PREHISTORIC OBSIDIAN PROCUREMENT AND EXCHANGE

IN WEST-CENTRAL ARIZONA

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ABSTRACT

PREHISTORIC OBSIDIAN PROCUREMENT AND EXCHANGE

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This research investigates prehistoric obsidian acquisition in the Northern and Southern Sinagua, Prescott, and Cohonina culture areas to elucidate obsidian foraging and exchange patterns among prehistoric groups that inhabited west-central Arizona. The spatial distribution of prehistoric features and elements of material culture lend themselves to archaeological study for the purpose of discerning the interactions between an area's population and neighboring people and cultures. I analyze obsidian artifacts, including debitage, at 608 prehistoric sites in west-central Arizona using a portable x-ray fluorescence (XRF) spectrometer, identify the obsidian source provenance based on microchemistry, and map potential exchange routes between obsidian source areas and points of deposition. I use human behavioral ecology and landscape archaeology theory to generate testable hypotheses regarding the distribution of obsidian artifacts, potential foraging or exchange routes, and the influence of landscape connectivity on these patterns. I infer plausible foraging and exchange routes based on the spatial distribution of obsidian artifacts and least-cost path modeling that integrates slope, proximity to water, and vegetation community type. This research provides compelling evidence of wide-ranging foraging and exchange interactions among prehistoric groups that inhabited west-central Arizona.

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Chapter One - Introduction

My thesis research focuses on obsidian acquisition in the Northern and Southern Sinagua, Cohonina, and Prescott culture areas in order to elucidate obsidian foraging and exchange patterns among precontact groups inhabiting west-central Arizona. This is important research, because interaction among Sinagua, Cohonina, and Prescott people groups has received very little archaeological study to date. The two major environmental regions that comprise my study area in west-central Arizona are the Colorado Plateau and the Central Mountains. The Mogollon Rim demarcates the transition between the Colorado Plateau to the north and the Central Mountains Region to the south (Reid and Whittlesey 1997). The Colorado Plateau is drained by the Colorado River and Little Colorado River. The Verde River and Agua Fria River drain the Central Mountains Region through the heart of my study area. The Verde River and Agua Fria River provide natural travel corridors that transect the Sinagua and Prescott culture areas.

Four previously defined principle culture areas intersect in west-central Arizona -- the ancestral Pueblo to the north, Mogollon to the east, Hohokam to the south, and Patayan to the west (Reid and Whittlesey 1997). Archaeologists have identified several ostensibly distinct precontact people groups associated with one or more of the four principal culture areas within west-central Arizona, including Sinagua, Cohonina, and Prescott, based on ceramics and other aspects of material culture (Barnett 2006; Cline and Cline 1983; Downum and Garcia 2012). The Prescott culture area is located at the intersection of the four principal culture areas identified in Arizona. Although there is substantial archaeological research describing the material culture and other aspects of the four principal culture areas and, to some extent, the Sinagua and Cohonina people groups, the Prescott culture area remains under-studied and enigmatic.

The juxtaposition of precontact culture areas presents a unique opportunity to study the extent and types of interactions among the Northern and Southern Sinagua, Cohonina, Prescott and other precontact people groups of west-central Arizona. The Agua Fria National Monument encompasses approximately 71,100 acres of public lands in the southeastern extent of my study area and includes at least 450 archeological sites dating between A.D. 1250 and 1450. Using the authority of Section 2 of the Antiquities Act of 1906, President William J. Clinton signed the proclamation creating the Agua Fria National Monument on January 11, 2000. According to the Agua Fria National Monument Proclamation (34 Stat. 225, 16 U.S.C. 431):

> The area's architectural features and artifacts are tangible objects that can help researchers reconstruct the human past. *Such objects and, more importantly, the spatial relationships among them, provide outstanding opportunities for archeologists to study the way humans interacted with one another, neighboring groups, and with the environment that sustained them in prehistoric times* (emphasis added).

The monument's founders recognized that the spatial distribution of archaeological features and elements of material culture lend themselves to archeological study for the purpose of discerning the interactions between the area's populations and neighboring people and cultures. My research elucidates patterns of social interaction among the precontact inhabitants of the Prescott culture area and surrounding parts of west-central Arizona based on archaeological evidence of obsidian acquisition through foraging and exchange.

Primary data sources for my research include obsidian microchemistry obtained through portable x-ray fluorescence (pXRF) spectrometry and archaeological site locations identified using aerial photography reconnaissance. Portable XRF spectroscopy provides accurate, repeatable, non-destructive analysis of elemental composition in the field, thus eliminating the need for artifact collection. My research entails using pXRF spectrometry to analyze thousands of obsidian artifacts, including debitage, at hundreds of widely distributed precontact sites throughout west-central Arizona. Based on pXRF-derived microchemistry, I assign each artifact to an obsidian source area and map potential obsidian exchange routes between source areas and points of deposition. Secondary data sources for my research include extant museum collections, topographic maps, and digital data representing elevation, vegetation, and surface water. I extensively use GIS for mapping and spatial analysis, because GIS provides tools for cost-surface analyses and has demonstrated capability to process landscape-scale data sets.

I developed three primary research questions to guide my research. 1) Which sources of obsidian are represented at archaeological sites in west-central Arizona? 2) Does the archaeological record provide evidence that precontact people groups in west-central Arizona acquired obsidian through exchange? 3) What aspects of precontact obsidian acquisition behaviors are discernable from the spatial distribution of obsidian artifacts? I use human behavioral ecology, landscape archaeology, and circuit theory to generate testable hypotheses regarding the distribution of obsidian artifacts, potential foraging or exchange routes, and the influence of landscape connectivity on these patterns. I infer plausible routes of travel or exchange based on the overall spatial distribution of obsidian artifacts, landscape connectivity, proximity to water, and other variables.

My research entails the application of proven methods including pXRF spectrometry and geospatial analyses to a poorly understood area of west-central Arizona. The research informs previously undescribed aspects of interactions among the inhabitants of the Prescott culture area and adjacent people groups. Information regarding the distribution of obsidian and relative utilization of obsidian from eight documented source areas contributes to the body of research on lithic material procurement and interactions among the prehistoric people groups of west-central Arizona. Research results supplement existing archaeological information in support of cultural resource managers on public lands managed by the Forest Service and Bureau of Land Management. The following six chapters present the theoretical framework, literature review, methodology, results, discussion, and conclusions of my research. The results of my research advance our understanding of foraging and exchange interactions among precontact groups that inhabited west-central Arizona.

Chapter Two – Theory

In this chapter, I outline the theoretical foundations for my thesis research on prehistoric obsidian acquisition in and around the Prescott culture area. The theoretical framework helps to frame my hypotheses and inform the methods I use for hypotheses testing. I borrow from several theoretical perspectives that primarily derive from the processual paradigm, including human behavioral ecology, circuit theory, and landscape archaeology. Portable XRF analysis has great potential to elucidate lithic foraging and exchange patterns among precontact groups that inhabited west-central Arizona.

The processual paradigm provides the primary theoretical basis for measuring the elemental composition of obsidian artifacts with portable x-ray fluorescence (pXRF) spectrometry and determining the sources of the obsidian via comparison with reference data collected from obsidian source areas. The processual paradigm in archaeology focuses on explaining the social and economic processes and adaptations of culture that contribute to the material record (Binford 1980). Pivotal to my research, processual archaeologists seek to understand past human behavior by investigating spatial and temporal patterns in cultural resource distribution (Binford 1980). The notion that aspects of culture are accessible through the material record is, by definition, logical positivism - a hallmark of the processual paradigm.

Processual theories, as represented by Binford (1967, 1982), are a departure from culture history or traditional archaeology, as represented by Hawkes (1954). Processual archaeology is more explicitly theoretical and focuses on explaining changes in social and economic aspects of culture based on evidence in the material record. Traditional archaeology focused on description, artifact typology and classification, chronologies and seriation, and compiling narrative contextual histories that frequently relied on imaginative reconstruction, appeals to authority, and hearsay (Salmon 1982:41). Processual archaeology is inherently positivist, believing that the past is understandable through the rigorous application of the scientific method to the material record and its contexts, whereas traditional archaeology maintained a more skeptical, even pessimistic perspective regarding what could be discerned from the archaeological record. The practice of processual archaeology emphasizes the hypothetico-deductive method, often in conjunction with statistical inference and predictions induced from hypotheses (Salmon 1982:40; Binford 1967), in contrast with traditional archaeology's use of "pure archaeological inference" inductively drawn from historical knowledge and notions of behavioral norms (Hawkes 1954). Processual archaeology also emphasizes the use of quantitative data and hypothesis testing (Binford 1967), while traditional archaeology often relied on qualitative data (Hawkes 1954). The processual research paradigm is the most appropriate framework for my obsidian provenance research and related data analysis, because I will infer aspects of obsidian acquisition in prehistoric cultures of west-central Arizona primarily based on patterns of geographic distribution and the elemental composition of obsidian found in archaeological contexts.

Although behavioral ecology is a theoretical perspective within the processual paradigm, behavioral ecology is distinctive and represents areas of divergence with the processual approach advocated by Binford (1967,1982). Archaeologists operating from the perspective of behavioral ecology primarily use historical and/or functional explanations to reconstruct human behavior (Bird and O'Connell 2006). Historical explanations typically differ from functional explanations "in emphasizing the unique characteristics of particular historical sequences and thus often reject the proposition that universal processes of any kind might be involved" (Bird and O'Connell 2006:145). In contrast, universal processes are one of the mainstays of processual archaeology.

Bird and O’Connell (2006:145) also noted that behavioral ecology may be used to “guide well-warranted speculation about aspects of past behavior that are unlikely to be represented archaeologically.” This stands in stark contrast to the processual paradigm espoused by Binford (1967,1982), in which explanations are strictly derived through deduction and analogs from the material record. Unlike historical explanations, functional explanations based in behavioral ecology usually relate to universal processes, more typical of processual archaeology.

Archaeologists working from the perspective of behavioral ecology assume that decision making capacities of people past and present are adaptive and shaped by natural selection (Bird and Codding 2016:396; Taliaferro et al. 2010:537; Bird and O’Connell 2006:143). Based on this premise, archaeologists generate hypotheses regarding how prehistoric human behaviors might have varied in response to specific ecological settings and test those hypotheses against patterns observed in the material record. Questions regarding patterns of resource procurement and transport have been a particular focus of archaeologists using the behavioral ecology approach. While the majority of archaeological studies conducted within the human behavioral ecology (HBE) theoretical framework have focused on developing optimization models for subsistence procurement, HBE-based optimization models are also effective tools for investigating non-subsistence resource procurement (Taliaferro et al. 2010).

I use a version of the optimal foraging model, which is rooted in human behavioral ecology (Taliaferro et al. 2010:537), to develop hypotheses that obsidian artifact distribution is based on relative proximity or least-cost paths to the obsidian source areas. Human Behavioral Ecology is an application of evolutionary theory that investigates how the behavior of humans is adapted to their ecological context, and is particularly useful in developing hypotheses for archaeological research, as described by Beck (2008) and Bird and O’Connell (2006). As noted above, archaeologists operating from the human behavioral ecology theoretical framework primarily use historical and/or functional explanations to reconstruct human behavior. Accessing the nearest obsidian source would be adaptive because it is conservative, minimizing the time, energy expenditure, and exposure to risk during foraging. Other material acquisition strategies that could conserve time and energy, and minimize exposure to risk, include using least-cost paths and exchange through a social network.

Material acquisition through exchange requires some level of social interaction. For example, Findlow and Bolognese (1982) conclude that prehistoric obsidian exchange increased with social stratification in the vicinity of the Antelope Wells obsidian source in Hidalgo County, New Mexico. Based on analysis of projectile points from Hogup and Danger Caves in the eastern Great Basin, Hughes (2015) demonstrates that obsidian source materials shifted in conjunction with transitions in lithic technology that accompanied the adoption of archery. Hughes (2015) concludes that the introduction of the bow and arrow likely expanded social contacts, increased foraging distance and material acquisition opportunities, and contributed to the alteration of the social structure in the eastern Great Basin. Wilcox (1991b:115-124) inferred that the nascent market exchange system that developed throughout central Arizona in association with ballcourts during the Hohokam sedentary period supplemented preexisting kinship-based exchange.

Human behavioral ecology is concerned with human agency (individual interests and actions) – the choices, social interactions, and decision-making of prehistoric people (Bird and Codding 2016:397, Dobres and Robb 2000:8). Archaeological interpretations of precontact human behaviors and lifeways can be greatly enhanced by embracing the perspective that the archaeological record is the result of decisions made by social actors (Roth 2017:299). Obsidian transport presupposes human agency. Two alternative expressions of human agency in obsidian procurement are direct acquisition from the obsidian source areas via round trip foraging, and indirect acquisition through exchange. Aggregations of obsidian debitage and other artifacts from multiple obsidian sources may suggest exchange, but would not rule out direct acquisition through multiple foraging trips to different source areas. Microchemistry data from XRF spectrometry will identify the source of obsidian artifacts, but will not indicate whether the material was obtained directly from the source, or indirectly through exchange; nor will XRF spectrometry reveal the route of travel between the source area and the point of deposition. Therefore, I infer plausible routes of travel or exchange based on GIS analyses of the overall spatial distribution of obsidian artifacts, landscape connectivity, proximity to water, and other variables.

Archaeologists routinely use least-cost path (LCP) analysis to analyze the prehistoric movements of people (Howey 2011:2523). LCP analysis assumes that a traveler has complete familiarity with the modeled landscape and is both willing and able to select the least-cost path (Howey 2011:2524). Despite these basic assumptions, however, numerous factors, such as weather, water availability, or disputes, could lead prehistoric travelers to select alternate routes (Howey 2011:2524). Most LCP models are based on a single factor - usually slope. Unlike LCP modeling, landscapes modeled using circuit theory quantify connectivity as a function of both resistance and conductance of movement (Howey 2011:2524). Using circuit theory with LCP analysis enhances models of prehistoric movement by incorporating scenarios with multiple potential pathways while acknowledging optimized routes (Howey 2011:2523). I apply circuit theory by creating multi-criteria cost surfaces that incorporate slope, vegetation, and proximity to water to model potential obsidian acquisition routes.

Distinguishing between exchange and direct acquisition of obsidian presents a key challenge for this analysis. Kelly (2011:190) discusses the difficulty of distinguishing between trade and direct acquisition of materials in the archaeological record, noting that the distinction is "important because the difference between social and physical connections reflects important differences in how people coped with their natural environment." Kelly (2011) uses relative debitage frequency and weight analyses to ascertain whether obsidian in the Carson Desert arrived as raw material, cores, or bifaces. By comparing the distributions of prehistoric campsites, obsidian artifacts, and obsidian sources to the ethnographically documented foraging distances of mobile foragers in the Carson Desert, Kelly (2011) concludes that much of the obsidian was obtained through exchange. Brown (1991) examines the structure and content of lithic assemblages from Chavez Pass and a number of neighboring sites to define contrasting patterns of procurement and production, and distinguish between lithic resources obtained through 'embedded' procurement (encountered during subsistence activities) and lithic materials obtained by direct procurement and exchange. Brown's (1991) results suggest that trade routes in the eastern half of my study area may have extended through Anderson Mesa and Chavez Pass.

Maschner (1996) describes challenges in applying evolutionary ecology in general and optimal foraging theory in particular to human decision-making processes in societies intermediate between bands and states. To address these challenges, Maschner (1996) integrates evolutionary theory, field survey, GIS (viewshed), and multivariate statistics to explain prehistoric settlement patterns and settlement change among the Tlingit in Tebenkof Bay, Alaska. Miroslav (2015) uses GIS to model potential routes of Neolithic obsidian conveyance into the region of present-day Vrac (Balkans) from two sources located near the present-day border area between Hungary and Slovakia. The projected routes indicate the existence of a settlement patterning close to the modelled pathways. Miroslav's (2015) results suggest that trade routes in my study area may be spatially correlated with settlement patterning between the obsidian sources and points of deposition.

The distribution, accumulation, and composition of lithic assemblages are highly conducive to the study of cultural landscapes, and surface lithic scatters commonly comprise the majority of the data in landscape-scale analyses (Clarkson 2016:493). The lithic raw materials suitable for flaked-stone tool manufacturing derive from specific, distinctive, and unevenly distributed sources, thereby providing evidence of material selection and transport that connect individual choices, places, and artifacts with the movements and social contacts of people in the past (Clarkson 2016:490). Lithic assemblages, therefore, can provide valuable insights into the places in a landscape people visited, or the nature and direction of social networks that facilitated lithic procurement across regions (Clarkson 2016:491).

Surface lithic accumulations may have served a symbolic function by marking the history of places to people passing through or returning to an area (Clarkson 2016:492). The scope and content of lithic assemblages may have also connoted the suitability of a place for habitation or served as a reminder of locally available raw materials or the social contacts associated with non-local lithic sources (Clarkson 2016:492). Habitation features, especially those with multiple rooms and associated ceramic and lithic scatter likely indicate extended periods of occupation or repeated occupations. A majority of the obsidian debitage analyzed in my study is associated with stone-masonry or pithouse features that fit this general description. Some of the obsidian debitage and other artifacts in the study area, however, present as isolated occurrences, or in association with other artifacts that do not include any habitation features. For example, there is obsidian debitage in context with approximately 36 bedrock metates adjacent to an extensive walnut grove near Mescal Spring in Yavapai County, Arizona. I hypothesize that such isolated occurrences are the result of hunting and gathering behaviors that were not associated lithic foraging or exchange routes. Alternatively, they may represent waypoints where subsistence activities occurred in conjunction with a larger lithic foraging or exchange network.

Landscape archaeology is the study of cultural and environmental variables that influence the way humans interact with their surroundings, and the influence of the environment on human activities (Hu 2012). Landscapes are more than the geographical distributions of artifacts and sites (Roth 2017:299). Rather, a landscape is a culturally constructed setting where people "survive, cognise the world, act, and make meaning" (Roth 2017:299; Hu 2012). Landscape archaeology provides a theoretical framework for pairing quantitative spatial data with qualitative, conceptual, contextual, and dynamic attributes of human-landscape interactions and interpretation (Hu 2012). Landscape archaeology theory is well suited to my research, because it provides a framework for integrating Geographic Information Systems (GIS), remote-sensing, cartographic data, and XRF technology with ethnographic and historical information. The spatial distribution of prehistoric features and elements of material culture lend themselves to archeological study of interactions between the area's population, neighboring people and cultures, and the environment. Landscape archaeology, therefore, heavily relies on spatial analyses using GIS tools. The GIS applications most relevant to my research are mapping site and artifact distributions and cost surface analyses.

Earle (1982) argues the need for theoretical development in the subdiscipline of prehistoric economics focusing on exchange. Earle (1982) goes on to discuss the need to develop methods to describe the form and content of exchange from archaeological data, and explain exchange as conditioned by individual choice and cultural context. Using concepts from human behavioral ecology and landscape archaeology theory, I generate testable hypotheses regarding the spatial distribution of obsidian artifacts and the influence of potential foraging and exchange routes on these patterns. The empirical components of this research are grounded in the processual archaeology paradigm, involving the collection of quantitative data and application of the scientific method to test hypotheses.

Renfrew (1975:3) noted that trade has become a principal focus of archaeology because imperishable trade goods are detectable, recent analytical techniques are able to identify material sources, and patterns of distribution are assessable using quantitative methods in geography. Although Renfrew (1975) primarily addresses exchange within higher levels of social and political organization, the fundamental concepts are also relevant to incipient forms of exchange. The material aspects of human culture (e.g., subsistence, technology, and economy) and the social aspects of human culture (e.g., social relations, religion, knowledge of the world) are inextricably linked (Renfrew 1975:4). Trade requires social organization and commodity, and imply criteria of value and measure, thereby relating the material and social aspects of human culture (Renfrew 1975:4). Polanyi (1957:266) defined trade (synonymous with exchange) as "the mutual appropriative movement of goods between hands." The movement of goods (and information) associated with exchange may operate within social units or across cultural boundaries between social units (Renfrew 1975:4). The term "movement" in Polanyi's definition of trade generates the distributions of material culture and information. The phrase "between hands" in Polanyi's definition establishes trade as social interaction (Renfrew 1975:4). Trade implies social organization that regulates both procurement of goods (including raw materials) and the social relations involved in human encounters during the exchange of goods

(Renfrew 1975:4). When people habitually exchange commodities at a specific location, that location functions as a central place, and takes on particular significance for the cohesiveness of the group (Renfrew 1975:5). According to Renfrew (1975:8), "High population need not be permanently associated with a central place, and indeed at periodic central places there is frequently no population." The imperative for any early civilization to control the resources necessary for survival is axiomatic (Renfrew 1975:22). As specialization develops within human populations, centers become points of attraction for a larger territory, and become exchange centers for non-local goods (Renfrew 1975:27). When applied to my study area in west-central Arizona, Renfrew's (1975) theoretical perspective suggests that I may find evidence of commoditization of obsidian and other resources, control of commodity resources, sites of commodity specialization, intra- and intercultural exchange, and central places of exchange.

The theoretical framework for my thesis research integrates aspects of human behavioral ecology, circuit theory, and landscape archaeology to help me explore obsidian procurement by precontact people living in and around the Prescott culture area. This integrated theoretical structure informs both the development of my hypotheses and the methods I use for hypotheses testing. In successive chapters, I use an optimization model derived from human behavioral ecology and circuit theory to investigate spatial distributions of obsidian artifacts across the cultural and environmental landscape of west-central Arizona. My research elucidates lithic foraging and exchange patterns among precontact groups within and surrounding the Prescott culture area.

Chapter Three – Background

Archaeologists have conducted obsidian provenance studies in numerous contexts to discern the foraging and exchange patterns of prehistoric groups throughout much of the western U.S. Numerous obsidian sources surround the Prescott culture area in west-central Arizona. The relative importance of these obsidian sources and the means through which prehistoric people living in the Prescott culture area acquired obsidian, however, have yet to be described beyond site-specific contexts. To date, there have been no obsidian provenance studies specifically designed to describe obsidian acquisition and exchange by prehistoric people in the Prescott culture area and the related interactions with adjacent cultural groups of west-central Arizona.

Obsidian Sources in Northern and Central Arizona

Archaeologically important obsidian sources in north-central Arizona include Partridge Creek, Presley Wash and Black Tank in the Mt. Floyd Volcanic Field north of Ash Fork and Government Mountain and RS Hill in the San Francisco Mountains Volcanic Field northwest of Flagstaff (Figure 3.1). Although the locations of these primary obsidian source areas are critical to understanding prehistoric obsidian foraging patterns, secondary deposits resulting from fluvial transport are also important in understanding the spatial distribution of obsidian in the archaeological record (Shackley 2005:26).

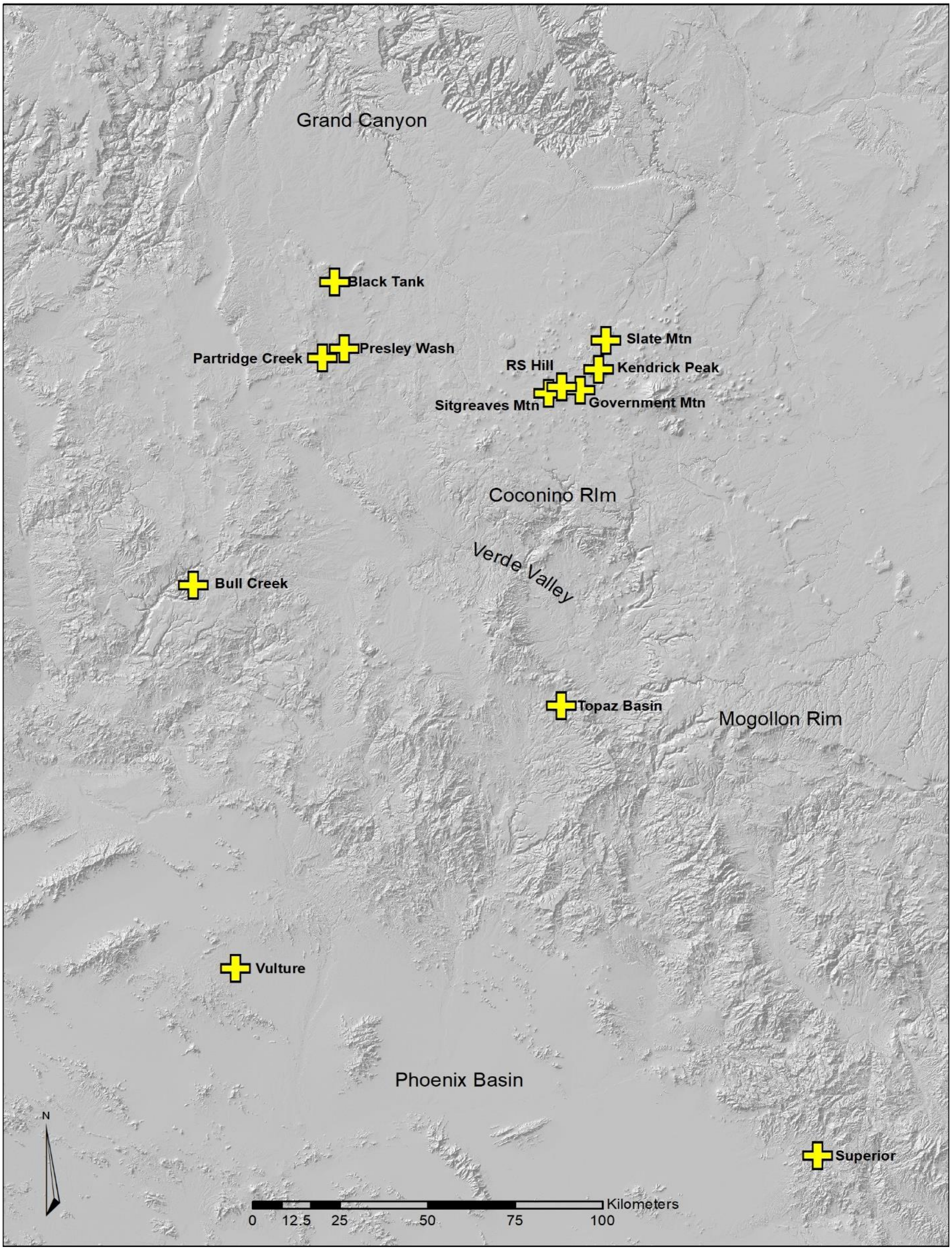

Figure 3.1. Obsidian sources in central Arizona.

Secondary sources of two varieties of Mount Floyd volcanic field obsidian (Partridge Creek and Presley Wash) are found in the alluvium of Partridge Creek downstream to Big Chino Wash west-northwest of Paulden, Arizona (Shackley 2005:30). Similarly, Tertiary obsidian sources (marekanites), including Bull Creek, Superior, Vulture, Sauceda, and to a lesser extent Topaz Basin, are found in secondary deposits downstream from their respective primary source areas. Bull Creek obsidian is distributed downstream in Bull Creek at least to the confluence of Burro Creek (Shackley 2005:38). Superior obsidian is distributed from the primary source area on Picketpost Mountain downstream "a considerable distance west" in Queen Creek (Shackley 2005:41). Vulture obsidian is distributed downstream from the primary source area "at least 20 km to the south and east" across Hassayampa Plain in Jackrabbit Wash (Shackley 2005:40). Sauceda obsidian is distributed "at least 20 km north" from the primary source areas in Sauceda Wash (Shackley 2005:42). Topaz Basin obsidian occasionally occurs in Cienega Creek several km downstream from the primary source area (Shackley 2019). In contrast to the Tertiary obsidian sources described above and the Mount Floyd Volcanic Field obsidian sources, the obsidian in the San Francisco Volcanic Field, including Government Mountain and RS Hill, is only available within a few kilometers of the primary source areas (Shackley 2005: 32-35).

Partridge Creek and Presley Wash obsidian occur in the archaeological record as far south as the Phoenix Basin (Peterson et al. 1997). Government Mountain obsidian was one of the most popular toolstones in the American Southwest from the Paleoindian through historic periods and has been recovered from archaeological contexts east to Chaco Canyon and south to the U.S. border with Mexico (Shackley 2005:34). The San Francisco Mountains in northern Arizona is the second-most prevalent source of obsidian recovered from the protohistoric Edwards I Site in southwest Oklahoma (Baugh and Terrell 1982). Obsidian from the San

Francisco Volcanic Field was also the most common exotic material at the Anderson Mesa study sites (Brown 1991). To date, however, there have been no comprehensive obsidian provenance studies within the Prescott culture area.

Obsidian Provenance Studies

Hawkes (1954) indicates that we could learn a great deal about long-range commerce among prehistoric cultures by identifying the source locations of materials that have been transported by people, and suggests the use of XRF spectrometry, which was experimental at that time. Researchers have since demonstrated the utility of X-ray fluorescence (XRF) technology to determine the sources of obsidian artifacts in the Western U.S. (Graves 2005; Haarklau et al. 2005; Jones et al. 2003; Shackley 2005; Scheiber and Finley 2011). Early research using XRF spectrometry to identify and distinguish obsidian sources in the San Francisco and Mt. Floyd volcanic fields is summarized by Lesko (1989). Jones et al. (2003) use source and artifact provenience data obtained from XRF spectroscopy to infer aspects of mobility, scale of conveyance, and possible routes of population movement among Paleo-archaic groups in the central Great Basin. The spatial distribution of XRF-sourced obsidian artifacts analyzed by Haarklau et al. (2005) confirms ethnographic evidence that prehistoric occupants of southern Nevada practiced highly mobile hunter-gatherer lifeways. XRF analysis of obsidian artifacts from three pueblos in central New Mexico supported Graves' (2005) finding that each of the pueblos obtained obsidian from different sources, and that each had independent nonlocal socioeconomic relationships. Schreiber and Finley (2011) use XRF spectroscopy of obsidian artifacts to assess patterns of mobility and exchange in the Yellowstone area. XRF analysis indicates that the majority of projectile points and almost all the debitage from several northern

Sinagua sites near Flagstaff, AZ are from Government Mountain, while Partridge Creek, Presley Wash, and RS Hill represent relatively minor sources (Whittaker et al. 2018).

Debitage, the biproducts of lithic flake-tool manufacturing and retouching, typically comprises the vast majority of flaked-stone artifacts at a habitation site (Bordaz 1970). Sources of obsidian debitage can be identified with XRF spectrometry (Beck 2008). To avoid the need to collect artifacts from field sites and maintain consistency in methods between field sites and museum collections, I use portable XRF technology throughout my research. Ferguson (2012) specifically addresses the use of handheld XRF technology to match obsidian to source areas in order to investigate trade and exchange of material objects. Handheld XRF has great potential for obsidian compositional analyses, because it combines non-destructive analysis with rapid results, relatively low equipment and analysis cost, and the option of in-field analysis. Frahm (2016) demonstrates two techniques for using portable XRF to analyze obsidian microdebitage – pressure flakes less than 1 cm wide and 3mm thick.

I use handheld XRF spectroscopy to map the distribution of obsidian debitage and formal tools in and around the Prescott culture area of west-central Arizona. Based on these results, the remainder of my research investigates the modes of human agency that may account for the observed spatial distribution of obsidian artifacts. Barker et al. (2002) suggest widespread exchange and contact between prehistoric societies in the western U.S. involving obsidian toolstone. Findlow and Bolognese (1980) model a prehistoric exchange system centered on the Antelope Wells obsidian source in Hidalgo County, New Mexico, and conclude that obsidian exchange increased with social stratification. Models incorporating obsidian distribution through regional exchange networks, socially bounded territories, and redistribution by elites led Peterson et al. (1997) to conclude that observed patterns in obsidian distribution may be explained by kin-based raw-material procurement and ritual item mobilization among the Hohokam. Hughes (2015) uses XRF spectroscopy of projectile points from Hogup and Danger Caves in the eastern Great Basin to demonstrate that the use of obsidian sources shifted in conjunction with transitions in style, suggesting that the introduction of the bow and arrow likely expanded social contacts and increased foraging distance and material acquisition opportunities. By comparing the distributions of prehistoric campsites, obsidian artifacts, and obsidian sources to the ethnographically documented foraging distances of mobile foragers in the Carson Desert, Kelly (2011) concludes that much of the obsidian was obtained through exchange. Lesko's (1989) review specifically suggests widespread exchange and contact among Hohokam, Sinagua, and other prehistoric societies in northern and central Arizona involving obsidian toolstone.

Prehistoric Exchange

The synonymous terms 'trade' and 'exchange' imply a reciprocal transaction between two people or groups. It follows that if prehistoric people in the Prescott culture area regularly exchanged durable raw materials or items of material culture with other people groups, then the spatial distribution of material culture in the archaeological record would reflect at least bidirectional flow of various commodities to and from the Prescott culture area. The flow of raw materials or goods in one direction implies a flow of other goods in the opposite direction (Abbott et al. 2007:468). In fact, the archaeological deposits at sites within and adjacent to the Prescott culture area do reflect the bidirectional distributions of ceramics and lithic materials, including obsidian, Perkinsville jasper, and argillite.

Trade and direct acquisition of materials are difficult to distinguish in the archaeological record. The distinction is important, however, because the "differences between social and physical connections reflects important differences in how people coped with their natural environment" (Kelly 2011:190). Earle (1982) summarized the role of the archaeologist in describing exchange as a three-step process: "1) source the commodities of exchange; 2) describe the spatial patterning of the commodities; and 3) reconstruct the organization of the prehistoric exchange." Obsidian source provenance studies are an important analytical tool for examining both local and long-distance exchange and procurement strategies of prehistoric peoples (Graves 2005). Obsidian source provenance research using XRF spectroscopy on obsidian artifacts from the San Francisco volcanic field may eventually delineate prehistoric trade routes (Schreiber and Breed 1971:119). The value of obsidian provenance studies is "to understand the more obvious social processes of procurement, exchange, cultural identity, and group interaction," and to "develop a database for future studies at a time when there may exist technology and theory transcending anything we can conceive of in the present" (Shackley 2005:6).

The major lithic manufacturing centers of Anderson Mesa, Kinnikinick and Grapevine sites, imported obsidian cores to supply a "thriving" obsidian trade by the thirteenth century (Brown 1991). The recovery of 47 unworked marekanites from Bull Creek during the excavation of the main pueblo at Fitzmaurice Ruin in Prescott Valley, Arizona, suggests that raw lithic materials were also acquired through exchange (Barnett 1974).

In some areas, distinctions between trade and direct acquisition can be inferred based on ethnographic information (Kelley 2011). Gifford (1936) offers the most comprehensive ethnographic accounts of lithic technology and lithic procurement among Yavapai hunter-gatherers in west-central Arizona. Gifford's (1936) description of the Yavapai "territory" very closely corresponds to the Prescott culture area – the focus of my thesis (Figure 3.2). Based on Gifford's (1936) description of the Yavapai territory and obsidian source provenance from

Middle and Late Archaic sites west of the Vulture source area and Middle Archaic sites north of Phoenix near New River, Shackley (2005:113) concluded a similar social organization and procurement range in the Prescott culture area for approximately 5,000 years. In contrast, based on limited survey data and early points on late sites, Whittaker et al. (2018) suggest that the pre-Sinagua Archaic populations were more mobile and used a wider variety of lithic sources than did later populations of Sinagua people in the area of Flagstaff, Arizona. Haarklau et al. (2005) provides a potentially useful comparison between the pattern of artifact distribution created by highly mobile hunter-gatherers in southern Nevada and the pattern created by more sedentary hunter-gatherers practicing agricultural in northern Arizona.

Using XRF to analyze over 450 obsidian artifacts from several northern Sinagua sites near Flagstaff, AZ, Whittaker et al. (2018) determined that the majority of points, and almost all the debitage, were from Government Mountain, while Partridge Creek, Presley Wash, and RS Hill represented minor obsidian sources in Sinagua sites. Based on the near absence of debitage from the minor obsidian sources, they concluded that obsidian projectile points from the Partridge Creek, Presley Wash, and RS Hill obsidian were not manufactured at the study sites, but reached the sites as completed arrowheads. They also suggest that the Sinagua exchanged obsidian for other exotic goods, based on the distribution of Government Mountain obsidian in outlying areas (Whittaker et al. 2018).

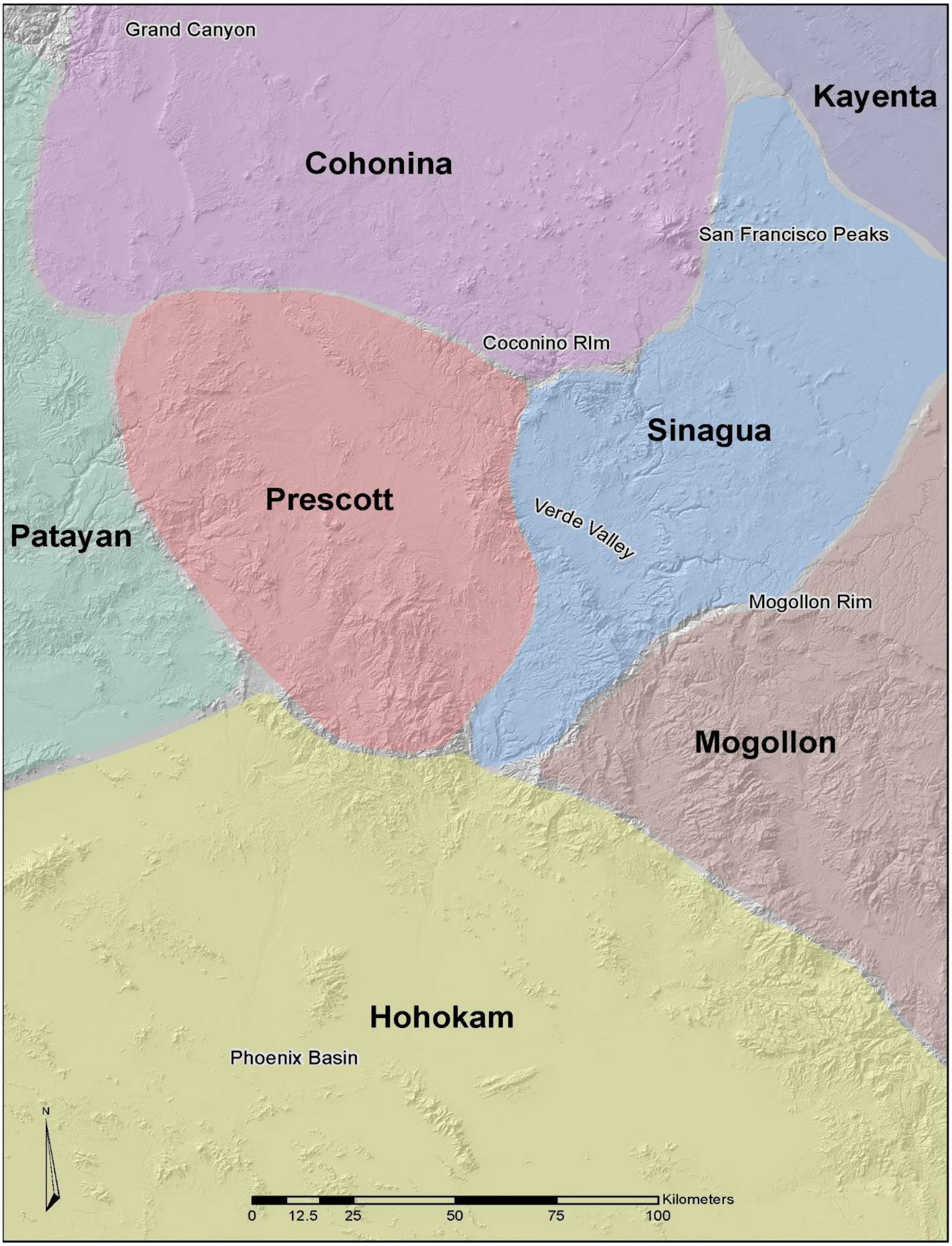

Figure 3.2. Prehistoric culture areas of central Arizona after Small (2010) Figure 3.22.

Although the relative influence of some central Arizona culture groups on exchange networks appears to have changed over time, the cultural boundaries in the frontier zones among Cohonina, Sinagua, and Kayenta territories remained permeable (Figure 3.2), supporting considerable exchange among these three groups (O'Hara 2006:4). Hohokam influence at Prescott culture sites within the upper Verde Valley seems to disappear between A.D. 1000 and 1125, although Hohokam influence continued at southern Sinagua sites in the middle Verde Valley during this period. During the same time period the influx of decorated ceramics into the Verde Valley became limited to Kayenta Anasazi wares. The abundance of intrusive, decorated wares frequently associated with large walled enclosures at Prescott culture sites dating from A.D. 1125 to 1300 supports the interpretation that such features served as trade centers (Fish and Fish 1977:14; Pilles 1976:115). Trade wares found in Verde Valley contexts dating between A.D. 1300 and 1425 indicate the strongest trade ties with the Hopi to the northeast (Fish and Fish 1977:18). Prehistoric dwellers of the Verde Valley were uniquely and ideally situated to acquire and redistribute northern goods to the south and southern goods to the north. The artifacts excavated from Exhausted Cave at the Clear Creek Ruins indicate that the site was used between A.D. 1100 and 1320, and that the Sinagua inhabitants had the strongest trade relationships with people of the Little Colorado River (Fish and Fish 1977:43).

Several researchers have acknowledged the existence of trade routes between the Prescott culture area and adjacent culture areas (Barnett 1981; Jeter 1977; King 1949; Spicer and Caywood 1936; Stone 1986; Byrkit 1989; Wilcox et al. 2000). Prescott Gray Ware found at sites in the Cohonina, Kayenta Anasazi, Sinagua, and Hohokam culture areas and ceramics from each of these culture areas found at sites within the Prescott culture area demonstrate the exchange of ceramics between the Prescott culture and adjacent cultures (Small 2010). Moreover, Small

(2010:6) concludes that the mechanism of exchange and its operation determine the spatial distribution of trade goods. Miroslav's (2015) results suggest that trade routes likely are spatially correlated with settlement patterning between obsidian sources and points of deposition.

Prescott Culture Archaeological Investigations

The Prescott culture area is a frontier zone at the nexus of at least four other prehistoric Southwest cultures – Cohonina to the north, Sinagua to the east, Hohokam to the south, and Patayan to the west (Figure 3.2). People living in the Prescott culture area had access to a variety of locally available flaked-stone materials, including fine-grained basalt, chert, chalcedony, jasper, and obsidian from secondary sources in alluvial deposits along lower Partridge Creek and Big Chino Wash, but also acquired obsidian from other, non-local sources. The Prescott culture's acquisition of non-local obsidian in addition to, or instead of locally available toolstone suggests some form of social interaction (i.e., exchange) may have been associated with obsidian acquisition. If people in the Prescott culture area acquired non-local obsidian via exchange rather than long-distance foraging, then I would expect to find evidence of other exchange goods in the archaeological record at sites within and outside of the Prescott culture area. In fact, archaeological contexts throughout west-central Arizona indicate the acquisition and distribution of lithic and ceramic goods from within the Prescott culture area.

The Prescott culture area is bounded by the Juniper Mountains to the north, Lonesome Valley to the east, Quartz Mountain to the south, and Bozarth Mesa to the west and the patterns of influence within the Prescott culture area changed through time (North 2008). The influence of Hohokam culture in the Prescott culture area is manifested in the presence of red-on-buff ceramics and ballcourts in the Prescott culture area more so than via obsidian artifacts from southern Arizona sources. The conspicuous Hohokam influence between A.D. 850 and 1050 faded later in the eleventh century, giving way to increased Sinagua interaction from the Verde Valley and Flagstaff areas through the end of the thirteenth century (North 2008).

Certain prehistoric communities in the Prescott culture area appear to have specialized in the procurement and distribution of specific trade goods, such as turquoise, argillite, or marine shells (North 2008). The large number of argillite ornaments in various stages of production at a large aggregation of pithouses (AZ N:4:12) on a terrace of the Verde River near Perkinsville, Arizona, suggests the accumulation of goods with trade potential (Fish and Fish 1977:42). Archaeological sites in the Del Rio Springs area likely were responsible for exchanging argillite with other groups throughout much of Arizona, especially throughout the Verde Valley and Flagstaff areas (Elson and Gunderson 1992:437). The people who lived in the six habitation sites around the Del Rio argillite mine apparently exercised control over the acquisition and distribution of argillite (North 2008:13.9). The large quantities of both Pacific shell and turquoise recovered from Kings Ruin near the confluence of Walnut Creek and Big Chino Wash suggest that Indian Peak and other habitation sites along Walnut Creek likely controlled the flow of Pacific shell and turquoise from the west into Chino Valley, the Verde Valley, and the Flagstaff area (North 2008:13.8).

