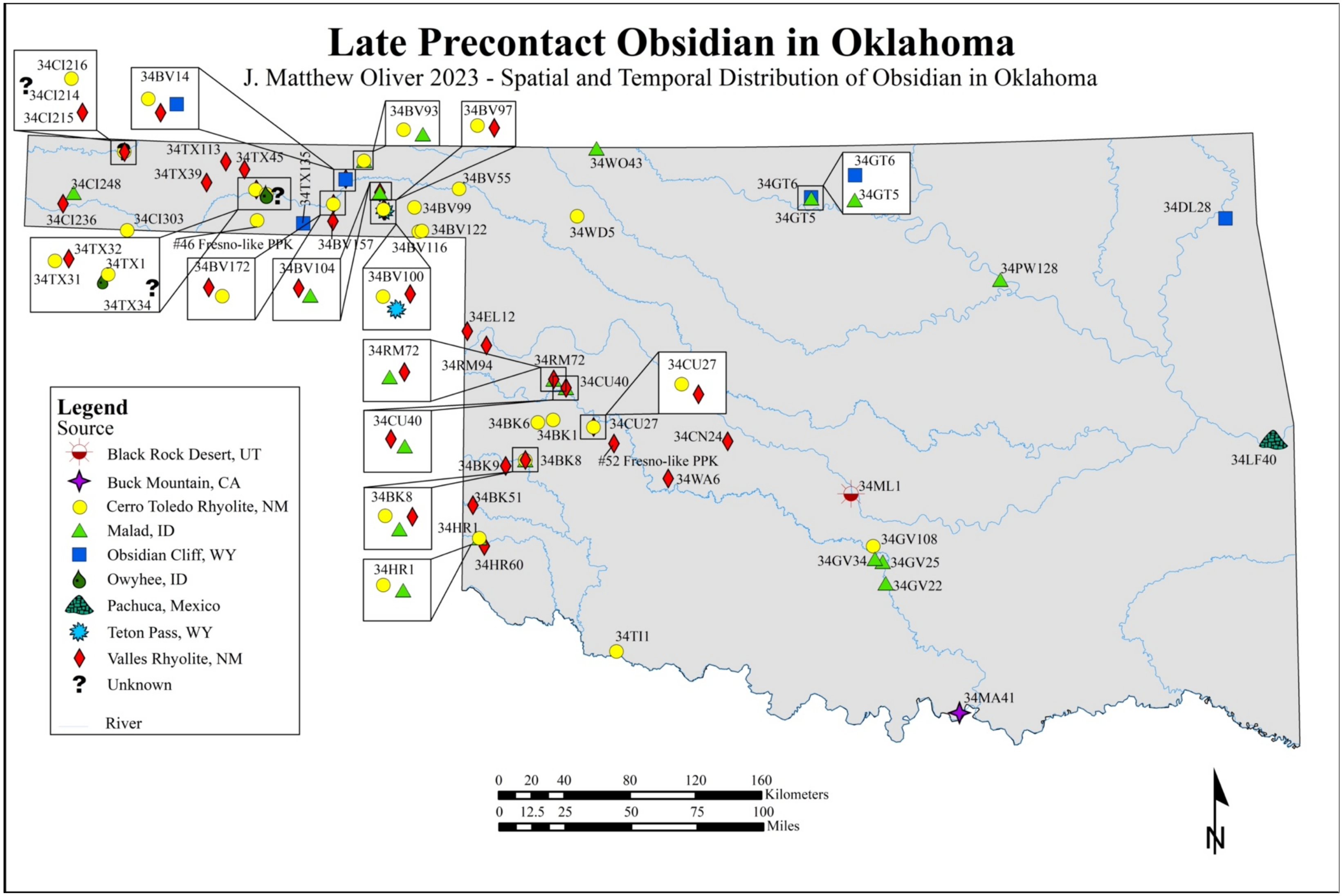
The Late Precontact Period yielded by far the most evidence for obsidian utilization in Oklahoma of any time period. Ninety-five artifacts from 26 different sites and localities were analyzed by various researchers. Of the 95 specimens, 71 originated from Southwest obsidian sources and 14 from more distant sources. Three artifacts did not match any known obsidian source and three were not obsidian. The two artifacts from 34ML1 that matched Black Rock Desert obsidian in Utah are outliers in that they are the two sole specimens attributed to a Utah obsidian source. Below is Table 5.5 summarizing Late Precontact Period obsidian research in Oklahoma I discussed above, as well as Figure 5.14, a synthesis map showing previous research on archaeological sites associated with Late Precontact obsidian in Oklahoma and my EDXRF results for Late Precontact Period obsidian.

Table 5.5: Previous Research on Late Precontact Period Obsidian in Oklahoma

Site	Artifact	Source		
34BK6	Flake	Cerro Toledo Rhyolite		
34WO43	Flake	Malad		
34RM72	Flakes	Malad	Valles Rhyolite	
34GV22	Flake	Malad		
34ML1	Flakes	Black Rock Desert		
34BV55	Flake	Cerro Toledo Rhyolite		
34BV116	Flake	Cerro Toledo Rhyolite		
34BV157	Flakes	Valles Rhyolite		
34TX34	Flake	Unknown		
Private Collection	Washita	Valles Rhyolite		
34BV100	Multiple	Cerro Toledo Rhyolite	Valles Rhyolite	Teton Pass
34BV97	Flakes	Cerro Toledo Rhyolite	Valles Rhyolite	
34BV99	Flakes	Cerro Toledo Rhyolite		
34BV104	Flake	Malad		
34BV93	Flakes	Malad	Cerro Toledo Rhyolite	
34BV122	Flake	Cerro Toledo Rhyolite		
34BV172	Flakes	Cerro Toledo Rhyolite	Valles Rhyolite	
34BV14	Flakes	Cerro Toledo Rhyolite	Valles Rhyolite	Obsidian Cliff
Private Collection	Flakes	Cerro Toledo Rhyolite		
34TX1	Flakes	Cerro Toledo Rhyolite	Owyhee	
34TX113	Flake	Valles Rhyolite		

Site	Artifact	Source		
34GV34	Flakes	Malad		
34PW128	Flakes	Malad		
34HR1	Flakes	Cerro Toledo Rhyolite		
34CI303	Flakes	Cerro Toledo Rhyolite		
34GT5	Flakes	Malad		
34CU40	Multiple	Malad	Valles Rhyolite	
34LF40	Scraper	Pachuca		

Figure 5.14: Late Precontact Obsidian in Oklahoma



EDXRF Results: Late Precontact Period

The majority of the EDXRF samples (n = 54) can be securely assigned to the Late Precontact Period including 54 obsidian artifacts from 32 previously-recorded Late Precontact archaeological sites. Seven of these 54 obsidian samples are not associated with an archaeological site and have loose spatial data connected to them. All seven EDXRF samples with loose spatial data were diagnostic PPKs. In contrast, many of the Late Precontact artifacts associated with an archaeological site were obsidian flakes.

Three obsidian PPKs (#1, #3, and #4) belong to the Goodner Collection, which I borrowed from Courson Archaeological Research (CAR), where the collection was being analyzed at the time I was collecting data. Artifact #1 is a Harrell-like PPK (900 – 200 B.P.) [Duncan et al. 2007] found in Oklahoma with no other spatial context and displayed EDXRF results indicating that the artifact is indeed obsidian, but could not be matched to any known obsidian source (Table 5.2; Figure 5.14; Appendix B). Artifact #3 is a Fresno-like PPK (750 – 250 B.P.) [Duncan et al. 2007] found in Oklahoma with no other spatial context sourcing to the Malad formation in southeast Idaho, over 1,505 km (935 mi) from the center of Oklahoma (Table 5.2; Figure 5.14; Appendix B). Artifact #4 is a Washita-like PPK (900 – 200 B.P.) [Duncan et al. 2007] found in Oklahoma with no further spatial context and sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 816 km (507 mi) from the center of Oklahoma (Table 5.2; Figure 5.14; Appendix B).

Two more obsidian Washita-like PPKs (900 – 200 B.P.) [Duncan et al. 2007], #8 and #16 belonging to the Harold Kachel Collection respectively sourced to the Valles Rhyolite formation in the Jemez Mountain, New Mexico, over 419 km (260 mi) from the northwest corner of Texas County in the Oklahoma Panhandle (#8), and the Obsidian Cliff formation in northwest

Wyoming, over 1,138 km (707 mi) from the northwest corner of Texas County, Oklahoma (#16) [Table 5.2; Figure 5.14; Appendix B]. Harold Kachel informed me that both artifacts were found along Goff Creek in northwest Texas County, Oklahoma. Another Fresno-like obsidian PPK (750 – 250 B.P.) [Duncan et al. 2007], artifact #46, from the Rick Williams Collection was found in Texas County, Oklahoma. Additionally, a friend of Rick Williams's recorded coordinates upon finding the PPK. Artifact #46 sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 456 km (283 mi) from where artifact #46 was recorded (Table 5.2; Figure 5.14 and 5.15; Appendix B).

Figure 5.15: Artifact #46 Obsidian Fresno-like PPK from the Rick Williams Collection

Artifact #52 is an obsidian Fresno-like PPK (750 – 250 B.P.) [Duncan et al. 2007] belonging to the Bill Ramsey Collection and was found in Washita County, Oklahoma. The EDXRF analysis of artifact #52 resulted in a determination that the artifact sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 678 km (421 mi) from where artifact #52 was recorded (Table 5.2; Figure 5.14; Appendix B).

Similar to other time periods, Late Precontact obsidian from the Oklahoma Panhandle is more prevalent than in other areas of the state. Five obsidian flakes (#1607, #1609, #1616, #1623, and #1629) found by Kenneth Saunders from five different Late Precontact archaeological sites in Cimarron County, Oklahoma belonging to the CCHC were submitted for EDXRF analysis and obsidian source characterization. Artifact #1607 is an obsidian flake found at the Late Precontact site 34CI215 in Cimarron County, Oklahoma, and sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 382 km (237 mi) from 34CI215 (Table 5.2; Figure 5.14; Appendix B). Artifact #1609 is another obsidian flake hailing from the Late Precontact site 34CI214 in Cimarron County, Oklahoma. While artifact #1609 is indeed obsidian, the EDXRF results show that this artifact does not match any known obsidian source (Table 5.2; Figure 5.14; Appendix B). Artifact #1616 is an obsidian flake from the Late Precontact site 34CI216 in Cimarron County, Oklahoma, and sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 386 km (240 mi) from 34CI216 (Table 5.2; Figure 5.14; Appendix B). Yet another obsidian flake (#1623) was found at the Late Precontact site 34CI236 in Cimarron County, Oklahoma, and sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 343 km (213 mi) from 34CI236 (Table 5.2; Figure 5.14; Appendix B). The final Late Precontact obsidian flake (#1629) from Cimarron County, Oklahoma, was found at site 34CI248 and sourced to the Malad formation in southeast Idaho, over 1,053 km (654 mi) from 34CI248 (Table 5.2; Figure 5.19; Appendix B).

Six obsidian artifacts from Late Precontact sites in Texas County, Oklahoma were analyzed for obsidian source characterization. A Washita-like PPK (900 – 200 B.P.) [Duncan et al. 2007], artifact #56, found at site 34TX135 and belonging to the Kimmie Karber Collection sourced to the Obsidian Cliff formation in northwest Wyoming, over 1,217 km (756 mi) from 34TX135 (Table 5.2; Figure 5.14 and 5.16; Appendix B).

Figure 5.16: Artifact #56 Obsidian Washita-like PPK from 34TX135

An obsidian flake from a collection at the OAS and hailing from site 34TX32 sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 460 km (286 mi) from 34TX32 (Table 5.2; Figure 5.14; Appendix B). A basally-notched Deadman's-like PPK (#1775) [1,450–450 B.P.] {Duncan et al. 2007} and a heavily resharpened Washita-like PPK (#1776) [900 – 200 B.P.] {Duncan et al. 2007} from the SNOMNH collections found at site 34TX39 both sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 431 km (268 mi) from 34TX39 (Table 5.2; Figure 5.14; Appendix B) [Duncan et al. 2007]. Yet another flake (#1836) from the SNOMNH collections coming from site 34TX31 sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 457 km (284 mi) from 34TX31 (Table 5.2; Figure 5.14; Appendix B). The final Late Precontact obsidian artifact (#1845) is a biface fragment found at site 34TX45 and belongs to the Dale Collection housed at the SNOMNH. Artifact #1845 sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 455 km (282 mi) from 34TX45 (Table 5.2; Figure 5.14; Appendix B).

I submitted nine obsidian artifacts from three Late Precontact sites in Beaver County, Oklahoma for EDXRF analysis and obsidian source characterization (Table 5.2; Appendix B). Artifact #18 is a bifacial eccentric artifact resembling a rectangle from the Russell Tibbetts Collection. This eccentric biface was found at site 34BV104 and sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 535 km (332 mi) from 34BV104. Four PPKs (#47, #63, #64, and #73) from site 34BV100 and belonging to the Kimmie Karber Collection were submitted for EDXRF analysis and obsidian source characterization. Artifact #47 is Washita-like PPK (900 – 200 B.P.) [Duncan et al. 2007] and sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 534 km (332 mi) from 34BV100 (Table 5.2; Figure 5.14; Appendix B). Artifact #63, another Washita-like PPK (900 – 200 B.P.) [Duncan et al. 2007], also sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 534 km (332 mi) from 34BV100 (Table 5.2; Figure 5.14; Appendix B). Two Fresno-like PPKs (750 – 250 B.P.) [Duncan et al. 2007], one small (#64) and one large (#73), both sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 534 km (332 mi) from 34BV100 (Table 5.2; Figure 5.14; Appendix B). Five additional Fresno-like PPKs (#91, #92, #94, #95, and #96) [750 – 250 B.P.] {Duncan et al. 2007} in the Kimmie Karber Collection from site 34BV99 all sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 552 km (343 mi) from 34BV99 (Table 5.2; Figure 5.14; Appendix B).

Twenty-five more of my obsidian samples from 17 Late Precontact sites in Oklahoma provided much more data about obsidian utilization in the interior of Oklahoma than was previously known. Two obsidian flakes (#1802 and #1803) belonging to the SNOMNH collections and coming from site 34EL12, a Late Precontact site in Ellis County, Oklahoma, both sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 584 km (363 mi) from 34EL12 (Table 5.2; Figure 5.14; Appendix B). An obsidian flake (#1769) belonging to a collection at the OAS was found at site 34WD5. Artifact #1769 sourced to the

Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 650 km (404 mi) from 34WD5 (Table 5.2; Figure 5.14; Appendix B).

Eight obsidian artifacts from four Late Precontact sites in Beckham County, Oklahoma were subjected to EDXRF analysis and obsidian source characterization. Two obsidian biface fragments (#1798 and #1799) belonging to the collections at the SNOMNH were found at site 34BK1, and both sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 639 km (397 mi) from 34BK1 (Table 5.2; Figure 5.14; Appendix B). Three obsidian artifacts (#1488, #1859, and #1860) from site 34BK8 and belonging to collections at the OAS (#1488) and the SNOMNH (#1859 and #1860) sourced to three separate obsidian sources. Artifact #1488 is an obsidian flake sourcing to the Malad formation in southeast Idaho, over 1,368 km (850 mi) from 34BK8 (Table 5.2; Figure 5.14; Appendix B). Artifact #1859 is a non-diagnostic PPK base sourcing to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 626 km (389 mi) from 34BK8 (Table 5.2; Figure 5.14; Appendix B). Artifact #1860 is an obsidian PPK base fragment sourcing to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 626 km (389 mi) from 34BK8 (Table 5.2; Figure 5.14; Appendix B). Continuing with Beckham County, an obsidian flake (#1489) belonging to a collection housed at the OAS was found at site 34BK9 and sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 615 km (382 mi) from 34BK9 (Table 5.2; Figure 5.14; Appendix B). The last two obsidian artifacts (#1742 and #1743) from Beckham County, Oklahoma both belong to a collection at the Panhandle-Plains Historical Museum (PPHM) and were found at site 34BK51. Both the obsidian flake (#1742) and the modified obsidian flake or scraper (#1743) sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 599 km (372 mi) from 34BK51 (Table 5.2; Figure 5.14; Appendix B).

An obsidian flake (#1806) from site 34RM94 in Roger Mills County, Oklahoma sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 596 km (370 mi) from 34RM94 (Table 5.2; Figure 5.14; Appendix B). This artifact was housed in the SNOMNH collections. Based on the presence of pottery the recorders of site 34RM94 deemed the site a Late Precontact manifestation (Hofman 1976). Three obsidian artifacts (#1788, #1830, and #1831) from the SNOMNH collections from sites 34HR1 and 34HR60 in Harmon County, Oklahoma were also subjected to EDXRF analysis and obsidian source characterization. The obsidian flake found at 34HR60 (#1788) sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 612 km (380 mi) from 34HR60 (Table 5.2; Figure 5.14; Appendix B). Both the biface fragment (#1830) and the flake (#1831) from site 34HR1 sourced to the Malad formation in southeast Idaho, over 1,378 km (856 mi) from 34HR1 (Table 5.2; Figure 5.14; Appendix B).

I included a small and loosely diagnostic broken PPK (#1827) from site 34WA6 in Washita County, Oklahoma in my study. This artifact belongs to the collections at the SNOMNH and is missing much of the base, yet it is still likely a Washita-like side-notched arrow point (900 – 200 B.P.) [Duncan et al. 2007]. Artifact #1827 sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 714 km (444 mi) from 34WA6 (Table 5.2; Figure 5.14; Appendix B). An obsidian flake (#1490) found at site 34TI1 in Tillman County, Oklahoma, and belonging to the collections at the OAS sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 708 km (440 mi) from 34TI1 (Table 5.2; Figure 5.14; Appendix B). Another obsidian flake (#1796) hailing from site 34GV25 in Garvin County, Oklahoma, and belonging to the SNOMNH collections, sourced to the Malad formation in southeast Idaho, over 1,577 km (980 mi) from 34GV25 (Table 5.2; Figure 5.14; Appendix B).

I analyzed two obsidian flakes (#1772 and #1773) from site 34CU27 in Custer County, Oklahoma belonging to a collection held at the OAS. These two flakes were linked to two different obsidian-bearing formations in the Jemez Mountains, New Mexico. Artifact #1772 sourced to the Valles Rhyolite formation, over 665 km (413 mi) from 34CU27, and artifact #1773 sourced to the Cerro Toledo Rhyolite formation, over 664 km (413 mi) from 34CU27 (Table 5.2; Figure 5.14; Appendix B). Two obsidian artifacts, a PPK base fragment (#1897) and a flake (#1898), from site 34CN24 in Canadian County, Oklahoma were included in my study. Both of these obsidian artifacts sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 747 km (464 mi) from 34CN24 (Table 5.2; Figure 5.14; Appendix B). Both of the artifacts from site 34CN24 were from a collection at the SNOMNH. Lastly, a fragment of debitage found at site 34GT6 in Grant County, Oklahoma, and belonging to the SNOMNH collections sourced to the Obsidian Cliff formation in northwest Wyoming, over 1,416 km (880 mi) from 34GT6 (Table 5.2; Figure 5.14; Appendix B).

A third case resulting in an obsidian artifact from Oklahoma sourcing to an obsidian-bearing formation at an extremely long distance is a biface fragment (#1749) from the Jim Cox Collection. This biface fragment, found at site 34MA41 in Marshall County, Oklahoma, sourced to the Buck Mountain obsidian source in northeast California, over 2,266 km (1,408 mi) from 34MA41 (Table 5.2; Figure 5.14; Appendix B).

A unique sample in my study of obsidian in Oklahoma is a flake (#1797) from site 34DL28 in Delaware County, northeast Oklahoma. This is the easternmost obsidian artifact in my study and the flake sourced to the Obsidian Cliff formation in northwest Wyoming, over 1,619 km (1,006 mi) from 34DL28 (Table 5.2; Figure 5.14; Appendix B). I found this artifact in a collection housed at the SNOMNH. There is no strict cultural association for site 34DL28, yet field notes and other miscellaneous documents attached to the site form mention artifacts such as pottery sherds, an effigy bird drill, shell hoes, and a shell spoon (Baerreis 1955). This evidence suggests that site 34DL28 is likely a Late Precontact manifestation.

Postcontact Period (Ca. 450 – 200 B.P)

Previously Reported Postcontact Period Obsidian in Oklahoma

Like the Late Precontact Period, the Postcontact Period has yielded robust evidence for obsidian utilization in Oklahoma (n = 72) [Baugh and Terrell 1982; Baugh 1986; Shackley 2009]. Robert Bell (1959) first mentioned obsidian in Oklahoma, referring to a polyhedral blade core possibly from 34BK2, the Edwards I site, a multicomponent (Late Precontact and Postcontact) site in Beckham County, southwest Oklahoma. There is some contention on the provenience of this artifact; however, many scholars believe that the artifact may have been brought in by Coronado's expedition in AD 1,541 (Bell 1959).

Baugh and Terrell (1982) conducted research on 34BK2 that ultimately led them to define the Edwards Complex (450 – 300 B.P.), a Late Precontact (Plains Village) manifestation comparable to the Wheeler Complex (300 – 200 B.P.) [Baugh 1986]. In this study, Baugh and Terrell (1982) subjected 30 obsidian flakes from 34BK2 to XRF analysis at the Laboratory of Anthropology, University of Idaho (Baugh and Terrell 1982). Twenty-nine of the samples matched obsidian from the Jemez Mountains in northern New Mexico, over 628 km (390 mi) from 34BK2, with an outlier sourcing to the San Francisco Mountains in Arizona, over 1,107 km (688 mi) from 34BK2 (Baugh and Terrell 1982).

Baugh (1986) also fingerprinted 41 obsidian flakes from five Postcontact sites including site 34BK2, 34RM14, the Goodwin-Baker site, in western Oklahoma, 34WA2, the Duncan site, and 34GR8, the Taylor site, in southwest Oklahoma, and 34CN2, the Scott site, in central

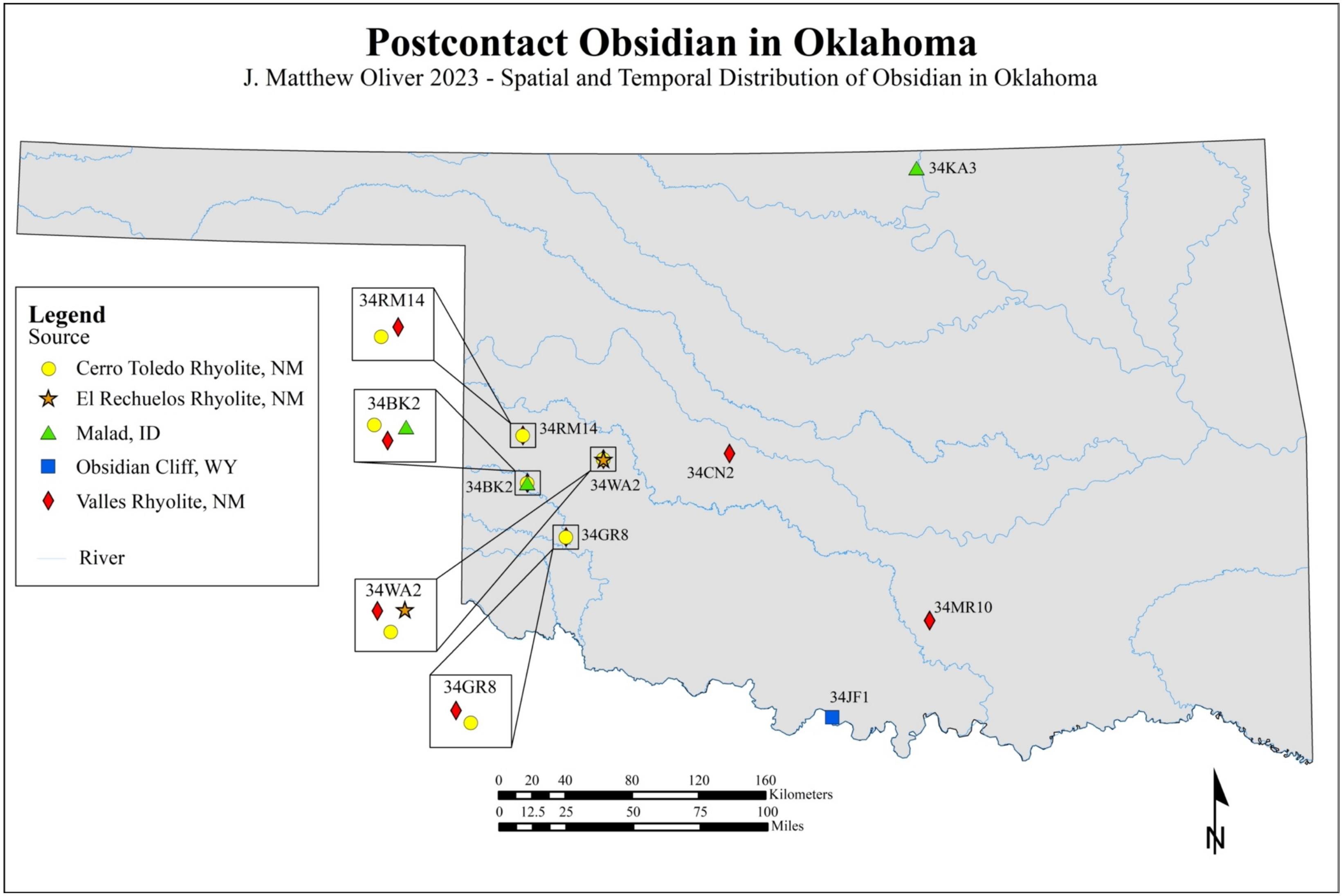
Oklahoma. Five of the six flakes from 34RM14 matched with the Valles Rhyolite formation, New Mexico, over 621 km (386 mi) from 34RM14, with the remaining flake matching the Cerro Toledo Rhyolite formation, New Mexico, over 620 km (385 mi) from 34RM14 (Baugh 1986). Baugh (1986) analyzed eight flakes from 34WA2 with five fingerprinting to Valles Rhyolite (over 671 km [417 mi] from 34WA2), two to Cerro Toledo Rhyolite (over 670 km [416 mi] from 34WA2), and one to El Rechuelos Rhyolite (over 669 km [416 mi] from 34WA2), New Mexico (Baugh 1986). Four flakes from 34GR8 sourced to the Valles Rhyolite formation, New Mexico, over 657 km (408 mi) from 34GR8, and the fifth to the Cerro Toledo Rhyolite formation, New Mexico, over 656 km (408 mi) from 34GR8. Baugh showed that a single flake from 34CN2 site was consistent with obsidian source characterization for the Valles Rhyolite formation in New Mexico, over 746 km (463 mi) from 34CN2. Last, Baugh (1986) analyzed 20 flakes from the 34BK2 showing that 13 came from the Valles Rhyolite formation in New Mexico, over 628 km (390 mi) from 34BK2, six from the Cerro Toledo Rhyolite formation in New Mexico, over 627 km (390 mi) from 34BK2, and one from the Malad formation in southeast Idaho, over 1,373 km (853 mi) from 34BK2.

The final example of obsidian research for the Postcontact Period in Oklahoma is a flake from 34KA3, the Deer Creek site in Kay County, north-central Oklahoma. Dr. Drass sent this flake to Shackley (2009) for obsidian source characterization, who determined that it was linked to the Malad formation, southeast Idaho, over 1,459 km (907 mi) from 34KA3. In total, 70 artifacts from six different Postcontact sites have been analyzed to date. Of those 70 artifacts, 68 were matched to obsidian from the Southwest and two were linked to more distant sources. Table 5.6 summarizes the research I describe above, and Figure 5.24 is a synthesis map showing archaeological sites covered in this section and the results of my EDXRF samples in the next section.

Table 5.6: Postcontact Obsidian in Oklahoma

Site	Artifact	Source		
34BK2	Flakes	Valles Rhyolite	Cerro Toledo Rhyolite	Malad
34RM14	Flakes	Valles Rhyolite	Cerro Toledo Rhyolite	
34WA2	Flakes	Valles Rhyolite	Cerro Toledo Rhyolite	El Rechuelos Rhyolite
34GR8	Flakes	Valles Rhyolite	Cerro Toledo Rhyolite	
34CN2	Flake	Valles Rhyolite		
34KA3	Flake	Malad		

Figure 5.17: Postcontact Obsidian in Oklahoma



EDXRF Results: Postcontact Period

My study of obsidian in Oklahoma provided new EDXRF data and obsidian source characterization information for 13 artifacts from four Postcontact Period sites. Three obsidian artifacts from site 34MR10 in Murray County, Oklahoma all sourced to the Valles Rhyolite formation, over 881 km (547 mi) from 34MR10 (Table 5.2; Figure 5.17; Appendix B). An obsidian Fresno-like PPK (750 – 250 B.P.) [Duncan et al. 2007], artifact #1869, and an obsidian flake, artifact #1870, from 34MR10 hailed from a collection at the OAS. Similarly, another obsidian flake (#1487) from 34MR10 came from a collection held at the SNOMNH. A comparatively large and rough biface fragment from site 34JF1 (#1765) and held in a collection at the Museum of the Great Plains (MGP) sourced to the Obsidian Cliff formation in northwest Wyoming, over 1,645 km (1,022 mi) from 34JF1 (Table 5.2; Figure 5.17; Appendix B).

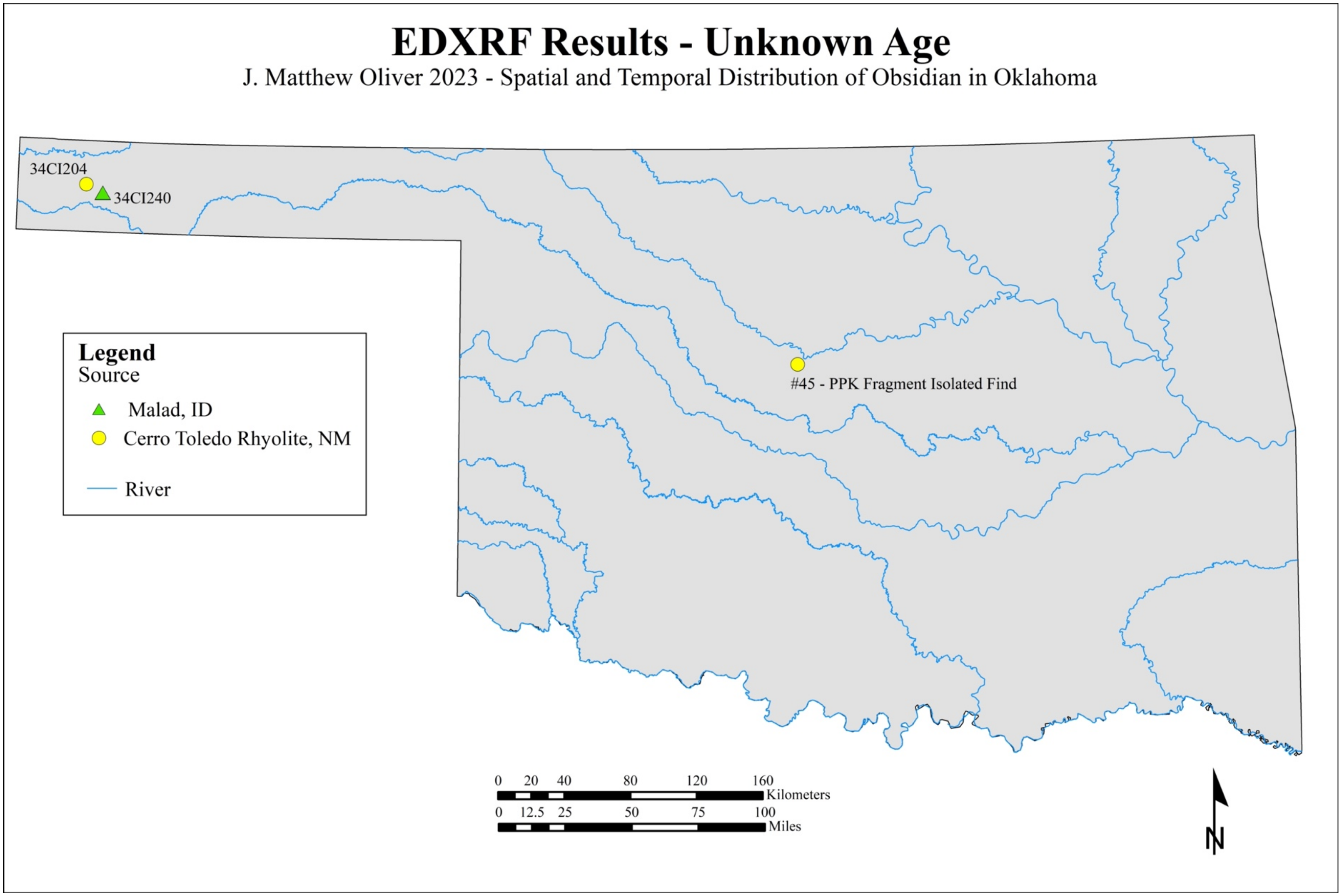
Five obsidian artifacts dating to the Postcontact Period were found at site 34WA2 in Washita County, Oklahoma. These five artifacts are from the Hemmingway Collection housed at the SNOMNH and include two obsidian flakes (#1601 and #1604), and three Fresno-like PPKs (#1944, #1948, and #1951) [750 – 250 B.P.] {Duncan et al. 2007}. Four of these obsidian artifacts (#1604, #1944, #1948, and #1951) sourced to the Valles Rhyolite formation in New Mexico, over 671 km (417 mi) from 34WA2 (Table 5.2; Figure 5.17; Appendix B). Artifact #1601 from site 34WA2 sourced to the Cerro Toledo Rhyolite formation in New Mexico, over 670 km (416 mi) from 34WA2 (Table 5.2; Figure 5.24; Appendix B).

I analyzed three PPKs (#2010, #2075, and #2097) from site 34RM14 in Roger Mills County, Oklahoma belonging to collections at the SNOMNH. Two of these PPKs are Harrell-like (#2010 and #2097) [900 – 200 B.P.] {Duncan et al. 2007} and the other is Fresno-like (#2075) [750 – 250 B.P.] {Duncan et al. 2007}, all of which sourced to the Valles Rhyolite formation in the Jemez Mountains, New Mexico, over 621 km (386 mi) from 34RM14 (Table 5.2; Figure 5.17; Appendix B).

EDXRF Results: Artifacts Lacking Temporal or Spatial Contexts

Four obsidian artifacts from the 102 samples selected for EDXRF analysis and obsidian source characterization lack either temporal or spatial data. An obsidian PPK fragment (#45) found near Campbell Creek in Kingfisher County, Oklahoma, and on loan from CAR, sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 786 km (488 mi) from the vicinity of Campbell Creek in southeast Kingfisher County, Oklahoma (Table 5.2; Figure 5.18; Appendix B). Figure 5.18 below is a map showing the EDXRF samples without temporal contexts.

Figure 5.18: EDXRF Results – Unknown Temporal Context



An obsidian flake (#1632) found at site 34CI204 in Cimarron County, Oklahoma being housed in the Kenneth Saunders Collection at the CCHC sourced to the Cerro Toledo Rhyolite formation in the Jemez Mountains, New Mexico, over 360 km (224 mi) from 34CI204 (Table 5.2; Figure 5.18; Appendix B). Site 34CI204 is a heavily eroded surface manifestation that lacks any diagnostic artifacts or features. An obsidian flake (#1602) belonging to the Kenneth Saunder's Collection at the CCHC was found at site 34CI240. Site 34CI240 is an eroded lithic scatter and lacks diagnostic artifacts or features. Artifact #1602 sourced to the Malad formation in southeast Idaho, over 1,069 km (664 mi) from 34CI240 (Table 5.2; Figure 5.18; Appendix B).

The final obsidian sample I submitted for EDXRF analysis and obsidian source characterization is an eccentric biface that resembles an ellipse (#1763). This artifact is worked on the obverse face while the reverse face retains the original flake surface along with some shallow edge-reworking. Artifact #1763 is from the Jim Cox collection and may be an ornament such as a pendant. Unfortunately, artifact #1763 lacks any temporal context, but was located by Jim Cox in an Oklahoma collection. Artifact #1763 sourced to the Malad formation in southeast Idaho, over 1,502 km (933 mi) from the center of Oklahoma (Table 5.2; Figure 5.18; Appendix B).

In this chapter I reported the results of my study on the temporal and spatial distribution of obsidian in Oklahoma. In the following chapter I discuss the results of my study and synthesize the previous obsidian source characterization data revealed by the literature review with the results of the 102 EDXRF from this study. I will discuss the results through the interpretive framework of conveyance zones and cultural interaction patterns within the Southern Plains and adjacent regions in the following chapter.

Chapter 6: Discussion and Conclusion

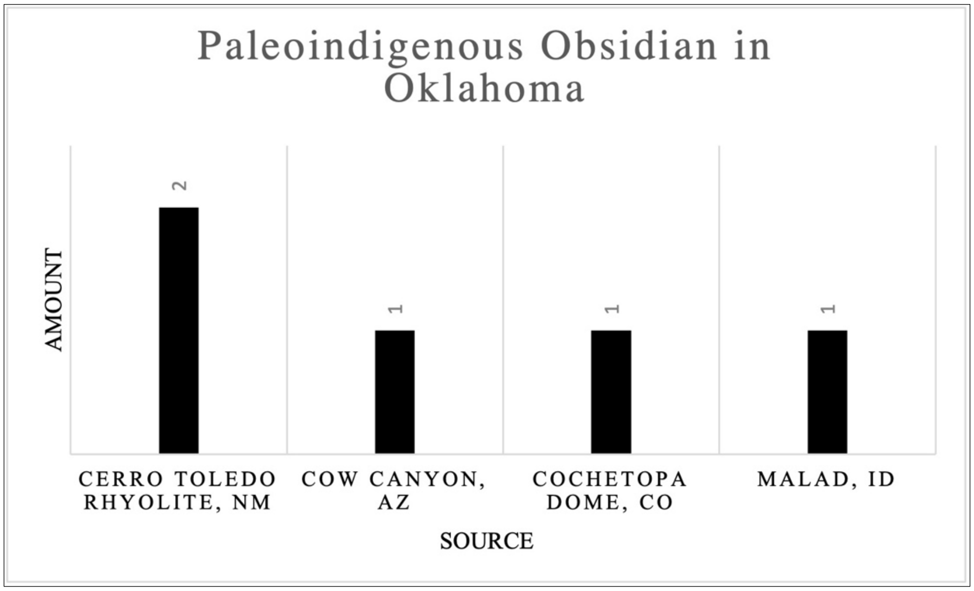
In this chapter I discuss what the results of my study mean and explore what those results can reveal about cultural interaction patterns both within the Southern Plains and adjacent regions. These discussions in this chapter answer my research question: what spatial patterning is expressed by obsidian in Oklahoma, and what do these patterns reveal about cultural interaction patterns through time? First, I will discuss the results based on time period with reference to synthesized versions of the maps and figures appearing in the previous chapter in addition to detailed graphs, wind rose diagrams, and conveyance zone maps. Next, I summarize the discussion followed by a response to previous ideas about obsidian on the Southern Plains. Afterward, I will discuss Indigenous perspectives on obsidian, a late dimension of my thesis. Finally, I will conclude the project by returning to my research question and summarizing its answer along with a handful of future research directions that could stem from this project.

Part One: Discussion and Interpretation of Results

<u>Paleoindigenous Period (Ca. 13,050 – 7,950 B.P.): Trends</u>

Considered together, then, Paleoindigenous obsidian (n = 5) derives from four obsidian sources, two relatively nearby (Cochetopa Dome, Colorado and Cerro Toledo Rhyolite, New Mexico) and the other two more distant (Cow Canyon, Arizona and Malad, Idaho) [Hofman and Blackmar 2012; Taylor-Montaya et al. 2006; Table 5.2; Appendix B]. Figure 6.1 is a graph showing the frequencies of Paleoindigenous obsidian in Oklahoma.

Figure 6.1: Frequencies of Paleoindigenous Obsidian in Oklahoma



There are not enough sourced obsidian artifacts from the Paleoindigenous Period in Oklahoma to say anything significant about a preferred type of obsidian. In fact, the data shows that the obsidian sources attached to the Paleoindigenous artifacts are scattered through a few different obsidian sources (Figures 6.1 and 6.2). Figure 6.2 is a Wind Rose diagram showing the directionality of obsidian coming into Oklahoma during the Paleoindigenous Period. Figures 6.3 and 6.4 are maps of obsidian conveyance zones during the Paleoindigenous Period in Oklahoma.

Figure 6.2: Directionality of Paleoindigenous Obsidian in Oklahoma

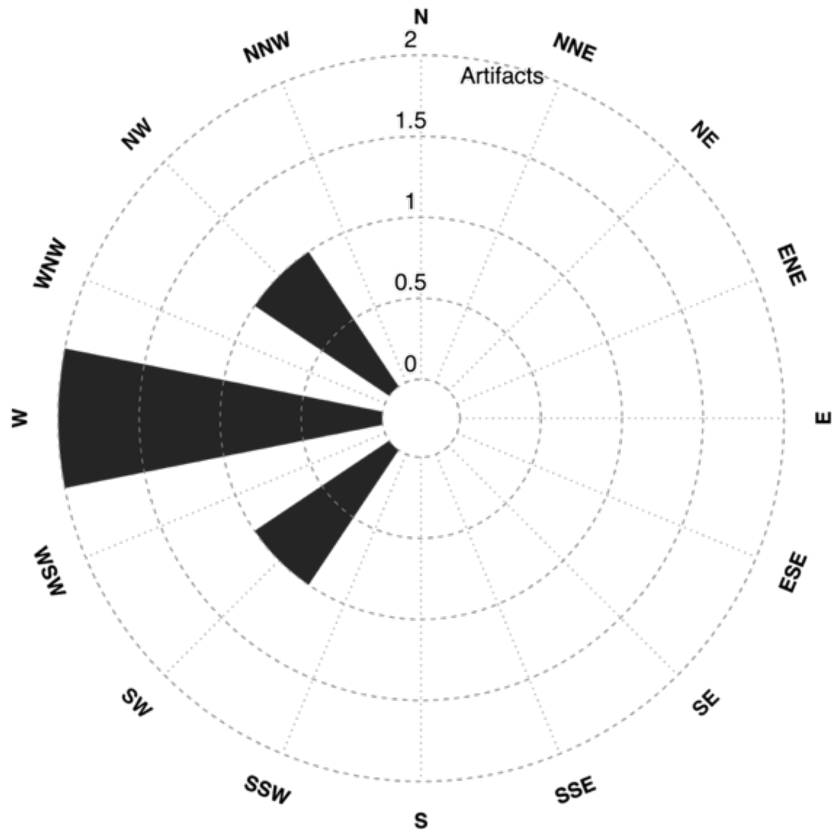


Figure 6.3: Paleoindigenous Obsidian Conveyance Zones in Oklahoma I

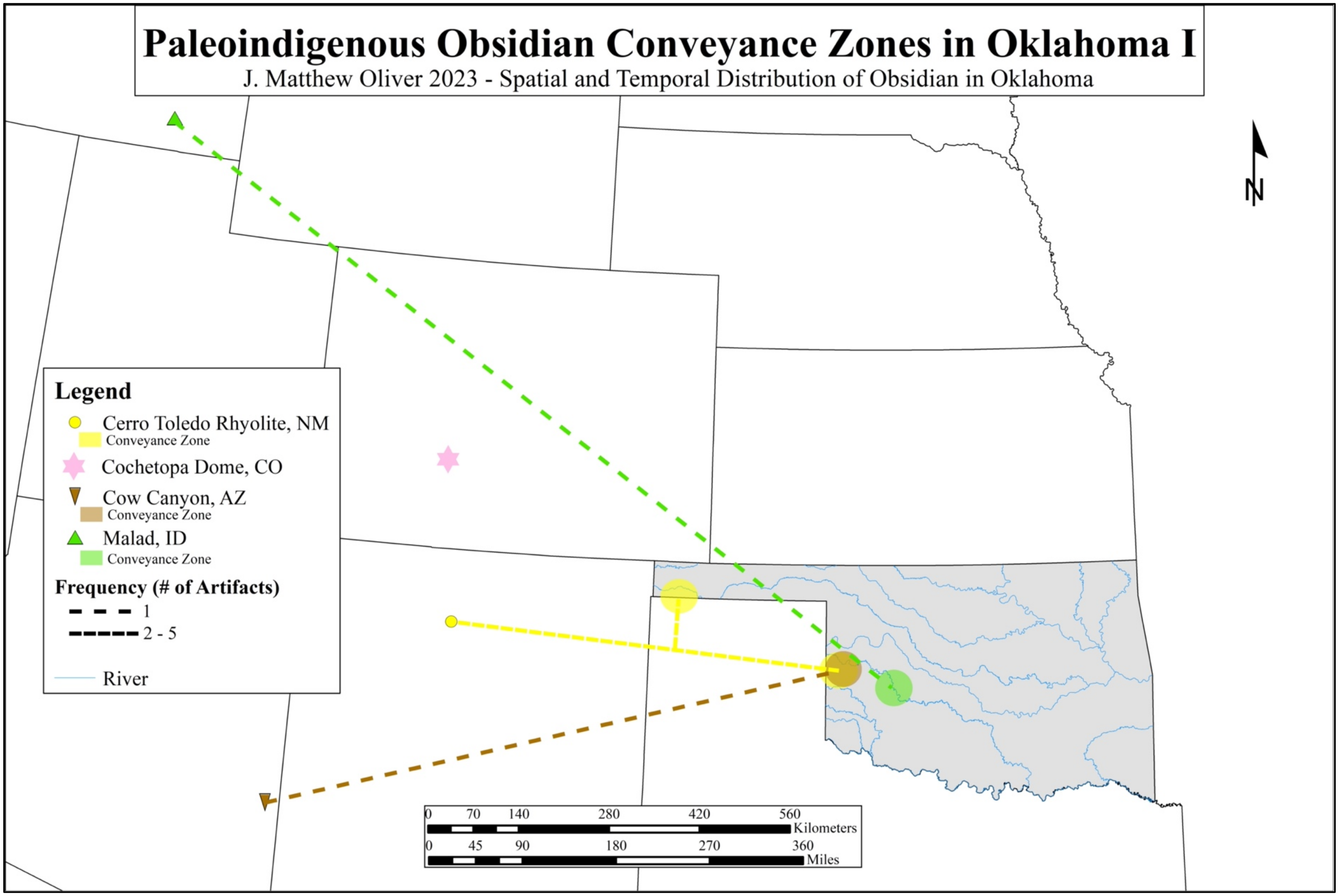
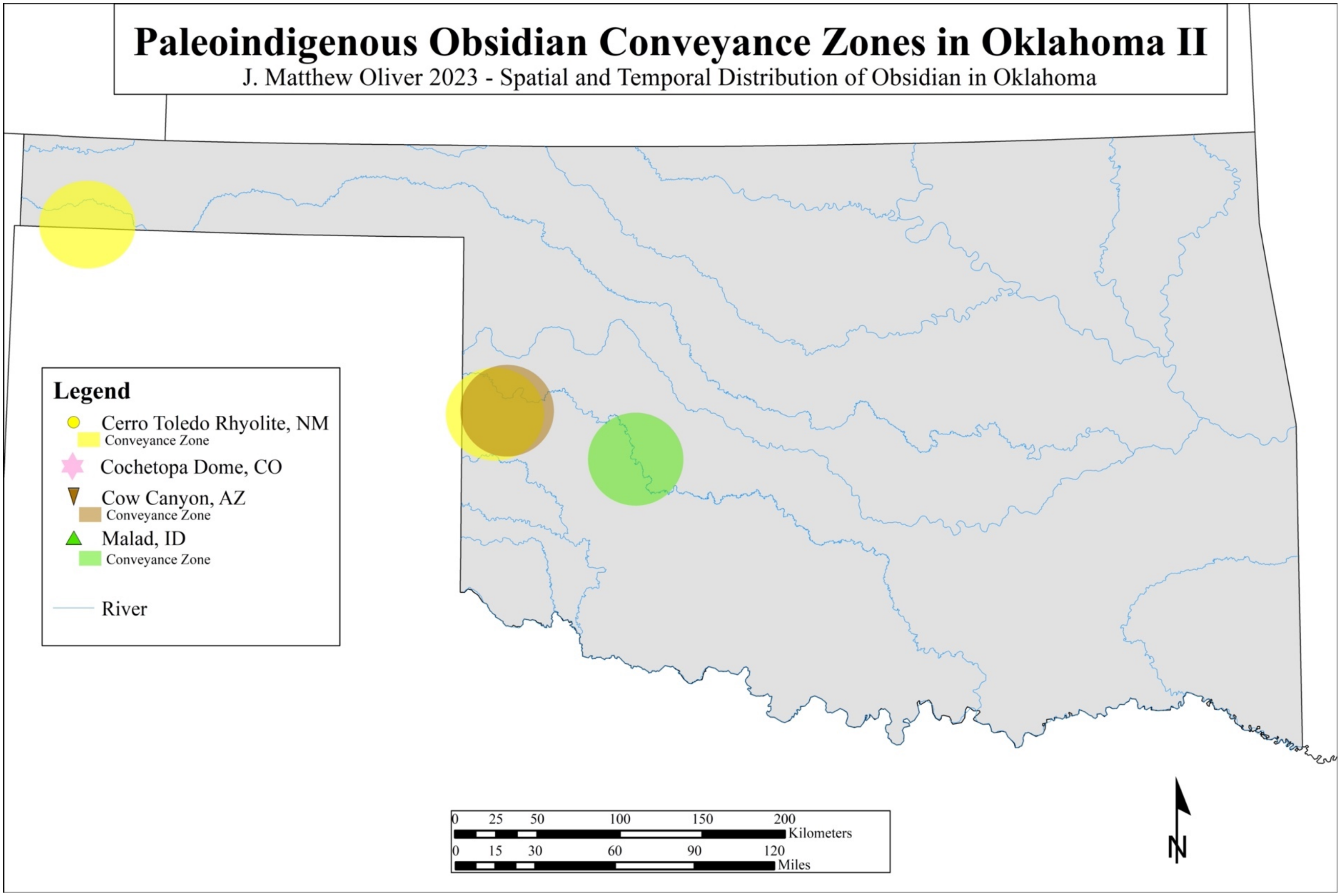


Figure 6.4: Paleoindigenous Obsidian Conveyance Zones in Oklahoma II



Paleoindigenous Period (Ca. 13,050 – 7,950 B.P.): Discussion and Interpretations

Data concerning Paleoindigenous obsidian in Oklahoma is rare. In fact, six artifacts are known to date. In addition to the two sites (34WA41 and 34RM439) and the isolated Agate Basin-like projectile point/knife (PPK) we have the obsidian Blankenship Clovis (Shackley 2015a), which has a few suspicious attributes surrounding its context.

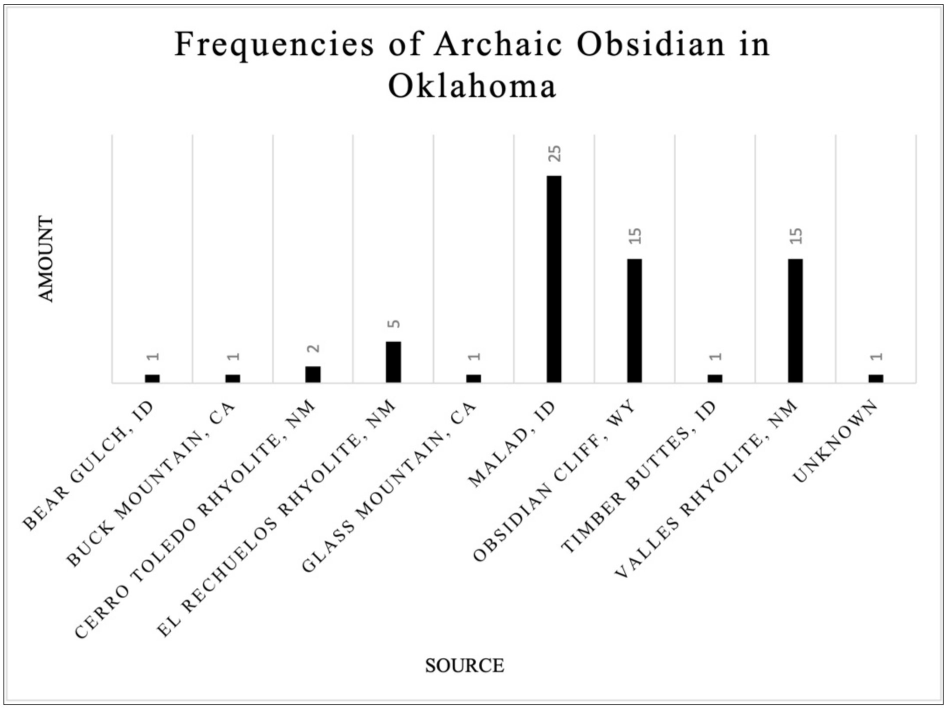
The largest issue with considering cultural interaction during the Paleoindigenous Period is that Paleoindigenous people were, in general, highly mobile. For instance, the Cerro Toledo Rhyolite formation in northern New Mexico is about 362 km (225 mi) from Boise City in Cimarron County, at the western extent of the Oklahoma Panhandle. Likewise, the Cochetopa Dome is located 405 km (252 mi) as the crow flies from Boise City, Oklahoma. It is at least possible, if not plausible, that Paleoindigenous groups utilizing the Southern Plains procured these two obsidian resources through their mobility directly, rather than through cultural interaction. In contrast, the Cow Canyon obsidian formation in southeastern Arizona is approximately 727 km (452 mi) from Boise City, Oklahoma, and the Malad formation in southeastern Idaho is about 1,056 km (656 mi) from Boise City, Oklahoma. As these two obsidian-bearing formations are quite farther away than the Cochetopa Dome and Cerro Toledo Rhyolite formations. It is plausible that groups of Paleoindigenous people utilizing the Southern Plains encountered other groups of people somewhere along the directionality of Arizona and Idaho and obtained the obsidian from them through some form of cultural interaction.

It is plausible that obsidian from the Cerro Toledo Rhyolite formation in northern New Mexico and Cochetopa Dome obsidian in southwest Colorado were in the mobility range of Paleoindigenous groups; however, it is also possible that these obsidian artifacts were received through some form of cultural interaction along the way, indicating a westerly direction of cultural interaction between Paleoindigenous groups on the Southern Plains and the Southwest (Figures 6.1 – 6.4). Likewise, it is plausible that the obsidian artifacts sourcing to the more distant sources (Cow Canyon in southeastern Arizona and Malad in southeastern Idaho) were obtained by Paleoindigenous groups through a westerly direction of a cultural interaction pattern from the Southern Plains to the Southwest in reference to the Cow Canyon obsidian source in Arizona, and a northwesterly direction of a cultural interaction pattern from the Southern Plains through the Central Plains and Rocky Mountains in reference to the Malad obsidian source in Idaho (Figure 6.1 – 6.4).

Archaic Period (Ca. 7,950 – 1,950 B.P.): Trends

Obsidian utilization by Archaic Period groups of people in Oklahoma and the Southern Plains provides much evidence for interpreting the directionality of cultural interaction patterns between the Southern Plains and adjacent regions. Obsidian attainment and utilization for the entirety of the 6,000 years covering the Archaic Period is complex. I present Figure 6.5, a graph showing the frequencies of obsidian sources appearing during this period.

Figure 6.5: Frequencies of Archaic Period Obsidian in Oklahoma



It appears as though people living in the Southern Plains during the Archaic Period preferred obsidian from distant sources as opposed to the closer and more accessible obsidians from the Jemez Mountains in northern New Mexico (Figure 6.5). Figure 6.6 is a Wind Rose diagram depicting the directionality of Archaic obsidian coming into Oklahoma. Figures 6.7 and 6.8 are maps of obsidian conveyance zones for Oklahoma during the Archaic Period.

Figure 6.6: Directionality of Archaic Obsidian in Oklahoma

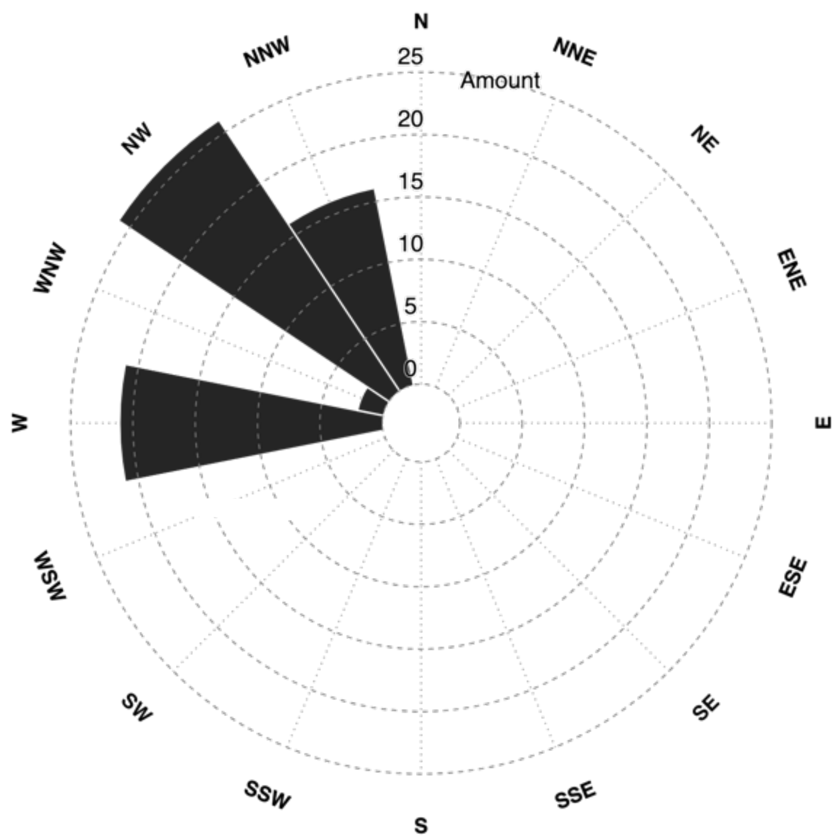


Figure 6.7: Archaic Obsidian Conveyance Zones in Oklahoma I

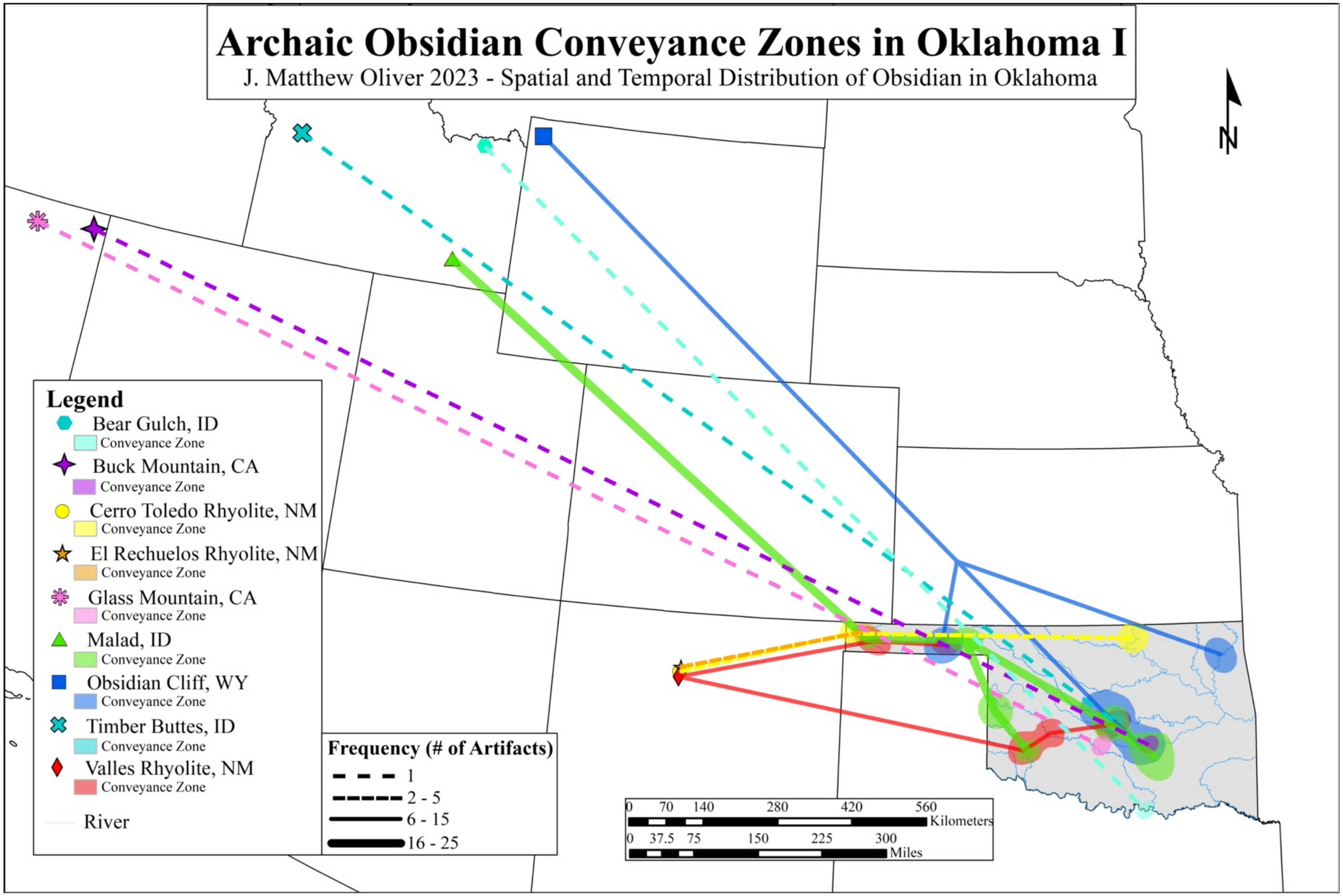
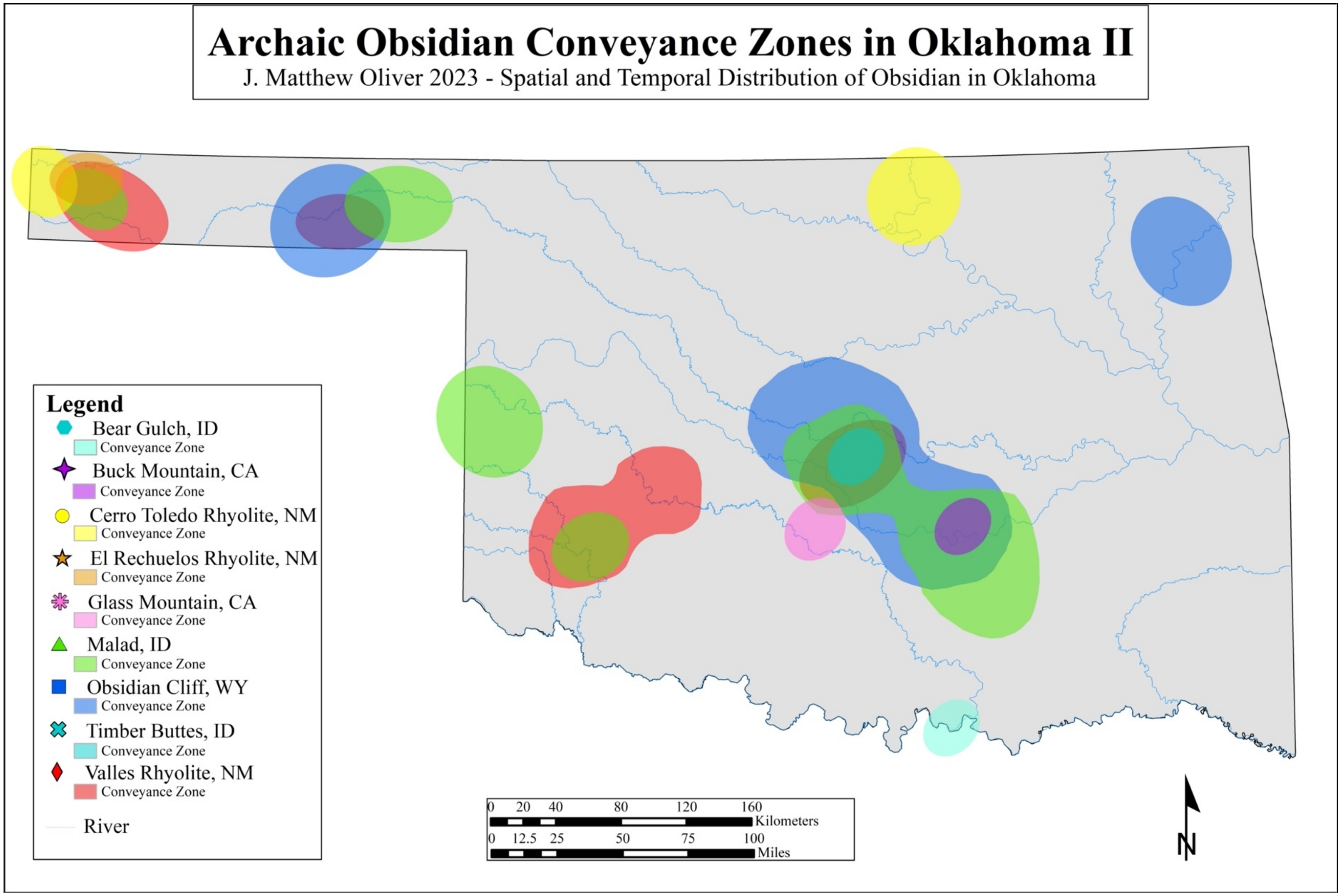


Figure 6.8: Archaic Obsidian Conveyance Zones in Oklahoma II



One must keep in mind, however, that Figure 6.5 and 6.6 are configured by artifact (n = 65) rather than by site, and that 22 of these data points came from site 34SM87 (Beale et al. 2022; Latham 2016; Latham and Hajic 2023, in review; Shackley 2016, 2017a, 2017b). Overall, 21 Archaic artifacts from Oklahoma have been linked to any one of the three obsidian sources in the Jemez Mountains in Northern New Mexico with a heavy emphasis on the Valles Rhyolite obsidian. The other 44 artifacts were geochemically fingerprinted to obsidian sources quite far from Oklahoma with heavy emphasis on obsidian from Malad in southeast Idaho and Obsidian Cliff from northwest Wyoming (Figures 6.5 – 6.8). Of course, there is also the outlying flake from site 34HR36 that sourced to a currently unknown obsidian source.

The same issue with mobility occurs in the Archaic Period in Oklahoma as it did with the Paleoindigenous Period, as people living in the area during the Archaic Period lived highly mobile lifestyles. It is within the realm of possibility, or even plausibility, that people living in the Archaic Southern Plains could have obtained obsidian from the three rhyolite formations in the Jemez Mountains in northern New Mexico by direct procurement. Spatially speaking, all of the sites with obsidian sourcing to the Jemez Mountains in New Mexico, with the exception of 34KA119 along the Arkansas River valley, are located along river valleys that have headwaters relatively near the Jemez Mountains (the North Fork of the Red River, the Washita River, and the Beaver/North Canadian River) [Figures 6.7 and 6.8]. People living during the Archaic Period likely used these rivers as highways for both mobility enterprises and cultural interaction. It is difficult to tell exactly how people in the past obtained their obsidian with primarily obsidian source characterization data.

As the vast majority of Archaic obsidian artifacts sourcing to the Jemez Mountains come from the Valles Rhyolite formation, which holds the highest quality and most difficulty in procuring compared to El Rechuelos Rhyolite obsidian and Cerro Toledo Rhyolite obsidian (Figure 6.5 – 6.8; Shackley 2005). In fact, Valles Rhyolite obsidian is entirely constricted to the caldera in the Jemez Mountains, making it more difficult to access and easily defendable (Shackley 2005). Obsidian from the Cerro Toledo Rhyolite and El Rechuelos Rhyolite formations occurs in outcrops outside of the caldera rim and has even been found in some creeks and rivers (Church 2000). As Valles Rhyolite obsidian is so much more inaccessible than the other two types in the Jemez Mountains, and the fact that Valles Rhyolite obsidian overwhelmingly dominates the other two in occurrence in Oklahoma suggests that Valles Rhyolite obsidian may have been culturally controlled. It is also interesting that three of the eight archaeological sites (34BV171, 34JK22, and 34CL76) with obsidian sourcing to the Jemez Mountains also produced obsidian linked to more distant sources (Figure 5.9, 6.5 – 6.8; Bement and Brosowske 2001; Shackley 2015b; Table 5.2; Appendix B). This suggests that either two patterns of cultural interaction were in effect in different directions (a westerly pattern to the Southwest and a northwesterly pattern to the Central Plains up to Idaho and Wyoming), or that obsidian from the Jemez Mountains was being directly procured and a cultural interaction pattern was in place through the Central Plains for the Idaho and Wyoming obsidian sources.

I expected the majority of the artifacts with spatial contexts in the Oklahoma Panhandle to source to three Jemez Mountain obsidian formations in New Mexico simply based on proximity. This was true enough as obsidian from four Archaic Period sites in the Oklahoma panhandle and three isolated finds (#10, #12, and #1610) [Table 5.2; Appendix B] sourced to the Jemez Mountains. Like the rest of the Archaic Period obsidian sourcing to the Jemez Mountains in New Mexico, this could be the result of either high mobility and direct procurement, or a cultural interaction pattern stretching west toward the Southwest. Site 34BV171, with the inclusion of new Energy Dispersal X-ray Fluroescence (EDXRF) data from this project, had six artifacts linked to the Valles Rhyolite formation in New Mexico, and another six artifacts matching the geochemical signature for northwestern sources in Idaho and Wyoming (Bement and Brosowske 2001; Figures 5.9, 6.5 – 6.8; Table 5.2; Appendix B). Site 34BV111 and an isolated corner-notched PPK (#51; Figures 5.9, 6.5 – 6.8; Table 5.2; Appendix B) had obsidian sourcing to the distant northwest. All of these data for the Oklahoma Panhandle suggest that there was a northwesterly directed pattern of cultural interaction through the Central Plains and High Plains toward Idaho and Wyoming, and either a second pattern of cultural interaction stretching west toward the Southwest, or the possibility of direct procurement for the artifacts sourcing to the Jemez Mountains.

Site 34MY312 with its single flake sourcing to the Obsidian Cliff formation in northwest Wyoming supports the idea that Archaic Period people were using the Missouri River as an axis for cultural interaction (Bybee et al. 2015). Site 34MY312 is located in the Grand River (Lower Neosho) valley, whose headwaters begin in eastern Kansas. The Missouri River turns east to meet the Mississippi River north of the headwaters of the Grand River. It is plausible that the obsidian that found its way to site 34MY312 was carried down the Missouri River, and then down the Grand River to the site.

Two clusters of Archaic Period sites with obsidian appear in central Oklahoma (Figures 5.9, 6.5 – 6.8). The southernmost of these are sites 34SM7, 34SM20, 34SM87, and to a lesser extent, site 34CO29 are located near the Canadian River valley, all of which had obsidian sourcing to northwest sources (Beale et al. 2022; Latham 2016; Latham and Hajic 2023, in review; Margolis et al. 2014; Shackley 2016, 2017a, 2017b). Of course, the obsidian flake from site 34SM7 sourced to Buck Mountain in northeast California, which I will discuss toward the end of the Archaic Period section of this chapter (Figures 5.9, 6.5 – 6.8; Table 5.2; Appendix B). Sites 34SM7 and 34SM87 are very close together. Considered together, obsidian from sites 34SM20, 34SM87, and 34CO29 suggest that obsidian was heavily utilized (relative to obsidian utilization in Oklahoma, other lithic resources overwhelmingly dominate obsidian statewide) by people during the Archaic Period . In fact, these three sites account for nearly half of the Archaic Period obsidian we know about in Oklahoma.

A second cluster of Archaic Period sites featuring obsidian from northwestern sources are sites 34OK71 and 34CL76 that lie between the Canadian River and the North Canadian River (Figure 5.10). Obsidian from both sites primarily comes from Malad, Idaho, with outliers at site 34CL76 including an obsidian core (one of the few cores in the assemblage of collections I selected for the 102 artifacts to subject to EDXRF sourcing) that sourced to the Timber Buttes obsidian formation in southwest Idaho (Table 5.2; Appendix B). The other oddity with site 34CL76 is a Frio-like PPK (4,950–450 B.P.) [Bell 1960] that sourced to the Valles Rhyolite formation in New Mexico. The obsidian data from these two sites suggest a far reaching cultural interaction pattern toward the northwestern sources, and either the possibility of direct procurement for the Frio-like PPK originating from the Jemez Mountains or another westerly-reaching pattern of cultural interaction toward the Southwest.

There are a number of interesting outliers in the obsidian derived data for the Archaic Period in Oklahoma. Site 34KA119 had a single obsidian flake sourcing to the Cerro Toledo Rhyolite formation in New Mexico (Figures 5.9, 6.5 – 6.8; Table 5.2; Appendix B). This is the easternmost example of obsidian from the Jemez Mountains in Oklahoma during the Archaic Period. Site 34KA119 is located along the Arkansas River valley, and I expected the obsidian flake from this site to source to the more distant northwestern sources. Furthermore, Cerro Toledo Rhyolite obsidian is a rather rare type of obsidian for the Archaic Period in Oklahoma.

Sites 34MA2 and 34CL76 both produced obsidian artifacts sourcing to northwestern sources (Figures 5.9, 6.5 – 6.8; Shackley 2015c; Table 5.2; Appendix B). While both of these cases suggest a cultural interaction pattern reaching to the northwest, in all likelihood they were picked up in the wake of obsidian from Malad, Idaho and Obsidian Cliff, Wyoming as the cultural interaction pattern extended south through the Central Plains to the Southern Plains.

The most intriguing outliers from the obsidian-derived data in Oklahoma during the Archaic Period are the two artifacts that sourced to far western sources in northeast California. Both of these California obsidian sources are well over 1,609 km (1,000 mi) from Boise City in the Oklahoma Panhandle and suggest an extremely lengthy exchange network reaching across the western US. Additionally, data from site 34JK22, another Middle Archaic (5,950 – 3,950 B.P.) manifestation in Oklahoma with an obsidian Calf Creek-like PPK (5,960 – 5,700 B.P.) [Lohse et al. 2021] {Figures 5.8 and 5.9, 6.7 and 6.8} sourcing to the Valles Rhyolite formation in New Mexico and a single obsidian flake (#1475) that sourced to Malad, Idaho, supports the directive that the flake from site 34ML168 was likely associated with the Middle Archaic Biface Cache at the site (Shackley 2015b). The two artifacts sourcing to obsidian formations in California were likely swept up in an already active pattern of cultural interaction reaching across the country.

<u>Archaic Period (Ca. 7,950 – 1,950 B.P.): Discussion and Interpretations</u>

There were likely many groups of people along the pathway obsidian took from northwestern sources in Idaho and Wyoming to end up in the Southern Plains. The fact that much of the obsidian from northwestern sources appears along the same river valleys as obsidian from the Jemez Mountains suggests that people living in the Southern Plains during the Archaic Period were interacting with multiple cultures.

Obsidian data from the Archaic Period in the Southern Plains and Oklahoma shows us a highly complex and interconnected world. The possibility of direct procurement via a large mobility range of obsidian from the Jemez Mountains still remains for the Archaic Period; however, a cultural interaction pattern reaching west from Oklahoma to the Southwest is also a possibility. Beyond that, obsidian artifacts from more distant, northwestern sources suggest a pattern of cultural interaction running north to south between the obsidian-bearing formations in Idaho and Wyoming to the Southern Plains. Oddly, there is some evidence for an extremely far-reaching pattern of cultural interaction extending all the way to northeast California across the western US to the Southern Plains.

Woodland Period (Ca. 1,950 – 1,050 B.P.): Trends

There was enough spatial evidence for obsidian utilization during the Woodland Period in Oklahoma to speak to some trends on plausible cultural interaction patterns between people living in the Woodland Period Southern Plains and elsewhere. Five artifacts are isolated Scallorn-like PPKs (1,750 – 800 B.P.) [Duncan et al. 2007] in private collections without tight spatial contexts (Table 5.2; Appendix B). Four of the five isolated Scallorn-like PPKs all fingerprinted to obsidian-bearing formations in the Jemez Mountains in northern New Mexico (Table 5.2; Appendix B). The remaining isolated Scallorn-like PPK (#11), being found in Beaver County, Oklahoma, sourced to the Malad formation in southeast Idaho (Table 5.2; Appendix B). Figure 6.9 is a graph showing the frequencies of Woodland Period Obsidian in Oklahoma and their geological origin, and Figure 6.10 is a Wind Rose diagram showing the directionality of obsidian entering Oklahoma during the Woodland Period. Figures 6.11 and 6.12 are obsidian conveyance zone maps for the Woodland Period in Oklahoma.

Figure 6.9: Frequencies of Woodland Obsidian in Oklahoma

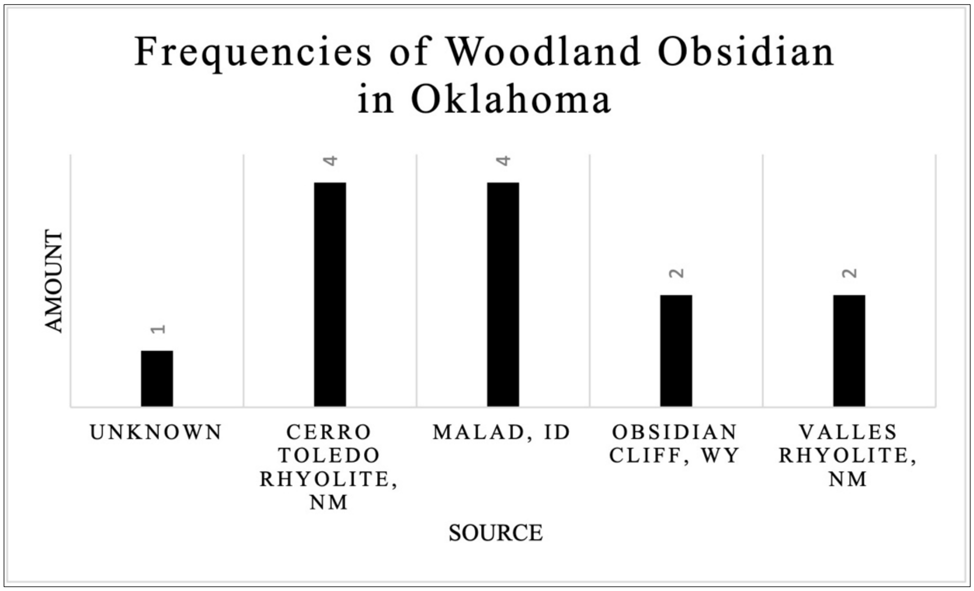


Figure 6.10: Directionality of Woodland Obsidian in Oklahoma

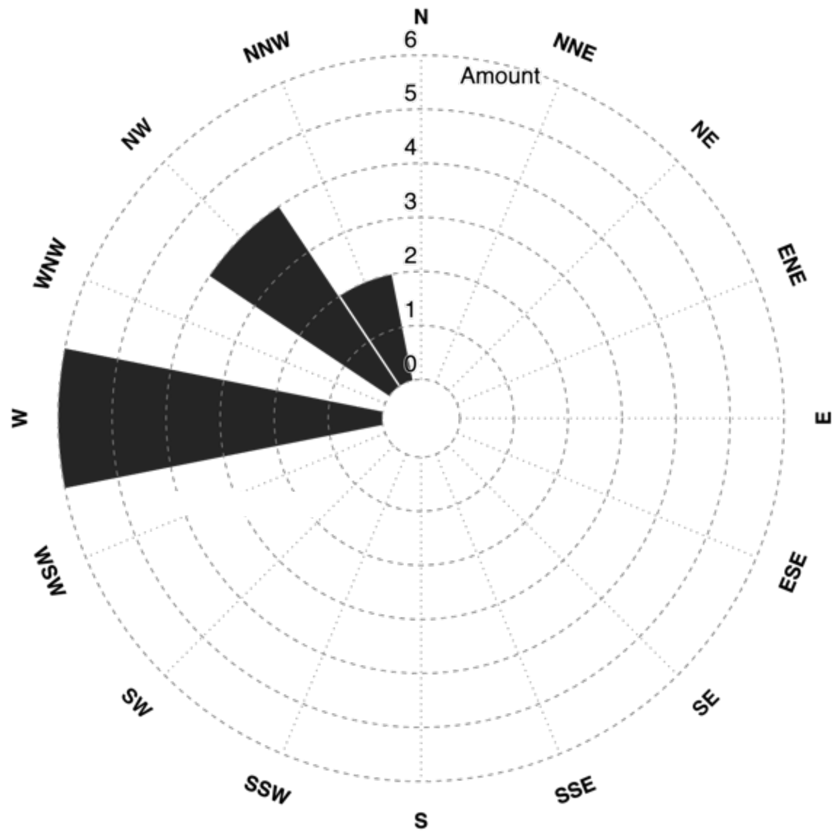


Figure 6.11: Woodland Obsidian Conveyance Zones in Oklahoma I

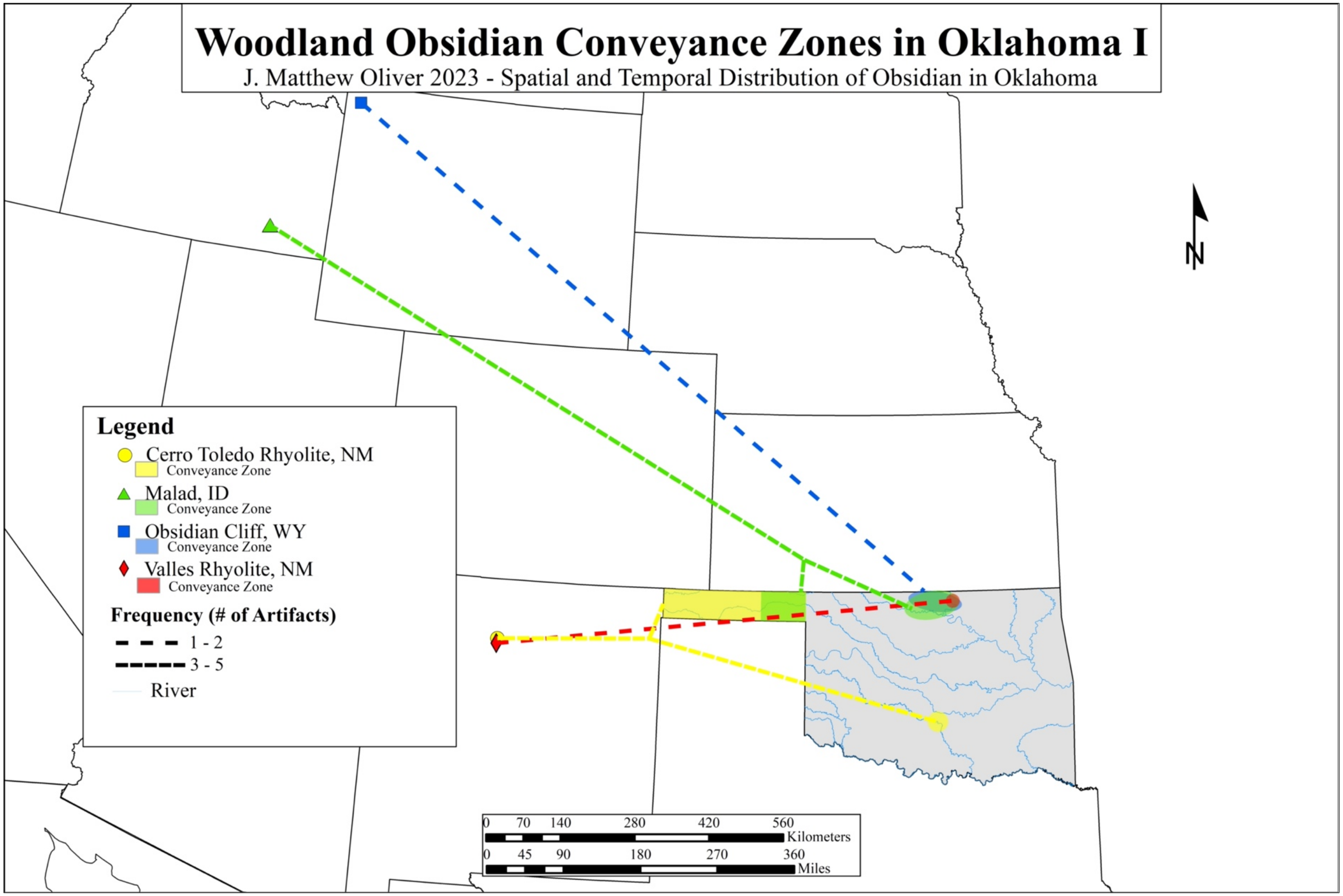
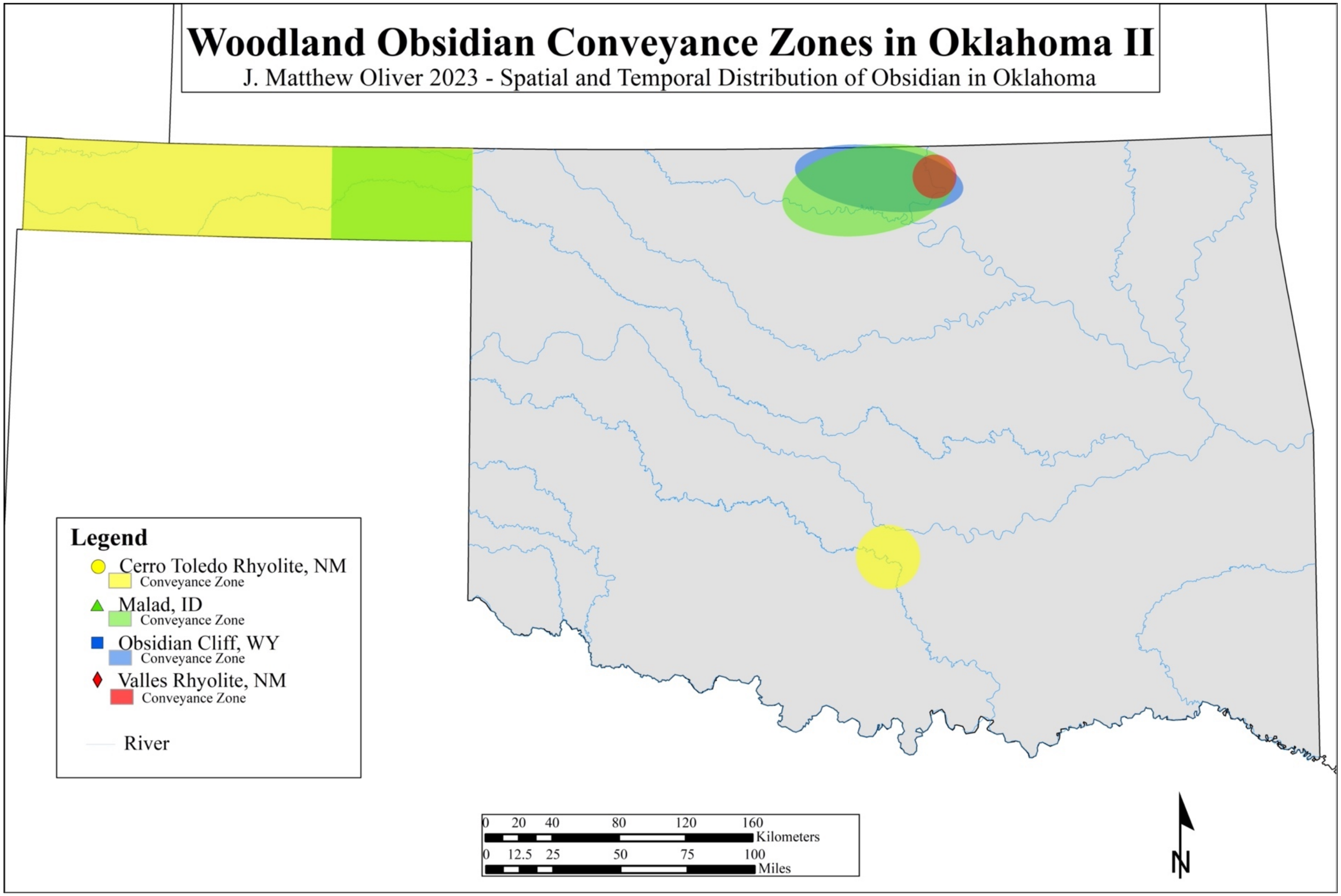


Figure 6.12: Woodland Obsidian Conveyance Zones in Oklahoma II



Overall, the obsidian sources appearing in Oklahoma during the Woodland Period seem evenly split with six artifacts sourcing to either the Cerro Toledo Rhyolite formation or the Valles Rhyolite formation in the Jemez Mountains, northern New Mexico (Table 5.2; Figures 5.12, 6.9 – 6.12; Appendix B). Likewise, six Woodland Period artifacts sourced to more distant northwest sources (Table 5.2; Figures 5.12, 6.9 – 6.12; Appendix B). Of course, we also have the outlier, an isolated Scallorn-like PPK found in Kiowa County, Oklahoma that originated from a currently unknown obsidian source.

Spatially, the majority of the obsidian Woodland Period artifacts found in the Oklahoma Panhandle are linked to the Valles Rhyolite obsidian formation (n = 2) and the Cerro Toledo Rhyolite obsidian formation (n = 2) in the Jemez Mountains, northern New Mexico. The outlier in the Oklahoma Panhandle is the isolated Scallorn-like PPK (#11) that matched the geochemical concentrations for the Malad formation in southeast Idaho.

Likewise for the main body of Oklahoma, the majority of Woodland Period sites with obsidian cluster around north-central Oklahoma, in the Arkansas River valley and the Salt Fork of the Arkansas River valley (Figures 5.12, 6.11 – 6.12). There are two spatial outliers in the main body of Oklahoma: 1) site 34GV108 along the Washita River valley; 2) the isolated Scallorn-like PPK (#49) found near the North Fork of the Red River valley.

Obsidian from the cluster of Woodland sites near the Arkansas River and its Salt Fork branch almost fully source to more distant sources to the northwest (Table 5.2; Figure 5.12, 6.11 – 6.12; Appendix B). Five out of six of the obsidian samples from these four sites (34GT9, 34GT47, 34KA62, and 34KA72) were linked to the more distant northwestern sources. The outlier here is a single obsidian flake from 34KA62 that sourced to the Valles Rhyolite formation in northern New Mexico (Table 5.2; Figure 5.12, 6.11 – 6.12; Appendix B).

Woodland Period (Ca. 1,950 – 1,050 B.P.): Discussion and Interpretations

My results suggest that, for the Woodland Period people living near the Arkansas River, a pattern of cultural interaction existed between these people and their neighbors farther north through the Central Plains toward the mountains of Wyoming and Idaho (Figures 5.12, 6.9 – 6.12). Similarly, in the Oklahoma Panhandle nearly all of the Woodland Period obsidian artifacts sourced to the Jemez Mountains in northern New Mexico, indicating a westerly cultural interaction pattern with their neighbors in the Southwest (Figures 5.12, 6.9 – 6.12). The single outliers both in the panhandle and the Arkansas River valley suggest a lower level of cultural interaction between Woodland Period people in the Oklahoma Panhandle and their neighbors to the North reaching toward Wyoming and Idaho; likewise, it is plausible that Woodland Period people living near the Arkansas River valley had a lower level of cultural interaction with their neighbors in the Southwest.

Obsidian from site 34GV108, and to an extent artifact #49, the isolated find in Kiowa County, indicate a cultural interaction pattern from south and south-central Woodland Period Oklahoma to the Southwest, being the Jemez Mountains in northern New Mexico. Both the headwaters of the Washita River and the North Fork of the Red River are located in the Texas Panhandle, which is much closer to the obsidian-bearing Jemez Mountains in northern New Mexico. These two instances of obsidian in southwest and south-central Oklahoma may indicate a degree of cultural interaction with people living on the High Plains in the Oklahoma and Texas Panhandles.

Late Precontact Period (Ca. 1,250 – 450 B.P.): Trends

Obsidian data from the Late Precontact Period in Oklahoma is exceedingly complex, and the Late Precontact Period boasts the most spatial and temporal data we have for obsidian in

Oklahoma (n = 148) with multiple sites spread throughout the state. In total, with the combined data from obsidian studies in the past and new data from this project, I present Figure 6.13, a graph showing the frequencies of obsidian from various sources appearing in Oklahoma during the Late Precontact Period, and Figure 6.14, a Wind Rose diagram of the directionality of Late Precontact obsidian coming into Oklahoma. Figures 6.15 and 6.16 are obsidian conveyance zone maps for the Late Precontact Period in Oklahoma.