Archaeologists divide the chronology of the Prescott culture into the early (A.D. 200-600) and late (A.D. 600-1500) Prehistoric Ceramic periods (Sorrell and Bryce 2018:15). The late Prehistoric Ceramic period is further divided into five phases: Agua Fria (A.D. 600– 850), Prescott (A.D. 850–1000), Copper Basin (A.D. 1000–1100), Chino (A.D. 1100–1300), and Willow Creek (A.D. 1300–1500) (Motsinger et al. 2000). The Agua Fria phase is distinguished by conspicuous Hohokam influence throughout the Prescott culture area, especially in the southern portion, as indicated by intrusive red-on-buff ceramics (Sorrell and Bryce 2018:15).

The Prescott phase is denoted by the earliest decorated Prescott gray ware ceramics, habitation sites with true earthen-walled pithouses, and the apparent abandonment of the Big Bug Creek area (Sorrell and Bryce 2018:16). In the Copper Basin phase, people in the Prescott culture area constructed pithouses lined with a single layer of stones around the perimeter and colonized the Ponderosa pine forests in the upper Hassayampa River drainage (Sorrell and Bryce 2018:16). People of the Prescott culture area began building above-ground pueblos and creating ceramic figurines during the Chino phase (Sorrell and Bryce 2018:16). The Willow Creek phase was a period of declining population and site abandonment in the Prescott culture area (Sorrell and Bryce 2018:16), likely due to changing climate.

The limited archaeological research focused on the Prescott culture area primarily consists of excavation reports from individual sites within the heartland between Prescott and Big Chino Wash. The periods of occupation, flaked-stone assemblage, percentage of obsidian, and sources of obsidian documented from excavated sites in the Prescott culture area are presented in Table 2.1. The following narrative summarizes findings from the excavated contexts that pertain to potential evidence of exchange as noted in the excavation reports.

Table 2.1. Occupation Periods, Obsidian in Flaked-stone Assemblages, and Obsidian Sources Found in Excavated Contexts in the Prescott Culture Area.

Site/Project & Reference	Period(s) of Occupation	Flaked-stone Assemblage (*n*)	Percent Obsidian	Obsidian Source(s)
American Ranch (AZ N:6:34 & AZ N:6:35) Haynes (2013)	Repeated occupations A.D. 600-1300	4,719	5.2	Bull Creek Burrro Creek Government Mtn Partridge Creek RS Hill Vulture Presley Wash
Stoneridge Leonard and Robinson (2005)	Repeated occupations 2470 B.C. – A.D. 1400	3,348	5.3	**Not analyzed in report* Bull Creek Government Mtn Partridge Creek RS Hill Presley Wash
Watson Lake site (AZ N:7:311) Baker (2011)	A.D. 600-850	716	18.3	RS Hill Government Mtn Partridge Creek two unknown sources
Willow Lake (AZ N:7:308) Rapp (2006)	A.D. 900-1167	1,788 (debitage only)	2.2	Government Mtn RS Hill Partridge Creek Sauceda Bull Creek
Sundown (NA16385) Cline and Grossman (1999)	A.D. 1112-1300	1,921 (debitage only)	4.2	Government Mtn Partridge Creek Vulture
Sandretto (AZ N:7:163) Christenson (2003)	A.D. 800-1200		13.0	**Not analyzed in report*
Big Bug Creek (AZ N:12:14) (AZ N:12:22) (AZ N:12:57) Punzmann et al. (1998) Shackley (1996)	A.D. 500-900			RS Hill Government Mtn Burro Creek Partridge Creek Presley Wash Cow Canyon Superior one unknown source
Coyote Ruin (NA 6654) Spall (2013)	A.D. 900 -1300			**Not analyzed in report* Government Mtn Presley Wash RS Hill Vulture

Matli Ranch sites: Hilltop, Crest, Fence Post, Foothill, and Rattlesnake Barnett (1970)	 A.D. 1025-1200 A.D. 1000-1280 A.D. 620-950 & A.D. 1080-1310			**Not analyzed in report* Bull Creek Presley Wash Partridge Creek RS Hill
Las Vegas Ranch East (NA14119) Barnett (1978)	A.D. 1000-1300			**Not analyzed in report* Government Mtn Partridge Creek RS Hill Bull Creek
Las Vegas Ranch West (NA14547) Barnett (1978)	A.D. 1000-1200			**Not analyzed in report* Government Mtn Partridge Creek RS Hill Bull Creek
Bonnie (NA 15810) Johnson (1996)	A.D. 1050-1200	274	14.0	**Not analyzed in report* Government Mtn Bull Creek
Stricklin (AZ N:7:63) (NA 25778) Johnson (1998)	A.D. 700-1345	130	35.4	**Not analyzed in report*
Neural (NA 20788) Grossman (1997)	A.D. 1240-1270	2,439	8.1	**Not analyzed in report* Government Mtn Partridge Creek Presley Wash Topaz Basin Vulture unknown source
Sullivan (NA 25473) Steger and Johnson (1997)	A.D. 1050-1200	467	10.7	**Not analyzed in report* Government Mtn Bull Creek Partridge Creek RS Hill Vulture
Perkinsville (AZ N:4:6) Fish and Wiffen (1967)	A.D. 1100-1250		>1	**Not analyzed in report*
Fitzmaurice Ruin (AZ N:7:17) Barnett (1974)	A.D. 1140-1300	62 (points only)	69	**Not analyzed in report* Government Mtn Bull Creek Presley Wash Partridge Creek RS Hill Black Tank Superior

*Obsidian source provenance data are the result of original research not provided by the author/s of the report.

Although obsidian comprised a relatively minor proportion of the lithic assemblage at the American Ranch site (AZ N:6:35), 26 (48.1%) of the 54 projectile points recovered during excavation of the site were made from obsidian (Haynes 2013:6.47). Haynes (2013:6.47) concluded that non-local lithic material procurement or exchange appears to have become more oriented toward the north of the American Ranch site (AZ N:6:35) over time. All temporal components of the American Ranch site (AZ N:6:35), from the Late Archaic to the Early Formative periods, contained Government Mountain obsidian, indicating that the earliest occupants of this site had trade connections with Late Archaic populations around Government Mountain and that these trade networks persisted into the fourteenth century (Haynes 2013:6.45). The results from Haynes' (2013:6.45) analysis indicate that the trade network expanded to the north and west through time, as evidenced by the incorporation of obsidian artifacts from RS Hill, Partridge Creek, and Presley Wash in later contexts at the American Ranch site (AZ N:6:35).

Leonard and Robinson (2005) noted that obsidian comprised only 2.2% of all production materials and 1.2% of cores. Obsidian was the second most frequently used lithic material for bifaces (17.4% of 161) and projectile points (26.3% of 205) recovered from 22 sites in the Stoneridge Development (Leonard and Robinson 2005). Four of the five projectile points recovered from a pithouse site (AZ N:7:286) that yielded the oldest radio-carbon date (A.D. 690 to 990) were made from obsidian. Obsidian artifacts recovered from the Stoneridge Development with source provenance in the San Francisco Volcanic Field were most likely obtained through exchange (Leonard and Robinson 2005:15.26).

Baker (2011) analyzed Mount Floyd volcanic artifacts (Partridge Creek obsidian and Presley Wash rhyodacite) recovered from the Watson Lake site (AZ N:7:311) and quarry sites along Big Chino Wash and the upper Verde River and concluded that raw materials for the Watson Lake site artifacts were most likely procured from the secondary sources rather than the primary sources in the Mount Floyd Volcanic Field. Baker (2011) noted that both chert and obsidian were more abundant in excavated features than surface collections at the Watson Lake site (AZ N:7:311). Baker (2011) found that obsidian artifacts recovered from excavated features at the Watson Lake site (AZ N:7:311) were the smallest among all lithic artifact materials in terms of length, width, thickness, and weight, and attributed the size difference to the quality of the material and the distance to the respective source areas. Baker (2011) concluded that obsidian was clearly the preferred lithic material for bifaces including projectile points at the Watson Lake site (AZ N:7:311).

XRF source provenance studies have identified obsidian artifacts from Vulture, Sauceda, and Bull Creek at certain sites in the Prescott area, suggesting extensive prehistoric exchange networks in the area (Rapp 2006:256). The high proportion of non-local obsidian at the Willow Creek site is evidence that the site occupants “had ready access to these materials through trade, exchange, or direct procurement” (Rapp 2006:232-233). Given the sources of all of the non-local materials are north of the Willow Lake site, the orientation of trade or procurement activities from the Willow Lake site appears to have been to the north (Rapp 2006:233). The use of obsidian from the San Francisco Volcanic Field decreased between earlier occupations during the Prescott phase (A.D. 900-1100) to later occupations during the Chino phase (A.D. 1100-1167) at the Willow Lake site, and obsidian acquisition from the Willow Lake site shifted from sources north (San Francisco Volcanic Field) and south (Vulture) to sources north (San Francisco Volcanic Field) and west (Partridge Creek and Bull Creek) (Rapp 2006:250). The analyses of lithic artifacts recovered from the Willow and Watson Lake sites indicate that preferences for lithic materials used in the production of formal tools shifted from chert to obsidian over time, and may reflect a temporal change in regional exchange networks (Rapp 2006:257). According to Rapp (2006:255), "More data from well-dated contexts are needed to investigate variability in obsidian trade and exchange patterns in the Prescott Region." Obsidian was the most common material used in the production of projectile points recovered from the Neural site – 29 of the 35 points recovered were made from obsidian (Rapp 2006:256).

Forty (85%) of the 47 projectile points recovered from the Sundown site were made from obsidian (Cline and Grossman 1999:67, 86). Given the extremely low number of pressure flakes in the lithic debitage at the Sundown site, it is likely that finished projectile points (most of which were obsidian) were a trade item and not locally manufactured (Higgins et al. 1999:193). Although 622 argillite artifacts were recovered from the Sundown site (NA 16385), the highest quantity of argillite reported at a single site other than Fitzmaurice Ruin, it is likely that even more was manufactured on site for trade (Cline and Grossman 1999:82). Rough and finished argillite objects were a medium of exchange for other non-local goods recovered from the Sundown site, including obsidian (Cline and Grossman 1999:82).

All seven of the arrowheads and 16 of 32 (50%) of the formal bifaces recovered from the Sandretto site (AZ N:7:163) were made from obsidian (Christenson 2003:68). The presence of obsidian and other exotic materials recovered from the Sandretto site (AZ N:7:163) is evidence of prehistoric trade (Long and Blan 2003:151). Christenson (2003:65) reported that five bifaces recovered from the Sandretto site (AZ N:7:163), three of which were made from obsidian, appeared to be Pinto-style points from the Archaic Period (8500 to 1000 B.C.), but concluded that these artifacts were likely curated, given no other evidence of Archaic occupation. Argillite, malachite, and other copper minerals were locally available to occupants of the Sandretto site (AZ N:7:163), and may have served as trade goods (Long and Blan 2003:151).

Locally produced or locally traded goods available for people in the Prescott culture area to exchange with outside groups included argillite from the quarry site near Del Rio Springs, Perkinsville jasper, Presley Wash and Partridge Creek obsidian from terraces along Big Chino Wash, agave, and Prescott gray ware (Spall 2013:183). Del Rio argillite has been recovered from numerous Sinagua and Hohokam sites (Spall 2013:183; Kamp and Whittaker 1999:133; Elson and Gundersen 1992; Howell 1940; Madsen 1999). Argillite sourced to the Del Rio quarry was recovered from excavated contexts at Tuzigoot N.M. indicating that the Del Rio quarry was active into the 14th century (Spall 2013:184). The primary trade materials coming from the Northern Sinagua culture area is obsidian from sources in the San Francisco Volcanic Field west of Flagstaff (Spall 2013:184; Christenson 2009, 2010).

Barnett (1970) documents the excavation of a complex of five small prehistoric dwellings (Hilltop, Crest, Foothill, Rattlesnake, and Fence Post) at Matli Ranch in Williamson Valley, Arizona. The artifact assemblage recovered from the Matli Ranch sites included 2,090 pieces of turquoise, 32 obsidian marekanites, 50 obsidian projectile points, 10 obsidian drills, 21 argillite ornaments, 109 marine shells, and 264 intrusive ceramic sherds (Barnett 1970). The abundance of potential trade goods, including turquoise, marine shell, and intrusive decorated ceramics suggests that the Matli Ranch sites were highly integrated in at least one exchange network.

A total of 30 obsidian artifacts were recovered from the surface of the Las Vegas Ranch East site, including fifteen marekanites, eight projectile points, two discs, and two scrapers (Barnett 1978:8). The artifact assemblage recovered from the Las Vegas Ranch East site included 346 pieces of turquoise, 22 obsidian marekanites, 16 obsidian projectile points, 4 obsidian drills, 15 pieces of argillite, 50 Olivella shells, and 279 intrusive ceramic sherds (Barnett 1978). Based on the abundance of non-local trade wares recovered from the Las Vegas Ranch East site, Barnett (1978:62) inferred strong trade contacts and sizeable trade interactions with Sinagua and Kayenta groups, limited ceramic trade with the Cohonina, but little ceramic exchange with the Hohokam. Barnett (1978:64) concluded that:

> More attention should be directed toward determination of trade routes and what commodities were being traded. Very little has been done in the Prescott region regarding trade relationships except to mention what ceramic trade wares occur at different sites.

The artifact assemblage recovered from the Las Vegas Ranch West site included 1,181 pieces of turquoise, 64 obsidian marekanites, 5 obsidian projectile points, 15 pieces of argillite, 64 marine shells, and 84 intrusive ceramic sherds (Barnett 1978). Approximately 3% of the 2,808 sherds recover from the Las Vegas Ranch West site were intrusive, indicating contacts with the Kayenta, Sinagua, and Hohokam (Barnett 1978:102).

Intrusive ceramics representing eight different wares comprised 6.74% of the ceramic artifacts recovered from the Stricklin site (Johnson 1998:21). The source and specific wares of intrusive ceramics recovered from the Stricklin site indicate trade with the Hohokam to the south and Cohonina to the north prior to A.D. 1000, and Anasazi groups to the northeast after A.D. 1100 (Johnson 1998:23).

Intrusive ceramics, including Tusayan white ware, Little Colorado white ware, Tsegi orange ware, San Francisco Mountain gray ware, and Elden corrugated, indicate contact or exchange between the Neural site and Kayenta and Sinagua groups to north and northeast of the Prescott area (Grossman 1997:39). Perkinsville jasper comprised 77.5% (n = 1,890) of surface lithic scatter recorded at the Neural site - another 1,465 pieces of Perkinsville jasper were recovered during excavation of the site (Grossman 1997:65-67). The Del Rio argillite source is between the Perkinsville jasper source area and the Neural site, yet only thirteen argillite chips and one finished argillite pendant were recovered from the Neural site, leading (Grossman 1997:80) to suggest that the occupants did not have access to the Del Rio quarry site or there was a taboo regarding argillite from Del Rio.

Perkinsville jasper has a homogenous microcrystalline structure that fractures conchoidally, making it ideal material for flint knapping (Bryce 2018:427). Perkinsville jasper was traded throughout and beyond the Coconino Plateau, and comprised the vast majority of the jasper in the lithic assemblage at the Antler House site (Bryce 2018:427). The relatively large amount of Perkinsville jasper and obsidian from the RS Hill and Government Mountain sources at the Antler House site suggests trade relations with Prescott and possibly Cohonina groups (Bryce 2018:428). The proportion of Perkinsville jasper decreases through time, constituting more than 80 percent of the sample in the Pioneer period, approximately two-thirds of the sample during the Colonial period, and less than half of the flaked stone assemblage during the Sedentary period (Bryce 2018:433). Based on the relative proportions of obsidian and jasper debitage and tool types, Bryce (2018:463) inferred that while some lithic artifacts of nonlocal materials may have been traded as finished tools (i.e., a Vulture obsidian projectile point), other flaked-stone materials were traded in as pieces conducive to reduction (Bryce 2018:463).

Based on excavation of an early Pueblo III site on the upper Verde River near Perkinsville, Arizona, Fish and Wiffen (1967) suggested that trade was the stimulus for a small influx of Hohokam people from the Phoenix Basin between A.D. 700 and 800, and that the presence of the small group of Hohokam strengthened trade ties with the south. Although less than one percent of the total flake-tool assemblage at the Perkinsville site was obsidian, twenty of the twenty-four projectile points recovered were made of obsidian (Fish and Wiffen 1967:66).

Wilcox et al. (2000:122) argued that the prehistoric route through Walnut Creek, noted by Lt. Amiel Whipple in 1854 (Foreman 1941) and later by Jesse Walter Fewkes (1912), was an eastern extension of the Mojave Trail, and that this trail was a conduit that supplied Pacific shell to people living in Chino Valley and the Verde Valley. Excavations recovered numerous Pacific shell artifacts from Prescott and Sinagua habitation sites east of Walnut Creek dating between A.D. 100 and 1450, including Kings Ruin near the mouth of Walnut Creek (Spicer and Caywood 1936), Fitzmaurice Ruin on Lynx Creek (Barnett 1974), and Tuzigoot near Clarkdale in the Verde Valley (Caywood and Spicer 1935; Hartman 1974). The frequency of Pacific shell, turquoise, and other exogenous trade goods reached its peak in Northern Sinagua sites near Flagstaff between A.D. 1150 and 1225 (Kashou 1988; Morrison 1990; Wilcox et al. 2000:124). Based on the distribution of Pacific shell, Wilcox et al. (2000:125) inferred a network of interaction among Northern Sinagua leaders and people in the Cohonina, Kayenta, Southern Sinagua, and Prescott areas. The valuables involved in exchange of prestige items included argillite from Del Rio Springs area (Wilcox et al. 2000:125).

For over 1,200 years, Hopi people used the Palatkwapi Trail to travel through Winslow to the Verde Valley to collect azurite and malachite pigments from mines in Jerome and salt from a mine in Camp Verde (Byrkit 1988:3). The Palatkwapi Trail was part of a larger trade route linking Colorado and New Mexico with the Pacific Coast of California (Byrkit 1988:3). The section of the Palatkwapi Trail that accessed the Verde Valley from the northeast led through Chavez Pass to Pine Springs and descended past Stoneman Lake to Beaverhead Springs between Rattlesnake Canyon and Rarick Canyon (Byrkit 1988:7). At Beaverhead Springs the trail forked, with one route leading west to the mines in Jerome and the other leading southwest to the salt mine in Camp Verde (Byrkit 1988:11). There is no discussion in Byrkit (1988) or Wilcox et al.

(2000), however, regarding the section of the exchange route linking the Verde Valley on the east with Walnut Creek to the west through the Prescott culture area.

Ballcourts

A growing body of archaeological research suggests that ballcourts provided a context for social interaction and exchange. By the middle Sedentary period (A.D. 1000-1070), the Hohokam regional system was characterized by a set of geographically dispersed but interdependent communities demarcated by a network of ballcourts that evidence a shared belief system and functioned as centers for social and economic interaction (Abbott et al. 2007:461-462). Marshall (2001:120) identified a total of 238 ballcourts at 194 sites in Arizona. The abundance and spatial distribution of ballcourts throughout southern and central Arizona led Bayman (2002), Doyel (1985;1979), Haury (1976:78), Heidke (2000), Wilcox (1991a), and Wilcox and Sternberg (1983:213) to hypothesize that large, periodic gatherings at ballcourt sites provided a venue for exchange and fostered trade fairs and incipient markets. Shackley (2005:168) concluded that much of the market-based exchange among the Hohokam likely occurred in association with ball games (Shackley 2005:168).

The Hohokam likely constructed the first ballcourts in the Phoenix Basin in the early ninth century (Abbott et al. 2007:462). Widely spaced lines of ballcourts paralleling waterways radiate from the Phoenix Basin, extending north into territories inhabited by the Northern and Southern Sinagua, Cohonina, and Prescott cultures (Abbott et al. 2007:463; Wilcox 1999; Wilcox et al. 1996). Hohokam villages on the banks of the Salt and Gila Rivers in the Phoenix Basin imported raw materials and finished goods including argillite and obsidian from upland areas in the north, and exported Hohokam red-on-buff ceramics northward (Abbott et al. 2007:463). "Most Southwestern archaeologists agree that the ballcourt gatherings facilitated the transfer of the rich diversity of goods from various ecological districts across considerable distances" (Abbott et al. 2007:463). Based on variation in the orientation of ballcourts, Wilcox (1991b:115-124) argued that the ballgames were calendrically timed, and that exchanges at the ballgames functioned to supplement reciprocal kinship-based exchange. The uniform distribution of Hohokam red-on-buff ceramic artifacts over a large area is not consistent with typical down-the-line transmission associated with kinship-based exchange, but rather reflects the homogenizing effect of marketplace exchange (Abbott et al. 2007:468-470). Abbott et al. (2007:479) concluded that the Hohokam economy of the middle Sedentary period exceeded typical expectations for a nascent marketing system due to widely accepted beliefs that promoted stability, surplus agricultural production, favorable climate, and a diverse surrounding landscape with disproportionately distributed natural resources.

There are five known ballcourts clustered in the frontier zone between the Cohonina and Prescott culture areas – Sycamore Point, Wagner Hill, JD Wash, Round Mountain, and Butler (Figure 3.3). Based on surface ceramic scatter, Wilcox et al. (1996) concluded that the Wagner Hill and Sycamore Point ballcourt sites were contemporary, dating to between A.D. 1025 to 1050. Wilcox et al. (1996:449) also posited that the Round Mountain ballcourt site was "contemporaneous or somewhat later than the Wagner Hill ballcourt," based on limited ceramic data. The surface ceramic scatter associated with the Wagner Hill, Round Mountain, and Sycamore Point ballcourts are consistent with the Cohonina culture, while the ceramics and architecture at the Perkinsville ballcourt site 15 km to the southwest and below the Mogollon Rim evidence Hohokam and Southern Sinagua culture, suggesting that the Mogollon Rim was an important cultural boundary (Wilcox et al. 1996:435). The Wagner Hill, Round Mountain, JD Wash, and Sycamore Point ballcourt sites may have been occupied seasonally, typical of many

Cohonina sites (Wilcox et al. 1996:440). The surface scatter at the Wagner Hill and Sycamore Point ballcourt sites included Perkinsville jasper, Verde Gray, and Verde Brown ceramics, indicating some interaction with people in the upper Verde Valley (Wilcox et al. 1996:440, 452). "The ceremonial exchange mechanism of the ball game often provided a peaceful context for interaction between ethnically distinct populations" (Wilcox et al. 1996:442). Although Wilcox et al. (1996:453) concluded that the Sinagua people living in the Flagstaff area apparently did not build ballcourts until A.D. 1070-1100 during the Winona phase, ceramic evidence indicates that the Sinagua played some version of the ballgame in the Flagstaff area prior to A.D. 1064 (Morales 1994:iii). Fish (1974) and Fish and Fish (1977) reported that the Perkinsville site with its large ballcourt dated between A.D. 800 and 1000.

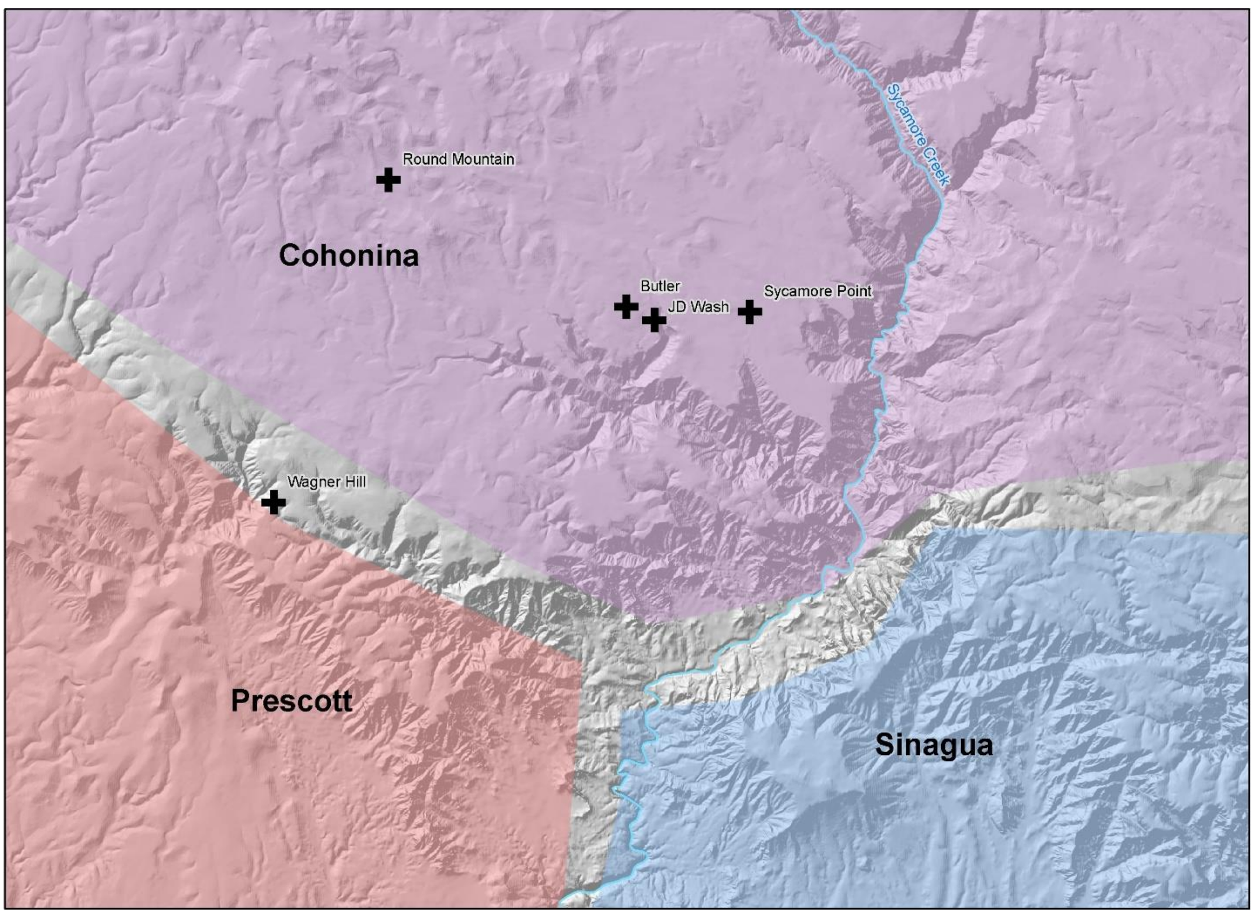

Figure 3.3. Ballcourts in Prescott – Cohonina – Sinagua frontier zone.

Ceramics found in Cohonina and Sinagua ballcourt contexts suggest that feasting events accompanied the ball games (O'Hara 2006:5). Limited evidence suggests that closely spaced ballcourts, such as the five Cohonina ballcourts near Sycamore Point, were used sequentially rather than simultaneously (O'Hara 2006:12). Surface ceramic data indicate that the Sycamore Point, Wagner Hill, JD Wash, and Round Mountain ballcourts were in use between A.D. 1000 and 1100 (O'Hara 2006:12). Murphy (2000) and Alexander (2004) concluded that Flagstaff-area ballcourts were integrated into the Hohokam exchange system.

The appearance and use of ballcourts in the Phoenix Basin and outlying areas were roughly contemporaneous (Wilcox 1991b:123). The formalization of the ballgame and construction of ballcourts at fixed locations served to mobilize large groups of people and relatively large quantities of goods, thereby supplementing kinship-based exchange (Wilcox 1991b:124). Archaeological evidence suggests that by about A.D. 1200-1250 all Hohokam ballcourts were abandoned (Wilcox 1991b:108). The abandonment of the Hohokam ballcourt system also suggests a change in the associated exchange networks.

Ballcourts may have functioned as central places for gathering, and facilitated secondary exchange (Wilcox and Sternberg 1983:51). Wilcox and Sternberg's (1983:51) postulate that the ballcourts were part of an evolving exchange system where social interaction relied on shared beliefs and practices. Variations in the orientation of Hohokam ballcourts may evidence structured calendrical events that facilitated interaction among different communities at specific times throughout the year (Wilcox and Sternberg 1983:253). Wilcox and Sternberg (1983:253) inferred that the communities within the ballcourt network were economically interdependent.

Northern Arizona ballcourt artifact assemblages indicate community participation, feasting, and exchange associated with the ballgame (Morales 1994:78). Ballcourts are an archaeological representation of social interaction between distinct regional groups (Morales 1994:7). Snaketown and other early courts are oriented east-west, while later Casa Grande-type courts are oriented north-south (Morales 1994:13). Fish et al. (1980:169-171) proposed a model of trade networks with ballcourts at trading centers. Ballcourt use in the Flagstaff area apparently ended by A.D. 1200 (Morales 1994:81). The artifact assemblages at the Flagstaff area ballcourts indicate that both social interaction and economic exchange were centered on the ballgame, suggesting a shared system of beliefs and values among participating communities (Morales 1994:85). Ballcourts were part of a long-term pattern of social interaction among prehistoric people groups of Arizona (Morales 1994:86).

Archaeologically important sources of obsidian for the Prescott culture area include Partridge Creek, Presley Wash, and Black Tank in the Mount Floyd Volcanic Field, Government Mountain and RS Hill in the San Francisco Volcanic Field, and the Tertiary deposits (marekanite sources) at Bull Creek, Topaz Basin, Vulture, and Superior. Some research suggests that the relative importance of these obsidian sources in the Prescott culture area changed through time. The Prescott culture area is encompassed on all sides by at least four other prehistoric culture areas – Cohonina on the north, Northern and Southern Sinagua on the northeast and east, Hohokam on the south, and Patayan on the west. The juxtaposition of prehistoric culture areas in west-central Arizona constituted frontier zones of potential interaction between adjacent culture areas. Archaeological evidence from limited excavations within and around the Prescott culture area indicates bidirectional flows of local and non-local goods, including obsidian, argillite, turquoise, marine shell, and ceramic wares. The spatial distribution of archaeological sites with deposited local and non-local materials including obsidian from multiple sources constitutes evidence of prehistoric exchange. From the late eleventh century through the twelfth century

A.D., people living in the Prescott, Cohonina, Sinagua, and Hohokam culture areas constructed a form of public architecture identified as ballcourts. The documented ballcourt sites in the Prescott, Cohonina, and Sinagua culture areas are situated in zones of potential interaction between adjacent cultures. For example, there are five ballcourts clustered on the Mogollon Rim between the Cohonina heartland and the Prescott culture area. Research at ballcourt sites in the Prescott, Cohonina, Sinagua, and Hohokam culture areas indicates that a variety of social interaction accompanied the ballgames, including feasting and exchange. Long-distance exchange networks through ballcourts or other places of interaction among adjacent culture groups likely supplied and supplemental local kinship-based exchange.

Chapter Four – Methods

My thesis research is designed as an obsidian provenance study of archaeological sites within the Prescott culture area of west-central Arizona. I developed three primary research questions to guide my research. 1) Which sources of obsidian are represented at archaeological sites in west-central Arizona? 2) Does the archaeological record provide evidence that precontact people groups in west-central Arizona acquired obsidian through exchange? 3) What aspects of precontact obsidian acquisition behaviors are discernable from the spatial distribution of obsidian artifacts? My study area encompasses most of Yavapai county and southern Coconino county, Arizona, including southern portions of the Kaibab National Forest, portions of the Coconino National Forest between Anderson Mesa and the Verde Valley, the entire Prescott National Forest, and the extreme northern portions of the Tonto National Forest and Phoenix District, Bureau of Land Management associated with the Agua Fria National Monument (Figure 4.1). The Prescott culture area includes the landscape from the upper Verde River watershed to the north, Mingus Mountain and the Bradshaw Mountains to the east, the upper Hassayampa River Watershed to the south, and the Baca Float and upper Burro Creek Watershed to the west.

Authorizations

Prior to conducting my research, I obtained authorizations to collect archaeological data on National Forest System and other public lands via volunteer agreements with the Kaibab National Forest, Prescott National Forest, and Phoenix District, Bureau of Land Management. I obtained authorizations to conduct archaeological research on the Coconino National Forest by securing a research permit from the forest supervisor (Appendix 1).

Reference collections

I conducted site visits to all known obsidian source areas in central Arizona, including Partridge Creek, Presley Wash, Black Tank, Government Mountain, RS Hill, Topaz Basin, Bull Creek, Vulture, and Superior. During site visits to obsidian source areas, I collected 20-30 reference samples from each source area for subsequent analysis using x-ray fluorescence (XRF) spectrometry. Collection of reference samples from obsidian source areas did not require special authorization or permitting.

Data Collection

XRF Spectrometry

XRF spectrometry works by bombarding a sample with an x-ray beam (high-energy, short wavelength radiation). When the energy of the radiation is sufficient to dislodge an electron from an inner shell of an atom within the sample, the atom becomes unstable until the electron is replaced from an outer shell. The electron replacement causes a release of energy, based on the difference in strength between the bonds of inner-shell and outer-shell electrons. The energy is released as lower-energy radiation in comparison to the incident x-rays, and is called fluorescent radiation. Because the energy differences between electron shells are known and constant, the resulting fluorescent x-rays can be measured to identify the concentrations of elements in a sample (after Shackley 2012:16).

Throughout my research, I analyzed obsidian reference samples and artifacts with the same Olympus Delta Pro x-ray fluorescence (XRF) spectrometer - property of the Prescott National Forest. The Olympus Delta Pro XRF spectrometer produces a 4-watt x-ray beam. I programmed the XRF spectrometer to analyze each obsidian specimen for 5 seconds with a 40kV beam followed by 30 seconds with a 10kV beam. I controlled the beam width by setting the collimator to 5 mm. I standardized my results by maintaining these same settings throughout my research, including data collection from all reference samples, collections, and field sites.

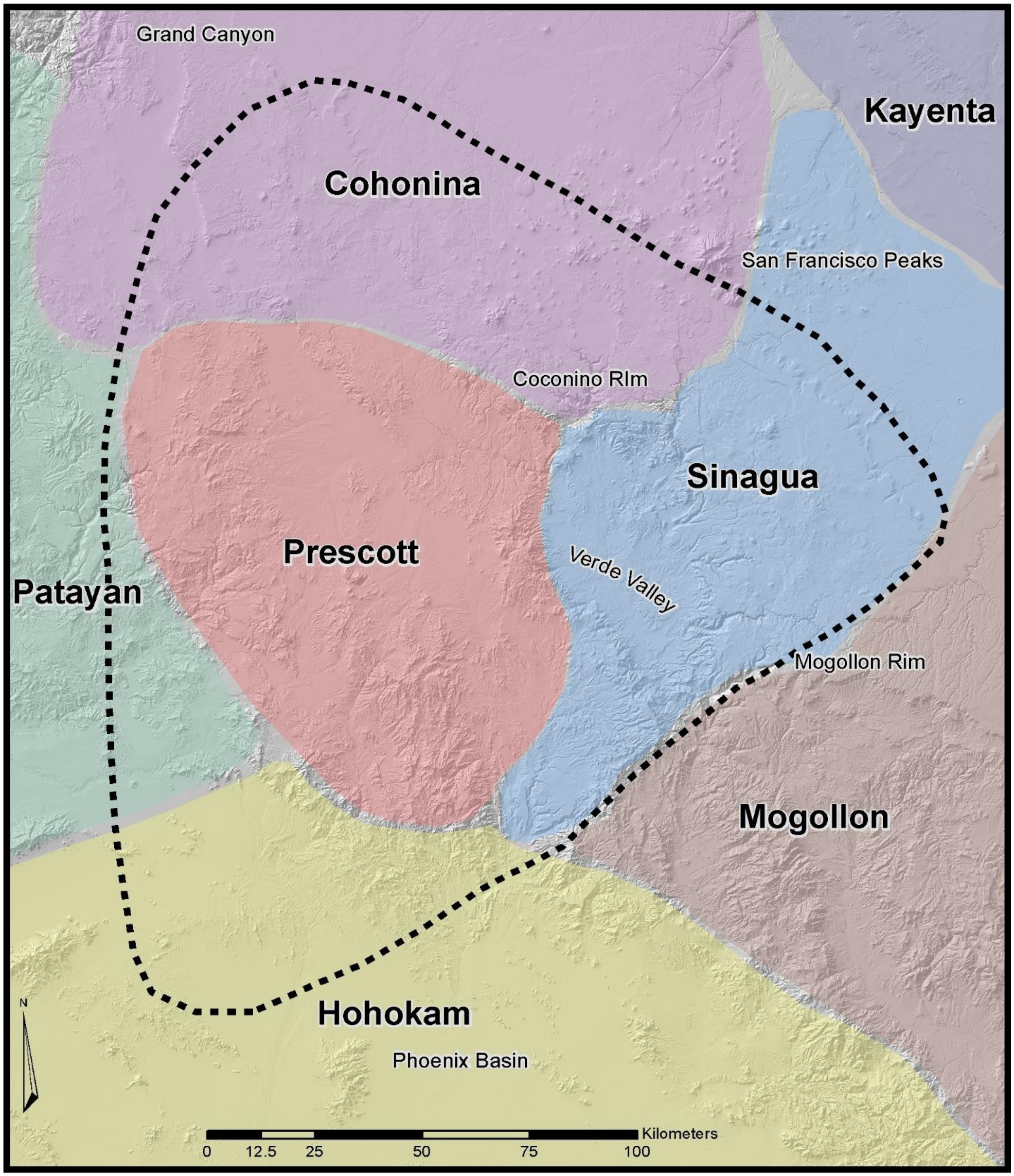

Figure 4.1. Map of study area.

There are limitations to using portable XRF spectroscopy. Noble gasses, barium, and elements lighter than magnesium cannot be detected with the portable XRF spectroscope that I used. Portable XRF spectroscopy is nevertheless an appropriate instrument for my obsidian provenance study, because I relied on iron (Fe), manganese (Mn), strontium (Sr), zirconium (Zr), yttrium (Y), rubidium (Rb), and niobium (Nb) to determine the sources of obsidian used by people in the Prescott culture area.

Site Identification

Throughout the course of my research, I identified probable archaeological sites for field data collection using Google Earth on a laptop computer and USGS topographic maps through the Avenza application on my cellular telephone. I located hilltops, mesa tops, ridges, and other areas of interest on topographic maps, noted the approximate coordinates, then panned and zoomed to the coordinates in Google Earth to view aerial photography of the area. I created a placemark for any rock alignments or other apparent stone-masonry features that I observed in Google Earth, pinned the location in Avenza, then used Avenza and Google Earth to plan a route to access the sites in the field.

Site Visits

I conducted site visits to 211 archaeological sites within my study area. During each site visit, I completed a comprehensive pedestrian survey to determine the spatial extent of surface artifact scatter and identify any obsidian artifacts. I analyzed all obsidian surface artifacts larger than 5mm in length and width that I observed on site using the XRF spectrometer. During each site visit, I recorded the geolocation (in decimal degrees) of the sites in the field using the Avenza application on my cellular telephone.

Museum Collections

I analyzed obsidian artifact collections from archaeological sites within my study area at the Sharlott Hall Museum (216 collections), Smoki Museum (nine collections), Verde Valley Archaeological Center (three collections), The Museum of Northern Arizona (two collections), the Kaibab National Forest Supervisor's Office (138 collections), and the Prescot National Forest Supervisor's Office (13 collections). I recorded the provenance of each collection based on the information in the site records.

Data Analysis

I exported the XRF data files in comma-separated variable (.csv) format and copied each file to my computer hard drive. To analyze the XRF data, I copied the raw .csv tables to an Excel spreadsheet and arranged the data into columns that are informative for obsidian analysis after Shackley (2005). For my research, I performed exploratory data analyses by arraying the XRF data (in ppm) from site visits and museum collections together with obsidian source reference data in pairwise scatterplots of Fe, Mn, Rb, Nb, Sr, Zr, and Y. I established the obsidian source provenance of the artifacts from site visits and museum collections by identifying where the XRF data from the artifacts consistently clustered when arrayed with the obsidian source reference data in six pairwise comparisons (Sr-Nb, Sr-Fe, Sr-Mn, Sr-Y, Sr-Zr, and Rb). I analyzed a total of 2,429 obsidian artifacts using this process throughout the course of my research. Examples of exploratory data analyses from my research are provided in Figures 4.2 – 4.7.

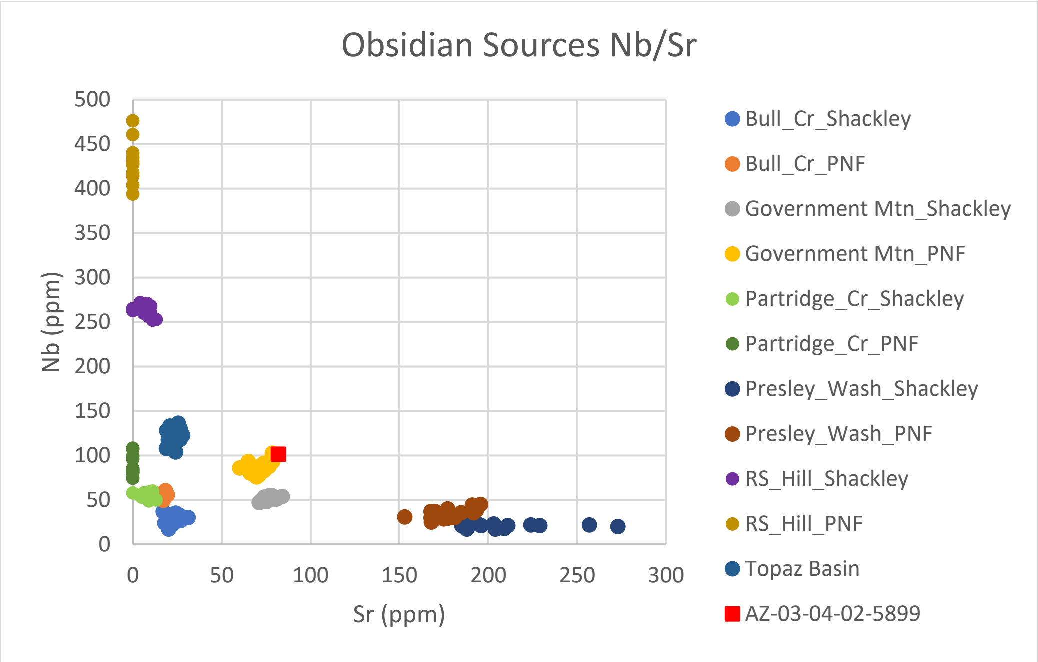

Figure 4.2. Pairwise scatter plot showing concentrations of strontium and niobium in reference samples from Bull Creek, Government Mountain, Partridge Creek, Presley Wash, RS Hill and Topaz Basin obsidian source areas analyzed with the same instrument or based on published data (Shackley 2019). One artifact from the AR-03-04-02-5899 site has been added for comparison. Note that he AR-03-04-02-5899 artifact data plot with the Government Mountain reference data.

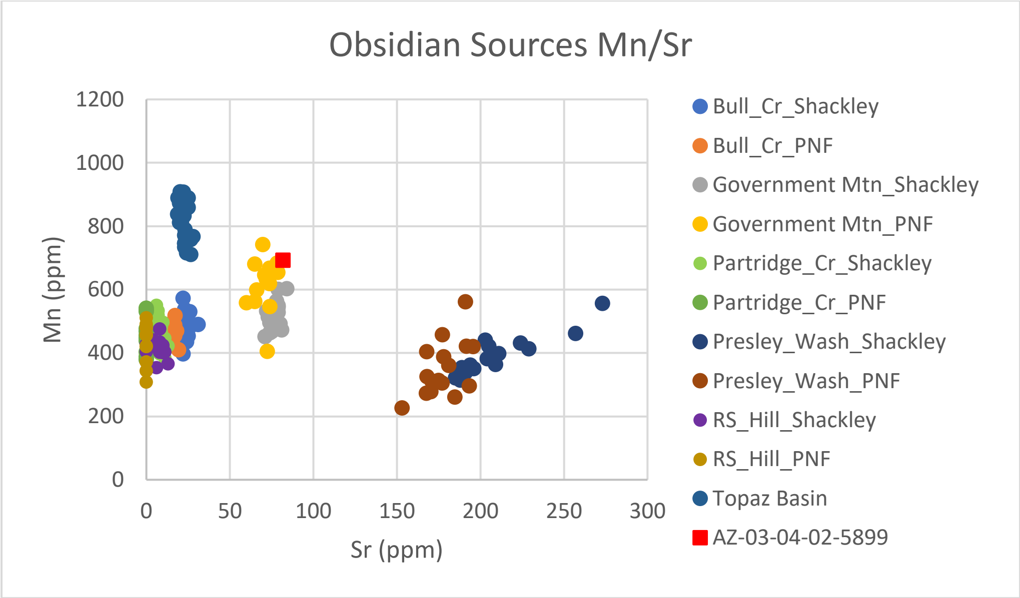

Figure 4.3. Pairwise scatter plot showing concentrations of strontium and manganese in reference samples from Bull Creek, Government Mountain, Partridge Creek, Presley Wash, RS Hill and Topaz Basin obsidian source areas analyzed with the same instrument or based on published data (Shackley 2019). One artifact from the AR-03-04-02-5899 site has been added for comparison. Note that he AR-03-04-02-5899 artifact data plot with the Government Mountain reference data.