Figure 6.13: Frequencies of Late Precontact Obsidian in Oklahoma

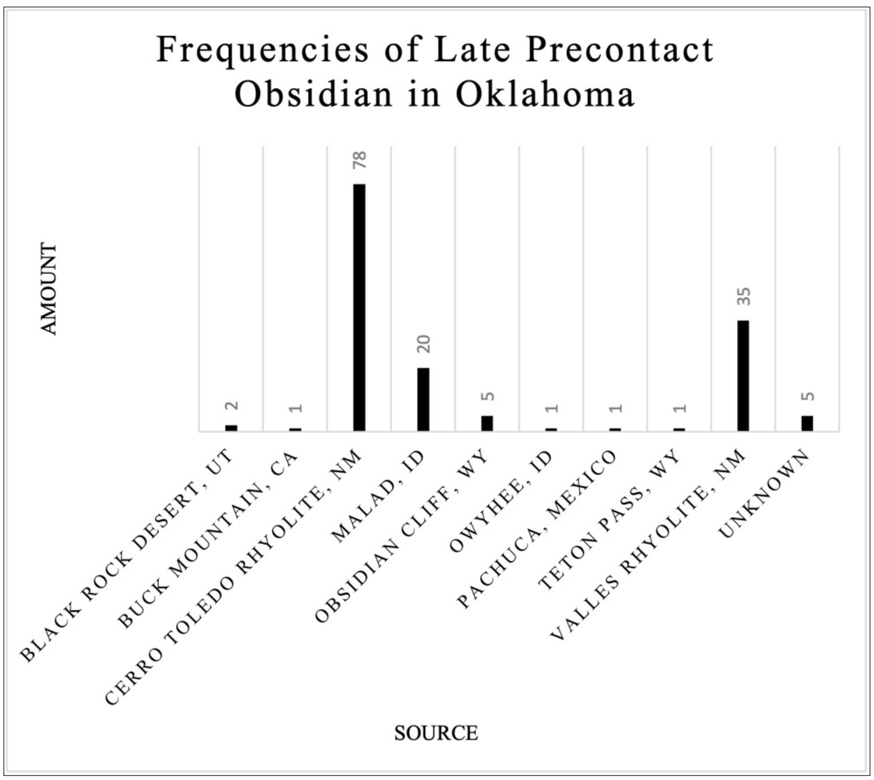


Figure 6.14: Directionality of Late Precontact Obsidian in Oklahoma

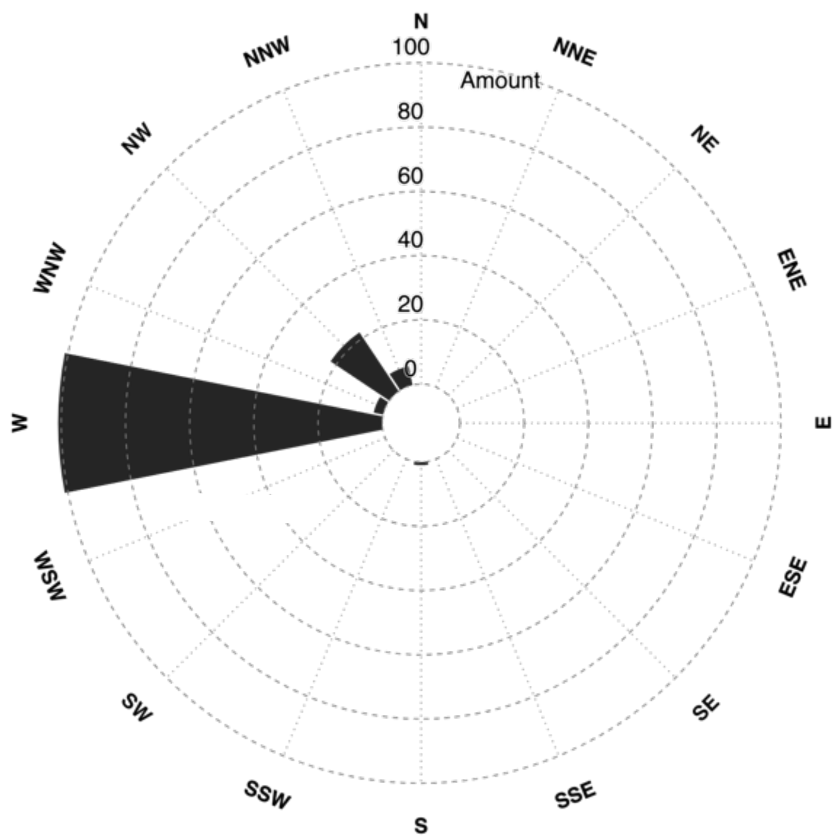


Figure 6.15: Late Precontact Obsidian Conveyance Zones in Oklahoma I

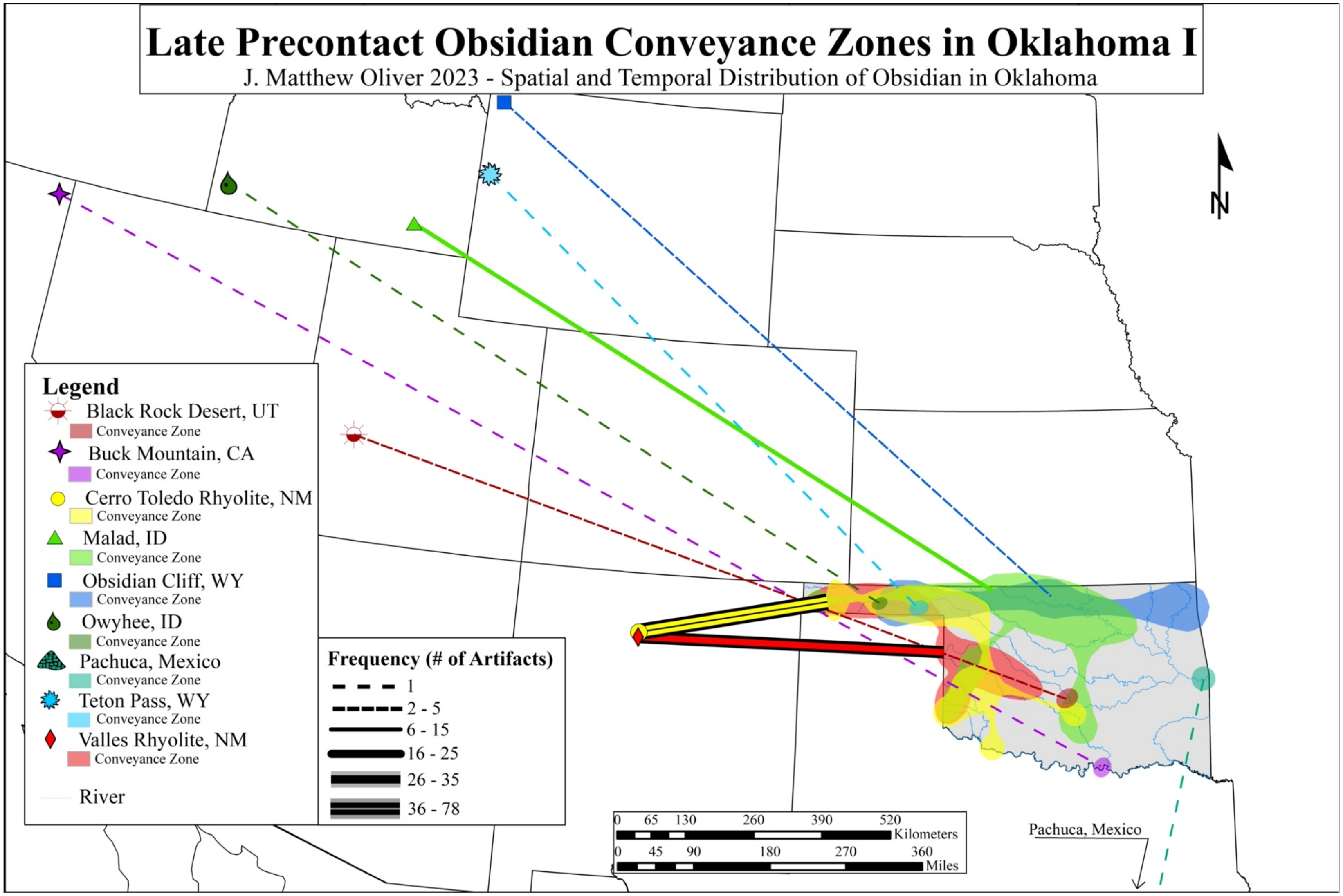
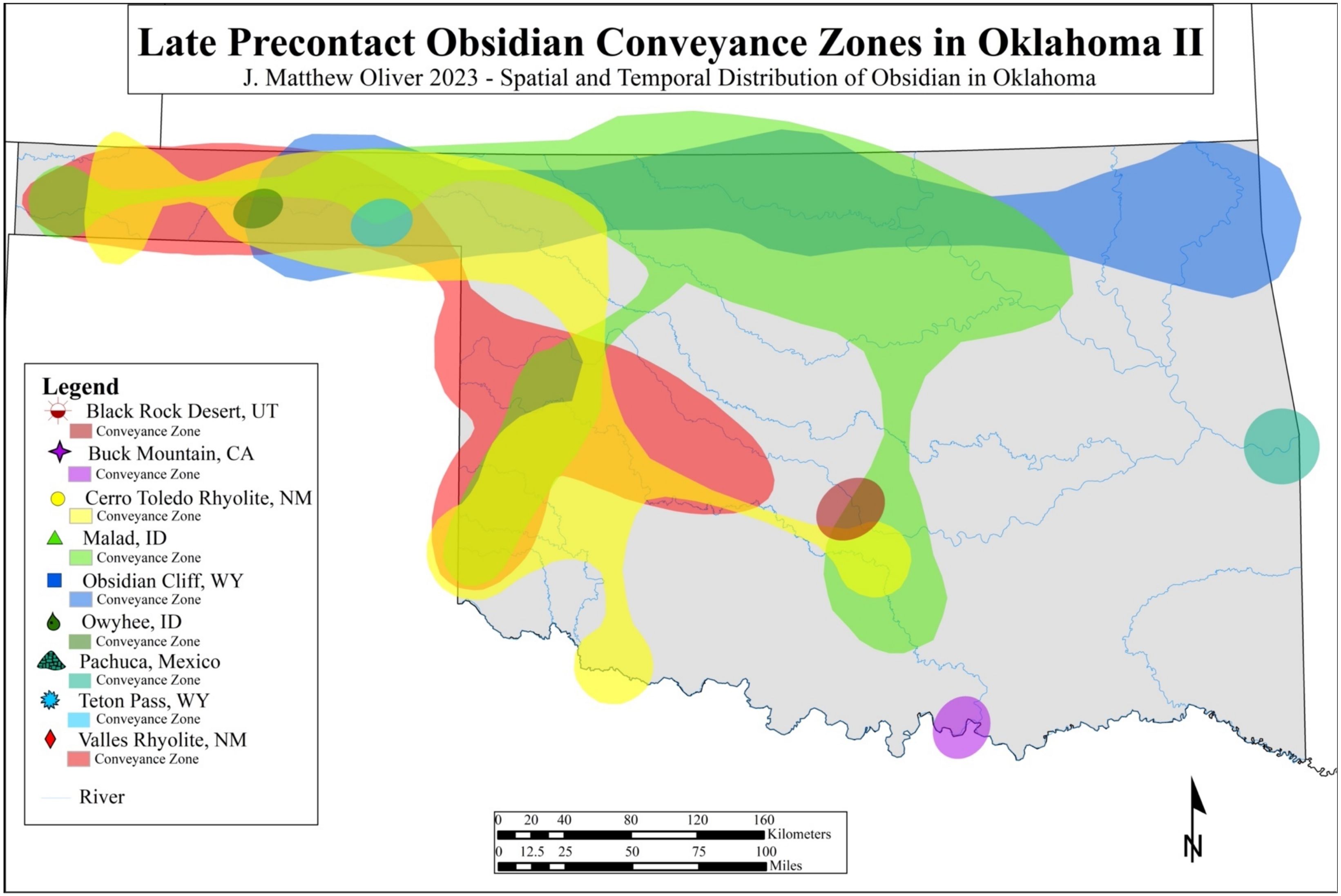


Figure 6.16: Late Precontact Obsidian Conveyance Zones in Oklahoma II



After briefly glancing at Figures 6.13 and 6.14, it is clear that there is a stark difference in the type of obsidian people preferred during the Late Precontact Period and previous time periods. By artifact, Cerro Toledo Rhyolite and Valles Rhyolite from the Jemez Mountains in New Mexico overwhelm the frequencies of obsidian types in Oklahoma. Overall, it looks as if the pattern of cultural interaction reaching to the northwest and the west are still present, yet the cultural interaction pattern to the northwest reaching through the Central Plains toward the more distant, northwestern sources is diminished, and the westerly reaching exchange network between the Southern Plains and the Southwest is strong. One can also see that there a quite a few outliers in the sourcing data beyond the typical northwestern sources like Malad and Obsidian Cliff. Additionally, we need to keep in mind that site 34BV100, the Odessa-Yates site, has produced loads of obsidian artifacts, even upwards of 90% of the entire Oklahoma obsidian assemblage (Brosowske 2005), which may skew the data for the Late Precontact Period.

In Texas County, Oklahoma, the middle county of the Oklahoma Panhandle, three sites (34TX39, 34TX45, and 34TX113) lying north of the Beaver/North Canadian River valley and an additional site sitting on the Beaver/North Canadian River valley (34TX32) had obsidian that only sourced to the Valles Rhyolite formation of New Mexico. Site 34TX32, which is very close to site 34TX31, had obsidian that sourced to the Valles Rhyolite formation in New Mexico. The obsidian from site 34TX1 had an interesting outlier, one flake, of course, sourced to the Cerro Toledo Rhyolite formation, yet the other sourced to the Owyhee obsidian formation in southwest Idaho (Brosowske 2005).

Beaver County, Oklahoma, the easternmost county in the Oklahoma Panhandle, has seen some extensive work done with obsidian. More work has been done with obsidian in Beaver County during the Late Precontact Period than any other area in the state. This is likely because of site 34BV100, which was a large exchange center and has produced thousands of obsidian artifacts (Brosowske 2005). In all reality, the geochemical information from site 34BV100 relatively matches the entire state of affairs concerning obsidian in the Oklahoma Panhandle. The Odessa-Yates site (34BV100) primarily consists of an obsidian assemblage sourcing to Cerro Toledo Rhyolite in the Jemez Mountains of New Mexico, with two flakes from this site sourcing to the Valles Rhyolite formation in New Mexico, and one outlier sourcing to Teton Pass in northwest Wyoming (Brosowske 2005). I accounted for the data bias with 34BV100 by coding it as a site that consisted of obsidian from three different sources, rather than including the large sample of flakes when I considered the project spatially. To remedy any skewed data from the presence of 34BV100, one could simply remove it from the sample set. I did not do that for this research project.

Many of the sites in central and western Beaver County have obsidian assemblages consisting of a mix of Cerro Toledo Rhyolite and Valles Rhyolite obsidian, with three sites (34BV14, 34BV93, and 34BV104) exhibiting minor components from either Malad, Idaho or Obsidian Cliff, Wyoming. Four sites (34BV55, 34BV99, 34BV116, and 34BV122) lying east of 34BV100 consist of obsidian solely sourcing to the Cerro Toledo Rhyolite formation in New Mexico.

In the main body of Oklahoma most of the Late Precontact obsidian sites cluster around the river valleys in southwest and west-central Oklahoma. There are four sites (34WD5, 34BK1, 34BK6, and 34TI1) that have obsidian that sources solely to the Cerro Toledo Rhyolite formation in New Mexico (Figures 5.14, 6.13 – 6.16). All four of these sites with Cerro Toledo Rhyolite obsidian are likely an extension of the same pattern I discussed in the Oklahoma Panhandle. Additionally, site 34CU27, site 34BK8, and site 34HR1 all have obsidian that sourced to the

Cerro Toledo Rhyolite formation in New Mexico; however, these three sites also yielded obsidian from the Valles Rhyolite formation in New Mexico, except for site 34HR1, which had obsidian from the Cerro Toledo Rhyolite formation and the Malad formation in southeast Idaho (Figures 5.14, 6.13 – 6.16). Nine sites and one isolated find (#52) in west-central and southwest Oklahoma had obsidian that sourced to the Valles Rhyolite formation in New Mexico and no obsidian from the Cerro Toledo Rhyolite formation (Figures 5.14, 6.13 – 6.16). In fact, two of these sites, 34RM72 and 34CU40, had obsidian that sourced to both the Valles Rhyolite formation in New Mexico and the Malad formation in Idaho.

For the more distant, northwestern obsidian sources we have a similar situation as with the Archaic and Woodland Periods. In north-central Oklahoma there are three sites (34WO43, 34GT5, and 34GT6) lying along the Salt Fork of the Arkansas River valley, and one site, 34PW128, lying along the Arkansas River valley (Figures 5.14, 6.13 – 6.16). Three of these four sites yielded obsidian that sourced to the Malad formation in southeast Idaho, and one site, 34GT6 had obsidian sourcing to the Obsidian Cliff formation in northwest Wyoming. Farther south in Garvin County, Oklahoma, there are three sites (34GV22, 34GV25, and 34GV34) that cluster around the eastern extent of the Washita River valley (Figures 5.14, 6.13 – 6.16). All three of these sites bore obsidian that originated from the Malad formation in southeast Idaho. There is also an outlier near the cluster of sites in Garvin County, Oklahoma. This site, 34GV108, while being located quite close to the other three sites along the eastern extent of the Washita River, surprisingly had obsidian that sourced to the Cerro Toledo Rhyolite formation in New Mexico (Figures 5.14, 6.13 – 6.16). Similar to the single site (34MY312) in northeast Oklahoma during the Archaic Period (Figure 5.9), there is site 34DL28, a Late Precontact site with an obsidian artifact sourcing to the Obsidian Cliff formation in northwest Wyoming (Figures 5.14, 6.13 – 6.16).

Late Precontact Period (Ca. 1,250 – 450 B.P.): Discussion and Interpretation

Spatially speaking, Late Precontact sites with obsidian primarily sourcing to two obsidian sources in the Jemez Mountains of New Mexico (Valles Rhyolite and Cerro Toledo Rhyolite) are restricted to the Oklahoma Panhandle and the western part of the state. For the most part, with the exception of site 34GV108, obsidian coming from New Mexico during the Late Precontact Period does not cross into or through the Cross Timbers (Figures 2.1, 5.14, 6.15 – 6.16). The Cross Timbers in the Southern Plains consist of some wicked vegetation that would have barred any traveller from crossing them. In 1832, during his trip through the Cross Timbers, Washington Irving compared the interwoven branches of Blackjack oak and greenbriers to a forest of iron (McDermott 1966; Wyckoff 1984). Obsidian coming from the more distant northwestern sources in Idaho and Wyoming seems to be relatively widespread throughout Oklahoma, with lesser amounts of Idaho and Wyoming obsidian being intermixed in obsidian assemblages primarily consisting of Jemez Mountain obsidian (Figures 5.14, 6.13 – 6.16).

In the Oklahoma Panhandle, most of the obsidian-bearing sites dating to the Late Precontact Period have significant components of obsidian originating from either Cerro Toledo Rhyolite or Valles Rhyolite in the Jemez Mountains of New Mexico, and most of these sites, with a few exceptions, cluster around the Beaver/North Canadian River valley, and a few sites cluster along the Cimarron River valley in Cimarron County, the far western county of the Oklahoma Panhandle (Figures 5.14, 6.13 – 6.16). There are two archaeological sites with obsidian that solely sources to the more distant sources to the northwest.

What obsidian sourcing data in the Oklahoma Panhandle has revealed is a strong westerly reaching pattern of cultural interaction to the Southwest with Cerro Toledo Rhyolite as people in the past's preferred type of obsidian (Figures 6.13 – 6.16). Valles Rhyolite obsidian is present in the Oklahoma Panhandle during the Late Precontact Period, but pales in comparison to the amount of Cerro Toledo Rhyolite obsidian. Some minor patterns of cultural interaction exist to the more distant northwestern sources in Idaho and Wyoming as well, yet we may also be seeing these types of obsidian from cultural interaction patterns solely within the Southern Plains as well.

Sites with obsidian in west-central and southwest Oklahoma primarily lie along, or between, the major river valleys in the area, especially the Washita River valley. The headwaters of the Canadian River are located rather close to the Jemez Mountains. What is interesting about the difference between the Oklahoma Panhandle and west-central/southwest Oklahoma during the Late Precontact Period is an emphasis on Cerro Toledo Rhyolite obsidian from New Mexico in the panhandle, and an emphasis on Valles Rhyolite obsidian from New Mexico in west-central and southwest Oklahoma (Figures 5.14, 6.13 – 6.16). This may be because the river valleys in west-central and southwest Oklahoma reach farther toward the Jemez Mountains than the Cimarron and Beaver/North Canadian Rivers do; however, it also suggests two different westerly-reaching cultural interaction patterns toward the Southwest. An occasional obsidian artifact sourcing to Malad, Idaho from many of the sites in both the Oklahoma Panhandle and west-central/southwest Oklahoma (Figures 5.14, 6.13 – 6.16) implies that a northwesterly-reaching cultural interaction pattern through the Central Plains toward the more distant northern sources.

In total, the northwesterly-reaching cultural interaction patterns I highlighted during the Archaic and Woodland Periods still existed in the Late Precontact Period. People occupying the cluster of sites in Garvin County were probably also involved in this pattern of cultural interaction, that would inevitably stretch itself throughout the Southern Plains.

Overall, the outlying samples of obsidian, with the scraper from 34LF40 excluded, were probably picked up along far-reaching patterns of cultural interaction. The two samples from the Oklahoma Panhandle sourcing to Owyhee in southwest Idaho and Teton Pass in northwest Wyoming were likely included as part of the north-south pattern of cultural interaction stretching between the Southern Plains and the more distant, northwestern obsidian sources in Idaho and Wyoming. In the Archaic Period section of this chapter I noted the possibility of an extremely large and far-reaching cultural interaction pattern across the southern US to explain the samples from northeast California appearing in Oklahoma. A similar situation is likely going on during the Late Precontact Period in Oklahoma as we have one obsidian artifact sourcing to Buck Mountain in northeast California, and two obsidian artifacts geochemically fingerprinted to Black Rock Desert in north-central Utah (Figures 5.14, 6.13 – 6.16; Appendix B). These three outliers suggest that same cultural interaction pattern reaching from California, through the Southwest, and finally to the Southern Plains.

Postcontact Period (Ca. 450 – 200 B.P): Trends

From the eight Postcontact obsidian sites in Oklahoma we have 83 artifacts with sourcing data attached to them. The frequencies of obsidian sources appearing during the Postcontact Period of Oklahoma are presented as Figure 6.17, and Figure 6.18 is a Wind Rose diagram showing the directionality of obsidian entering Oklahoma during the Postcontact Period. Figures 6.19 and 6.20 are obsidian conveyance zone maps for the Postcontact Period in Oklahoma.

Figure 6.17: Frequencies of Postcontact Obsidian in Oklahoma

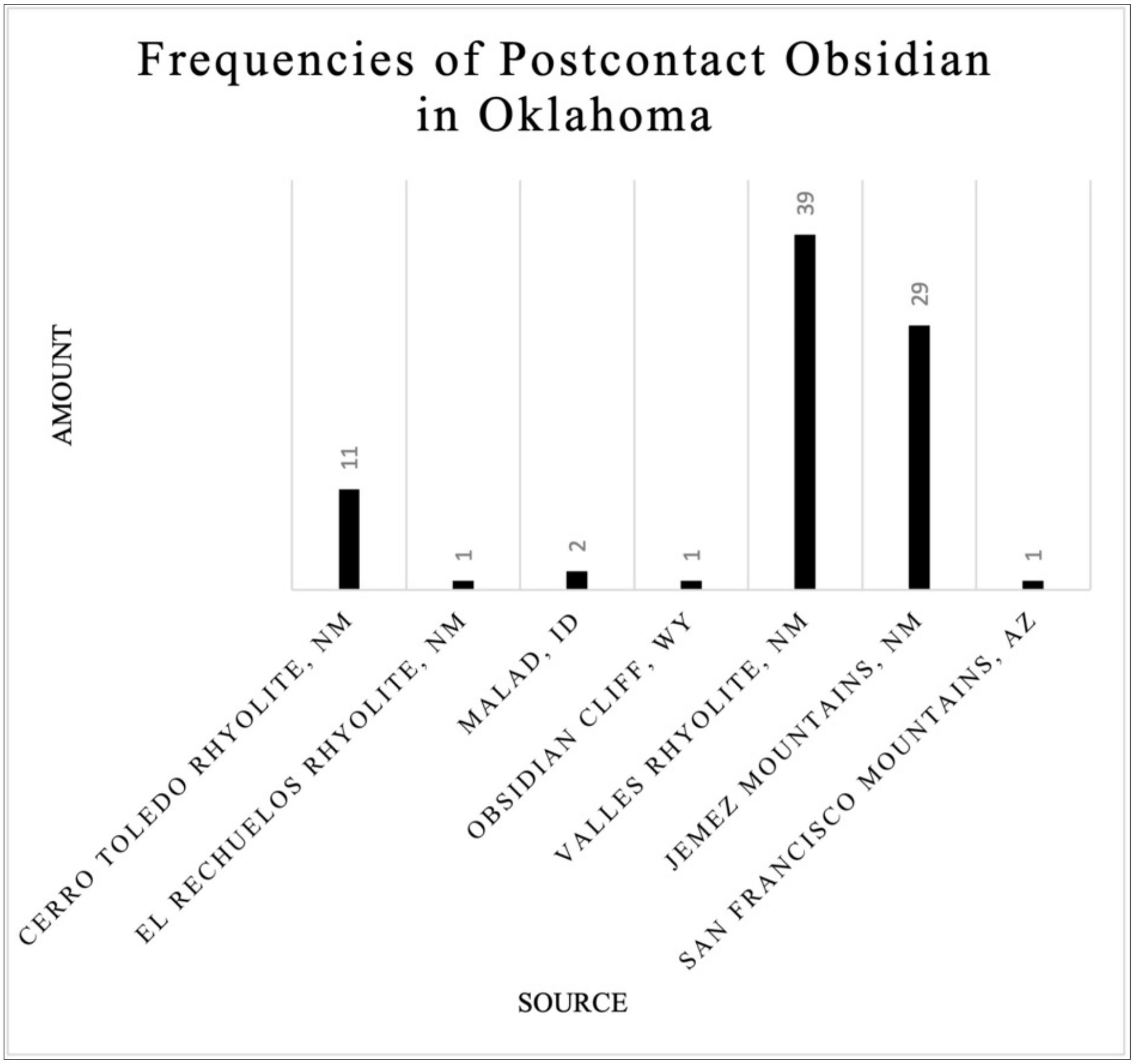


Figure 6.18: Directionality of Postcontact Obsidian in Oklahoma

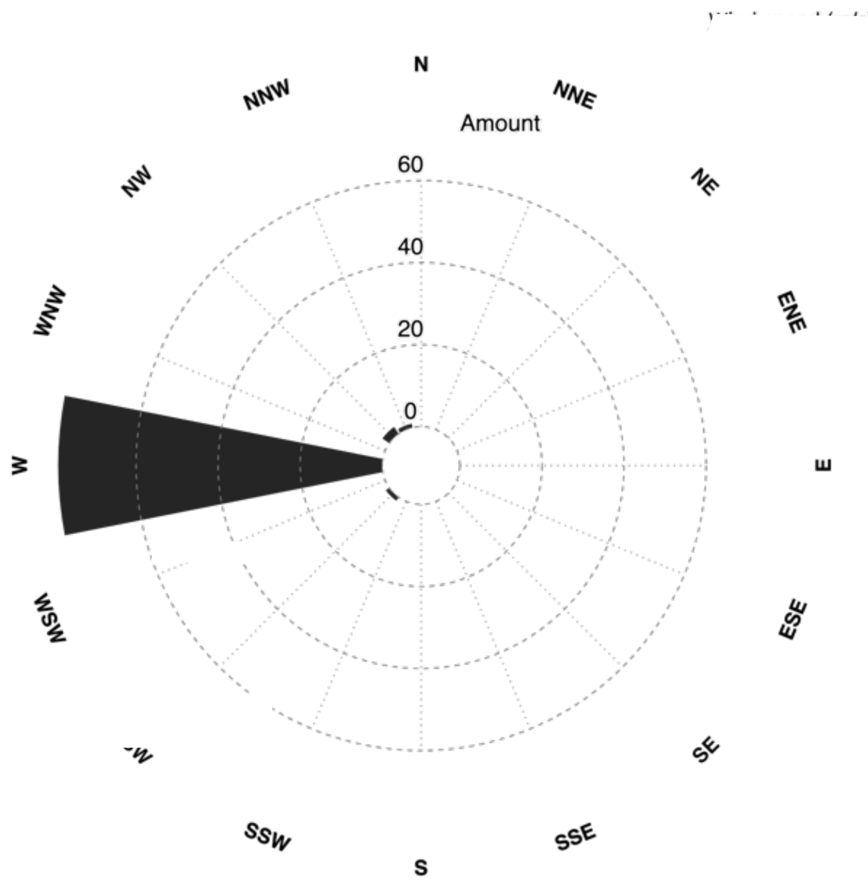


Figure 6.19: Postcontact Obsidian Conveyance Zones in Oklahoma I

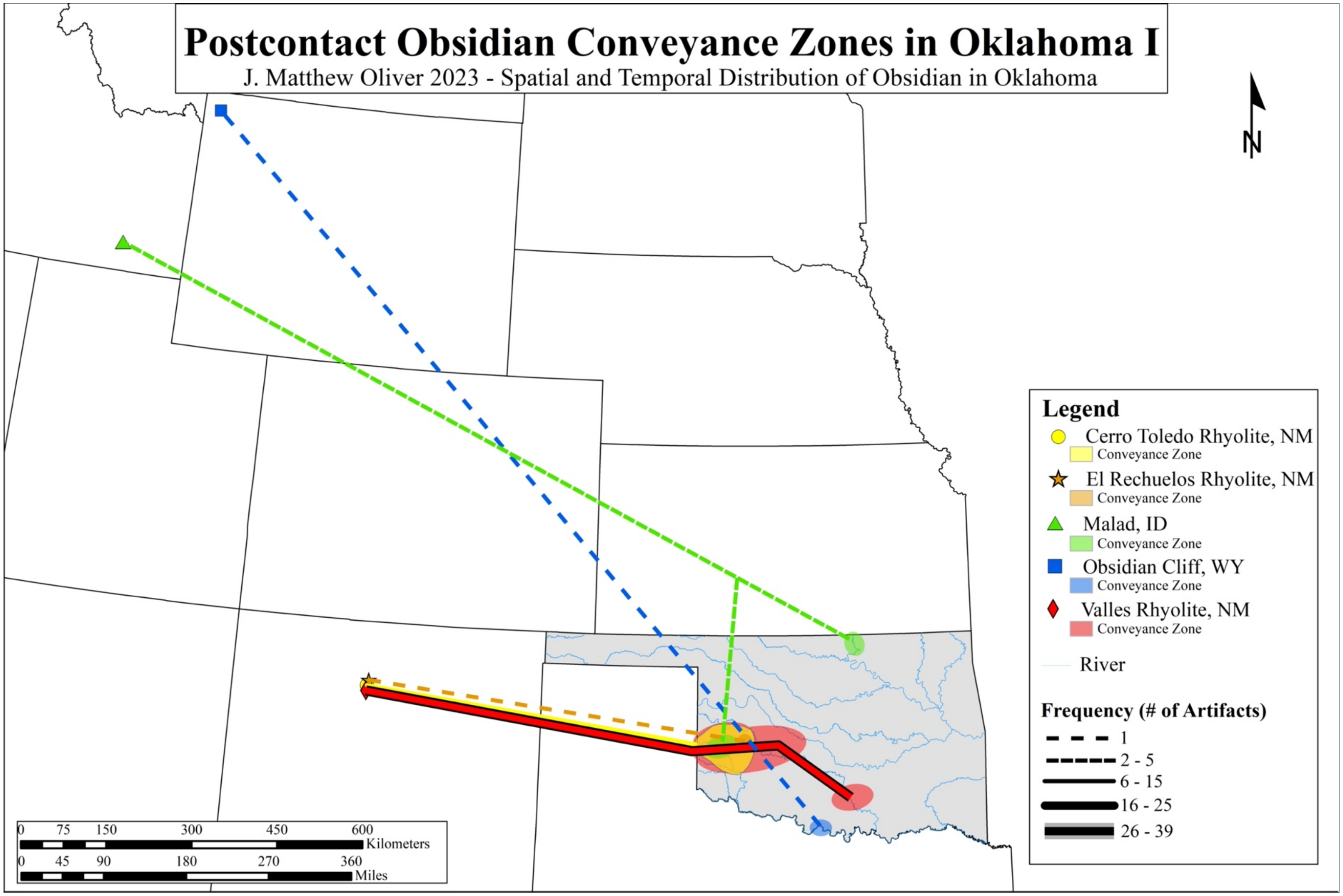
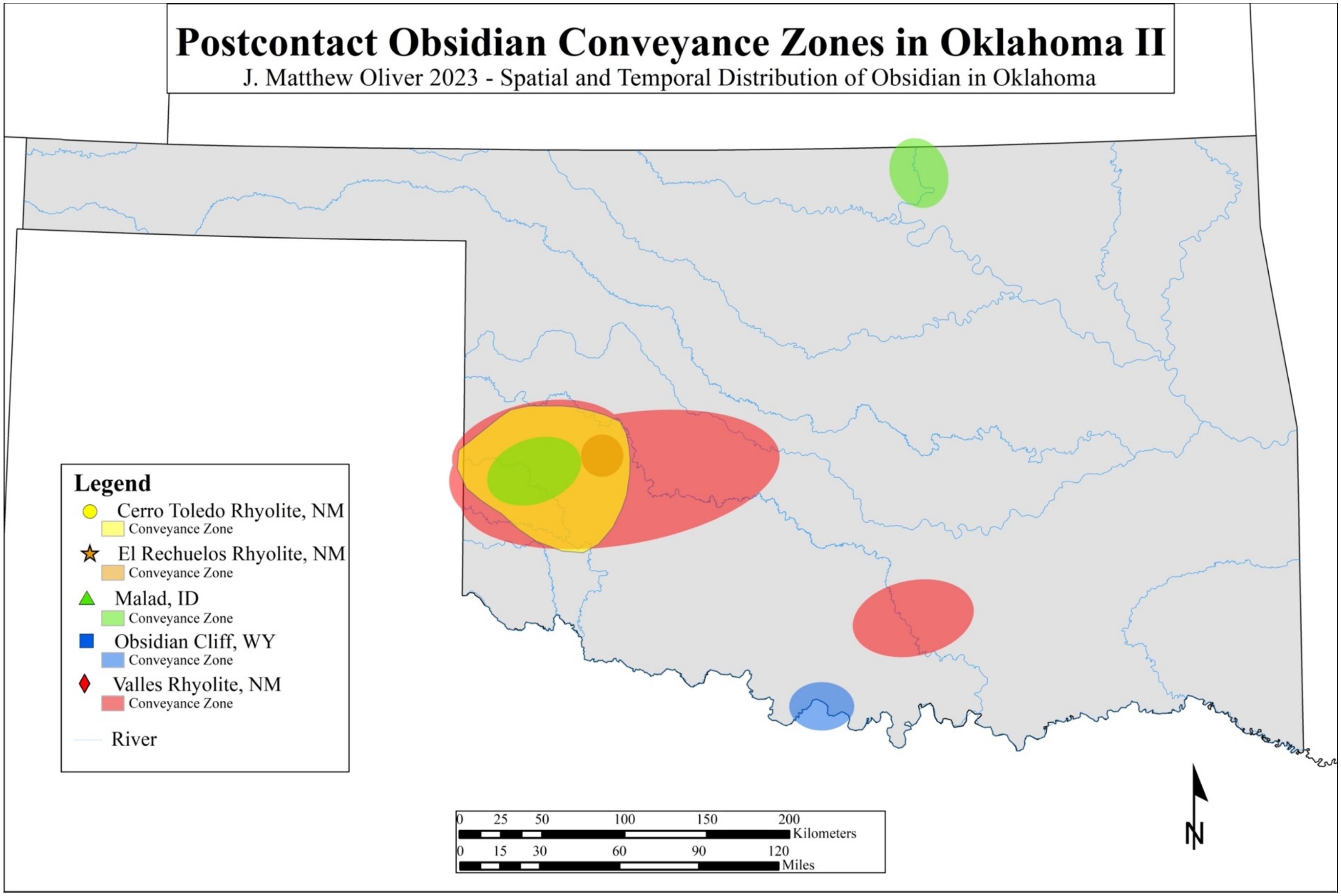


Figure 6.20: Postcontact Obsidian Conveyance Zones in Oklahoma II



Figures 6.17 – 6.20 clarify the trends in obsidian preference during the Postcontact Period. Obsidian from the Jemez Mountains in New Mexico, and of those three, primarily obsidian from the Valles Rhyolite formation, dominates the assemblages of the eight Postcontact Period sites with obsidian in Oklahoma. In fact, out of 83 artifacts, four of those where geochemically linked to an obsidian-bearing formation outside of the Jemez Mountains (Table 5.2; Figures 6.17 and 6.18).

The obsidian artifacts from sites 34JF1 and 34KA3 both were linked to the more distant northwestern sources in Idaho (Malad) and Wyoming (Obsidian Cliff). Additionally, one obsidian flake among multitudes from site 34BK2 sourced to Malad, Idaho, and another, studied in 1986 by Timothy Baugh, was attributed to the San Francisco Mountains in northern Arizona. These examples are the outliers for Postcontact Period obsidian utilization in Oklahoma. The flake Baugh (1986) linked to the San Francisco Mountains is suspect in my opinion for a number of reasons. One other obsidian artifact from Oklahoma sourced to Arizona, and this was during the Paleoindigenous Period (Taylor-Montoya et al. 2006) [Figure 5.7]. Furthermore, in Baugh's 1986 article he attributed the other 29 flakes from site 34BK2 to the "Jemez Mountains" rather than linking the 29 flakes to any of the three obsidian-bearing rhyolite formations in the Jemez Mountains. This could have been because we, as archaeologists, did not know of the geochemical differences between Cerro Toledo Rhyolite, Valles Rhyolite, and El Rechuelos Rhyolite at that time. In the last four decades since Baugh's (1986) article geochemical studies on obsidian have vastly improved our understanding of obsidian and sourcing techniques in general. If the flake sourcing to the San Francisco Mountains from site 34BK2 is veritable, it was likely swept up in the wake of a cultural interaction pattern stretching through the Southwest toward the Southern Plains

Postcontact Period (Ca. 450 – 200 B.P): Discussion and Interpretation

There is quite a bit of data concerning obsidian utilization in Oklahoma during the Postcontact Period; however, all of this data comes from eight archaeological sites (34KA3, 34RM14, 34WA2, 34BK2, 34GR8, 34JF1, 34MR10, and 34CN2) spread throughout the main body of Oklahoma (Figures 5.17, 6.19 – 6.20).

All eight of these Postcontact sites are large, important archaeological sites in Oklahoma and many of them have seen field schools from the University of Oklahoma. Beyond that, three of the eight sites (34KA3, 34JF1, and 34BK2) are listed on the National Register of Historic Places (NRHP), yet all eight should be. After poring over Figures 5.17, 6.19, and 6.20, I see that all of the Postcontact Period sites with primarily Jemez Mountain obsidian in their assemblages lie either along the North Fork of the Red River valley, the Washita River valley, or the Canadian River valley. The placement of these sites is plausibly connected to the Southwest and a westerly-reaching pattern of cultural interaction is suggested with the Ancestral Puebloan groups of the Southwest, and even Spanish and French colonizers traversing the area during this time period.

The two outlying Postcontact Period sites with obsidian sourcing to the more distant northwestern sources are 34KA3 and 34JF1. Both of these Postcontact sites were fortified trading centers that many different cultures including the Southern Plains tribes, French and Spanish colonists, and Indigenous peoples from the Southeast, the Southwest, and the Central Plains. At site 34JF1 an obsidian biface fragment sourced to the Obsidian Cliff formation in northwest Wyoming, and at site 34KA3 and obsidian flake sourced to the Malad formation in southeast Idaho. Additionally, a single flake from 34BK2 sourced to the Malad formation in southeast Idaho. The three obsidian artifacts from these three Postcontact sites likely represent a diminishing, northwesterly-directed cultural interaction pattern through the Southern Plains, Central Plains, and more mountainous areas farther north in Idaho and Wyoming. The degradation of this north-south pattern of cultural interaction may have been the result of Ancestral Osage raiding in northeast Oklahoma to the Arkansas River valley, the arrival and influx of Spanish and French colonizers, or other cultural pressures orienting people on the Southern Plains more toward the Southwest.

Six of the eight Postcontact sites in Oklahoma with obsidian have been affiliated with either the Edwards Complex (400 – 300 B.P.) or the Wheeler Complex (300 – 200 B.P.). The Edwards Complex was defined by Timothy Baugh based on site 34BK2 (Baugh et al. 1982), and the Wheeler Complex was defined by Jack Hofman (1978). Obsidian is not an uncommon lithic material in either of these complexes. The fact that almost all (except for the single flake from site 34BK2 and the outlier sourcing to the San Francisco Mountains of Arizona) of the obsidian artifacts from these six Postcontact sites sources to the Jemez Mountains suggests a strongly integrated cultural interaction pattern between the Southern Plains and the Southwest during the Postcontact Period.

<u>Atemporal and Total Considerations for Obsidian in Oklahoma</u>

Figure 6.21 is a bar chart displaying all obsidian data for Oklahoma. Figure 6.22 is a wind rose diagram that also displays all obsidian data for Oklahoma. Figure 6.23 is a partial map of North America depicting the total frequency (amount) of obsidian in Oklahoma that has been geochemically analyzed and their respective sources. These three figures show that, overall, people in the past in Oklahoma preferred obsidian from either Cerro Toledo Rhyolite or Valles Rhyolite in the Jemez Mountains, and to a lesser degree the two distant northwestern sources Malad, Idaho and Obsidian Cliff, Wyoming. Considered without divisions through time, Cerro

Toledo Rhyolite and Valles Rhyolite obsidian from the Jemez Mountains in New Mexico overwhelmingly dominate obsidian assemblages in Oklahoma (Figures 6.21 and 6.22).

Figure 6.21: Atemporal Frequency of Obsidian in Oklahoma

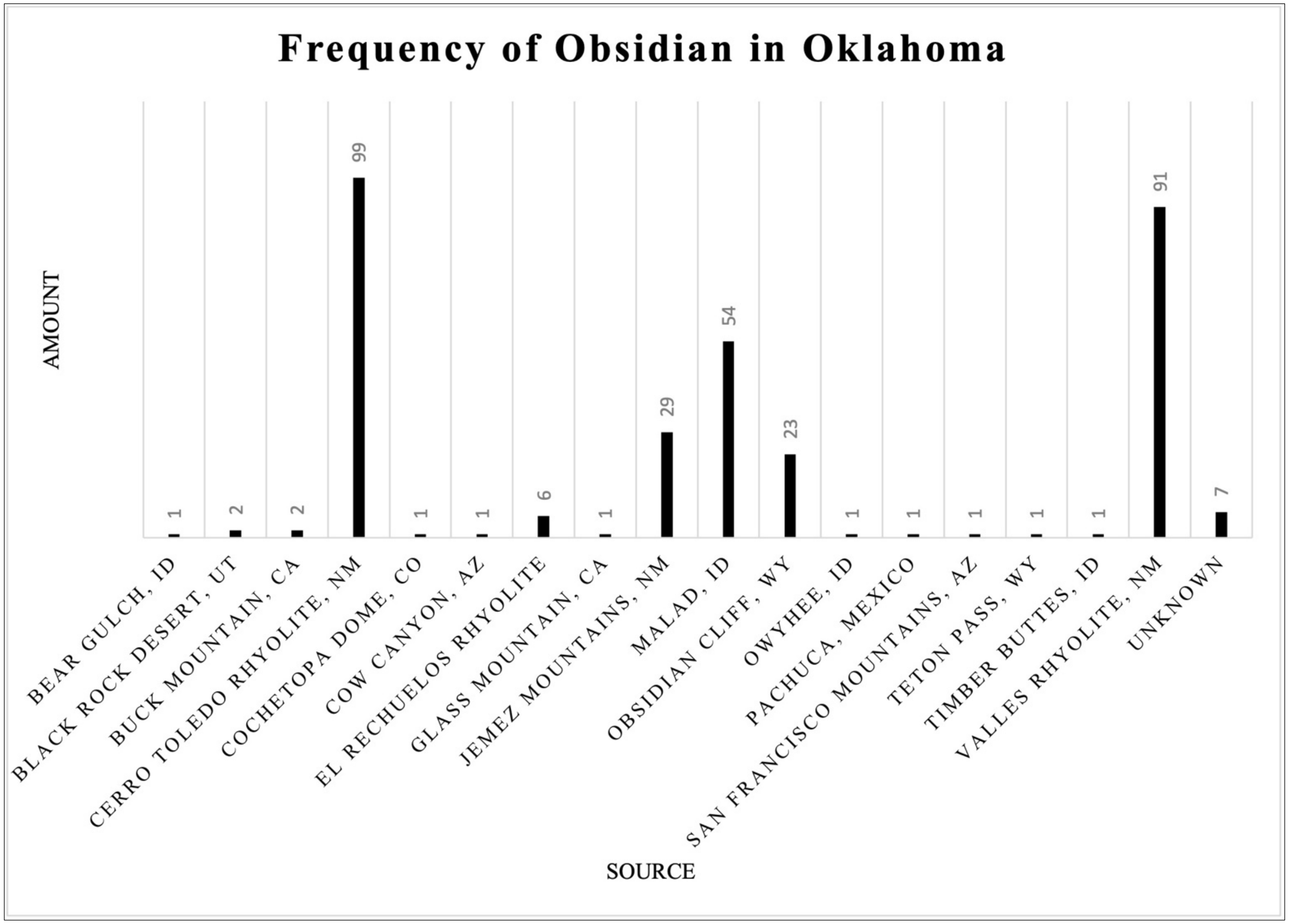


Figure 6.22: Atemporal Directionality of Obsidian in Oklahoma

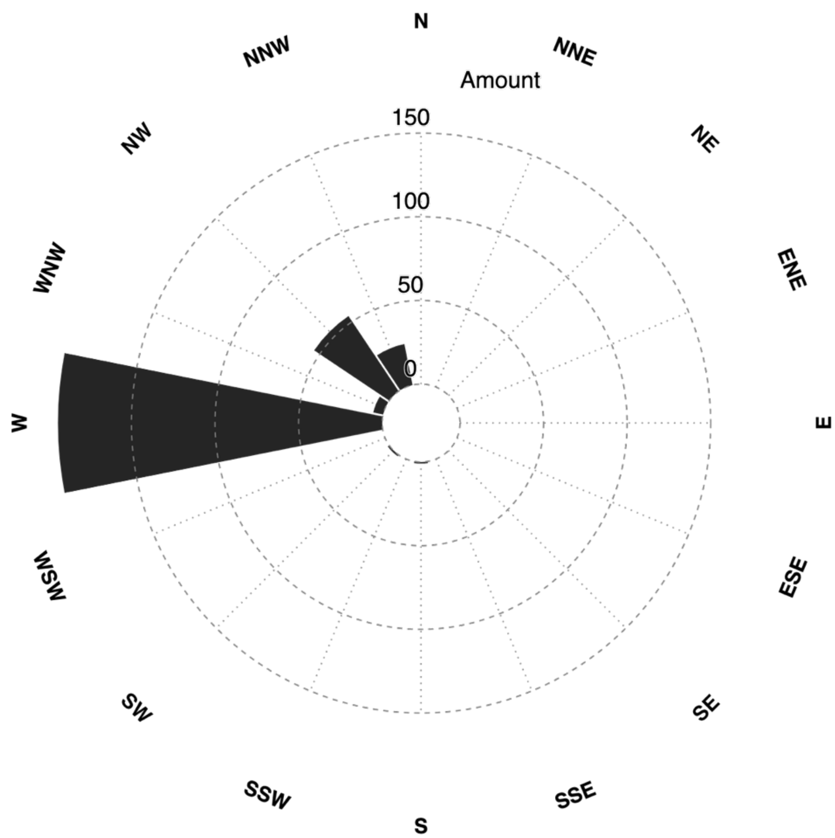
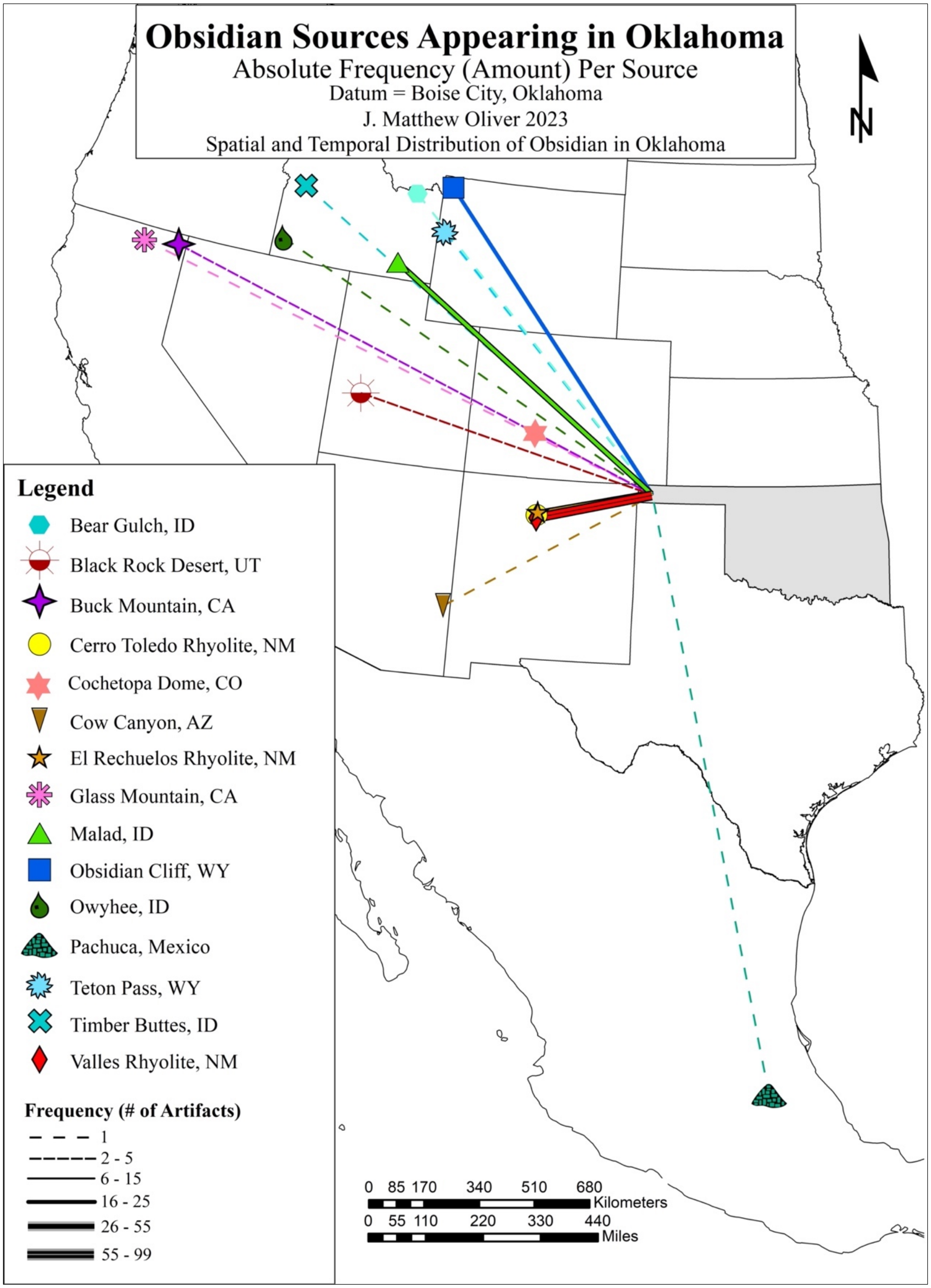


Figure 6.23: Obsidian Sources Appearing in Oklahoma and Their Absolute Frequency (Amount) Per Source



It is important to consider different kinds of obsidian found in Oklahoma and what artifact types are typically made from whichever specific kind of obsidian. These data can inform us on the choices people in the past in Oklahoma made about their preferred type of obsidian, and which obsidian sources are more useful for particular artifact types. Table 6.1 displays how many and which artifact types per source have been studied in Oklahoma, for both this research project and previous studies. Overall, Valles Rhyolite obsidian was worked in to the most amount of PPKs, with about twice the amount of debitage than PPKs. In contrast, there are a multitude of flakes (n = 79) sourcing to the Cerro Toledo Rhyolite formation and 16 PPKs (Table 6.1). Obsidian Cliff obsidian was also primarily utilized by people in the past for PPKs or bifaces, likely because of its large nodule size and high quality (Table 2.1). Malad obsidian is easily accessible and of high quality for tool production, yet the majority of Malad obsidian artifacts from Oklahoma are debitage (n = 44) with seven PPKs represented in Oklahoma (Table 6.1). Most of the outliers, being obsidian sources that rarely make it to Oklahoma, consist of debitage with the exception of Timber Buttes, Idaho, Buck Mountain, California, El Rechuelos Rhyolite, New Mexico, and Cochetopa Dome, Colorado. The sole core I included in the 102 EDXRF samples sourced to the Timber Buttes obsidian formation. The two artifacts sourcing to Buck Mountain, California are one PPK mid-section and one biface, suggesting that Buck Mountain obsidian was chosen for formal tool production (Table 6.1). The Blankenship Clovis sourced to Cochetopa Dome, Colorado and is the sole Cochetopa Dome obsidian artifact found in Oklahoma so far. El Rechuelos Rhyolite obsidian is an enigma as most of the artifacts (n = 6) sourcing to El Rechuelos Rhyolite are PPKs, two of which are larger Archaic PPKs, and the other two are smaller Woodland Period PPKs.