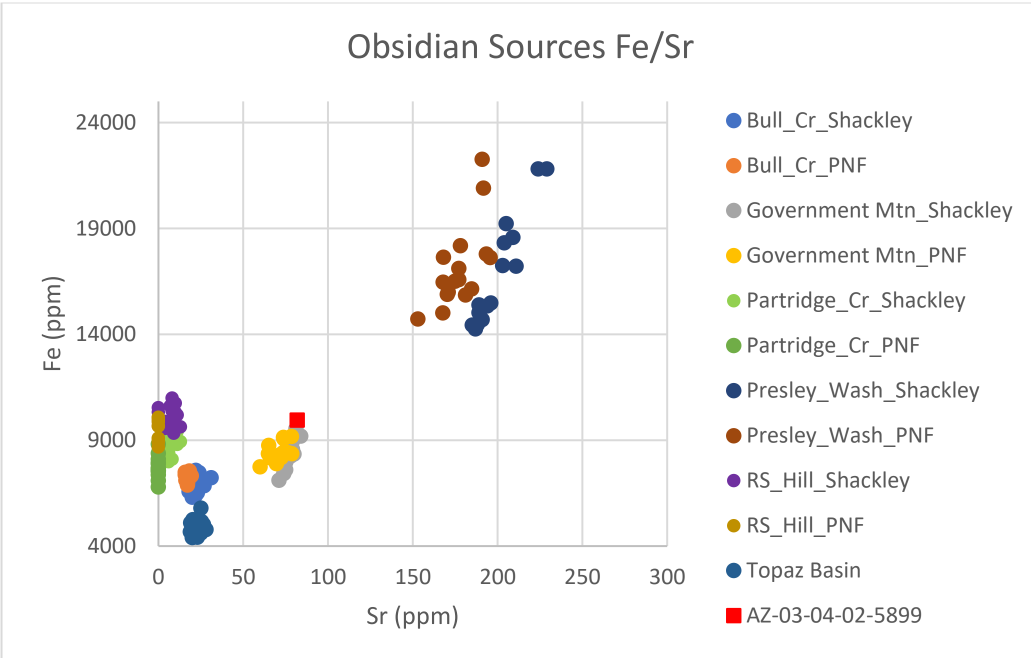

Figure 4.4. Pairwise scatter plot showing concentrations of strontium and iron in reference samples from Bull Creek, Government Mountain, Partridge Creek, Presley Wash, RS Hill and Topaz Basin obsidian source areas analyzed with the same instrument or based on published data (Shackley 2019). One artifact from the AR-03-04-02-5899 site has been added for comparison. Note that he AR-03-04-02-5899 artifact data plot with the Government Mountain reference data.

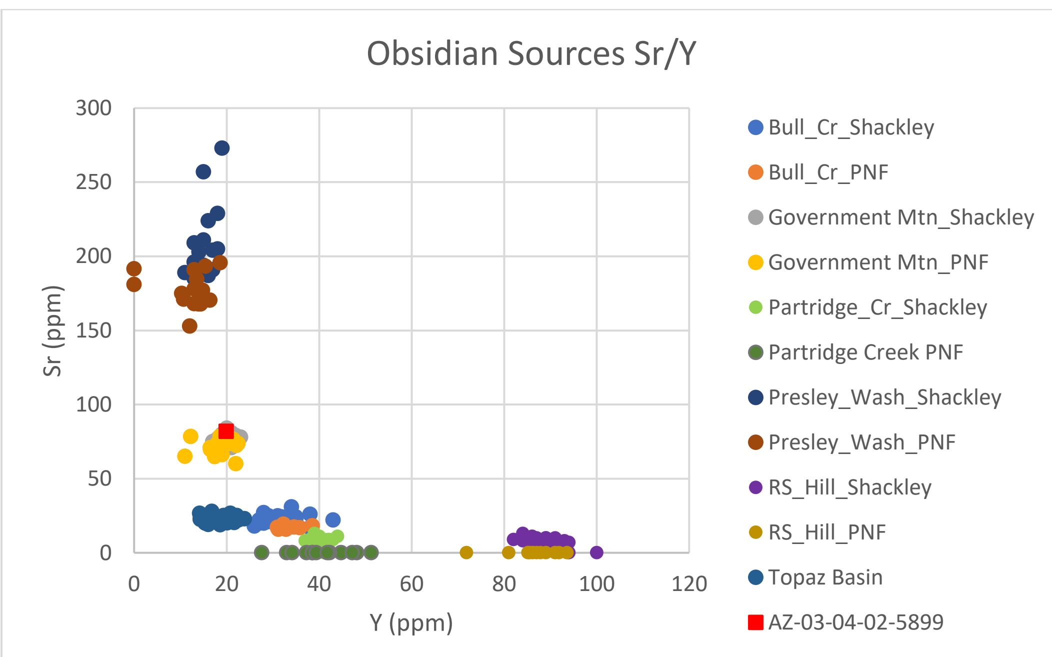

Figure 4.5. Pairwise scatter plot showing concentrations of strontium and yttrium in reference samples from Bull Creek, Government Mountain, Partridge Creek, Presley Wash, RS Hill and Topaz Basin obsidian source areas analyzed with the same instrument or based on published data (Shackley 2019). One artifact from the AR-03-04-02-5899 site has been added for comparison. Note that he AR-03-04-02-5899 artifact data plot with the Government Mountain reference data.

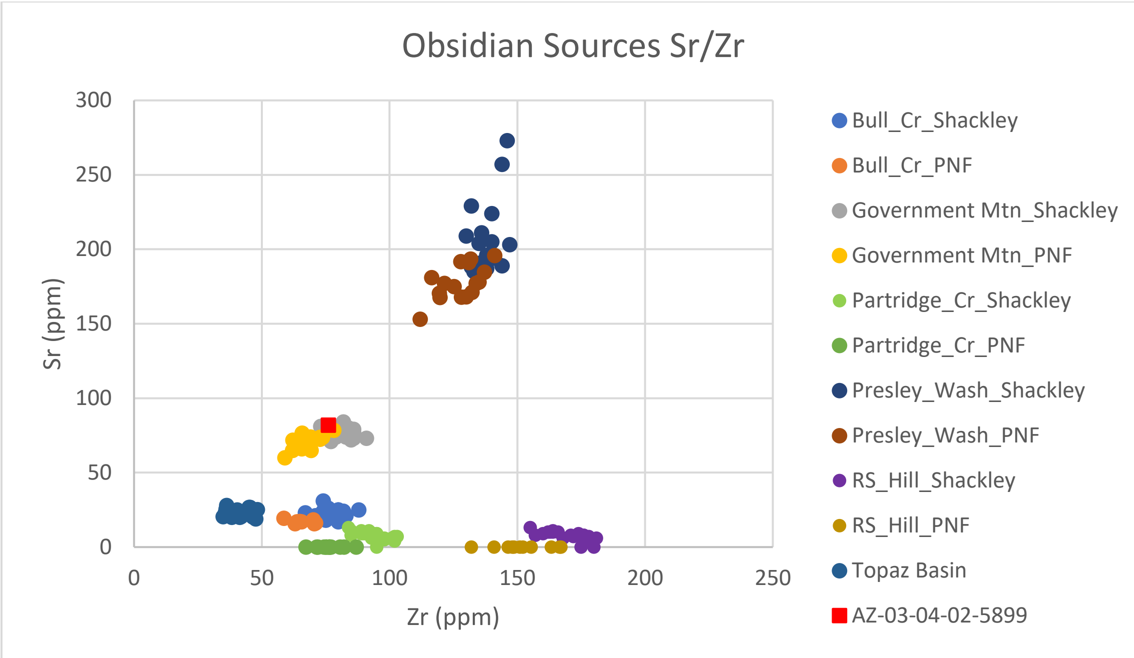

Figure 4.6. Pairwise scatter plot showing concentrations of strontium and zirconium in reference samples from Bull Creek, Government Mountain, Partridge Creek, Presley Wash, RS Hill and Topaz Basin obsidian source areas analyzed with the same instrument or based on published data (Shackley 2019). One artifact from the AR-03-04-02-5899 site has been added for comparison. Note that he AR-03-04-02-5899 artifact data plot with the Government Mountain reference data.

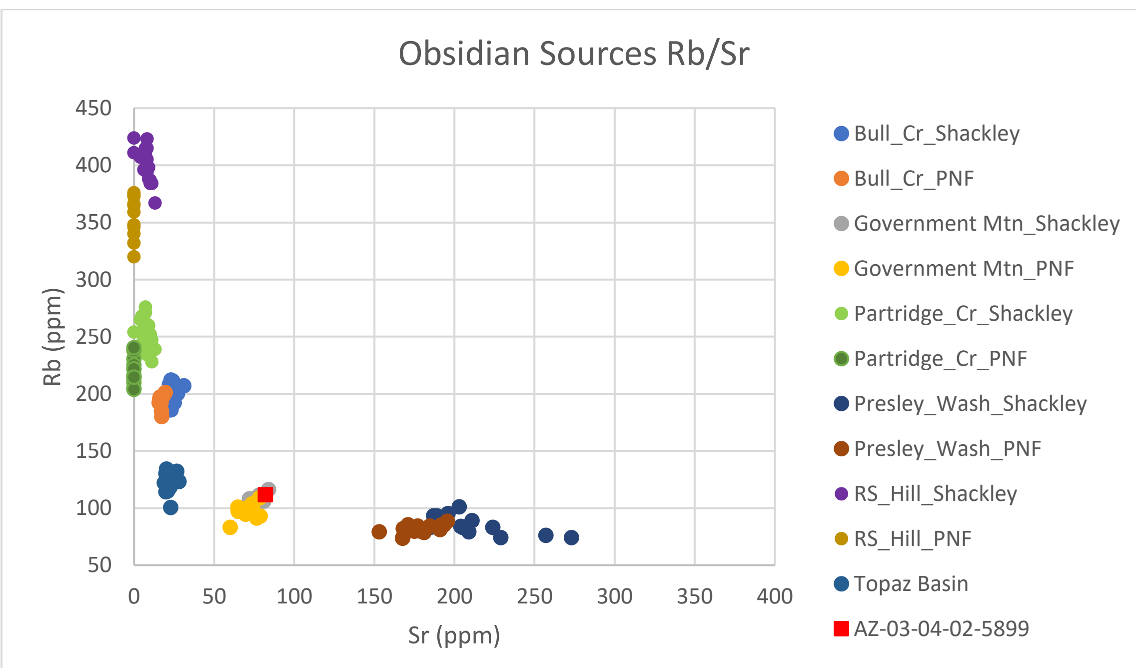

Figure 4.7. Pairwise scatter plot showing concentrations of strontium and rubidium in reference samples from Bull Creek, Government Mountain, Partridge Creek, Presley Wash, RS Hill and Topaz Basin obsidian source areas analyzed with the same instrument or based on published data (Shackley 2019). One artifact from the AR-03-04-02-5899 site has been added for comparison. Note that he AR-03-04-02-5899 artifact data plot with the Government Mountain reference data.

Spatial Data Array

Following the XRF data analyses and assignment of obsidian source provenance to each artifact, I tallied the number of artifacts from each obsidian source at each site in a spreadsheet along with the respective site coordinates in decimal degrees and Universal Transverse Mercator (UTM), projected the XY data in ArcMap, and exported the data to a shapefile. Figure 4.8 illustrates the resulting spatial array of archaeological sites sampled within and adjacent to my study area.

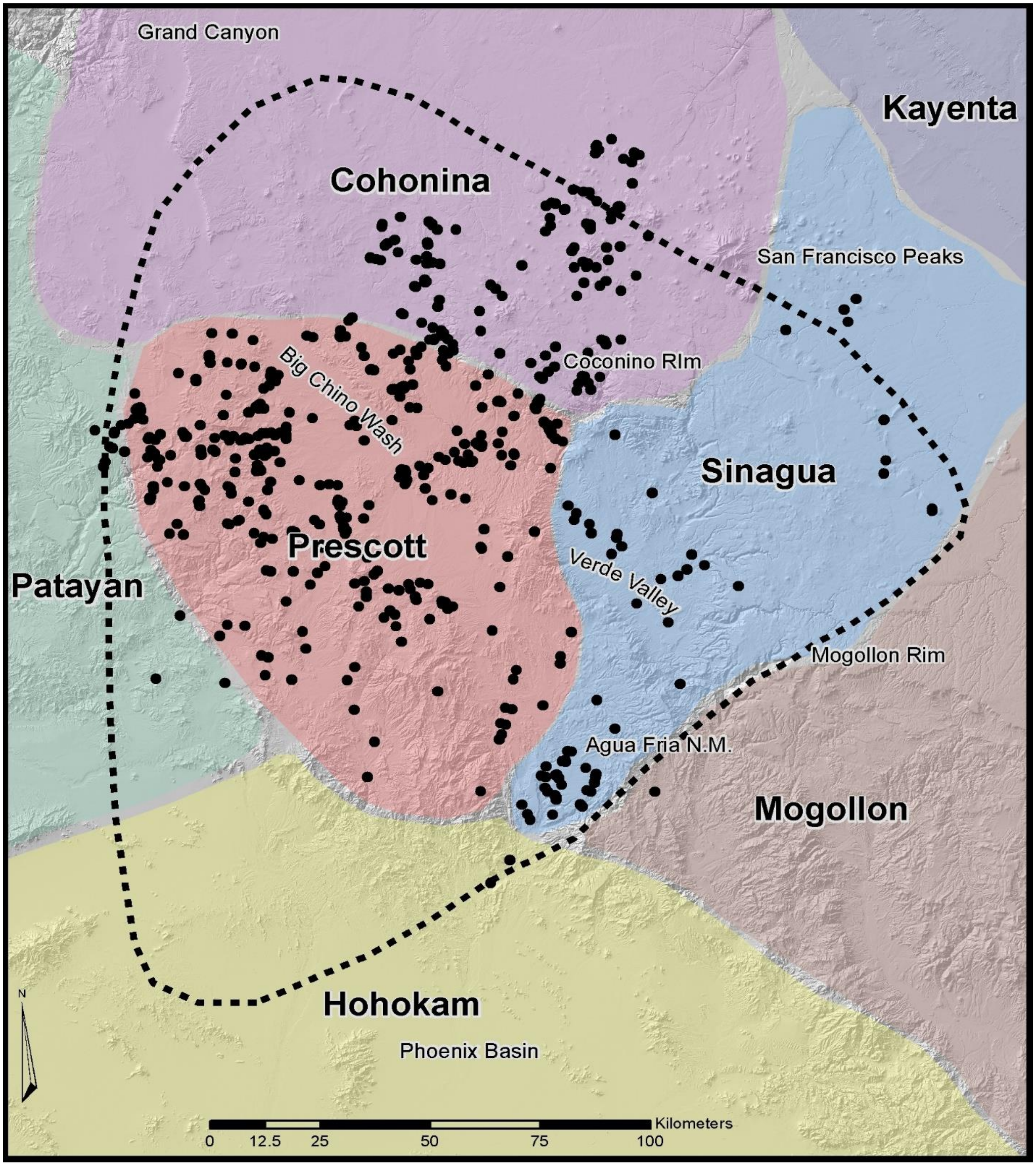

Figure 4.8. Spatial array of archaeological sites (n = 608) sampled within study area.

Cost Surface Construction

I constructed two cost surfaces to facilitate least-cost path analyses of the spatially arrayed archaeological sites with obsidian artifacts within my study area. Each cost surface is composed of 30-meter raster data representing slope, vegetation, and proximity to surface water.

I derived the cost-surface slope data from a 30-meter digital elevation model (USGS 2018) using the ArcMap Slope Tool, and then classified the resulting slope raster data into nine classes using the ArcMap Reclassify Tool. The vegetation data in my cost surfaces are derived from ecological response unit (ERU) polygon data downloaded from USDA (2018). I added a value field to the attribute table of the ERU data, and assigned values based on the system type field (riparian = 1, grassland = 2, woodland or forest = 3, and shrubland = 4). I assigned the values (representing costs) based on desirability for foot travel, wherein riparian areas have the highest desirability and lowest cost given their association with surface water, and shrublands (which include chaparral) have the lowest desirability and highest cost. After assigning values, I converted the ERU polygons to raster data using the ArcMap Polygon to Raster Tool. I derived the proximity to water data for the cost surfaces from the National Hydrographic Dataset (USGS 2019) points representing springs. I based the distance to surface water data on springs rather than perennial streams because springs are more persistent through time than perennial streams and the NHD perennial stream data appear to be incomplete for my study area. I converted the NHD spring points into raster data using the ArcMap Point to Raster Tool, then used the Euclidian Distance Tool to assign the distance to the nearest spring to each cell in the raster dataset. I subsequently performed two classifications of the resulting distance raster data using the ArcMap Reclassify Tool – the first into nine classes and the second into thirty classes. I compiled the two cost surfaces by adding together the classified slope, classified distance to water, and ERU raster datasets using the ArcMap Map Algebra Tool.

Once the cost surfaces were built, I produced least-cost paths between each of the obsidian source areas and selected archaeological habitation sites that include obsidian artifacts with the corresponding source provenance using the ArcMap Cost Connectivity Tool. Due to the large file size of the cost surfaces (40.61 MB), I found it necessary to extract relevant portions of the cost surfaces prior to running the Cost Connectivity tool. I defined the area of interest for a given source-site pair by drawing a rectangle encompassing the area between the points, converting the rectangular graphic to a polygon feature, converting the polygon feature to a raster using the ArcMap Polygon to Raster tool, and extracting the area from the cost surface using the ArcMap Extract by Mask tool. I performed the least-cost path analyses by pairing one obsidian source with one site at a time, preferentially selecting habitation sites from the periphery of the spatial distribution of sites from a given source area, as illustrated in Figure 4.9. I repeated this process using both cost surfaces to produce two least-cost paths for each source-site pair.

In addition to the least-cost paths derived from the two composite cost surfaces, I produced least-cost paths for the same set of source-site pairs using each of the three cost surface components - classified slope, classified distance to water, and ERU raster datasets. I subsequently compared each of the resulting least-cost paths to those produced from the composite cost surfaces by selecting sites from the spatial array of archaeological sites with obsidian artifacts using the ArcMap Select by Location tool. I selected all sites from the spatial array of archaeological sites with obsidian artifacts that were within 300 meters of each cost path and tallied the total number of sites, the number of sites with the same source of obsidian used to generate the respective least-cost path, and the total number of obsidian artifacts with the same source provenance. I compared the results from the least-cost paths derived from the composite cost surfaces against the paths derived from each of the three components for all three variables using pairwise Student's *t*-tests.

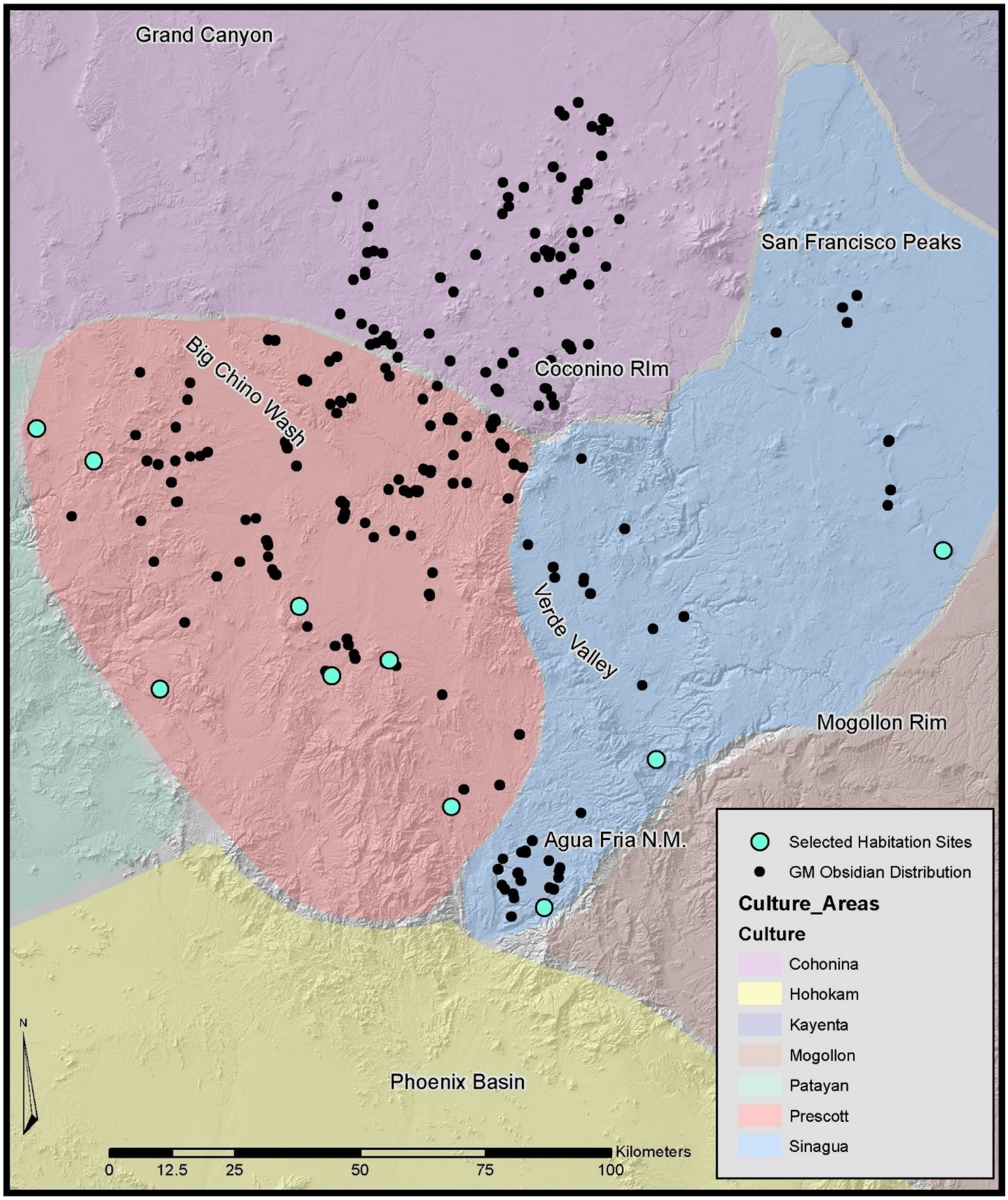

Figure 4.9. Habitation sites selected for least-cost path analysis from the periphery of Government Mountain obsidian artifact distribution.

Chapter Five – Results

I collected obsidian artifact data from a total of 608 archaeological sites within my study area. Government Mountain, Partridge Creek, Bull Creek, Presley Wash, and RS Hill proved to be the principle obsidian sources within and surrounding the Prescott culture area. Secondary obsidian sources in my study area include Black Tank, Topaz Basin, and Vulture. The obsidian source provenances for all 2,429 artifacts associated with all 608 sites that I analyzed over the course of my research are presented in Appendix 2, Table 5.1.

The lithic assemblages at 44.6% of the sites (n = 271) in my study area included obsidian artifacts from the Government Mountain source area. Government Mountain was the most ubiquitous obsidian source throughout my study area. The distribution of obsidian artifacts across my study area, however, is not homogeneous. Rather, the frequency of occurrence of Government Mountain obsidian decreases from east to west across my study area (Figure 5.1).

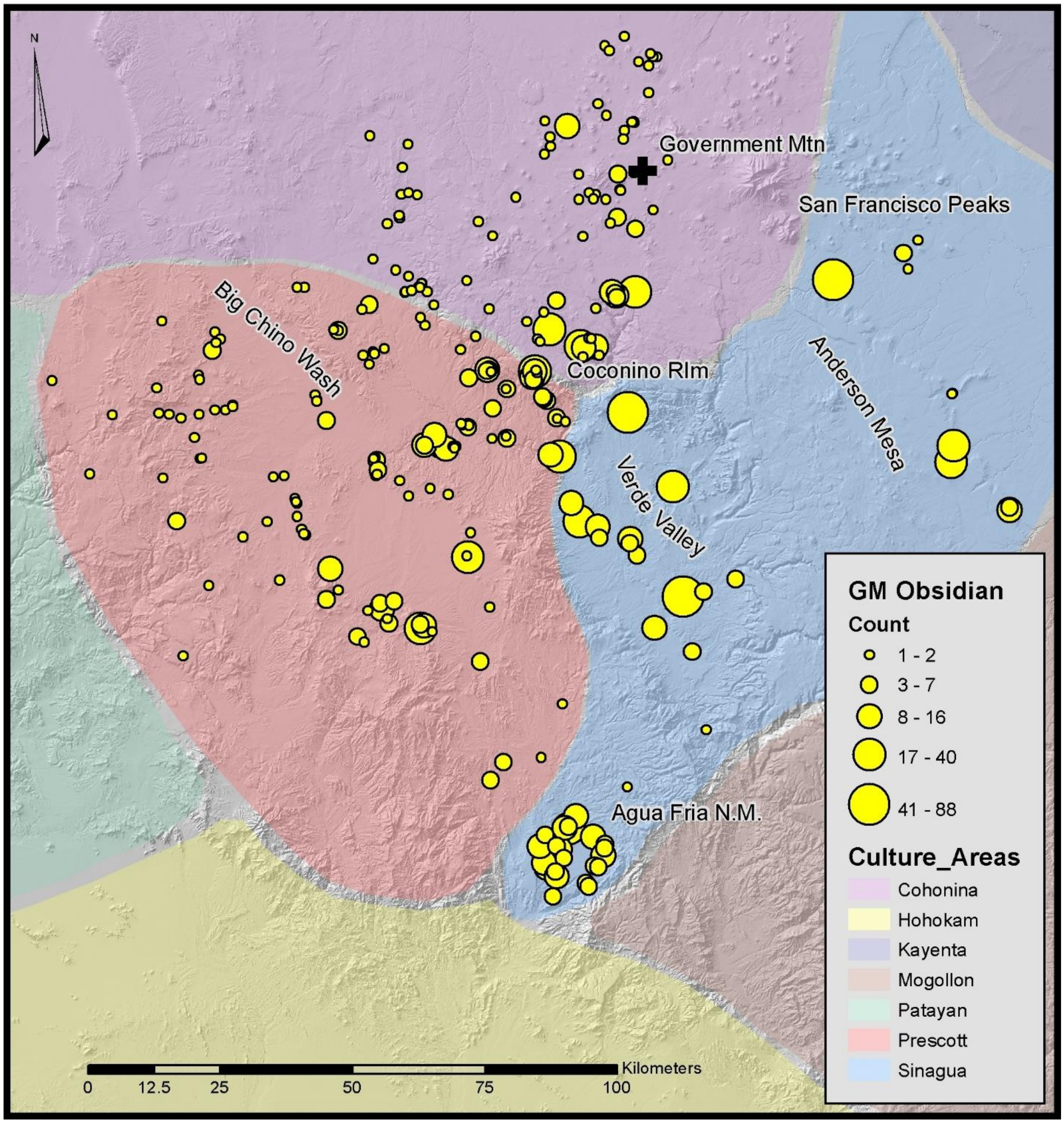

Figure 5.1. Distribution and frequency of Government Mountain obsidian artifacts.

The lithic assemblages at 15.3% of the sites (n = 93) throughout my study area included obsidian artifacts from the RS Hill source area. The frequency of RS Hill obsidian in my study area is approximately one-third the frequency of Government Mountain obsidian despite the close proximity of the two source areas. In further contrast with Government Mountain obsidian, the distribution of sites with RS Hill obsidian is oriented in a northeast to southwest swath, and the frequency of occurrence of RS Hill obsidian is greatly diminished in the eastern portion of my study area (Figure 5.2).

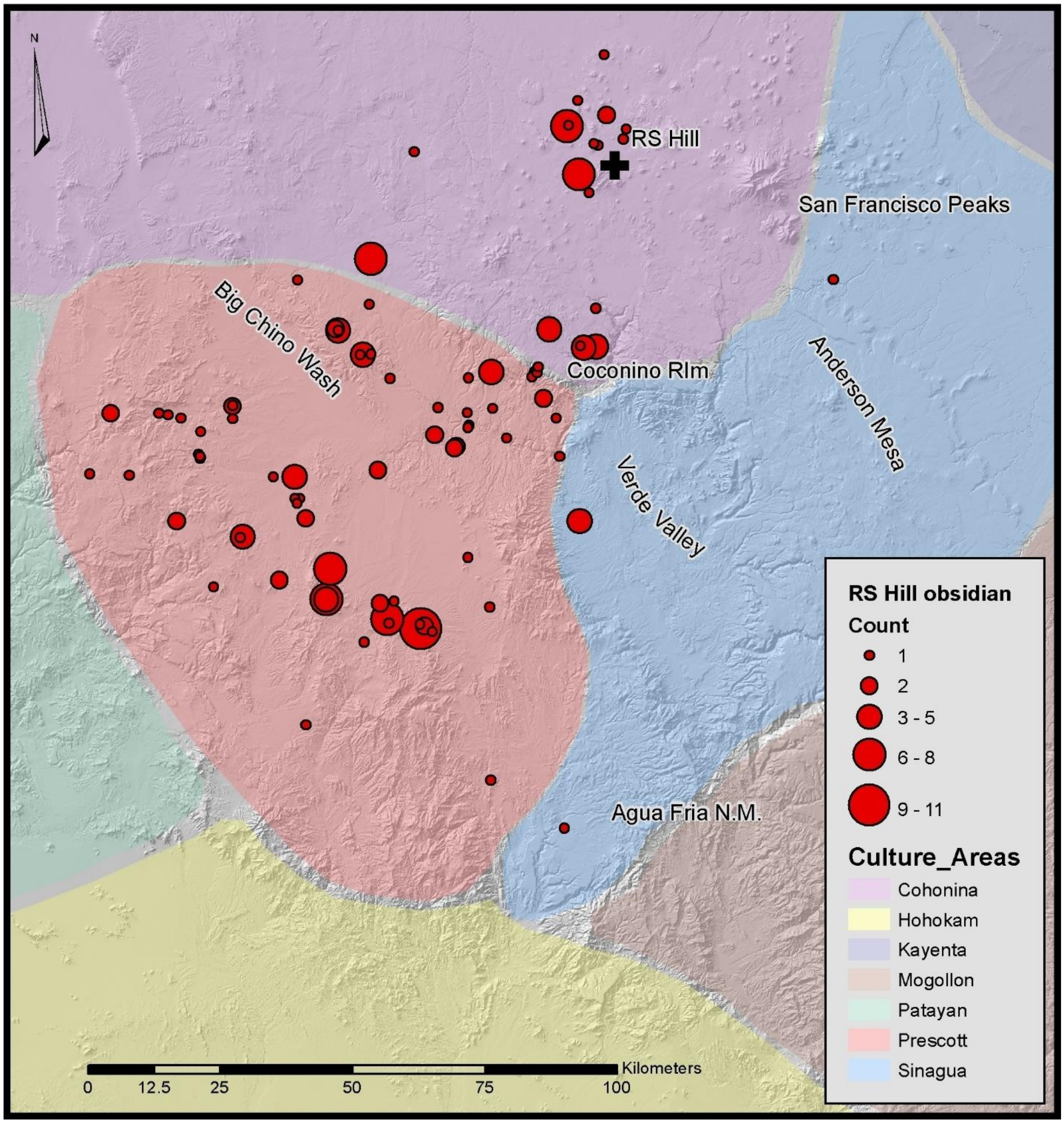

Figure 5.2. Distribution and frequency of RS Hill obsidian artifacts.

The lithic assemblages at 30.1% of the sites (n = 183) throughout my study area included obsidian artifacts from the Partridge Creek source area. The distribution of sites with Partridge Creek obsidian artifacts is oriented west to east, with the greatest density of sites and greater numbers of obsidian artifacts from the Partridge Creek obsidian source in the western third of my study area. Both the spatial distribution of archaeological sites with Partridge Creek obsidian and the frequency of Partridge Creek obsidian artifacts reflect the availability of obsidian from this source in secondary deposits in the alluvium of Partridge Creek downstream to Big Chino Wash (Figure 5.3).

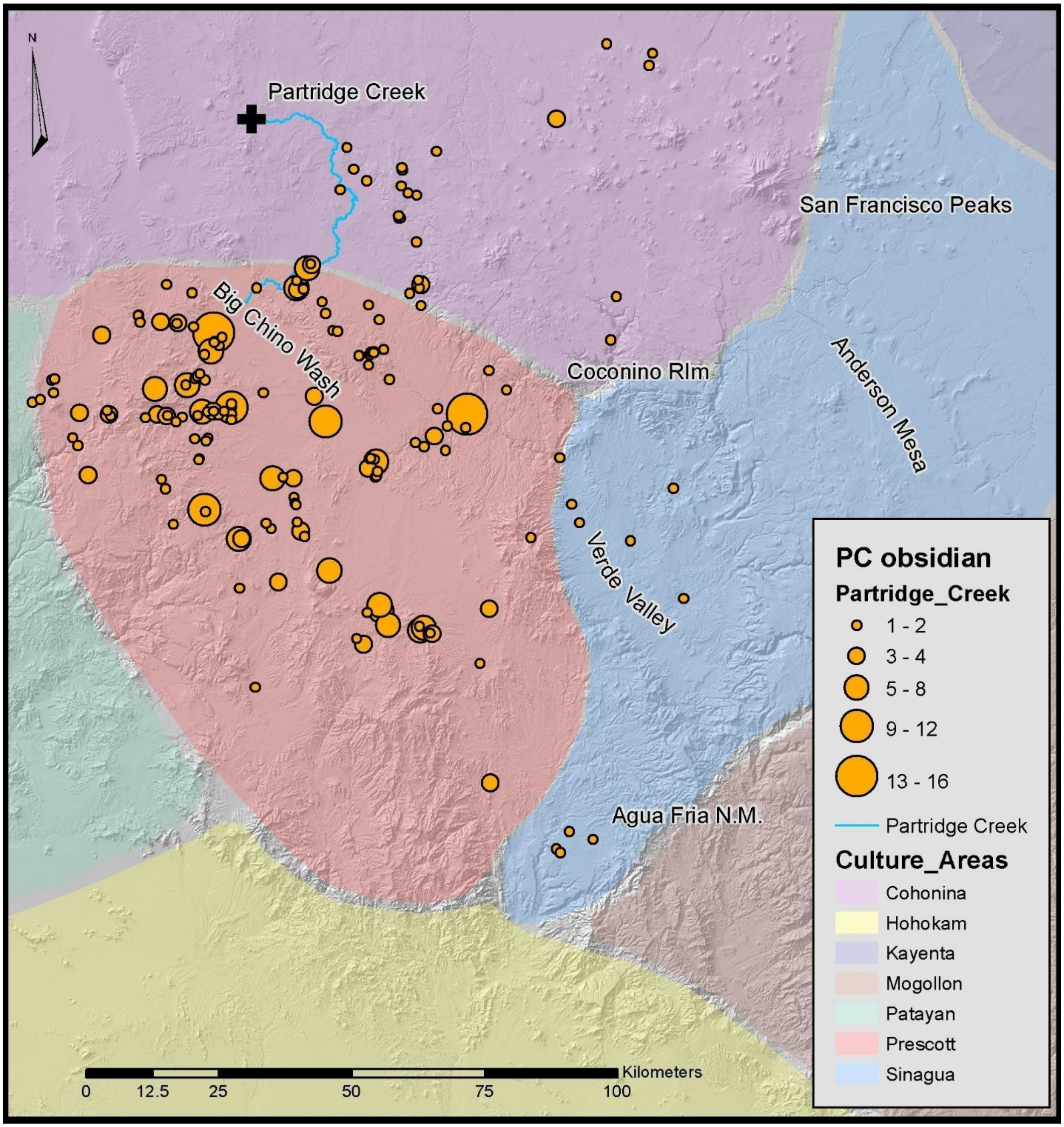

Figure 5.3. Distribution and frequency of Partridge Creek obsidian artifacts.

The lithic assemblages at 17.6% of the sites (n = 107) throughout my study area included obsidian artifacts from the Presley Wash source area. The distribution of sites with Presley Wash obsidian artifacts is similar to that of Partridge Creek obsidian. The highest density of sites with Presley Wash obsidian artifacts is in the central portion of my study area in a swath due south of the primary source. Both the spatial distribution of archaeological sites with Partridge Creek obsidian and the frequency of Partridge Creek obsidian artifacts, however, also reflect the availability of obsidian from this source in secondary deposits in the alluvium of Partridge Creek downstream to Big Chino Wash (Figure 5.4).

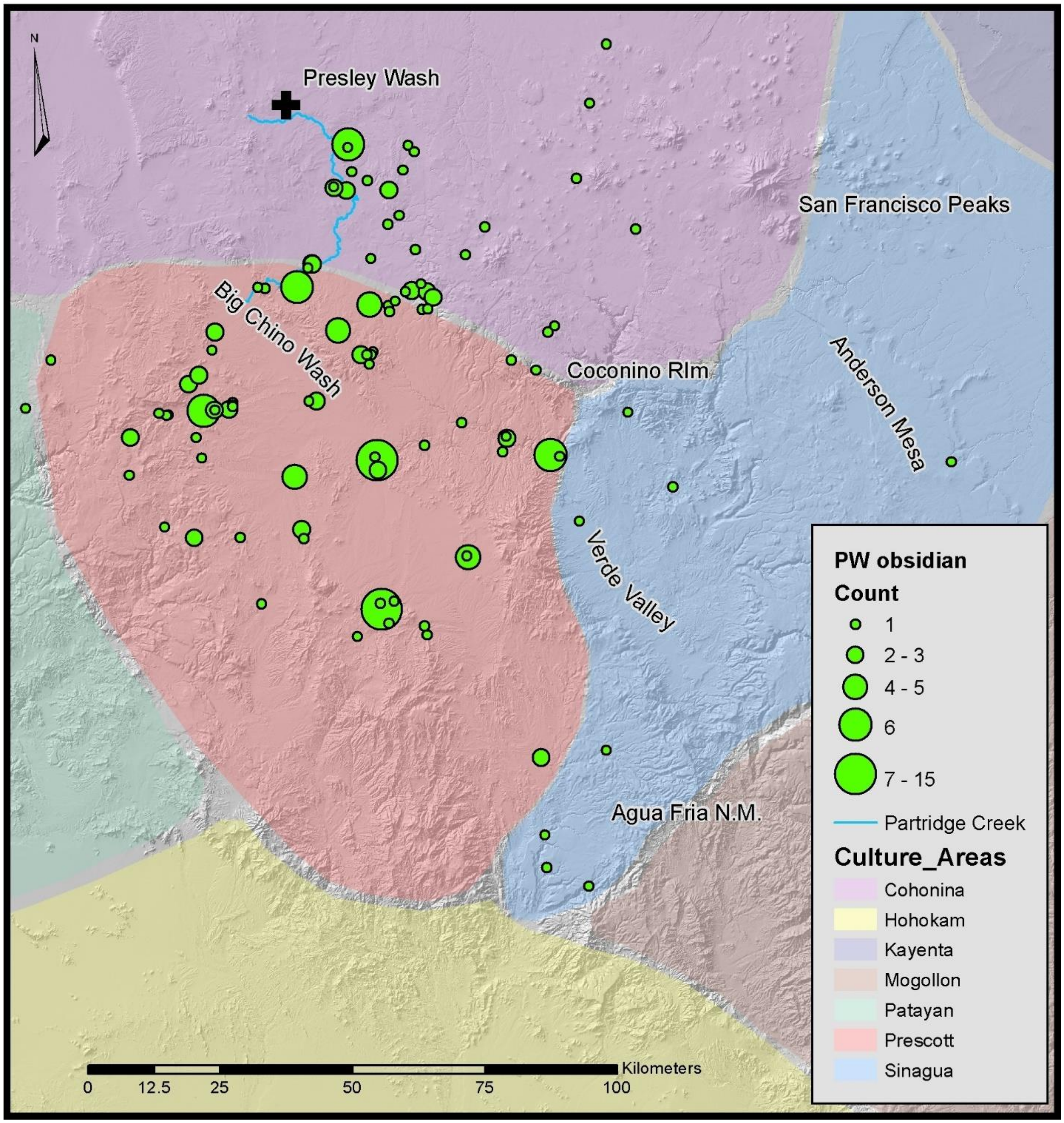

Figure 5.4. Distribution and frequency of Presley Wash obsidian artifacts.

The lithic assemblages at 17.8% of the sites (n = 108) throughout my study area included obsidian artifacts from the Bull Creek source area. The distribution of sites with Bull Creek obsidian artifacts is oriented west to southeast, with the greatest density of sites nearest the primary source area at the western edge of my study area (Figure 5.5).

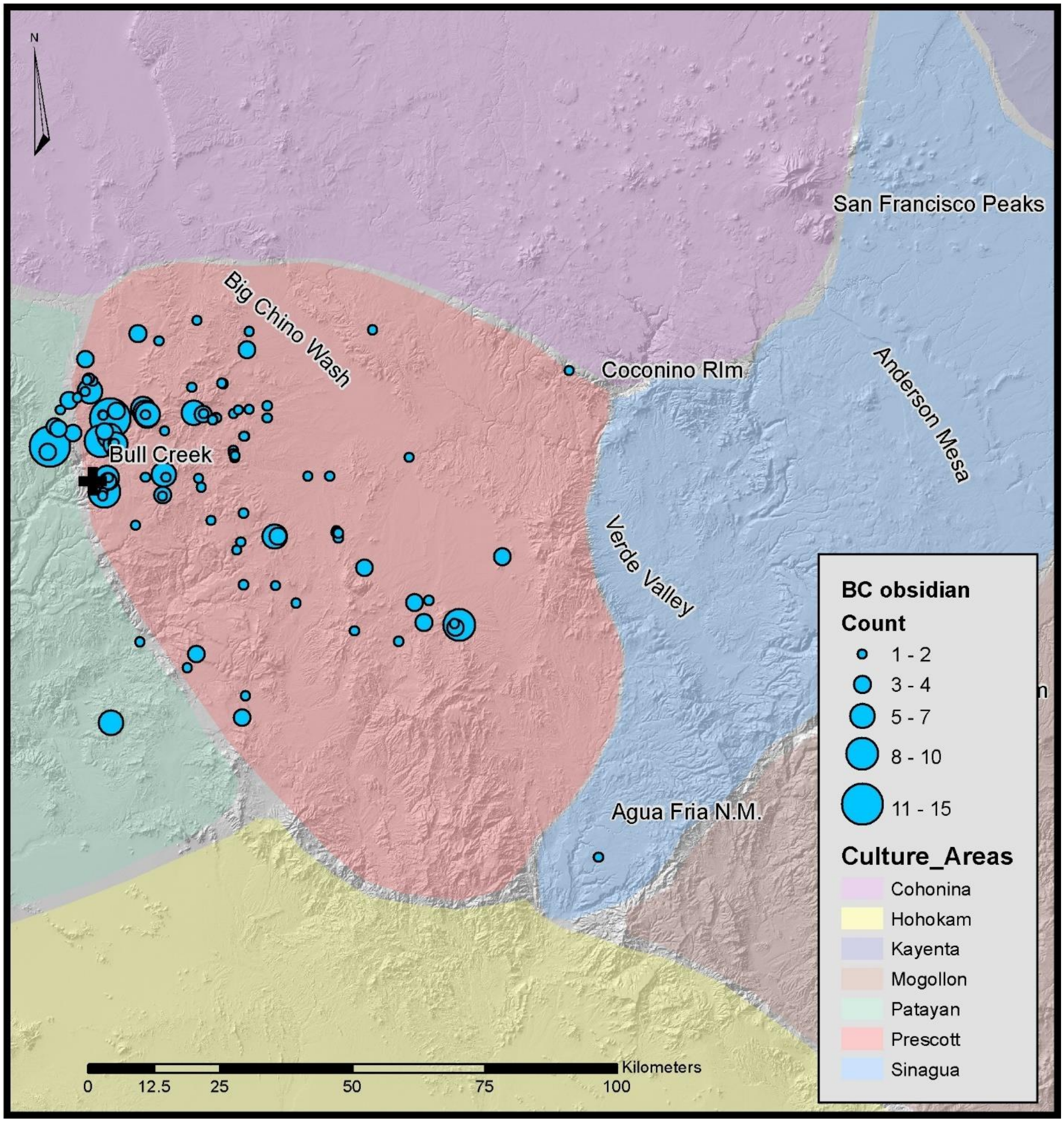

Figure 5.5. Distribution and frequency of Bull Creek obsidian artifacts.