Table 6.1: Artifact Types in Oklahoma by Obsidian Source

Obsidian Source	Projectile Point	Debitage	Biface	Eccentric	Scraper	Blade	Core
Bear Gulch, ID	0	0	0	1	0	0	0
Black Rock Desert, UT	0	2	0	0	0	0	0
Buck Mountain, CA	1	0	1	0	0	0	0
Cerro Toledo Rhyolite, NM	16	79	2	0	0	0	0
Cochetopa Dome, CO	1	0	0	0	0	0	0
Cow Canyon, AZ	0	1	0	0	0	0	0
El Rechuelos Rhyolite, NM	4	2	0	0	0	0	0
Glass Mountain, CA	0	1	0	0	0	0	0
Jemez Mountains, NM	0	29	0	0	0	0	0
Malad, ID	7	44	1	1	0	0	0
Obsidian Cliff, WY	5	13	4	0	0	1	0
Owyhee, ID	0	1	0	0	0	0	0
Pachuca, Mexico	0	0	0	0	1	0	0
San Francisco Mountains, AZ	0	1	0	0	0	0	0
Teton Pass, WY	0	1	0	0	0	0	0
Timber Buttes, ID	0	0	0	0	0	0	1
Valles Rhyolite, NM	23	51	1	1	1	0	0
Unknown Source	2	5	0	0	0	0	0

The fact that most (n = 4) of the very few obsidian artifacts sourcing to El Rechuelos Rhyolite (n = 6) are PPKs suggests that the obsidian formation in the Jemez Mountains have been culturally controlled throughout time.

Part Two: Discussion Summary, Response to Previous Ideas on Obsidian in Oklahoma, and Indigenous Perspectives

Summary of Discussion

I now return to the hypothesis I posited in Chapter 3: Archaeological Context. It is rather clear at this point that my hypothesis is supported by my research. Obsidian utilization in Oklahoma changed over time.

Overall and in consideration of temporality, the data within my thesis suggests that during the Archaic Period in Oklahoma, ties to the North-Northwest were strong. Most of the obsidian dating to the Archaic Period came from those more distant, northwestern sources in Idaho and Wyoming indicating a northwest-south pattern of cultural interaction between people on the Southern Plains and people in the Central Plains and farther north. For the Archaic Period an east-west pattern of cultural interaction was in place as well, particularly for the Oklahoma Panhandle, but the evidence dictates that the east-west pattern of cultural interaction was not as strong as the northwest-south cultural interaction pattern during this time (Figures 5.9, 6.7 – 6.8).

For the Woodland Period in Oklahoma the situation is, for the most part, the same as the Archaic Period. Most Woodland Period obsidian from Oklahoma sourced to the more distant, northwestern sources in Idaho and Wyoming, suggesting a strong northwest-south pattern of cultural interaction. A small number of isolated PPKs diagnostic of the Woodland Period sourced to the Jemez Mountains, but these were mostly constricted to the Oklahoma Panhandle. This suggests, like the Archaic Period, the existence of an east-west cultural interaction pattern that may not have been as heavy and far-reaching as the northwest-south cultural interaction pattern (Figures 5.12, 6.11 – 6.12).

During the Late Precontact Period the story is quite different. Overall, obsidian from the Jemez Mountains, and particularly Cerro Toledo Rhyolite, is predominant (Figures 6.13 and 6.14). In the Oklahoma Panhandle most of the obsidian sourced to the Cerro Toledo Rhyolite formation with some minor components of obsidian from the Valles Rhyolite formation and more distant, northern sources in Idaho and Wyoming. This suggests a strong east-west pattern of cultural interaction from the Oklahoma Panhandle to the Southwest with a weaker, northwest-south cultural interaction pattern in place covering the artifacts sourcing to Idaho and Wyoming (Figures 5.14, 6.13 – 6.16).

In west-central and southwest Oklahoma obsidian from the Valles Rhyolite formation predominates, with minor components of obsidian from the Cerro Toledo Rhyolite formation in the Jemez Mountains and the Malad formation in southeast Idaho (Figures 5.14, 6.15 – 6.16). This indicates that, for people living in west-central and southwest Oklahoma a separate east-west cultural interaction pattern existed reaching to the Southwest that is different than the east-west pattern I parsed out in the Oklahoma Panhandle (Figures 5.14, 6.15 – 6.16). Similar to the Oklahoma Panhandle, a weaker, northwest-south pattern of cultural interaction is exemplified by the presence of obsidian from the Malad formation in southeast Idaho (Figures 5.14, 6.15 – 6.16).

In central Oklahoma there are two clusters of sites: 1) around the Salt Fork of the Arkansas River and the Arkansas River itself, and 2) around the eastern extent of the Washita River in Garvin County, Oklahoma (Figure 5.14, 6.15 – 6.16). These clusters of sites primarily had obsidian that sourced to the more distant, northwestern sources in Idaho and Wyoming leaving me to infer that a northwest-south pattern of cultural interaction existed for central Oklahoma that was stronger than those that we saw in west-central and southwest Oklahoma along with the panhandle (Figures 5.14, 6.15 – 6.16). Indeed, the obsidian from the more distant, northwestern sources appearing in the Oklahoma Panhandle and the western part of the state may have been an extension of the northwest-south cultural interaction pattern that predominates central Oklahoma during the Late Prehistoric Period (Figures 5.14, 6.15 – 6.16).

During the Postcontact period the plot thickens in regard to obsidian and cultural interaction. There is currently no obsidian data for the Oklahoma Panhandle during the Postcontact Period. In the main body of Oklahoma, particularly the southwest and west-central parts of the state, the strong east-west cultural interaction pattern is still in place from the Southern Plains to the Southwest (Figures 5.17, 6.19 – 6.20). Curiously, the type of preferred obsidian from the Jemez Mountains flowing through this east-west pattern of cultural interaction shifts from obsidian from the Cerro Toledo Rhyolite formation to the Valles Rhyolite formation (Figures 5.17, 6.19 – 6.20). There is also evidence for a continually weakening northwest-south ties between the Southern Plains, through the Central Plains, and farther north to the more distant sources of obsidian in Idaho and Wyoming (Figures 5.17, 6.19 – 6.20). The diminishment of this northwest-south cultural interaction pattern started in the Late Precontact Period and continued into the Postcontact Period with a handful of obsidian artifacts providing ties to the northwest.

Response to Previous Ideas on Obsidian in Oklahoma

In this section, I return to the previous arguments about obsidian in Oklahoma I discussed at the end of Chapter 3: Archaeological Context. Baugh and Nelson's (1987) idea on exchange networks on the Southern Plains shifting toward the Southwest after contact has some merit, but data from my project shows that a shift in obsidian preference on the Southern Plains occurred during the Late Precontact Period and a few hundred years earlier than contact (Figures 5.14, 6.13 – 6.16). My thesis also shows that a northwest-south pattern of cultural interaction still existed between the Southern Plains and the more distant northwestern sources during the Postcontact Period. We have to remember that Baugh and Nelson's (1987) study occurred nearly 40 years ago now, and today we have much more evidence.

Cojeen and Burkhalter (2004) came close to what the data in my thesis suggests – cultural interaction patterns existing simultaneously toward the Southwest and the North, but they were working with one site (34CU40). Data from my thesis shows that while both interaction patterns are in place during both the Late Precontact and Postcontact Periods in Oklahoma, the east-west pattern of cultural interaction to the Southwest intensified over time (Figures 5.14, 5.17, 6.13 – 6.20).

Dr. Robert Brooks's (2014) paper presentation on obsidian in Oklahoma is what started my project. Brooks identified both the east-west cultural interaction pattern and the north-south cultural interaction pattern and followed Baugh and Nelson's (1987) interpretations. Brooks's first point was that most obsidian outside the Oklahoma Panhandle comes from the more distant, northwestern sources in Idaho and Wyoming. Data from my thesis suggests that this is true for the Archaic and Woodland Periods. After the Woodland Period obsidian from the Southwest regularly occurs in the main body of Oklahoma (Figures 5.14, 5.17, 6.13 – 6.20). His second point is that there is a strong connection between the Oklahoma Panhandle and the Southwest (Brooks 2014). This is true for all time periods, although, during and after the Late Prehistoric Period in Oklahoma, there appears to be a strong connection between west and southwest Oklahoma to the Jemez Mountains as well (Figures 5.14, 5.17, 6.13 – 6.20). Brooks's (2014) final point is that during the Postcontact Period all obsidian in Oklahoma originated from the

Jemez Mountains. This point is not true as data from my thesis clearly shows the continued existence of a northwest-south pattern of cultural interaction between the Southern Plains and the more distant, northwestern sources in Idaho and Wyoming, even though it may have diminished in intensity (Figures 5.17, 6.17 – 6.20).

In comparison with Hoard et al. (2008) there is a strikingly similar situation concerning the temporal distribution of obsidian in Oklahoma as there is in Kansas, yet Oklahoma has enough data for the Archaic and Woodland Periods to make some inferences on cultural interaction patterns. In both states there is a preference for obsidian originating from the more distant, northwestern sources in Idaho and Wyoming until the Late Precontact/Middle Ceramic Period where obsidian becomes more common with an emphasis on obsidian from the Cerro Toledo Rhyolite formation in New Mexico. This is true for the Oklahoma Panhandle, yet in southwest Oklahoma Valles Rhyolite obsidian from New Mexico is preferred. During the Postcontact/Late Ceramic Period people had a preference for Valles Rhyolite obsidian from New Mexico for both states, yet in Oklahoma, there are still a handful of obsidian artifacts sourcing to the distant northwest in Idaho and Wyoming.

Indigenous Perspectives on Obsidian

Late in my thesis project Dr. Bonnie Pitblado tasked me with contacting many of the 37 Indigenous communities living in Oklahoma to inquire about Indigenous perspectives on obsidian. The inspiration for this came from the fifth chapter in Shackley's (2005) book on obsidian entitled *Obsidian in Ethnohistory and the Public Imagination*. To help me work through this dimension of my research, I was joined by Elijah C. Whalen, my undergraduate research assistant at the University of Oklahoma and active member of the Oklahoma Public Archaeology

Network (OKPAN). Together, we reached out to over half of the 37 Indigenous communities around Oklahoma.

Some of the Indigenous communities we contacted were unavailable, and others had no heritage or cultural department we could talk to. A handful of Indigenous communities responded that they had no Indigenous perspectives on obsidian. We had two positive responses to this inquiry. Dr. Ian Thompson of the Choctaw Historic Preservation Department informed us that he knew a collector in southeast Oklahoma who possessed obsidian found around Lake Texoma. While this is some great information it wasn't exactly what we were looking for. The other positive response was from Cherokee Nation. Vyrl Keeter, a Cherokee elder and our National Treasure for Flintknapping, mostly spoke about obsidian in terms of modern knapping. He praised it for being relatively easy to knap and widely accessible. Vyrl also informed me that he know of some precontact obsidian travelling through the Neosho River valley. This information supports the continued existence of the north-south exchange relationship between the Southern Plains and the more distant, northern sources in Idaho and Wyoming; however, this information still wasn't what Elijah and I were looking for. We were unable to parse out any Indigenous perspectives on obsidian from the Indigenous communities in Oklahoma that we were able to contact.

Part Three: Conclusion – Research Question Summary and Future Research Directions

Research Question Summary

Returning now to my thesis research question: what spatial patterning is expressed by obsidian in Oklahoma, and what do these patterns reveal about cultural interaction through time? There are a number of spatial patterns expressed by obsidian appearance and its originating geologic formation. Using these patterns as a lens, and in conjunction with the conveyance zones, I parsed out cultural interaction patterns that shifted (or remained intact) throughout time all across central and western North America.

The distribution of obsidian artifacts throughout an area and their subsequent source characterization can identify the existence of pattern of cultural interaction, and even the directionality of those interactions. Adding other lines of evidence will strengthen the inferences parsed out from the obsidian data, such as ceramics, architecture, and other trade goods. Inferences on cultural interaction patterns and their archaeological implications derived from obsidian would be strengthened even further if artifacts were found belonging to one area or the other along the directionality of the pattern if found outside of their typical area of manufacture.

Future Research Directions

Multiple future research directions can stem from my project. I will touch on a few of those here. If a lithic analysis was applied to the assemblage (n = 2,140) from which I chose artifacts to subject to EDXRF sourcing analysis, this approach could reveal the manner of cultural relationships already identified in my project. For instance, while looking through the assemblage the vast majority of debitage was very small and that there were three cores in the entire assemblage. These insights suggest a down-the-line type of exchange network of which Oklahoma would have been on the fringe receiving obsidian in small quantities.

Another future research direction, and possibly the most substantial one, would be to add data on obsidian source characterization from other states, such as the states lying between Oklahoma and the more distant, northwestern sources in Idaho and Wyoming. Combining data from my thesis with obsidian sourcing data from Texas (especially the Texas Panhandle) and New Mexico could reveal much about the east-west pattern of cultural interaction between Oklahoma and the Jemez Mountains. I am also interested in the extremely long-distance cultural interaction pattern between the far west (California) and the Southern Plains, as suggested by the appearance of the three obsidian artifacts from Oklahoma sourcing to Buck Mountain and Glass Mountain in northeast California. One artifact sourcing to California would have been suspicious, but in this project there were two with an additional flake sourcing to California from Dolan et al. (2008). Obsidian data from other states may reveal more about this curiosity.

During the Late Precontact and Postcontact Periods, it would be possible to attach a specific cultural affiliation to many of the archaeological sites in Oklahoma with obsidian. This future research direction could provide insight into the movements and interactions of many Indigenous groups in the Southern Plains and along its margins. Data from this thesis project, if combined with other lines of evidence, could reveal information about the influx and rise of the Ancestral Comanche, Kiowa, and Apache peoples and the subsequent disruption of Caddoan speaking groups such as the Ancestral Wichita and Caddo. To institute this line of inquiry, the temporality of each site needs to be considered instead of grouping many into one broad time period.

Why is El Rechuelos Rhyolite so poorly represented in the amalgam of obsidian from Oklahoma? So far, there have been 322 artifacts subjected to obsidian source characterization in Oklahoma and six of those artifacts were matched with the El Rechuelos Rhyolite chemical signature. The reason for the almost complete absence of El Rechuelos Rhyolite could have something to do with the obsidian itself. For instance, El Rechuelos Rhyolite has a relatively ashy matrix making it difficult to knap. Beyond that, most raw nodules of El Rechuelos Rhyolite obsidian are rather small, as in 5 cm or less. Additionally, the Valles Rhyolite formation in the Jemez Mountains is entirely constricted to the caldera rim and is easily culturally controlled (Shackley 2005), which could account for the lesser amounts of El Rechuelos Rhyolite obsidian appearing in Oklahoma. These facts may be the reason that El Rechuelos Rhyolite was not selected for in the past on the Southern Plains.

Utilizing some methodology to calculate how long the travel time may be between various parts of Oklahoma and the obsidian sources appearing in the state's archaeological record would inform how people in the past in Oklahoma procured obsidian. Tools like a least-cost path analysis or ethnographic evidence could inform this line of inquiry and will help parse out which obsidian sources may have been procured directly or traded for. We should also consider the travel time to and from an obsidian source via water for this future research direction.

More intrasite research should be conducted on archaeological sites in Oklahoma with obsidian assemblages from more than one geologic source. Studies along those lines may reveal further evidence on cultural interaction implications within the Southern Plains and adjacent regions.

The final future research direction I will discuss here is to continue to work with Indigenous communities on any possible Indigenous perspectives on obsidian. To continue this line of inquiry, the lens should be expanded to include Indigenous communities outside of Oklahoma as well as the 37 Indigenous communities existing in the state now. After all, most of the Indigenous communities living in Oklahoma are from the Southeast and were not as likely to be in contact with obsidian than other Indigenous communities farther west.

My project was successful in identifying the existence and directionality of cultural interaction patterns through time and space in Oklahoma, but the work is never done. With the addition of more data from other parts of North America, and more lines of evidence to support the obsidian source data, we can learn much about the widely-connected North American world in the past.

References

Aaberg, Stephen A.
1995 The 1989 Archaeological Reconnaissance. *The Obsidian Cliff Plateau Prehistoric Lithic Source, Yellowstone National Park, Wyoming*. Davis et al., eds. Selections from the Division of Cultural Resources 6:27-38, Rocky Mountain Region, National Park Service.

Albert, Lois E. and Don G. Wyckoff
1984 Oklahoma Environments: Past and Present. *Prehistory of Oklahoma*. Robert E. Bell, ed.: 1-43. Academic Press, Inc., Orlando.

Amick, Daniel S.
1994 Technological Organization and the Structure of Inference in Lithic Analysis: An Examination of Folsom Hunting Behavior in the American Southwest. *The Organization of North American Prehistoric Chipped Stone Tool Technologies.* Philip J. Carr, ed.:9 – 34. International Monographs in Prehistory, Archaeological Series 7, Ann Arbor.

Anderson, Adrian D.
1975 The Cooperton Mammoth: An Early Man Bone Quarry. *Great Plains Journal* 14:143-173.

Andrefsky, William Jr.
2005 *Lithics: Macroscopic Approaches to Analysis*. University Printing House, Cambridge.

Antevs, E.
1955 Geologic-Climatic Dating in the West. *American Antiquity* 20(4):317-335.

Asher, R. R.
1965 *Volcanic Construction Materials in Idaho*. Idaho Bureau of Mines and Geology, pamphlet 135. Moscow, Idaho.

Baerreis, David E.
1955 *Oklahoma Archeological Survey Site File Form DL-28.* Oklahoma Archeological Survey, University of Oklahoma, Department of Anthropology, Norman, Oklahoma.

Baker, William E., T. N. Campbell, and G. L. Evans
1957 The Nall Site: Evidence for Early Man in the Oklahoma Panhandle. *Bulletin of the Oklahoma Anthropological Society* 5:1-20.

Bamforth, Douglas B.
1988 *Ecology and Human Organization on the Great Plains*. Plenum Press, New York.

Banks, Larry D.
1984 Lithic Resources and Quarries. *Prehistory of Oklahoma*. Robert E. Bell, ed.: 65-95. Academic Press, Inc., Orlando.
1990. *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Sources in the Trans-Mississippian South, the Southern Plains, and Adjacent Southwest*. Oklahoma Anthropological Society Memoir 4.

Barker, A. W., C. E. Skinner, M. S. Shackley, M. D. Glascock, and J.D. Rogers
2002 Mesoamerican Origin for an Obsidian Scraper from the Precolumbian Southeastern United States. *American Antiquity* 67(1): 103–108.

Bartlett, Robert and Lauren O'Shea
2014 *Archeological Investigations at 34GT47: A Transitional Plains Woodland/Plains Village Site in North Central Oklahoma.* Reports in Highway Archeology 17. Oklahoma Department of Transportation, Oklahoma City.

Baugh, Timothy G.
1986 Culture History and Protohistoric Societies in the Southern Plains. *Plains Anthropologist* 31(114), Part 2, Memoir 21: Current Trends in Southern Plains Archeology: 167 – 187.

Baugh, Timothy G. and Fred W. Nelson Jr.
1987 New Mexico Obsidian Sources and Exchange on the Southern Plains. *In* Journal of Field Archaeology, Vol. 14(3): 313 – 329.

Baugh, Timothy G. and Charles W. Terrell
1982 An Analysis of Obsidian Debitage and Protohistoric Exchange Systems in the Southern Plains as Viewed from the Edwards I Site (34BK2). *In* Plains Anthropologist, Vol. 27(95): 1 – 17.

Baugh, Timothy G. and Don G. Wyckoff
1982 *Edwards I (34BK2): Southern Plains Adaptations in the Protohistoric Period*. Timothy G. Baugh, ed., contributions by Susan Thomas Baugh, Jack L. Hofman, Fern E. Swenson, and Don G. Wyckoff. Studies in Oklahoma's Past 8, Oklahoma Archeological Survey, University of Oklahoma, Norman.

Beale, Nicholas H., Greg J. Maggard, and Mark Latham
2022 *Excavations at the Jumper Creek Site in Central Oklahoma*. Poster presented at the 79th annual Plains Anthropological Society conference, Oklahoma City.

Bell, Robert E.
1948 Recent Archaeological Research in Oklahoma. *Bulletin of the Texas Archeological Society* 19:148-154.
1954a *Buncombe Creek 34MA2*. Oklahoma Archeological Survey Data Record. Oklahoma Archeological Survey, Norman.

Bell, Robert E. (cont.)
1954b Projectile Points from West Central Oklahoma: Dan Base Collection. *Bulletin of the Oklahoma Anthropological Society* 2:12-15.
1958 *Guide to the Identification of Certain American Indian Projectile Points.* Oklahoma Anthropological Society Special Bulletin 1, Oklahoma City.
1959 Obsidian Core Found in Western Oklahoma. *El Palacio* 22: 72.
1960 *Guide to the Identification of Certain American Indian Projectile Points*. Oklahoma Anthropological Society, Special Bulletin 2. Oklahoma City.
1967 The Cooperton Mammoth. *Great Plains Newsletter* 3(5):9.
1977 Early Man Points from Tulsa County. *Oklahoma Anthropological Society Newsletter* 25(1):9.
1984 The Plains Villagers: The Washita River. *Prehistory of Oklahoma*, Robert E. Bell, ed.:307-324. Academic Press, Inc., New York.

Bement, Leland C.
1997 The Cooper Site: A Stratified Folsom Bison Kill in Oklahoma. *Plains Anthropologist* 42(159): 85-99, Memoir 29: Southern Plains Bison Procurement and Utilization from Paleoindian to Historic.
1999 *Bison Hunting at Cooper Site: Where Lightning Bolts Drew Thundering Herds*. University of Oklahoma Press, Norman.

Bement, Leland C. and Kent J. Buehler
2000 *Archaeological Survey of Late Archaic Bison Kill Sites in Beckham County Oklahoma.* Archeological Resource Survey Report 41, University of Oklahoma, Oklahoma Archeological Survey, Norman.

Bement, Leland C. and Scott D. Brosowske
2001 Streams in No Man's Land: A Cultural Resource Survey in Beaver and Texas Counties, Oklahoma. Archeological Resource Survey Report No. 43. Oklahoma Archeological Survey, Norman.

Benefield, Paul and Marjorie Duncan
2021 Replicating Calf Creek Lithic Technology: Heat Treatment of Favored Lithic Materials. *The Calf Creek Horizon: A Mid-Holocene Hunter-Gatherer Adaptation in the Central and Southern Plains of North America.* Jon C. Lohse, Marjorie A. Duncan, and Don G. Wyckoff, eds.:185-205. Texas A&M University Press, College Station.

Bettinger, Robert L., James F. O'Connell, and David Hurst Thomas
1991 Projectile Points as Time Markers in the Great Basin. *American Anthropologist* 93 (1):166-172.

Binford, Lewis R.
1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.
1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:1-17.

Binford, Lewis R. (cont.)
1983 *In Pursuit of the Past*. Thames and Hudson, New York.

Blair, W. F. and T. H. Hubbell
1938 The Biotic Districts of Oklahoma. *The American Midland Naturalist* 20:425-455.

Bonfield, William
1975 Deformation and Fracture Characteristics of the Cooperton Mammoth Bones. *In* Cooperton Mammoth: An Early Man Bone Quarry, Adrian D. Anderson ed.:158-164. *Great Plains Journal* 14:130-173.

Boyd, F. R.
1961 Welded Tuffs and Flows in the Rhyolite Plateau of Yellowstone Park, Wyoming. *Geological Society of America Bulletin* 72:387-426.

Briscoe, James
1993 *Oklahoma Archeological Survey Site File Form SM-7*. Oklahoma Archeological Survey, University of Oklahoma, Department of Anthropology, Norman, Oklahoma.

Brooks, Robert L.
2014 *If It's Bright and Shiny: An Assessment of Sites With Obsidian in Oklahoma.* Paper presented to the 72nd Annual Plains Anthropological Society conference. Fayetteville, Arkansas.

Brooks, Robert L. and Lauren M. Cleland
2015 *The Stalker Site (34GT9): The 1980 – 1982 Phillips University Excavations.* Archeological Resource Survey Report 72. Oklahoma Archeological Survey, Norman.

Brosowske, Scott D.
2005 *The Evolution of Exchange in Small-Scale Societies of the Southern High Plains.* Dissertation, University of Oklahoma, Department of Anthropology, Norman.

Brown, James A.
1984 Arkansas Valley Caddoan: The Spiro Phase. *Prehistory of Oklahoma*, Robert E. Bell, ed.:241-263. Academic Press, Inc., New York.

Buchanan, Briggs, J. David Kilby, Jason M. LaBelle, Todd A. Surovell, Jacob Holland-Lulewicz, and Marcus J. Hamilton
2022 Bayesian Modeling of the Clovis and Folsom Radiocarbon Records Indicates a 200-Year Multigenerational Transition. *American Antiquity* 87(3):567-580.

Bybee, John et al.
2015 *National Register of Historic Places Eligibility Testing of Archaeological Sites 34MY73, 34MY312, 34MY327, and 34MY333, Mayes County, Oklahoma*. Amec Foster Wheeler Environment & Infrastructure, Inc. Report Submitted to the Oklahoma Archeological Survey, Norman.

Caldwell, Joseph R.
1964 Interaction Spheres in Prehistory. *Hopewellian Studies.* Illinois State Museum Scientific Papers 8, Joseph R. Caldwell and Ryan L. Hall, eds.:133-143. Department of Registration and Education, State of Illinois, Springfield.

Carlson, Kristen, Jenna Domeishcel, and Leland Bement
2014 *Archeological Survey Along Cold Springs Creek and Other Drainages Between the Cimarron and Beaver Rivers, Cimarron County, Oklahoma.* Archeological Resource Survey Report 67. Oklahoma Archeological Survey, Norman.

Church, T.
2000 Distribution of Sources of Obsidian in the Rio Grande Gravels of New Mexico. *Geoarchaeology* 15:649-678.

Cojeen, Christopher and Roger Burkhalter
2004 *Report on Archeological Testing at the Chesapeake Operating, Inc. Smallwood #15-5 Well.* Report submitted to the Oklahoma Archeological Survey, Norman.

Corn, T. L.
2006 *Timber Butte Obsidian Source Survey: Geology, Prehistory, Chemical Sourcing, and Debitage Analysis*. MA Thesis, Department of Anthropology, University of Idaho.

Davis, L. B., S. A. Aaberg, J. G. Schmitt, and A. M. Johnson
1995 *The Obsidian Cliff Plateau Prehistoric Lithic Source, Yellowstone National Park, Wyoming.* Selections from the Division of Cultural Resources 6, Rocky Mountain Region, National Park Service.

Delcourt, H. R.
1979 Late Quaternary Vegetation History of the Eastern Highland Rim and Adjacent Cumberland Plateau of Tennessee. *Ecological Monographs* 49(3):255-280.

Dolan, Sean G., M. Steven Shackley, Don G. Wyckoff, and Craig G. Skinner
2018 Long-Distance Conveyance of California Obsidian at the Hayhurst Lithic Cache Site (34ML168) in Oklahoma. *Plains Anthropologist* 63:279-297.

Drager, Dwight L. and Thomas R. Lyons
1985 *Remote Sensing: Photogrammetry in Archeology: The Chaco Mapping Project*. United States Department of the Interior, National Parks Service, Albuquerque.

Drager, Dwight L. and Arthur K. Ireland
1986 *The Seedskadee Project: Remote Sensing in Non-Site Archeology*. United States Project Department of the Interior, National Parks Service, Albuquerque.

Drass, Richard R.
1985 *Archeological Resources in the Bird Creek Basin: Rogers, Tulsa, and Osage Counties, Oklahoma.* Archeological Resource Survey Report 21, Oklahoma Archeological Survey, University of Oklahoma, Norman.
1999 Redefining Plains Village Complexes in Oklahoma: the Paoli Phase and the Redbed Plains Varient. *Plains Anthropologist* 44(168).
2003 *Archeological Survey of Deer Creek and the West Central Canadian River Basin, Blaine, Custer, and Dewey Counties, Oklahoma.* Archeological Resource Survey Report 47, Oklahoma Archeological Survey, University of Oklahoma, Norman.
2016 Personal Communications on Obsidian in North-Central Oklahoma concerning M. Steven Shackley's (No Date) *XRF Analysis of Obsidian Artifacts from Sites 34GR4, 34GV34, 34KA3, 34PW128 in Oklahoma.* Letter Report Prepared for the Oklahoma Archeological Survey.

Ducke, Benjamin
2015 Spatial Cluster Detection in Archaeology: Current Theory and Practice. *Mathematics and Archaeology,* Juan A. Barcelo and Igor Bogdanovic, eds.:352–368. CRC Press, Boca Raton.

Duncan, Marjorie
1995 Calf Creek Foragers: Mobility on the Southern Plains During the Altithermal. *Bulletin of the Oklahoma Anthropological Society* 42:89-144.

Duncan, Marjorie, Larry Neal, Don Shockey, Don Wyckoff, Michael Sullivan, and L. M. Sullivan
2007 *Southern Plains Lithics: The Small Points*. Oklahoma Anthropological Society, Special Bulletin 26, Norman.

Earle, Timothy K.
1982 Prehistoric Economics and the Archaeology of Exchange. *In* Contexts for Prehistoric Exchange, Jonathon E. Ericson and Timothy K. Earle, eds.:1-12. Academic Press, Inc., New York.

Ebert, James I., Eileen L. Camilli, and Michael J. Bermen
1996 GIS in the Analysis of Distributional Archaeological Data. *New Methods, Old Problems: Geographic Information Systems in Modern Archaeological Research*, Herbert D. G. Maschner, ed.:25-37. Center for Archaeological Investigations, Occasional Paper 23. Southern Illinois University, Carbondale.

Ferring, C. Reid
1989 The Aubry Clovis Site: A Paleoindian Locality in the Upper Trinity River Basin, Texas. *Current Research in the Pleistocene* 6:9-11.

Fertelmes, Craig M.
2014 *Vesicular Basalt Provisioning Practices Among the Prehistoric Hohokam of the Salt-Gila Basin, Southern Arizona.* PhD dissertation. Department of Anthropology, Arizona State University, Phoenix.

Flenniken, J. Jeffrey and Philip J. Wilke
1989 Typology, Technology, and Chronology of Great Basin Dart Points. *American Anthropology,* New Series 91 (1):149-158.

Flint, R. F.
1957 *Glacial and Pleistocene Geology*. John Wiley and Sons, New York.

Ford, James A. and Julian H. Steward
1954 On the Concept of Types. *American Anthropologist* 56 (1):42-57.

Frison, George C., Gary A. Wright, James B. Griffin, and Adon A. Gordus
1968 Neutron Activation Analysis of Obsidian: An Example of its Relevance to Northwestern Plains Archaeology. *Plains Anthropologist* 13(41):209-217.

Galm, Jerry R.
1984 Arkansas Valley Caddoan Formative: The Wister and Fourche Maline Phases. *Prehistory of Oklahoma*, Robert E. Bell, ed.:199-219. Academic Press, Inc., New York.

Gamble, Lynn H.
2011 Structural Transformation and Innovation in Emergent Political Economies of Southern California. *In* Hunter-Gatherer Archaeology as Historical Process. Kenneth E. Sassaman and Donald H. Holly Jr., eds.: 227-247. University of Arizona Press, Tucson.

Gettys, Marshall
1984 Early Specialized Hunters. *Prehistory of Oklahoma*, Robert E. Bell, ed.:97-117. Academic Press, Inc., New York.

Glascock, Michael D. et al
1998 A Systematic Approach to Obsidian Source Characterization. *Archaeological Obsidian Studies.* M. Steven Shackley, ed.:15-65. Plenum Press, New York.

Griffin, James B., A. A. Gordus, and G.A. Wright
1969 Identification of the Sources of Hopeweillian Obsidian in the Middle West. *American Antiquity* 34:1-14.

Gunnerson, James A.
1956 Plains-Promontory Relationships. *American Antiquity* 22:69 – 72.
1969 *The Fremont Culture: A Study of Culture Dynamics on the Northern Anasazi Frontier.* Papers of the Peabody Museum of Archaeology and Ethnology 59(2). Harvard University, Cambridge.

Hammatt, Hallett H.
1976 The Gore Pit Site: An Archaic Occupation in Southwestern Oklahoma and a Review of the Archaic Stage in the Southern Plains. *Plains Anthropologist* 21(74):245-277.

Harbottle, Garman
1982 Chemical Characterization in Archaeology. *Contexts for Prehistoric Exchange*, Jonathon E. Ericson and Timothy K. Earle, eds.:13-51. Academic Press, Inc., New York.

Hatch, James W., Joseph W. Michels, Christopher M. Stevenson, Barry E. Sheetz, and Richard A. Geidel
1990 Hopewell Obsidian Studies: Behavioral Implications of Recent Sourcing and Dating Research. *American Antiquity* 55(3):461-479.

Hayden, Brian M.
1981 Interaction Parameters and the Demise of Paleoindian Craftmanship. *Plains Anthropologist* 27:109 – 123.

Hoard, Robert J., C. Tod Bevitt, and Janice McLean
2008 Source Determination of Obsidian from Kansas Archaeological Sites Using Compositional Analysis. *Transactions of the Kansas Academy of Science* 111 (3/4). Kansas Academy of Science.

Hodder, Ian and Clive Orton
1976 *Spatial Analysis in Archaeology*. New Studies in Archaeology. Cambridge University Press: Cambridge.

Hofman, Jack L.
1976 *Oklahoma Archeological Survey Site File Form RM-94*. Oklahoma Archeological Survey, University of Oklahoma, Department of Anthropology, Norman, Oklahoma.
1978 The Development and Northern Relationships of Two Archeological Phases in the Southern Plains Subarea. In *The Central Plains Tradition: Internal Development and External Relationships*, Donald J. Blakeslee, ed., pp. 6–35. Office of the State Archaeologist, University of Iowa, Report 11, Iowa City.
1984 The Plains Villagers: The Custer Phase. *Prehistory of Oklahoma*, Robert E. Bell, ed.:287-305. Academic Press, Inc., New York.
1994 Paleoindian Aggregations on the Great Plains. *Journal of Anthropological Archaeology* 13:341 – 370.

Hofman, Jack L. and Jeannette M. Blackmar
2012 A Cody Complex Site on the Southern Prairie Plains. *Plains Anthropologist* 57 (224): 393 – 410.

Holder, Preston
1973 *The Hoe and the Horse on the Plains.* University of Nebraska Press, Lincoln.

Hughes, David T.
1984 The Foragers: Western Oklahoma. *Prehistory of Oklahoma*, Robert E. Bell, ed.:109-117. Academic Press, Inc., New York.

Hughes, Jack T.
1991 Prehistoric Cultural Developments on the Texas High Plains. *Texas Archeological Society Bulletin* 60:1-55.

Hughes, Richard E.
1983 *Exploring Diachronic Variability in Obsidian Procurement Patterns in Northeast California and Southcentral Oregon: Geochemical Characterization of Obsidian Sources and Projectile Points by Energy-Dispersive X-ray Fluorescence.* Ph.D. Dissertation, Department of Anthropology, University of California, Davis.
1997 *Geochemical Research Laboratory Letter Report 97-90.* October 21, 1997.
1998 On Reliability, Validity, and Scale in Obsidian Sourcing Research. *Unit Issues in Archaeology: Measuring Time, Space, and Material*. Ann Felice Ramenofsky, Anastasia Steffen, eds.:103-114. University of Utah Press, Salt Lake City.
2011 Sources of Inspiration for Studies of Prehistoric Resource Acquisition and Materials Conveyance in California and the Great Basin. *In* Perspectives on Prehistoric Trade and Exchange in California and the Great Basin: 1–21. Richard E. Hughes, ed. University of Utah Press: Salt Lake City.

Irwin-Williams, Cynthia
1973 The Oshara Tradition: Origins of Anasazi Culture. *Eastern New Mexico University Contributions in Anthropology* 5 (1):1-19.

Janetski, Joel C., Cady B. Jardine, and Christopher N. Watkins
2011 Interaction and Exchange in Fremont Society. *Perspectives on Prehistoric Trade and Exchange in California and the Great Basin,* Richard E. Hughes, ed.:2–54. University of Utah Press: Salt Lake City.

Jodry, Margaret A.
1999 *Folsom Technological and Socioeconomic Strategies: View from Stewart's Cattle Guard and the Upper Rio Grande Basin, Colorado.* PhD dissertation, Department of Anthropology, American University, Washington D.C.

Jones, George T. et al.
2012 Reconsidering Paleoarchaic Mobility in the Central Great Basin. *American Antiquity* 77 (2): 351 – 367.

Kelly, Robert L.
1992 Mobility / Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Reviews of Anthropology* 21: 43 – 66.

King, J. E.
1973 Late Pleistocene Palynology and Biogeography of the Western Missouri Ozarks. *Ecological Monographs* 43:539 – 565.

Kooyman, Brian P.
2000 *Understanding Stone Tools and Archaeological Sites.* University of New Mexico Press, Albuquerque.

Latham, Mark
2016 *Research Design for the Data Recovery Fieldwork for Site 34SM87, Seminole County, Oklahoma.* Burns & McDonnell Engineering Company, Inc., Kansas City.

Latham, Mark A., and Edwin R. Hajic
2023 (In Review) *Archaeology of the Jumper Creek Site (34SM87)*. Prepared for Oklahoma Department of Transportation, Jumper Creek Site, Seminole County, Oklahoma, JP No. 28911(04). Burns and McDonnell Engineering Company, Inc., Cultural Resources Research Report Series 7, Kansas City.

Leary, Jim
2014 Past Mobility: An Introduction. *Past Mobilities: Archaeological Approaches to Movement and Mobility*. Jim Leary, ed.:1 – 21. Ashgate Publishing, Ltd., Dorchester.

Lee, Richard B. and Irven Devore
1968 *Man the Hunter*. Aldine Publishing Company, Chicago.

Leith, Luther J.
2011 *A Re-Conceptualization of the Fourche Maline Culture: The Woodland Period as a Transition in Eastern Oklahoma.* Doctoral dissertation, Department of Anthropology, University of Oklahoma, Norman.

Leonhardy, Frank C., ed.
1966a *Domebo: A Paleo-Indian Mammoth Kill in the Prairie-Plains*. Contributions of the Museum of the Great Plains 1. Trustees of The Great Plains Historical Association. Lawton, Oklahoma.
1966b *Test Excavations in the Mangum Reservoir Area of Southwestern Oklahoma.* Contributions of the Museum of the Great Plains 2. Trustees of The Great Plains Historical Association. Lawton, Oklahoma

LeTourneau, P. D., M. S. Shackley, J. M. Warnica, and J. Cummings
1996 Analysis of Obsidian Folsom Artifacts from New Mexico. *Current Research in the Pleistocene* 13:59-61.

Lintz, Christopher
2015 *Obsidian in Oklahoma and Surrounding States.* A master obsidian database. Personal communications Fall of 2015, Norman.

Lintz, Christopher and Leon George Zabawa
1984 The Kenton Caves of Western Oklahoma. *Prehistory of Oklahoma*. Robert E. Bell ed.:161–74. Academic Press, Inc., New York

Liritzis, Ioannis and Nikolaos Zacharias
2011 Portable XRF of Archaeological Artifacts: Current Research, Potentials and Limitations. *X-Ray Fluorescence (XRF) Spectrometry in Geoarchaeology*, M. Steven Shackley, ed.:109-142. Springer Publishers, New York.

Lohse, Jon C., Brenden J. Culleton, and Douglas J. Kennett
2021 A Precise Chronology for Calf Creek. *The Calf Creek Horizon: A Mid-Holocene Hunter-Gatherer Adaptation in the Central and Southern Plains of North America.* Jon C. Lohse, Marjorie A. Duncan, and Don G. Wyckoff, eds.:24–44. Texas A&M University Press, College Station.

Lovis, William A., Robert Whallon, and Randolph E. Donahue
2006 Introduction to Mesolithic Mobility, Exchange, and Interaction: A Special Issue of the Journal of Anthropological Archaeology. *Journal of Anthropological Archaeology* 25:175 – 177.

Malinowski, Bronislaw
1922 *Argonauts of the Western Pacific*. G. Routledge & Sons, London.

Marcum-Heiman, Alesha, Leland C. Bement, and Brian J. Carter
2016 *Cold Springs Warm Hearth: Test Excavations at Sites 34CI480, 34CI488, and 34CI492 Cimarron County, Oklahoma.* Project No. 15-201. Archeological Resource Survey Report 73. University of Oklahoma, Oklahoma Archeological Survey, Norman.

Margolis, Michael et al.
2014 *Archaeological Data Recovery at Site 34CO29, Coal County, Oklahoma*. URS Corporation, Dallas.

Maschner, Herbert D. G.
1996 Geographic Information Systems in Archaeology. *New Methods, Old Problems: Geographic Information Systems in Modern Archaeological Research,* Herbert D. G. Maschner, ed.:1-21. Center for Archaeological Investigations, Occasional Paper 23. Southern Illinois University, Carbondale.

Mauss, Marcel
1950 *The Gift: The Form and Reason for Exchange in Archaic Societies*. 1990 Translation, G. Routledge & Sons, London.

McDermott, John F.
1966 *The Western Journals of Washington Irving.* University of Oklahoma Press, Norman.

Northwest Research Obsidian Studies Laboratory (NROSL)
2011a *Idaho Obsidian Sources (Preliminary).* Available from https://www.sourcecatalog.com/image_maps/map_obsidian_idaho.pdf.
2011b *Idaho Obsidian Sources: Owyhee*. U.S. Obsidian Source Catalog, www.sourcecatalog.com. Available at https://www.sourcecatalog.com/id/source_id_owyhee.pdf

Northwest Research Obsidian Studies Laboratory (NROSL) [cont.]
2011c *Utah Obsidian Sources*. Available from https://www.sourcecatalog.com/image_maps/map_obsidian_utah.pdf.
2011d *Utah Obsidian Sources: Black Rock Area.* U.S. Obsidian Source Catalog, www.sourcecatalog.com. Available at https://www.sourcecatalog.com/ut/source_ut_black_rock_area.pdf.

O'Dell, Larry
2009 Jefferson County. *The Encyclopedia of Oklahoma History and Culture*. https://www.okhistory.org/publications/enc/entry?entry=JE001.

Obradovich,. J. D.
1992 *Geochronology of the Late Cenozoic Volcanism of Yellowstone National Park and Adjoining Areas, Wyoming and Idaho.* U.S. Geological Survey, Open File Report 92-408, Reston, Virginia.

Park, Robin J.
2010 *A Culture of Convenience? Obsidian Source Selection in Yellowstone National Park.* Master's Thesis, Department of Archaeology and Anthropology, University of Saskatchewan, Saskatoon.

Perino, Gregory
1968 *Guide to the Identification of Certain American Indian Projectile Points.* Oklahoma Anthropological Society, Special Bulletin 3, Oklahoma City.
1971 *Guide to the Identification of Certain American Indian Projectile Points.* Oklahoma Anthropological Society, Special Bulletin 4, Oklahoma City.

Pitblado, Bonnie L.
2003 *Late Paleoindian Occupation of the Southern Rocky Mountains: Early Holocene Projectile Points and Land Use in the High Country*. University of Colorado Press, Boulder.
2016 *Personal Communications on Cochetopa Dome Obsidian*. Upper Gunnison Basin, Southwest Colorado.

Pitblado, Bonnie L. (cont.)
2014 An Argument for Ethical, Proactive, Archaeologist-Artifact Collector Collaboration. *American Antiquity* 79(3):385-400.
2022 On Rehumanizing Pleistocene People of the Western Hemisphere. *American Antiquity* 87(2):217-235.
2023 *Personal Communications on the Burnham Site and its Pre-Clovis attribution*. University of Oklahoma, Norman.

Politis, Gustavo G.
1996 Moving to Produce: Nukak Mobility and Settlement Patterns in Amazonia. *World Archaeology* 27 (3): 492 – 511.

Ponomarenko, Alyson Lighthart
2004 The Pachuca Obsidian Source, Hidalgo, Mexico: A Geoarchaeological Perspective. *Geoarchaeology: An International Journal* 19(1):71-91.

Powell, Valli
1995 Bifaces of the Calf Creek Horizon: A Collection from Cedar Canyon, Oklahoma. *Bulletin of the Oklahoma Anthropological Society* 42:145-166.

Prewitt, E. R.
1981 Cultural Chronology in Central Texas. *Bulletin of the Texas Archeological Society* 52:65-89.

Projectilepoints.net
2022a *Owyhee Obsidian*. Available from https://www.projectilepoints.net/Materials/Owyhee%20Obsidian.html
2022b *Black Rock Obsidian.* Available from https://www.projectilepoints.net/Materials/Black%20Rock%20Obsidian.html

Ray, Jack H.
2016 *Projectile Point Types in Missouri and Portions of Adjacent States*. Missouri Archaeological Society Special Publication 10. Missouri Archaeological Society, Springfield.