Obsidian from Vulture, Black Tank, Topaz Basin, and Superior was a relatively minor component of the lithic artifact assemblages across my study area. I identified a total of eight sites (1.8%) throughout my entire study area with obsidian artifacts from Topaz Basin. All eight sites with Topaz Basin obsidian artifacts are within approximately 50 km of the primary source in the southeast portion of my study area (Figure 5.6).

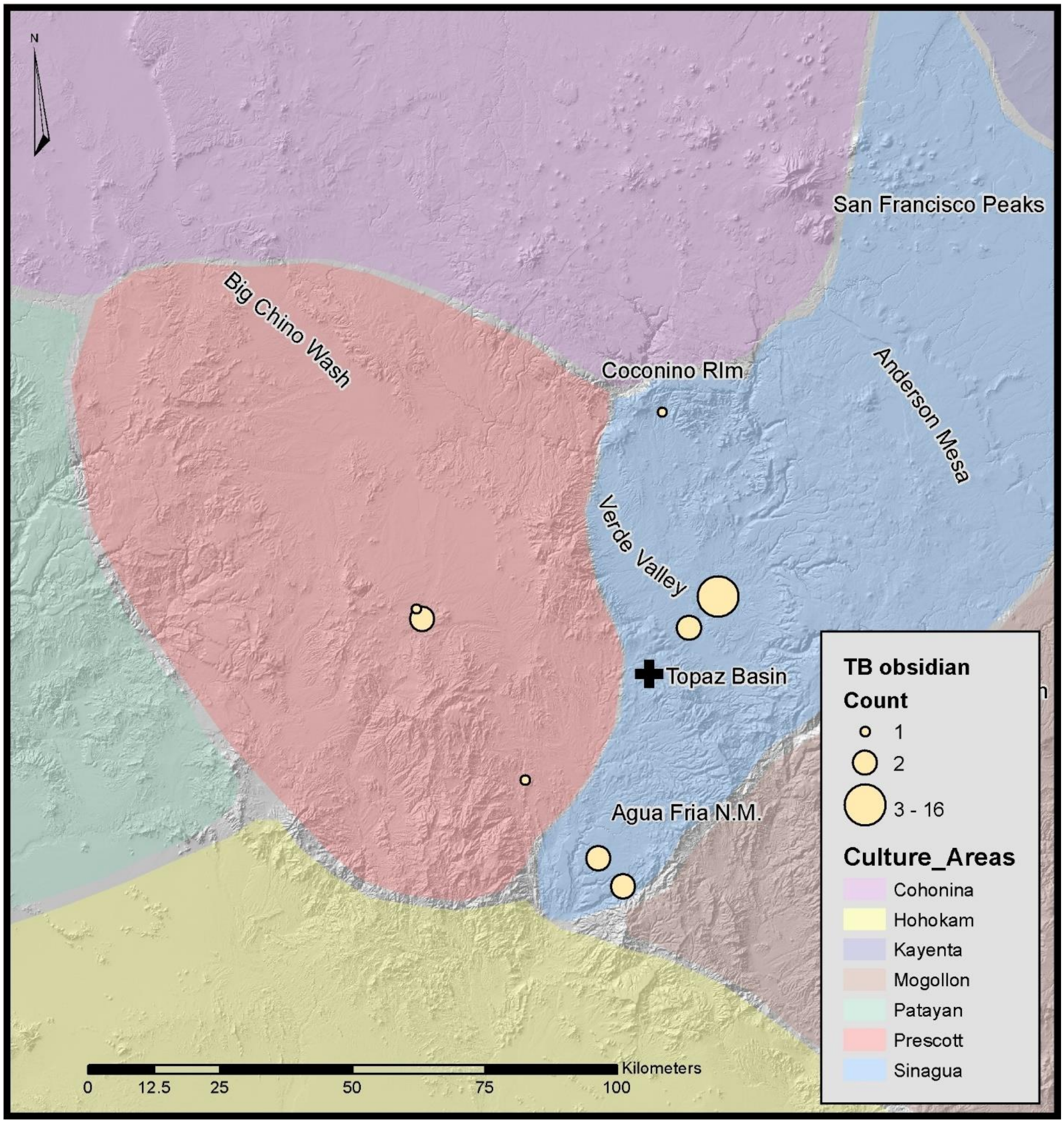

Figure 5.6. Distribution and frequency of Topaz Basin obsidian artifacts.

Over my entire study area, 19 sites (3.1%) had one or more obsidian artifacts from the Black Tank source area. Sites with Black Tank obsidian artifacts are sparsely distributed across the entire northern half of my study area (Figure 5.7).

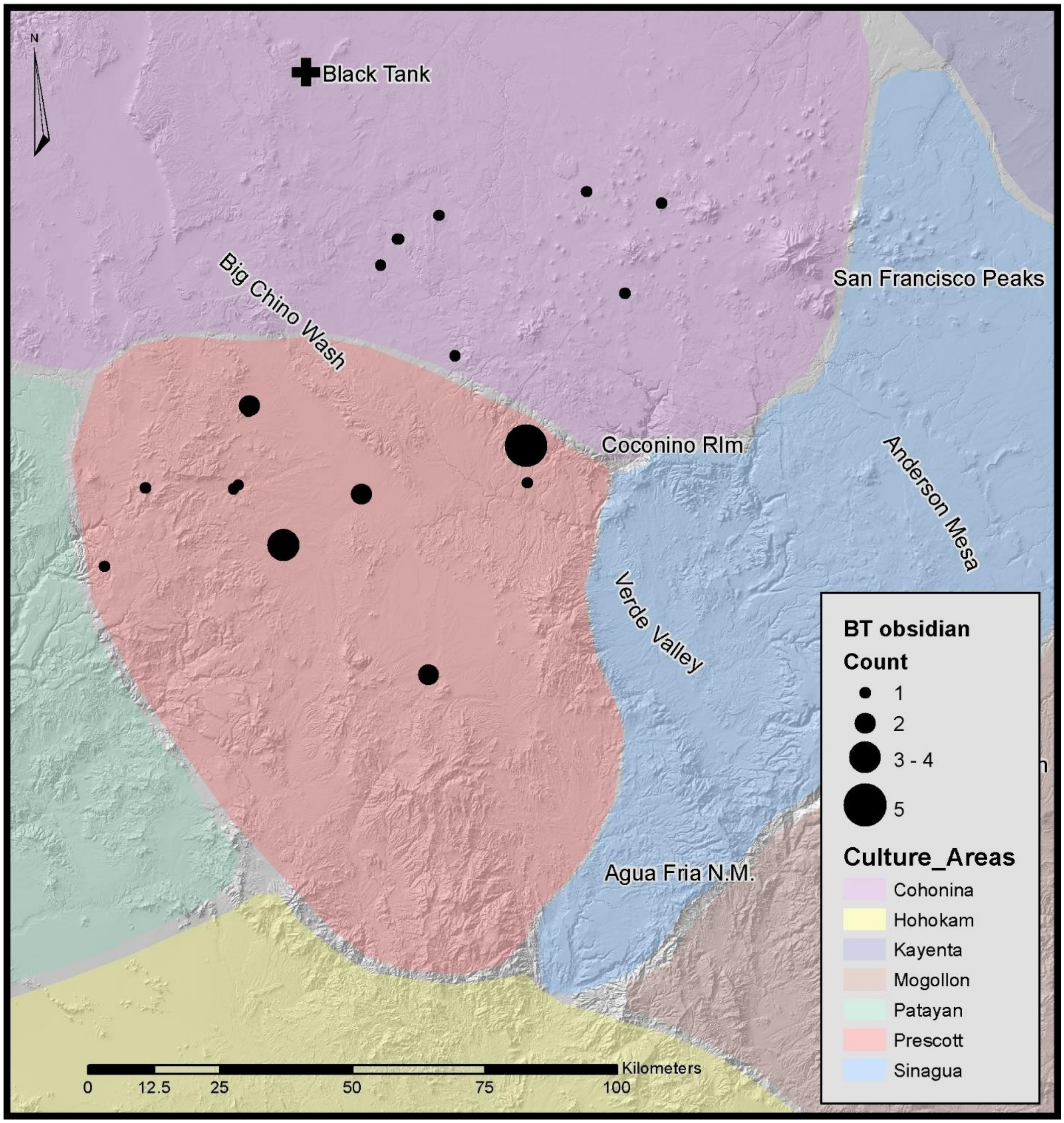

Figure 5.7. Distribution and frequency of Black Tank obsidian artifacts.

A total of 15 sites (2.5%) throughout my entire study area had obsidian artifacts from the Vulture source area. The distribution of sites with Vulture obsidian artifacts is oriented south to north, with the greatest density of sites in the vicinity of Prescott, approximately halfway between the secondary source area (Jackrabbit Wash) at the northern extent of my study area (Figure 5.8).

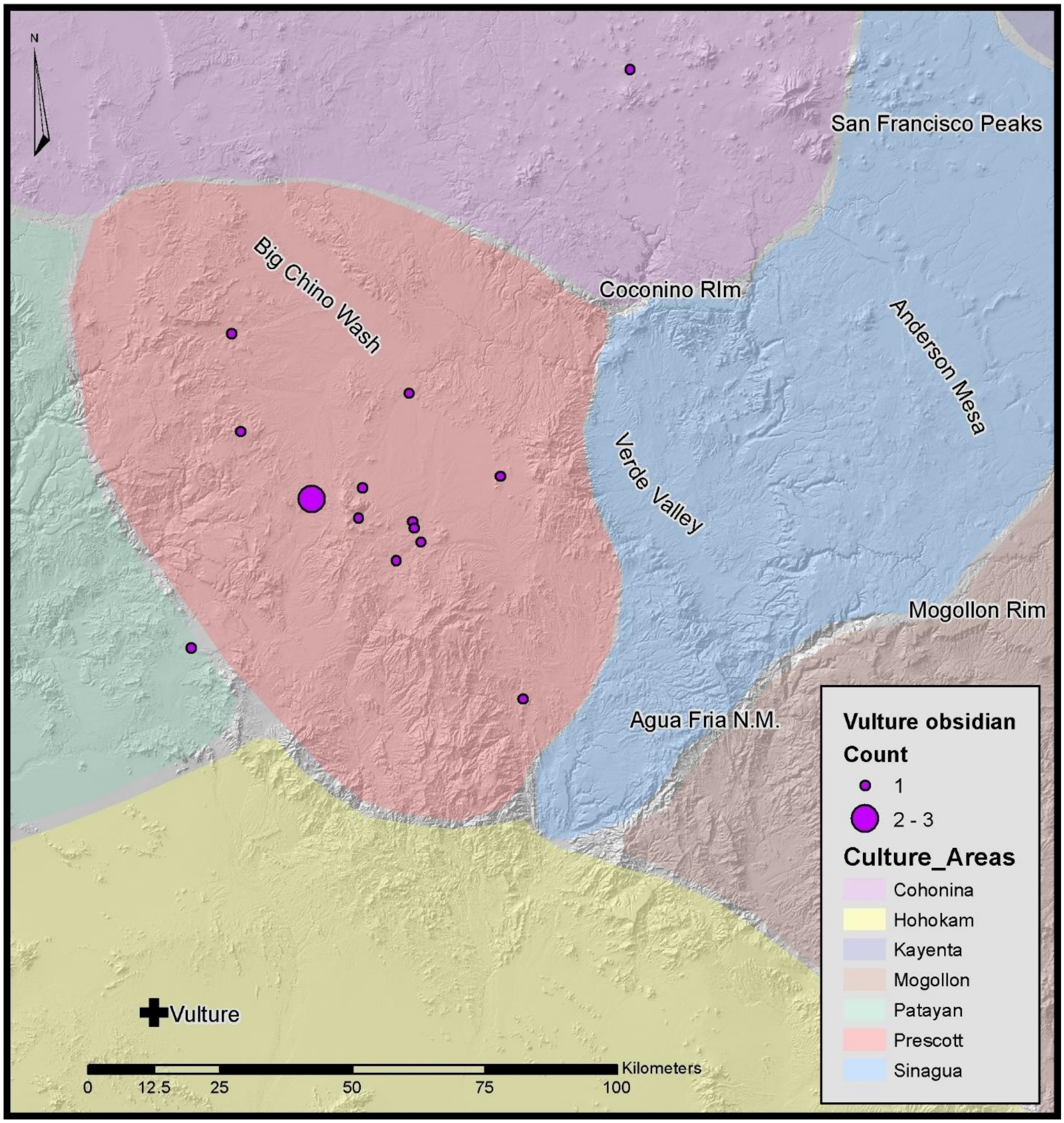

Figure 5.8. Distribution and frequency of Vulture obsidian artifacts.

I identified only two artifacts from the Superior source in the 608 sites I sampled in my research. One Superior obsidian artifact is an intact marekanite associated with the JD Wash Ballcourt site, located on the south edge of the Coconino Rim, approximately 24 km southeast of Bill Williams Mountain. The second Superior obsidian artifact is broken projectile point excavated from the Neural site (NA 20788), located in Prescott, Arizona.

If ballcourts were involved in obsidian exchange, then one would expect ballcourts to be located in geographical and/or topographical transition areas between adjacent people groups and between the obsidian source areas and neighboring people groups. My research data indicate that the Sycamore Point, Wagner Hill, JD Wash, Butler, and Round Mountain ballcourts are located at the southern edge of the Cohonina territory on the northern edge of the steep topographic break formed by the Coconino Rim, which defines the northern extent of the Prescott culture area (Figure 5.9).

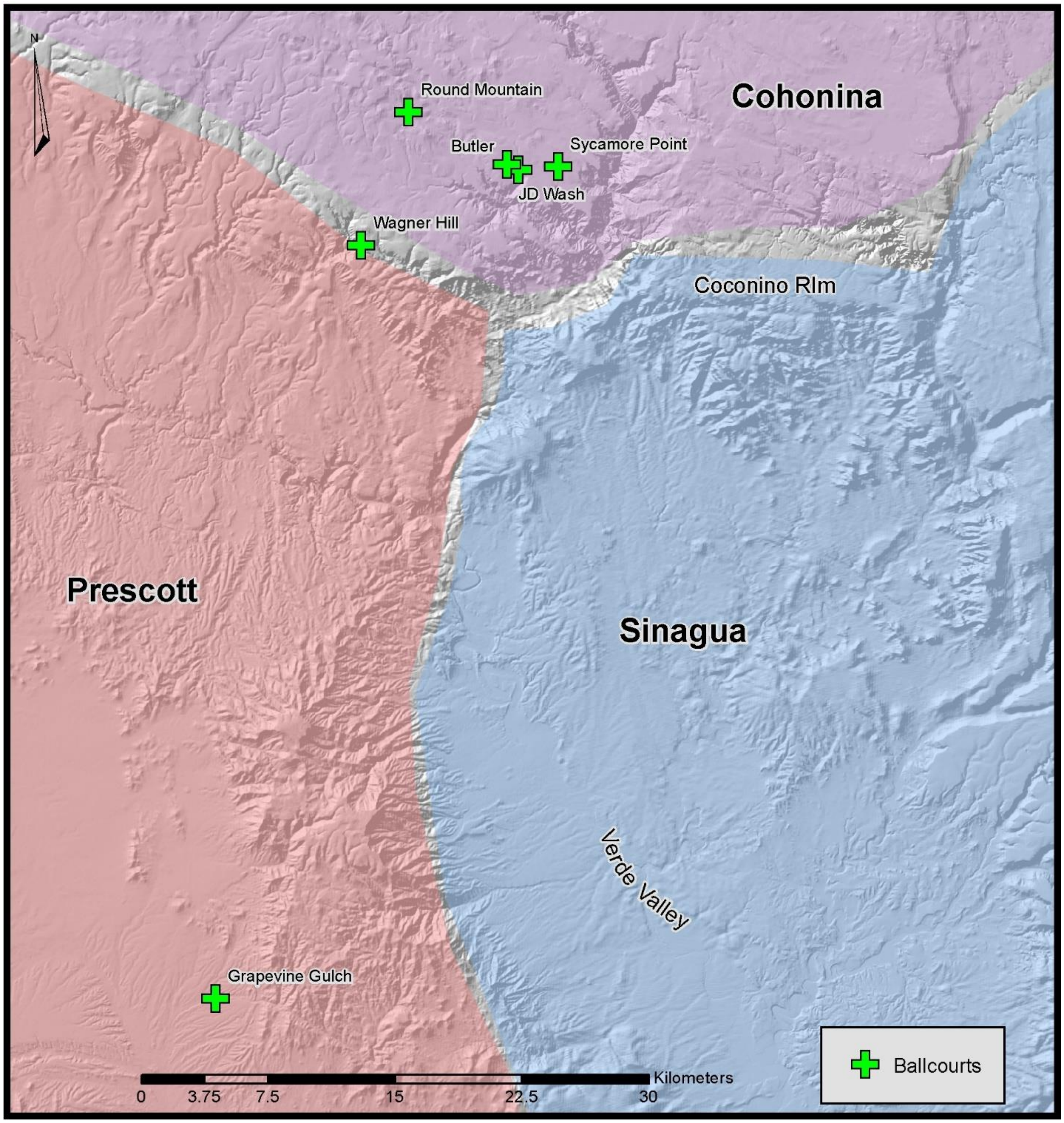

Figure 5.9. Ballcourts in Prescott-Cohonina-Sinagua frontier zone.

I would also expect to find obsidian as a major component of the lithic scatter in the immediate vicinity of ballcourts if ballcourts were involved in obsidian exchange. My research data indicate that obsidian (primarily from the Government Mountain source area) is a major component of the surface lithic scatter surrounding the Sycamore Point, Wagner Hill, JD Wash, Butler, and Round Mountain ballcourts. A large lithic scatter immediately north of JD Wash ballcourt includes obsidian from the Government Mountain, RS Hill, and Superior source areas. The lithic scatter immediately to the east of the Sycamore Point ballcourt includes obsidian from the Government Mountain and RS Hill source areas. The large lithic scatter area immediately to the south of the Wagner Hill ballcourt includes obsidian from the Government Mountain, RS Hill, and Bull Creek source areas. The Round Mountain ballcourt site has a large lithic scatter area immediately to the northwest of the ballcourt feature that includes Government Mountain and RS Hill obsidian. The Butler ballcourt has a moderate lithic scatter including Government Mountain and RS Hill obsidian debitage surrounding the ballcourt and adjacent stone-masonry features. The Grapevine Gulch ballcourt has a concentration of lithic scatter that includes Partridge Creek, Government Mountain and RS Hill obsidian debitage approximately 200 meters north of the ballcourt feature.

Aggregations of obsidian artifacts from multiple obsidian sources may indicate exchange. If prehistoric people in the Prescott culture area obtained obsidian via exchange, then one would expect to find sites with obsidian artifacts from multiple sources in the lithic assemblages at Prescott culture sites. Furthermore, I regard sites with obsidian artifacts that did not originate from the nearest obsidian source provenance as evidence of indirect acquisition via exchange.

My research indicates that 41 sites within my study area each include obsidian artifacts from three different source areas. I identified 20 sites in my study area that have obsidian artifacts from four different source areas. There are 10 sites in my study area that have artifacts from five different obsidian source areas. The artifact assemblage at each of three sites in my study area includes obsidian from six different source areas. Finally, Both the Fitzmaurice Ruin (AZ N:7:17) and the Willow Lake site (AZN:7:308) include obsidian artifacts from seven different source areas. The spatial distribution of sites with artifacts from multiple obsidian sources is illustrated in Figure 5.10.

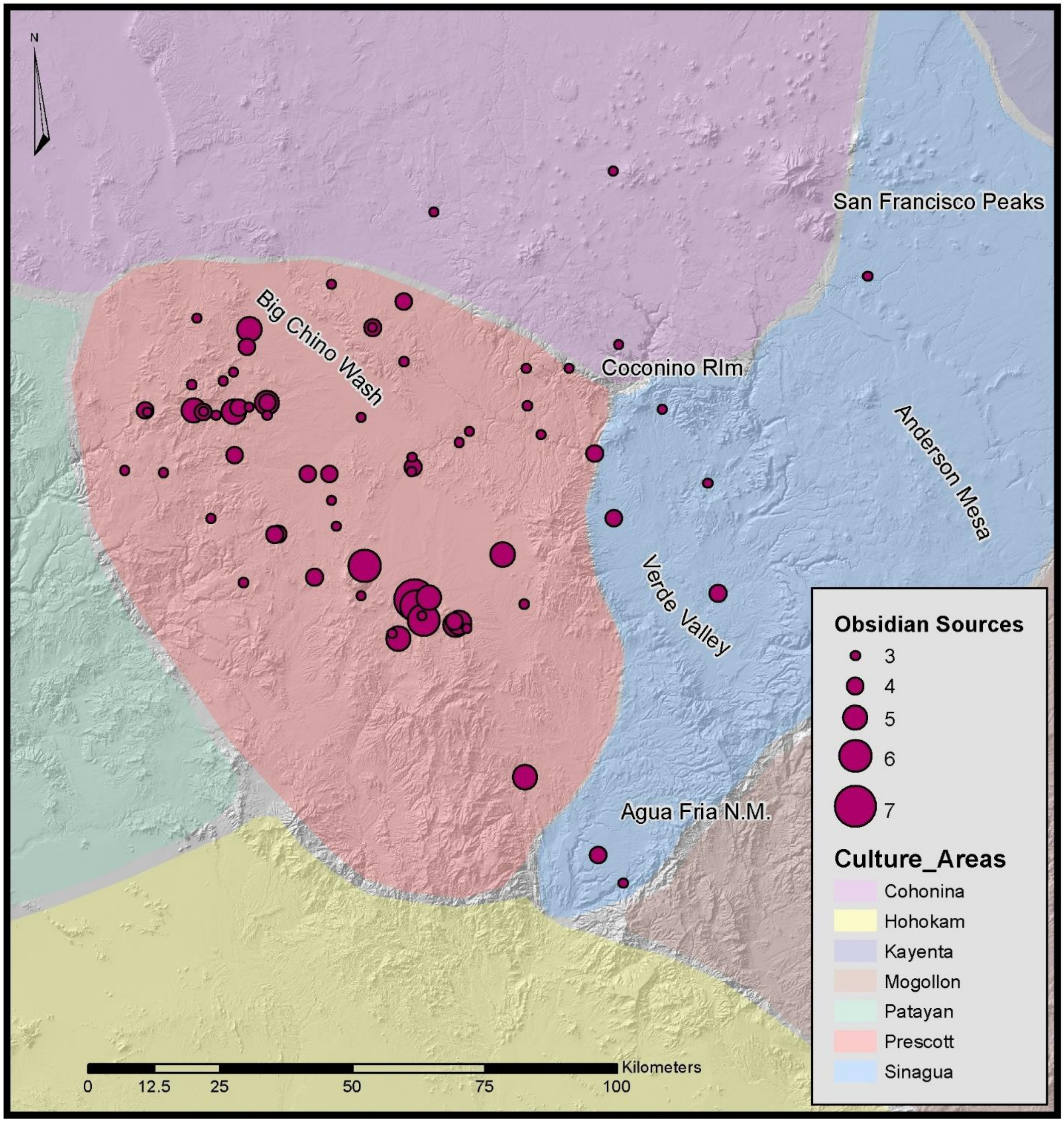

Figure 5.10. Spatial Distribution of sites with artifacts from multiple obsidian sources.

I also evaluated the proportion of archaeological sites in my study area with lithic assemblages that include both Government mountain and RS Hill obsidian, or both Partridge Creek and Presley Wash obsidian. I determined the proportion of archaeological sites with both

Government Mountain and RS Hill obsidian due to the proximity of the two source areas, hence the potential for acquisition of obsidian from both sources to be linked. Similarly, I determined the proportion of archaeological sites with both Partridge Creek and Presley Wash obsidian because both are available in secondary alluvial deposits along Partridge, thus, there is a likelihood that acquisition of obsidian from both sources is linked. The lithic assemblages at 303 (49.8%) of the sites I analyzed in my study area included obsidian artifacts from the Government Mountain source area, RS Hill source area, or both. The lithic assemblages at 249 (40.9%) of the sites that I analyzed in my study area included obsidian artifacts from the Partridge Creek source area, Presley Wash source area, or both.

Proportion of obsidian in lithic artifact assemblages

The following narrative discusses findings specific to the archaeological sites referenced in Table 2.1 of the literature review. Beck (2013:101) reported a total of 12,394 pieces of flaked lithic debitage, including 2,401 pieces of obsidian (19.4%), during the excavation of Coyote Ruin (NA6654). Of the 337 total projectile points and projectile point or biface fragments recovered during the excavation of Coyote Ruin, 263 (78%) were made from obsidian (Christenson 2013:106). The source provenance of obsidian artifacts recovered from Coyote Ruin, however, was not reported in the literature. I analyzed a total of 29 obsidian artifacts from Coyote Ruin (NA6654) in the collections at the Smoki Museum in Prescott, Arizona. My analyses of the 29 obsidian projectile points indicate that 23 have a Government Mountain source provenance, four have a Presley Wash source provenance, one has an RS Hill source provenance, and one has a Vulture source provenance. I also analyzed three obsidian flakes in a surface collection from the “Emilienne” site (also known as Coyote Ruin) by Ken Austin on 3/12/1976 (curated as Object ID 2016.037.523 at the Sharlott Hall Museum in Prescott, Arizona). My analyses indicate that two of the flakes have a Government Mountain source provenance and one of the flakes has a Presley Wash source provenance. The high proportion of projectile points made from obsidian at the Coyote Ruin (78%) compared to the relatively low proportion of obsidian debitage (19.4%), together with the high proportion of projectile points made from Government Mountain obsidian (79%) suggest that Government Mountain obsidian projectile points were not locally manufactured. My obsidian analyses of artifacts from Coyote Ruin (a Prescott culture site) supports Brown's (1991) suggestion that preformed or finished Government Mountain obsidian projectile points were exchange goods manufactured on Anderson Mesa by Northern Sinagua people with ready access to the Government Mountain obsidian source area.

I analyzed a total of 36 obsidian artifacts from the American Ranch site (AZ N:6:35) in collection 2014.002 at the Sharlott Hall Museum in Prescott, Arizona, including 14 projectile points, 20 flakes, and 2 cores. My analyses indicate that 14 artifacts (seven points and seven flakes) have a Government Mountain source provenance, four (three points and one core) have a Bull Creek source provenance, seven (two points and five flakes) have a Partridge Creek source provenance, seven (six flakes and one core) have an RS Hill source provenance, one (flake) has a Vulture source provenance, and one (point) has a Burro Creek source provenance. Although the Sharlott Hall Museum collection represents only a fraction of the obsidian artifacts recovered from the American Ranch site, my XRF analysis identified six of the seven obsidian sources reported by Haynes (2013). Obsidian composed 5.2% of the lithic assemblage and 48% of the projectile points recovered from the American Ranch site (Haynes 2013). The high number of obsidian sources and high proportion of obsidian projectile points compared to the low proportion of obsidian in the overall lithic assemblage supports the hypothesis that obsidian, including finished or preformed projectile points, were trade commodities.

I analyzed a total of 58 obsidian artifacts from the Stoneridge Development sites in collection 2005.112 at the Sharlottt Hall Museum in Prescott, Arizona, including 44 projectile points, 11 flakes, and two shatters. The source provenance of obsidian artifacts recovered from Stoneridge Development sites was not reported in the literature. My analyses indicate that 28 artifacts (21 points, four flakes, one drill, one biface, and one shatter) have a Government Mountain source provenance, 12 (seven points, four flakes, and one shatter) have an RS Hill source provenance, 12 (10 points, one biface, and one flake) have a Partridge Creek source provenance, five points have a Bull Creek source provenance , one point has a Presley Wash source provenance, and one point has an unknown source provenance. Approximately 48% of projectile points analyzed from the Stoneridge Development sites were made from Government Mountain obsidian. The high proportion of projectile points made from Government Mountain obsidian relative to the low proportion of obsidian flakes with the same source provenance indicates that Government Mountain obsidian projectile points were not locally manufactured. My results support the hypothesis that Government Mountain obsidian projectile points were exchange goods manufactured by Northern Sinagua or Cohonina people with ready access to the Government Mountain obsidian source area. Furthermore, my analysis identified six sources of obsidian in the lithic assemblage from the Stoneridge sites, which supports Leonard and Robinson's (2005) suggestion that people living at the Stoneridge sites acquired obsidian through exchange.

I analyzed a total of 19 obsidian artifacts from the Willow Lake site (AZN:7:308) in collection 2008.078 at the Sharlottt Hall Museum in Prescott, Arizona, including nine projectile points and 10 flakes. My analyses indicate that six artifacts (four points and two flakes) have a Government Mountain source provenance, five (two points and three flakes) have a Partridge Creek source provenance, three artifacts (two points and one flake) have a Bull Creek source provenance, two flakes have an RS Hill source provenance, one point has a Presley Wash source provenance, one flake has a Vulture source provenance, and one flake has an unknown source provenance. My analysis identified seven sources of obsidian from the Willow Lake site, two more than the sample reported by Rapp (2006), and the largest number of obsidian sources identified at any site in my study area. The high number of obsidian sources in the lithic assemblage from the Willow Lake site supports the hypothesis that people living at AZN:7:308 acquired obsidian through exchange.

I analyzed a total of 11 obsidian artifacts from the Watson Lake site (AZN:7:311) in collection 2014.001 at the Sharlottt Hall Museum in Prescott, Arizona, including two projectile points, four flakes, one drill, one scraper, one preform, one shatter, and one marekenite. My analyses indicate that eight artifacts (one point, one drill, one scraper, one preform, one shatter, and three flakes) have an RS Hill source provenance, two artifacts (one marekenite and one flake) have a Topaz Basin source provenance, and one point has a Government Mountain source provenance. Although the Sharlottt Hall Museum collection represents only a fraction of the obsidian artifacts recovered from the Watson Lake site, my XRF analysis identified three of the five obsidian sources reported by Baker (2011), which indicated Government Mountain, RS Hill, Partridge Creek, and two unknown sources.

I analyzed a total of 11 obsidian artifacts (projectile points) from the Matli Ranch sites (Hilltop, Crest, Fence Post, Foothill, and Rattlesnake) in collection 2824 at the Smoki Museum in Prescott, Arizona. The source provenance of obsidian artifacts recovered from the Matli

Ranch sites was not reported in the literature. My analyses indicate that four projectile points have a Presley Wash source provenance, three projectile points have an RS Hill source provenance, two projectile points have a Partridge Creek source provenance, and two projectile points have a Bull Creek source provenance. My analysis identified four sources of obsidian (Presley Wash, RS Hill, Partridge Creek, and Bull Creek) in 11 artifacts from the Matli Ranch sites.

I analyzed a total of 14 obsidian artifacts from the Las Vegas Ranch East site (NA14119), 11 artifacts (one point and ten flakes) in collection 2000.005 at the Smoki Museum in Prescott, Arizona, and three flakes during a field visit on 12/29/2018. The source provenance of obsidian artifacts recovered from the Las Vegas Ranch East site was not reported in the literature. My analyses indicate the projectile point and six flakes have a Partridge Creek source provenance, five flakes have a Government Mountain source provenance, one flake has an RS Hill source provenance, and one flake has a Bull Creek source provenance. My analysis identified four sources of obsidian (Partridge Creek, Government Mountain, RS Hill, and Bull Creek) in 14 artifacts from the Las Vegas Ranch East site.

I analyzed a total of 11 obsidian artifacts (one projectile point and ten flakes) at the Las Vegas Ranch West site (NA14547) during a field visit on 5/8/2019. The source provenance of obsidian artifacts recovered from the Las Vegas Ranch West site was not reported in the literature. My analyses indicate the projectile point and five flakes have a Partridge Creek source provenance, two flakes have a Government Mountain source provenance, two flakes have a Bull Creek source provenance, and one flake has an RS Hill source provenance. My analysis identified four sources of obsidian (Partridge Creek, Government Mountain, RS Hill, and Bull Creek) in 11 artifacts from the Las Vegas Ranch West site.

I analyzed two obsidian artifacts (one projectile point and one marekenite) from the Bonnie site (NA 15810) in collection 21412 at the Smoki Museum in Prescott, Arizona. The source provenance of obsidian artifacts recovered from the Bonnie site was not reported in the literature. My analyses indicate that the projectile point has a Government Mountain source provenance and the marekenite has a Bull Creek source provenance. My analysis identified two sources of obsidian (Government Mountain and Bull Creek) in two artifacts from the Bonnie site.

I analyzed a total of 31 obsidian artifacts (projectile points) from the Neural site (NA 20788) in collections at the Smoki Museum in Prescott, Arizona. The source provenance of obsidian artifacts recovered from the Neural site was not reported in the literature. My analyses indicate that twelve projectile points have a Government Mountain source provenance, ten projectile points have a Presley Wash source provenance, six projectile points have a Partridge Creek source provenance, one projectile point has a Superior source provenance, one projectile point has a Vulture source provenance, and one projectile point has an unknown source provenance. My analysis identified six sources of obsidian (Government Mtn, Partridge Creek, Presley Wash, Superior, Vulture, and an unknown source) in 31 artifacts from the Neural site.

I analyzed a total of eight obsidian artifacts (five projectile points, two flakes, and one scraper) from the Sullivan site (NA 25473) in collections at the Smoki Museum in Prescott, Arizona. The source provenance of obsidian artifacts recovered from the Sullivan site was not reported in the literature. My analyses indicate that two projectile points have a Bull Creek source provenance, one projectile point has a Government Mountain source provenance, one projectile point has a Vulture source provenance, one projectile point has an RS Hill source provenance, one scraper has a Partridge Creek source provenance, and two flakes have a

Partridge Creek source provenance. My analysis identified five sources of obsidian (Partridge Creek, Bull Creek, Government Mountain, RS Hill, and Vulture) in eight artifacts from the Sullivan site.

I analyzed a total of 38 obsidian artifacts from the Fitzmaurice Ruin (AZ N:7:17) - 10 artifacts (two points and ten flakes) in collection 2000.1 at the Smoki Museum in Prescott, Arizona, 21 artifacts (eight projectile points, six flakes, and seven marekenites) curated at the Prescott Valley Historical Society in Prescott Valley, Arizona, three flakes during a field visit on 11/23/2018, and four pieces of shatter during a field visit on 1/21/2019. The source provenance of obsidian artifacts recovered from the Fitzmaurice Ruin site was not reported in the literature. My analyses indicate that five projectile points, ten flakes, and two shatters have a Government Mountain source provenance, two points, two flakes, and two shatters have a Partridge Creek source provenance, seven marekenites have a Superior source provenance, one point and three flakes have an RS Hill source provenance, one point has a Bull Creek source provenance, one flake has a Presley Wash source provenance, and one flake has a Black Tank source provenance. My analysis identified seven sources of obsidian (Government Mountain, Partridge Creek, Superior, RS Hill, Bull Creek, Presley Wash, and Black Tank) in 38 artifacts from the Fitzmaurice Ruin.

The Influence of Proximity to Obsidian Source Areas on Lithic Assemblages

To test the hypothesis that prehistoric people within and surrounding the Prescott culture area preferentially acquired obsidian from the nearest source area, I used the ArcGIS Near tool to attribute each of the spatially arrayed sites with obsidian artifacts with the identity of nearest obsidian source area and the distance to the nearest obsidian source area. I subsequently queried the source provenance data to determine the proportion of sites with obsidian from the nearest obsidian source area and the proportion of obsidian artifacts at each site that are from the nearest obsidian source area.

The Vulture obsidian source area was not the closest obsidian source area to any of the 15 archaeological sites in my database that included Vulture obsidian artifacts. Topaz Basin is the nearest obsidian source to six of the 15 archaeological sites with Vulture obsidian artifacts, however, only two of those six sites include Topaz Basin artifacts. Bull Creek is the nearest obsidian source to five of the 15 archaeological sites with Vulture obsidian artifacts, however, only one of those five sites include Bull Creek artifacts. The Partridge Creek secondary source area is the nearest obsidian source to three of the 15 archaeological sites with Vulture obsidian artifacts – all three of these sites include Partridge Creek obsidian. One of the sites with Vulture obsidian artifacts is closest to the RS Hill source area, but the lithic assemblage at that site includes no RS Hill obsidian artifacts.

The Black Tank obsidian source area was not the closest obsidian source area to any of the 19 archaeological sites in my database that included Black Tank obsidian artifacts. The Partridge Creek secondary source area is the nearest obsidian source to 13 of the 19 archaeological sites with Black Tank obsidian artifacts, however, only five of these 13 sites include Partridge Creek or Presley Wash obsidian. Bull Creek is the nearest obsidian source to two of the 19 archaeological sites with Black Tank obsidian artifacts - both sites include Bull Creek obsidian artifacts. Sitgreaves Mountain is the nearest obsidian source to two of the 19 archaeological sites with Black Tank obsidian artifacts – neither site includes Sitgreaves obsidian artifacts. One of the sites with Black Tank obsidian artifacts is closest to the RS Hill source area - the lithic assemblage at that site also includes one RS Hill obsidian artifact. One of the sites with Black Tank obsidian artifacts is closest to the Topaz Basin obsidian source area, but the lithic assemblage at that site includes no Topaz Basin obsidian artifacts.

The Topaz Basin obsidian source area was the closest obsidian source area to seven (87.5%) of the eight archaeological sites in my database that include Topaz Basin obsidian artifacts. Topaz Basin obsidian artifacts comprised 3.2%-28.6% of the obsidian in the lithic assemblages at the seven sites that included Topaz Basin obsidian artifacts and are nearest to the Topaz Basin obsidian source area. Sitgreaves Mountain is the nearest obsidian source to one of the eight archaeological sites with Topaz Basin obsidian artifacts, but the lithic assemblage at that site includes no Sitgreaves obsidian artifacts.

The Partridge Creek secondary source area is the nearest obsidian source to 65 (60.7%) of the 107 archaeological sites with Presley Wash obsidian artifacts - 29 of these 65 sites also include Partridge Creek obsidian. Presley Wash obsidian artifacts comprised 6.7%-100% (60.6% mean) of the obsidian in the lithic assemblages at the 65 sites that included Presley Wash obsidian artifacts and are nearest to the Partridge Creek secondary source area. Bull Creek is the nearest obsidian source to twelve of the 107 archaeological sites with Presley Wash obsidian artifacts – six of these twelve sites include Bull Creek obsidian artifacts. Sitgreaves Mountain is the nearest obsidian source to seven of the 107 archaeological sites with Presley Wash obsidian artifacts, however, none of these seven sites includes Sitgreaves obsidian artifacts. Topaz Basin is the nearest obsidian source to 20 of the 107 archaeological sites with Presley Wash obsidian artifacts, however, only two of those 20 sites include Topaz Basin artifacts. One of the sites with Presley Wash obsidian artifacts is closest to the Government Mountain obsidian source area - the lithic assemblage at that site includes three Government Mountain obsidian artifacts. One of the sites with Presley Wash obsidian artifacts is closest to the RS Hill obsidian source area, however, the lithic assemblage at that site includes no RS Hill obsidian artifacts.

The RS Hill obsidian source area is the nearest obsidian source to six (6.5%) of the 93 archaeological sites with RS Hill obsidian artifacts. RS Hill obsidian artifacts comprised 50%-100% (75% mean) of the obsidian in the lithic assemblages at the six sites that included RS Hill obsidian artifacts and are nearest to the RS Hill obsidian source area. The Partridge Creek secondary source area is the nearest obsidian source to 36 of the 93 archaeological sites with RS Hill obsidian artifacts - 20 of these 36 sites also include Partridge Creek or Presley Wash obsidian. Bull Creek is the nearest obsidian source to 16 of the 93 archaeological sites with RS Hill obsidian artifacts – ten of these 16 sites also include Bull Creek obsidian artifacts. Kendrick Peak is the nearest obsidian source to one of the 93 archaeological sites with RS Hill obsidian artifacts, however, the lithic assemblage at that site does not include Kendrick Peak obsidian artifacts. Sitgreaves Mountain is the nearest obsidian source to 16 of the 93 archaeological sites with RS Hill obsidian artifacts, however, none of these 16 sites includes Sitgreaves obsidian artifacts. Topaz Basin is the nearest obsidian source to 16 of the 93 archaeological sites with RS Hill obsidian artifacts, however, only two of those 16 sites include Topaz Basin artifacts. One of the sites with RS Hill obsidian artifacts is closest to the Slate Mountain obsidian source area, however, the site's lithic assemblage includes no Slate Mountain obsidian artifacts.

The Partridge Creek secondary source area is the nearest obsidian source to 120 (65.6%) of the 183 archaeological sites with Partridge Creek obsidian artifacts - 29 of these 120 sites also include Presley Wash obsidian artifacts. Partridge Creek obsidian artifacts comprised 7.7%-100% (70.3% mean) of the obsidian in the lithic assemblages at the 120 sites that included Partridge Creek obsidian artifacts and are nearest to the Partridge Creek secondary source area.

Bull Creek is the nearest obsidian source to 31 of the 183 archaeological sites with Partridge Creek obsidian artifacts – 17 of these 31 sites also include Bull Creek obsidian artifacts. Sitgreaves Mountain is the nearest obsidian source to three of the 183 archaeological sites with Partridge Creek obsidian artifacts, however, none of these three sites includes Sitgreaves obsidian artifacts. Topaz Basin is the nearest obsidian source to 25 of the 183 archaeological sites with Partridge Creek obsidian artifacts, however, only three of those 25 sites include Topaz Basin artifacts. Three of the sites with Partridge Creek obsidian artifacts are closest to the Slate Mountain obsidian source area, however, none of these three sites include Slate Mountain obsidian artifacts.

The Government Mountain obsidian source area is the nearest obsidian source to four (1.5%) of the 271 archaeological sites in my study area with Government Mountain obsidian artifacts. Government Mountain obsidian artifacts comprised 75%-100% (94% mean) of the obsidian in the lithic assemblages at the four sites that included Government Mountain obsidian artifacts and are nearest to the Government Mountain obsidian source area. The Partridge Creek secondary source area is the nearest obsidian source to 104 of the 271 archaeological sites with Government Mountain obsidian artifacts - 51 of these sites also include Partridge Creek or Presley Wash obsidian. Bull Creek is the nearest obsidian source to 17 of the 271 archaeological sites with Government Mountain obsidian artifacts – eight of these 17 sites also include Bull Creek obsidian artifacts. Kendrick Peak is the nearest obsidian source to 13 of the 271 archaeological sites with Government Mountain obsidian artifacts, however, none of these 13 sites include Kendrick Peak obsidian artifacts. RS Hill is the nearest obsidian source area to seven of the 271 archaeological sites with Government Mountain obsidian, however, only two of those seven sites include RS Hill obsidian artifacts. Sitgreaves Mountain is the nearest obsidian source to 48 of the 271 archaeological sites with Government Mountain obsidian artifacts, however, only one of these 48 sites includes Sitgreaves obsidian artifacts. Topaz Basin is the nearest obsidian source to 66 of the 271 archaeological sites with Government Mountain obsidian artifacts, however, only seven of those 66 sites include Topaz Basin artifacts. Eleven of the sites with Government Mountain obsidian artifacts is closest to the Slate Mountain obsidian source area, however, none of these eleven sites include Slate Mountain obsidian artifacts.

The Bull Creek obsidian source area is the nearest obsidian source to 68 (63.0%) of the 108 archaeological sites with Bull Creek obsidian artifacts. Bull Creek obsidian artifacts comprised 16.7%-100% ($\bar{x}$ = 82.7%) of the obsidian in the lithic assemblages at the six sites that included Bull Creek obsidian artifacts and are nearest to the Bull Creek obsidian source area. The Partridge Creek secondary source area is the nearest obsidian source to 28 of the 108 archaeological sites with Bull Creek obsidian artifacts - 19 of these 28 sites also include Partridge Creek or Presley Wash obsidian. Topaz Basin is the nearest obsidian source to 10 of the 108 archaeological sites with Bull creek obsidian artifacts, however, only one of those 10 sites include Topaz Basin artifacts. Sitgreaves Mountain is the nearest obsidian source to one of the 108 archaeological sites with Bull Creek obsidian artifacts, however, the lithic assemblage at that site includes no Sitgreaves Mountain obsidian artifacts.

Least-Cost Path Analysis – Government Mountain

Using each of the two composite cost surfaces, I produced least-cost paths between the Government Mountain obsidian source area and ten habitation sites on the periphery of the spatial distribution of Government Mountain obsidian artifacts (Figure 5.11). The least-cost paths generated from the composite cost surface with distance to water classified from one to nine are hereafter referred to as LCP-1. The least-cost paths generated from the composite cost surface with distance to water classified from one to thirty are hereafter referred to as LCP-2.

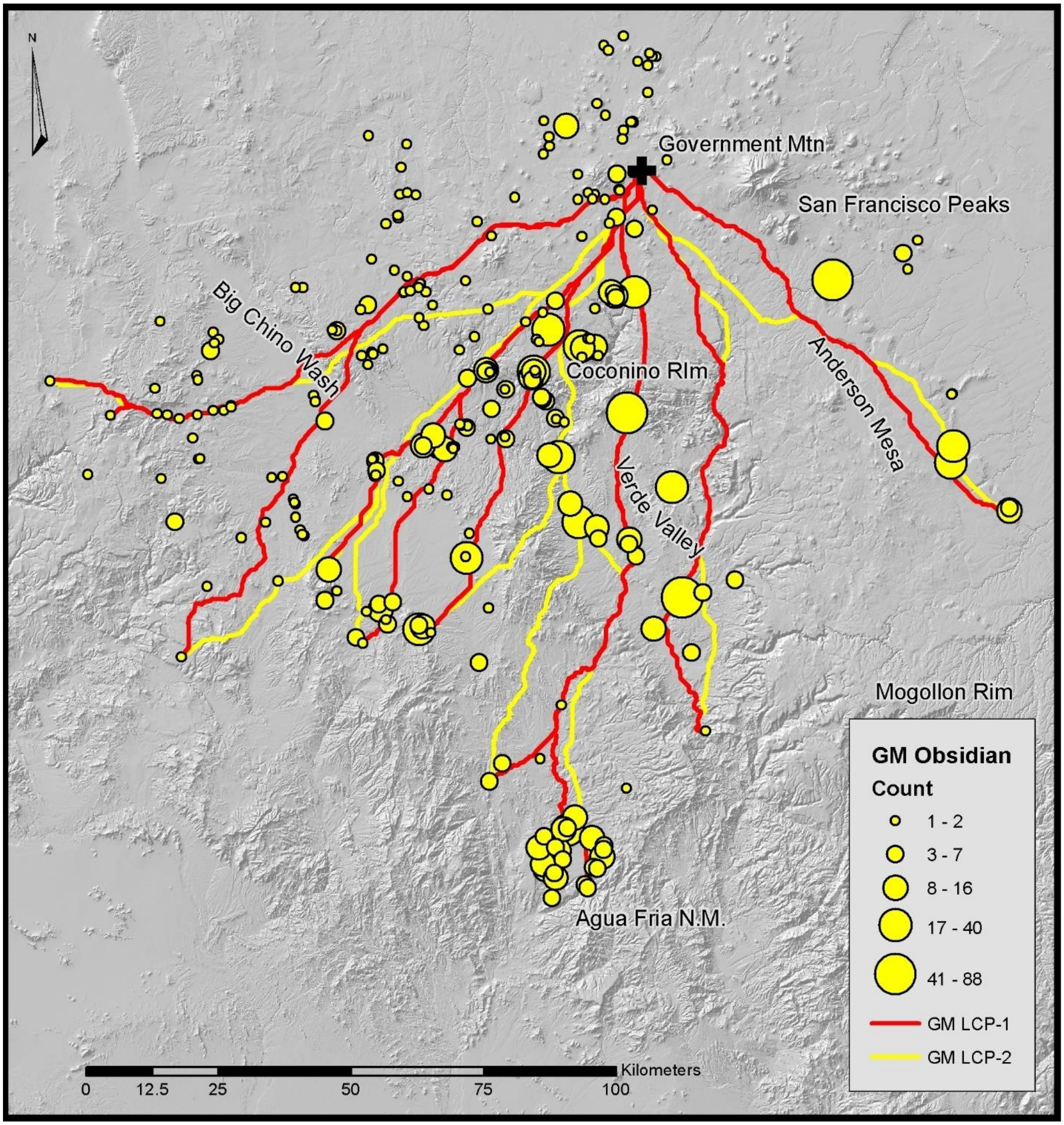

Figure 5.11. Least-cost paths between the Government Mountain obsidian source area and ten habitation sites with Government Mountain obsidian artifacts.

I subsequently evaluated the Government Mountain least-cost paths based on the number of other sites and artifacts intercepted (within 300 meters) by LCP-1 and LCP-2 between each source-site pair. The results of the side by side comparison of site and artifact interceptions for each of the ten Government Mountain LCP-1 and LCP-2 are provided in Table 5.2. The results of Student's *t*-testing indicate that there are no significant differences between mean Government Mountain site interceptions (p = 0.181) or mean Government Mountain obsidian artifact interceptions (p = 0.535) by the two sets of Government Mountain least-cost paths (Table 5.3). The least-cost paths generated from composite cost surface 1, however, intercepted significantly (p = 0.009) more sites overall than the least cost paths generated from composite cost surface 2 (Table 5.3).

Table 5.2. Comparison of Site and Artifact Intercepts for Government Mountain LCP-1 and LCP-2.

Least-Cost Path	Intercepted sites with GM obsidian		Intercepted GM obsidian artifacts		Total sites intercepted	
	LCP-1	LCP-2	LCP-1	LCP-2	LCP-1	LCP-2
GM – Chavez Pass	1	2	7	26	1	2
GM – Gospel Hollow	0	0	0	0	0	0
GM – Agua Fria	2	1	22	24	4	1
GM – Cedar Canyon	3	1	31	24	5	3
GM - Fitzmaurice	4	1	47	24	6	2
GM – Sullivan	8	1	12	3	9	2
GM – AZ N:6:35	5	2	18	6	7	4
GM – Sarah K	1	2	1	6	5	5
GM – Cindy H	7	8	7	8	20	17
GM - Zeta	7	8	7	8	22	17
Mean	3.8	2.6	15.2	12.9	7.9	5.3

Table 5.3. Result of Student's *t*-test Comparing Site Interceptions by Government Mountain LCP-1 and LCP-2.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	LCP1 GM site intercepts LCP2 GM site intercepts	1.2	2.61619	0.82731	-0.67151	3.07151	1.450	9	0.181
Pair 2	LCP1 artifact count LCP2 artifact count	2.3	11.26499	3.56230	-5.75849	10.35849	0.646	9	0.535
Pair 3	LCP1 all site intercepts LCP2 all site intercepts	2.6	2.45855	0.77746	0.84126	4.35874	3.344	9	0.009

I also generated least-cost paths between Government Mountain and the same set of ten habitation sites based on each of the three composite cost surface one components (slope, distance to water, and ecological response units) individually. I then compared Government Mountain LCP-1 with each of the three resulting sets of least-cost paths based on the number of other sites and artifacts intercepted (within 300 meters) by each least-cost path between each source-site pair. The results of the side by side comparison of site and artifact interceptions by LCP-1and the least-cost paths generated based on slope (LCP_{slope}) are provided in Table 5.4. The results of Student's *t*-testing indicate that the ten LCP-1 routes intercept significantly more sites with Government Mountain obsidian (p = 0.009), significantly more Government Mountain obsidian artifacts (p = 0.01), and significantly more sites overall (p = 0.031) than the LCP_{slope} routes between the same ten source-site pairs (Table 5.5).

Table 5.4. Comparison of Site and Artifact Intercepts for Government Mountain LCP-1 and LCP_{slope}.

Least-Cost Path	Intercepted sites with GM obsidian		Intercepted GM obsidian artifacts		Total sites intercepted	
	LCP-1	LCP_{slope}	LCP-1	LCP_{slope}	LCP-1	LCP_{slope}
GM – Chavez Pass	2	1	26	7	2	1
GM – Gospel Hollow	0	0	0	0	0	1
GM – Agua Fria	2	0	22	0	4	1
GM – Cedar Canyon	3	1	31	3	5	1
GM - Fitzmaurice	4	3	47	12	6	3
GM – Sullivan	7	5	12	9	9	5
GM – AZ N:6:35	5	5	18	6	7	8
GM – Sarah K	2	2	6	2	5	2
GM – Cindy H	7	6	7	6	20	11
GM - Zeta	7	3	7	3	22	6
Mean	3.9	2.6	17.6	4.8	8.0	3.9

Table 5.5. Result of Student's *t*-test comparing site and artifact interceptions by LCP-1 and LCP_{slope}.

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	LCP-1 GM site intercepts LCP_{slope} GM site intercepts	1.3	1.25167	0.39581	0.40461	2.19539	3.284	9	0.009
Pair 2	LCP-1 GM artifact count LCP_{slope} GM artifact count	12.8	12.47932	3.94631	3.87283	21.72717	3.244	9	0.010
Pair 3	LCP-1 all site intercepts LCP_{slope} all site intercepts	4.1	5.06513	1.60174	0.47662	7.72338	2.560	9	0.031

The results of the side by side comparison of site and artifact interceptions by LCP-1and the least-cost paths generated based on distance to water (LCP_{H2O}) are provided in Table 5.6. The results of Student's *t*-testing indicate that the ten LCP-1 routes intercept significantly more sites with Government Mountain obsidian ($p = 0.007$), significantly more Government Mountain obsidian artifacts ($p = 0.012$), and significantly more sites overall ($p = 0.012$) than the LCP_{H2O} routes between the same ten source-site pairs (Table 5.7).

Table 5.6. Comparison of Site and Artifact Intercepts for Government Mountain LCP-1 and LCP_{H2O}.

Least-Cost Path	Intercepted sites with GM obsidian		Intercepted GM obsidian artifacts		Total sites intercepted	
	LCP-1	LCP_{H2O}	LCP-1	LCP_{H2O}	LCP-1	LCP_{H2O}
GM – Chavez Pass	2	1	26	7	2	1
GM – Gospel Hollow	0	0	0	0	0	0
GM – Agua Fria	2	2	22	16	4	2
GM – Cedar Canyon	3	2	31	6	5	2
GM - Fitzmaurice	4	3	47	8	6	3
GM – Sullivan	7	2	12	5	9	2
GM – AZ N:6:35	5	1	18	3	7	2
GM – Sarah K	2	1	6	1	5	4
GM – Cindy H	7	4	7	5	20	10
GM - Zeta	7	3	7	3	22	7
Mean	3.9	1.9	17.6	5.4	8.0	3.3

Table 5.7. Result of Student's *t*-test Comparing Site and Artifact Interceptions by LCP-1 and LCP_{H2O}.

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	LCP-1 GM site intercepts LCP_{H2O} GM site intercepts	2.0	1.82574	0.57735	0.69394	3.30606	3.464	9	0.007
Pair 2	LCP-1 GM artifact count LCP_{H2O} GM artifact count	12.2	12.35404	3.90669	3.36245	21.03755	3.123	9	0.012
Pair 3	LCP-1 all site intercepts LCP_{H2O} all site intercepts	4.7	4.73873	1.49852	1.31012	8.08988	3.136	9	0.012

The results of the side by side comparison of site and artifact interceptions by the Government Mountain LCP-1 routes and the least-cost paths generated based on ecological response units (LCP_{ERU}) are provided in Table 5.8. The results of Student's *t*-testing indicate that there are no significant differences between the number of sites with Government Mountain obsidian ($p = 0.446$), Government Mountain obsidian artifacts ($p = 0.629$), or the total number of sites ($p = 0.857$) intercepted by the LCP-1 routes and LCP_{ERU} routes between the same ten source-site pairs (Table 5.9).

Table 5.8. Comparison of Site and Artifact Intercepts for Government Mountain LCP-1 and LCP_{ERU}.

Least-Cost Path	Intercepted sites with GM obsidian		Intercepted GM obsidian artifacts		Total sites intercepted	
	LCP-1	LCP_{H2O}	LCP-1	LCP_{H2O}	LCP-1	LCP_{H2O}
GM – Chavez Pass	2	1	26	7	2	1
GM – Gospel Hollow	0	3	0	19	0	3
GM – Agua Fria	2	7	22	52	4	8
GM – Cedar Canyon	3	2	31	14	5	2
GM - Fitzmaurice	4	2	47	14	6	2
GM – Sullivan	7	3	12	15	9	3
GM – AZ N:6:35	5	9	18	39	7	14
GM – Sarah K	2	9	6	39	5	14
GM – Cindy H	7	6	7	6	20	18
GM - Zeta	7	6	7	6	22	18
Mean	3.9	4.8	17.6	21.1	8.0	8.3

Table 5.9. Result of Student's *t*-test Comparing Site and Artifact Interceptions by LCP-1 and LCP_{ERU}.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	LCP-1 GM site intercepts LCP_{ERU} GM site intercepts	-0.90	3.57305	1.12990	-3.45600	1.65600	-0.797	9	0.446
Pair 2	LCP-1 GM artifact count LCP_{ERU} GM artifact count	-3.50	22.15727	7.00674	-19.35035	12.35035	-0.500	9	0.629
Pair 3	LCP-1 all site intercepts LCP_{ERU} all site intercepts	-0.30	5.12185	1.61967	-3.96395	3.36395	-0.185	9	0.857

LCP-1 between Government Mountain and Chavez Pass intercepts one site and 7 Government Mountain obsidian artifacts. LCP-2 between Government Mountain and Chavez pass intercepts one additional site (Grapevine Pueblo) and 19 more Government Mountain obsidian artifacts than LCP-1. The difference between LCP-1 and LCP-2 between Government Mountain and Chavez Pass is based on the sensitivity of the two cost surface models regarding distance to water. The second composite cost surface (Model 2) is more sensitive regarding distance to water than the first composite cost surface (Model 1), because distance to water is classified from 1-30 in Model 2 versus 1-9 in Model 1. The surface water on Anderson Mesa is supplied by springs along the east edge of the mesa. The Grapevine and Kinnikinick sites are situated on the east edge of Anderson Mesa adjacent to springs. Given the relative sensitivity of Model 2 regarding distance to water, LCP-2 more is more closely aligned with the east edge of Anderson Mesa than LCP-1 and passes within 300 meters of the Grapevine site. The results for LCP-2 between Government Mountain and Chavez pass comport better than LCP-1 with Brown's (1991) conclusion that the Kinnikinick and Grapevine sites were major lithic manufacturing centers that supplied Government Mountain obsidian trade goods through Chavez Pass.

Both LCP-1 and LCP-2 between Government Mountain and the Gospel Hollow site descend the Coconino Rim via Oak Creek Canyon, roughly corresponding to the Arizona State Route 89 corridor, then veer south from Oak Creek to intercept and parallel Dry Beaver Creek. LCP-1 and LCP-2 diverge upstream of the confluence of Wet Beaver Creek. LCP-1 follows the course of Beaver Creek to the confluence with the Verde River, then parallels the Verde River to the Gospel Hollow site. LCP-2 follows a more direct overland route from Dry Beaver Creek, crossing Wet Beaver Creek, Wickiup Creek, West Clear Creek, and Cottonwood Creek before reaching the Gospel Hollow site. Neither LCP-1 nor LCP-2 intercept other archaeological sites in my database that are between Government Mountain and the Gospel Hollow site. The lack of site interceptions by both LCP-1 and LCP-2 between Government Mountain and the Gospel Hollow site suggests that the two Government Mountain obsidian artifacts in the lithic assemblage at the Gospel Hollow site arrived indirectly via down-the-line exchange through another site. My results indicate that neither LCP-1 nor LCP-2 between Government Mountain and Gospel Hollow are viable obsidian acquisition routes and that the Gospel Hollow site was not a primary site in obsidian exchange.

LCP-1 between Government Mountain and the Agua Fria National Monument crosses Volunteer Wash and descends the Coconino Rim between Sycamore Creek Canyon and Oak Creek Canyon, approximately 800 meters east of Honanki, then parallels Spring Creek south to Oak Creek, passing within 300 meters of the Cornville pueblo before reaching the Verde River. From the confluence of Oak Creek and the Verde River, LCP-1 between Government Mountain and the Agua Fria National Monument parallels the Verde River south to Cherry Creek and crosses the pass to follow Cienega Creek to the Agua Fria River and the Agua Fria National Monument, intersecting four sites, including two sites where I documented a total of 22 Government Mountain artifacts. LCP-2 between Government Mountain and the Agua Fria National Monument crosses Tule Tank Wash on the west side of Sycamore Canyon and descends the Coconino Rim across Cedar Creek and joins Sycamore Creek approximately 1.25 km east of Seldom Seen cliff dwelling. LCP-2 between Government Mountain and the Agua Fria National Monument then follows Sycamore Creek south to the confluence of the Verde River, intersecting the Packard Pueblo, and follows the Verde River south past the Peck's Lake and Rocking Chair pueblos before following the same route as LCP-1 along Cherry Creek and over the pass to Cienega Creek. At Cienega Creek, LCP-2 diverges to the east of LCP 1 overland across Dry Creek, Little Ash Creek, Sycamore Creek, Indian Creek, and Silver Creek before reaching the Agua Fria National Monument. LCP-2 between Government Mountain and the Agua Fria National Monument intersects one site where I documented a total of 24 Government Mountain artifacts.

LCP-1 between Government Mountain and the Cedar Canyon site follows the same route as LCP-1 between Government Mountain and the Agua Fria National Monument to Ash Creek, where LCP-1 between Government Mountain and the Cedar Canyon site diverges overland to the southwest, crossing the Agua Fria River, Big Bug Creek, and Antelope Creek before reaching the Cedar Canyon site. LCP-1 between Government Mountain and the Cedar Canyon site intersects a total of five other archaeological sites, including three where I documented a total of 31 Government Mountain obsidian artifacts. LCP-2 between Government Mountain and the Cedar Canyon site follows the same route as LCP-2 between Government Mountain and the Agua Fria National Monument to the Peck's Lake pueblo on the Agua Fria River, then diverges to the south overland across Blowout Creek and Oak Wash. South of Oak Wash, LCP-2 between Government Mountain and the Cedar Canyon site veers west along Black Canyon and south to Ash Creek over the southern tip of Mingus Mountain. From Ash Creek, LCP-2 between Government Mountain and the Cedar Canyon site continues to the southwest overland across Osborn Spring Wash, Yarber Wash, Brushy Wash, the Agua Fria River, Big Bug Creek, Hackberry Creek, and Antelope Creek before reaching the Cedar Canyon site. LCP-2 between Government Mountain and the Cedar Canyon site intersects a total of three other sites, including one with a total of 24 Government Mountain obsidian artifacts.

LCP-1 between Government Mountain and the Fitzmaurice Ruin passes through the Wagner Hill ballcourt site before descending the Coconino Rimvia the headwaters of Railroad Draw and continues south across Rafael draw to cross the Verde River 600 meters west of Perkinsville. From the Verde River, LCP-1 between Government Mountain and the Fitzmaurice Ruin follows the ridge between Munds Draw and Orchard Draw south to grasslands of Lonesome Valley, passing approximately one km to the east of Coyote Ruin before veering southwest across Coyote Wash and the Agua Fria River and following Lynx Creek to the Fitzmaurice Ruin. LCP-1 between Government Mountain and the Fitzmaurice Ruin intersects a total of six other sites, including four with a total of 47 Government Mountain obsidian artifacts. LCP-2 between Government Mountain and the Fitzmaurice Ruin follows the same route as LCP-2 between Government Mountain and the Cedar Canyon site and LCP-2 between Government Mountain and the Agua Fria National Monument to the confluence of Sycamore Creek and the Verde River. From the Verde River, LCP-2 between Government Mountain and the Fitzmaurice Ruin veers southwest and crosses Mingus Mountain along the Arizona State Route 89A corridor through Yeager Canyon. On the west side of Mingus Mountain, LCP-2 between Government

Mountain and the Fitzmaurice Ruin continues southwest across Coyote Wash and the Agua Fria River, then veers west along Lynx Creek to Fitzmaurice Ruin. LCP-2 between Government Mountain and the Fitzmaurice Ruin intersects a total of two other sites, including one with a total of 24 Government Mountain obsidian artifacts.

LCP-1 between Government Mountain and the Sullivan site follows the same route as LCP-1 between Government Mountain and the Fitzmaurice Ruin to a point west of KA Hill, then diverts to the southwest paralleling Bear Canyon across may Tank Pocket to MC Canyon. From MC Canyon, LCP-1 between Government Mountain and the Sullivan site heads due south and joins the Verde River via Grindstone Wash at Hell Point, and follows the Verde River upstream to the Duff Spring cliff dwelling. From the Verde River, LCP-1 between Government Mountain and the Sullivan site veers southwest overland, paralleling the west side of Gold Basin Canyon to King Canyon, then south through the Chino Valley grasslands along Granite Creek to the Sullivan site. LCP-1 between Government Mountain and the Sullivan site intercepts a total of nine other archaeological sites in my database, including eight sites with a total of twelve Government Mountain obsidian artifacts. LCP-2 between Government Mountain and the Sullivan site diverts to the west of LCP-1 between Government Mountain and the Sullivan site near KA Hill and stays one to seven km to the west until reaching the Sullivan site. LCP-2 between Government Mountain and the Sullivan site intercepts a total of two other archaeological sites in my database, including one site with a total of three Government Mountain obsidian artifacts.

LCP-1 between Government Mountain and AZ N:6:35 follows the same route as LCP-1 between Government Mountain and the Sullivan site to MC Canyon, then diverts to the southwest overland across Grindstone Wash and Hell Canyon to the Verde River ford south of

Page Flat. From the Page Flat ford, LCP-1 between Government Mountain and AZ N:6:35 follows the Verde River to the Granite Creek confluence, then diverts overland southwest to A N:6:35. LCP-1 between Government Mountain and AZ N:6:35 intercepts a total of seven other archaeological sites in my database, including five sites with a total of 18 Government Mountain obsidian artifacts. LCP-2 between Government Mountain and AZ N:6:35 parallels LCP-1 between Government Mountain and AZ N:6:35 one to four km to the west to Del Rio Springs, then parallels to the east of LCP-1 between Government Mountain and AZ N:6:35 to AZ N:6:35. LCP-2 between Government Mountain and AZ N:6:35 intercepts a total of four other archaeological sites in my database, including two sites with a total of six Government Mountain obsidian artifacts.

LCP-1 between Government Mountain and the Sarah K (Austin) site parallels the I-17 corridor west from Government Mountain past Williams, then diverts southwest along West Cataract Creek and overland to Meath Wash. From Meath Wash, LCP-1 between Government Mountain and the Sarah K site continues southwest across Big Black Mesa and Big Chino Wash and follows Williamson Valley Wash and Strickland Wash to Weed Canyon. From Weed Canyon, LCP-1 between Government Mountain and the Sarah K site veers south over Tank Creek Mesa to the Sarah K site. LCP-1 between Government Mountain and the Sarah K site intercepts a total of five other archaeological sites in my database, including one site with one Government Mountain obsidian artifact. LCP-2 between Government Mountain and the Sarah K site follows the same route as LCP-2 between Government Mountain and AZ N:6:35 to Del Rio Springs, then veers south across Chino Valley and Mint Wash to Granite Mountain.   From Mint Wash, LCP-2 between Government Mountain and the Sarah K site cuts across the north flank of Granite mountain and follows Tonto Wash and Skull Valley Wash southwest around the south side of Brushy Mountain, then parallels the north side of Cottonwood Canyon to Black Canyon and the Sarah K site. LCP-2 between Government Mountain and the Sarah K site intercepts a total of five other archaeological sites in my database, including two sites with a total of six Government Mountain obsidian artifacts. The low number of site and artifact interceptions by both LCP-1 and LCP-2 between Government Mountain and the Sarah K site suggests that the single Government Mountain obsidian artifact in the lithic assemblage at the Sarah K site arrived indirectly via down-the-line exchange through another site. My results indicate that neither LCP-1 nor LCP-2 between Government Mountain and the Sarah K site are viable obsidian acquisition routes and that the Sarah K site was not a primary site in obsidian exchange.

LCP-1 between Government Mountain and the Zeta (Austin) site parallels LCP-1 between Government Mountain and the Sarah K site to Big Black Mesa, then veers west-southwest across Big Back Mesa and Big Chino Valley to Walnut Creek. LCP-1 between Government Mountain and the Zeta follows the length of Walnut Creek west through the pass, then continues west along Muddy Wash to the Zeta site. LCP-1 between Government Mountain and the Zeta site intercepts a total of 22 other archaeological sites in my database, including seven sites with a total of seven Government Mountain obsidian artifacts. LCP-2 between Government Mountain and the Zeta site parallels LCP-2 between Government Mountain and the Sarah K site to Summit Mountain, then veers west overland across the headwaters of Grindstone Wash, Rattlesnake Wash, and Wagontire Wash to Meath Wash. From Meath Wash, LCP-2 between Government Mountain and the Zeta site continues overland west across Big Black Mesa to Big Chino Wash. From Big Chino Wash, LCP-2 between Government Mountain and the Zeta site joins LCP-1 between Government Mountain and the Zeta site along Walnut Creek and Muddy Wash to the Zeta site. LCP-2 between Government Mountain and the Zeta site intercepts a total of 17 other archaeological sites in my database, including eight sites with a total of eight Government Mountain obsidian artifacts. LCP-1 and LCP-2 between Government Mountain and the Zeta site are illustrated in Figure 5.12. Seven sites intercepted by both LCP-1 and LCP-2 between Government Mountain and the Zeta site are along Walnut Creek, which supports Wilcox and Samples' (1990) conclusion that Walnut Creek was a key prehistoric travel corridor.

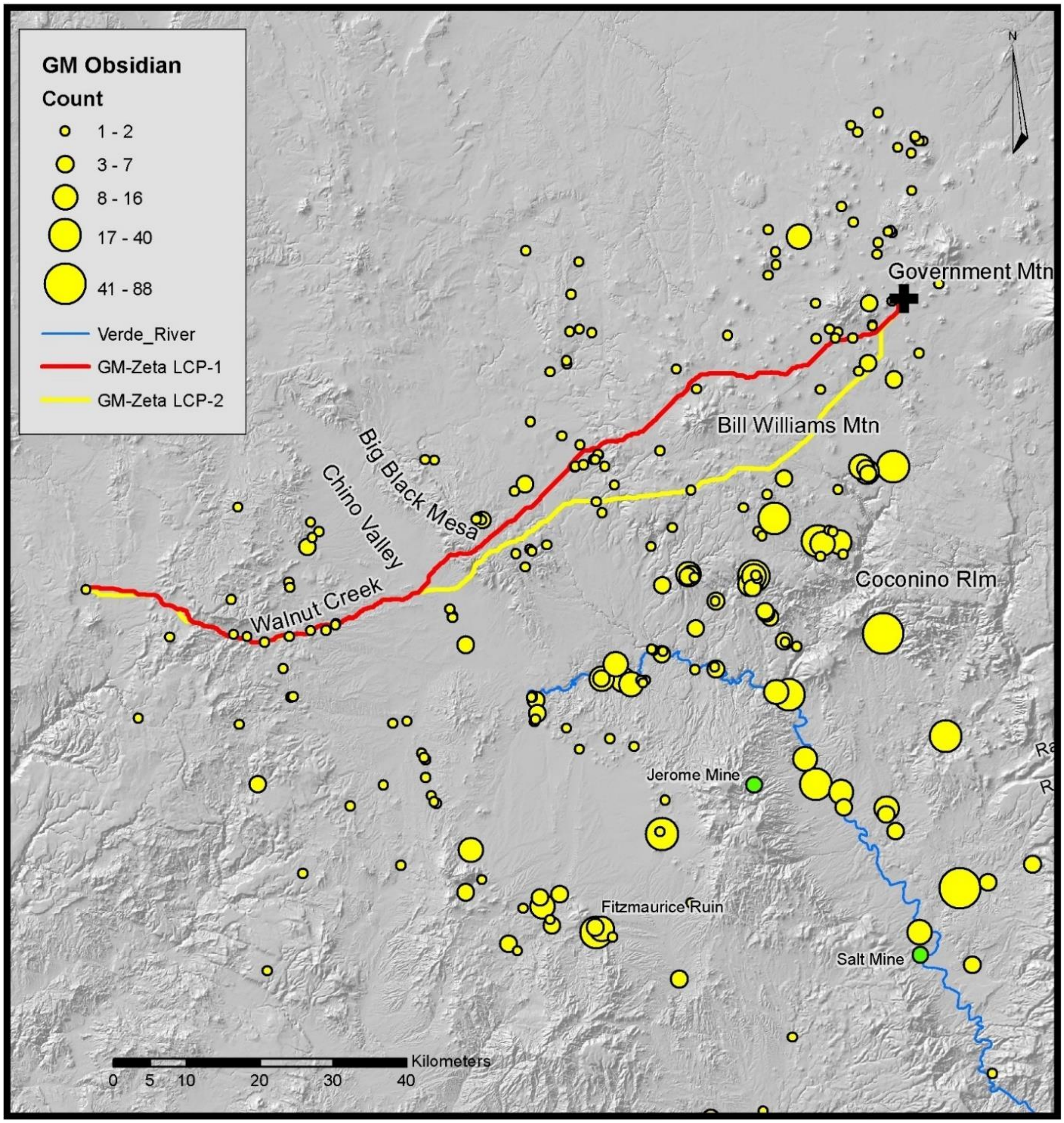

Figure 5.12. Least-cost paths between Government Mountain and the Zeta (Austin) site.

LCP-1 between Government Mountain and the Cindy H (Austin) site parallels the entire course of LCP-1 between Government Mountain and the Zeta site to the headwaters of Muddy Wash, then veers southwest to the Cindy H site. LCP-1 between Government Mountain and the Cindy H site intercepts a total of 20 other archaeological sites in my database, including seven sites with a total of seven Government Mountain obsidian artifacts. LCP-2 between Government Mountain and the Cindy H site parallels the entire course of LCP-2 between Government Mountain and the Zeta site to the headwaters of Muddy Wash, then veers southwest to the Cindy H site. LCP-2 between Government Mountain and the Cindy H site intercepts a total of 17 other archaeological sites in my database, including eight sites with a total of eight Government Mountain obsidian artifacts. The redundancy in LCP-1 and LCP-2 in the routes between the Government Mountain and the Zeta and Cindy H sites indicates that Government Mountain obsidian artifacts at one or both sites may have arrived indirectly via down-the-line exchange through another site and that neither Zeta and Cindy H was a primary site in obsidian exchange.

I generated one additional set of least-cost paths between Chavez Pass and the Fitzmaurice Ruin, based on the temporal overlap in occupation, presence of Government Mountain obsidian artifacts, and similar trade wares at both sites (Figure 5.13). Both LCP-1 and LCP-2 between Chavez Pass and Fitzmaurice Ruin follow the Palatkwapi Trail route between Chavez Pass and Pine Spring described by Byrkit (1988). West of Pine Spring, however, LCP-2 more closely approximates the Palatkwapi Trail route south of Stoneman Lake described Byrkit (1988) in comparison to LCP-1. Both LCP-1 and LCP-2 deviate to the south side of Rarick Canyon and converge along the north side of Beaver Creek rather than between Rattlesnake Canyon and Rarick Canyon as described by Byrkit (1988). Both LCP-1 and LCP-2 pass approximately eight km south of Beaverhead Spring, where Byrkit (1988) indicated the

Palatkwapi Trail forked toward the Jerome Mines and the Salt Mine in Camp Verde. Both LCP-1 and LCP-2 cross the Verde Valley following Beaver Creek past the Sacred Mountain pueblo, Montezuma Well, Lake Montezuma pueblo, and the Dyck Cave shelter, then follow Cherry Creek around the south end of Mingus Mountain before reaching Fitzmaurice Ruin. The results of the side by side comparison of least-cost paths generated from each of the two composite cost surfaces for the Government Mountain source area, however, indicate that cost surfaces 1 and 2 have comparable utility outside the context of Anderson Mesa.

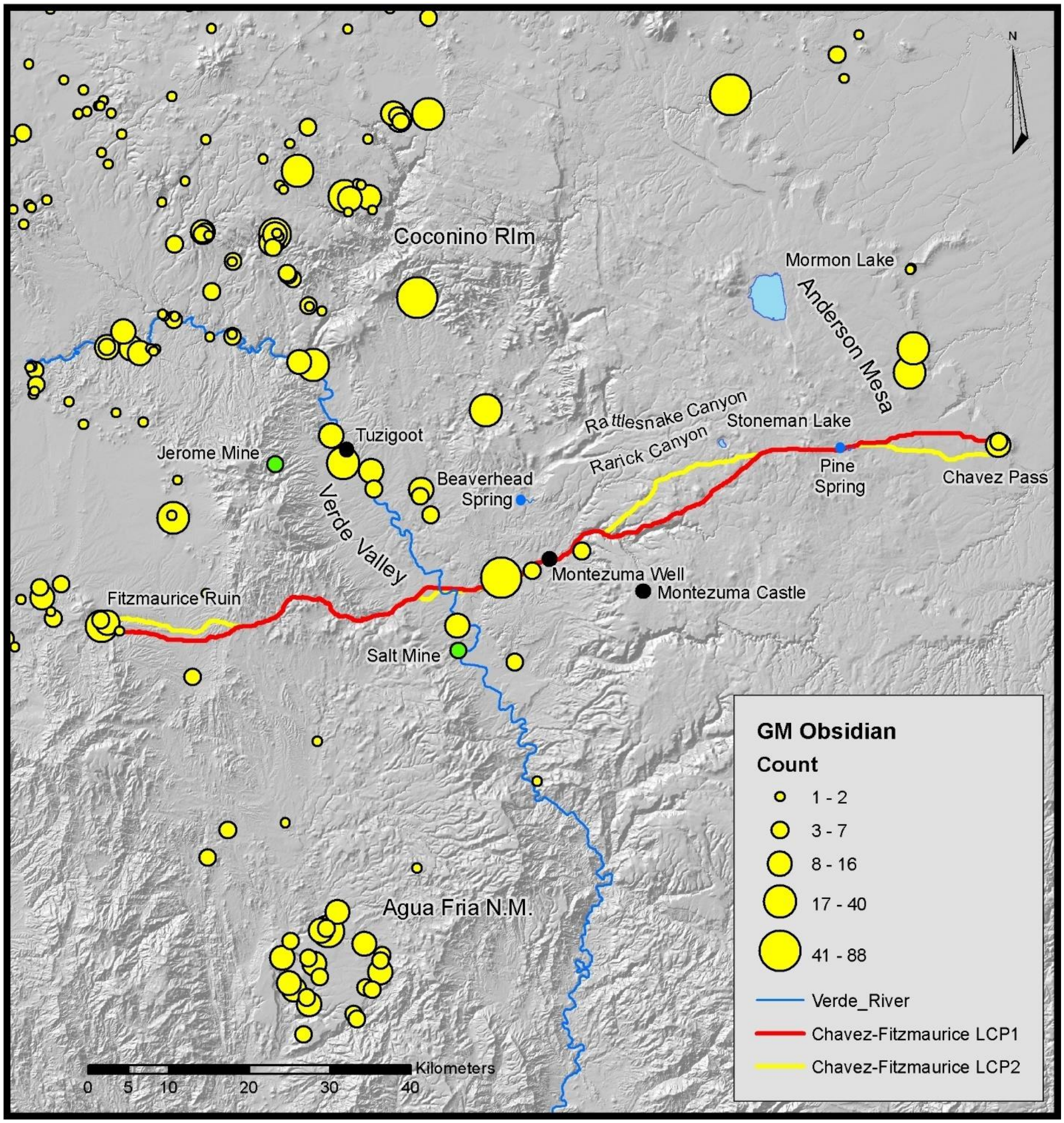

Figure 5.13. Least-cost paths between Chavez Pass and Fitzmaurice Ruin.

Least-Cost Path Analysis – Bull Creek

Using each of the two composite cost surfaces, I produced least-cost paths between the Bull Creek obsidian source area and ten habitation sites on the periphery of the spatial distribution of Bull Creek obsidian artifacts (Figure 5.14). The least-cost paths generated from the composite cost surface with distance to water classified from one to nine are hereafter referred to as BC- LCP-1. The least-cost paths generated from the composite cost surface with distance to water classified from one to thirty are hereafter referred to as BC- LCP-2.

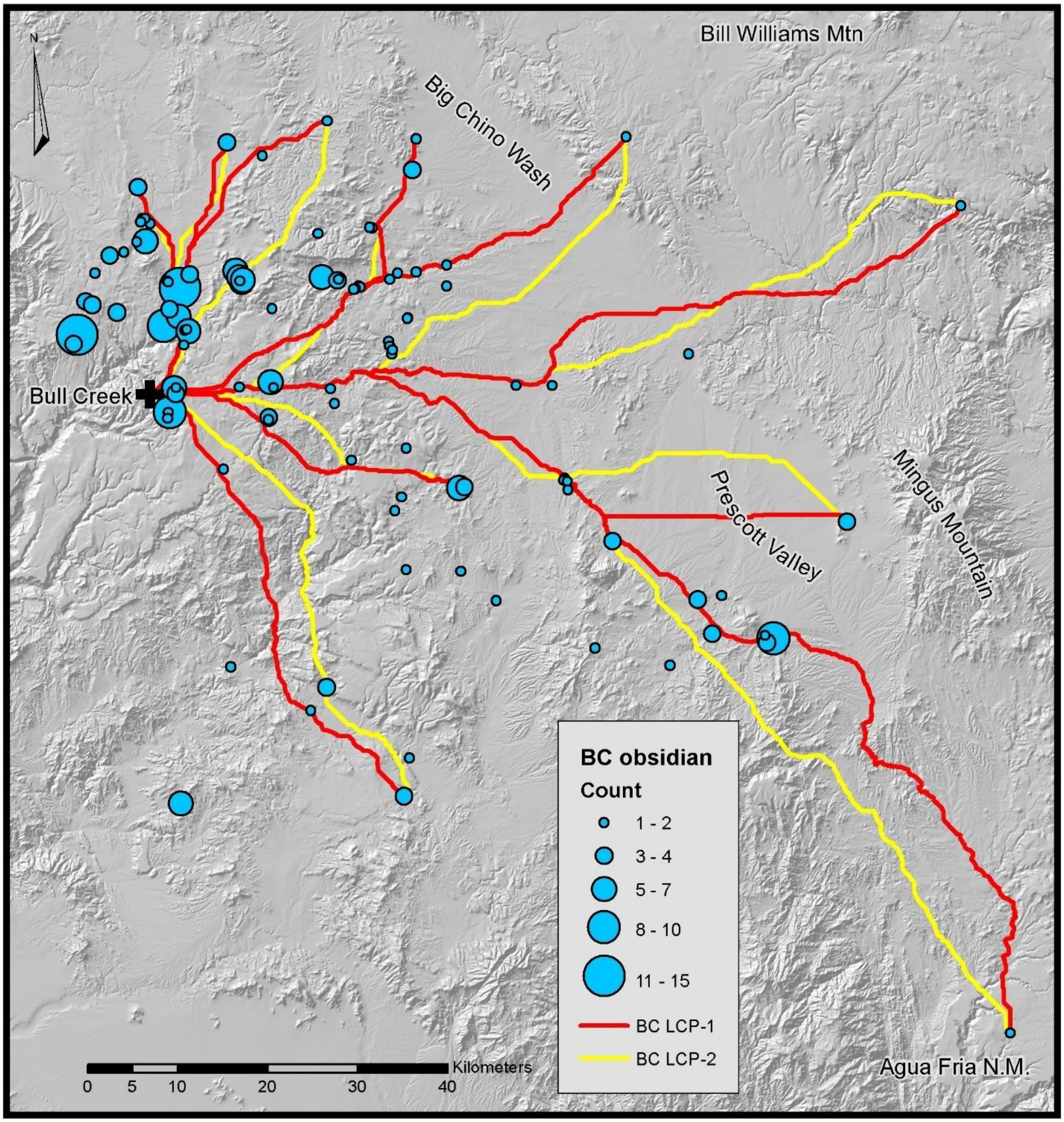

Figure 5.14. Least-cost paths between the Bull Creek obsidian source area and ten habitation sites with Bull Creek obsidian artifacts.

I subsequently evaluated the Bull Creek least-cost paths based on the number of other sites and artifacts intercepted (within 300 meters) by BC-LCP-1 and BC-LCP-2 between each source-site pair. The results of the side by side comparison of site and artifact interceptions for each BC- LCP-1 and BC-LCP-2 are provided in Table 5.10. The results of Student's *t*-testing indicate that there are no significant differences between mean Bull Creek site interceptions ($p = 0.434$), mean Bull Creek artifact interceptions ($p = 0.097$), or mean overall site interceptions ($p = 0.066$) by the two sets of Bull Creek least-cost paths (Table 5.11).

Table 5.10. Comparison of Site and Artifact Intercepts for Bull Creek LCP-1 and LCP-2.

Least-Cost Path	Intercepted sites with Bull Creek obsidian		Intercepted BC obsidian artifacts		Total sites intercepted	
	LCP-1	LCP-2	LCP-1	LCP-2	LCP-1	LCP-2
BC – Theta	1	1	6	6	2	2
BC – ORO	3	1	22	6	3	1
BC – Nettie	3	4	22	10	3	4
BC – AR-03-09-01-581	1	3	4	6	6	7
BC – Wilma	4	3	7	7	11	6
BC – Wagner Hill	3	3	7	7	11	7
BC – Coyote Ruin	5	4	9	8	10	8
BC – Joes Hill East	8	7	22	14	14	11
BC – Old Camp	2	2	9	9	3	3
BC – Pamela	1	0	1	0	1	1
Mean	3.1	2.8	10.9	7.3	6.4	5.0

Table 5.11. Result of Student's *t*-test Comparing Site Interceptions by Bull Creek LCP-1 and LCP-2.

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper	t	df	Sig. (2-tailed)
Pair 1	LCP1 BC site intercepts LCP2 BC site intercepts	0.3	1.15950	0.36667	-0.52946	1.12946	0.818	9	0.434
Pair 2	BC-LCP1 artifact count BC-LCP2 artifact count	3.6	6.14998	1.94479	-0.79943	7.99943	1.851	9	0.097
Pair 3	BC-LCP1 all site intercepts BC-LCP2 all site intercepts	1.4	2.11870	0.66999	-0.11563	2.91563	2.090	9	0.066

I also generated least-cost paths between the Bull Creek obsidian source area and the same set of ten habitation sites based on each of the three composite cost surface one components (slope, distance to water, and ecological response units) individually. I then compared Bull Creek LCP-1 routes with each of the three resulting sets of least-cost paths based on the number of other sites and artifacts intercepted (within 300 meters) by each least-cost path between each source-site pair. The results of the side by side comparison of site and artifact interceptions by Bull Creek LCP-1 routes and the least-cost paths generated based on slope (LCP_{slope}) are provided in Table 5.12. The results of Student's *t*-testing indicate that there are no significant differences between mean Bull Creek site interceptions ($p = 0.496$), mean Bull Creek artifact interceptions ($p = 0.816$), or mean overall site interceptions ($p = 0.301$) by Bull Creek LCP-1 and the Bull Creek LCP_{slope} routes (Table 5.13).

Table 5.12. Comparison of Site and Artifact Intercepts for Bull Creek LCP-1 and LCP_{slope}.

Least-Cost Path	Intercepted sites with Bull Creek obsidian		Intercepted BC obsidian artifacts		Total sites intercepted	
	LCP-1	LCP_{slope}	LCP-1	LCP_{slope}	LCP-1	LCP_{slope}
BC – Theta	1	1	6	6	2	1
BC – ORO	3	3	22	22	3	3
BC – Nettie	3	3	22	22	3	3
BC – AR-03-09-01-581	1	5	4	16	6	12
BC – Wilma	4	6	7	17	11	11
BC – Wagner Hill	3	2	7	5	11	5
BC – Coyote Ruin	5	2	9	5	10	8
BC – Joes Hill East	8	2	22	5	14	6
BC – Old Camp	2	1	9	5	3	2
BC – Pamela	1	0	1	0	1	0
Mean	3.1	2.5	10.9	10.3	6.4	5.1

Table 5.13. Result of Student's *t*-test Comparing Site and Artifact Interceptions by Bull Creek LCP-1 and LCP_{slope}.