Renfrew, Colin
1977 Alternative Models of Exchange and Spatial Distribution. *Exchange Systems in Prehistory*. Timothy K. Earle and Jonathon E. Ericson, eds.:71-89. Academic Press, New York.

Rhoton, Charles
1995 Calf Creek on the High Plains, Part II: Finds from Cimarron County, Oklahoma, and Adjacent Parts of Colorado and Texas. *Bulletin of the Oklahoma Anthropological Society* 42:171-178.

Rohrbaugh, Charles L. ed.
1974 *Kaw Reservoir – The Central Section: Report of Phase III Research of the General Plan for Investigation of the Archaeological Resources of Kaw Reservoir, North-Central Oklahoma.* Archaeological Site Report 27, Oklahoma River Basin Survey. University of Oklahoma Office of Research Administration, Norman, Oklahoma.

Sahlins, Marshall D.
1972 *Stone Age Economics*. Aldine-Atherton, Chicago.

Sano, Katsuhiro
2010 Mobility and Lithic Economy in the Terminal Pleistocene of Central Honshu. *Asian Perspectives* 49 (2): 279 – 293.

Sappington, R. L.
1981a A Progress Report on the Obsidian and Vitrophyre Sourcing Project. *Idaho Archaeologist* 4(4):4-17.
1981b Additional Obsidian and Vitrophyre Source Descriptions from Idaho and Adjacent Areas. *Idaho Archaeologist* 5(1):4-8.

Sassaman, Kenneth E.
2001 Hunter-Gatherers and Traditions of Resistance. *The Archaeology of Traditions: Agency and History Before and After Columbus*. Timothy R. Pauketat, ed.:218 – 236. University of Florida Press, Gainesville.

Schmitt, J. G.
1995 Obsidian Cliff Plateau geology and petrography. *The Obsidian Cliff Plateau Prehistoric Lithic Source, Yellowstone National Park, Wyoming*. Davis et al., eds. Selections from the Division of Cultural Resources 6:17-26, Rocky Mountain Region, National Park Service.

Schoen, James R.
1997 As Clear as Opaque Obsidian: Source Locations in Jackson Hole, Wyoming. *Tebiwa* 26 (2): 216-224.

Seeman, Mark F.
1994 Intercluster Lithic Patterning at Nobles Pond: A Case for "Disembedded" Procurement among Early Paleoindian Societies. *American Antiquity* 59:273-288.

Shackley, M. Steven
1988 Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study. *American Antiquity* 53:752-772.
1989 *Early Hunter-Gatherer Procurement Ranges in the Southwest: Evidence from Obsidian Geochemistry and Lithic Technology.* Ph.D. Dissertation, Department of Anthropology, Arizona State University.

Shackley, M. Steven (cont.)
1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60:531-551.
1998 *An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from Eight Prehistoric Sites on the Oklahoma Panhandle*. Letter Report Prepared for the Oklahoma Archeological Survey.
1999 *Source Provenance of Archaeological Obsidian from the Odessa Yates Site (34BV100), Beaver County, Oklahoma*. Letter Report to Scott Brosowske, Oklahoma Archeological Survey.
2001 *X-Ray Fluorescence Analysis of Obsidian and Glass Artifacts from the Oklahoma Panhandle.* Letter Report Prepared for the Oklahoma Archeological Survey.
2003 *Source Provenance of Obsidian Artifacts from the Texas and Oklahoma Panhandles.* Letter Report to Scott Brosowske, Oklahoma Archeological Survey.
2005 *Obsidian: Geology and Archaeology in the North American Southwest*. University of Arizona Press, Tucson.
2009 *An Energy Dispersive X-Ray Fluorescence Analysis of Obsidian from 34KA3, Kay County, Oklahoma.* Letter Report Prepared for Richard Drass, Oklahoma Archeological Survey.
2011 *X-Ray Fluorescence (XRF) Spectrometry in Geoarchaeology*. M. Steven Shackley, ed. Springer Publishers, New York.
2013 *An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from 34GT47, Grant County, Oklahoma*. Letter Report Prepared for Robert Bartlett, Oklahoma Department of Transportation.
2014a *An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from Oklahoma*. Letter Report Prepared for Robert Brooks, Oklahoma Archeological Survey.
2014b *An Energy-Dispersive X-Ray Fluorescence Analysis of Obsidian Artifacts from Various Sites in Oklahoma*. Letter Report to Kristen Carlson, Oklahoma Archeological Survey.
2015a *An Energy-Dispersive X-Ray Fluorescence Analysis of Two Obsidian Artifacts from Oklahoma.* Letter Report Prepared for Leland Bement, Oklahoma Archeological Survey. October 2015, Albuquerque.
2015b *An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian from Chihuahua, Montana, and Oklahoma*. Letter Report Prepared for Sean Dolan, University of Oklahoma.
2015c *An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from Oklahoma*. Letter Report Prepared for Marjorie Duncan, Oklahoma Archeological Survey.
2016 *An Energy-Dispersive X-Ray Fluorescence Analysis of Obsidian Artifacts from 34SM87, Seminole County, Oklahoma*. Letter Report Prepared for Mark Latham, Burns and McDonnell, Inc. March 2016, Albuquerque.
2017a *An Additional Energy-Dispersive X-Ray Fluorescence Analysis of Obsidian Artifacts from 34SM87, Seminole County, Oklahoma.* Letter Report Prepared for Mark Latham, Burns and McDonnell, Inc. January 2017, Albuquerque.

Shackley, M. Steven (cont.)
2017b *An Energy-Dispersive X-Ray Fluorescence Analysis of Obsidian Artifacts from 34SM87, Seminole County, Oklahoma.* Letter Report Prepared for Mark Latham, Burns and McDonnell, Inc. March 2017, Albuquerque.
2021 *Source Provenance of Obsidian Artifacts from the Oklahoma Archaeological Survey.* Report prepared for: Matthew Oliver, Department of Anthropology, University of Oklahoma, Norman. Geoarchaeological X-Ray Fluorescence Spectrometry Laboratory, Albuquerque, New Mexico.

Shott, Michael J.
2004 Hunter-Gatherer Aggregation in Theory and Evidence: The Eastern North American Paleoindian Case. *Hunters and Gatherers in Theory and Archaeology*. George M. Crothers, ed.:8 – 102. Occasional Paper 31, Center for Archaeological Investigations, Southern Illinois University, Carbondale.

Singleton, Eric D. and F. Kent Reilly III
2020 Introduction. *Recovering Ancient Spiro: Native American Art, Ritual, and Cosmic Renewal.* Eric D. Singleton and F. Kent Reilly III, eds.:1-15. National Cowboy and Western Heritage Museum, Oklahoma City.

Skinner, Craig E.
2015 *X-Ray Fluorescence Analysis of Artifact Obsidian from 34MY312, Mayes County, Oklahoma.*

Steeves, Paulette F. C.
2021 *The Indigenous Paleolithic of the Western Hemisphere.* University of Nebraska Press, Lincoln.

Stiger, Mark
2001 *Hunter-Gatherer Archaeology of the Colorado High Country.* University Press of Colorado, Boulder.

Suhm, Dee Ann and Alex D. Krieger
1954 *An Introductory Handbook of Texas Archaeology*. The Texas Archeological Society 25, Abilene.

Taylor-Montoya, John J., Stance Hurst, and M. Steven Shackley
2006 Preliminary Analysis and Geochemical Sourcing of Obsidian Artifacts from the Charley Terrace (34RM439) Late Paleoindigenous site, Roger Mills County, Oklahoma. *Oklahoma Archaeology*, Journal of the Oklahoma Anthropological Society 54(1): 21-32.

Thomas, Suzie, Anna Wessman, Bonnie L. Pitblado, Matthew Rowe, and Bryon Schroeder
2022 Professional-Collector Collaboration: Global Challenges and Solutions. *Advances in Archaeological Practice* 10(3):245-248.

Thompson, R. A.
2004 *Trade or Transport: Occurrence of Obsidian from the Malad, Idaho Source in the Great Plains*. MA Thesis, Department of Anthropology, Idaho State University.

Thomson, Donald F.
1939 The Seasonal Factor of Human Culture. *Proceedings of the Prehistoric Society* 10:209-221.
1949 *Economic Structure and the Ceremonial Exchange Cycle in Arnhem Land.* MacMillan & Co. Ltd., Melbourne.

Vehik, Susan C.
1984 The Woodland Occupations. *Prehistory of Oklahoma*, Robert E. Bell, ed.:175-197. Academic Press, Inc., New York.
1994 Cultural Continuity and Discontinuity in the Southern Prairies and Cross Timbers. *Plains Indians, A.D. 500-1500: The Archaeological Past of Historic Groups.* Karl H. Schlesier, ed.:239-263. University of Oklahoma Press, Norman.

Veth, Peter
2006 Cycles of Aridity and Human Mobility: Risk Minimalization among Late Pleistocene Foragers of the Western Desert, Australia. *Archaeology and Ethnoarchaeology of Mobility*. Frederic Sellet, Russell Greaves, and Pei-Lin Yu, eds.:262-282. The University Press of Florida, Gainesville.

Wallace, Earnest and E. Adamson Hoebel
1952 *The Comanches: Lords of the South Plains.* University of Oklahoma Press, Norman.

Waters, Michael R., Thomas W. Stafford Jr., and David L. Carlson
2020 The Age of Clovis – 13,050 to 12,750 cal yr B.P. *Science Advances* (6).

Weig, Doerte
2015 From Mobility to Motility: Changes in Baka Mobilities and Sociality in North-Eastern Gabon. *Hunter-Gatherer Research* 1.4: 421 – 444.

Wendorf, Fred
1975 Summary and Conclusions. *Southern Methodist University, Publications of the Fort Burgwin Research Center* 9:275-278.

Whallon, Robert J.
2006 Social Networks and Information: Non-"Utilitarian" Mobility Among Hunter-Gatherers. *Journal of Anthropological Archaeology* 25:259 – 270.

White, Ralph W.
1995 Calf Creek on the High Plains, Part I: Some Central Oklahoma Panhandle Finds. *Bulletin of the Oklahoma Anthropological Society* 42:167-170.

Whittaker, John C.
1994 *Flintknapping: Making & Understanding Stone Tools.* University of Texas Press, Austin.

Willingham, Charles G.
1995 Big Table Mountain: An Obsidian Source in the Centennial Mountains of Eastern Idaho. *Idaho Archaeologist* 18:3-7.

Wilson, A. L.
1978 Elemental Analysis of Pottery in the Study of its Provenance: A Review. *Journal of Archaeological Science* 5:219-236.

Wood, W. Raymond
1980 Plains Trade in Prehistoric and Protohistoric Intertribal Relations. *Anthropology of the Great Plains*. W. Raymond Wood and Margot Liberty, eds.:98-109. University of Nebraska Press, Lincoln.

Woods, A.J., Omernik, J.M., Butler, D.R., Ford, J.G., Henley, J.E., Hoagland, B.W., Arndt, D.S., and Moran, B.C.
2005 *Ecoregions of Oklahoma* (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,250,000).

Wyckoff, Don G. and Robert L. Brooks
1983 *Oklahoma Archeology: A 1981 Perspective of the State's Archeological Resources, Their Significance, Their Problems and Some Proposed Solutions.* Archeological Resource Survey Report 16, Oklahoma Archeological Survey, University of Oklahoma, Norman.

Wyckoff, Don G. and Brian J. Carter
2003 Dating the Burnham Site. *The Burnham Site in Northwestern Oklahoma: Glimpses Beyond Clovis?* Don G. Wyckoff, James L. Theler, and Brian J. Carter, eds.: 249-262. Sam Noble Oklahoma Museum of Natural History, University of Oklahoma, Oklahoma Anthropological Society Memoir 9, Norman.

Wyckoff, Don G., James L. Theler, and Brian J. Carter, eds.
2003 *The Burnham Site in Northwestern Oklahoma: Glimpses Beyond Clovis?* Sam Noble Oklahoma Museum of Natural History, University of Oklahoma, Oklahoma Anthropological Society Memoir 9, Norman.

Wyckoff, Don G. and Lyonel Taylor
1971 The Pumpkin Creek Site, an Early Archaic Site in the Southern Plains Border. *Plains Anthropologist* 16(51):20-50.

Wyckoff, Don G.

1964 *The Archaeological Survey of the Kaw Reservoir, Kay and Osage Counties, Oklahoma*. General Survey Report 6, Oklahoma River Basin Survey Project. University of Oklahoma Research Institute, Norman, Oklahoma.

1984 The Cross Timbers: An Ecotone in Historic Perspective. *Contributions to Cross Timbers Prehistory*. Oklahoma Archeological Survey, Studies in Oklahoma's Past 12, Cross Timbers Heritage Association Contribution 3:1-20. University of Oklahoma, Norman.

1995 A Summary of the Calf Creek Horizon in Oklahoma. *Bulletin of the Oklahoma Anthropological Society* 42:179-210.

APPENDIX A

Comprehensive Artifact Inventory

Artifact #	County	Site #	Specimen	Type (typology)	Collection
1	?	?	Projectile Point	Harrell	Goodner
2	?	?	Projectile Point		Goodner
3	?	?	Projectile Point		Goodner
4	?	?	Projectile Point Base		Goodner
5	?	?	Flake	Overshot	Goodner
6	?	?	Flake		Goodner
7	?	?	Flake		Goodner
8	Beaver	?	Projectile Point	Washita	H. Ketchell
9	Beaver	?	Projectile Point		H. Ketchell
10	Beaver	?	Projectile Point	Pandale	H. Ketchell
11	Beaver	?	Projectile Point	Deadman's	H. Ketchell
12	Beaver	?	Projectile Point		H. Ketchell
13	Beaver	?	Mid-Section		H. Ketchell
14	Beaver	?	Mid-Section		H. Ketchell
15	Beaver	?	Mid-Section		H. Ketchell
16	Beaver	?	Projectile Point Base		H. Ketchell
17	Beaver	?	Biface / Preform		H. Ketchell
18	Beaver	BV104	Eccentric / Biface		R. Tibbetts
19	Beaver	"Newton Site"	Biface		R. Tibbetts
20	Beaver	"Oilfield Site"	Flake		R. Tibbetts
21	Beaver	BV140	Flake		R. Tibbetts
22	Beaver	BV140	Flake		R. Tibbetts
23	Beaver	BV140	Flake		R. Tibbetts
24	Beaver	BV140	Flake		R. Tibbetts
25	Beaver	BV149	Biface	Pendant	B. Kerns

26	Beaver	BV171	Projectile Point Base		B. Kerns
27	Beaver	BV171	Projectile Point Base		B. Kerns
28	Beaver	BV171	Projectile Point Base		B. Kerns
29	Beaver	BV171	Scraper		B. Kerns
30	Beaver	BV171	Projectile Point Tip		B. Kerns
31	Beaver	BV171	Biface		B. Kerns
32	Beaver	BV171	Flake		B. Kerns
33	Beaver	BV171	Flake		B. Kerns
34	Beaver	BV171	Biface Fragment		B. Kerns
35	Beaver	BV171	Flake		B. Kerns
36	Beaver	BV171	Flake		B. Kerns
37	Beaver	BV171	Biface Fragment		B. Kerns
38	Beaver	?	Flake		B. Kerns
39	Beaver	?	Flake		B. Kerns
40	Beaver	?	Projectile Point Fragment		B. Kerns
41	Beaver	?	Biface Fragment		B. Kerns
42	Beaver	?	Flake		B. Kerns
43	Beaver	?	Flake		B. Kerns
44	Beaver	?	Eccentric		B. Kerns
45	Kingfisher	?	Projectile Point Fragment		?
46	Texas	?	Projectile Point	Fresno	R. Williams
47	Beaver	BV100	Projectile Point Base	Washita	K. Karber
48	?	?	Projectile Point		B. Ramsey
49	Tillman	?	Projectile Point		B. Ramsey
50	Cimarron	?	Projectile Point		B. Ramsey
51	Cimarron	?	Projectile Point		B. Ramsey

52	Washita	?	Projectile Point		B. Ramsey
53	Washita	?	Projectile Point Base	Harrell	B. Ramsey
54	Beaver	BV100	Flake		K. Karber
55	Beaver	BV111	Projectile Point Base	Corner Notch Dart Point	K. Karber
56	Texas	TX135	Projectile Point	Washita	K. Karber
57	Beaver	BV100	Projectile Point Base Fragment		K. Karber
58	Beaver	BV100	Mid-Section		K. Karber
59	Beaver	BV100	Projectile Point Base	Fresno	K. Karber
60	Beaver	BV100	Projectile Point Tip		K. Karber
61	Beaver	BV100	Projectile Point Tip		K. Karber
62	Beaver	BV100	Projectile Point Tip		K. Karber
63	Beaver	BV100	Projectile Point Base	Washita	K. Karber
64	Beaver	BV100	Projectile Point Base	Fresno	K. Karber
65	Beaver	BV99	Shatter		K. Karber
66	Beaver	BV99	Projectile Point Fragment	Washita	K. Karber
67	Beaver	BV99	Projectile Point	Washita	K. Karber
68	Beaver	BV100	Projectile Point Tip		K. Karber
69	Beaver	BV100	Flake		K. Karber
70	Beaver	BV99/BV100	Projectile Point Tip		K. Karber
71	Beaver	BV99/BV100	Projectile Point Tip		K. Karber
72	Beaver	BV100	Projectile Point Tip		K. Karber
73	Beaver	BV100	Projectile Point	Fresno (Large)	K. Karber
74	Beaver	BV100	Projectile Point Fragment	Washita	K. Karber
75	Beaver	BV100	Flake		K. Karber
76	Beaver	BV100	Projectile Point Base		K. Karber
77	Beaver	BV100	Flake		K. Karber

78	Beaver	BV100	Flake		K. Karber
79	Beaver	BV99/BV100	Projectile Point Base	Washita	K. Karber
80	Beaver	BV100	Projectile Point Base	Washita	K. Karber
81	Beaver	BV100	Projectile Point Fragment		K. Karber
82	Beaver	BV100	Projectile Point Base	Fresno	K. Karber
83	Beaver	BV100	Projectile Point Base	Fresno	K. Karber
84	Beaver	BV100	Projectile Point Base	Washita	K. Karber
85	Beaver	BV99/BV100	Projectile Point Fragment		K. Karber
86	Beaver	BV100	Flake		K. Karber
87	Beaver	BV100	Biface / Preform		K. Karber
88	Beaver	BV100	Projectile Point Fragment		K. Karber
89	Beaver	BV100	Biface Fragment		K. Karber
90	Beaver	BV99/BV100	Projectile Point Fragment		K. Karber
91	Beaver	BV99/BV100	Projectile Point Base	Fresno	K. Karber
92	Beaver	BV99/BV100	Projectile Point Base	Fresno	K. Karber
93	Beaver	BV99/BV100	Projectile Point Tip		K. Karber
94	Beaver	BV99/BV100	Projectile Point Base	Fresno	K. Karber
95	Beaver	BV99/BV100	Projectile Point Base	Fresno	K. Karber
96	Beaver	BV99/BV100	Projectile Point Base	Fresno	K. Karber
97	Beaver	BV100	Core		K. Karber
98	Beaver	BV100	Flake		K. Karber
99	Beaver	BV100	Flake		K. Karber
100	Beaver	BV100	Shatter		K. Karber
101	Beaver	BV100	Flake		K. Karber
102	Beaver	BV100	flake		K. Karber

103	Beaver	BV100	Flake		K. Karber
104	Beaver	BV100	flake		K. Karber
105	Beaver	BV100	flake		K. Karber
106	Beaver	BV100	flake		K. Karber
107	Beaver	BV100	flake		K. Karber
108	Beaver	BV100	flake		K. Karber
109	Beaver	BV100	flake		K. Karber
110	Beaver	BV100	flake		K. Karber
111	Beaver	BV100	flake		K. Karber
112	Beaver	BV100	flake		K. Karber
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114	Beaver	BV100	flake		K. Karber
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116	Beaver	BV100	flake		K. Karber
117	Beaver	BV100	flake		K. Karber
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121	Beaver	BV100	flake		K. Karber
122	Beaver	BV100	flake		K. Karber
123	Beaver	BV100	flake		K. Karber
124	Beaver	BV100	flake		K. Karber
125	Beaver	BV100	flake		K. Karber
126	Beaver	BV100	flake		K. Karber
127	Beaver	BV100	shatter		K. Karber
128	Beaver	BV100	flake		K. Karber
129	Beaver	BV100	shatter		K. Karber
130	Beaver	BV100	flake		K. Karber

131	Beaver	BV100	flake		K. Karber
132	Beaver	BV100	flake		K. Karber
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135	Beaver	BV100	flake		K. Karber
136	Beaver	BV100	flake		K. Karber
137	Beaver	BV100	flake		K. Karber
138	Beaver	BV100	flake		K. Karber
139	Beaver	BV100	shatter		K. Karber
140	Beaver	BV100	flake		K. Karber
141	Beaver	BV100	flake		K. Karber
142	Beaver	BV100	flake		K. Karber
143	Beaver	BV100	flake		K. Karber
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148	Beaver	BV100	flake		K. Karber
149	Beaver	BV100	flake		K. Karber
150	Beaver	BV100	flake		K. Karber
151	Beaver	BV100	flake		K. Karber
152	Beaver	BV100	flake		K. Karber
153	Beaver	BV100	flake		K. Karber
154	Beaver	BV100	flake		K. Karber
155	Beaver	BV100	flake		K. Karber
156	Beaver	BV100	flake		K. Karber
157	Beaver	BV100	flake		K. Karber
158	Beaver	BV100	flake		K. Karber

159	Beaver	BV100	flake		K. Karber
160	Beaver	BV100	shatter		K. Karber
161	Beaver	BV100	flake		K. Karber
162	Beaver	BV100	flake		K. Karber
163	Beaver	BV100	flake		K. Karber
164	Beaver	BV100	flake		K. Karber
165	Beaver	BV100	flake		K. Karber
166	Beaver	BV100	flake		K. Karber
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168	Beaver	BV100	flake		K. Karber
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170	Beaver	BV100	flake		K. Karber
171	Beaver	BV100	flake		K. Karber
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175	Beaver	BV100	flake		K. Karber
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177	Beaver	BV100	flake		K. Karber
178	Beaver	BV100	flake		K. Karber
179	Beaver	BV100	flake		K. Karber
180	Beaver	BV100	flake		K. Karber
181	Beaver	BV100	flake		K. Karber
182	Beaver	BV100	flake		K. Karber
183	Beaver	BV100	flake		K. Karber
184	Beaver	BV100	shatter		K. Karber
185	Beaver	BV100	shatter		K. Karber
186	Beaver	BV100	shatter		K. Karber

187	Beaver	BV100	flake		K. Karber
188	Beaver	BV100	flake		K. Karber
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190	Beaver	BV100	flake		K. Karber
191	Beaver	BV100	flake		K. Karber
192	Beaver	BV100	flake		K. Karber
193	Beaver	BV100	flake		K. Karber
194	Beaver	BV100	flake		K. Karber
195	Beaver	BV100	flake		K. Karber
196	Beaver	BV100	flake		K. Karber
197	Beaver	BV100	flake		K. Karber
198	Beaver	BV100	flake		K. Karber
199	Beaver	BV100	Biface Fragment		K. Karber
200	Beaver	BV100	Biface		K. Karber
201	Beaver	BV100	flake		K. Karber
202	Beaver	BV100	flake		K. Karber
203	Beaver	BV100	flake		K. Karber
204	Beaver	BV100	flake		K. Karber
205	Beaver	BV100	flake		K. Karber
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210	Beaver	BV100	flake		K. Karber
211	Beaver	BV100	flake		K. Karber
212	Beaver	BV100	flake		K. Karber
213	Beaver	BV100	shatter		K. Karber
214	Beaver	BV100	flake		K. Karber

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226	Beaver	BV100	flake		K. Karber
227	Beaver	BV100	flake		K. Karber
228	Beaver	BV100	shatter		K. Karber
229	Beaver	BV100	flake		K. Karber
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232	Beaver	BV100	flake		K. Karber
233	Beaver	BV100	flake		K. Karber
234	Beaver	BV100	shatter		K. Karber
235	Beaver	BV100	flake		K. Karber
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246	Beaver	BV100	shatter		K. Karber
247	Beaver	BV100	flake		K. Karber
248	Beaver	BV100	Biface Fragment		K. Karber
249	Beaver	BV100	flake		K. Karber
250	Beaver	BV100	flake		K. Karber
251	Beaver	BV100	flake		K. Karber
252	Beaver	BV100	Biface Fragment		K. Karber
253	Beaver	BV100	shatter		K. Karber
254	Beaver	BV100	flake		K. Karber
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260	Beaver	BV100	shatter		K. Karber
261	Beaver	BV100	flake		K. Karber
262	Beaver	BV100	shatter		K. Karber
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265	Beaver	BV100	shatter		K. Karber
266	Beaver	BV100	flake		K. Karber
267	Beaver	BV100	flake		K. Karber
268	Beaver	BV100	flake		K. Karber
269	Beaver	BV100	flake		K. Karber
270	Beaver	BV100	shatter		K. Karber

271	Beaver	BV100	flake		K. Karber
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274	Beaver	BV100	flake		K. Karber
275	Beaver	BV100	flake		K. Karber
276	Beaver	BV100	shatter		K. Karber
277	Beaver	BV100	flake		K. Karber
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289	Beaver	BV100	flake		K. Karber
290	Beaver	BV100	shatter		K. Karber
291	Beaver	BV100	flake		K. Karber
292	Beaver	BV100	shatter		K. Karber
293	Beaver	BV100	Biface Fragment		K. Karber
294	Beaver	BV100	flake		K. Karber
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301	Beaver	BV100	flake		K. Karber
302	Beaver	BV100	shatter		K. Karber
303	Beaver	BV100	flake		K. Karber
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306	Beaver	BV100	flake		K. Karber
307	Beaver	BV100	shatter		K. Karber
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309	Beaver	BV100	shatter		K. Karber
310	Beaver	BV100	shatter		K. Karber
311	Beaver	BV100	shatter		K. Karber
312	Beaver	BV100	shatter		K. Karber
313	Beaver	BV100	flake		K. Karber
314	Beaver	BV100	flake		K. Karber
315	Beaver	BV100	Core (possible)		K. Karber
316	Beaver	BV100	flake		K. Karber
317	Beaver	BV100	flake		K. Karber
318	Beaver	BV100	flake		K. Karber
319	Beaver	BV100	flake		K. Karber
320	Beaver	BV100	flake		K. Karber
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322	Beaver	BV100	flake		K. Karber
323	Beaver	BV100	shatter		K. Karber
324	Beaver	BV100	flake		K. Karber
325	Beaver	BV100	flake		K. Karber
326	Beaver	BV100	shatter		K. Karber

327	Beaver	BV100	flake		K. Karber
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334	Beaver	BV100	flake		K. Karber
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336	Beaver	BV100	flake		K. Karber
337	Beaver	BV100	shatter		K. Karber
338	Beaver	BV100	flake		K. Karber
339	Beaver	BV100	flake		K. Karber
340	Beaver	BV100	flake		K. Karber
341	Beaver	BV100	flake		K. Karber
342	Beaver	BV100	Biface Fragment		K. Karber
343	Beaver	BV100	flake		K. Karber
344	Beaver	BV100	flake		K. Karber
345	Beaver	BV100	flake		K. Karber
346	Beaver	BV100	flake		K. Karber
347	Beaver	BV100	shatter		K. Karber
348	Beaver	BV100	flake		K. Karber
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363	Beaver	BV100	flake		K. Karber
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365	Beaver	BV100	flake		K. Karber
366	Beaver	BV100	shatter		K. Karber
367	Beaver	BV100	flake		K. Karber
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370	Beaver	BV100	flake		K. Karber
371	Beaver	BV100	shatter		K. Karber
372	Beaver	BV100	shatter		K. Karber
373	Beaver	BV100	flake		K. Karber
374	Beaver	BV100	flake		K. Karber
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376	Beaver	BV100	flake		K. Karber
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393	Beaver	BV100	flake		K. Karber
394	Beaver	BV100	flake		K. Karber
395	Beaver	BV100	shatter		K. Karber
396	Beaver	BV100	shatter		K. Karber
397	Beaver	BV100	flake		K. Karber
398	Beaver	BV100	flake		K. Karber
399	Beaver	BV100	shatter		K. Karber
400	Beaver	BV100	flake		K. Karber
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407	Beaver	BV100	flake		K. Karber
408	Beaver	BV100	flake		K. Karber
409	Beaver	BV100	flake		K. Karber
410	Beaver	BV100	flake		K. Karber

411	Beaver	BV100	flake		K. Karber
412	Beaver	BV100	flake		K. Karber
413	Beaver	BV100	flake		K. Karber
414	Beaver	BV100	flake		K. Karber
415	Beaver	BV100	flake		K. Karber
416	Beaver	BV100	Projectile Point Base	Fresno	K. Karber
417	Beaver	BV100	flake		K. Karber
418	Beaver	BV100	flake		K. Karber
419	Beaver	BV100	flake		K. Karber
420	Beaver	BV100	flake		K. Karber
421	Beaver	BV100	flake		K. Karber
422	Beaver	BV100	flake		K. Karber
423	Beaver	BV100	flake		K. Karber
424	Beaver	BV100	flake		K. Karber
425	Beaver	BV100	flake		K. Karber
426	Beaver	BV100	flake		K. Karber
427	Beaver	BV100	flake		K. Karber
428	Beaver	BV100	shatter		K. Karber
429	Beaver	BV100	flake		K. Karber
430	Beaver	BV100	flake		K. Karber
431	Beaver	BV100	flake		K. Karber
432	Beaver	BV100	flake		K. Karber
433	Beaver	BV100	flake		K. Karber
434	Beaver	BV100	flake		K. Karber
435	Beaver	BV100	flake		K. Karber
436	Beaver	BV100	flake		K. Karber
437	Beaver	BV100	flake		K. Karber
438	Beaver	BV100	flake		K. Karber

439	Beaver	BV100	flake		K. Karber
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449	Beaver	BV100	flake		K. Karber
450	Beaver	BV100	flake		K. Karber
451	Beaver	BV100	flake		K. Karber
452	Beaver	BV100	flake		K. Karber
453	Beaver	BV100	shatter		K. Karber
454	Beaver	BV100	flake		K. Karber
455	Beaver	BV100	flake		K. Karber
456	Beaver	BV100	flake		K. Karber
457	Beaver	BV100	flake		K. Karber
458	Beaver	BV100	flake		K. Karber
459	Beaver	BV100	flake		K. Karber
460	Beaver	BV100	flake		K. Karber
461	Beaver	BV100	flake		K. Karber
462	Beaver	BV100	flake		K. Karber
463	Beaver	BV100	flake		K. Karber
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486	Beaver	BV100	flake		K. Karber
487	Beaver	BV100	flake		K. Karber
488	Beaver	BV100	shatter		K. Karber
489	Beaver	BV100	shatter		K. Karber
490	Beaver	BV100	flake		K. Karber
491	Beaver	BV100	flake		K. Karber
492	Beaver	BV100	flake		K. Karber
493	Beaver	BV100	shatter		K. Karber
494	Beaver	BV100	flake		K. Karber

495	Beaver	BV100	flake		K. Karber
496	Beaver	BV100	flake		K. Karber
497	Beaver	BV100	flake		K. Karber
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501	Beaver	BV100	flake		K. Karber
502	Beaver	BV100	flake		K. Karber
503	Beaver	BV100	shatter		K. Karber
504	Beaver	BV100	flake		K. Karber
505	Beaver	BV100	flake		K. Karber
506	Beaver	BV100	flake		K. Karber
507	Beaver	BV100	flake		K. Karber
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513	Beaver	BV100	flake		K. Karber
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525	Beaver	BV100	flake		K. Karber
526	Beaver	BV100	shatter		K. Karber
527	Beaver	BV100	flake		K. Karber
528	Beaver	BV100	flake		K. Karber
529	Beaver	BV100	flake		K. Karber
530	Beaver	BV100	flake		K. Karber
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533	Beaver	BV100	shatter		K. Karber
534	Beaver	BV100	flake		K. Karber
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536	Beaver	BV100	flake		K. Karber
537	Beaver	BV100	shatter		K. Karber
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539	Beaver	BV100	flake		K. Karber
540	Beaver	BV100	shatter		K. Karber
541	Beaver	BV100	flake		K. Karber
542	Beaver	BV100	flake		K. Karber
543	Beaver	BV100	flake		K. Karber
544	Beaver	BV100	flake		K. Karber
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549	Beaver	BV100	flake		K. Karber
550	Beaver	BV100	shatter		K. Karber

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557	Beaver	BV100	flake		K. Karber
558	Beaver	BV100	flake		K. Karber
559	Beaver	BV100	flake		K. Karber
560	Beaver	BV100	shatter		K. Karber
561	Beaver	BV100	flake		K. Karber
562	Beaver	BV100	flake		K. Karber
563	Beaver	BV100	flake		K. Karber
564	Beaver	BV100	flake		K. Karber
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569	Beaver	BV100	flake		K. Karber
570	Beaver	BV100	flake		K. Karber
571	Beaver	BV100	flake		K. Karber
572	Beaver	BV100	flake		K. Karber
573	Beaver	BV100	shatter		K. Karber
574	Beaver	BV100	flake		K. Karber
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583	Beaver	BV100	flake		K. Karber
584	Beaver	BV100	shatter		K. Karber
585	Beaver	BV100	flake		K. Karber
586	Beaver	BV100	shatter		K. Karber
587	Beaver	BV100	flake		K. Karber
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589	Beaver	BV100	flake		K. Karber
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591	Beaver	BV100	flake		K. Karber
592	Beaver	BV100	flake		K. Karber
593	Beaver	BV100	flake		K. Karber
594	Beaver	BV100	shatter		K. Karber
595	Beaver	BV100	flake		K. Karber
596	Beaver	BV100	flake		K. Karber
597	Beaver	BV100	shatter		K. Karber
598	Beaver	BV100	flake		K. Karber
599	Beaver	BV100	flake		K. Karber
600	Beaver	BV100	shatter		K. Karber
601	Beaver	BV100	flake		K. Karber
602	Beaver	BV100	flake		K. Karber
603	Beaver	BV100	flake		K. Karber
604	Beaver	BV100	flake		K. Karber
605	Beaver	BV100	flake		K. Karber
606	Beaver	BV100	flake		K. Karber

607	Beaver	BV100	shatter		K. Karber
608	Beaver	BV100	flake		K. Karber
609	Beaver	BV100	flake		K. Karber
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611	Beaver	BV100	flake		K. Karber
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615	Beaver	BV100	flake		K. Karber
616	Beaver	BV100	flake		K. Karber
617	Beaver	BV100	flake		K. Karber
618	Beaver	BV100	shatter		K. Karber
619	Beaver	BV100	flake		K. Karber
620	Beaver	BV100	flake		K. Karber
621	Beaver	BV100	flake		K. Karber
622	Beaver	BV100	shatter		K. Karber
623	Beaver	BV100	shatter		K. Karber
624	Beaver	BV100	flake		K. Karber
625	Beaver	BV100	flake		K. Karber
626	Beaver	BV100	flake		K. Karber
627	Beaver	BV100	flake		K. Karber
628	Beaver	BV100	flake		K. Karber
629	Beaver	BV100	flake		K. Karber
630	Beaver	BV100	flake		K. Karber
631	Beaver	BV100	flake		K. Karber
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633	Beaver	BV100	flake		K. Karber
634	Beaver	BV100	flake		K. Karber

635	Beaver	BV100	flake		K. Karber
636	Beaver	BV100	shatter		K. Karber
637	Beaver	BV100	flake		K. Karber
638	Beaver	BV100	flake		K. Karber
639	Beaver	BV100	shatter		K. Karber
640	Beaver	BV100	flake		K. Karber
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642	Beaver	BV100	flake		K. Karber
643	Beaver	BV100	flake		K. Karber
644	Beaver	BV100	flake		K. Karber
645	Beaver	BV100	shatter		K. Karber
646	Beaver	BV100	flake		K. Karber
647	Beaver	BV100	flake		K. Karber
648	Beaver	BV100	flake		K. Karber
649	Beaver	BV100	flake		K. Karber
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658	Beaver	BV100	flake		K. Karber
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660	Beaver	BV100	flake		K. Karber
661	Beaver	BV100	shatter		K. Karber
662	Beaver	BV100	flake		K. Karber

663	Beaver	BV100	flake		K. Karber
664	Beaver	BV100	flake		K. Karber
665	Beaver	BV100	flake		K. Karber
666	Beaver	BV100	shatter		K. Karber
667	Beaver	BV100	flake		K. Karber
668	Beaver	BV100	shatter		K. Karber
669	Beaver	BV100	shatter		K. Karber
670	Beaver	BV100	flake		K. Karber
671	Beaver	BV100	flake		K. Karber
672	Beaver	BV100	shatter		K. Karber
673	Beaver	BV100	flake		K. Karber
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675	Beaver	BV100	flake		K. Karber
676	Beaver	BV100	flake		K. Karber
677	Beaver	BV100	flake		K. Karber
678	Beaver	BV100	shatter		K. Karber
679	Beaver	BV100	flake		K. Karber
680	Beaver	BV100	flake		K. Karber
681	Beaver	BV100	flake		K. Karber
682	Beaver	BV100	flake		K. Karber
683	Beaver	BV100	shatter		K. Karber
684	Beaver	BV100	flake		K. Karber
685	Beaver	BV100	shatter		K. Karber
686	Beaver	BV100	flake		K. Karber
687	Beaver	BV100	shatter		K. Karber
688	Beaver	BV100	flake		K. Karber
689	Beaver	BV100	flake		K. Karber
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691	Beaver	BV100	flake		K. Karber
692	Beaver	BV100	shatter		K. Karber
693	Beaver	BV100	flake		K. Karber
694	Beaver	BV100	flake		K. Karber
695	Beaver	BV100	flake		K. Karber
696	Beaver	BV100	flake		K. Karber
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711	Beaver	BV100	flake		K. Karber
712	Beaver	BV100	flake		K. Karber
713	Beaver	BV100	flake		K. Karber
714	Beaver	BV100	shatter		K. Karber
715	Beaver	BV100	shatter		K. Karber
716	Beaver	BV100	flake		K. Karber
717	Beaver	BV100	flake		K. Karber
718	Beaver	BV100	flake		K. Karber

719	Beaver	BV100	flake		K. Karber
720	Beaver	BV100	flake		K. Karber
721	Beaver	BV100	flake		K. Karber
722	Beaver	BV100	flake		K. Karber
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724	Beaver	BV100	flake		K. Karber
725	Beaver	BV100	flake		K. Karber
726	Beaver	BV100	flake		K. Karber
727	Beaver	BV100	shatter		K. Karber
728	Beaver	BV100	flake		K. Karber
729	Beaver	BV100	flake		K. Karber
730	Beaver	BV100	shatter		K. Karber
731	Beaver	BV100	flake		K. Karber
732	Beaver	BV100	flake		K. Karber
733	Beaver	BV100	flake		K. Karber
734	Beaver	BV100	flake		K. Karber
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736	Beaver	BV100	flake		K. Karber
737	Beaver	BV100	flake		K. Karber
738	Beaver	BV100	flake		K. Karber
739	Beaver	BV100	flake		K. Karber
740	Beaver	BV100	flake		K. Karber
741	Beaver	BV100	flake		K. Karber
742	Beaver	BV100	shatter		K. Karber
743	Beaver	BV100	flake		K. Karber
744	Beaver	BV100	flake		K. Karber
745	Beaver	BV100	flake		K. Karber
746	Beaver	BV100	shatter		K. Karber

747	Beaver	BV100	flake		K. Karber
748	Beaver	BV100	flake		K. Karber
749	Beaver	BV100	flake		K. Karber
750	Beaver	BV100	shatter		K. Karber
751	Beaver	BV100	flake		K. Karber
752	Beaver	BV100	shatter		K. Karber
753	Beaver	BV100	flake		K. Karber
754	Beaver	BV100	flake		K. Karber
755	Beaver	BV100	shatter		K. Karber
756	Beaver	BV100	flake		K. Karber
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764	Beaver	BV100	flake		K. Karber
765	Beaver	BV100	flake		K. Karber
766	Beaver	BV100	shatter		K. Karber
767	Beaver	BV100	flake		K. Karber
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769	Beaver	BV100	flake		K. Karber
770	Beaver	BV100	flake		K. Karber
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778	Beaver	BV100	flake		K. Karber
779	Beaver	BV100	flake		K. Karber
780	Beaver	BV100	shatter		K. Karber
781	Beaver	BV100	flake		K. Karber
782	Beaver	BV100	flake		K. Karber
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784	Beaver	BV100	flake		K. Karber
785	Beaver	BV100	flake		K. Karber
786	Beaver	BV100	flake		K. Karber
787	Beaver	BV100	shatter		K. Karber
788	Beaver	BV100	shatter		K. Karber
789	Beaver	BV100	flake		K. Karber
790	Beaver	BV100	flake		K. Karber
791	Beaver	BV100	flake		K. Karber
792	Beaver	BV100	flake		K. Karber
793	Beaver	BV100	flake		K. Karber
794	Beaver	BV100	flake		K. Karber
795	Beaver	BV100	flake		K. Karber
796	Beaver	BV100	shatter		K. Karber
797	Beaver	BV100	shatter		K. Karber
798	Beaver	BV100	flake		K. Karber
799	Beaver	BV100	flake		K. Karber
800	Beaver	BV100	flake		K. Karber
801	Beaver	BV100	flake		K. Karber
802	Beaver	BV100	shatter		K. Karber

803	Beaver	BV100	flake		K. Karber
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806	Beaver	BV100	flake		K. Karber
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814	Beaver	BV100	flake		K. Karber
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816	Beaver	BV100	flake		K. Karber
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818	Beaver	BV100	flake		K. Karber
819	Beaver	BV100	flake		K. Karber
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823	Beaver	BV100	flake		K. Karber
824	Beaver	BV100	flake		K. Karber
825	Beaver	BV100	flake		K. Karber
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830	Beaver	BV100	flake		K. Karber

831	Beaver	BV100	flake		K. Karber
832	Beaver	BV100	flake		K. Karber
833	Beaver	BV100	shatter		K. Karber
834	Beaver	BV100	flake		K. Karber
835	Beaver	BV100	flake		K. Karber
836	Beaver	BV100	shatter		K. Karber
837	Beaver	BV100	flake		K. Karber
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840	Beaver	BV100	flake		K. Karber
841	Beaver	BV100	shatter		K. Karber
842	Beaver	BV100	flake		K. Karber
843	Beaver	BV100	shatter		K. Karber
844	Beaver	BV100	shatter		K. Karber
845	Beaver	BV100	flake		K. Karber
846	Beaver	BV100	flake		K. Karber
847	Beaver	BV100	shatter		K. Karber
848	Beaver	BV100	shatter		K. Karber
849	Beaver	BV100	flake		K. Karber
850	Beaver	BV100	flake		K. Karber
851	Beaver	BV100	flake		K. Karber
852	Beaver	BV100	shatter		K. Karber
853	Beaver	BV100	flake		K. Karber
854	Beaver	BV100	flake		K. Karber
855	Beaver	BV100	shatter		K. Karber
856	Beaver	BV100	shatter		K. Karber
857	Beaver	BV100	shatter		K. Karber
858	Beaver	BV100	flake		K. Karber

859	Beaver	BV100	flake		K. Karber
860	Beaver	BV100	flake		K. Karber
861	Beaver	BV100	flake		K. Karber
862	Beaver	BV100	flake		K. Karber
863	Beaver	BV100	shatter		K. Karber
864	Beaver	BV100	flake		K. Karber
865	Beaver	BV100	flake		K. Karber
866	Beaver	BV100	flake		K. Karber
867	Beaver	BV100	flake		K. Karber
868	Beaver	BV100	flake		K. Karber
869	Beaver	BV100	flake		K. Karber
870	Beaver	BV100	flake		K. Karber
871	Beaver	BV100	flake		K. Karber
872	Beaver	BV100	flake		K. Karber
873	Beaver	BV100	flake		K. Karber
874	Beaver	BV100	flake		K. Karber
875	Beaver	BV100	shatter		K. Karber
876	Beaver	BV100	flake		K. Karber
877	Beaver	BV100	flake		K. Karber
878	Beaver	BV100	flake		K. Karber
879	Beaver	BV100	shatter		K. Karber
880	Beaver	BV100	flake		K. Karber
881	Beaver	BV100	flake		K. Karber
882	Beaver	BV100	flake		K. Karber
883	Beaver	BV100	flake		K. Karber
884	Beaver	BV100	flake		K. Karber
885	Beaver	BV100	flake		K. Karber
886	Beaver	BV100	flake		K. Karber

887	Beaver	BV100	flake		K. Karber
888	Beaver	BV100	flake		K. Karber
889	Beaver	BV100	flake		K. Karber
890	Beaver	BV100	shatter		K. Karber
891	Beaver	BV100	flake		K. Karber
892	Beaver	BV100	flake		K. Karber
893	Beaver	BV100	flake		K. Karber
894	Beaver	BV100	flake		K. Karber
895	Beaver	BV100	flake		K. Karber
896	Beaver	BV100	flake		K. Karber
897	Beaver	BV100	flake		K. Karber
898	Beaver	BV100	flake		K. Karber
899	Beaver	BV100	flake		K. Karber
900	Beaver	BV100	flake		K. Karber
901	Beaver	BV100	shatter		K. Karber
902	Beaver	BV100	flake		K. Karber
903	Beaver	BV100	flake		K. Karber
904	Beaver	BV100	flake		K. Karber
905	Beaver	BV100	flake		K. Karber
906	Beaver	BV100	flake		K. Karber
907	Beaver	BV100	flake		K. Karber
908	Beaver	BV100	flake		K. Karber
909	Beaver	BV100	flake		K. Karber
910	Beaver	BV100	shatter		K. Karber
911	Beaver	BV100	flake		K. Karber
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913	Beaver	BV100	flake		K. Karber
914	Beaver	BV100	flake		K. Karber

915	Beaver	BV100	flake		K. Karber
916	Beaver	BV100	flake		K. Karber
917	Beaver	BV100	flake		K. Karber
918	Beaver	BV100	flake		K. Karber
919	Beaver	BV100	flake		K. Karber
920	Beaver	BV100	shatter		K. Karber
921	Beaver	BV100	flake		K. Karber
922	Beaver	BV100	flake		K. Karber
923	Beaver	BV100	shatter		K. Karber
924	Beaver	BV100	shatter		K. Karber
925	Beaver	BV100	flake		K. Karber
926	Beaver	BV100	flake		K. Karber
927	Beaver	BV100	flake		K. Karber
928	Beaver	BV100	flake		K. Karber
929	Beaver	BV100	flake		K. Karber
930	Beaver	BV100	flake		K. Karber
931	Beaver	BV100	flake		K. Karber
932	Beaver	BV100	flake		K. Karber
933	Beaver	BV100	shatter		K. Karber
934	Beaver	BV100	shatter		K. Karber
935	Beaver	BV100	flake		K. Karber
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937	Beaver	BV100	flake		K. Karber
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940	Beaver	BV100	flake		K. Karber
941	Beaver	BV100	flake		K. Karber
942	Beaver	BV100	flake		K. Karber

943	Beaver	BV100	flake		K. Karber
944	Beaver	BV100	shatter		K. Karber
945	Beaver	BV100	flake		K. Karber
946	Beaver	BV100	flake		K. Karber
947	Beaver	BV100	flake		K. Karber
948	Beaver	BV100	flake		K. Karber
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950	Beaver	BV100	flake		K. Karber
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956	Beaver	BV100	flake		K. Karber
957	Beaver	BV100	flake		K. Karber
958	Beaver	BV100	flake		K. Karber
959	Beaver	BV100	flake		K. Karber
960	Beaver	BV100	flake		K. Karber
961	Beaver	BV100	flake		K. Karber
962	Beaver	BV100	shatter		K. Karber
963	Beaver	BV100	flake		K. Karber
964	Beaver	BV100	flake		K. Karber
965	Beaver	BV100	flake		K. Karber
966	Beaver	BV100	flake		K. Karber
967	Beaver	BV100	flake		K. Karber
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970	Beaver	BV100	flake		K. Karber