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	LCP1 BC site intercepts Slope BC site intercepts	0.6	2.67499	0.84591	-1.31357	2.51357	0.709	9	0.496
Pair 2	BC-LCP1 artifact count Slope artifact count	0.6	7.93305	2.50865	-5.07496	6.27496	0.239	9	0.816
Pair 3	BC-LCP1 all site intercepts Slope all site intercepts	1.3	3.74314	1.18369	-1.37768	3.97768	1.098	9	0.301

The results of the side by side comparison of site and artifact interceptions by Bull Creek LCP-1 routes and least-cost paths based on distance to water (LCP_{H2O}) are provided in Table 5.14. The results of Student's *t*-testing indicate that the ten Bull Creek LCP-1 routes intercept significantly more sites with Bull Creek obsidian (p = 0.029) and significantly more sites overall (p = 0.021) than the LCP_{H2O} routes between the same ten source-site pairs (Table 5.15). There is no significant difference, however, between mean Bull Creek obsidian artifact interceptions (p = 0.134) by Bull Creek LCP-1 routes and least-cost paths based on distance to water (Table 5.15).

Table 5.14. Comparison of Site and Artifact Intercepts for Bull Creek LCP-1 and LCP_{H2O}.

Least-Cost Path	Intercepted sites with Bull Creek obsidian		Intercepted BC obsidian artifacts		Total sites intercepted	
	LCP-1	LCP_{H2O}	LCP-1	LCP_{H2O}	LCP-1	LCP_{H2O}
BC – Theta	1	1	6	1	2	2
BC – ORO	3	0	22	0	3	0
BC – Nettie	3	1	22	6	3	2
BC – AR-03-09-01-581	1	1	4	4	6	2
BC – Wilma	4	3	7	8	11	7
BC – Wagner Hill	3	1	7	4	11	8
BC – Coyote Ruin	5	3	9	12	10	8
BC – Joes Hill East	8	2	22	11	14	4
BC – Old Camp	2	3	9	16	3	4
BC – Pamela	1	0	1	0	1	0
Mean	3.1	1.5	10.9	6.2	6.4	3.7

Table 5.15. Result of Student's *t*-test Comparing Site and Artifact Interceptions by Bull Creek LCP-1 and LCP_{H2O}.

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	LCP1 BC site intercepts H2O BC site intercepts	1.6	1.95505	0.61824	0.20144	2.99856	2.588	9	0.029
Pair 2	BC-LCP1 artifact count H2O artifact count	4.7	9.03143	2.85599	-1.76069	11.16069	1.646	9	0.134
Pair 3	BC-LCP1 all site intercepts H2O all site intercepts	2.7	3.05687	0.96667	0.51325	4.88675	2.793	9	0.021

The results of the side by side comparison of site and artifact interceptions by the Bull Creek LCP-1 routes and the least-cost paths generated based on ecological response units (LCP_{ERU}) are provided in Table 5.16. The results of Student's *t*-testing indicate that there are no significant differences between the number of sites with Bull Creek obsidian (p = 0.068), Bull Creek obsidian artifacts (p = 0.156), or the total number of sites (p = 0.054) intercepted by the Bull Creek LCP-1 routes and LCP_{ERU} routes between the same ten source-site pairs (Table 5.17).

Table 5.16. Comparison of Site and Artifact Intercepts for Bull Creek LCP-1 and LCP_{ERU}.

Least-Cost Path	Intercepted sites with Bull Creek obsidian		Intercepted BC obsidian artifacts		Total sites intercepted	
	LCP-1	LCP_{ERU}	LCP-1	LCP_{ERU}	LCP-1	LCP_{ERU}
BC – Theta	1	3	6	26	2	3
BC – ORO	3	3	22	26	3	3
BC – Nettie	3	3	22	26	3	3
BC – AR-03-09-01-581	1	5	4	9	6	11
BC – Wilma	4	5	7	9	11	14
BC – Wagner Hill	3	4	7	9	11	29
BC – Coyote Ruin	5	4	9	5	10	11
BC – Joes Hill East	8	8	22	22	14	18
BC – Old Camp	2	3	9	7	3	6
BC – Pamela	1	2	1	2	1	3
Mean	3.1	4.0	10.9	14.1	6.4	10.1

Table 5.17. Result of Student's *t*-test Comparing Site and Artifact Interceptions by Bull Creek LCP-1 and LCP_{ERU}.

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Pair 1	LCP1 BC site intercepts ERU BC site intercepts	-0.9	1.37032	0.43333	-1.88027	0.08027	-2.077	9	0.068
Pair 2	BC-LCP1 artifact count ERU artifact count	-3.2	6.52857	2.06452	-7.87026	1.47026	-1.550	9	0.156
Pair 3	BC-LCP1 all site intercepts ERU all site intercepts	-3.7	5.29255	1.67365	-7.48606	0.08606	-2.211	9	0.054

LCP-1 and LCP-2 between the Bull Creek source area and the Theta (Austin) site each intercept one site with Bull Creek obsidian artifacts, 6 Bull Creek obsidian artifacts, and a total of two sites overall. LCP-1 and LCP-2 between Bull Creek and the Theta site traverse nearly identical routes around the north end of Burro Creek Canyon, north along Cabin Wash, around the east side of Hope Mountain, across Hope Wash, around the north side of Lake Mary, and northwest to the Theta site.

LCP-1 between the Bull Creek source area and the ORO (Austin) site intercepts three sites with Bull Creek obsidian artifacts, 22 Bull Creek obsidian artifacts, and a total of three sites overall. LCP-2 between the Bull Creek source area and the ORO site intercepts one site with Bull Creek obsidian artifacts, six Bull Creek obsidian artifacts, and one site overall. LCP-1 and LCP-2 between Bull Creek and the ORO site parallel LCP-1 and LCP-2 between the Bull Creek Source area and the Theta site to the confluence of Cabin Wash and Sherman Wash. From Sherman Wash, LCP-1 and LCP-2 between the Bull Creek source area and the ORO site veer northeast and follow parallel routes separated by approximately one km across Muddy Wash and overland to the ORO site.

LCP-1 between the Bull Creek source area and the Nettie (Austin) site intercepts three sites with Bull Creek obsidian artifacts, 22 Bull Creek obsidian artifacts, and a total of three sites overall. LCP-2 between the Bull Creek source area and the Nettie site intercepts four sites with Bull Creek obsidian artifacts, ten Bull Creek obsidian artifacts, and four sites overall. LCP-1 between the Bull Creek source area and the Nettie site follows the same route as LCP-1 and LCP-2 between the Bull Creek Source area and the ORO site to Muddy Wash. From Muddy Wash, LCP-1 between the Bull Creek source area and the Nettie site veers east across the Juniper Mountains and across Turkey Canyon to the Nettie site. LCP-2 between the Bull Creek source area and the Nettie site parallels LCP-1 between Bull Creek and the Nettie site to the north end of Burro Creek, then veers northeast along the length of Deep Canyon. From the upper end of Deep Canyon, LCP-2 between the Bull Creek source area and the Nettie site continues northeast overland across Muddy Wash and the Juniper Mountains, then turns north from Turkey Creek to the Nettie site.

LCP-1 between the Bull Creek source area and AR-03-09-01-581 intercepts one site with Bull Creek obsidian artifacts, four Bull Creek obsidian artifacts, and a total of six sites overall. LCP-2 between the Bull Creek source area and AR-03-09-01-581 intercepts three sites with Bull Creek obsidian artifacts, six Bull Creek obsidian artifacts, and seven sites overall. LCP-1 between the Bull Creek source area and AR-03-09-01-581 heads due east from the Bull Creek source area to Pine Creek, then veers northeast and follows Apache Creek to Walnut Creek near Indian Peak. From Indian Peak, LCP-1 between the Bull Creek source area and AR-03-09-01-581 veers north overland across Pine Creek and the southern portion of Big Chino Valley to AR-03-09-01-581. LCP-2 between the Bull Creek source area and AR-03-09-01-581 parallels LCP-1 between the Bull Creek source area and AR-03-09-01-581 approximately four km past Pine

Creek, then veers northeast over Pinetop Mountain. From Pinetop Mountain, LCP-2 between the Bull Creek source area and AR-03-09-01-581 continues northeast and rejoins LCP-1 between the Bull Creek source area and AR-03-09-01-581 at Apache Creek the rest of the way to AR-03-09-01-581.

LCP-1 between the Bull Creek source area and the Wilma (Austin) site intercepts four sites with Bull Creek obsidian artifacts, seven Bull Creek obsidian artifacts, and a total of eleven sites overall. LCP-2 between the Bull Creek source area and the Wilma site intercepts three sites with Bull Creek obsidian artifacts, seven Bull Creek obsidian artifacts, and six sites overall. LCP-1 between the Bull Creek source area and the Wilma site follows the same route as LCP-1 between the Bull Creek Source area and AR-03-09-01-581 to Walnut Creek, then follows Walnut Creek east to Big Chino Valley. In Big Chino Valley, LCP-1 between the Bull Creek source area and the Wilma site veers northeast across Pine Creek and Big Chino Wash, the ascends Big Black Mesa to the Wilma site. LCP-2 between the Bull Creek source area and the Wilma site follows the same route as LCP-2 between the Bull Creek Source area and AR-03-09-01-581 to Pine Creek, then continues east overland to the south side of Camp Wood Mountain. From Camp Wood Mountain, LCP-2 between the Bull Creek source area and the Wilma site follows Stringtown Wash east to the Santa Maria Mountains, then veers overland northeast across Hitt Wash to Indian Springs Wash. LCP-2 between the Bull Creek source area and the Wilma site follows Indian Springs Wash to Mud Tank Wash, then veers northeast overland across Big Chino Valley and ascends Big Black Mesa to the Wilma site.

LCP-1 between the Bull Creek source area and the Wagner Hill ballcourt intercepts three sites with Bull Creek obsidian artifacts, seven Bull Creek obsidian artifacts, and a total of eleven sites overall. LCP-2 between the Bull Creek source area and the Wagner Hill ballcourt intercepts three sites with Bull Creek obsidian artifacts, seven Bull Creek obsidian artifacts, and seven sites overall. LCP-1 between the Bull Creek source area and the Wagner Hill ballcourt follows the same route as LCP-2 between the Bull Creek Source area and the Wilma site to Pine Creek, then follows Hitt Wash east to Williamson Valley Wash. LCP-1 between the Bull Creek source area and the Wagner Hill ballcourt follows Williamson Valley Wash northeast to the Confluence of Big Chino Wash, then crosses Big Chino Valley to Page Flat on the north side of the Verde River. From Page Flat, LCP-1 between the Bull Creek source area and the Wagner Hill ballcourt crosses Hell Canyon at Hell Point, then veers northeast overland along the east rim of Government Canyon to the Wagner Hill ballcourt. LCP-2 between the Bull Creek source area and the Wagner Hill ballcourt follows the same route as LCP-1 between the Bull Creek Source area and the Wagner Hill ballcourt to Williamson Valley Wash, then veers east overland through the Sullivan Buttes to the confluence of Williamson Valley Wash and Big Chino Wash. From Big Chino Wash, LCP-2 between the Bull Creek source area and the Wagner Hill ballcourt continues northeast and rejoins LCP-1 between the Bull Creek Source area and the Wagner Hill ballcourt through Page Flat. From Page Flat, LCP-2 between the Bull Creek source area and the Wagner Hill ballcourt veers northeast along Page Wash, crosses Hell Canyon, then follows MC Canyon northeast. From MC Canyon, LCP-2 between the Bull Creek source area and the Wagner Hill ballcourt veers northeast overland and turns east to cross Bear Canyon, May Tank Canyon, Secret Pocket, and Government Canyon and reach the Wagner Hill ballcourt.

LCP-1 between the Bull Creek source area and Coyote Ruin intercepts five sites with Bull Creek obsidian artifacts, nine Bull Creek obsidian artifacts, and a total of ten sites overall. LCP-2 between the Bull Creek source area and Coyote Ruin intercepts four sites with Bull Creek obsidian artifacts, eight Bull Creek obsidian artifacts, and eight sites overall. LCP-1 between the

Bull Creek source area and Coyote Ruin follows the same route as LCP-1 between the Bull Creek Source area and Wagner Hill ballcourt to Pine Creek, then veers southeast along Pine Creek across Long Valley to Mint Wash. From Mint Wash, LCP-1 between the Bull Creek source area and Coyote Ruin veers due east across the Chino Valley Grasslands and Lonesome Valley to Coyote Ruin. LCP-2 between the Bull Creek source area and Coyote Ruin follows the same route as LCP-1 between the Bull Creek Source area and Coyote Ruin to Williamson Valley, then veers east overland across Mint Wash, Copper Wash, and Chino Valley, turning southeast across lonesome Valley to Coyote Ruin.

LCP-1 between the Bull Creek source area and the Joes Hill East site intercepts eight sites with Bull Creek obsidian artifacts, 22 Bull Creek obsidian artifacts, and a total of 14 sites overall. LCP-2 between the Bull Creek source area and the Joes Hill East site intercepts seven sites with Bull Creek obsidian artifacts, 14 Bull Creek obsidian artifacts, and eleven sites overall. LCP-1 between the Bull Creek source area and the Joes Hill East site follows the same route as LCP-1 between the Bull Creek Source area and Coyote Ruin to Mint Wash, then veers southeast overland across Granite Creek to the south side of Glassford Hill. From Glassford Hill, LCP-1 between the Bull Creek source area and the Joes Hill East site follows Lynx Creek and Clipper Wash to the Agua Fria River, then follows the Agua Fria River south to the Agua Fria National Monument and the Joes Hill East site. LCP-2 between the Bull Creek source area and the Joes Hill East site follows the same route as LCP-1 between the Bull Creek Source area and Coyote Ruin to Mint Wash, then veers southeast overland across Granite Creek and Lynx Creek over Mount Elliott to Big Bug Creek. LCP-2 between the Bull Creek source area and the Joes Hill East site follows Big Bug Creek, Antelope Creek, and Badger Spring Wash, then crosses the Agua Fria River onto the Agua Fria Monument and the Joes Hill East site. LCP-1 between the

Bull Creek source area and the Joes Hill East site directly passes through the highest concentration of sites with artifacts from multiple sources in my study area (Figure 5.15).

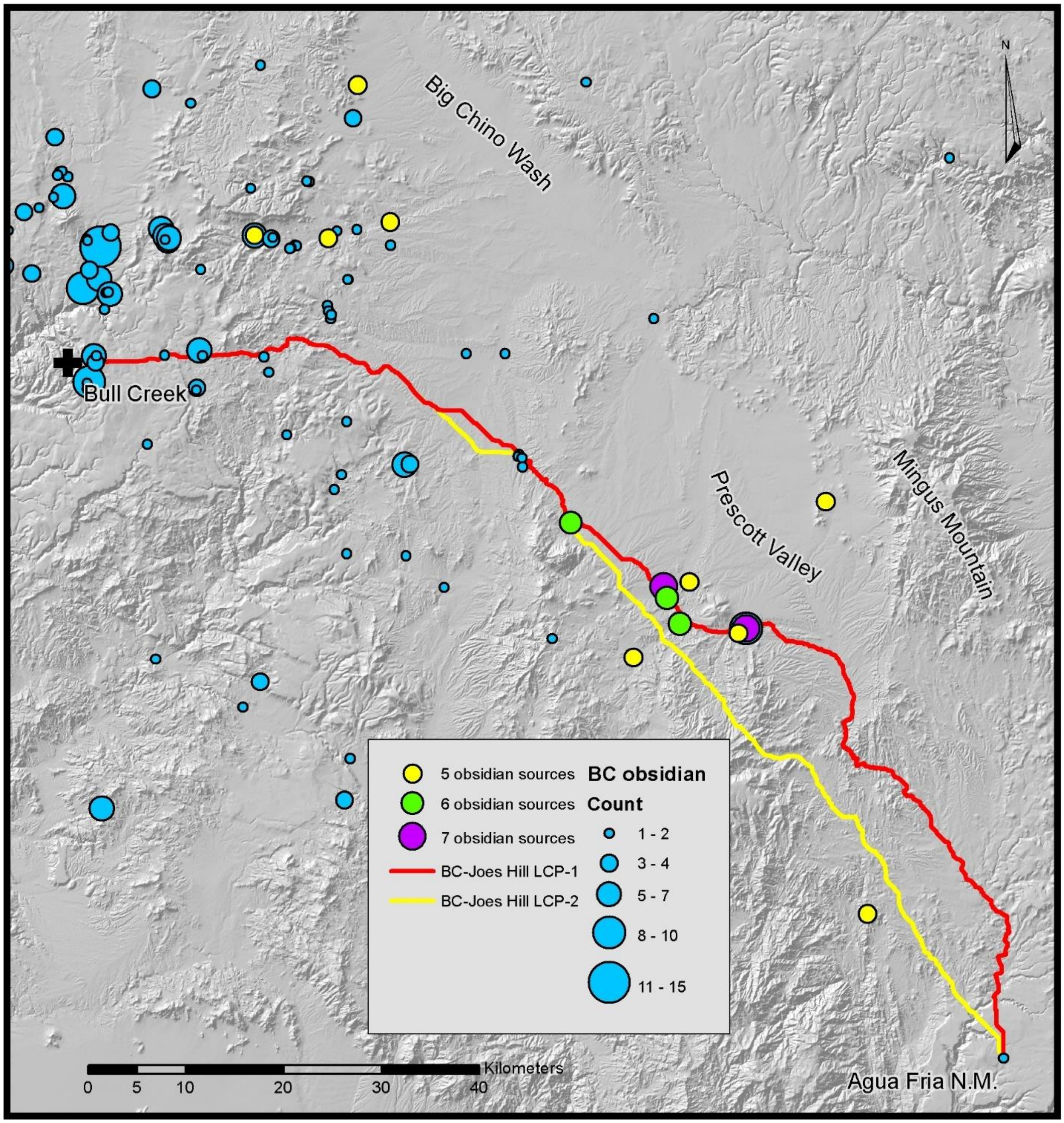

Figure 5.15. Least-cost paths between the Bull Creek obsidian source area and the Joes Hill East Site intersecting sites with multiple sources of obsidian.

LCP-1 and LCP-2 between the Bull Creek source area and the Old Camp site each intercept two sites with Bull Creek obsidian artifacts, nine Bull Creek obsidian artifacts, and a total of three sites overall. LCP-1 between the Bull Creek source area and the Old Camp site follows the same route as LCP-1 between the Bull Creek Source area and the Joes Hill East site to Black Butte, then veers southeast overland across Connell Gulch and the Connell Mountains, then follows Cottonwood Canyon east to Smith Mesa. From Smith Mesa, LCP-1 between the Bull Creek source area and the Old Camp site continues east overland across Horse Wash to the Old Camp site. LCP-2 between the Bull Creek source area and the Old Camp site follows the same route as LCP-2 between the Bull Creek Source area and the Joes Hill East site to Pine Creek, then veers southeast overland across lower Connell Gulch to the south side of Stinson Mountain. From Stinson Mountain, LCP-2 between the Bull Creek source area and the Old Camp site veers farther southeast around the north side of BT Butte and rejoins LCP-1 between the Bull Creek source area and the Old Camp site across Smith Mesa and Horse Wash east to the Old Camp site.

LCP-1 between the Bull Creek source area and the Pamela (Austin) site intercepts one site with Bull Creek obsidian artifacts, one Bull Creek obsidian artifact, and one site overall. LCP-2 between the Bull Creek source area and the Pamela site does not intercept any sites with Bull Creek obsidian artifacts and intercepts one site overall. LCP-1 between the Bull Creek source area and the Pamela site follows the same route as LCP-1 between the Bull Creek Source area and the Old Camp site to Black Butte, then veers southeast overland across Windy Ridge and Anderson Mesa. From the south edge of Anderson Mesa, LCP-1 between the Bull Creek source area and the Pamela site veers south across Loco Creek to Sycamore Creek, then follows Sycamore Creek to the Santa Maria River, and Kirkland Creek southeast to the Pamela site. LCP-2 between the Bull Creek source area and the Pamela site crosses Bull Creek and continues southeast overland across Windy Ridge and Anderson Mesa to Cottonwood Canyon. LCP-2 between the Bull Creek source area and the Pamela site follows Cottonwood Canyon south to Sycamore Creek, then continues south overland to Eastwood Creek. From Eastwood Creek, LCP-2 between the Bull Creek source area and the Pamela site veers southeast across the Thompson Valley to Kirkland Creek, then follows Kirkland Creek to the Pamela site. The low number of site and artifact interceptions by both LCP-1 and LCP-2 between the Bull Creek source area and the Pamela site suggests that the four Bull Creek obsidian artifacts in the lithic assemblage at the Pamela site arrived indirectly via down-the-line exchange through another site. My results indicate that neither LCP-1 nor LCP-2 between the Bull Creek source area and the Pamela site are viable obsidian acquisition routes and that the Pamela site was not a primary site in obsidian exchange.

Least-Cost Path Analysis – RS Hill

Using each of the two composite cost surfaces, I produced least-cost paths between the RS Hill obsidian source area and ten habitation sites on the periphery of the spatial distribution of RS Hill obsidian artifacts (Figure 5.16). The least-cost paths generated from the composite cost surface with distance to water classified from one to nine are hereafter referred to as RS-LCP-1. The least-cost paths generated from the composite cost surface with distance to water classified from one to thirty are hereafter referred to as RS- LCP-2.

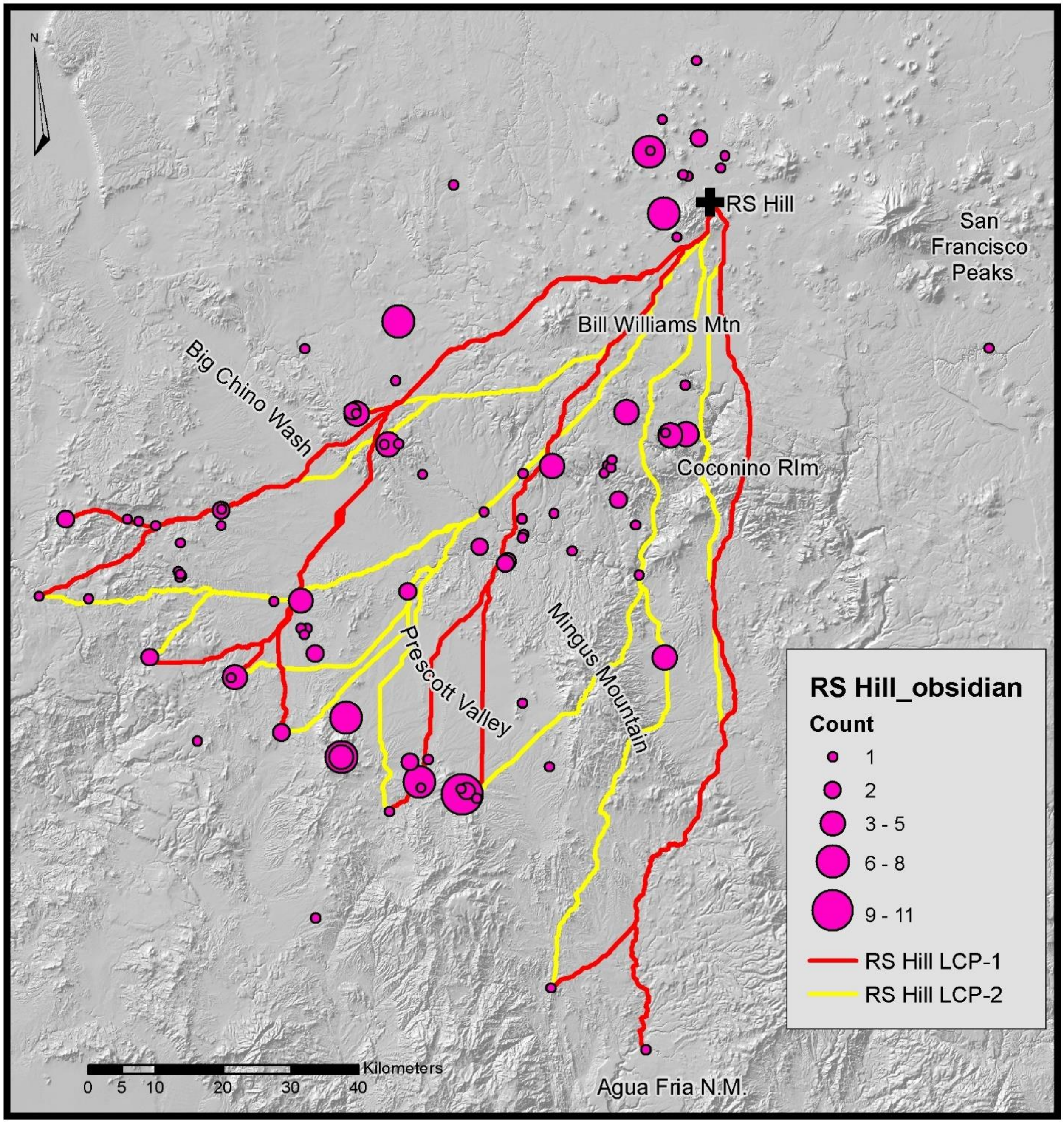

Figure 5.16. Least-cost paths between the RS Hill obsidian source area and ten habitation sites with RS Hill obsidian artifacts.

I subsequently evaluated the RS Hill least-cost paths based on the number of other sites and artifacts intercepted (within 300 meters) by RS-LCP-1 and RS-LCP-2 between each source-site pair. The results of the side by side comparison of site and artifact interceptions for each RS- LCP-1 and RS-LCP-2 are provided in Table 5.18. The results of Student's t-testing indicate that there are no significant differences between mean RS Hill artifact interceptions (p = 0.591), or mean overall site interceptions (p = 0.152) by the two sets of RS Hill least-cost paths (Table 5.19). The least-cost paths generated from composite cost surface 2, however, intercepted significantly (p = 0.017) more sites with RS Hill obsidian artifacts than the least cost paths generated from composite cost surface 1 (Table 5.19).

Table 5.18. Comparison of Site and Artifact Intercepts for RS Hill LCP-1 and LCP-2.

Least-Cost Path	Intercepted sites with RS Hill obsidian		Intercepted RS Hill obsidian artifacts		Total sites intercepted	
	LCP-1	LCP-2	LCP-1	LCP-2	LCP-1	LCP-2
RS – Bishop Canyon	0	0	0	0	4	4
RS – Cedar Canyon	0	1	0	1	4	4
RS – Fitzmaurice Ruin	0	1	0	1	5	3
RS – Sullivan	1	2	8	2	6	2
RS – Tonto Wash	0	3	0	4	4	5
RS – Old Camp	0	3	0	4	4	7
RS – Cottonwood Spr.	0	2	0	2	4	4
RS – Kimberly	2	2	3	2	12	6
RS – Ralph	5	5	6	6	21	18
RS – Cotton Dam	2	2	2	2	6	4
Mean	1.0	2.1	1.9	2.4	7.0	5.7

Table 5.19. Result of Student's *t*-test Comparing Site Interceptions by RS Hill LCP-1 and LCP-2.

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	LCP1 RS site intercepts LCP2 RS site intercepts	-1.1	1.19722	0.37859	-1.95644	-0.24356	-2.905	9	0.017
Pair 2	RS-LCP1 artifact count RS-LCP2 artifact count	-0.5	2.83823	0.89753	-2.53035	1.53035	-0.557	9	0.591
Pair 3	RS-LCP1 all site intercepts RS-LCP2 all site intercepts	1.3	2.62679	0.83066	-0.57909	3.17909	1.565	9	0.152

I also generated least-cost paths between the RS Hill obsidian source area and the same set of ten habitation sites based on each of the three composite cost surface two components (slope, distance to water, and ecological response units). I then compared RS Hill LCP-2 routes with each of the three resulting sets of least-cost paths based on the number of other sites and artifacts intercepted (within 300 meters) by each least-cost path between each source-site pair. The results of the side by side comparison of site and artifact interceptions by RS Hill LCP-2 routes and the least-cost paths generated based on slope (LCP_{slope}) are provided in Table 5.20. The results of Student's *t*-testing indicate that the ten RS Hill LCP-2 routes intercept significantly more sites with RS Hill obsidian ($p = 0.050$) than the LCP_{slope} routes between the same ten source-site pairs (Table 5.21). There are no significant differences, however, in mean RS Hill obsidian artifact interceptions ($p = 0.074$) or mean overall site interceptions by RS Hill LCP-2 routes and least-cost paths based on slope (Table 5.21).

Table 5.20. Comparison of Site and Artifact Intercepts for RS Hill LCP-2 and LCP_{slope}.

Least-Cost Path	Intercepted sites with RS Hill obsidian		Intercepted RS Hill obsidian artifacts		Total sites intercepted	
	RS-LCP-2	LCP_{slope}	RS-LCP-2	LCP_{slope}	RS-LCP-2	LCP_{slope}
RS – Bishop Canyon	0	0	0	0	4	1
RS – Cedar Canyon	1	0	1	0	4	2
RS – Fitzmaurice Ruin	1	2	1	3	3	4
RS – Sullivan	2	0	2	0	2	9
RS – Tonto Wash	3	0	4	0	5	2
RS – Old Camp	3	0	4	0	7	3
RS – Cottonwood Spr.	2	0	2	0	4	3
RS – Kimberly	2	3	2	3	6	7
RS – Ralph	5	0	6	0	18	7
RS – Cotton Dam	2	2	2	2	4	2
Mean	2.1	0.7	2.4	0.8	5.7	4.0

Table 5.21. Result of Student's *t*-test Comparing Site and Artifact Interceptions by RS Hill LCP-2 and LCP_{slope}.

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	LCP2 RS site intercepts Slope RS site intercepts	1.4	1.95505	0.61824	0.00144	2.79856	2.264	9	0.050
Pair 2	RS-LCP2 artifact count Slope RS artifact count	1.6	2.50333	0.79162	-0.19078	3.39078	2.021	9	0.074
Pair 3	RS-LCP2 all site intercepts Slope all site intercepts	1.7	4.54728	1.43798	-1.55293	4.95293	1.182	9	0.267

The results of the side by side comparison of site and artifact interceptions by RS Hill LCP-2 routes and the least-cost paths generated based on distance to water (LCP_{H2O}) are provided in Table 5.22. The results of Student's *t*-testing indicate that the ten RS Hill LCP-2 routes intercept significantly more sites with RS Hill obsidian ($p = 0.002$), significantly more RS Hill obsidian artifacts ($p = 0.017$), and significantly more sites overall ($p = 0.004$) than the LCP_{H2O} routes between the same ten source-site pairs (Table 5.23).

Table 5.22. Comparison of Site and Artifact Intercepts for RS Hill LCP-2 and LCP_{H2O}.

Least-Cost Path	Intercepted sites with RS Hill obsidian		Intercepted RS Hill obsidian artifacts		Total sites intercepted	
	RS-LCP-2	LCP_{H2O}	RS-LCP-2	LCP_{H2O}	RS-LCP-2	LCP_{H2O}
RS – Bishop Canyon	0	0	0	0	4	3
RS – Cedar Canyon	1	0	1	0	4	1
RS – Fitzmaurice Ruin	1	0	1	0	3	0
RS – Sullivan	2	0	2	0	2	0
RS – Tonto Wash	3	0	4	0	5	0
RS – Old Camp	3	0	4	0	7	2
RS – Cottonwood Spr.	2	0	2	0	4	5
RS – Kimberly	2	0	2	0	6	5
RS – Ralph	5	1	6	1	18	6
RS – Cotton Dam	2	2	2	2	4	2
Mean	2.1	0.3	2.4	0.3	5.7	2.4

Table 5.23. Result of Student's *t*-test Comparing Site and Artifact Interceptions by RS Hill LCP-2 and LCP_{H2O}.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	LCP2 RS site intercepts H2O RS site intercepts	1.8	1.31656	0.41633	0.85819	2.74181	4.323	9	0.002
Pair 2	RS-LCP2 artifact count H2O RS artifact count	2.1	1.72884	0.54671	0.86326	3.33674	3.841	9	0.004
Pair 3	RS-LCP2 all site intercepts H2O all site intercepts	3.3	3.56059	1.12596	0.75291	5.84709	2.931	9	0.017

The results of the side by side comparison of site and artifact interceptions by the RS Hill LCP-2 routes and the least-cost paths generated based on ecological response units (LCP_{ERU}) are provided in Table 5.24. The results of Student's *t*-testing indicate that the ten LCP_{ERU} routes intercept significantly more sites overall (p = 0.003) than the RS Hill LCP-2 routes between the same ten source-site pairs (Table 5.25). These results suggest that ERU has a dominant influence in overall site interceptions by least-cost paths from the RS Hill obsidian source area. There are no significant differences, however, between mean interceptions of sites with RS Hill obsidian (p = 0.591) or RS Hill obsidian artifact interceptions (p = 0.146) by RS Hill LCP-2 routes and least-cost paths based on ecological response units (Table 5.25).

Table 5.24. Comparison of Site and Artifact Intercepts for RS Hill LCP-2 and LCP_{ERU}.

Least-Cost Path	Intercepted sites with RS Hill obsidian		Intercepted RS Hill obsidian artifacts		Total sites intercepted	
	RS-LCP-2	LCP_{ERU}	RS-LCP-2	LCP_{ERU}	RS-LCP-2	LCP_{ERU}
RS – Bishop Canyon	0	1	0	1	4	6
RS – Cedar Canyon	1	1	1	1	4	4
RS – Fitzmaurice Ruin	1	1	1	1	3	4
RS – Sullivan	2	2	2	9	2	5
RS – Tonto Wash	3	2	4	4	5	13
RS – Old Camp	3	2	4	4	7	12
RS – Cottonwood Spr.	2	2	2	4	4	15
RS – Kimberly	2	2	2	3	6	14
RS – Ralph	5	5	6	6	18	21
RS – Cotton Dam	2	2	2	2	4	7
Mean	2.1	2.0	2.4	3.5	5.7	10.1

Table 5.25. Result of Student's *t*-test Comparing Site and Artifact Interceptions by RS Hill LCP-2 and LCP_{ERU}.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper			
Pair 1	LCP2 RS site intercepts ERU RS site intercepts	0.10000	0.56765	0.17951	-0.30607	0.50607	0.557	9	0.591
Pair 2	RS-LCP2 artifact count ERU RS artifact count	-1.10000	2.18327	0.69041	-2.66182	0.46182	-1.593	9	0.146
Pair 3	RS-LCP2 all site intercepts ERU all site intercepts	-4.40000	3.53396	1.11754	-6.92804	-1.87196	-3.937	9	0.003

LCP-1 between RS Hill and the Bishop Creek West site on the Agua Fria National Monument crosses Government Prairie and Garland Prairie on a south heading, skirts the east side of Sycamore Canyon, and descends the Coconino Rim via Loy Canyon approximately 800 meters east of Honanki. From the Honanki area, LCP-1 between RS Hill and the Bishop Creek West site follows Coffee Creek then Sheepshead Creek south to Oak Creek, passing within 500 meters of the Cornville pueblo and 300 meters of the Sugarloaf pueblo before reaching the Verde River. From the confluence of Oak Creek and the Verde River, LCP-1 between RS Hill and the

Bishop Creek West site parallels the Verde River south to Cherry Creek and crosses the pass to follow Cienega Creek and Ash Creek to the Agua Fria River and the Bishop Creek West site on the Agua Fria National Monument, intersecting four sites – none of which include RS Hill obsidian artifacts. LCP-2 between RS Hill and the Bishop Creek West site follows the same route as LCP-1 between RS Hill and the Bishop Creek West site through Government Prairie, then diverges southwest in the area of Parks, Arizona and parallels two to three km to the west of LCP-1 through Garland Prairie. From the south end of Garland Prairie, LCP-2 between RS Hill and the Bishop Creek West site crosses to the west side of Sycamore Canyon southeast of Whitehorse Lake and descends the Coconino Rim into Sycamore Canyon north of Sycamore Point. LCP-2 between RS Hill and the Bishop Creek West site follows Sycamore Creek south and crosses Buck Ridge into Mooney Canyon, then parallels Spring Creek to converge with LCP-1 along Coffee Creek. LCP-2 between RS Hill and the Bishop Creek West site follows LCP-1 along Coffee Creek to the upper end of Sheepshead Creek, then diverges south overland and rejoins LCP-1 at the confluence of Oak Creek and the Verde River the rest of the way to the Bishop Creek West site on the Agua Fria National Monument. The low number of site and artifact interceptions by both LCP-1 and LCP-2 between RS Hill and the Bishop Creek West site suggests that the single RS Hill obsidian artifact in the lithic assemblage at the Bishop Creek West site arrived indirectly via down-the-line exchange through another site. My results indicate that neither LCP-1 nor LCP-2 between RS Hill and the Bishop Creek West site are viable obsidian acquisition routes and that the Bishop Creek West site was not a primary site in RS Hill obsidian exchange.

LCP-1 between RS Hill and the Cedar Canyon site follows the same route as LCP-1 between RS Hill and the Bishop Creek West site to Ash Creek, then veers southwest overland across the Agua Fria River and Big Bug Creek to the Cedar Canyon site. LCP-2 between RS Hill and the Cedar Canyon site maintains a south heading between Sitgreaves Mountain and Government Hill, through Garland Prairie, and skirts around the west side of Sycamore Canyon to Deadman Pocket. From Deadman Pocket, LCP-2 between RS Hill and the Cedar Canyon site descends the Coconino Rim and joins Sycamore Creek approximately one km east of the Seldom Seen cliff dwelling. LCP-2 between RS Hill and the Cedar Canyon site follows Sycamore Creek to the confluence of the Verde River, then follows the Verde River past the Packard Pueblo and Peck's Lake pueblo to Tuzigoot N.M. From Tuzigoot, LCP-2 between RS Hill and the Cedar Canyon site continues south overland to Black Canyon, then veers southwest along Black Canyon and overland to Ash Creek. From lower Ash Creek, LCP-2 between RS Hill and the Cedar Canyon site continues south overland across Osborne Spring Wash and Yarber Wash to the Agua Fria River at Stoddard Spring, then veers southwest around Copper Mountain and south across Big Bug Creek and Antelope Wash to the Cedar Canyon site. The low number of site and artifact interceptions by both LCP-1 and LCP-2 between RS Hill and the Cedar Canyon site suggests that the single RS Hill obsidian artifact in the lithic assemblage at the Cedar Canyon site arrived indirectly via down-the-line exchange through another site. My results indicate that neither LCP-1 nor LCP-2 between RS Hill and the Cedar Canyon site are viable obsidian acquisition routes and that the Bishop Creek West site was not a primary site in RS Hill obsidian exchange.

LCP-1 between RS Hill and the Fitzmaurice Ruin passes between Sitgreaves Mountain and Government Hill, then veers southwest past Kaufman Spring and Duck Lake before crossing Pitman Valley and McDonald Flat. From McDonald Flat, LCP-1 between RS Hill and the Fitzmaurice Ruin passes to the west of Summit Mountain and parallels the west side of Bear

Canyon following the Overland Road Historic Trail (Byrkit 1989) to the Verde River at Hell Point. From Hell Point, LCP-1 between RS Hill and the Fitzmaurice Ruin follows the Verde River south, then continues south overland along the ridge between Gold Basin Canyon and King Canyon through Lonesome Valley to Lynx Creek and the Fitzmaurice Ruin. LCP-2 between RS Hill and the Fitzmaurice Ruin follows the same route as LCP-2 between RS Hill and the Cedar Canyon site to the confluence of Sycamore Creek and the Verde River, then veers south overland to Deception Gulch near Jerome, Arizona. From Jerome, LCP-2 between RS Hill and the Fitzmaurice Ruin follows Hull Canyon over Mingus Mountain to Yeager Canyon along the Arizona State Route 89A route, and then continues southwest across Prescott Valley and the Agua Fria River to Lynx Creek and the Fitzmaurice Ruin.

LCP-1 between RS Hill and the Sullivan site follows the same route as LCP-1 between RS Hill and the Fitzmaurice Ruin to the north end of Lonesome Valley, then veers southwest to Granite Creek and south across Lonesome Valley following Granite Creek to the Sullivan site. LCP-2 between RS Hill and the Sullivan site follows the same route as LCP-1 between RS Hill and the Fitzmaurice Ruin to McDonald Flat, then veers south around the east side of Summit Mountain to May Tank Pocket. From May Tank Pocket, LCP-2 between RS Hill and the Sullivan site crosses Bear Canyon, MC Canyon, and Hell Canyon, then follows the Verde River to Granite Creek. From Granite Creek, LCP-2 between RS Hill and the Sullivan site turns south overland across Little Chino Valley to the Sullivan site.

LCP-1 between RS Hill and the Tonto Wash site passes between Sitgreaves Mountain and Government Hill, then veers southwest past Kaufman Spring and crosses Pitman Valley to Davenport Lake. From Davenport Lake, LCP-1 between RS Hill and the Tonto Wash site veers west and follows the I-17 corridor between Bill Williams Mountain and Signal Hill, then veers southwest overland across Meath Wash and Big Black Mesa. From the west side of Big Black Mesa, LCP-1 between RS Hill and the Tonto Wash site continues southwest across Big Chino Valley and follows Williamson Valley south to Long Canyon and the Tonto Wash site. LCP-2 between RS Hill and the Tonto Wash site follows the same route as LCP-2 between RS Hill and the Sullivan site to the north end of Little Chino Valley, then veers southwest around the north side of Table Mountain and Granite Mountain to the Tonto Wash site.

LCP-1 between RS Hill and the Old Camp site follows the same route as LCP-1 between RS Hill and the Tonto Wash site to Williamson Valley, then veers southwest to the Old Camp site. LCP-2 between RS Hill and the Old Camp site follows the same route as LCP-2 between RS Hill and the Tonto Wash site to the north end of Little Chino Valley, then veers west across Cooper Wash and Mint Wash to the Old Camp site.

LCP-1 between RS Hill and the Cottonwood Springs site follows the same route as LCP-1 between RS Hill and the Old Camp site to Williamson Valley, then veers west along Horse Wash and across Smith Mesa to the Cottonwood Springs site. LCP-2 between RS Hill and the Cottonwood Springs site follows the same route as LCP-2 between RS Hill and the Old Camp site to Page Flat, then veers southwest across Big Chino Valley and Sullivan Buttes to Williamson Valley. From the east side of Williamson Valley, LCP-2 between RS Hill and the Cottonwood Springs site veers west along Hitt Wash to the north side of Johnson Peak, then veers southwest along Wickiup Canyon to Cottonwood Canyon to the Cottonwood Springs site.

LCP-1 between RS Hill and the Kimberly (Austin) site follows the same route as LCP-1 between RS Hill and the Cottonwood Springs site to Big Black Mesa, then veers southwest across Big Chino Valley to Walnut Creek. LCP-1 between RS Hill and the Kimberly site follows Walnut Creek to the confluence of Apache Creek, then follows Apache Creek southwest to the headwaters and crosses Pine Creek to the Kimberly site. LCP-2 between RS Hill and the Kimberly site follows the same route as LCP-2 between RS Hill and the Cottonwood Springs site to Hitt Wash, then follows Pine Creek around the south side of Hyde Mountain to the Kimberly site.

LCP-1 between RS Hill and the Ralph (Austin) site follows the same route as LCP-1 between RS Hill and the Kimberly site to the confluence of Walnut Creek and Apache Creek, then continues along North Fork Walnut Creek to the headwaters and over the pass to the Ralph site. LCP-2 between RS Hill and the Ralph site follows the same route as LCP-1 between RS Hill and the Sullivan site to Hell Canyon, then veers west overland across Meath Wash and Big Black Mesa to Big Chino Valley. From Big Chino Valley LCP-2 between RS Hill and the Ralph site follows the same route as LCP-1 between RS Hill and the Ralph site along Walnut Creek to the Ralph site.

LCP-1 between RS Hill and the Cotton Dam site follows the same route as LCP-1 between RS Hill and the Ralph site to the east edge of Big Black Mesa, then veers west to the Cotton Dam site. LCP-2 between RS Hill and the Cotton Dam site follows the same route as LCP-2 between RS Hill and the Ralph site to Meath Wash, then veers west onto Big Black Mesa and the Cotton Dam site.