971	Beaver	BV100	flake		K. Karber
972	Beaver	BV100	shatter		K. Karber
973	Beaver	BV100	flake		K. Karber
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976	Beaver	BV100	flake		K. Karber
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978	Beaver	BV100	shatter		K. Karber
979	Beaver	BV100	flake		K. Karber
980	Beaver	BV100	flake		K. Karber
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982	Beaver	BV100	flake		K. Karber
983	Beaver	BV100	flake		K. Karber
984	Beaver	BV100	flake		K. Karber
985	Beaver	BV100	flake		K. Karber
986	Beaver	BV100	flake		K. Karber
987	Beaver	BV100	flake		K. Karber
988	Beaver	BV100	flake		K. Karber
989	Beaver	BV100	shatter		K. Karber
990	Beaver	BV100	flake		K. Karber
991	Beaver	BV100	shatter		K. Karber
992	Beaver	BV100	shatter		K. Karber
993	Beaver	BV100	flake		K. Karber
994	Beaver	BV100	flake		K. Karber
995	Beaver	BV100	flake		K. Karber
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997	Beaver	BV100	flake		K. Karber
998	Beaver	BV100	shatter		K. Karber

999	Beaver	BV100	shatter		K. Karber
1000	Beaver	BV100	flake		K. Karber
1001	Beaver	BV100	shatter		K. Karber
1002	Beaver	BV100	flake		K. Karber
1003	Beaver	BV100	flake		K. Karber
1004	Beaver	BV100	shatter		K. Karber
1005	Beaver	BV100	shatter		K. Karber
1006	Beaver	BV100	shatter		K. Karber
1007	Beaver	BV100	flake		K. Karber
1008	Beaver	BV100	flake		K. Karber
1009	Beaver	BV100	flake		K. Karber
1010	Beaver	BV100	shatter		K. Karber
1011	Beaver	BV100	flake		K. Karber
1012	Beaver	BV100	shatter		K. Karber
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1015	Beaver	BV100	shatter		K. Karber
1016	Beaver	BV100	flake		K. Karber
1017	Beaver	BV100	flake		K. Karber
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1019	Beaver	BV100	flake		K. Karber
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1021	Beaver	BV100	flake		K. Karber
1022	Beaver	BV100	flake		K. Karber
1023	Beaver	BV100	flake		K. Karber
1024	Beaver	BV100	shatter		K. Karber
1025	Beaver	BV100	shatter		K. Karber
1026	Beaver	BV100	flake		K. Karber

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1040	Beaver	BV100	flake		K. Karber
1041	Beaver	BV100	shatter		K. Karber
1042	Beaver	BV100	flake		K. Karber
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1046	Beaver	BV100	flake		K. Karber
1047	Beaver	BV100	flake		K. Karber
1048	Beaver	BV100	flake		K. Karber
1049	Beaver	BV100	shatter		K. Karber
1050	Beaver	BV100	flake		K. Karber
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1082	Beaver	BV100	flake		K. Karber

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1087	Beaver	BV100	flake		K. Karber
1088	Beaver	BV100	flake		K. Karber
1089	Beaver	BV100	flake		K. Karber
1090	Beaver	BV100	flake		K. Karber
1091	Beaver	BV100	flake		K. Karber
1092	Beaver	BV100	flake		K. Karber
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1100	Beaver	BV100	flake		K. Karber
1101	Beaver	BV100	flake		K. Karber
1102	Beaver	BV100	shatter		K. Karber
1103	Beaver	BV100	shatter		K. Karber
1104	Beaver	BV100	flake		K. Karber
1105	Beaver	BV100	flake		K. Karber
1106	Beaver	BV100	flake		K. Karber
1107	Beaver	BV100	shatter		K. Karber
1108	Beaver	BV100	flake		K. Karber
1109	Beaver	BV100	flake		K. Karber
1110	Beaver	BV100	flake		K. Karber

1111	Beaver	BV100	flake		K. Karber
1112	Beaver	BV100	flake		K. Karber
1113	Beaver	BV100	flake		K. Karber
1114	Beaver	BV100	flake		K. Karber
1115	Beaver	BV100	flake		K. Karber
1116	Beaver	BV100	flake		K. Karber
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1119	Beaver	BV100	flake		K. Karber
1120	Beaver	BV100	flake		K. Karber
1121	Beaver	BV100	flake		K. Karber
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1123	Beaver	BV100	flake		K. Karber
1124	Beaver	BV100	flake		K. Karber
1125	Beaver	BV100	flake		K. Karber
1126	Beaver	BV100	flake		K. Karber
1127	Beaver	BV100	flake		K. Karber
1128	Beaver	BV100	flake		K. Karber
1129	Beaver	BV100	flake		K. Karber
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1132	Beaver	BV100	shatter		K. Karber
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1148	Beaver	BV100	flake		K. Karber
1149	Beaver	BV100	flake		K. Karber
1150	Beaver	BV100	flake		K. Karber
1151	Beaver	BV100	flake		K. Karber
1152	Beaver	BV100	flake		K. Karber
1153	Beaver	BV100	flake		K. Karber
1154	Beaver	BV100	flake		K. Karber
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1170	Beaver	BV100	flake		K. Karber
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1177	Beaver	BV100	flake		K. Karber
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1185	Beaver	BV100	flake		K. Karber
1186	Beaver	BV100	flake		K. Karber
1187	Beaver	BV100	flake		K. Karber
1188	Beaver	BV100	flake		K. Karber
1189	Beaver	BV100	flake		K. Karber
1190	Beaver	BV100	shatter		K. Karber
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1198	Beaver	BV100	flake		K. Karber
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1211	Beaver	BV100	flake		K. Karber
1212	Beaver	BV100	flake		K. Karber
1213	Beaver	BV100	flake		K. Karber
1214	Beaver	BV100	flake		K. Karber
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1217	Beaver	BV100	flake		K. Karber
1218	Beaver	BV100	flake		K. Karber
1219	Beaver	BV100	flake		K. Karber
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1222	Beaver	BV100	shatter		K. Karber

1223	Beaver	BV100	shatter		K. Karber
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1231	Beaver	BV100	flake		K. Karber
1232	Beaver	BV100	flake		K. Karber
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1234	Beaver	BV100	flake		K. Karber
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1240	Beaver	BV100	shatter		K. Karber
1241	Beaver	BV100	flake		K. Karber
1242	Beaver	BV100	flake		K. Karber
1243	Beaver	BV100	shatter		K. Karber
1244	Beaver	BV100	flake		K. Karber
1245	Beaver	BV100	flake		K. Karber
1246	Beaver	BV100	flake		K. Karber
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1250	Beaver	BV100	flake		K. Karber

1251	Beaver	BV100	shatter		K. Karber
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1254	Beaver	BV100	flake		K. Karber
1255	Beaver	BV100	flake		K. Karber
1256	Beaver	BV100	flake		K. Karber
1257	Beaver	BV100	flake		K. Karber
1258	Beaver	BV100	flake		K. Karber
1259	Beaver	BV100	flake		K. Karber
1260	Beaver	BV100	shatter		K. Karber
1261	Beaver	BV100	flake		K. Karber
1262	Beaver	BV100	shatter		K. Karber
1263	Beaver	BV100	flake		K. Karber
1264	Beaver	BV100	flake		K. Karber
1265	Beaver	BV100	flake		K. Karber
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1273	Beaver	BV100	flake		K. Karber
1274	Beaver	BV100	flake		K. Karber
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1282	Beaver	BV100	flake		K. Karber
1283	Beaver	BV100	flake		K. Karber
1284	Beaver	BV100	flake		K. Karber
1285	Beaver	BV100	flake		K. Karber
1286	Beaver	BV100	flake		K. Karber
1287	Beaver	BV100	shatter		K. Karber
1288	Beaver	BV100	flake		K. Karber
1289	Beaver	BV100	flake		K. Karber
1290	Beaver	BV100	flake		K. Karber
1291	Beaver	BV100	flake		K. Karber
1292	Beaver	BV100	shatter		K. Karber
1293	Beaver	BV100	flake		K. Karber
1294	Beaver	BV100	flake		K. Karber
1295	Beaver	BV100	flake		K. Karber
1296	Beaver	BV100	flake		K. Karber
1297	Beaver	BV100	flake		K. Karber
1298	Beaver	BV100	flake		K. Karber
1299	Beaver	BV100	flake		K. Karber
1300	Beaver	BV100	shatter		K. Karber
1301	Beaver	BV100	flake		K. Karber
1302	Beaver	BV100	shatter		K. Karber
1303	Beaver	BV100	flake		K. Karber
1304	Beaver	BV100	shatter		K. Karber
1305	Beaver	BV100	flake		K. Karber
1306	Beaver	BV100	flake		K. Karber

1307	Beaver	BV100	flake		K. Karber
1308	Beaver	BV100	flake		K. Karber
1309	Beaver	BV100	shatter		K. Karber
1310	Beaver	BV100	flake		K. Karber
1311	Beaver	BV100	flake		K. Karber
1312	Beaver	BV100	flake		K. Karber
1313	Beaver	BV100	flake		K. Karber
1314	Beaver	BV100	shatter		K. Karber
1315	Beaver	BV100	flake		K. Karber
1316	Beaver	BV100	flake		K. Karber
1317	Beaver	BV100	flake		K. Karber
1318	Beaver	BV100	flake		K. Karber
1319	Beaver	BV100	flake		K. Karber
1320	Beaver	BV100	flake		K. Karber
1321	Beaver	BV100	flake		K. Karber
1322	Beaver	BV100	shatter		K. Karber
1323	Beaver	BV100	shatter		K. Karber
1324	Beaver	BV100	flake		K. Karber
1325	Beaver	BV100	flake		K. Karber
1326	Beaver	BV100	flake		K. Karber
1327	Beaver	BV100	flake		K. Karber
1328	Beaver	BV100	flake		K. Karber
1329	Beaver	BV100	flake		K. Karber
1330	Beaver	BV100	flake		K. Karber
1331	Beaver	BV100	flake		K. Karber
1332	Beaver	BV100	flake		K. Karber
1333	Beaver	BV100	flake		K. Karber
1334	Beaver	BV100	flake		K. Karber

1335	Beaver	BV100	flake		K. Karber
1336	Beaver	BV100	flake		K. Karber
1337	Beaver	BV100	flake		K. Karber
1338	Beaver	BV100	flake		K. Karber
1339	Beaver	BV100	flake		K. Karber
1340	Beaver	BV100	shatter		K. Karber
1341	Beaver	BV100	shatter		K. Karber
1342	Beaver	BV100	flake		K. Karber
1343	Beaver	BV100	flake		K. Karber
1344	Beaver	BV100	shatter		K. Karber
1345	Beaver	BV100	flake		K. Karber
1346	Beaver	BV100	flake		K. Karber
1347	Beaver	BV100	shatter		K. Karber
1348	Beaver	BV100	flake		K. Karber
1349	Beaver	BV100	flake		K. Karber
1350	Beaver	BV100	flake		K. Karber
1351	Beaver	BV100	flake		K. Karber
1352	Beaver	BV100	flake		K. Karber
1353	Beaver	BV100	flake		K. Karber
1354	Beaver	BV100	flake		K. Karber
1355	Beaver	BV100	flake		K. Karber
1356	Beaver	BV100	shatter		K. Karber
1357	Beaver	BV100	flake		K. Karber
1358	Beaver	BV100	flake		K. Karber
1359	Beaver	BV100	shatter		K. Karber
1360	Beaver	BV100	flake		K. Karber
1361	Beaver	BV100	flake		K. Karber
1362	Beaver	BV100	flake		K. Karber

1363	Beaver	BV100	flake		K. Karber
1364	Beaver	BV100	flake		K. Karber
1365	Beaver	BV100	shatter		K. Karber
1366	Beaver	BV100	flake		K. Karber
1367	Beaver	BV100	shatter		K. Karber
1368	Beaver	BV100	flake		K. Karber
1369	Beaver	BV100	flake		K. Karber
1370	Beaver	BV100	flake		K. Karber
1371	Beaver	BV100	flake		K. Karber
1372	Beaver	BV100	flake		K. Karber
1373	Beaver	BV100	flake		K. Karber
1374	Beaver	BV100	flake		K. Karber
1375	Beaver	BV100	flake		K. Karber
1376	Beaver	BV100	flake		K. Karber
1377	Beaver	BV100	shatter		K. Karber
1378	Beaver	BV100	flake		K. Karber
1379	Beaver	BV100	flake		K. Karber
1380	Beaver	BV100	flake		K. Karber
1381	Beaver	BV100	flake		K. Karber
1382	Beaver	BV100	flake		K. Karber
1383	Beaver	BV100	flake		K. Karber
1384	Beaver	BV100	flake		K. Karber
1385	Beaver	BV100	shatter		K. Karber
1386	Beaver	BV100	shatter		K. Karber
1387	Beaver	BV100	flake		K. Karber
1388	Beaver	BV100	flake		K. Karber
1389	Beaver	BV100	shatter		K. Karber
1390	Beaver	BV100	flake		K. Karber

1391	Beaver	BV100	shatter		K. Karber
1392	Beaver	BV100	flake		K. Karber
1393	Beaver	BV100	shatter		K. Karber
1394	Beaver	BV100	flake		K. Karber
1395	Beaver	BV100	flake		K. Karber
1396	Beaver	BV100	flake		K. Karber
1397	Beaver	BV100	flake		K. Karber
1398	Beaver	BV100	flake		K. Karber
1399	Beaver	BV100	flake		K. Karber
1400	Beaver	BV100	flake		K. Karber
1401	Beaver	BV100	flake		K. Karber
1402	Beaver	BV100	shatter		K. Karber
1403	Beaver	BV100	flake		K. Karber
1404	Beaver	BV100	flake		K. Karber
1405	Beaver	BV100	flake		K. Karber
1406	Beaver	BV100	flake		K. Karber
1407	Beaver	BV100	flake		K. Karber
1408	Beaver	BV100	flake		K. Karber
1409	Beaver	BV100	flake		K. Karber
1410	Beaver	BV100	flake		K. Karber
1411	Beaver	BV100	flake		K. Karber
1412	Beaver	BV100	flake		K. Karber
1413	Beaver	BV100	flake		K. Karber
1414	Beaver	BV100	flake		K. Karber
1415	Beaver	BV100	shatter		K. Karber
1416	Beaver	BV100	shatter		K. Karber
1417	Beaver	BV100	flake		K. Karber
1418	Beaver	BV100	flake		K. Karber

1419	Beaver	BV100	flake		K. Karber
1420	Beaver	BV100	flake		K. Karber
1421	Beaver	BV100	flake		K. Karber
1422	Beaver	BV100	shatter		K. Karber
1423	Beaver	BV100	flake		K. Karber
1424	Beaver	BV100	flake		K. Karber
1425	Beaver	BV100	flake		K. Karber
1426	Beaver	BV100	shatter		K. Karber
1427	Beaver	BV100	shatter		K. Karber
1428	Beaver	BV100	shatter		K. Karber
1429	Beaver	BV100	flake		K. Karber
1430	Beaver	BV100	flake		K. Karber
1431	Beaver	BV100	shatter		K. Karber
1432	Beaver	BV100	flake		K. Karber
1433	Beaver	BV100	flake		K. Karber
1434	Beaver	BV100	flake		K. Karber
1435	Beaver	BV100	flake		K. Karber
1436	Beaver	BV100	flake		K. Karber
1437	Beaver	BV100	flake		K. Karber
1438	Beaver	BV100	flake		K. Karber
1439	Beaver	BV100	flake		K. Karber
1440	Beaver	BV100	flake		K. Karber
1441	Beaver	BV100	flake		K. Karber
1442	Beaver	BV100	flake		K. Karber
1443	Beaver	BV100	shatter		K. Karber
1444	Beaver	BV100	flake		K. Karber
1445	Beaver	BV100	shatter		K. Karber
1446	Beaver	BV100	flake		K. Karber

1447	Beaver	BV100	flake		K. Karber
1448	Beaver	BV100	flake		K. Karber
1449	Beaver	BV100	flake		K. Karber
1450	Beaver	?	NOT OBSIDIAN		K. Karber
1451	Beaver	?	flake		K. Karber
1452	Beaver	?	shatter		K. Karber
1453	Beaver	?	Biface Fragment		K. Karber
1454	Beaver	?	Projectile Point Tip		K. Karber
1455	Beaver	?	shatter		K. Karber
1456	Beaver	?	flake		K. Karber
1457	Beaver	?	Biface Fragment		K. Karber
1458	Beaver	?	Biface Fragment		K. Karber
1459	Beaver	?	flake		K. Karber
1460	Beaver	?	flake		K. Karber
1461	Beaver	?	flake		K. Karber
1462	Beaver	?	flake		K. Karber
1463	Beaver	?	flake		K. Karber
1464	Beaver	?	flake		K. Karber
1465	Beaver	?	flake		K. Karber
1466	Beaver	?	flake		K. Karber
1467	Beaver	?	flake		K. Karber
1468	Beaver	?	flake		K. Karber
1469	Greer	GR4	Flake		OASurvey
1470	Garvin	GV34	Flake		OASurvey
1471	Garvin	GV34	Flake		OASurvey
1472	Pawnee	PW128	Flake		OASurvey
1473	Pawnee	PW128	Flake		OASurvey
1474	Custer	CU10	Flake		OASurvey

1475	Jackson	JK22	Flake		OASurvey
1476	Canadian	CN2	Flake		OASurvey
1477	Canadian	CN2	Flake		OASurvey
1478	Canadian	CN2	Flake		OASurvey
1479	Roger Mills	RM14	Flake		OASurvey
1480	Roger Mills	RM14	Flake		OASurvey
1481	Beaver	BV14	Flake		OASurvey
1482	Beaver	BV14	Flake		OASurvey
1483	Beaver	BV14	Flake		OASurvey
1484	Beaver	BV14	Flake		OASurvey
1485	Beaver	BV14	Flake		OASurvey
1486	Beaver	BV14	Flake		OASurvey
1487	Murray	MR10	Flake		OASurvey
1488	Beckham	BK8	Flake		OASurvey
1489	Beckham	BK9	Flake		OASurvey
1490	Tillman	TI1	Flake		OASurvey
1491	Texas	TX32	Flake		OASurvey
1492	Texas	TX32	Flake		OASurvey
1493	Texas	TX32	Flake		OASurvey
1494	?	?	Projectile Point		NMLM
1495	?	?	Projectile Point		Duckett Coll.
1496	?	?	Projectile Point		Duckett Coll.
1497	?	?	Biface		Billy Baker Coll.
1498	?	?	flake		Billy Baker Coll.
1499	*Cimarron?*	?	Flake		K. Saunders Coll.
1500	*Cimarron?*	?	Projectile Point		K. Saunders Coll.

1501	*Cimarron?*	?	Projectile Point		Hutchison Coll.
1502	*Cimarron?*	?	Projectile Point		Hutchison Coll.
1503	*Cimarron?*	?	Flake		Max Vamleer Coll.
1504	*Cimarron?*	?	Projectile Point Tip		K. Saunders Coll.
1505	*Cimarron?*	?	Biface		K. Saunders Coll.
1506	*Cimarron?*	?	Projectile Point		K. Saunders Coll.
1507	*Cimarron?*	?	Projectile Point Base		K. Saunders Coll.
1508	*Cimarron?*	?	Projectile Point		K. Saunders Coll.
1509	*Cimarron?*	?	Projectile Point Base		K. Saunders Coll.
1510	*Cimarron?*	?	Projectile Point		K. Saunders Coll.
1511	*Cimarron?*	?	Projectile Point Base		K. Saunders Coll.
1512	*CImarron?*	?	Projectile Point		K. Saunders Coll.
1513	*Cimarron?*	?	Flake		K. Saunders Coll.
1514	*Cimarron?*	?	Flake		K. Saunders Coll.
1515	*Cimarron?*	?	Flake		K. Saunders Coll.
1516	*Cimarron?*	?	Flake		K. Saunders Coll.
1517	*Cimarron?*	?	Flake		K. Saunders Coll.
1518	*Cimarron?*	?	Flake		K. Saunders Coll.
1519	*Cimarron?*	?	Flake		K. Saunders Coll.
1520	*Cimarron?*	?	Flake		K. Saunders Coll.
1521	*Cimarron?*	?	Flake		K. Saunders Coll.
1522	*Cimarron?*	?	Flake		K. Saunders Coll.
1523	*Cimarron?*	?	Projectile Point Base		K. Saunders Coll.
1524	*Cimarron?*	?	Projectile Point		K. Saunders Coll.
1525	*Cimarron?*	?	Flake		K. Saunders Coll.
1526	*Cimarron?*	?	Projectile Point Tip		K. Saunders Coll.
1527	*Cimarron?*	?	Biface		K. Saunders Coll.
1528	*Cimarron?*	?	Projectile Point		K. Saunders Coll.

1529	*Cimarron?*	?	Biface Fragment		K. Saunders Coll.
1530	*Cimarron?*	?	Biface Fragment		K. Saunders Coll.
1531	*Cimarron?*	?	Projectile Point Fragment		K. Saunders Coll.
1532	*Cimarron?*	?	Mid-Section		K. Saunders Coll.
1533	*Cimarron?*	?	Projectile Point Tip		K. Saunders Coll.
1534	*Cimarron?*	?	Biface Fragment		K. Saunders Coll.
1535	*Cimarron?*	?	Projectile Point Tip		K. Saunders Coll.
1536	*Cimarron?*	?	Projectile Point Tip		K. Saunders Coll.
1537	*Cimarron?*	?	Biface Fragment		K. Saunders Coll.
1538	*Cimarron?*	?	Projectile Point		K. Saunders Coll.
1539	*Cimarron?*	?	Biface Fragment		K. Saunders Coll.
1540	Cimarron	?	Flake		K. Saunders Coll.
1541	Cimarron	?	Flake		K. Saunders Coll.
1542	Cimarron	?	Flake		K. Saunders Coll.
1543	Cimarron	?	Flake		K. Saunders Coll.
1544	Cimarron	?	Flake		K. Saunders Coll.
1545	Cimarron	?	Flake		K. Saunders Coll.
1546	Cimarron	?	Flake		K. Saunders Coll.
1547	Cimarron	?	Flake		K. Saunders Coll.
1548	Cimarron	?	Flake		K. Saunders Coll.
1549	Cimarron	?	Flake		K. Saunders Coll.
1550	Cimarron	?	Flake		K. Saunders Coll.
1551	Cimarron	?	Flake		K. Saunders Coll.
1552	Cimarron	?	Flake		K. Saunders Coll.
1553	Cimarron	?	Flake		K. Saunders Coll.
1554	Cimarron	?	Flake		K. Saunders Coll.
1555	Cimarron	?	Flake		K. Saunders Coll.

1556	Cimarron	?	Flake		K. Saunders Coll.
1557	Cimarron	?	Flake		K. Saunders Coll.
1558	Cimarron	?	Flake		K. Saunders Coll.
1559	Cimarron	?	Flake		K. Saunders Coll.
1560	Cimarron	?	Flake		K. Saunders Coll.
1561	Cimarron	?	Flake		K. Saunders Coll.
1562	Cimarron	?	Flake		K. Saunders Coll.
1563	Cimarron	?	Flake		K. Saunders Coll.
1564	Cimarron	?	Flake		K. Saunders Coll.
1565	Cimarron	?	Flake		K. Saunders Coll.
1566	Cimarron	?	Flake		K. Saunders Coll.
1567	Cimarron	?	Flake		K. Saunders Coll.
1568	Cimarron	?	Flake		K. Saunders Coll.
1569	Cimarron	?	Flake		K. Saunders Coll.
1570	Cimarron	?	Flake		K. Saunders Coll.
1571	Cimarron	?	Flake		K. Saunders Coll.
1572	Cimarron	?	Flake		K. Saunders Coll.
1573	Cimarron	?	Flake		K. Saunders Coll.
1574	Cimarron	?	Flake		K. Saunders Coll.
1575	Cimarron	?	Flake		K. Saunders Coll.
1576	Cimarron	?	Flake		K. Saunders Coll.
1577	Cimarron	?	Flake		K. Saunders Coll.
1578	Cimarron	?	Flake		K. Saunders Coll.
1579	Cimarron	?	Flake		K. Saunders Coll.
1580	Cimarron	?	Flake		K. Saunders Coll.
1581	Cimarron	?	Flake		K. Saunders Coll.
1582	Cimarron	?	Flake		K. Saunders Coll.
1583	Cimarron	?	Flake		K. Saunders Coll.

1584	Cimarron	?	Flake		K. Saunders Coll.
1585	Cimarron	?	Flake		K. Saunders Coll.
1586	Cimarron	?	Flake		K. Saunders Coll.
1587	Cimarron	?	Flake		K. Saunders Coll.
1588	Cimarron	?	Flake		K. Saunders Coll.
1589	Cimarron	?	Flake		K. Saunders Coll.
1590	Cimarron	?	Flake		K. Saunders Coll.
1591	Cimarron	?	Flake		K. Saunders Coll.
1592	Cimarron	?	Flake		K. Saunders Coll.
1593	Cimarron	?	Flake		K. Saunders Coll.
1594	Cimarron	?	Flake		K. Saunders Coll.
1595	Cimarron	?	Flake		K. Saunders Coll.
1596	Cimarron	?	Flake		K. Saunders Coll.
1597	Cimarron	?	Flake		K. Saunders Coll.
1598	Cimarron	?	Flake		K. Saunders Coll.
1599	Cimarron	?	Flake		K. Saunders Coll.
1600	Cimarron	?	Flake		K. Saunders Coll.
1601	Cimarron	CI15	Flake		K. Saunders Coll.
1602	Cimarron	CI240	Flake		K. Saunders Coll.
1603	Cimarron	?	Flake		K. Saunders Coll.
1604	Cimarron	CI203	Flake		K. Saunders Coll.
1605	Cimarron	CI203	Mid-Section		K. Saunders Coll.
1606	Cimarron	CI215	Flake		K. Saunders Coll.
1607	Cimarron	CI215	Flake		K. Saunders Coll.
1608	Cimarron	CI214	Flake		K. Saunders Coll.
1609	Cimarron	CI214	Flake		K. Saunders Coll.
1610	Cimarron	CI209	Mid-Section		K. Saunders Coll.
1611	Cimarron	?	Projectile Point Base	Fresno	K. Saunders Coll.

1612	Cimarron	CI161	Flake		K. Saunders Coll.
1613	Cimarron	CI161	Flake		K. Saunders Coll.
1614	Cimarron	?	Flake		K. Saunders Coll.
1615	Cimarron	?	Flake		K. Saunders Coll.
1616	Cimarron	CI216	Flake		K. Saunders Coll.
1617	Cimarron	CI216	Flake		K. Saunders Coll.
1618	Cimarron	?	Flake		K. Saunders Coll.
1619	Cimarron	?	Flake		K. Saunders Coll.
1620	Cimarron	?	Flake		K. Saunders Coll.
1621	Cimarron	?	Flake		K. Saunders Coll.
1622	Cimarron	?	Projectile Point Fragment		K. Saunders Coll.
1623	Cimarron	CI236	Flake		K. Saunders Coll.
1624	Cimarron	CI236	Flake		K. Saunders Coll.
1625	Cimarron	CI236	Flake		K. Saunders Coll.
1626	Cimarron	?	Flake		K. Saunders Coll.
1627	Cimarron	?	biface Fragment		K. Saunders Coll.
1628	Cimarron	CI248	Flake		K. Saunders Coll.
1629	Cimarron	CI248	Flake		K. Saunders Coll.
1630	Cimarron	CI209	Flake		K. Saunders Coll.
1631	Cimarron	?	projectile point base fragment		K. Saunders Coll.
1632	Cimarron	CI204	Flake		K. Saunders Coll.
1633	Cimarron	CI204	Flake		K. Saunders Coll.
1634	Cimarron	CI204	Flake		K. Saunders Coll.
1635	Cimarron	CI204	Flake		K. Saunders Coll.
1636	Cimarron	CI204	Flake		K. Saunders Coll.
1637	Cimarron	CI204	Flake		K. Saunders Coll.
1638	Cimarron	CI204	Flake		K. Saunders Coll.

1639	Cimarron	CI204	Flake		K. Saunders Coll.
1640	Cimarron	CI204	Flake		K. Saunders Coll.
1641	Cimarron	CI204	Flake		K. Saunders Coll.
1642	Cimarron	CI204	Flake		K. Saunders Coll.
1643	Cimarron	CI204	Flake		K. Saunders Coll.
1644	Cimarron	CI204	Flake		K. Saunders Coll.
1645	Cimarron	CI204	Flake		K. Saunders Coll.
1646	Cimarron	CI204	Flake		K. Saunders Coll.
1647	Cimarron	CI204	Flake		K. Saunders Coll.
1648	Cimarron	CI204	Flake		K. Saunders Coll.
1649	Cimarron	CI204	Flake		K. Saunders Coll.
1650	Cimarron	CI204	Flake		K. Saunders Coll.
1651	Cimarron	CI204	Flake		K. Saunders Coll.
1652	Cimarron	CI204	Flake		K. Saunders Coll.
1653	Cimarron	CI204	Flake		K. Saunders Coll.
1654	Cimarron	CI204	Flake		K. Saunders Coll.
1655	Cimarron	CI204	Flake		K. Saunders Coll.
1656	Cimarron	CI204	Flake		K. Saunders Coll.
1657	Cimarron	CI204	Flake		K. Saunders Coll.
1658	Cimarron	CI204	Flake		K. Saunders Coll.
1659	Cimarron	CI204	Flake		K. Saunders Coll.
1660	Cimarron	CI204	Flake		K. Saunders Coll.
1661	Cimarron	CI204	Flake		K. Saunders Coll.
1662	Cimarron	?	Projectile Point Base	Washita	K. Saunders Coll.
1663	Beckham	BK2	flake		T. Baugh
1664	Beckham	BK2	flake		T. Baugh
1665	Beckham	BK2	flake		T. Baugh

1666	Beckham	BK2	Projectile Point Fragment	Fresno	SNMNH
1667	Beckham	BK2	Projectile Point	Fresno	SNMNH
1668	Beckham	BK2	Projectile Point Base	Fresno	SNMNH
1669	Greer	GR3	flake		T. Baugh
1670	Greer	GR3	flake		T. Baugh
1671	Greer	GR3	flake		T. Baugh
1672	Greer	GR6	Flake		T. Baugh
1673	Greer	GR6	flake		T. Baugh
1674	Greer	GR4	flake		T. Baugh
1675	Greer	GR4	flake		LeVick
1676	Greer	GR4	flake		T. Baugh
1677	Greer	GR4	flake		LeVick
1678	Greer	GR4	flake		LeVick
1679	Greer	GR4	flake		LeVick
1680	Greer	GR4	flake		LeVick
1681	Greer	GR4	flake		LeVick
1682	Greer	GR4	flake		LeVick
1683	Greer	GR4	flake		LeVick
1684	Greer	GR4	flake		LeVick
1685	Greer	GR4	flake		T. Baugh
1686	Greer	GR8	flake		LeVick
1687	Greer	GR8	flake		LeVick
1688	Greer	GR8	flake		Taylor
1689	Beckham	BK2	Projectile Point Tip	Fresno	SNMNH
1690	Beckham	BK2	Projectile Point Fragment	Fresno	SNMNH
1691	Beckham	BK2	Projectile Point Fragment	Fresno	SNMNH

1692	Beckham	BK2	Projectile Point Fragment	Fresno	SNMNH
1693	Beckham	BK2	Projectile Point Fragment	Fresno	SNMNH
1694	Beckham	BK2	Flake		SNMNH
1695	Beckham	BK2	Flake		SNMNH
1696	Beckham	BK2	Flake		SNMNH
1697	Beckham	BK2	Flake		SNMNH
1698	Beckham	BK2	Flake		SNMNH
1699	Greer	GR8	flake		Taylor
1700	Greer	GR8	flake		Taylor
1701	Greer	GR8	flake		Taylor
1702	Greer	GR8	flake		Taylor
1703	Greer	GR8	flake		Taylor
1704	Greer	GR8	flake		Taylor
1705	Greer	GR8	flake		Taylor
1706	Greer	GR8	flake		Taylor
1707	Greer	GR8	flake		Taylor
1708	Greer	GR8	flake		Taylor
1709	Greer	GR8	flake		Taylor
1710	Greer	GR8	flake		Taylor
1711	Greer	GR8	flake		Taylor
1712	Greer	GR8	flake		Taylor
1713	Greer	GR8	flake		Taylor
1714	Greer	GR8	flake		Taylor
1715	Greer	GR8	flake		Taylor
1716	Greer	GR8	flake		Taylor
1717	Greer	GR8	flake		Taylor

1718	Greer	GR8	flake		Taylor
1719	Greer	GR8	flake		Taylor
1720	Greer	GR8	flake		LeVick
1721	Greer	GR8	flake		LeVick
1722	Greer	GR8	flake		Taylor
1723	Greer	GR8	flake		LeVick
1724	Greer	GR8	flake		LeVick
1725	Greer	GR8	flake		T. Baugh
1726	Greer	GR8	flake		T. Baugh
1727	Greer	GR8	flake		LeVick
1728	Greer	GR8	flake		LeVick
1729	Greer	GR8	flake		T. Baugh
1730	Greer	GR8	flake		LeVick
1731	Greer	GR8	flake		T. Baugh
1732	Greer	GR8	flake		LeVick
1733	Greer	GR8	flake		Taylor
1734	Cimarron	?	Projectile Point		B. Ramsey
1735	Dallam, TX	?	Projectile Point Base	Agate Basin	B. Ramsey
1736	Marshall	MA2	Eccentric		T. Spivey
1737	Washita	?	Eccentric		T. Spivey
1738	Cleveland	CL76	Core		J. Cox
1739	Washita	WA6	Projectile Point		J. Cox
1740	Washita	WA6	Projectile Point		J. Cox
1741	Caddo	CD181	Projectile Point Base	Dalton	J. Cox
1742	Beckham	BK51	Flake		PPHM
1743	Beckham	BK51	Scraper / Modified Flake		PPHM

1744	Beaver	BV14	Modified Flake		SNMNH
1745	Beaver	BV14	Flake		SNMNH
1746	Beaver	BV14	Shatter		SNMNH
1747	Beaver	BV14	Retouched Flake		SNMNH
1748	Beaver	BV14	Flake		SNMNH
1749	Marshall	MA41	Biface Fragment		J. Cox
1750	Oklahoma	OK71	Flake		J. Cox
1751	McClain	ML1	Flake		J. Cox
1752	McClain	ML1	Flake		J. Cox
1753	Grady	GD2	Projectile Point	Fresno	J. Cox
1754	Caddo	?	Projectile Point Fragment		J. Cox
1755	Cleveland	CL76	Flake		William Choate Coll.
1756	Greer	GR8	Projectile Point		J. Cox
1757	Cleveland	CL76	Biface Fragment		J. Cox
1758	Greer	?	Projectile Point		J. Cox
1759		?	Projectile Point		J. Cox
1760		?	Projectile Point		J. Cox
1761		?	Projectile Point		J. Cox
1762		?	Projectile Point		J. Cox
1763	?	?	Eccentric / Biface		E. Hemmings
1764	Comanche	CM130	NOT OBSIDIAN		MGP
1765	Jefferson	JF1	Biface Fragment		MGP
1766	Kay	KA3	Flake		Deer Creek OAS Spring Dig
1767	Roger Mill's	RM14	Modified Flake		Sudbury Coll.
1768	Roger Mill's	RM14	Biface Fragment		Sudbury Coll.

1769	Woodward	WD5	Flake		OASurvey
1770	Custer	CU27	Flake		OASurvey
1771	Custer	CU27	Flake		OASurvey
1772	Custer	CU27	Flake		OASurvey
1773	Custer	CU27	Flake		OASurvey
1774	Texas	TX39	Flake		SNMNH
1775	Texas	TX39	Projectile Point		SNMNH
1776	Texas	TX39	Projectile Point		SNMNH
1777	Texas	TX39	Biface		SNMNH
1778	Texas	TX39	Biface Fragment		SNMNH
1779	Texas	TX39	Flake		SNMNH
1780	Texas	TX39	Projectile Point Fragment		SNMNH
1781	Texas	TX39	Biface Fragment		SNMNH
1782	Texas	TX39	Biface Fragment		SNMNH
1783	Texas	TX39	Flake		SNMNH
1784	Texas	TX39	flake		SNMNH
1785	Texas	TX39	Biface Fragment		SNMNH
1786	Roger Mills	RM208	flake		SNMNH
1787	Kay	KA119	flake		SNMNH
1788	Harmon	HR60	flake		SNMNH
1789	Seminole	SM7	Projectile Point Mid section		SNMNH
1790	Beaver	BV14	flake		SNMNH
1791	Kay	KA72	flake		SNMNH
1792	Kay	KA72	Flake		SNMNH
1793	Seminole	SM20	flake		SNMNH
1794	Garvin	GV108	flake		SNMNH

1795	Garvin	GV25	flake		SNMNH
1796	Garvin	GV25	flake		SNMNH
1797	Delaware	DL28	flake		SNMNH
1798	Beckham	BK1	Biface Fragment		SNMNH
1799	Beckham	BK1	Biface Fragment		SNMNH
1800	Beckham	BK1	Biface Fragment		SNMNH
1801	Washita	WA3	Projectile Point Base	Fresno	SNMNH
1802	Ellis	EL12	flake		SNMNH
1803	Ellis	EL12	flake		SNMNH
1804	Ellis	EL12	flake		SNMNH
1805	Ellis	EL12	flake		SNMNH
1806	Roger Mills	RM94	flake		SNMNH
1807	Harmon	HR36	flake		SNMNH
1808	Cimarron	CI199	Biface Fragment		SNMNH
1809	Cimarron	CI199	flake		SNMNH
1810	Roger Mills	RM72	flake		SNMNH
1811	Roger Mills	RM72	flake		SNMNH
1812	Beckham	BK0	Flake		SNMNH
1813	Beckham	BK0	Flake		SNMNH
1814	Grant	GT6	shatter		SNMNH
1815	Kay	KA62	flake		SNMNH
1816	Kay	KA62	flake		SNMNH
1817	Washita	WA1	Biface		SNMNH
1818	Washita	WA1	Projectile Point	Washita	SNMNH
1819	Canadian	CN2	flake		SNMNH
1820	Canadian	CN2	shatter		SNMNH

1821	Canadian	CN2	flake		SNMNH
1822	Canadian	CN2	flake		SNMNH
1823	Canadian	CN2	flake		SNMNH
1824	Canadian	CN2	flake		SNMNH
1825	Canadian	CN2	flake		SNMNH
1826	Canadian	CN2	flake		SNMNH
1827	Washita	WA6	Projectile Point		SNMNH
1828	Washita	WA6	Projectile Point		SNMNH
1829	Harmon	HR1	Biface Fragment		SNMNH
1830	Harmon	HR1	Biface Fragment		SNMNH
1831	Harmon	HR1	flake		SNMNH
1832	Harmon	HR1	flake		SNMNH
1833	Harmon	HR1	flake		SNMNH
1834	Harmon	HR1	flake		SNMNH
1835	Harmon	HR1	Biface Fragment		SNMNH
1836	Texas	TX31	flake		SNMNH
1837	Texas	TX31	flake		SNMNH
1838	Texas	TX31	flake		SNMNH
1839	Texas	TX31	flake		SNMNH
1840	Texas	TX31	flake		SNMNH
1841	Texas	TX31	flake		SNMNH
1842	Texas	TX31	flake		SNMNH
1843	Texas	TX31	flake		SNMNH
1844	Texas	TX31	flake		SNMNH
1845	Texas	TX45	Biface Fragment		SNMNH
1846	Texas	TX45	Biface Fragment		SNMNH
1847	Texas	TX45	flake		SNMNH
1848	Texas	TX45	flake		SNMNH

1849	Texas	TX45	flake		SNMNH
1850	Texas	TX45	flake		SNMNH
1851	Texas	TX45	flake		SNMNH
1852	Texas	TX45	flake		SNMNH
1853	Texas	TX45	flake		SNMNH
1854	Texas	TX45	flake		SNMNH
1855	Texas	TX45	flake		SNMNH
1856	Texas	TX45	flake		SNMNH
1857	Texas	TX45	flake		SNMNH
1858	Texas	TX45	flake		SNMNH
1859	Beckham	BK8	projectile point base		SNMNH
1860	Beckham	BK8	Projectile Point Base Fragment		SNMNH
1861	Beckham	BK8	Projectile Point Mid section		SNMNH
1862	Beckham	BK8	Biface Fragment		SNMNH
1863	Beckham	BK8	Biface Fragment		SNMNH
1864	Beckham	BK8	flake		SNMNH
1865	Beckham	BK8	flake		SNMNH
1866	Beckham	BK8	flake		SNMNH
1867	Beckham	BK8	flake		SNMNH
1868	Beckham	BK8	flake		SNMNH
1869	Murray	MR10	Projectile Point Base	Fresno	SNMNH
1870	Murray	MR10	flake		SNMNH
1871	Murray	MR10	flake		SNMNH
1872	Murray	MR10	flake		SNMNH
1873	Murray	MR10	flake		SNMNH
1874	Murray	MR10	flake		SNMNH
1875	Beaver	BV100	flake		SNMNH

1876	Beaver	BV100	flake		SNMNH
1877	Beaver	BV100	flake		SNMNH
1878	Beaver	BV100	flake		SNMNH
1879	Beaver	BV100	flake		SNMNH
1880	Beaver	BV100	flake		SNMNH
1881	Beaver	BV100	flake		SNMNH
1882	Beaver	BV100	flake		SNMNH
1883	Beaver	BV100	flake		SNMNH
1884	Beaver	BV100	flake		SNMNH
1885	Beaver	BV100	flake		SNMNH
1886	Beaver	BV100	flake		SNMNH
1887	Beaver	BV100	flake		SNMNH
1888	Beaver	BV100	flake		SNMNH
1889	Beaver	BV100	flake		SNMNH
1890	Beaver	BV100	flake		SNMNH
1891	Beaver	BV100	flake		SNMNH
1892	Beaver	BV100	flake		SNMNH
1893	Beaver	BV100	flake		SNMNH
1894	Beaver	BV100	flake		SNMNH
1895	Beaver	BV100	flake		SNMNH
1896	Beaver	BV100	Projectile Point	Washita	SNMNH
1897	Canadian	CN24	Projectile Point Base Fragment		SNMNH
1898	Canadian	CN24	flake		SNMNH
1899	Canadian	CN24	flake		SNMNH
1900	Canadian	CN24	flake		SNMNH
1901	Canadian	CN24	flake		SNMNH
1902	Canadian	CN24	flake		SNMNH
1903	Canadian	CN24	flake		SNMNH

1904	Canadian	CN24	flake		SNMNH
1905	Canadian	CN24	flake		SNMNH
1906	Canadian	CN24	flake		SNMNH
1907	Canadian	CN24	flake		SNMNH
1908	Canadian	CN24	flake		SNMNH
1909	Canadian	CN24	flake		SNMNH
1910	Canadian	CN24	flake		SNMNH
1911	Canadian	CN24	flake		SNMNH
1912	Canadian	CN24	flake		SNMNH
1913	Beckham	BK2	flake		SNMNH
1914	Beckham	BK2	flake		SNMNH
1915	Beckham	BK2	flake		SNMNH
1916	Beckham	BK2	flake		SNMNH
1917	Beckham	BK2	flake		SNMNH
1918	Beckham	BK2	flake		SNMNH
1919	Beckham	BK2	flake		SNMNH
1920	Beckham	BK2	flake		SNMNH
1921	Beckham	BK2	flake		SNMNH
1922	Beckham	BK2	flake		SNMNH
1923	Beckham	BK2	flake		SNMNH
1924	Beckham	BK2	flake		SNMNH
1925	Beckham	BK2	flake		SNMNH
1926	Beckham	BK2	flake		SNMNH
1927	Beckham	BK2	flake		SNMNH
1928	Beckham	BK2	flake		SNMNH
1929	Beckham	BK2	flake		SNMNH
1930	Beckham	BK2	flake		SNMNH
1931	Beckham	BK2	flake		SNMNH

1932	Beckham	BK2	flake		SNMNH
1933	Beckham	BK2	flake		SNMNH
1934	Beckham	BK2	flake		SNMNH
1935	Beckham	BK2	flake		SNMNH
1936	Beckham	BK2	flake		SNMNH
1937	Beckham	BK3	flake		SNMNH
1938	Washita	WA2	Flake		Hemmingway Collection
1939	Washita	WA2	Flake		Hemmingway Collection
1940	Washita	WA2	Flake		Hemmingway Collection
1941	Washita	WA2	Flake		Hemmingway Collection
1942	Washita	WA2	Flake		Hemmingway Collection
1943	Washita	WA2	Flake		Hemmingway Collection
1944	Washita	WA2	Projectile Point	Fresno	Hemmingway Collection
1945	Washita	WA2	Projectile Point Tip		Hemmingway Collection
1946	Washita	WA2	Projectile Point Tip		Hemmingway Collection
1947	Washita	WA2	Projectile Point Base	Fresno	Hemmingway Collection
1948	Washita	WA2	Projectile Point Base	??????	Hemmingway Collection
1949	Washita	WA2	Projectile Point Base	Fresno	Hemmingway Collection
1950	Washita	WA2	Projectile Point Base	Fresno	Hemmingway Collection

1951	Washita	WA2	Projectile Point	Fresno	Hemmingway Collection
1952	Washita	WA2	Projectile Point Mid section		Hemmingway Collection
1953	Washita	WA2	flake		Hemmingway Collection
1954	Washita	WA2	flake		Hemmingway Collection
1955	Washita	WA2	flake		Hemmingway Collection
1956	Washita	WA2	Biface Fragment		Hemmingway Collection
1957	Washita	WA2	Projectile Point Base	Fresno	Hemmingway Collection
1958	Washita	WA2	Projectile Point Base	Fresno	Hemmingway Collection
1959	Washita	WA2	Projectile Point Base	Fresno	Hemmingway Collection
1960	Washita	WA2	Projectile Point Base	Fresno	Hemmingway Collection
1961	Washita	WA2	Projectile Point Base Fragment		Hemmingway Collection
1962	Washita	WA2	Projectile Point Base Fragment		Hemmingway Collection
1963	Washita	WA2	Projectile Point Tip		Hemmingway Collection
1964	Washita	WA2	Projectile Point Tip		Hemmingway Collection
1965	Washita	WA2	Projectile Point Mid section		Hemmingway Collection
1966	Washita	WA2	Projectile Point Mid section		Hemmingway Collection

1967	Washita	WA2	flake		Hemmingway Collection
1968	Washita	WA2	flake		Hemmingway Collection
1969	Washita	WA2	flake		Hemmingway Collection
1970	Washita	WA2	flake		Hemmingway Collection
1971	Washita	WA2	flake		Hemmingway Collection
1972	Washita	WA2	flake		Hemmingway Collection
1973	Washita	WA2	flake		Hemmingway Collection
1974	Washita	WA2	flake		Hemmingway Collection
1975	Washita	WA2	flake		Hemmingway Collection
1976	Washita	WA2	flake		Hemmingway Collection
1977	Washita	WA2	flake		Hemmingway Collection
1978	Washita	WA2	flake		Hemmingway Collection
1979	Washita	WA2	flake		Hemmingway Collection
1980	Washita	WA2	flake		Hemmingway Collection
1981	Washita	WA2	flake		Hemmingway Collection
1982	Washita	WA2	flake		Hemmingway Collection

1983	Washita	WA2	flake		Hemmingway Collection
1984	Washita	WA2	flake		Hemmingway Collection
1985	Washita	WA2	flake		Hemmingway Collection
1986	Washita	WA2	flake		Hemmingway Collection
1987	Washita	WA2	flake		Hemmingway Collection
1988	Washita	WA2	flake		Hemmingway Collection
1989	Roger Mills	RM14	flake		SNMNH
1990	Roger Mills	RM14	flake		SNMNH
1991	Roger Mills	RM14	flake		SNMNH
1992	Roger Mills	RM14	flake		SNMNH
1993	Roger Mills	RM14	flake		SNMNH
1994	Roger Mills	RM14	flake		SNMNH
1995	Roger Mills	RM14	flake		SNMNH
1996	Roger Mills	RM14	flake		SNMNH
1997	Roger Mills	RM14	flake		SNMNH
1998	Roger Mills	RM14	flake		SNMNH