Least-Cost Path Analysis – Partridge Creek

Using each of the two composite cost surfaces, I produced least-cost paths between the Partridge Creek obsidian primary and secondary source areas and ten habitation sites on the periphery of the spatial distribution of Partridge Creek obsidian artifacts (Figure 5.17). The least-cost paths generated from the composite cost surface with distance to water classified from one to nine are hereafter referred to as PC- LCP-1. The least-cost paths generated from the composite cost surface with distance to water classified from one to thirty are hereafter referred to as PC- LCP-2. All least-cost paths generated for Partridge Creek obsidian originated from the secondary source area in lower Partridge Creek, suggesting that the secondary source area was the focus of prehistoric acquisition of Partridge Creek obsidian.

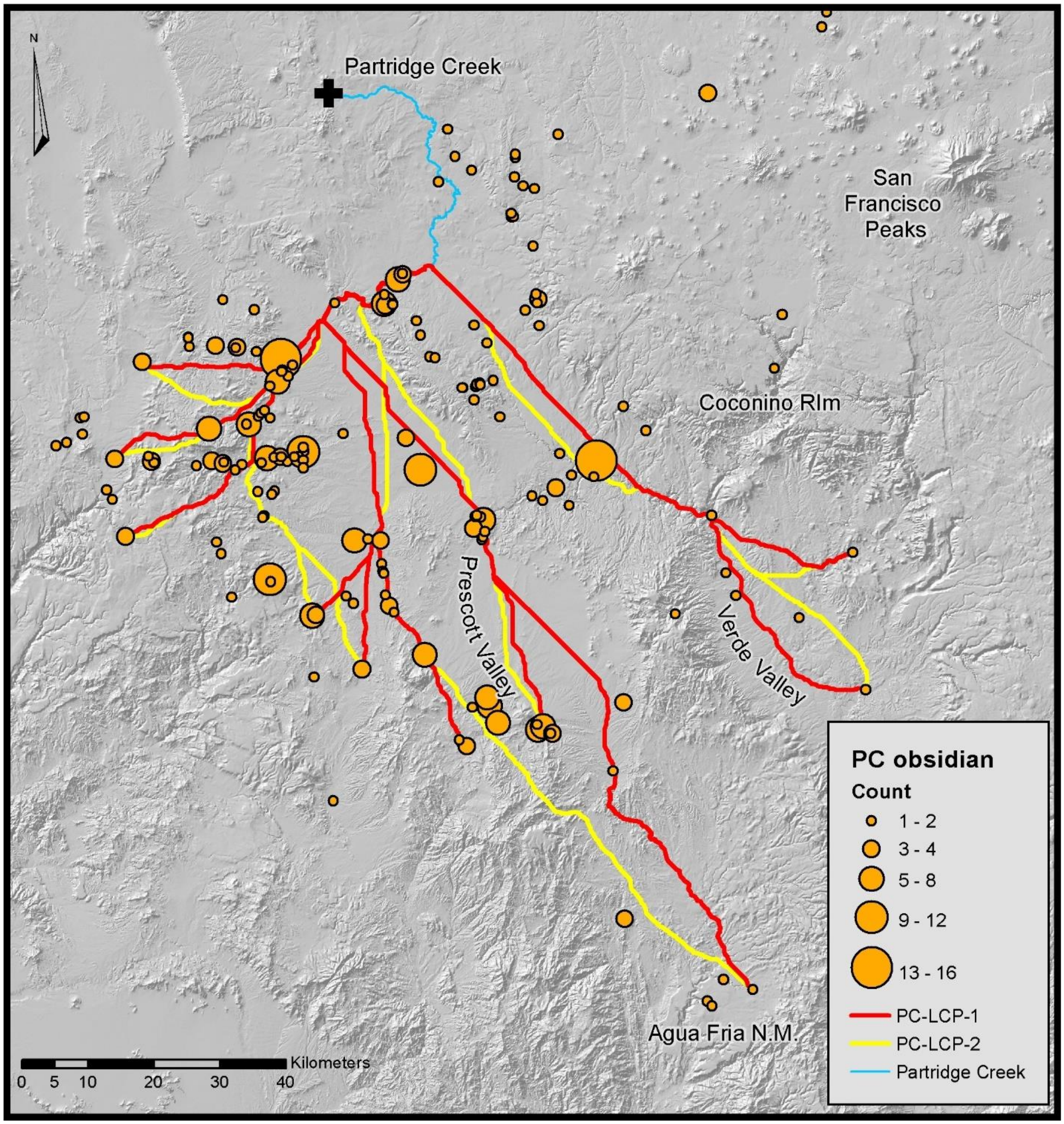

Figure 5.17. Least-cost paths between the Partridge Creek obsidian source areas and ten habitation sites with Partridge Creek obsidian artifacts.

I subsequently evaluated the Partridge Creek least-cost paths based on the number of other sites and artifacts intercepted (within 300 meters) by PC-LCP-1 and PC-LCP-2 between each source-site pair. The results of the side by side comparison of site and artifact interceptions for each PC- LCP-1 and PC-LCP-2 are provided in Table 5.26. The results of Student's *t*-testing indicate that there are no significant differences between mean Partridge Creek artifact interceptions ($p = 0.161$), mean Partridge Creek artifact interceptions ($p = 0.835$), or mean site interceptions ($p = 0.122$) by the two sets of Partridge Creek least-cost paths (Table 5.27).

Table 5.26. Comparison of Site and Artifact Intercepts for Partridge Creek LCP-1 and LCP-2.

Least-Cost Path	Intercepted sites with PC obsidian		Intercepted PC obsidian artifacts		Total sites intercepted	
	LCP-1	LCP-2	LCP-1	LCP-2	LCP-1	LCP-2
PC – Cross Creek	0	1	0	1	3	8
PC – Dyck Cave	0	1	0	1	3	8
PC – West Brooklyn	7	8	17	27	13	11
PC – Fitzmaurice	7	5	17	14	9	7
PC – Sullivan	11	9	32	29	15	12
PC – Tonto Wash	4	9	13	18	6	15
PC – Old Camp	4	9	13	18	6	15
PC – Kimberly	5	5	5	5	8	7
PC – Sandstone 1	5	5	5	5	8	8
PC – ORO	2	5	17	5	3	8
Mean	4.5	5.7	11.9	12.3	7.4	9.9

Table 5.27. Result of Student's *t*-test Comparing Site Interceptions by Partridge Creek LCP-1 and LCP-2.

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	LCP1 PC site intercepts LCP2 PC site intercepts	-1.2	2.48551	0.78599	-2.97803	0.57803	-1.527	9	0.161
Pair 2	PC-LCP1 artifact count PC-LCP2 artifact count	-0.4	5.89161	1.86309	-4.61461	3.81461	-0.215	9	0.835
Pair 3	PC-LCP1 all site intercepts PC-LCP2 all site intercepts	-2.5	4.62481	1.46249	-5.80839	0.80839	-1.709	9	0.122

I also generated least-cost paths between the Partridge Creek obsidian source areas and the same set of ten habitation sites based on each of the three composite cost surface two components (slope, distance to water, and ecological response units) individually. I then compared Partridge Creek LCP-2 routes with each of the three resulting sets of least-cost paths based on the number of other sites and artifacts intercepted (within 300 meters) by each least-cost path between each source-site pair. The results of the side by side comparison of site and artifact interceptions by Partridge Creek LCP-2 routes and the least-cost paths generated based on slope (LCP_{slope}) are provided in Table 5.28. The results of Student's *t*-testing indicate that the ten Partridge Creek LCP-2 routes intercept significantly more sites overall ($p = 0.019$) than the LCP_{slope} routes between the same ten source-site pairs (Table 5.29). There are no significant differences, however, between mean interceptions of sites with Partridge Creek obsidian ($p = 0.067$), or interceptions of Partridge Creek artifacts ($p = 0.380$) by Partridge Creek LCP-2 routes and least-cost paths based on slope (Table 5.29).

Table 5.28. Comparison of Site and Artifact Intercepts for Partridge Creek LCP-2 and LCP_{slope}.

Least-Cost Path	Intercepted sites with PC obsidian		Intercepted PC obsidian artifacts		Total sites intercepted	
	PC-LCP-2	LCP_{slope}	PC-LCP-2	LCP_{slope}	PC-LCP-2	LCP_{slope}
PC – Cross Creek	1	0	1	0	8	1
PC – Dyck Cave	1	0	1	0	8	1
PC – West Brooklyn	8	6	27	20	11	8
PC – Fitzmaurice	5	5	14	16	7	7
PC – Sullivan	9	5	29	16	12	8
PC – Tonto Wash	9	5	18	15	15	7
PC – Old Camp	9	4	18	13	15	6
PC – Kimberly	5	8	5	13	7	11
PC – Sandstone 1	5	6	5	11	8	9
PC – ORO	5	1	5	1	8	2
Mean	5.7	4.0	12.3	10.5	9.9	6.0

Table 5.29. Result of Student's *t*-test Comparing Site and Artifact Interceptions by Partridge Creek LCP-2 and LCP_{slope}.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	LCP2 PC site intercepts - LCP_{slope} PC site intercepts	1.7	2.58414	0.81718	-0.14858	3.54858	2.080	9	0.067
Pair 2	PC-LCP2 artifact count - LCP_{slope} PC artifact count	1.8	6.16081	1.94822	-2.60718	6.20718	0.924	9	0.380
Pair 3	PC-LCP2 all site intercepts - LCP_{slope} all site intercepts	3.9	4.33205	1.36991	0.80104	6.99896	2.847	9	0.019

The results of the side by side comparison of site and artifact interceptions by Partridge Creek LCP-2 routes and the least-cost paths generated based on distance to water (LCP_{H2O}) are provided in Table 5.30. The results of Student's *t*-testing indicate that the ten Partridge Creek LCP-2 routes intercept significantly more sites overall (p = 0.003) than the LCP_{H2O} routes between the same ten source-site pairs (Table 5.31). There are no significant differences, however, between mean interceptions of sites with Partridge Creek obsidian (p = 0.185), or interceptions of Partridge Creek artifacts (p = 0.733) by Partridge Creek LCP-2 routes and least-cost paths based on Distance to water (Table 5.31).

Table 5.30. Comparison of Site and Artifact Intercepts for Partridge Creek LCP-2 and LCP_{H2O}.

Least-Cost Path	Intercepted sites with PC obsidian		Intercepted PC obsidian artifacts		Total sites intercepted	
	PC-LCP-2	LCP_{H2O}	PC-LCP-2	LCP_{H2O}	PC-LCP-2	LCP_{H2O}
PC – Cross Creek	1	4	1	13	8	6
PC – Dyck Cave	1	4	1	13	8	6
PC – West Brooklyn	8	4	27	13	11	6
PC – Fitzmaurice	5	4	14	13	7	6
PC – Sullivan	9	5	29	19	12	9
PC – Tonto Wash	9	7	18	16	15	11
PC – Old Camp	9	7	18	16	15	12
PC – Kimberly	5	4	5	4	7	8
PC – Sandstone 1	5	4	5	4	8	7
PC – ORO	5	3	5	3	8	6
Mean	5.7	4.6	12.3	11.4	9.9	7.7

Table 5.31. Result of Student's *t*-test Comparing Site and Artifact Interceptions by Partridge Creek LCP-2 and LCP$_{H2O}$.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	Upper			
Pair 1	LCP2 PC site intercepts H2O PC site intercepts	1.1	2.42441	0.76667	-0.63432	2.83432	1.435	9	0.185
Pair 2	PC-LCP2 artifact count H2O PC artifact count	0.9	8.10281	2.56233	-4.89640	6.69640	0.351	9	0.733
Pair 3	PC-LCP2 all site intercepts H2O all site intercepts	2.2	1.68655	0.53333	0.99352	3.40648	4.125	9	0.003

The results of the side by side comparison of site and artifact interceptions by the Partridge Creek LCP-2 routes and the least-cost paths generated based on ecological response units (LCP$_{ERU}$) are provided in Table 5.32. The results of Student's *t*-testing indicate that there are no significant differences between mean interceptions of sites with Partridge Creek obsidian ($p = 0.627$), Partridge Creek obsidian artifact interceptions ($p = 0.079$), or overall site interceptions ($p = 0.574$) by Partridge Creek LCP-2 routes and least-cost paths based on ecological response units (Table 5.33).

Table 5.32. Comparison of Site and Artifact Intercepts for Partridge Creek LCP-2 and LCP$_{ERU}$.

Least-Cost Path	Intercepted sites with PC obsidian		Intercepted PC obsidian artifacts		Total sites intercepted	
	PC-LCP-2	LCP$_{ERU}$	PC-LCP-2	LCP$_{ERU}$	PC-LCP-2	LCP$_{ERU}$
PC – Cross Creek	1	2	1	2	8	11
PC – Dyck Cave	1	2	1	2	8	11
PC – West Brooklyn	8	15	27	45	11	24
PC – Fitzmaurice	5	13	14	39	7	19
PC – Sullivan	9	11	29	32	12	16
PC – Tonto Wash	9	4	18	13	15	6
PC – Old Camp	9	4	18	13	15	6
PC – Kimberly	5	6	5	19	7	9
PC – Sandstone 1	5	5	5	5	8	8
PC – ORO	5	2	5	17	8	3
Mean	5.7	6.4	12.3	18.7	9.9	11.3

Table 5.33. Result of Student's *t*-test Comparing Site and Artifact Interceptions by Partridge Creek LCP-2 and LCP_{ERU}.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	LCP2 PC site intercepts ERU PC site intercepts	-0.7	4.39823	1.39084	-3.84631	2.44631	-0.503	9	0.627
Pair 2	PC-LCP2 artifact count ERU PC artifact count	-6.4	10.22198	3.23247	-13.71236	0.91236	-1.980	9	0.079
Pair 3	PC-LCP2 all site intercepts ERU all site intercepts	-1.4	7.58947	2.40000	-6.82918	4.02918	-0.583	9	0.574

LCP-1 between the Partridge Creek source area and the Cross Creek site vectors southeast from lower Partridge Creek approximately seven km southwest of Ash Fork, Arizona, and crosses Meath Wash, Wagon Tire Flat, Grindstone Wash, lower Bear Canyon, and lower Government Canyon before reaching the Verde River at Perkinsville, Arizona. From Perkinsville, LCP-1 between Partridge Creek and the Cross Creek site follows the Verde River to the confluence of Sycamore Creek, then veers east overland across Duff Flat and Coffee Creek to Oak Creek and the Cross Creek site. LCP-2 between the Partridge Creek source area and the Cross Creek site follows the same route as LCP-1 between Partridge Creek and the Cross Creek site to Meath Wash, then veers southeast across upper Hell Canyon and parallels approximately three km to the south of PC-LCP-1 to the Verde River at Perkinsville. From Perkinsville, LCP-2 follows the Verde River to the confluence of Sycamore Creek, then vectors southeast overland across Duff Flat to within approximately 2.5 km of Tuzigoot N.M. before turning east to Oak Creek and the Cross Creek site.

LCP-1 between Partridge Creek and the Dyck Cave site follows the same route as LCP-1 between Partridge Creek and the Cross Creek site to the confluence of Sycamore Creek, then veers south along the Verde River to Hayfield Draw before turning east to Beaver Creek and the Dyck Cave site. LCP-2 between Partridge Creek and the Dyck Cave site follows the same route as LCP-2 between Partridge Creek and the Cross Creek site to the south end of Duff Flat, then veers southeast across Oak Creek and Beaverhead Flat to Beaver Creek and the Dyck Cave site.

LCP-1 between Partridge Creek and the West Brooklyn site follows lower Partridge Creek to Big Chino Wash, then vectors southeast the length of Big Chino Valley to the upper end of Little Chino Valley. From Little Chino Valley, LCP-1 between Partridge Creek and the West Brooklyn site veers southeast across Lonesome Valley to Prescott Valley, then follows the Agua Fria River to the West Brooklyn site. LCP-2 between Partridge Creek and the West Brooklyn site follows lower Partridge Creek southwest to Tucker Springs, then veers south around the east side of South Butte and across Big Chino Valley and Williamson Valley to Mint Wash. LCP-2 between Partridge Creek and the West Brooklyn site follows Mint Wash south and continues southeast overland across Granite Creek and Lynx Creek to Big Bug Creek near Poland Junction. From Poland Junction, LCP-2 between Partridge Creek and the West Brooklyn site follows Big Bug Creek southeast to Badger Springs and crosses the Agua Fria River to the West Brooklyn site.

LCP-1 between Partridge Creek and the Fitzmaurice Ruin follows the same route as LCP-1 between Partridge Creek and the West Brooklyn site to Little Chino Valley, then veers south across Prescott Valley to the Fitzmaurice Ruin. LCP-2 between Partridge Creek and the Fitzmaurice Ruin follows the same route as LCP-2 between Partridge Creek and the West Brooklyn site to Big Chino Wash, then follows Big Chino Valley and turns south through Little Chino Valley and Prescott Valley to the Fitzmaurice Ruin.

LCP-1 between Partridge Creek and the Sullivan site follows the same route as LCP-1 between Partridge Creek and the Fitzmaurice Ruin site to Big Chine Wash, then veers south across Big Chino Valley to Williamson Valley. From Williamson Valley, LCP-1 between Partridge Creek and the Sullivan site follows Mint Wash south around the east side of Granite Mountain to the Sullivan site. LCP-2 between Partridge Creek and the Sullivan site follows the same route as LCP-2 between Partridge Creek and the Fitzmaurice Ruin site to Big Chino Wash, then veers south across Big Chino Valley to Williamson Valley and continues south along Mint Wash around the east side of Granite Mountain to the Sullivan site.

LCP-1 between Partridge Creek and the Tonto Wash site follows the same route as LCP-1 between Partridge Creek and the Sullivan site to Williamson Valley, then veers south through Long Canyon to the Tonto Wash site. LCP-2 between Partridge Creek and the Tonto Wash site follows the same route as LCP-2 between Partridge Creek and the Sullivan site to Big Chino Wash, then veers southwest overland across Big Chino Valley to Walnut Creek. From Walnut Creek, LCP-2 between Partridge Creek and the Tonto Wash site continues south overland to Hitt Wash, then turns southeast and follows Strickland Wash to the Tonto Wash site.

LCP-1 between Partridge Creek and the Old Camp site follows the same route as LCP-1 between Partridge Creek and the Tonto Wash site to Williamson Valley, then veers southwest overland to the Old Camp site. LCP-2 between Partridge Creek and the Old Camp site follows the same route as LCP-2 between Partridge Creek and the Tonto Wash site to Hitt Wash, then veers south overland across Pine Creek, Humphrey Wash, and Horse Wash to the Old Camp site.

LCP-1 between Partridge Creek and the Kimberly (Austin) site follows the same route as LCP-2 between Partridge Creek and the Old Camp site to Walnut Creek, then veers southwest along Apache Creek and crosses Pine Creek to access the Kimberly site. LCP-2 between

Partridge Creek and the Kimberly site follows the same route as LCP-2 between Partridge Creek and the Old Camp site to Walnut Creek, then veers southwest and follows the same route as LCP-1 along Apache Creek to the Kimberley site.

LCP-1 between Partridge Creek and the Sandstone 1 (Austin) site follows the same route as LCP-1 between Partridge Creek and the Kimberly site to Pine Creek, then veers southwest along Pine Creek to the west edge of Juniper Mesa and crosses Muddy Wash to access the Sandstone 1 site. LCP-2 between Partridge Creek and the Sandstone 1 site follows the same route as LCP-1 between Partridge Creek and the Sandstone 1 site to upper Pine Creek, then veers southwest down the south edge of Juniper Mesa into the upper Walnut Creek watershed and west overland to the Sandstone 1 site.

LCP-1 between Partridge Creek and the ORO (Austin) site follows the same route as LCP-1 between Partridge Creek and the Sandstone 1 site to Big Chino Wash, then veers west overland to upper Turkey Canyon. From upper Turkey Canyon, LCP-1 between Partridge Creek and the ORO site continues due west past the south side of Haystack Peak to the ORO site. LCP-2 between Partridge Creek and the ORO site follows the same route as LCP-2 between Partridge Creek and the Sandstone 1 site to lower Pine Creek, then veers west overland across the Juniper Mountains to the ORO site.

In this chapter, I presented the results of my research on the source provenance of obsidian artifacts in west-central Arizona. I collected obsidian provenance data from a total of 2,429 artifacts at 608 archaeological sites within my study area. Government Mountain is the most ubiquitous obsidian source represented in artifact assemblages throughout my study area, followed in descending frequency of occurrence by Partridge Creek, Bull Creek, Presley Wash, RS Hill, Black Tank, Vulture, and Topaz Basin. I collected obsidian provenance data at six ballcourts in my study area – all six have lithic assemblages that include multiple sources of obsidian. Over the course of my research, I identified 41 sites with obsidian artifacts from three different sources, 20 sites with obsidian artifacts from four different sources, ten sites with artifacts from five different obsidian sources, three sites with obsidian from six different sources, and two sites with obsidian from seven different sources. I investigated the influence of proximity to obsidian source areas on lithic assemblages and found that proximity to source areas is a very poor predictor of obsidian sources represented in lithic assemblages, except for sites near the secondary source area for Partridge Creek and Presley Wash obsidian or the Topaz Basin source area. I also completed least-cost path modelling for a total of 40 source-site pairs using two different cost surfaces. My results indicate that the least-cost paths generated from cost surface 1 intercepted significantly ($p = 0.009$) more sites overall than the least cost paths generated from cost surface 2 for Government Mountain source-site pairs. Both cost surfaces produced comparable results for Bull Creek, RS Hill, and Partridge Creek source-site-pairs. Several least-cost paths connect multiple sites and appear to correspond with portions of prehistoric trade routes referenced in the literature, namely the Mojave Trail from the west and the Palatkwapi Trail from the east.

Chapter Six – Discussion

In this chapter, I discuss how my research questions, hypotheses, obsidian provenance data, spatial distribution information, and least-cost path analyses relate to the theoretical underpinnings of my research on prehistoric obsidian acquisition in the Prescott culture area. The theoretical framework serves to frame my hypotheses, inform the methods I use for hypotheses testing, and guide the interpretation of my results. As described in Chapter 2, my research represents a conjunction of theoretical perspectives stemming from the processual paradigm, including behavioral ecology, landscape archaeology, and circuit theory. The following discussion describes how theory and the results of my research help to elucidate obsidian foraging and exchange patterns among prehistoric people groups that inhabited west-central Arizona.

My research focuses on determining the means of obsidian acquisition and sources of obsidian used by pre-contact people in west-central Arizona. I developed three primary research questions to guide my thesis research. 1) Which sources of obsidian are represented at archaeological sites in west-central Arizona? 2) Does the archaeological record provide evidence that precontact people groups in west-central Arizona acquired obsidian through exchange? 3) What aspects of precontact obsidian acquisition behaviors are discernable from the spatial distribution of obsidian artifacts? The following discussion is organized to address each of these research questions in order.

Which sources of obsidian are represented at archaeological sites in west-central Arizona?

Through rigorous application of the scientific method, I established baseline x-ray fluorescence (pXRF) microchemistry profiles for reference collections of obsidian from eight obsidian sources surrounding the Prescott culture area. I subsequently used the same pXRF spectrometer to analyze a total of 2,429 obsidian artifacts from 608 archaeological sites within and around the Prescott culture area. Finally, I deduced the source provenance of each artifact through exploratory data analyses comparing artifact microchemistry to the reference data I collected with the same instrument. I used the same portable XRF spectrometer (pXRF) to control one potential source of variability and maintain consistency throughout my research. My results strongly indicate that precontact peoples in and around the Prescott culture area primarily used obsidian from the Government Mountain source area, followed in decreasing frequency of occurrence by Partridge Creek, Bull Creek, Presley Wash, RS Hill, Black Tank, Vulture, Topaz Basin, and Superior. I also identified 75 archaeological sites in my study area with lithic assemblages that include multiple (3-7) obsidian sources.

Does the archaeological record provide evidence that precontact people groups in west-central Arizona acquired obsidian through exchange?

I developed the hypothesis that prehistoric people groups in west-central Arizona preferentially acquired obsidian from the nearest source area based on the premises of human behavioral ecology. Acquiring raw lithic materials from the nearest obsidian source would minimize the investment of time, energy expenditure, and exposure to risk during foraging. From a human behavioral ecology perspective, obtaining obsidian from the nearest source area is an adaptive strategy that functions to conserve time and energy and minimize risk during foraging. Other obsidian acquisition strategies that could conserve time and energy, and minimize exposure to risk, include using least-cost paths and exchange through a social network. Local foraging, use of least-cost paths, exchange through a social network, or a combination thereof are possible functional explanations to reconstruct human behavior from the spatial distribution of obsidian artifacts using human behavioral ecology.

I used a Geographic Information System (GIS) to attribute each of the spatially arrayed sites with obsidian artifacts with the identity of nearest obsidian source area and the distance to the nearest obsidian source area. I subsequently queried the source provenance data to determine the proportion of sites with obsidian from the nearest obsidian source area and the proportion of obsidian artifacts at each site that are from the nearest obsidian source area. The lithic assemblages at slightly less than half (48.2%) of the archaeological sites I evaluated include obsidian from the nearest obsidian source area. Obsidian from the nearest source comprised 3.2% to 100% (mean 78.6%) of obsidian of the lithic assemblages that included obsidian from the nearest source area. This finding demonstrates that even in contexts where people acquired obsidian from the nearest source, the use of local obsidian was not exclusive. The finding that the majority of archaeological sites in my study area do not include obsidian from the nearest source area also strongly indicates that precontact people in west-central Arizona primarily obtained obsidian through exchange or some means other than direct acquisition.

Beyond evidence of exchange, the use of obsidian from both local and non-local sources suggests that obsidian may have represented social or non-utilitarian values to precontact people in west-central Arizona. Individual obsidian sources may retain special roles within prehistoric culture and belief systems (Dillian 2002:2). Groups in the Prescott culture area used a variety of locally available flaked-stone materials, including fine-grained basalt, chert, chalcedony, jasper, and obsidian from secondary deposits along lower Partridge Creek and Big Chino Wash, but also acquired different types of obsidian from non-local sources. Sites with non-local obsidian in addition to, or instead of, locally available toolstone, therefore, suggests not only some form of social interaction in procurement, but also that obsidian may have signified associated social connections, places, events, or beliefs.

Pre-contact people inhabiting the vicinities of Bull Creek or the secondary deposits of Partridge Creek and Presley Wash obsidian in lower Partridge Creek account for most of the obsidian acquisition from the nearest source. Results strongly indicate that proximity to obsidian source areas is a poor predictor of obsidian in lithic assemblages in west-central Arizona. The results further suggest that people obtained most of the obsidian in lithic assemblages at sites in the study area through some means other than direct acquisition from the nearest obsidian source area. In conjunction with the spatial distribution of 75 archaeological sites with multiple sources of obsidian, the data regarding proximity to obsidian source areas provides unequivocal evidence that prehistoric people inhabiting west-central Arizona primarily obtained obsidian toolstone via exchange through a social network.

What aspects of precontact obsidian acquisition behaviors are discernable from the spatial distribution of obsidian artifacts?

I used landscape archaeology theory as a framework for integrating GIS, remote-sensing, cartographic data, and pXRF technology with historical information in the spatial analyses of obsidian provenance data. First, I spatially arrayed all 608 archaeological sites with obsidian provenance data using coordinates I obtained in the field, from site records, from aerial imagery, or from USGS topographic maps. Second, I used GIS raster tools to construct two cost surfaces, each a composite of slope, distance to water, and vegetation community type. I derived all three components of each of the two cost surfaces from cartographic data – a digital elevation model for slope, the National Hydrographic Dataset (NHD) springs (point) feature class for distance to water, and the ecological response unit (polygon) feature class for vegetation community type. Third, I used the GIS Spatial Analyst Cost Connectivity tool to generate least-cost paths between the four most frequently used obsidian source areas and archaeological sites with obsidian artifacts from the corresponding source provenance.

I developed the second cost surface that incorporates greater sensitivity for distance to water based on the principles of human behavioral ecology and circuit theory in conjunction with the findings of Brown (1991). If Government Mountain obsidian was transported to Grapevine, Kinnickinick, and other lithic manufacturing sites on Anderson Mesa before entering the exchange network via Chavez Pass as inferred by Brown (1991), then the obsidian acquisition route between Government Mountain and Chavez Pass (simulated by a least-cost path) should connect one or more lithic manufacturing sites on Anderson Mesa. The NHD data indicate that springs are concentrated along the east edge of Anderson Mesa. The least-cost path between Government Mountain and Chavez Pass based on the first cost surface (with distance to water classified from 1-9) passed over 1.5 km to the west of the Grapevine and Kinnickinick sites. The least-cost path between Government Mountain and Chavez Pass based on the second cost surface (with distance to water classified from 1-30), however, passed within 100 meters of the Grapevine site and 850 meters from the Kinnickinick site (Figure 6.1). In my research, using human behavioral ecology in conjunction with circuit theory resulted in least-cost path modeling that supports Brown's (1991) inference regarding the movement of obsidian between Government Mountain and Chavez Pass and suggests that proximity to water was an important site selection criteria for Grapevine, Kinnickinick, and other lithic manufacturing sites on Anderson Mesa. Thus, my spatial data analyses heavily relied on the integration of GIS tools, remote-sensing data, cartographic data, pXRF-based source provenance data, and historical information grounded in landscape archaeology theory.

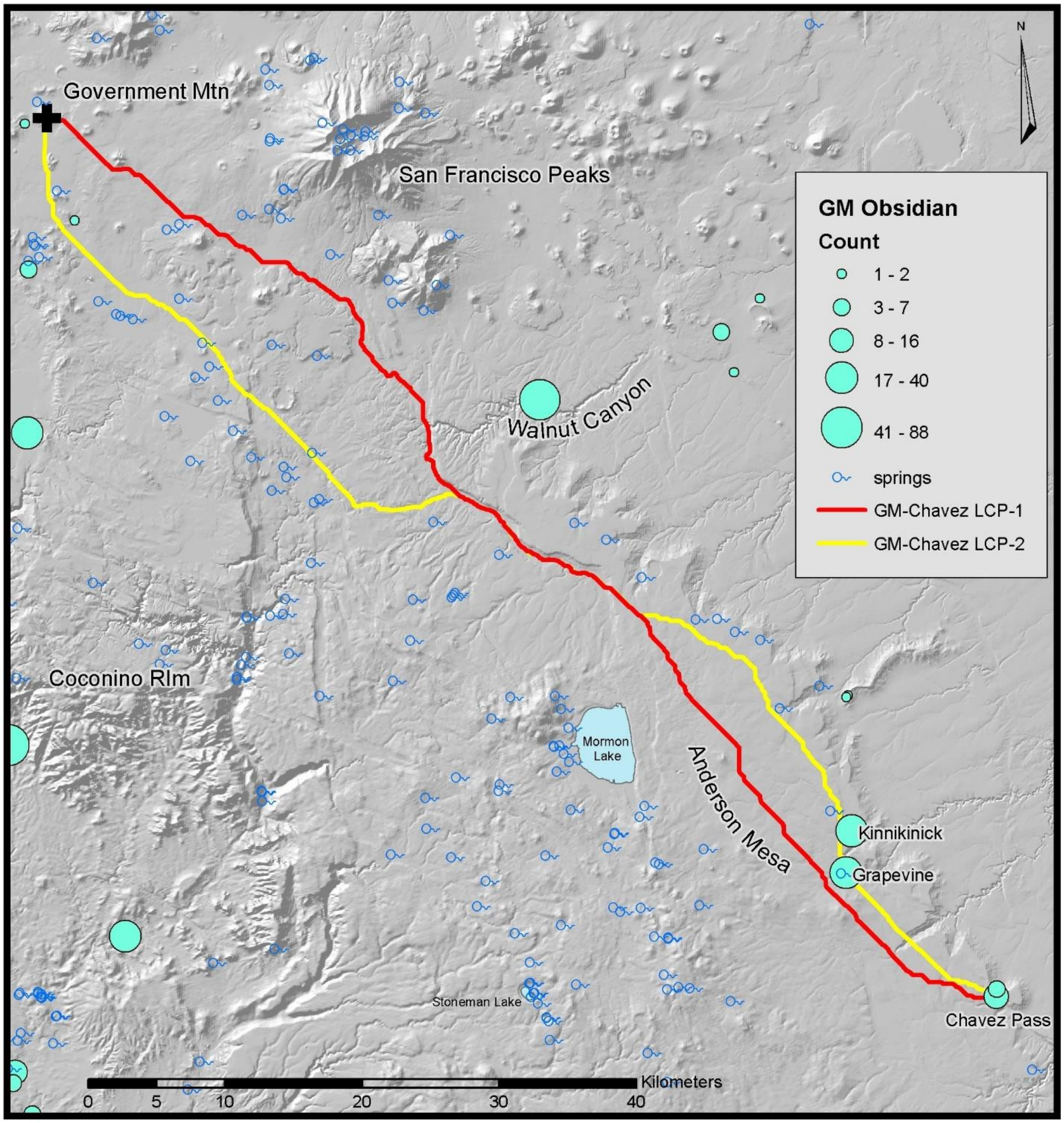

Figure 6.1. Least-cost paths between Government Mountain and Chavez Pass.

I evaluated the least-cost paths between obsidian source areas and points of artifact deposition based, in part, on Miroslav's (2015) observation that the spatial distribution of habitation features (settlement patterning) is correlated with trade routes. Findings indicate that the most probable routes of obsidian exchange in the Prescott culture area, as represented by least-cost paths, connect numerous archaeological sites between the modelled source-site pairs and extend documented historic/prehistoric travel corridors. For example, both of the modelled least-cost paths between Chavez Pass and the Fitzmaurice Ruin connected four other archaeological sites in the Verde Valley, including Montezuma Well N.M., Lake Montezuma pueblo, Sacred Mountain pueblo, and the Dyck Cave shelter (Figure 5.13). The modelled least-cost paths between Chavez Pass and the Fitzmaurice Ruin suggest a westward extension of the Palatkwapi Trail from the Hopi Mesas described by Byrkit (1988), which may also have served to distribute trade wares from ancestral Puebloan manufacturing centers to consumers in the Prescott culture area.

A second example of coincidence between a documented historic/prehistoric travel route and least-cost path modelling in the Prescott culture area is apparent in the Walnut Creek corridor. Modelled least-cost paths between the Government Mountain obsidian source area and two archaeological sites near Mount Hope with lithic assemblages that include Government Mountain obsidian artifacts follow the entire length of the Walnut Creek corridor, connecting at least 22 other archaeological sites (Figure 5.12). The modelled least-cost paths between Government Mountain and two archaeological sites near Mount Hope suggest an eastward extension of the Mojave Trail from the Pacific Coast described by Wilcox and Samples (1990), which likely facilitated the shell trade between the Pacific Coast and consumers in the Prescott culture area and the Sinagua and Kayenta groups to the east.

A third example of connectivity between modelled least-cost paths and the spatial distribution of archaeological sites in the Prescott culture area is observed in the northwest to southeast corridor through the southern portions of Williamson Valley, Little Chino Valley, and Lonesome Valley. Modelled least-cost paths between the Bull Creek obsidian source area and the Joes Hill East site on the Agua Fria National Monument follow the modern-day Williamson

Valley Road and Arizona State Route 69 corridors, connecting at least 14 other archaeological sites (Figure 6.2). One of the two least-cost paths between the Bull Creek obsidian source area and the Joes Hill East site on the Agua Fria National Monument (LCP-1) connects six other archaeological sites that have the highest obsidian source diversity in my entire study area, including the Fitzmaurice Ruin. LCP-1 between Bull Creek and the Fitzmaurice Ruin indicates probable connectivity between the Mojave Trail from the Pacific Coast described by Wilcox and Samples (1990) and the Palatkwapi Trail from the east described by Byrkit (1988) through the heartland of the Prescott culture area.

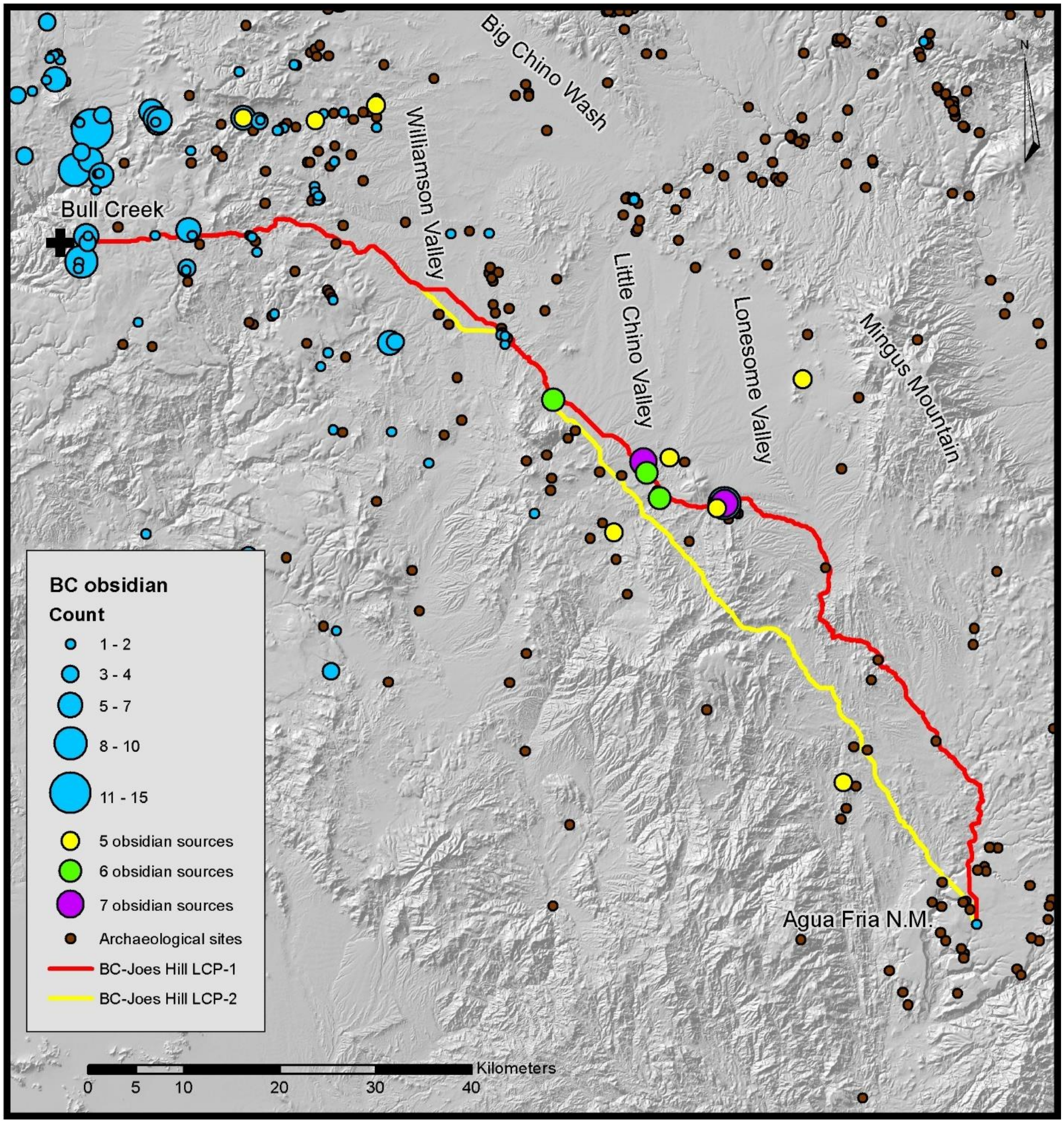

Figure 6.2. Least-cost paths between Bull Creek source area and the Joes Hill East site intersecting other archaeological sites with multiple sources of obsidian.

My obsidian provenance results demonstrate that all five of the ballcourts in the Prescott-Cohonina frontier zone on the Coconino Rim have lithic assemblages that include predominantly Government Mountain and RS Hill obsidian. The lithic assemblage at the Wagner Hill ballcourt also includes Bull Creek obsidian, and the lithic assemblage at the JD Wash ballcourt also includes Superior obsidian. One of the modelled least-cost paths between Government Mountain and the Fitzmaurice Ruin (LCP-1) directly passes through the Wagner Hill ballcourt site and between several other ballcourts in the Prescott-Cohonina frontier zone (Figure 6.3). Ballcourts are an archaeological representation of social interaction between distinct regional groups (Morales 1994:7). Northern Arizona ballcourt artifact assemblages indicate community participation, feasting, and exchange associated with the ballgame (Morales 1994:78). The movement of goods (and information) associated with exchange may operate across cultural boundaries between social units (Renfrew 1975:4). When exchange repeatedly occurs at a specific location, that location may be described as a central place, with appurtenant significance for the cohesiveness of the group (Renfrew 1975:5). As specialization develops within human populations, centers become points of attraction for a larger territory, and become exchange centers for non-local goods (Renfrew 1975:27). My obsidian provenance data and least-cost path modelling indicate commoditization and intercultural exchange of obsidian, and that the Wagner Hill ballcourt constituted a central place of exchange between Prescott and Cohonina groups.

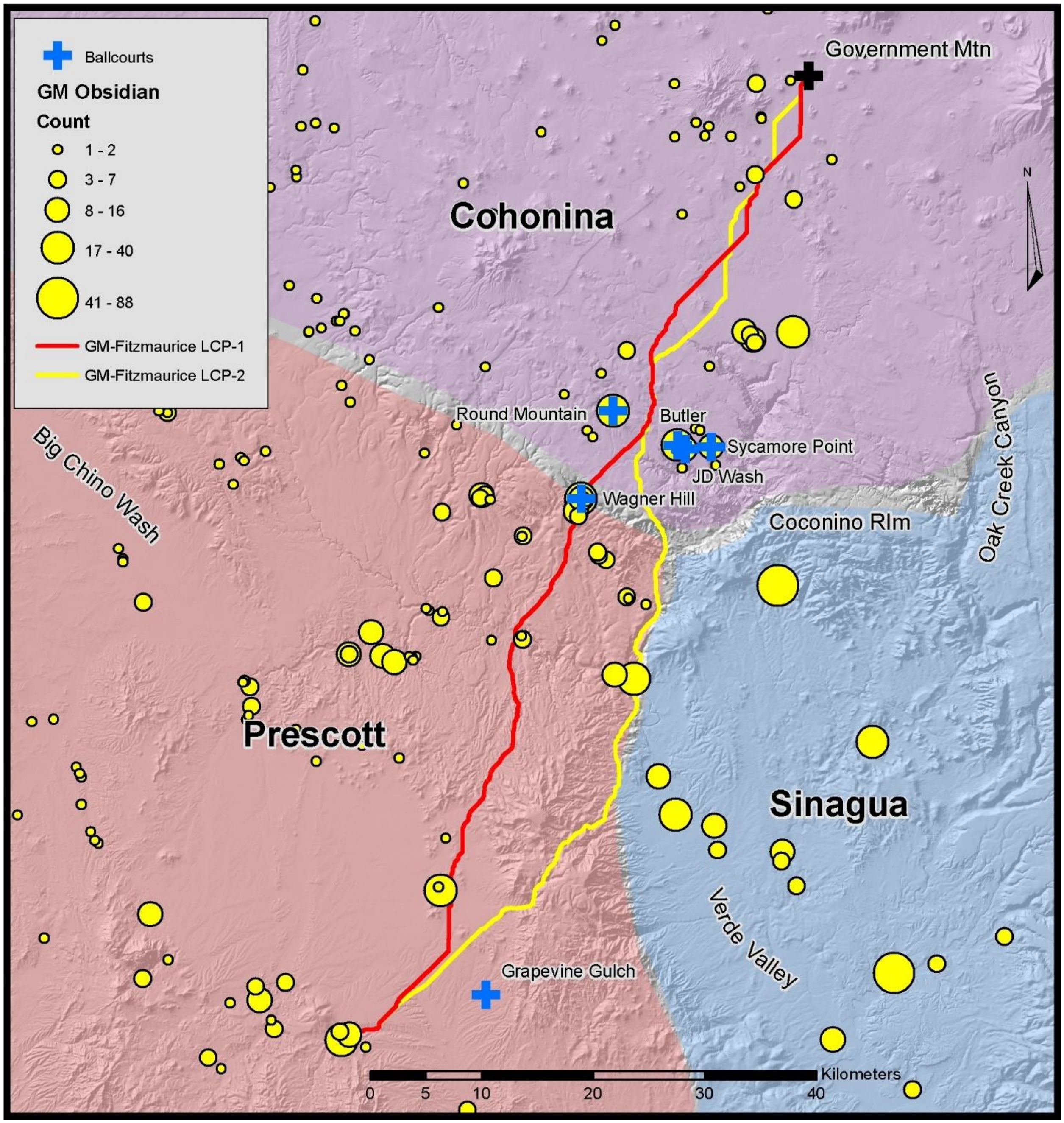

Figure 6.3. Least-cost paths between Government Mountain and Fitzmaurice Ruin showing proximity to ballcourts in the Prescott-Cohonina-Sinagua frontier zone.