1999	Roger Mills	RM14	flake		SNMNH
2000	Roger Mills	RM14	flake		SNMNH
2001	Roger Mills	RM14	flake		SNMNH
2002	Roger Mills	RM14	flake		SNMNH
2003	Roger Mills	RM14	flake		SNMNH
2004	Roger Mills	RM14	flake		SNMNH
2005	Roger Mills	RM14	flake		SNMNH
2006	Roger Mills	RM14	flake		SNMNH
2007	Roger Mills	RM14	flake		SNMNH
2008	Roger Mills	RM14	flake		SNMNH
2009	Roger Mills	RM14	flake		SNMNH
2010	Roger Mills	RM14	Projectile Point Base	Harrell	SNMNH
2011	Roger Mills	RM14	Projectile Point Base Fragment		SNMNH
2012	Roger Mills	RM14	Projectile Point Tip		SNMNH
2013	Roger Mills	RM14	Projectile Point Tip		SNMNH
2014	Roger Mills	RM14	Projectile Point Tip		SNMNH

2015	Roger Mills	RM14	Projectile Point Mid section		SNMNH
2016	Roger Mills	RM14	Projectile Point Mid section		SNMNH
2017	Roger Mills	RM14	Projectile Point Mid section		SNMNH
2018	Roger Mills	RM14	flake		SNMNH
2019	Roger Mills	RM14	flake		SNMNH
2020	Roger Mills	RM14	flake		SNMNH
2021	Roger Mills	RM14	flake		SNMNH
2022	Roger Mills	RM14	flake		SNMNH
2023	Roger Mills	RM14	flake		SNMNH
2024	Roger Mills	RM14	flake		SNMNH
2025	Roger Mills	RM14	flake		SNMNH
2026	Roger Mills	RM14	flake		SNMNH
2027	Roger Mills	RM14	flake		SNMNH
2028	Roger Mills	RM14	flake		SNMNH
2029	Roger Mills	RM14	flake		SNMNH
2030	Roger Mills	RM14	flake		SNMNH

2031	Roger Mills	RM14	flake		SNMNH
2032	Roger Mills	RM14	flake		SNMNH
2033	Roger Mills	RM14	flake		SNMNH
2034	Roger Mills	RM14	flake		SNMNH
2035	Roger Mills	RM14	flake		SNMNH
2036	Roger Mills	RM14	flake		SNMNH
2037	Roger Mills	RM14	flake		SNMNH
2038	Roger Mills	RM14	flake		SNMNH
2039	Roger Mills	RM14	flake		SNMNH
2040	Roger Mills	RM14	flake		SNMNH
2041	Roger Mills	RM14	flake		SNMNH
2042	Roger Mills	RM14	flake		SNMNH
2043	Roger Mills	RM14	flake		SNMNH
2044	Roger Mills	RM14	flake		SNMNH
2045	Roger Mills	RM14	flake		SNMNH
2046	Roger Mills	RM14	flake		SNMNH

2047	Roger Mills	RM14	flake		SNMNH
2048	Roger Mills	RM14	flake		SNMNH
2049	Roger Mills	RM14	flake		SNMNH
2050	Roger Mills	RM14	flake		SNMNH
2051	Roger Mills	RM14	flake		SNMNH
2052	Roger Mills	RM14	flake		SNMNH
2053	Roger Mills	RM14	flake		SNMNH
2054	Roger Mills	RM14	flake		SNMNH
2055	Roger Mills	RM14	flake		SNMNH
2056	Roger Mills	RM14	flake		SNMNH
2057	Roger Mills	RM14	flake		SNMNH
2058	Roger Mills	RM14	flake		SNMNH
2059	Roger Mills	RM14	flake		SNMNH
2060	Roger Mills	RM14	flake		SNMNH
2061	Roger Mills	RM14	flake		SNMNH
2062	Roger Mills	RM14	flake		SNMNH

2063	Roger Mills	RM14	flake		SNMNH
2064	Roger Mills	RM14	flake		SNMNH
2065	Roger Mills	RM14	flake		SNMNH
2066	Roger Mills	RM14	flake		SNMNH
2067	Roger Mills	RM14	flake		SNMNH
2068	Roger Mills	RM14	flake		SNMNH
2069	Roger Mills	RM14	flake		SNMNH
2070	Roger Mills	RM14	flake		SNMNH
2071	Roger Mills	RM14	flake		SNMNH
2072	Roger Mills	RM14	flake		SNMNH
2073	Roger Mills	RM14	flake		SNMNH
2074	Roger Mills	RM14	flake		SNMNH
2075	Roger Mills	RM14	Projectile Point Base	Fresno	SNMNH
2076	Roger Mills	RM14	flake		SNMNH
2077	Roger Mills	RM14	flake		SNMNH
2078	Roger Mills	RM14	Flake		SNMNH

2079	Roger Mills	RM14	Flake		SNMNH
2080	Roger Mills	RM14	Flake		SNMNH
2081	Roger Mills	RM14	flake		SNMNH
2082	Roger Mills	RM14	flake		SNMNH
2083	Roger Mills	RM14	flake		SNMNH
2084	Roger Mills	RM14	flake		SNMNH
2085	Roger Mills	RM14	flake		SNMNH
2086	Roger Mills	RM14	flake		SNMNH
2087	Roger Mills	RM14	flake		SNMNH
2088	Roger Mills	RM14	flake		SNMNH
2089	Roger Mills	RM14	flake		SNMNH
2090	Roger Mills	RM14	flake		SNMNH
2091	Roger Mills	RM14	flake		SNMNH
2092	Roger Mills	RM14	flake		SNMNH
2093	Roger Mills	RM14	flake		SNMNH
2094	Roger Mills	RM14	flake		SNMNH

2095	Roger Mills	RM14	flake		SNMNH
2096	Roger Mills	RM14	flake		SNMNH
2097	Roger Mills	RM14	Projectile Point	Harrell	SNMNH
2098	Roger Mills	RM14	Projectile Point Mid section		SNMNH
2099	Roger Mills	RM14	flake		SNMNH
2100	Roger Mills	RM14	flake		SNMNH
2101	Roger Mills	RM14	flake		SNMNH
2102	Roger Mills	RM14	flake		SNMNH
2103	Roger Mills	RM14	flake		SNMNH
2104	Roger Mills	RM14	flake		SNMNH
2105	Roger Mills	RM14	flake		SNMNH
2106	Roger Mills	RM14	flake		SNMNH
2107	Roger Mills	RM14	flake		SNMNH
2108	Roger Mills	RM14	flake		SNMNH
2109	Roger Mills	RM14	flake		SNMNH
2110	Roger Mills	RM14	flake		SNMNH

2111	Roger Mills	RM14	flake		SNMNH
2112	Roger Mills	RM14	flake		SNMNH
2113	Roger Mills	RM14	flake		SNMNH
2114	Roger Mills	RM14	flake		SNMNH
2115	Roger Mills	RM14	flake		SNMNH
2116	Roger Mills	RM14	flake		SNMNH
2117	Roger Mills	RM14	flake		SNMNH
2118	Roger Mills	RM14	flake		SNMNH
2119	Roger Mills	RM14	flake		SNMNH
2120	Roger Mills	RM14	flake		SNMNH
2121	Roger Mills	RM14	Flake		SNMNH
2122	Roger Mills	RM14	Flake		SNMNH
2123	Roger Mills	RM14	Flake		SNMNH
2124	Roger Mills	RM14	Flake		SNMNH
2125	Roger Mills	RM14	Flake		SNMNH
2126	Roger Mills	RM14	Flake		SNMNH

2127	Roger Mills	RM14	Flake		SNMNH
2128	Roger Mills	RM14	Flake		SNMNH
2129	Roger Mills	RM14	Flake		SNMNH
2130	Roger Mills	RM14	Flake		SNMNH
2131	Roger Mills	RM14	Flake		SNMNH
2132	Roger Mills	RM14	Flake		SNMNH
2133	Roger Mills	RM14	Flake		SNMNH
2134	Roger Mills	RM14	Flake		SNMNH
2135	Roger Mills	RM14	Flake		SNMNH
2136	Roger Mills	RM14	Flake		SNMNH
2137	Roger Mills	RM14	Flake		SNMNH
2138	Roger Mills	RM14	Flake		SNMNH
2139	Roger Mills	RM14	Flake		SNMNH
2140	Roger Mills	RM14	Flake		SNMNH
2141	Roger Mills	RM14	Flake		SNMNH
2142	Roger Mills	RM14	Flake		SNMNH

2143	Roger Mills	RM14	Flake		SNMNH
2144	Roger Mills	RM14	Flake		SNMNH
2145	Roger Mills	RM14	Flake		SNMNH
2146	Roger Mills	RM14	Flake		SNMNH
2147	Roger Mills	RM14	Flake		SNMNH
2148	Roger Mills	RM14	Flake		SNMNH
2149	Roger Mills	RM14	Flake		SNMNH
2150	Roger Mills	RM14	Flake		SNMNH
2151	Roger Mills	RM14	Flake		SNMNH
2152	Roger Mills	RM14	Flake		SNMNH
2153	Roger Mills	RM14	Flake		SNMNH
2154	Roger Mills	RM14	Flake		SNMNH
2155	Roger Mills	RM14	Flake		SNMNH
2156	Roger Mills	RM14	Flake		SNMNH
2157	Roger Mills	RM14	Flake		SNMNH
2158	Roger Mills	RM14	Flake		SNMNH

2159	Roger Mills	RM14	Flake		SNMNH
2160	Roger Mills	RM14	Flake		SNMNH
2161	Roger Mills	RM14	Flake		SNMNH
2162	Roger Mills	RM14	Flake		SNMNH
2163	Roger Mills	RM14	Flake		SNMNH
2164	Roger Mills	RM14	Flake		SNMNH
2165	Roger Mills	RM14	Flake		SNMNH
2166	Roger Mills	RM14	Flake		SNMNH
2167	Roger Mills	RM14	Flake		SNMNH
2168	Roger Mills	RM14	Flake		SNMNH
2169	Roger Mills	RM14	Flake		SNMNH
2170	Roger Mills	RM14	Flake		SNMNH
2171	Roger Mills	RM14	Flake		SNMNH
2172	Roger Mills	RM14	Flake		SNMNH
2173	Roger Mills	RM14	Flake		SNMNH
2174	Roger Mills	RM14	Flake		SNMNH

2175	Roger Mills	RM14	Flake		SNMNH
2176	Roger Mills	RM14	Flake		SNMNH
2177	Roger Mills	RM14	Flake		SNMNH
2178	Roger Mills	RM14	Flake		SNMNH
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2180	Roger Mills	RM14	Flake		SNMNH
2181	Roger Mills	RM14	Flake		SNMNH
2182	Roger Mills	RM14	Flake		SNMNH
2183	Roger Mills	RM14	Flake		SNMNH
2184	Roger Mills	RM14	Flake		SNMNH
2185	Roger Mills	RM14	Flake		SNMNH
2186	Roger Mills	RM14	Flake		SNMNH
2187	Roger Mills	RM14	Flake		SNMNH
2188	Roger Mills	RM14	Flake		SNMNH
2189	Roger Mills	RM14	Flake		SNMNH
2190	Roger Mills	RM14	Flake		SNMNH

2191	Roger Mills	RM14	Flake		SNMNH
2192	Roger Mills	RM14	Flake		SNMNH
2193	Roger Mills	RM14	Flake		SNMNH
2194	Roger Mills	RM14	Flake		SNMNH
2195	Roger Mills	RM14	Flake		SNMNH
2196	Roger Mills	RM14	Flake		SNMNH
2197	Roger Mills	RM14	Flake		SNMNH
2198	Roger Mills	RM14	Flake		SNMNH
2199	Roger Mills	RM72	flake		SNMNH

APPENDIX B

Source Provenance of Obsidian Artifacts from the Oklahoma Archaeological Survey: Report Prepared for Matthew Oliver
Department of Anthropology
University of Oklahoma
Norman, Oklahoma

September 22, 2021

By
M. Steven Shackley, Ph.D., Director
Geoarchaeological XRF Laboratory
Albuquerque, New Mexico

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A GREEN SOLAR FACILITY

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SOURCE PROVENANCE OF OBSIDIAN ARTIFACTS FROM THE OKLAHOMA ARCHAEOLOGICAL SURVEY

by

M. Steven Shackley, Ph.D., Director
Geoarchaeological XRF Laboratory
Albuquerque, New Mexico

Report Prepared for

Matthew Oliver
Department of Anthropology
University of Oklahoma
Norman, Oklahoma

22 September 2021

INTRODUCTION

The analysis here of 110 artifacts (102 obsidian) from the collections of the Oklahoma Archaeological Survey indicates a dominance of artifacts produced from Jemez Mountains volcanic field obsidian sources in northern New Mexico, and a number of other sources in the Mountain West and the U.S. Northwest. Indeed, over 68% were produced from one of the sources in the Jemez Mountains of northern New Mexico, Valles Rhyolite (Cerro del Medio) at 38.2%, Cerro Toledo Rhyolite at 26.5%, and El Rechuelos Rhyolite at 2.9% (Shackley 2005). Most of the other artifacts were produced from sources in the Mountain West, frequently encountered in western Plains contexts including Malad, Idaho (18.6%), Obsidian Cliff, Wyoming (5.9%), and Timber Butte, Idaho (1%; Shackley 2021a). Two artifacts were produced from the Buck Mountain source in the far northeast of California in the Warner Mountains volcanic field, not commonly recovered in western Plains contexts (c.f. Dolan et al. 2018). A short description of these sources of archaeological obsidian will be provided in the discussion section below.

LABORATORY SAMPLING, ANALYSIS AND INSTRUMENTATION

All archaeological samples are analyzed whole. The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984; Shackley 2011).

All analyses for this study were conducted on a ThermoScientific *Quant'X* EDXRF spectrometer, located at the Geoarchaeological XRF Laboratory, Albuquerque, New Mexico. It is equipped with a thermoelectrically Peltier cooled solid-state Si(Li) X-ray detector, with a 50 kV, 50 W, ultra-high-flux end window bremsstrahlung, Rh target X-ray tube and a 76 μm (3 mil) beryllium (Be) window (air cooled), that runs on a power supply operating from 4-50 kV/0.02-1.0 mA at 0.02 increments. The spectrometer is equipped with a 200 l min^{-1} Edwards vacuum pump, allowing for the analysis of lower-atomic-weight elements between sodium (Na) and titanium (Ti). Data acquisition is accomplished with a pulse processor and an analogue-to-digital converter. Elemental composition is identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities and net peak intensities above background.

Trace Element Analysis

For the analysis of mid Zb condition elements Ti-Nb, Pb, Th, the x-ray tube is operated at 30 kV with automatically determnined mA, using a 0.05 mm (medium) Pd primary beam filter in an air path at 100 seconds livetime to generate x-ray intensity $K\alpha_1$-line data for elements titanium (Ti), manganese (Mn), iron (as $Fe_2O_3^T$), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), and $L\alpha_1$-line data for lead (Pb), and thorium (Th). Not all these elements are reported since their values in many volcanic rocks are very low. Trace element intensities were converted to concentration estimates by employing a linear calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements. When barium (Ba) is analyzed in the High Zb condition, the Rh tube is operated at 50 kV and up to 1.0 mA, ratioed to the bremsstrahlung region (see Davis 2011; Shackley 2011b). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1995, 2005, 2012; Shackley et al. 2016, 2018; also Mahood and Stimac 1991; and Hughes and Smith

1993). Nineteen specific pressed powder standards are used for the best fit regression calibration for elements Ti-Nb, Pb, Th, and Ba, and include G-2 (basalt), AGV-2 (andesite), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (hawaiite), STM-1 (syenite), QLO-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), NOD-A-1 and NOD-P-1 (oceanic manganese) all US Geological Survey standards, U.S. National Institute of Standards and Technology SRM-278 (obsidian), BE-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France, and JR-1 and JR-2 (obsidian) from the Geological Survey of Japan (Govindaraju 1994).

Statistical and Graphical Source Assignment.

The data from the WinTrace™ software were translated directly into Excel for Windows software for manipulation and on into SPSS, ver. 27 for Windows and/or JMP 12.01 for statistical analyses as appropriate (Figure 1). In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-1 a USGS rhyolite (obsidian) standard is analyzed during each sample run of ≤20 for obsidian artifacts to check machine calibration (Appendix Table 1).

Source assignments were made by reference to the laboratory data base (see Shackley 1995, 2005, 2011a, 2012; Shackley et al. 2016; the Skinner/Shackley database of >160,000 obsidian source standards from western North America; see Appendix Table 1). Further information on the laboratory instrumentation and source data can be found at: http://www.swxrflab.net and (Shackley et al. 2016, 2018). Trace element data exhibited here are reported in parts per million (ppm), a quantitative measure by weight.

The elemental concentrations for the artifact data are assigned to source by a stepped statistical and graphical method, outlined in Shackley et al. (2018). Given the dominance of Jemez Mountain sources a Nb versus Y plot is initially used for all obsidian artifacts from all sites (see Figure 1). This effectively discriminates the Jemez Mountains sources (see Shackley et al. 2016). While multivariate statistical analysis (i.e. cluster, PCA, and discriminant) can be used in these large sample cases, they often assign incorrectly, mainly due to the non-parametric character of compositional analysis leaving empty cells in the sum of squares of cross-products matrix (Baxter 1992, 1994; Glascock 2011; Shackley 1998a). The stepped plotting strategy has been found to be the best approach in Southwestern obsidian provenance studies, particularly north of the US/Mexican border (Baxter 1992; Shackley 1998a; Shackley et al. 2018).

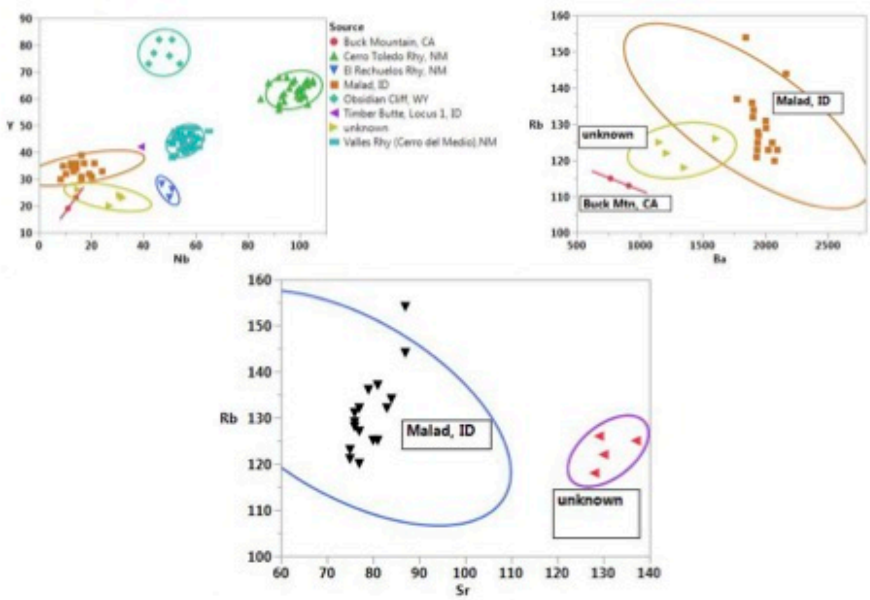


Figure 1. Nb/Y bivariate plot of the obsidian artifacts (all samples upper left), and Ba/Rb bivariate plot (upper right, Buck Mtn, Malad, and unknown), the former providing better discrimination of the Jemez Mountains sources, and Obsidian Cliff, and the latter better discriminating Buck Mountain. The Sr/Rb bivariate plot (lower center) provides discrimination between the Malad known source and the "unknown" samples. Confidence ellipses at 90%.

RESULTS AND DISCUSSION

Sources of Obsidian in the Assemblage

The sources of archaeological obsidian in the assemblage have all received considerable geoarchaeological study, particularly the Jemez Mountains and Mountain State sources for more than a century (Davis et al. 1995; Holmes 1879; Iddings 1888, Shackley 2005, 2021b, Shackley et al. 2016; Steffen 2016; see Table 1 and Figure 2 in text; Appendix Figures 1 through 3). Below is a short description of the sources relevant to their presence in the site, and prehistory of the region (see Appendix Table 1 and Appendix Figures 1 through 3).

Table 1. Frequency distribution of obsidian source provenance. Non-obsidian samples deleted.

Source	Frequency	Percent
Valles Rhy (Cerro del Medio),NM	39	38.2
Cerro Toledo Rhy, NM	28	27.5
El Rechuelos Rhy, NM	3	2.9
Malad, ID	19	18.6
Obsidian Cliff, WY	6	5.9
Timber Butte, Locus 1, ID	1	1.0
Buck Mountain, CA	2	2.0
unknown	4	3.9
Total	**102**	**100.0**

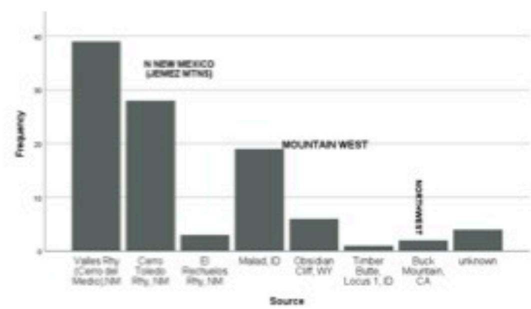


Figure 2. Frequency histogram of the distribution of obsidian source provenance (see Table 1 text, Appendix Table 1).

THE JEMEZ LINEAMENT AND THE JEMEZ MOUNTAIN VOLCANIC FIELD

The Jemez Mountains sources both caldera and pre-caldera are derived from Jemez Lineament volcanism (Aldrich 1986; Gardner et al. 1986; Goff et al. 2019). According to Aldrich the Jemez lineament describes a northeast trending crustal flaw that controlled volcanism and tectonism in the Jemez Mountains and the Rio Grande rift zone including the Mount Taylor volcanic field at the interface between the rift and the Colorado Plateau (Aldrich, 1986; Goff and Gardner, 2004; Goff et al., 2019). Along the lineament is a string of Miocene to Holocene volcanic fields and volcanoes including the Mount Taylor and the Jemez Mountains fields, all of which have eroded in variable quantities into the ancestral Rio Puerco and Rio Grande respectively, likely not an issue in this study (Baker and Ridley, 1970; Shackley, 1998b, 2005, 2021b). This volcanism has occurred in a transition zone between the Colorado Plateau, and the Rio Grande Rift, and in part this origin is reflected in the elemental composition of the obsidian (Baker and Ridley, 1970; Shackley, 1998b, 2005; Figure 3 here)

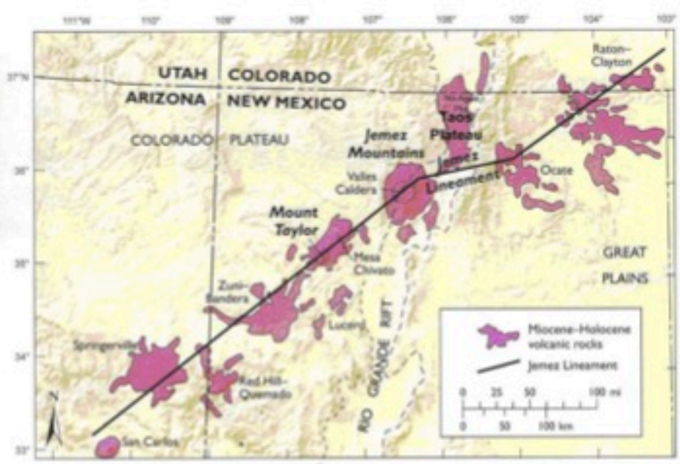


Figure 3. Location of the Jemez Lineament with major obsidian sources at Mount Taylor, the Jemez Mountains, and No Agua Peaks (adapted from Aldrich 1986; Goff and Gardner 2004; Goff et al. 2019).

JEMEZ MOUNTAINS VOLCANIC FIELD

Distributed in archaeological contexts over a great distance throughout North America, particularly for Cerro del Medio (Valles Rhyolite), the Neogene and Quaternary sources in the Jemez Mountains, two associated with caldera formation, have been recovered in 12 U.S. and Mexican states at least as far south as Chihuahua through secondary deposition in the Rio Grande, and northeast to the Oklahoma and Texas Panhandles, Kansas, and as far east as Mississippi, north into Colorado and Utah as far north as Montana, west into Arizona, and even California through various social networks (Shackley 2021a; Steffen 2016; Figure 4 herein). And like the sources in the San Francisco and Mount Floyd volcanic fields of northern Arizona, the nodule sizes are up to 10-20 cm in diameter, even large boulders for Cerro del Medio; El Rechuelos Rhyolite, Canovas Canyon Rhyolite, Cerro Toledo Rhyolite, and Valles Rhyolite (Cerro del Medio) glass sources are as good a media for tool production as anywhere (Figures 4 and 5).

Until the land exchange of the Baca Ranch properties, the Valles Rhyolite primary dome (Cerro del Medio) was off-limits to most research. The discussion of this source group here is based on collections facilitated by the Valles Caldera National Preserve, National Park Service and Anna Steffen, as well as collections under Santa Fe National Forest Permit # SFE222402 (see Shackley 2005; Wolfman 1994).

Due to its proximity and relationship to the Rio Grande Rift system, potential uranium ore, geothermal possibilities, an active magma chamber, and a number of other geological issues, the Jemez Mountains and the Toledo and Valles Calderas particularly have been the subject of intensive structural and petrological study since the 1970s (Bailey et al., 1969; Gardner et al., 1986, 2007; Goff and Gardner, 2004; Heiken et al., 1986; Self et al., 1986; Shackley, 2005, 2021b; Shackley et al., 2016; Smith et al., 1970; Figure 5). Half of the 1986 *Journal of*

Geophysical Research, volume 91, was devoted to the then current research on Jemez Mountain volcanic field geology, and two New Mexico Geological Society field conferences have been held here (Goff et al. 1996; Kues et al. 2007). More accessible for archaeologists, the geology of which is mainly derived from much of the 1986 and earlier work, is Baugh and Nelson's (1987) article on the relationship between northern New Mexico archaeological obsidian sources and procurement on the southern Plains, as well as Glascock et al's (1999) analysis of these sources (see also Shackley 2005, 2021b and http://swxrflab.net/jemez.htm). As evident in this study, except for Cerro del Medio, for over 8 million years, these obsidian sources have been eroding into the Rio Chama (El Rechuelos Rhyolite) or Rio Grande, particularly during and after the large scale Cerro Toledo Rhyolite Plinian event that created the Bandelier Tuff propelling lava, ash including rapidly quenching rhyolite into glass, to the east and southeast toward the ancestral Rio Grande depositing obsidian nodules up to at least 80 mm in diameter through what is now Cochiti Canyon, Obsidian Ridge, and over the Puye Formation east of Española (Shackley 2021b; see Figure 5 herein). In many ways, the obsidian sources in the Jemez Mountains have defined archaeological obsidian studies in New Mexico, and much of the West for decades, and likely decades to come.

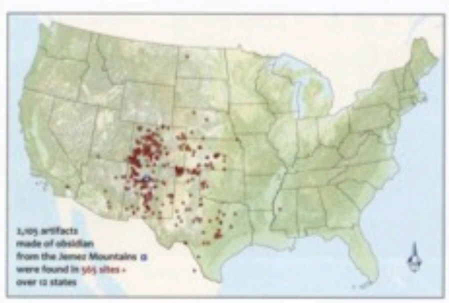


Figure 4. Distribution of mainly Cerro de Medio obsidian in North American archaeological contexts in 2016 (from Steffen 2016).

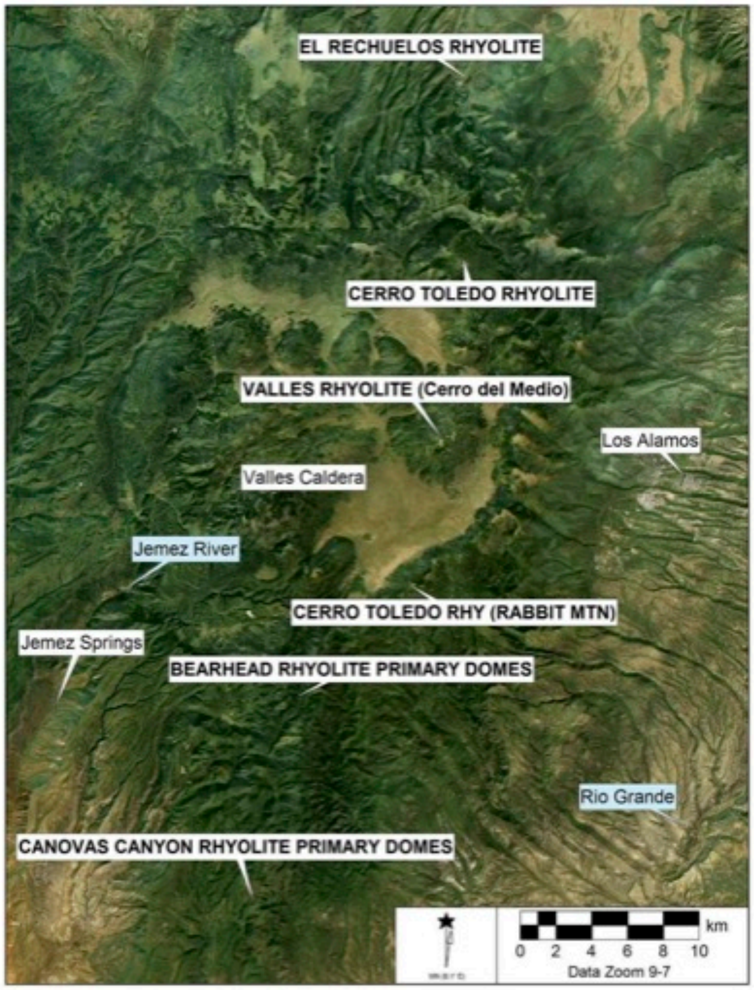


Figure 5. Obsidian source locations (capitals) of the Jemez Mountains Volcanic Field and Valles Caldera of northern New Mexico, and relevant features.

El Rechuelos Rhyolite of the Polvadera Group

The Polvadera Group best exposed in the northern Jemez Mountains, consists of three formations, oldest to youngest, Lobato basalt, Tschicoma Formation, and El Rechuelos Rhyolite (Goff and Gardner 2004). The latter is the subject here. For years in the archaeological vernacular, the obsidian produced by El Rechuelos Rhyolite was called "Polvadera Peak" even though that peak is a dacite dome that did not produce obsidian.

El Rechuelos obsidian (two samples in this assemblage) is derived from five small domes one west and four north of Polvadera Peak as originally noted by Baugh and Nelson (1987) and Wolfman (1994; see also Goff and Gardner, 2004; Konkright 2019; Shackley 2005). Collections here were made at two to three small coalesced domes near the head of Cañada de los Ojitos and as secondary deposits in Cañada de los Ojitos that flows north into the Rio Chama (collection localities 080999-1&2; see Figure 5). The center of the domes is located north of Polavadera Peak on the Polvadera Peak 7.5' quadrangle. The three domes are approximately 50 meters in diameter each and exhibit an ashy lava with rhyolite and aphyric obsidian nodules up to 15 cm in diameter, but dominated by nodules between 1 cm and 5 cm. Core fragments and primary and secondary flakes are common in the area.

Small nodules under 10-15 mm are also common in the alluvium throughout the area near Polvadera Peak, probably where the "Polvadera Peak" misnomer originated. Presumably they are remnants of various eruptive events associated with El Rechuelos Rhyolite. The source samples analyzed, the results of which are available at http://swxrflab.net/jemez.htm#El%20Rechuelos are compositionally similar to the data presented in Baugh and Nelson (1987), Glascock et al. (1999), and Konkright (2019). El Rechuelos obsidian is generally very prominent in northern New Mexico archaeological collections from Paleoindian to historic periods. Although it is not distributed geologically over a large area, it is one of the finest raw materials for tool production in the Jemez

Mountains. Its high quality as a toolstone probably explains its desirability in prehistory, particularly during the Archaic period. In nearly 500 nodules collected from the El Rechuelos area, few of the nodules exhibited spherulites or phenocrysts in the fabric, unlike some of the Cerro Toledo and Valles Rhyolite obsidian. Additionally, El Rechuelos glass is megascopically distinctive from the other two major sources in the Jemez Mountains. It is uniformly micro-granular in character, apparently from ash incorporated into the matrix during the eruptive event. Cerro Toledo and Valles Rhyolite glass is generally not granular and more vitreous.

El Rechuelos obsidian dates by K/Ar to 2.02 to 2.07 Ma, and from that time has been eroding north into the Rio Chama, and into the Rio Grande above Española (Dalrymple et al., 1967; Loeffler et al., 1988; Shackley 2021b, Figure 5 herein). More recently Konkright re-dated much of the El Rechuelos Rhyolite by $^{40}Ar/^{39}Ar$ and concluded that "these seven units represent five separate eruptive episodes", divided into early, middle and late, but based on field relations, optical petrography, elemental, and isotopic analyses only the latest (2.23 ± 0.15 Ma) should be called El Rechuelos Rhyolite, the event that produced artifact quality obsidian (2019:iv, 89-92). The proportion of El Rechuelos obsidian recovered in Rio Grande alluvium at least as far as Las Cruces indicates that the sediment load through the Rio Chama and into the Rio Grande from this source has been substantial over time (see Data table here).

As with the Canovas Canyon Rhyolite obsidian sample, El Rechuelos obsidian present in this assemblage is somewhat vexing. Again, it seems possible that this was included in a package exchanged possibly at one of the northern pueblos like Taos or Pecos. More on that below.

Tewa Group Obsidian: Cerro Toledo and Valles Rhyolites

Bailey et al. (1969), Smith et al. (1970), and Gardner et. al. (1986) have characterized the Tewa Group from the oldest to the youngest formations - Bandelier Tuff, Cerro Toledo Rhyolite, Cerro Rubio Quartz Latite, and Valles Rhyolite. The group consists almost entirely of rhyolite, and for geoarchaeological purposes Cerro Toledo Rhyolite and Valles Rhyolite are volumetrically the most common archaeological obsidian used throughout prehistory in much of the Southwest and the southern Plains, as evident both archaeologically and in Rio Grande secondary deposits and dominate obsidian studies in New Mexico (Mills et al. 2013; Shackley 2005, 2021b). The Group deposits "unconformably blanket or intrude most older volcanic units within the Toledo and Valles calderas...and on the plateaus that flank the east, west, and north sides of the Jemez Mountains" (Gardner et al. 1986:1774). The Valles Caldera is so topographically prominent that it is easily seen from space (Goff et al. 2011; see Figure 5 herein). The magma chamber under the Jemez Mountains, as at Yellowstone, is still quite hot, and could very likely perform another eruptive miracle in the future, when is unknown.

Cerro Toledo Rhyolite. Known in the archaeological vernacular incorrectly as "Obsidian Ridge" obsidian, Cerro Toldedo Rhyolite obsidian is derived from the Cerro Toledo Rhyolite eruptive events (Bailey et al. 1969; Baugh and Nelson 1987; Gardner et al. 1986; Goff et al. 2011; Heiken et al. 1986; Self et al. 1986; Smith et al. 1970; Spell et al. 1996). This is the most common secondary deposit obsidian in Quaternary alluvium along the entire length of the Rio Grande in New Mexico, and presumably south into Mexico (Shackley 2021b).

There were six pyroclastic eruptive events associated with the Cerro Toledo Rhyolite:

> All tuff sequences from Toledo intracaldera activity are separated by epiclastic sedimentary rocks that represent periods of erosion and deposition in channels, important in this study. All consist of rhyolitic tephra and most contain Plinian

> pumice falls and thin beds of very fine grained ash of phreatomagmatic origin. Most Toledo deposits are thickest in paleocanyons cut into lower Bandelier Tuff and older rocks [as with the Rabbit Mountain ash flow]. Some of the phreatomagmatic tephra flowed down canyons from the caldera as base surges (Heiken et al. 1986:1802; brackets mine).

Two major ash flows are relevant here, separate from the Bandelier Tuff events (Goff and Gardner 2004; Goff, personal communication, July 2021). Weighted mean of $^{40}Ar/^{39}Ar$ dates from Spell et al. (1996) of the Cerro Toledo multiple events is from 1.54 ± 0.02 to 1.26 ± 0.01 Ma. One ash flow derived from what is now called the Toledo Embayment on the northeast side of the caldera is a 20 km wide band that trends to the northeast and is now highly eroded and interbedded in places with the upper levels of the earlier Puye Formation from around Guaje Mountain north to Santa Fe Forest Road 144 east of Española. This area has eroded rapidly and obsidian from this tuff is now an integral part of the Rio Grande alluvium north of Santa Fe, again relevant here. The other major ash flow is derived from the Rabbit Mountain portion of the Cerro Toledo event and is comprised of a southeast trending 4 km wide and 7 km long "tuff blanket" interbedded with a rhyolite breccia three to six meters thick that contains abundant obsidian erupted as lapilli during the Rabbit Mountain ash flow (Heiken et al. 1986). All of this is still eroding into the southeast trending canyons toward the Rio Grande and has been for over one million years. The surge deposits immediately south of Rabbit Mountain contain abundant obsidian chemically identical, at least when analyzed by XRF, to the samples from the ridges farther south and in the Rio Grande alluvium, as well as in sediments to the north above the Puye Formation between Española and the Toledo Embayment (Shackley, 2005, 2021b). Heiken et al's. NAA analysis of Rabbit Mountain lavas is very similar to those from this study (1986:1810; c.f. Spell et al. 1996; Glascock et al. 1999; see here).

pumice falls and thin beds of very fine grained ash of phreatomagmatic origin. Most Toledo deposits are thickest in paleocanyons cut into lower Bandelier Tuff and older rocks [as with the Rabbit Mountain ash flow]. Some of the phreatomagmatic tephra flowed down canyons from the caldera as base surges (Heiken et al. 1986:1802; brackets mine).

Two major ash flows are relevant here, separate from the Bandelier Tuff events (Goff and Gardner 2004; Goff, personal communication, July 2021). Weighted mean of $^{40}Ar/^{39}Ar$ dates from Spell et al. (1996) of the Cerro Toledo multiple events is from 1.54 ± 0.02 to 1.26 ± 0.01 Ma. One ash flow derived from what is now called the Toledo Embayment on the northeast side of the caldera is a 20 km wide band that trends to the northeast and is now highly eroded and interbedded in places with the upper levels of the earlier Puye Formation from around Guaje Mountain north to Santa Fe Forest Road 144 east of Española. This area has eroded rapidly and obsidian from this tuff is now an integral part of the Rio Grande alluvium north of Santa Fe, again relevant here. The other major ash flow is derived from the Rabbit Mountain portion of the Cerro Toledo event and is comprised of a southeast trending 4 km wide and 7 km long "tuff blanket" interbedded with a rhyolite breccia three to six meters thick that contains abundant obsidian erupted as lapilli during the Rabbit Mountain ash flow (Heiken et al. 1986). All of this is still eroding into the southeast trending canyons toward the Rio Grande and has been for over one million years. The surge deposits immediately south of Rabbit Mountain contain abundant obsidian chemically identical, at least when analyzed by XRF, to the samples from the ridges farther south and in the Rio Grande alluvium, as well as in sediments to the north above the Puye Formation between Española and the Toledo Embayment (Shackley, 2005, 2021b). Heiken et al's. NAA analysis of Rabbit Mountain lavas is very similar to those from this study (1986:1810; c.f. Spell et al. 1996; Glascock et al. 1999; see here).

While Obsidian Ridge has received all the archaeological "press" as the source of obsidian from Cerro Toledo Rhyolite on the southern edge of the caldera, the density of nodules and nodule sizes on ridges to the west is greater by a factor of two or more. All these ridges, of course, are remnants of the Rabbit Mountain ash flow and base surge, and the depth of canyons like Cochiti Canyon is a result of the loosely compacted tephra that comprises this plateau. At Locality 081199-1, nodules on the ridge top are up to 200 per m^2 with over half that number of cores and flakes, comparable to the "monster quarry" on top of Cerro del Medio (Ana Steffen, personal communication, 2006; see images at http://swxrflab.net/jemez.htm). This density of nodules and artifacts forms a discontinuous distribution all the way back to Rabbit Mountain. The discontinuity is probably due to cooling dynamics and/or subsequent colluviation. Where high density obsidian is exposed, prehistoric production and procurement is evident. At the base of Rabbit Mountain the density is about 1/8 that of Locality 081199-1, and south of this locality the density falls off rapidly. At Locality 081199-1 nodules range from pea gravel to 16 cm in diameter. Flake sizes suggest that 10 cm size nodules were typical in prehistory. Nodule sizes at Rabbit Mountain are up to 30 cm or more, reflected in the nodule sizes in Rio Grande alluvium particularly at Cochiti Reservoir and Tijeras Wash (Rory Gauthier, personal communication, 2006; Shackley 2021b).

Cerro Toledo Rhyolite obsidian both from the northern domes along the scarp of the Toledo Embayment and Rabbit Mountain varies from an excellent aphyric translucent brown glass to glass with large devitrified spherulites that make productive knapping nearly impossible. This character of the fabric is probably why there is so much test knapping at the sources – a need to determine the quality of the nodules before transport. While spherulitic fabric occurs sporadically in most of the Jemez Mountain obsidian, it seems to be most common in the Cerro Toledo glass and may explain why Valles Rhyolite (Cerro del Medio) obsidian occurs in sites a considerable distance from the caldera even though it is not secondarily distributed outside the caldera in any quantity while Cerro Toledo obsidian is common throughout the Rio Grande alluvium (Church 2000; Shackley 2021b). Indeed, in Folsom period contexts in the Albuquerque basin, *only* Valles Rhyolite obsidian was selected for obsidian tool production even though Cerro Toledo obsidian is available almost on-site in areas such as the West Mesa of Albuquerque (Huckell et al. 2012; LeTourneau et al. 1996; Shackley 2010, 2012). So, while Cerro Toledo Rhyolite obsidian is and was numerically superior in the Rio Grande Basin, it wasn't necessarily the preferred raw material in all time periods and archaeological contexts, all things being equal.

Valles Rhyolite (Cerro del Medio). In 1956 two geology graduate students from the University of New Mexico published the first paper on archaeological obsidian in the American Southwest, a refractive index analysis (Boyer and Robinson 1956). In this examination of the Jemez Mountain sources, they noted that obsidian did not occur in the alluvium of San Antonio Creek where it crosses New Mexico State Highway 126, but did occur "in pieces as large as hen's eggs, but the material is not plentiful and must be searched for with care" in the East Jemez River alluvium where it crosses State Highway 4 (Boyer and Robinson 1956:336). A return to the latter locality (Locality 102799-2) exhibited about the same scenario as that recorded 43 years earlier. The East Jemez River alluvium exhibits nodules up to 40 mm in diameter at a density up to $5/m^2$, but generally much lower. Boyer and Robinson did find nodules up to 15.5 cm in diameter along the upper reaches of San Antonio Creek as shown in their plate (Boyer and Robinson 1956:337).

My survey along San Antonio Creek from its junction with New Mexico State Highway 126 for two miles upstream did not reveal any obsidian, as in the Boyer and Robinson study (see Figure 5). It appears then that Valles Rhyolite obsidian does not enter secondary contexts outside the caldera, at least in nodules of any size compared to Cerro Toledo Rhyolite as evident along the Rio Grande (see Church 2000; Shackley 2021b).

Valles Rhyolite obsidian exhibits a fabric that seems to be a combination of El Rechuelos and Cerro Toledo. Some of the glass has that granular texture of El Rechuelos and some has devitrified spherulites similar to Cerro Toledo, and much of it is aphyric black glass. Flakes of Valles Rhyolite obsidian can be indistinguishable from El Rechuelos or Cerro Toledo in hand sample. On the west slope of Cerro del Medio is an outcrop of artifact quality mahogany colored obsidian (Ana Steffen, personal communication, 2010). The elemental composition by XRF is the same as the dominant black variety (see Data table here).

Volumetrically the obsidian from Cerro del Medio (the other domes along the ring fracture did not produce artifact quality obsidian) is by far the highest in the U.S. Southwest, perhaps only approached by Government Mountain in the San Francisco volcanic field of northern Arizona (Shackley 1988, 1995, 2005). Boulders meters across still occur on the slopes of Cerro del Medio, and the "monster quarry" near the top of the peak still exhibits cobbles of obsidian 20-30 cm in diameter, and prehistoric reduction debris up to 50 cm thick in places with large biface preforms present on the surface. As mentioned above, even though Cerro Toledo Rhyolite through the Plinian eruptive event scattering obsidian southeast of the caldera for one million years is dominant in Rio Grande alluvium, Valles Rhyolite (Cerro del Medio) is archaeological distributed through at least 12 U.S. and Mexican states and as far east as at least Mississippi and west to California, as noted above (Steffen 2016; Figure 4 herein).

The Valles Rhyolite event occurred after the Cerro Toldedo event, but has "presented challenges for radiometric dating" partly due to multiple smaller events at Cerro del Medio, with what appears to be about 50 to 80 ka of eruptions, many of those producing artifact quality obsidian (Gardner et al. 2007:368). Dates by $^{40}Ar/^{39}Ar$ range between 1.161 ± 0.01 to 1.229 ± 0.017 Ma (Gardner et al. 2007; Phillips 2004). The elemental composition of the smaller events at Cerro del Medio are not different as detectable by ICPMS or XRF, and the analyses of various portions of the dome or secondary deposits along San Antonio Creek or the East Jemez River are statistically similar (Gardner et al. 2007:370; see http://swxrflab.net/jemez.htm#Valle%20Grande%20Rhyolite).

While some Cerro del Medio obsidian is available in secondary deposits down the Jemez River at least as far as Jemez Nation land, the major reason that Cerro del Medio obsidian is rare in secondary deposits outside the caldera is that the event did not produce the large scale Plinian ash flows that Cerro Toledo Rhyolite did earlier. Generally, when Valles Rhyolite (Cerro del Medio) obsidian is recovered archaeologically, even nearby the caldera, it most likely was originally procured at the dome proper as seen by the large quantity of prehistoric reduction debris throughout the surface of the dome and surrounding alluvium, probably throughout prehistory by many groups when visiting the Jemez Mountains for a variety of purposes (Moore et al. 2020; Shackley and Moore 2018).

The Wyoming Basin Obsidian Conveyance Zone

Two of the non-Jemez Mountains sources present in the assemblage (Malad, Idaho, and the Obsidian Cliff Plateau chemical group, Wyoming have been included in what Harvey (2012) has called the Wyoming Basin Obsidian Conveyance Zone for the eastern Great Basin, Intermountain region, and southern Plains (see also Fowler 2014, Thompson 2004; see Appendix Figure 1 herein). These two sources are two of the most commonly recovered obsidian sources in Western North America similar to Cerro del Medio. Since the proportion of these two sources in the assemblage is quite low, extensive detailed discussion of the sources is not offered here.

Obsidian Cliff and the Yellowstone Volcanic Field. The obsidian sources in the Yellowstone basin have been of interest to geology and archaeology for well over 100 years (Davis et al. 1995; Holmes 1879; Iddings 1888). Obsidian Cliff (48YE433) and associated rhyolite plateau is located in the Rocky Mountain chain of northwestern Wyoming, probably the most studied prehistoric obsidian source in North America (Davis et al. 1995:4-5). Few toolstone sources have gained nationally as prominent status and protection as Obsidian Cliff (Schmitt 1995). The Yellowstone Plateau is one of the largest Quaternary siliceous volcanic fields on earth, even larger than the Jemez Mountains volcanic field, also containing a Quaternary collapsed caldera. Obsidian Cliff occurs within one of the four major rhyolite flows in the basin (Boyd 1961; Christiansen and Blank 1972). The Obsidian Cliff flow filled a pre-existing valley rapidly chilling against the valley wall and rapidly quenched underneath a portion of the continental glacier. The extreme cold quenched the largest single block of glass on earth (Pierce 1973; Schmitt 1995). Obsidian Cliff is dated to 183±0.003 ka, and covers an area of 14.5 km^2 with an exposed thickness of 30 m, an impressive sight to anyone (Obradovich 1992; Schmitt 1995:20). As with Cerro del Medio, and even more so, Obsidian Cliff obsidian has been found throughout North America at least as far west as the Hopewell cultural region in the upper Midwest, into the Chaco Canyon Pueblo II-III sites in northwest New Mexico, to the Gulf of Mexico coast, and well into Canada including British Columbia (Shackley 2016). The Tobias Site is substantially later than Hopewell and Chaco, but it appears that the exchange system stimulated by Hopewell exchange extended well into the Historic period (see cover image). Parenthetically, the distribution of Obsidian Cliff and Cerro del Medio obsidian is only slightly different, particularly if the Yellowstone Hopewell material is ignored (see Steffen 2016; Figure 4 herein).

The Malad, Idaho Source. The Malad source is present in the Bannock Range of southeastern Idaho within a perlite devitrified deposit (Fowler 2014; Thompson 2004). Similar to Obsidian Cliff although in a more southerly direction, Malad is approximately 1260 km from the Tobias Site. While certainly not as extensive a dome structure as Obsidian Cliff, nodule sizes of the Quaternary obsidian reach over 25 cm in diameter. Malad obsidian is also distributed throughout western North America and appears to be somewhat more common in Paleoindian and Archaic contexts in the West. If so, whether it's presence in later period sites is due to exchange, direct procurement, curation, or scavenging earlier site contexts is unknown (see Vehik 2002).

The Timber Butte, Idaho Source

One artifact was produced from the Timber Butte, Area 1 source, most recently reported by Corn (2006). This is a volumetrically large obsidian source located in Gem County, Idaho north of Boise (Corn 2006). Geologically it could be part of Timber Butte Rhyolite, but Corn found that the elemental chemistry of the obsidian did not match the crystalline rhyolite, and there is some suggestion that it is product of crustal melting from the mafic Columbia River Basalt, not an unusual process (Clemons and Woods 1991; Shackley 2005). I have not seen this source in Southern Plains contexts, but given the quantity at the source, and the quality of the obsidian, it seems quite possible.

The Buck Mountain, California Source

Most unusual in the assemblage are the two artifacts produced from the Buck Mountain source from the Warner Mountains in extreme northeast California near the California, Oregon, and Nevada "three corners" (see Hughes 1983). The Warner Mountains include a large rhyolite dome complex with a number of obsidian chemical groups with differing fabric and quality. The Buck Mountain group as defined by Hughes (1983:296-311) exhibits extensive variability. However the Nelson and North Fork quarry areas that match these artifact's composition, exhibit voluminous obsidian with nodule sizes up to at least 80 cm in diameter (I have large boulders in my collection at Albuquerque). This glass varies from translucent black sometimes with a purple sheen to dark mahogany. It was used to produce bifaces up to 1 m in length for the Yurok White Deerskin dance on the northwest California coast, and is common in Great Basin and northern and central California archaeological contexts (Hughes 1972, 1982, 1983; Dillian 2002).

Recently, Dolan et al. (2018) reported a piece of debitage in the Middle Holocene Calf Creek biface cache, Oklahoma (34ML168) that was produced from the Glass Mountain obsidian source in the Medicine Lake Highlands volcanic field to the west of the Warner Mountains in Lassen County, California (see also Dillian 2002). This type of long-distance conveyance, indeed the long-distance discovered in this collection appears to be more common than originally conceived, the discovery of which is all due to the efficacy of obsidian compositional analysis and extensive North American source provenance studies (see Barker et al., 2002; Dillian et al. 2010).

REFERENCES CITED

Aldrich, M.J. 1986, Tectonics of the Jemez Lineament in the Jemez Mountains and Rio Grande rift. *Journal of Geophysical Research* 91:1753-1762.

Bailey, R.A., Smith, R.L. and Ross, C.S. 1969, Stratigraphic nomenclature of volcanic rocks in the Jemez Mountains, New Mexico. *U.S. Geological Survey Bulletin* 1274-P:1-19.

Baker, I., and Ridley, W.I. 1970, Field evidence and K, Rb, Sr data bearing on the origin of Mt. Taylor volcanic field, New Mexico, U.S.A. *Earth and Planetary Science Letters* 10:106-114.

Baugh, T.G. and Nelson, F.W. 1987, New Mexico obsidian sources and exchange on the Southern Plains. *Journal of Field Archaeology* 14:313-329.

Baxter, M.J., 1992, Archaeological uses of the biplot—a neglected technique? In Lock, G., and Moffet J. eds, *Computer Applications and Quantitative Methods in Archaeology*, pp. 141- 148. BAR International Series S577. Oxford, British Archaeological Reports.

Baxter, M.J., 1994, Stepwise discriminant analysis in archaeometry: a critique. *Journal of Archaeological Science* 21:659-666.

Boyd, F.R. 1961, Welded tuffs and flows in the rhyolite plateau of Yellowstone Park, Wyoming. *Geological Society of America Bulletin* 72:387-426.

Boyer, W.W., and Robinson, P. 1956, Obsidian artifacts of northwestern New Mexico and their correlation with source material. *El Palacio* 63:333-345.

Church, T. 2000, Distribution of sources of obsidian in the Rio Grande gravels of New Mexico. *Geoarchaeology* 15:649-678.

Christiansen, R.L., and H.R. Blank, 1972, Volcanic stratigraphy of the Quaternary rhyolite plateau in Yellowstone National Park. *U.S. Geological Survey Professional Paper* 729-B.

Clemons, D.M., and Woods S.H. 1991, K-Ar age of silicic volcanic rocks within the Lower Columbia River Basalt Group at Timber Butte, Boise and Gem Counties, West-Central Idaho. Department of Geology and Geophysics, Boise State University, Boise, Idaho. *Isochron/West* 57, July.

Corn, T.L. 2006, *Timber Butte Obsidian Source Survey: Geology, Prehistory, Chemical Sourcing, and Debitage Analysis*. MA thesis, Department of Anthropology, University of Idaho.

Dalrymple, G., Cox, A., Doell, R., and Grommé, C. 1967, Pliocene geomagnetic polarity epochs. *Earth and Planetary Science Letters* 2:163-173.

Davis, L.B., S.A. Aaberg, J.G. Schmitt, and A.M. Johnson, 1995, *The Obsidian Cliff Plateau Prehistoric Lithic Source, Yellowstone National Park, Wyoming.* Selections from the Division of Cultural Resources 6, Rocky Mountain Region, National Park Service.

Davis, M.K., T.L. Jackson, M.S. Shackley, T. Teague, and J. Hampel, 2011, Factors Affecting the Energy-Dispersive X-Ray Fluorescence (EDXRF) Analysis of Archaeological Obsidian. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M.S. Shackley, pp. 45-64. Springer, New York.

Dillian, C.D. 2002, *More than Toolstone: Differential Utilization of Glass Mountain Obsidian.* Ph.D. dissertation, Department of Anthropology, University of California, Berkeley.

Dillian, C.D., Bello, C.A., and Shackley, M.S. 2010, Long-distance exchange of obsidian in the mid-Atlantic United States. In Dillian, C.D., and White, C.L. (Eds.) *Trade and Exchange: Archaeological Studies from History and Prehistory*, pp 17-36. New York: Springer.

Dolan, S.G., Shackley, M.S., Wyckoff, D.G, and Skinner, C.G. 2018, Long-distance conveyance of California obsidian at the Hayhurst lithic cache site (34ML168) in Oklahoma. *Plains Anthropologist* 63:279-297.

Fowler, B.L. 2014, *Obsidian Toolstone Conveyance: Southern Idaho Forager Mobility.* Unpublished Master's thesis, Department of Anthropology, Utah State University, Logan.

Gardner, J.N., Goff, F., Garcia, F., and Hagan, R. 1986, Stratigraphic relations and lithologic variations in the Jemez Volcanic Field, New Mexico. *Journal of Geophysical Research* 91, B2:1763-1778.

Gardner, J.M., Sandoval, M.M., Goff, F., Phillips, E., and Dickens, A. 2007, Geology of the Cerro del Medio moat rhyolite center, Valles Caldera, New Mexico. In B.S. Kues, S.A. Kelley, and V.W. Lueth (Eds.) *Geology of the Jemez Region II* (pp. 367-372.). Socorro, New Mexico: New Mexico Geological Society 58th Annual Field Conference, New Mexico Geological Society.

Glascock, M.D., 2011, Comparison and contrast between XRF and NAA: used for characterization of obsidian sources in central Mexico. In Shackley, M.S. (Ed.), *X-Ray*

Fluorescence Spectrometry (XRF) in Geoarchaeology, pp. 161-192. New York: Springer.

Glascock, M.D., Kunselman, R., and Wolman, D. 1999, Intrasource chemical differentiation of obsidian in the Jemez Mountains and Taos Plateau, New Mexico. *Journal of Archaeological Science* 26:861-868.

Goff, F., Kues, B.S., Rogers, M.A., McFadden, L.D., and Gardner, J.N., Eds. 1996, *The Jemez Mountains Region.* New Mexico Geological Society 47th Annual Field Conference, Socorro, New Mexico.

Goff, F., and J.N. Gardner. 2004, Late Cenozoic geochronology of volcanism and mineralization in the Jemez Mountains and Valles Caldera, north central New Mexico. In G.H. Mack and K.A. Giles (Eds.) *The Geology of New Mexico: A Geologic History* (pp. 295-312). Socorro, New Mexico: New Mexico Geological Society Special Publication 11.

Goff, F. Kelley, S.A., Goff, C.J., McGraw, D.J., Osburn, G.R., Lawrence, J.R., Drakos, P.G., and Skotnicki, S.J. 2019, Geologic Map of the Mount Taylor Volcano Area, New Mexico. Geologic map 80. Socorro, New Mexico: New Mexico Bureau of Geology and Mineral Resources.

Govindaraju, K., 1994, 1994 Compilation of Working Values and Sample Description for 383 Geostandards. *Geostandards Newsletter* 18 (special issue).

Hampel, Joachim H., 1984, Technical Considerations in X-ray Fluorescence Analysis of Obsidian. In *Obsidian Studies in the Great Basin*, edited by R.E. Hughes, pp. 21-25. Contributions of the University of California Archaeological Research Facility 45. Berkeley.

Harvey, D.C., 2012, *A Cost Surface Analysis of Obsidian Use in the Wyoming Basin, USA.* Unpublished Master's thesis, Department of Earth Sciences, University of Memphis, Memphis, Tennessee.

Heiken, G., Goff, F., Stix, J., Tamanyu, S., Shafiqullah, M., Garcia, S., and Hagan, R. 1986, Intercaldera volcanic activity, Toledo caldera and embayment, Jemez Mountains, New Mexico. *Journal of Geophysical Research* 91:1799-1815.

Hildreth, W., 1981, Gradients in Silicic Magma Chambers: Implications for Lithospheric Magmatism. *Journal of Geophysical Research* 86:10153-10192.

Holmes, W.H. 1879, Notes on an extensive deposit of obsidian in the Yellowstone National Park. *American Naturalist* 13:247-250.

Huckell, B.B., M.S. Shackley, M.J. O'Brien, and C.W. Merriman, 2012, Folsom obsidian procurement and use at the Boca Negra Wash Site, New Mexico. *Current Research in the Pleistocene* 28:49-52.

Hughes, R.E. 1978, Aspects of prehistoric Wiyot exchange and social ranking. *Journal of*

California Anthropology 5: 53-66.

Hughes, R.E. 1982, Age and exploitation of obsidian from the Medicine Lake Highland, California. *Journal of Archaeological Science* 9:173-185.

Hughes, R.E. 1983, *Exploring Diachronic Variability in Obsidian Procurement Patterns in Northeast California and Southcentral Oregon: Geochemical Characterization of Obsidian Sources and Projectile Points by Energy-Dispersive X-ray Fluorescence*. Ph.D. dissertation, Department of Anthropology, University of California, Davis.

Hughes, R. E., and R. L. Smith, 1993, Archaeology, geology, and geochemistry in obsidian provenance studies. *In Scale on Archaeological and Geoscientific Perspectives*, edited by J.K. Stein and A.R. Linse, pp. 79-91. Geological Society of America Special Paper 283.

Iddings, J.P. 1888, *Obsidian Cliff, Yellowstone National Park.* Seventh Annual Report of the U.S. Geological Survey, Washington, DC.

Kelley, S.A., McIntosh, W.C., Goff, F., Kempter, K.A., Wolff, J.A., Esser, R., Braschayko, S., Love, D., and Gardner, J.N. 2013, Spatial and temporal trends in pre-caldera Jemez Mountains volcanic and fault activity. *Geosphere* 9:614-646.

Kempter, K, Osburn, G.R., Kelley, S., Rampey, M., Ferguson, C., and Gardner, J. 2004, Preliminary geologic map of the Bear Springs Peak quadrangle, Sandoval County, New Mexico. Socorro, New Mexico: Bureau of Geology and Mineral Resources Open-file Digital Geologic Map OF-GM 74.

Konkright, K.J. 2019, *Petrogenesis of the El Rechuelos Rhyolite, Jemez Mountains Volcanic Field, New Mexico, USA*. MS thesis, Department of Geoscience, University of Nevada, Las Vegas.

Kues, B.S., Kelley, S.A., and Lueth, V.W., Eds. 2007, *Geology of the Jemez Region II.* New Mexico Geological Society 58th Annual Field Conference, Socorro, New Mexico.

LeTourneau, P.D., M.S. Shackley, J.M. Warnica, and J. Cummings, 1996, Analysis of Obsidian Folsom Artifacts from New Mexico. *Current Research in the Pleistocene* 13:59-61.

Loeffler, B., Vaniman, D. Baldridge, W., and Shafiqualla, M. 1988, Neogene rhyolites of the northern Jemez volcanic field, New Mexico. *Journal of Geophysical Research* 93:6157-6167.

Mahood, Gail A., and James A. Stimac, 1990, Trace-element partitioning in pantellerites and trachytes. *Geochemica et Cosmochimica Acta* 54:2257-2276.

McCarthy, J.J., and F.H. Schamber, 1981, Least-squares fit with digital filter: a status report. In *Energy Dispersive X-ray Spectrometry*, edited by K.F.J. Heinrich, D.E. Newbury, R.L. Myklebust, and C.E. Fiori, pp. 273-296. National Bureau of Standards Special Publication 604, Washington, D.C.

Mills, B.J., Clark, JJ., Peeples, M.A., Haas, Jr., W.R., Roberts, Jr., J.M., Hill, J.B., Huntley, D.L. Borck, L., Breiger, R.L., Clauset, A., and Shackley M.S. 2013, Transformation of Social Networks in the Late Pre-Hispanic US Southwest. *Proceedings of the National Academy of Science* 110:5785-5790.

Moore, J.L., E. Blinman, and M.S. Shackley, 2020, Temporal variations in obsidian procurement in the Northern Rio Grande and its implications for obsidian movement into the San Juan Area. *American Antiquity* 85:152-170.

Phillips, E.H. 2004, *Collapse and resurgence of the Valles caldera, Jemez Mountains, New Mexico: $^{40}Ar/^{39}Ar$ age constraints on the timing and duration of resurgence and ages of megabreccia blocks.* Master's thesis, New Mexico Institute of Mining and Technology, Socorro, New Mexico.

Schamber, F.H., 1977, A modification of the linear least-squares fitting method which provides continuum suppression. In *X-ray Fluorescence Analysis of Environmental Samples*, edited by T.G. Dzubay, pp. 241-257. Ann Arbor Science Publishers.

Schmitt, J.G. 1995, Obsidian Cliff Plateau geology and petrography. In Davis et al. (Eds.), *The Obsidian Cliff Plateau Prehistoric Lithic Source, Yellowstone National Park, Wyoming.* Selections from the Division of Cultural Resources 6, Rocky Mountain Region, National Park Service, pp. 17-26.

Self, S., Goff, F., Gardner, J., Wright, J., and Kite, W. 1986, Explosive rhyolitic volcanism in the Jemez Mountains: vent locations, caldera development, and relation to regional structure. *Journal of Geophysical Research* 91:1779-1798.

Shackley, M.S., 1988, Sources of archaeological obsidian in the Southwest: an archaeological, petrological, and geochemical study. *American Antiquity* 53:752-772.

Shackley, M. S.,1995, Sources of archaeological obsidian in the greater American Southwest: an update and quantitative analysis. *American Antiquity* 60(3):531-551.

Shackley, M.S., 1998a, Current issues and future directions in archaeological volcanic glass studies: an introduction. In M.S. Shackley (Ed.) *Archaeological Obsidian Studies: Method and Theory*, pp. 1-14. New York: Springer.

Shackley, M.S. 1998b, Geochemical differentiation and prehistoric procurement of obsidian in the Mount Taylor Volcanic Field, northwest New Mexico. *Journal of Archaeological Science* 25:1073-1082.

Shackley, M.S., 2005, *Obsidian: Geology and Archaeology in the North American Southwest.* University of Arizona Press, Tucson.

Shackley, M.S., 2011, An introduction to x-ray fluorescence (XRF) analysis in archaeology. In *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, M.S. Shackley (Ed.), pp. 7-44. Springer, New York.

Shackley, M.S., 2016, Source provenance of obsidian artifacts from later period sites, Chaco Culture National Historical Park, New Mexico. Report prepared for Jeremy Moss, Pecos National Historical Park, New Mexico..

Shackley, M.S., 2021a, Source provenance of obsidian artifacts from the Tobias Site (14RC8), Little Arkansas River Basin, Central Kansas. Report prepared for Robert Hoard, Archaeology Office, Kansas Historical Society, Topeka.

Shackley, M.S., 2021b, Distribution and sources of secondary deposit archaeological obsidian in Rio Grande alluvium New Mexico, USA. *Geoarchaeology* 36:808-825.

Shackley, M.S., F. Goff, and S.G. Dolan, 2016, Geologic origin of the source of Bearhead Rhyolite (Paliza Canyon) obsidian, Jemez Mountains, northern New Mexico. *New Mexico Geology* 38:52-62.

Shackley, M.S., and J.L. Moore, 2018, More than just Jemez Pueblo obsidian: comment on Liebmann's "...Landscapes of Signification in the American Southwest". *American Antiquity* 83:753-755.

Shackley, M.S., L.E. Morgan, and D. Pyle, 2018, Elemental, isotopic, and geochronological variability in Mogollon-Datil Volcanic Province archaeological obsidian, southwestern North America: solving issues of inter-source discrimination. *Geoarchaeology* 33:486-497.

Smith, R.L., Bailey, R.A., and Ross, C.S. 1970, Geologic map of the Jemez Mountains, New Mexico. Reston, Virginia: U.S. Geological Survey, Miscellaneous Geologic I nvestigations Map I-571.

Thompson, R.A. 2004, *Trade or Transport: Occurrence of Obsidian from the Malad, Idaho Source in the Great Plains*. Unpublished Master's thesis, Department of Anthropology, Idaho State University.

Vehik, S.C. 2002, Conflict, trade, and political development on the Southern Plains. *American Antiquity* 67:37-64.

Wolfman, D. 1993, *Jemez Mountains Chronology Study*. Report prepared for the Office of Archaeological Studies, Museum of New Mexico and the USDA National Forest Service. Manuscript available at Santa Fe National Forest, Santa Fe, New Mexico.

APPENDIX

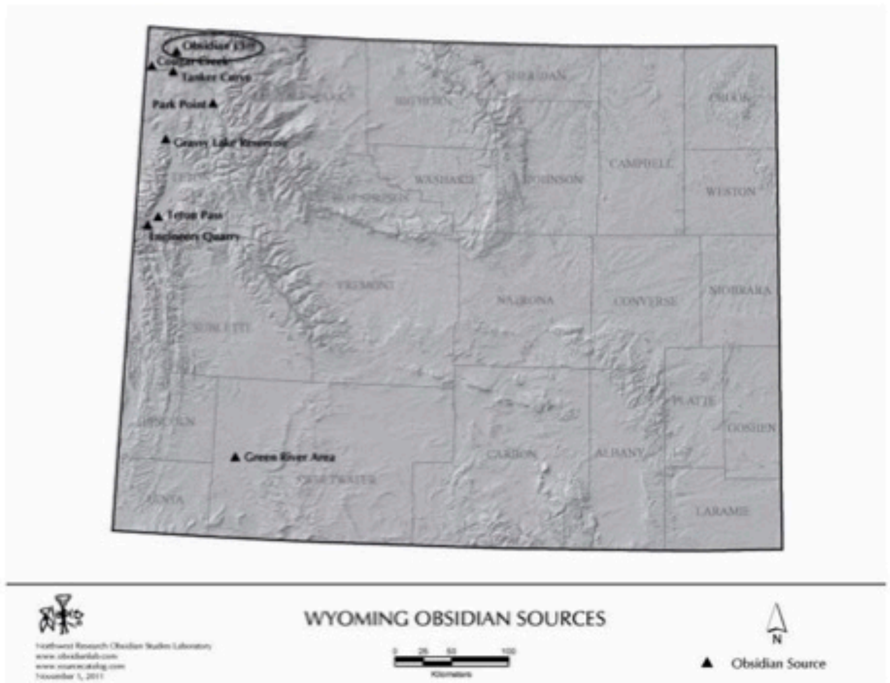
Table 1. Elemental concentrations for the obsidian artifacts, and USGS RGM-1 rhyolite standards. All measurements in parts per million (ppm).

Sample	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba	Source
1	438	9970	125	137	23	137	32	1158	unknown
2	241	9605	123	75	36	93	17	1933	Malad, ID
3	415	10620	167	11	42	170	58	5	Malad, ID
4	414	10341	165	12	49	162	57	30	Valles Rhy (Cerro del Medio),NM
8	405	10580	167	15	45	168	55	19	Valles Rhy (Cerro del Medio),NM
10	466	8262	162	15	23	74	50	0	El Rechuelos Rhy, NM
11	257	10316	127	77	32	94	19	1943	Malad, ID
12	412	8155	155	15	26	71	51	1	El Rechuelos Rhy, NM
16	253	11864	271	12	76	176	50	39	Obsidian Cliff, WY
17.42	446	11230	184	17	41	172	55	0	Valles Rhy (Cerro del Medio),NM
18	410	11366	172	12	42	175	57	152	Valles Rhy (Cerro del Medio),NM
26	381	10220	164	16	43	170	58	0	Valles Rhy (Cerro del Medio),NM
27	425	10590	168	12	40	171	56	70	Valles Rhy (Cerro del Medio),NM
28	386	10058	152	11	49	173	54	2	Valles Rhy (Cerro del Medio),NM
45	468	10578	202	10	68	176	95	0	Cerro Toledo Rhy, NM
46	483	10541	211	11	66	180	105	0	Cerro Toledo Rhy, NM
47	484	10722	212	10	64	178	101	0	Cerro Toledo Rhy, NM
48	162	5465	1	13	4	16	1	18	not obsidian
49	424	9633	122	130	24	132	31	1218	unknown
50	499	10324	205	11	61	180	101	0	Cerro Toledo Rhy, NM
51	251	10048	129	76	35	95	12	2003	Malad, ID
52	370	9948	158	15	46	171	59	45	Valles Rhy (Cerro del Medio),NM
53	144	5690	0	219	6	17	3	0	not obsidian
55	286	10049	125	81	33	102	13	1936	Malad, ID
56	254	11740	271	13	82	184	46	26	Obsidian Cliff, WY
63	497	10569	211	15	64	174	96	2	Cerro Toledo Rhy, NM
64	472	10397	216	9	58	181	103	0	Cerro Toledo Rhy, NM
73	478	10577	211	11	64	185	100	11	Cerro Toledo Rhy, NM
91	522	11007	214	9	63	193	100	0	Cerro Toledo Rhy, NM
92	509	11680	223	9	61	179	102	0	Cerro Toledo Rhy, NM

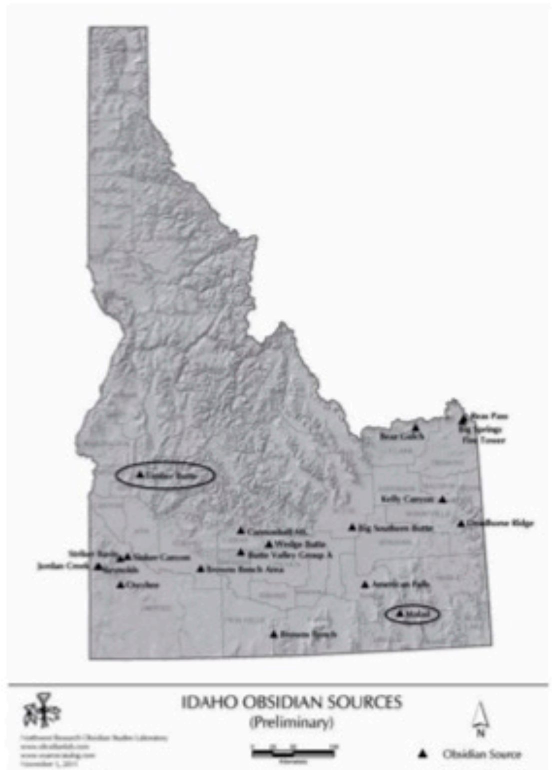
Sample	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba	Source
94	556	12001	234	9	63	190	99	17	Cerro Toledo Rhy, NM
95	540	11116	219	11	62	180	94	77	Cerro Toledo Rhy, NM
96	541	11086	219	9	67	189	98	5	Cerro Toledo Rhy, NM
1475	242	9050	121	75	30	88	16	1928	Malad, ID
1487	446	11772	183	12	42	182	61	0	Valles Rhy (Cerro del Medio),NM
1488	274	9837	128	76	34	97	13	1938	Malad, ID
1489	387	9874	157	15	45	171	62	0	Valles Rhy (Cerro del Medio),NM
1490	414	9539	189	11	58	165	92	0	Cerro Toledo Rhy, NM
1492	422	11263	165	14	39	166	52	0	Valles Rhy (Cerro del Medio),NM
1494	398	10615	161	12	41	169	58	0	Valles Rhy (Cerro del Medio),NM
1495	509	11067	204	12	66	172	97	0	Cerro Toledo Rhy, NM
1496	403	10097	162	14	42	164	56	0	Valles Rhy (Cerro del Medio),NM
1601	480	11050	202	9	67	176	98	0	Cerro Toledo Rhy, NM
1602	281	9880	123	75	31	96	20	2021	Malad, ID
1604	376	10051	157	15	43	156	51	31	Valles Rhy (Cerro del Medio),NM
1607	497	11805	207	11	68	178	92	0	Cerro Toledo Rhy, NM
1609	385	11583	126	129	26	78	15	1610	unknown
1610	400	8251	136	13	28	72	47	0	El Rechuelos Rhy, NM
1612	401	10652	163	12	43	164	57	0	Valles Rhy (Cerro del Medio),NM
1616	393	10437	156	13	41	161	54	32	Valles Rhy (Cerro del Medio),NM
1623	396	11267	158	15	49	166	59	0	Valles Rhy (Cerro del Medio),NM
1629	308	11135	144	87	33	101	24	2162	Malad, ID
1632	498	11403	204	9	66	187	102	0	Cerro Toledo Rhy, NM
1734	534	10320	211	9	63	176	100	38	Cerro Toledo Rhy, NM
1735	468	10331	204	10	59	179	94	0	Cerro Toledo Rhy, NM
1738	525	8262	180	23	42	60	39	34	Timber Butte, Locus 1, ID
1743	413	10688	178	19	44	180	50	0	Valles Rhy (Cerro del Medio),NM
1749	380	9499	115	73	23	100	14	767	Buck Mountain, CA
1750	285	10414	136	79	32	95	19	1892	Malad, ID
1753	144	5446	1	507	4	19	5	62	not obsidian
1754	144	5302	0	1015	7	24	4	0	not obsidian
1755	278	9987	132	77	30	97	8	1896	Malad, ID
1763	245	9773	123	75	39	102	16	2093	Malad, ID
1765	307	12959	270	12	82	182	51	11	Obsidian Cliff, WY

Sample	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba	Source
1769	465	9870	194	10	60	166	85	22	Cerro Toledo Rhy, NM
1772	371	10147	162	16	46	165	60	33	Valles Rhy (Cerro del Medio),NM
1773	459	10140	197	11	61	173	93	0	Cerro Toledo Rhy, NM
1775	406	11019	162	13	45	171	54	0	Valles Rhy (Cerro del Medio),NM
1776	390	10956	167	11	42	167	58	32	Valles Rhy (Cerro del Medio),NM
1786	278	10230	131	76	32	102	10	2000	Malad, ID
1787	483	10365	205	9	67	176	103	0	Cerro Toledo Rhy, NM
1788	416	10430	167	13	49	174	60	30	Valles Rhy (Cerro del Medio),NM
1789	400	8942	113	74	19	104	11	913	Buck Mountain, CA
1791	293	10638	137	81	36	101	12	1772	Malad, ID
1792	256	11640	257	9	73	175	42	35	Obsidian Cliff, WY
1793	283	10527	132	83	36	101	14	1898	Malad, ID
1794	636	12816	242	10	66	177	88	0	Cerro Toledo Rhy, NM
1796	298	10269	134	84	36	103	21	1903	Malad, ID
1797	256	11045	247	11	77	174	44	51	Obsidian Cliff, WY
1798	411	9709	192	9	56	171	92	0	Cerro Toledo Rhy, NM
1799	496	10555	199	9	65	175	103	0	Cerro Toledo Rhy, NM
1801	149	5398	2	10	9	20	1	1	not obsidian
1802	438	11389	169	15	44	177	59	93	Valles Rhy (Cerro del Medio),NM
1803	371	10000	162	12	46	161	56	0	Valles Rhy (Cerro del Medio),NM
1806	433	11021	175	16	48	171	65	14	Valles Rhy (Cerro del Medio),NM
1807	438	9597	118	128	20	134	27	1359	unknown
1809	522	11348	232	9	67	182	105	0	Cerro Toledo Rhy, NM
1814	250	11146	241	9	73	175	54	14	Obsidian Cliff, WY
1815	463	11657	176	10	48	163	52	0	Valles Rhy (Cerro del Medio),NM
1816	309	11798	154	87	35	97	9	1841	Malad, ID
1817	195	7493	4	86	9	46	1	0	not obsidian
1818	154	5742	3	20	5	19	1	0	not obsidian
1827	402	10835	170	12	46	171	52	0	Valles Rhy (Cerro del Medio),NM
1828	153	5601	1	1211	4	28	6	19	not obsidian
1830	267	10367	120	77	31	95	16	2070	Malad, ID
1831	250	9562	125	80	34	95	14	2052	Malad, ID
1836	521	11143	223	11	61	195	99	0	Cerro Toledo Rhy, NM
1845	352	9895	156	12	38	166	51	24	Valles Rhy (Cerro del Medio),NM

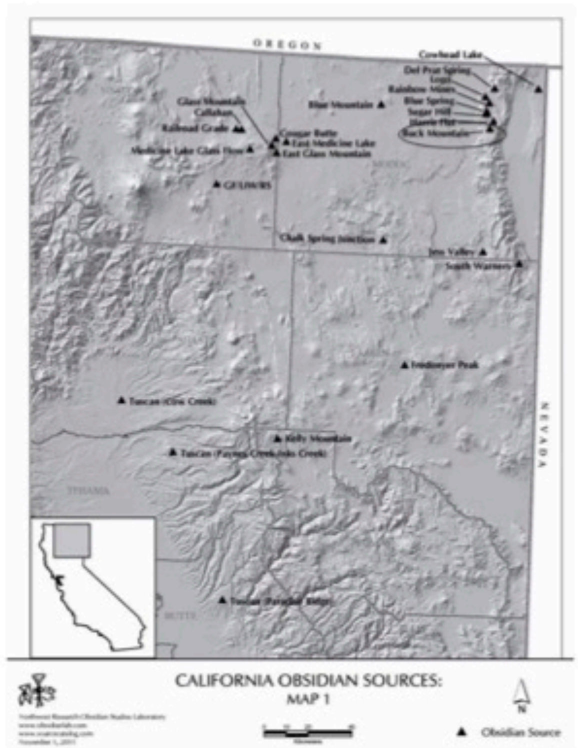
Sample	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba	Source
1859	506	10794	217	9	60	187	100	0	Cerro Toledo Rhy, NM
1860	410	10973	175	13	44	166	55	56	Valles Rhy (Cerro del Medio),NM
1869	454	10880	167	15	47	175	58	31	Valles Rhy (Cerro del Medio),NM
1870	404	10824	173	11	44	174	55	125	Valles Rhy (Cerro del Medio),NM
1897	398	10857	165	12	43	165	55	32	Valles Rhy (Cerro del Medio),NM
1898	405	10869	174	15	46	173	59	0	Valles Rhy (Cerro del Medio),NM
1944	387	10587	163	13	47	170	54	20	Valles Rhy (Cerro del Medio),NM
1948	391	10446	161	12	45	164	52	9	Valles Rhy (Cerro del Medio),NM
1951	427	10855	169	12	41	168	54	19	Valles Rhy (Cerro del Medio),NM
2010	366	9786	154	14	43	164	55	0	Valles Rhy (Cerro del Medio),NM
2075	396	10520	165	10	47	170	53	6	Valles Rhy (Cerro del Medio),NM
2097	422	11145	167	15	45	182	52	0	Valles Rhy (Cerro del Medio),NM
RGM1-S4	305	13150	149	104	25	218	7	869	standard
RGM1-S4	272	13282	141	107	26	222	7	859	standard
RGM1-S4	290	13276	155	108	28	221	1	835	standard
RGM1-S4	294	13190	148	106	23	222	8	843	standard



Appendix Figure 1. Location of Wyoming obsidian sources. Obsidian Cliff encircled. From https://www.sourcecatalog.com/



Appendix Figure 2. Idaho obsidian sources with Malad and Timber Butte localities encircled. From https://www.sourcecatalog.com/



Appendix Figure 3. Northeast California obsidian sources with Buck Mountain encircled. From https://www.sourcecatalog.com/

Appendix C

Comprehensive Obsidian Site List for Oklahoma

County	Trinomia l	Site Name	Cultural Affiliation	Obsidian Artifacts
Beckham	34BK1	Sandstone Creek #1	Plains Village	Unknown
Beckham	34BK2	Edwards I	Archaic / Plains Village	Multiple Artifacts
Beckham	34BK6	Fowler	Plains Village	Unknown
Beckham	34BK8	Gene Gaines	Plains Village	Unknown
Beckham	34BK9	Bell	Plains Village	Unknown
Beckham	34BK44	Edwards #2	Plains Village	Unknown
Beckham	34BK51	Salton Canyon Salt Source	Plains Village	Flakes
Blaine	34BL28	Shawver	Plains Village	Unknown
Blaine	34BL103	Ruby Mill #2	Plains Village	Unknown
Bryan	34BR8	Lamar #2	Late Paleoindian/Middle Archaic	Unknown
Beaver	34BV1	Pueblo Village	Plains Village	Unknown
Beaver	34BV14	Roy Smith	Plains Village	4 Flakes
Beaver	34BV25	Comanche Ridge	Plains Village	Multiple Flakes
Beaver	34BV55	Skull Springs	Plains Village	1 Artifact
Beaver	34BV93	Coldwater #1	Late Archaic to Plains Village	3 Flakes
Beaver	34BV97	Campbell Malone	Plains Village	3 Flakes
Beaver	34BV99	Sprague	Late Archaic to Plains Village	2 Points, 2 Flakes
Beaver	34BV100	Odessa Yates	Late Archaic to Plains Village	14 Points, 37 Flakes
Beaver	34BV104	Spangler	Archaic to Plains Village	1 Flake
Beaver	34BV111	Goetzinger	Plains Village	Unknown
Beaver	34BV116	Porcupine	Middle Paleoindian / Plains Village	1 Flake
Beaver	34BV122	Gilger	Middle Archaic / Plains Village	1 Flake
Beaver	34BV140	Wilson	Late Archaic to Plains Village	Unknown
Beaver	34BV149	Cowan	Late Archaic / Woodland	1 Pendant

Beaver	34BV157	Kerns #7	Plains Village	2 Flakes
Beaver	34BV171	Obsidian Hill	Late Paleoindian to Late Archaic	24 Artifacts
Beaver	34BV172	Pierce	Plains Village	3 Flakes
Carter	34CA122	Enderby #1	Plains Village	1 Flake
Caddo	34CD11	Duncan-Wilson Shelter	Woodland	Unknown
Caddo	34CD47	Taylor	Plains Village	1 Serrated Point
Caddo	34CD181	Fort Cobb Lake A	Paleoindian	Unknown
Cimmaron	34CI8	Doc Long Lake	Archaic / Plains Village	1 Flake
Cimmaron	34CI44	Brookhart Quarry	Unknown	1 Flake
Cimmaron	34CI47	Lookout Midden	Unknown	Multiple Flakes
Cimmaron	34CI72	CI72	Plains Village	5 Flakes
Cimmaron	34CI148	McBride	Plains Village	1 Artifact
Cimmaron	34CI155	Foreman #1	Plains Village	1 Artifact
Cimmaron	34CI161	Alexander #2	Archaic / Plains Village	Unknown
Cimmaron	34CI199	Carrizozo Creek / Bridge	Late Archaic / Plains Village	Unknown
Cimmaron	34CI202	Ilene Roberts	Plains Village	1 Artifact
Cimmaron	34CI203	Smith-Baird	Unknown	2 or 3 Artifacts
Cimmaron	34CI204	South Smith	Unknown	22 Artifacts
Cimmaron	34CI209	Dwight Bohn	Plains Village	Unknown
Cimmaron	34CI211	Harriet Bush Gillipsie	Unknown	2 Artifacts
Cimmaron	34CI214	Laneer Ranch #1	Plains Village	Unknown
Cimmaron	34CI215	Laneer Ranch #2	Plains Village	Unknown
Cimmaron	34CI216	Laneer Ranch	Plains Village	Unknown
Cimmaron	34CI218	Purdy-Fry	Plains Village	1 Artifact
Cimmaron	34CI221	Frank Hamilton	Plains Village	2 Artifacts
Cimmaron	34CI223	P. B. Foreman	Plains Village	2 Artifacts
Cimmaron	34CI236	Grimmer	Plains Village	6 Artifacts

Cimmaron	34CI239	K. Boyd	Plains Village	2 Artifacts
Cimmaron	34CI240	C. White	Unknown	Unknown
Cimmaron	34CI248	CI248	Plains Village	Unknown
Cimmaron	34CI251	Bradley	Unknown	1 Artifact
Cimmaron	34CI264	Troy Burton #2	Plains Village	4 Artifacts
Cimmaron	34CI265	Troy Burton #3	Plains Village	3 Artifacts
Cimmaron	34CI280	CI280	Plains Village	Unknown
Cimmaron	34CI303	CI303	Plains Village	1 Point
Cimmaron	34CI397	Neal Walker 12	Unknown	1 Flake
Cimmaron	34CI487	Camp 11 / Sharp Ranch	Archaic	2 Flakes, 1 Biface
Cimmaron	34CI489	Camp 13 / Sharp Ranch	Unknown	2 Flakes
Cleveland	34CL55	Williamson #1	Unknown	Multiple Flakes
Cleveland	34CL76	East Elm Creek	Archaic	1 Core
Cleveland	34CL77	Point 16	Unknown	Unknown
Comanche	34CM130	Cedar Creek	Unknown	1 Flake
Comanche	34CM158	CM158	Unknown	1 Flake
Comanche	34CM161	Sheridan Lodge	Unknown	Multiple Flakes
Comanche	34CM173	CM173	Unknown	1 Modified Flake
Comanche	34CM420	CM420	Possibly Woodland	Unknown
Canadian	34CN2	Weil	Plains Village	11 Flakes, 2 Biface Fragments
Canadian	34CN24	Valley Site	Plains Village	Multiple Flakes
Canadian	34CN98	CN98	Plains Village	1 Flake
Coal	34CO29	Foreman	Woodland	2 Flakes
Cotton	34CT5	Stewart #1	Unknown	1 Flake
Custer	34CU7/27	Heerwald Site / Shahan II	Plains Village	Multiple Flakes
Custer	34CU10	Little Deer	Plains Village	1 Point
Custer	34CU40	Hodge	Plains Village	1 Point Base, 1 Flake

Custer	34CU59	Hodge #2	Plains Village	1 Modified Flake
Custer	34CU137	David Switzer / Frymire Site	Plains Village	1 Flake
Delaware	34DL28	Evans #1	Unknown	1 Flake
Ellis	34EL2	Barton	Plains Village	Multiple Flakes
Ellis	34EL12	Laubhan	Plains Village	Multiple Flakes
Ellis	34EL59	Herber #2	Plains Village	Unknown
Ellis	34EL65	Wagoner #1	Plains Village	2 Flakes
Ellis	34EL66	Wagoner #2	Plains Village	2 Flakes
Grady	34GD2	Scribner	Plains Village	Unknown
Grady	34GD23	Curtis	Unknown	Unknown
Garfield	34GF73	GF73	Unknown	3 Flakes, 1 Core
Garfield	34GF80	GF80	Unknown	1 Core
Greer	34GR3	GR3	Plains Village	Unknown
Greer	34GR4	Rattlesnake Sluogh	Unknown	1 Flake
Greer	34GR6	GR6	Plains Village	Unknown
Greer	34GR8	Taylor (2)	Plains Village	6 Flakes
Greer	34GR55	Jester Cave	Plains Village (Pueblo Influences)	1 Flake
Greer	34GR99	Maddox	Unknown Multicomponent	Multiple Flakes
Grant	34GT5	Spoon	Plains Village	Unknown
Grant	34GT6	Hunter	Plains Village	2 Flakes
Grant	34GT8	GT8	Woodland	Unknown
Grant	34GT9	Stalker	Woodland / Plains Village	3 Flakes
Grant	34GT47	Cralley Frederick	Plains Village	1 Flake
Garvin	34GV22	Currie	Plains Village	Unknown
Garvin	34GV23	Cherokee Crossing	Plains Village	Unknown
Garvin	34GV25	Holt	Plains Village	Multiple Flakes
Garvin	34GV34	Paul	Woodland / Plains Village	2 Flakes

Garvin	34GV90	E. Carpenter #1	Archaic / Plains Village	Unknown
Garvin	34GV108	Jim Dulin	Woodland / Plains Village	Unknown
Harmon	34HR1	Weldon #1	Plains Village	Unknown
Harmon	34HR36	Jesse Mills #1	Archaic	Multiple Flakes
Harmon	34HR60	Hollis City Water Works/Water Wells	Plains Village	1 Flake
Jefferson	34JF1	Longest	Plains Village	Unknown
Jackson	34JK10	JK10	Unknown	Multiple Flakes
Jackson	34JK15	McDaniel	Unknown	1 Flake
Jackson	34JK22	Ralph Winters	Middle Paleoindian to Woodland	1 Calf Creek Point, 1 Flake
Kay	34KA10	Von Elm	Woodland / Plains Village	Unknown
Kay	34KA11	Spencer	Archaic	Unknown
Kay	34KA3	Deer Creek	Plains Village (Wichita)	1 Artifact
Kay	34KA20	Hammons	Woodland	Unknown
Kay	34KA62	Spencer #2	Unknown	Unknown
Kay	34KA65	Goodson #2	Plains Village	Unknown
Kay	34KA72	Irwin	Woodland / Plains Village	Unknown
Kay	34KA73	Hudsonpillar	Woodland / Plains Village	Unknown
Kay	34KA119	Jim Butterfield	Woodland	Unknown
Kay	34KA172	Uncas	Plains Village	Unknown
Kiowa	34KI215	Leased District Battleground	Plains Village	Unknown
Le Flore	34LF40	Craig Mound, Spiro	Caddoan	End Scraper
Marshall	34MA2	Buncombe Creek	Paleoindian / Late Archaic	1 Eccentric
Marshall	34MA41	MA41	Archaic / Plains Village	Unknown
McCurtain	34MC151	Driftwood	Middle to Late Archaic / Caddoan	Unknown
McClain	34ML1	Allcorn	Plains Village	2 Flakes
McClain	34ML14	Spring Creek	Plains Village	2 Flakes

McClain	34ML168	Hayhurst Farm	Unknown	1 Flake
Murray	34MR10	Lowrence	Plains Village	1 Modified Flake
Mayes	34MY39	Boat Docks	Archaic / Plains Village	1 Flake
Mayes	34MY54	Pohly Shelter	Woodland	1 Flake
Mayes	34MY312	MY312	Late Archaic to Caddoan	1 Cutting/Scraping Tool
Nowata	34NW6	Lawrence Site	Late Archaic / Woodland	1 Flake
Oklahoma	34OK13	Steed School House	Middle Archaic	Unknown
Oklahoma	34OK71	Steed School #3	Late Archaic to Plains Village	1 Flake
Pawnee	34PW128	PW128	Unknown	2 Flakes
Roger Mills	34RM14	Goodwin – Baker	Paleoindian / Plains Village	Multiple
Roger Mills	34RM72	Zimms	Plains Village	2 Flakes
Roger Mills	34RM78	RM78	Plains Village	1 Flake
Roger Mills	34RM94	Calvert	Unknown	Unknown
Roger Mills	34RM106	Croton Creek Lithic Scatter	Unknown	1 Flake
Roger Mills	34RM208	Thurmond Ranch #2 / Beaver Dam Site	Late Archaic / Multicomponent	Unknown
Roger Mills	34RM439	Chanley Terrace	Paleoindian	1 Modified Flake, 1 Flake
Roger Mills	34RM501	Swift Horse	Late Archaic to Woodland	Unknown
Roger Mills	34RM681	RM681	Unknown	1 Flake
Seminole	34SM7	Amoche	Unknown	Unknown
Seminole	34SM20	Diamond Point #1 / Raulston – Rogers	Late Archaic / Woodland	Unknown
Seminole	34SM25	Thomas	Plains Village	1 Knife, 1 Point
Seminole	34SM87	Jumper Creek	Archaic	Multiple Flakes
Stevens	34ST14	Central School	Plains Village	Multiple Flakes
Tillman	34TI1	Lowery	Plains Village	Unknown
Tillman	34TI83	Sand Point	Plains Village	Multiple Flakes
Tulsa	34TU67	TU67	Unknown	Unknown

Tulsa	34TU90	Hampton	Plains Village	Unknown
Texas	34TX1	Stamper Site	Plains Village	2 Flakes
Texas	34TX30	Brubaker	Plains Village	1 Flake
Texas	34TX31	McGrath	Plains Village	Unknown
Texas	34TX32	Two Sisters	Plains Village	3 Flakes
Texas	34TX34	Clawson	Plains Village	1 Flake
Texas	34TX39	Shores / Muncy	Paleoindian / Plains Village	1 Point
Texas	34TX45	Eula	Plains Village	Unknown
Texas	34TX112	TX112	Unknown	Unknown
Texas	34TX113	Tharp 2	Plains Village	1 Flake
Texas	34TX135	Tharp	Late Archaic to Plains Village	1 Point
Washita	34WA1	Bungardt Site / Boggy Creek	Unknown	Unknown
Washita	34WA2	Duncan	Plains Village	6 Flakes, 1 Eccentric
Washita	34WA3	Franklin	Plains Village	Multiple Flakes
Washita	34WA6	Cedar Creek	Archaic	Unknown
Washita	34WA22	Hill	Plains Village	Multiple Flakes
Washita	34WA41	Flaming	Late Paleoindian / Plains Village	1 Point
Woodward	34WD5	Trader’s Creek	Late Archaic / Plains Village	1 Flake
Washington	34WN61	Squirrelpatch	Woodland	Unknown
Woods	34WO43	Omey	Plains Village	Unknown
Woods	34WO44	Lee Mackey	Plains Village	Unknown