This research represents a conjunction of several theoretical perspectives stemming from the processual paradigm, including behavioral ecology, landscape archaeology, and circuit theory. The theoretical framework for my research on precontact obsidian acquisition in the Prescott culture area facilitates the development of my research questions and hypotheses, and informs the methods I use to collect, analyze, and interpret obsidian provenance data and the related spatial distribution information. I used pXRF spectrometry to analyze and assign source provenance to 2,429 obsidian artifacts from 608 archaeological sites and determine that precontact peoples in west-central Arizona primarily used obsidian from Government Mountain, Partridge Creek, Bull Creek, Presley Wash, and RS Hill. Based on human behavioral ecology, I developed and tested the hypothesis that precontact people groups in west-central Arizona preferentially acquired obsidian from the nearest source area. I rejected this hypothesis by determining that a majority of sites with obsidian in my study area do not include obsidian from the nearest source area and identifying 75 sites with obsidian from multiple source areas. Based on the processual tenet that past behavior is discernable from spatial and temporal patterns in the archaeological record, the spatial distribution of archaeological sites with multiple sources of obsidian, and data regarding proximity to obsidian source areas, I inferred that prehistoric people inhabiting west-central Arizona primarily obtained obsidian toolstone via exchange through a social network. Landscape archaeology theory provides a framework for integrating GIS, remote-sensing, cartographic data, pXRF technology, and ethnographic or historical information in the spatial analyses of my obsidian provenance data. By using human behavioral ecology in conjunction with circuit theory, I produced least-cost path modeling that supports Brown's (1991) inference regarding the movement of obsidian between Government Mountain and Chavez Pass through lithic manufacturing sites on Anderson Mesa. By using human behavioral ecology in conjunction with the spatial distribution of obsidian provenance data, I also developed least-cost paths connecting precontact trade routes from the east and west through the heartland of the Prescott culture area. My theoretical framework and research results function together to elucidate obsidian foraging and exchange patterns among precontact people groups in west-central Arizona.

Chapter Seven – Conclusions

In this chapter, I summarize the findings of my obsidian provenance study and data analyses, relate my thesis research to the body of literature pertaining to prehistoric obsidian acquisition and the Prescott culture area, and make recommendations for further research. As described in Chapter 2, there is a limited body of archaeological research focused on the Prescott culture area. Although there are numerous documented obsidian sources in northern and central Arizona (Shackley 2005), the relative importance of individual obsidian sources and the means that pre-contact people living in the Prescott culture area used to acquired obsidian are not described beyond site-specific contexts. To date, there have been no obsidian provenance studies specifically designed to describe obsidian acquisition and exchange by pre-contact people in the Prescott culture area and the related interactions with adjacent cultural groups of west-central Arizona. My research elucidates obsidian foraging and exchange patterns among pre-contact people groups that inhabited west-central Arizona to address gaps in our understanding and identifies the need for further research.

My obsidian provenance data indicate that pre-contact people groups of west-central Arizona primarily obtained obsidian from the Government Mountain, Partridge Creek, Bull Creek, Presley Wash, and RS Hill source areas, in decreasing frequency of occurrence. Government Mountain is by far the most prevalent obsidian source found in lithic assemblages within and surrounding the Prescott culture area. Much less commonly used obsidian sources in my study area include Black Tank, Vulture, Topaz Basin, and Superior.

Obsidian and other lithic materials were essential to the survival of hunter-gatherers and early agriculturalist people groups inhabiting west-central Arizona. It follows that the Government Mountain and RS Hill obsidian source areas were likely controlled by the Cohonina or Northern Sinagua people groups inhabiting the area immediately west of the San Francisco Peaks. The relative frequency of Government Mountain and RS Hill obsidian in lithic assemblages in the Prescott culture area, therefore, supports the inference that people in the Prescott culture area likely acquired obsidian from these two sources via exchange with Cohonina or Sinagua people groups. Using the same logic, I infer that obsidian from the Superior and Vulture source areas that is found in lithic assemblages in the Prescott culture area most likely was acquired through exchange with Hohokam people groups to the south.

Spatial data indicate that the Sycamore Point, Wagner Hill, JD Wash, Butler, and Round Mountain ballcourts are located at the southern edge of the Cohonina territory on the northern edge of the steep topographic break formed by the Coconino Rim, which defines the northern extent of the Prescott culture area. The Wagner Hill ballcourt is furthest south in the cluster of ballcourts on the Coconino Rim, in the frontier zone between the Cohonina and Prescott culture areas. The cluster of five ballcourts on the Coconino Rim, therefore, are located in geographical and topographical transition areas between adjacent people groups and between the obsidian source areas and neighboring people groups. Obsidian provenance results demonstrate that all five of the ballcourts in the Prescott-Cohonina frontier zone on the Coconino Rim have lithic assemblages that include obsidian - predominantly from the Government Mountain and RS Hill source areas. The least-cost path between the Government Mountain source area and the Fitzmaurice Ruin directly passes through the Wagner Hill ballcourt site and between several other ballcourts in the Prescott-Cohonina frontier zone. The spatial distribution of the five Cohonina ballcourt features, the source provenance of the obsidian in the associated lithic assemblages, together with the conclusions of Morales (1994) and Wilcox and Sternberg (1983) regarding the role of ballcourts in exchange, support the inference that the Wagner Hill ballcourt likely served as a center of exchange for obsidian and other commodities between Cohonina and Prescott culture groups.

My obsidian provenance study identifies 41 sites in west-central Arizona that each include artifacts from three different obsidian source areas, 20 sites that have obsidian artifacts from four different source areas, ten sites that have artifacts from five different obsidian source areas, three sites that include obsidian from six different source areas, and two sites that include obsidian artifacts from seven different source areas. The spatial distribution of archaeological sites in my study area that include multiple sources of obsidian is clustered in a northwest to southeast swath between Walnut Creek and the upper Agua Fria River at the south end of Lonesome Valley. The 75 archaeological sites with lithic assemblages that include obsidian artifacts from multiple sources support the inference that people in the Prescott culture area obtained at least some of the obsidian via exchange.

The lithic assemblages at fewer than half (48.2%) of the archaeological sites I evaluated include obsidian from the nearest obsidian source area. Prehistoric people inhabiting the vicinities of Bull Creek or the secondary deposits of Partridge Creek and Presley Wash obsidian in lower Partridge Creek account for most of the obsidian acquisition from the nearest source. Even in contexts where lithic assemblages include obsidian from the nearest source, the use of local obsidian was not exclusive. My results indicate that proximity to obsidian source areas is a poor predictor of obsidian in lithic assemblages in west-central Arizona, and support the inference that obsidian in lithic assemblages at most sites in my study area was obtained through some means other than direct acquisition from the nearest obsidian source area.

Least-cost path modelling between the Bull Creek source area and a site with Bull Creek obsidian (Joes Hill East) on the Agua Fria National Monument connects 14 other sites, including several sites with lithic assemblages that contain four to seven different sources of obsidian. Based on the spatial distribution of 75 archaeological sites with multiple sources of obsidian, the data regarding proximity to obsidian source areas, and the results of least-cost path modelling, I conclude that prehistoric people inhabiting the Prescott culture area primarily obtained obsidian toolstone via exchange through a social network.

Implications of the Spatial Distributions of Obsidian

The spatial distribution of archaeological sites with high counts of obsidian artifacts from the Government Mountain source area is skewed to the east by sites on Anderson Mesa, the middle Verde Valley, and the Agua Fria National Monument. By the Tuzigoot phase (A.D. 1300 to 1425), the Flagstaff area was largely abandoned and Sinagua populations contracted to approximately 40 large pueblos and cliff dwelling sites in riparian corridors of the middle Verde Valley (Pilles 1976). The major occupations of the Kinnickinick, Grapevine, and Chavez Pass sites on Anderson Mesa occurred between A.D. 1300 and 1450 (Brown 1991). Sites on the Agua Fria National Monument primarily were occupied between the fourteenth and early fifteenth centuries (Abbott and Spielman 2014). Thus, the skewed distribution of archaeological sites with high counts of obsidian artifacts from the Government Mountain source area appears to spatially and temporally correspond with late prehistoric movements of the Sinagua.

The Chavez Pass North, and Chavez Pass South pueblos have 200 and 937 rooms, respectively (Brown 1991). Pueblo La Plata and the Las Mujeres Pueblo on the Agua Fria N.M. have 66 and 77 rooms, respectively (Schollmeyer and Nelson 2014). In contrast, Fitzmaurice Ruin, by far the largest pueblo in the Prescott culture area, has a total of 47 rooms (Motsinger et. al. 2000). Thus, the pattern of spatial distribution of archaeological sites with high counts of obsidian artifacts from the Government Mountain source area also corresponds with the increase in habitation size from the Prescott culture area east to Anderson Mesa, the middle Verde Valley and Agua Fria National Monument. The skewed spatial distribution of archaeological sites with high counts of obsidian artifacts from the Government Mountain source area likely is also a reflection of the Sinagua cultural dominance in west-central Arizona (Potter 2003:143).

The spatial distribution of RS Hill obsidian artifacts is skewed to the west in comparison to the spatial distribution of obsidian artifacts from the Government Mountain source area. The vast majority of sites (90 of 93) in my database with lithic assemblages that include RS Hill obsidian artifacts are within the Cohonina or Prescott culture areas (Figure 5.2). Walnut Canyon N.M., Gray Fox Ridge in the Verde Valley, and Bishop Creek West on the Agua Fria National Monument are the only three Sinagua sites in my database that include RS Hill obsidian artifacts. The disparity between the spatial distributions of Government Mountain and RS Hill obsidian artifacts is peculiar, given the Government Mountain and RS Hill source areas are approximately five km apart.

Cohonina sites in the northern portion of my study area were largely abandoned by A.D. 1100 (Wilcox et. al. 1996). The Prescott culture area was largely depopulated by A.D. 1310 (Motsinger et. al. 2000). Most of the Sinagua sites on Anderson Mesa, the middle Verde Valley, and Agua Fria National Monument in the eastern portion of my study area were established after A.D. 1300 (Pilles 1976; Brown 1991; Abbott and Spielman 2014). Thus, the distribution of archaeological sites with obsidian artifacts from the RS Hill source area appears to spatially and temporally correspond with sites that were occupied prior to A.D. 1310.

Another factor that may influence the difference between Government Mountain and RS Hill obsidian artifact distributions is the relative quality of the obsidian from these two source areas. RS Hill obsidian typically has 1-3 mm feldspar phenocrysts (Shackley 2005) – inclusions that hamper control during flint knapping. Government Mountain obsidian, in contrast, has no phenocrysts, and is the highest quality of all the large-nodule sources on the Coconino Plateau (Shackley 2005). RS Hill obsidian artifacts comprise 187 (7.7%) of the 2,429 artifacts in the source provenance database. Government Mountain obsidian artifacts comprise 1,244 (51.2%) of the 2,429 artifacts in my source provenance database. Given the close proximity of the Government Mountain and RS Hill obsidian source areas and the difference in spatial and temporal distributions of artifacts from the two source areas, my results indicate that precontact people groups in west-central Arizona developed a preference for Government Mountain obsidian over RS Hill obsidian due to inherent differences in toolstone quality. Further research is needed to establish the occupation dates for more of the sites with obsidian artifacts in the Prescott culture area to better elucidate the chronology of changes in the use of different obsidian sources.

Obsidian artifacts with a Topaz Basin, Vulture, or Superior source provenance have relatively limited distributions in west-central Arizona. Topaz Basin, Vulture, and Superior are Tertiary obsidian sources that yield relatively small nodules called marekenites. The diminutive proportions of Topaz Basin, Vulture, and Superior marekenites requires bipolar reduction techniques and limits the size and type of tools that can be manufactured with obsidian from these sources. Thus, the relatively limited distributions of Topaz Basin, Vulture, and Superior artifacts in my study area may be related to the limited utility of the raw material from these sources.

All eight sites with lithic assemblages that include Topaz Basin obsidian are within 50 km of the Topaz Basin source area. The aerial extent of the Topaz Basin obsidian source area is less than 0.25 km^2. Thus, in addition to the limited utility of Topaz Basin marekenites, the limited distribution of Topaz Basin artifacts likely is related to the discrete aerial extent of the Topaz Basin source area.

Most of the 15 sites with lithic assemblages that include Vulture obsidian are 100-130 km north of Jackrabbit Wash – the secondary source area for Vulture obsidian. The two sites with lithic assemblages that include Superior obsidian are 190-210 km northwest of Queen Creek – the secondary source area for Superior obsidian. Vulture and Superior are the southernmost and most distant obsidian sources that I analyzed in my study area. Vulture and Superior are also the only two obsidian sources within Hohokam territory that I analyzed in my study area. Hohokam influence in the Prescott culture area faded late in the eleventh century, giving way to increased Sinagua influence from the Verde Valley and Flagstaff areas through the end of the thirteenth century (North 2008). Thus, the relatively limited distributions of Vulture and Superior obsidian artifacts in my study area may also be related to the distance from the source areas and abbreviated interaction between the Hohokam and Prescott culture areas. Most of the Vulture obsidian artifacts at sites in my study area are projectile points and one of the two Superior obsidian artifacts is a projectile point. The evidence from my research suggests that most Vulture and Superior obsidian may have arrived in the Prescott culture area as finished projectile points. The small sample size of Topaz Basin, Vulture, and Superior obsidian artifacts in my database, however, limits the strength of my inferences regarding obsidian from these three sources.

Shackley (2005:29) noted that Black Tank obsidian had not been reported south of the Coconino Rim. My research identifies nine sites south of the Coconino Rim with lithic assemblages that include Black Tank obsidian, thereby extending the known range and archaeological use of obsidian from this source. The Black Tank obsidian source area is located approximately 23 km north of the Partridge Creek primary source area, in the west-central portion of the Cohonina territory. Given the location of the Black Tank obsidian source area, the distribution of Black Tank obsidian is likely an indication of Cohonina influence. After the Vulture and Superior obsidian source areas, the Black Tank obsidian source area is the third most distant from my study area. The mean distance between the 19 sites with artifact assemblages that include Black Tank obsidian and the Black Tank source area is 70.5 km. The distribution of the 19 sites with lithic assemblages that include Black Tank obsidian is limited to the Cohonina and Prescott culture areas. None of the sites with lithic assemblages that include Black Tank obsidian are located in the Sinagua territory. Thus, the spatial distribution of sites that include Black Tank obsidian likely corresponds to occupation dates prior to A.D. 1310 (Motsinger et. al. 2000) and possibly prior to A.D. 1100 (Wilcox et. al. 1996), as described for the distribution of RS Hill obsidian.

The spatial distribution of Bull Creek obsidian artifacts is clustered around the Bull Creek source area and extends east up to 120 km. The spatial distribution of sites with lithic assemblages that include Bull Creek obsidian is largely limited to the Prescott and Patayan culture areas. None of the sites with lithic assemblages that include Bull Creek obsidian are located in Cohonina territory above the Coconino Rim. The only context where I identified Bull Creek obsidian in the Sinagua culture area is two artifacts at the Joes Hill East site on the Agua Fria National Monument. The Joes Hill East site is a small group of pithouses with sparse ceramic scatter that includes Deadman’s black-on-red, consistent with occupation prior to A.D. 1100. Thus, the spatial distribution of sites that include Bull Creek obsidian likely corresponds to occupation of the Prescott culture area prior to A.D. 1310 (Motsinger et. al. 2000), as described for the distribution of RS Hill obsidian.

Bull Creek is a Tertiary obsidian source that yields relatively small nodules called marekenites, similar to Topaz Basin, Vulture, and Superior. The diminutive proportions of Bull Creek marekenites requires bipolar reduction techniques and limits the size and type of tools that can be manufactured from this source. Thus, the relatively limited spatial distribution of Bull Creek artifacts in my study area (in comparison with Government Mountain, RS Hill, Partridge Creek, and Presley Wash) may also be related to the limited utility of the raw material from Bull Creek.

It is important to note, however, that the cluster of sites near the Bull Creek source area with Bull Creek obsidian artifacts includes eleven sites along Walnut Creek, a corridor on the Mojave Trail from the Pacific Coast (Wilcox and Samples 1990). The spatial distribution of sites with Bull Creek obsidian southeast from lower Walnut Creek also strongly corresponds to the distribution of sites with lithic assemblages that include five, six, or seven different sources of obsidian, including the Fitzmaurice Ruin (Figure 5.10). The lithic assemblage at the Fitzmaurice Ruin includes six whole Bull Creek marekenites. The coincidence of Bull Creek obsidian artifacts distributed along Walnut Creek and southeast through a swath of archaeological sites with multiple sources of obsidian strongly indicates that precontact people transported obsidian from the Bull Creek source area along the Mojave Trail, an exchange route used for Pacific shell and turquoise from the west (Wilcox et al. 2000).

I identified 183 archaeological sites in my study area with lithic assemblages that include Partridge Creek obsidian artifacts – 78.7% (n = 144) are in the Prescott culture area, 13.1% (n = 24) are in the Cohonina culture area, and 5.0% (n = 9) are in the Sinagua culture area (Table 7.1). I identified 408 Partridge Creek obsidian artifacts in my study area – 85.3% (n = 348) are in the Prescott culture area, 7.6% (n = 31) are in the Cohonina culture area, and 2.5% (n = 10) are in the Sinagua culture area. I identified 107 archaeological sites in my study area with lithic assemblages that include Presley Wash obsidian artifacts – 58.9% (n = 63) are in the Prescott culture area, 27.1% (n = 29) are in the Cohonina culture area, and 7.5% (n = 8) are in the Sinagua culture area. I identified 192 Presley Wash obsidian artifacts in my study area – 67.2% (n = 129) are in the Prescott culture area, 24.0% (n = 46) are in the Cohonina culture area, and 4.2% (n = 8) are in the Sinagua culture area.

Table 7.1. Proportions of Archaeological Sites in West-Central Arizona with Partridge Creek or Presley Wash Obsidian Artifacts.

Source Provenance	Prescott		Cohonina		Sinagua	
	Sites	Artifacts	Sites	Artifacts	Sites	Artifacts
Partridge Creek	78.7% (n = 144)	85.3% (n = 348)	13.1% (n = 24)	7.6% (n = 31)	5.0% (n = 9)	2.5% (n = 10)
Presley Wash	58.9% (n = 63)	67.2% (n = 129)	27.1% (n = 29)	24.0% (n = 46)	7.5% (n = 8)	4.2% (n = 8)

The spatial distributions of Partridge Creek and Presley Wash obsidian artifacts (Figures 5.3 and 5.4) indicate that precontact people in the western Cohonina and Prescott culture areas primarily acquired Partridge Creek and Presley Wash obsidian from secondary deposits in the alluvium of Partridge Creek, rather than the primary source areas. The vast majority of archaeological sites with lithic assemblages that include Partridge Creek and Presley Wash obsidian and the highest counts of Partridge Creek and Presley Wash obsidian artifacts are associated with the Prescott culture area. The spatial distributions of sites with Partridge Creek and Presley Wash obsidian artifacts, therefore, indicates that precontact people within the Prescott culture area likely were responsible for handling most of the obsidian from Partridge Creek and Presley Wash found in the archaeological record throughout west-central Arizona. Given Renfrew's (1975:22) perspective on resource control and the occupation dates of most pueblos on Anderson Mesa, the Verde Valley, and the Agua Fria National Monument, the Presley Wash and Partridge Creek artifacts associated with Sinagua sites support the inference that people in the Prescott culture area exchanged Partridge Creek and Presley Wash obsidian with Sinagua groups after the thirteenth century.

My least-cost path analyses based on the spatial distribution of obsidian source areas and artifacts identifies probable exchange routes linking precontact people and commodities in the Sinagua, Patayan, Cohonina, and Prescott culture areas. The modelled least-cost paths between Chavez Pass and the Fitzmaurice Ruin suggest a westward extension of the Palatkwapi Trail from the Hopi Mesas described by Byrkit (1988), linking Sinagua sites in the Verde Valley and consumers in the Prescott culture area with ancestral Puebloan ceramic manufacturing centers to the northeast. The modelled least-cost paths between Government Mountain and two archaeological sites near Mount Hope suggest an eastward extension of the Mojave Trail from the Pacific Coast described by Wilcox and Samples (1990), linking the Pacific shell trade and consumers in the Prescott culture area and the Sinagua and Kayenta groups to the east. The modelled least-cost path between Bull Creek and the Fitzmaurice Ruin indicates probable connectivity between the Mojave Trail from the Pacific Coast (Wilcox and Samples 1990) and the Palatkwapi Trail from the east (Byrkit 1988) through the heartland of the Prescott culture area. The least-cost path between RS Hill and the Fitzmaurice Ruin follows the Overland Road Historic Trail (Byrkit 1989) through the Del Rio Springs area, linking Sinagua and Cohonina people groups with argillite from the Prescott culture area.

Limitations of This Research

My research is limited by the published information and the data I was able to gather from National Forest System lands in west-central Arizona, museum collections, and the collections of federal land management agency offices in Yavapai and Coconino counties. Given the time limitations and necessary focus of thesis research, I was not able to incorporate tribal input or indigenous perspectives. The interpretation and potential applications of my research would greatly benefit by incorporating tribal data and the traditional knowledge of Native American communities.

Another limitation of my thesis research is low data density in the middle Verde Valley. Artifact collections from Tuzigoot, Montezuma Castle, and Montezuma Well National Monument are curated at the Western Archeological and Conservation Center (WACC) in Tucson, Arizona. Despite multiple applications, Email correspondence, and telephone calls, I was unable to access obsidian artifact collections from any of the national monuments in the Verde Valley. I readily acknowledge that the resulting dearth of obsidian provenance data from major precontact habitation sites in the middle Verde Valley limits the scope, interpretation, and potential applications of my thesis research.

I also recognize that poor chronometric control is a major limitation of my research. Although I photographed ceramic scatter during field data collection and observed ceramic artifacts in numerous museum collections that I analyzed, I did not commit the time or make the additional effort to derive ceramic dates or develop other chronological metrics for most of the archaeological sites in my obsidian provenance database. The lack of chronometric control limits the kinds of inferences I can make based on my research data and the overall contribution of my research to archaeology.

The lack of lithic analysis beyond source provenance is also a limitation of my research. Although I photographed obsidian artifacts with a scale in conjunction with pXRF spectroscopic analysis and recorded the artifact type (i.e., primary flake or projectile point), I did not measure or weigh the obsidian artifacts, or attempt to classify the styles or use wear of finished tools. Without the addition information regarding obsidian debitage or tools, I am not able to assess any relationships between artifact attributes and distance from the obsidian source, or associate specific artifact attributes with lithic acquisition behaviors such as foraging and exchange.

Recommendations for Further Research

Additional research is needed to incorporate tribal input, including obsidian provenance data from tribal lands and the traditional knowledge of Native American communities regarding precontact obsidian acquisition in west-central Arizona. Another research opportunity is to incorporate obsidian provenance data from major habitation sites in the Verde Valley, including collections curated at the WACC from Tuzigoot, Montezuma Castle, and Montezuma Well National Monument. Further research is also needed to establish the occupation dates for more of the sites with obsidian artifacts in the Prescott culture area to better elucidate the chronology of changes in the use of different obsidian sources. A final research recommendation is to analyze relationships between obsidian artifact attributes and distance from the obsidian source, and associate specific artifact attributes with precontact obsidian acquisition behaviors, including foraging and exchange.

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Appendix 1

Authorization ID: ______
Contact ID: Kellett
Expiration Date: Dec. 3, 2020
Use Code : 422 – Research

FS-2700-32 (V.05/09)
OMB No. 0596-0082
CNF Project No.: 2019-25

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

PERMIT FOR ARCHAEOLOGICAL INVESTIGATIONS

Authority:
The Archaeological Resources Protection Act of 1979, 16 U.S.C. 470aa-mm
The Organic Act of 1897, 16 U.S.C. 551

1. Holder: Michael S. Kellett	**2. Date of corresponding application:** July 11, 2019
3. Address: 9020 E. Headquaters Road, Prescott Valley, AZ 86315	**4. Telephone numbers:** (208) 371-9216 **5. Email addresses:** fishguy61@hotmail.com, msk242@nau.edu
6. Name of authorized officer: Michael S. Kellett **Telephone numbers:** (208) 371-9216 **Email addresses:** fishguy61@hotmail.com; msk242@nau.edu	**7. Name of principal investigators:** Michael S. Kellett **Telephone numbers:** (208) 371-9216 **Email addresses:** fishguy61@hotmail.com, msk242@nau.edu

8. Name of field directors authorized to carry out field projects: Michael S. Kellett

Telephone numbers: (208) 371-9216

Email addresses: fishguy61@hotmail.com, msk242@nau.edu

9. Activities authorized:

- Academic Research (consulting activities not authorized)
- Personnel *Vitae* will be provided for all people working under this permit. If any additional people other than those originally identified will be working under this permit, *Vitae* must be provided for them. These additional people will need to be approved by the Forest Archaeologist before working under this permit. All work must be done in accordance with the *General Requirements for Conducting Archaeological Survey on the Coconino National Forest* unless otherwise agreed to in advance of field work by the Forest Archaeologist.

10. Description of National Forest System lands authorized for use (hereinafter referred to as "the permit area") **CNF Project No. and Name: 2019-25 - Prehistoric Obsidian Exchange in Northern Arizona** All lands of the Coconino National Forest
11. Permit term: **From**: August 1, 2019 **To:** December 31, 2020
12. Name and address of the curatorial facility in which collections, records, data, photographs, and other documents resulting from activities conducted under this permit shall be deposited for permanent preservation on behalf of the United States Government: Coconino National Forest Supervisor's Office, 1824 S. Thompson St., Flagstaff, AZ 86001

TERMS AND CONDITIONS

I. GENERAL TERMS

A. AUTHORITY. This permit is issued pursuant to 36 CFR Part 251, Subpart B, Forest Service Special Uses Authorization ; 36 CFR Part 296, the Uniform Rules and Regulations of the Antiquities Act of 1906, 43 CFR Part 3; 16 USC 470aa, Archaeological Resources Protection Act, and applicable Forest Service policies and procedures and is subject to their provisions.

B. AUTHORIZED OFFICER. The authorized officer for this permit is the Forest Supervisor or a subordinate officer with delegated authority.

C. ANNUAL REVIEW. If this permit is issued for more than one year, it shall be reviewed annually by the authorized officer.

D. RENEWAL AND EXTENSION. This permit is not renewable. The holder may request an extension of this permit for a limited, specified period to complete activities authorized under this permit. Requests for an extension must be submitted in writing at least one month before expiration of this permit.

E. AMENDMENT. This permit may be amended in whole or in part by the Forest Service when, at the discretion of the authorized officer, such action is deemed necessary or desirable to incorporate new terms that may be required by law, regulation, the applicable land management plan, or projects and activities implementing a land management plan pursuant to 36 CFR Part 215. Any amendments to individuals named in or activities authorized by this permit that are needed by the holder must be approved by the authorized officer in writing.

F. COMPLIANCE WITH LAWS, REGULATIONS, AND OTHER LEGAL REQUIREMENTS. In exercising the privileges granted by this permit, the holder shall comply with all present and future federal laws and regulations and all present and future state, county, and municipal laws, regulations, and other legal requirements that apply to the permit area, to the extent they do not conflict with federal law, regulations, or policy. The Forest Service assumes no responsibility for enforcing laws, regulations, and other legal requirements that fall under the jurisdiction of other governmental entities.

G. NON-EXCLUSIVE USE. The use and occupancy authorized by this permit are not exclusive. The Forest Service reserves the right of access to the permit area, including a continuing right of physical entry to the permit area for inspection, monitoring, or any other purpose consistent with any right or obligation of the United States under any law or regulation. The holder shall allow the authorized officer or the authorized officer's representative full access to the permit area at any time the holder is in the field for purposes of examining the permit area and any recovered materials and related records. The Forest Service reserves the right to allow others to use the permit area in any way that is not inconsistent with the holder's rights and privileges under this permit, after consultation with all parties involved.

H. ASSIGNABILITY. This permit is not assignable or transferable.

Appendix 2

Table 5.1. Obsidian Source Provenances for 2,429 Artifacts from 608 Sites in Study Area

ID	Site	Obsidian	GM	Bull	PW	PC	RS	TB	VT	BT	Super	Burrro	Sauceda	Unknown	Sources
1	Grapevine	Yes	19	0	1	0	0	0	0	0	0	0	0	0	2
2	Kinnikinick	Yes	18	0	0	0	0	0	0	0	0	0	0	0	1
3	Youngs South	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
4	Youngs North	Yes	5	0	0	0	0	0	0	0	0	0	0	0	1
5	Rattlesnake	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
6	Anderson Fort upper	Yes	2	0	0	0	0	0	0	0	0	0	0	2	2
7	Anderson Fort lower	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
8	Honanki	Yes	62	0	1	0	0	1	0	0	0	0	0	0	3
9	Walnut Canyon	Yes	52	0	0	0	1	0	0	0	0	0	0	9	3
10	03070100140	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
11	03070100233	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
12	03070100271	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
13	03070100325	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
14	03070100382	Yes	0	0	0	0	0	0	0	1	0	0	0	0	1
15	03070100391	Yes	0	0	0	0	0	0	0	1	0	0	0	0	1
16	03070100393	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
17	03070100512	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
18	03070100539	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
19	03070100562	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1

20	03070100614	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
21	03070100709	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
22	03070100733	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
23	03070100763	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
24	03070100791	Yes	0	0	0	0	0	0	0	1	0	0	0	0	1
25	03070100796	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
26	03070100809	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
27	03070100822	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
28	03070100832	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
29	03070100833	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
30	03070100877	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
31	03070100916	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
32	03070100989	Yes	0	0	1	0	6	0	0	0	0	0	0	0	2
33	03070100990	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
34	03070100994	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
35	03070101004	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
36	03070101005	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
37	03070101016	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
38	03070101017	Yes	1	0	1	0	0	0	0	0	0	0	0	0	2
39	03070101019	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
40	03070101021	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
41	03070101030	Yes	1	0	0	2	0	0	0	0	0	0	0	0	2
42	03070101031	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
43	03070101032	Yes	1	0	1	1	0	0	0	0	0	0	0	0	3

44	03070101035	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
45	03070101036	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
46	03070101044	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
47	03070101094	Yes	4	0	0	0	0	0	0	0	0	0	0	0	1
48	03070101095	Yes	1	0	0	0	1	0	0	0	0	0	0	0	2
49	03070101104	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
50	03070101118	Yes	0	0	1	1	0	0	0	0	0	0	0	0	2
51	03070101121	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
52	03070101125	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
53	03070101141	Yes	0	0	3	0	0	0	0	0	0	0	0	0	1
54	03070101145	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
55	03070101146	Yes	1	0	0	2	0	0	0	0	0	0	0	0	2
56	03070101147	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
57	03070101157	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
58	03070101159	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
59	03070101174	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
60	03070101175	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
61	03070101176	Yes	0	0	1	3	0	0	0	0	0	0	0	0	2
62	03070101189	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
63	03070101192	Yes	0	0	2	0	0	0	0	1	0	0	0	0	2
64	03070101197	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
65	03070101198	Yes	0	0	2	0	0	0	0	0	0	0	0	0	1
66	03070101201	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
67	03070101203	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1

68	03070101206	Yes	1	0	2	0	0	0	0	0	0	0	0	0	2
69	03070101207	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
70	03070101208	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
71	03070101211	Yes	0	0	0	0	0	0	0	1	0	0	0	0	1
72	03070101213	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
73	03070101219	Yes	2	0	2	0	0	0	0	0	0	0	0	0	2
74	03070101221	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
75	03070101227	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
76	03070101228	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
77	03070101233	Yes	0	0	1	0	1	0	0	0	0	0	0	0	2
78	03070101237	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
79	03070101241	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
80	03070101249	Yes	0	0	1	1	0	0	0	0	0	0	0	0	2
81	03070101281	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
82	03070101291	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
83	03070101292	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
84	03070101319	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
85	03070101325	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
86	03070101473	Yes	13	0	0	0	3	0	0	0	1	0	0	0	3
87	03070200001	Yes	0	0	0	0	0	0	0	1	0	0	0	0	1
88	03070200053	Yes	3	0	1	0	0	0	0	0	0	0	0	0	2
89	03070200070	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
90	03070200086	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
91	03070200259	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1

92	03070200318	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
93	03070200363	Yes	9	0	0	0	7	0	0	0	0	0	0	0	2
94	03070200391	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
95	03070200430	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
96	03070200544	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
97	03070200548	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
98	03070200550	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
99	03070200554	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
100	03070200598	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
101	03070200693	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
102	03070200730	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
103	03070200732	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
104	03070200771	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
105	03070200792	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
106	03070200811	Yes	1	0	0	0	1	0	0	0	0	0	0	0	2
107	03070200839	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
108	03070200849	Yes	0	0	1	1	0	0	0	0	0	0	0	0	2
109	03070200850	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
110	03070200852	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
111	03070200860	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
112	03070200919	Yes	4	0	0	0	0	0	0	0	0	0	0	0	1
113	03070200922	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
114	03070200926	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
115	03070200927	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1

116	03070200935	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
117	03070200937	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
118	03070200944	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
119	03070200956	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
120	03070200959	Yes	3	0	0	0	0	0	0	0	0	0	0	0	1
121	03070200980	Yes	2	0	0	1	0	0	0	0	0	0	0	0	2
122	03070200989	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
123	03070201000	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
124	03070201012	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
125	03070201014	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
126	03070201015	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
127	03070201017	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
128	03070201019	Yes	0	0	0	0	0	0	1	0	0	0	0	0	1
129	03070201030	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
130	03070201054	Yes	1	0	0	0	1	0	0	0	0	0	0	0	2
131	03070201056	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
132	03070201058	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
133	03070201079	Yes	0	0	0	0	1	0	0	1	0	0	0	0	2
134	03070201094	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
135	03070201103	Yes	2	0	0	0	2	0	0	0	0	0	0	0	2
136	03070201130	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
137	03070201134	Yes	0	0	0	3	0	0	0	0	0	0	0	0	1
138	03070201136	Yes	0	0	0	0	0	0	0	1	0	0	0	0	1
139	03070102104	Yes	0	0	6	0	0	0	0	0	0	0	0	0	1

140	03070100413	Yes	0	0	1	1	0	0	0	0	0	0	0	0	2
141	03070200152	Yes	2	0	0	0	8	0	0	0	0	0	0	4	3
142	03070100127	Yes	15	0	0	0	4	0	0	0	0	0	0	0	2
143	GP1	Yes	8	0	0	0	0	0	0	0	0	0	0	0	1
144	NA19658	Yes	5	0	0	0	0	0	0	0	0	0	0	0	1
145	NA19130	Yes	10	0	0	1	0	0	0	0	0	0	0	0	2
146	NA19132	Yes	4	0	0	0	0	0	0	0	0	0	0	0	1
147	NA19135	Yes	20	0	0	0	0	0	0	0	0	0	0	0	1
148	K4 Ranch	Yes	4	0	0	12	0	0	0	2	0	0	0	0	3
149	Old Camp	Yes	1	3	0	4	4	0	0	0	0	0	0	0	4
150	Walnut K4	Yes	2	2	0	1	0	0	1	1	0	0	0	0	5
151	Perkinsville Cave	Yes	3	0	2	0	1	0	0	0	0	0	0	0	3
152	Hitt Wash	Yes	0	0	0	0	0	0	0	4	0	0	0	0	1
153	Aaron	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
154	Aiken	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
155	Alta	Yes	2	0	1	0	0	0	0	0	0	0	0	0	2
156	Ames	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
157	Applewhite	Yes	0	0	1	7	0	0	0	0	0	0	0	0	2
158	AR AZN-6-35	Yes	14	4	0	7	7	0	1	0	0	1	0	0	6
159	Arnie	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
160	AZN-7-228	Yes	5	1	0	2	1	0	0	0	0	0	0	0	4
161	AZN-7-261	Yes	1	0	0	3	1	0	0	0	0	0	0	0	3
162	AZN-7-262	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
163	AZN-7-267	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1

164	AZN-7-286	Yes	21	4	0	6	11	0	0	0	0	0	0	1	5
165	B&B	Yes	1	1	0	0	1	0	0	0	0	0	0	0	3
166	Baldy	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
167	Baldy S	Yes	1	0	0	0	1	0	0	0	0	0	0	0	2
168	Barbara	Yes	0	0	0	1	1	0	0	0	0	0	0	0	2
169	Base	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
170	Bear Paw	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
171	Bench	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
172	Bessie	Yes	0	0	2	1	0	0	0	0	0	0	0	0	2
173	Beth	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
174	Betty	Yes	0	3	0	0	0	0	0	0	0	0	0	0	1
175	Bill_Bonnie	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
176	Bill_Bonnie	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
177	Bill_Bonnie	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
178	Blanton	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
179	Branigan	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
180	Branigar	Yes	0	3	0	0	0	0	0	0	0	0	0	0	1
181	Brisman	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
182	Bruce	Yes	0	1	0	0	1	0	0	0	0	0	0	0	2
183	Bull	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
184	Cabin B	Yes	0	4	0	0	0	0	0	0	0	0	0	0	1
185	Cabin East	Yes	0	6	0	1	0	0	0	0	0	0	0	0	2
186	Cabin West	Yes	0	4	0	0	0	0	0	0	0	0	0	0	1
187	Camp Hill	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1

188	Camp Kirk	Yes	2	2	0	1	1	0	0	0	0	0	0	0	4
189	Camp Robin	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
190	Carol Patrik	Yes	1	0	0	1	1	0	0	0	0	0	0	0	3
191	Cartwell	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
192	Caywood	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
193	Cecelia	Yes	3	0	0	0	0	0	0	0	0	0	0	0	1
194	Charley	Yes	0	1	0	2	0	0	0	0	0	0	0	0	2
195	Chris	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
196	Cindy H	Yes	1	5	0	2	0	0	0	0	0	0	0	0	3
197	Cindy T	Yes	0	6	0	0	0	0	0	0	0	0	0	0	1
198	Corner	Yes	0	2	0	0	0	0	0	0	0	0	0	0	1
199	Cort	Yes	2	0	0	0	1	0	0	0	0	0	0	0	2
200	Cross Creek Ranch	Yes	40	0	1	1	0	0	0	0	0	0	0	0	3
201	Dahlberg 1	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
202	Dahlberg2_3	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
203	Dante	Yes	3	0	0	0	1	0	0	0	0	0	0	0	2
204	David	Yes	1	0	1	0	0	0	0	0	0	0	0	0	2
205	Del Cantaro A&B	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
206	Del Cantaro C	Yes	0	0	1	2	0	0	0	0	0	0	0	0	2
207	Dent Base	Yes	0	1	0	1	0	0	0	0	0	0	0	0	2
208	Dent East	Yes	0	2	0	0	0	0	0	0	0	0	0	0	1
209	Dent West	Yes	0	6	0	0	0	0	0	0	0	0	0	0	1
210	Don	Yes	0	10	0	0	0	0	0	0	0	0	0	0	1

211	Donald_1	Yes	0	3	1	3	1	0	0	0	0	0	0	0	4
212	Donald_2	Yes	1	2	0	1	0	0	0	0	0	0	0	0	3
213	Don Ward B	Yes	0	0	2	0	0	0	0	0	0	0	0	0	1
214	Duff_major	Yes	1	0	0	0	2	0	0	0	0	0	0	0	2
215	Duff_minor	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
216	Ellsworth	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
217	Elinor	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
218	Emilienne	Yes	2	0	1	0	0	0	0	0	0	0	0	0	2
219	Epsilon	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
220	Ethel	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
221	Everall	Yes	6	0	5	1	1	0	0	0	0	0	0	0	4
222	Favour	Yes	3	0	0	1	0	0	0	0	0	0	0	0	2
223	Favour_1	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
224	Finney	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
225	Foster	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
226	Fran Schwartz	Yes	0	1	0	1	0	0	0	0	0	0	0	0	2
227	Fulton_1	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
228	German	Yes	0	4	0	0	0	0	0	0	0	0	0	0	1
229	Gilpin B	Yes	0	0	0	3	0	0	0	0	0	0	0	0	1
230	Goodwin	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
231	Gordon A	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
232	Gray	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
233	Guest_1	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
234	Guest_4	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1

235	Harlow	Yes	0	6	1	0	1	0	0	0	0	0	0	0	3
236	Hatch	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
237	Hell Point	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
238	Hilton	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
239	Holt	Yes	0	0	0	2	1	0	0	0	0	0	0	0	2
240	Horseshoe	Yes	0	0	2	0	0	0	0	0	0	0	0	0	1
241	Hunter_3	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
242	Intervale	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
243	Irwin	Yes	0	15	0	0	0	0	0	0	0	0	0	0	1
244	Isabel	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
245	Jane	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
246	Jeffrey	Yes	0	0	0	1	1	0	0	0	0	0	0	0	2
247	Jim_Peg	Yes	1	0	2	4	0	0	0	0	0	0	0	0	3
248	John	Yes	0	3	0	0	0	0	0	0	0	0	0	0	1
249	Jones	Yes	0	4	0	0	0	0	0	0	0	0	0	0	1
250	Keith	Yes	0	0	0	4	0	0	0	0	0	0	0	0	1
251	Kellie3	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
252	Kimberly	Yes	2	0	0	3	1	0	0	0	0	0	0	0	3
253	Kimmet	Yes	4	0	1	0	0	0	0	0	0	0	0	0	2
254	Kimsey A	Yes	1	0	1	1	0	0	0	0	0	0	0	0	3
255	King	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
256	Kings Ruin	Yes	1	0	0	3	0	0	0	0	0	0	0	0	2
257	King Wall	Yes	0	0	0	1	1	0	0	0	0	0	0	0	2
258	Laney	Yes	4	0	0	0	1	0	0	1	0	0	0	0	3

259	Laura	Yes	0	1	1	0	0	0	0	0	0	0	0	0	2
260	Lava	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
261	Leah	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
262	Lindahl	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
263	Linda Jo	Yes	0	5	0	0	0	0	0	0	0	0	0	0	1
264	Lindsay	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
265	Liz Schwartz	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
266	Lizard	Yes	0	6	0	1	0	0	0	0	0	0	0	0	2
267	Lombard	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
268	Lou Curtis	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
269	Louise A	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
270	Low	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
271	Lucy	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
272	Luhana_A	Yes	0	2	0	1	0	0	0	0	0	0	0	0	2
273	Marsh	Yes	0	2	0	0	0	0	0	0	0	0	0	0	1
274	Mason	Yes	1	0	2	0	0	0	0	0	0	0	0	0	2
275	Matilda	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
276	Matt Schwartz	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
277	McBride	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
278	McCanyon	Yes	3	0	0	0	1	0	0	0	0	0	0	0	2
279	McFarland	Yes	0	2	0	0	0	0	0	0	0	0	0	0	1
280	Meadow	Yes	0	9	0	0	0	0	0	1	0	0	0	0	2
281	Melcher	Yes	0	1	0	1	1	0	0	0	0	0	0	0	3
282	Miller_2	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1

283	Nancy_L	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
284	Nettie	Yes	1	1	0	4	0	0	0	0	0	0	0	0	3
285	Neville	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
286	Nora_A	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
287	Oldham	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
288	Oro	Yes	0	4	0	4	0	0	0	0	0	0	0	0	2
289	Pamela	Yes	0	4	0	0	0	0	0	0	0	0	0	0	1
290	Peggy	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
291	Perch	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
292	Pilles	Yes	0	0	0	15	1	0	0	0	0	0	0	0	2
293	Poffet A	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
294	Poffet C	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
295	Q	Yes	0	1	0	1	0	0	0	0	0	0	0	0	2
296	Quincy B	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
297	R	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
298	Ralph	Yes	0	6	0	3	2	0	0	1	0	0	0	0	4
299	Rhea	Yes	0	0	1	1	0	0	0	0	0	0	0	0	2
300	Roadside	Yes	0	4	0	1	0	0	0	0	0	0	0	0	2
301	Robert	Yes	0	3	0	0	0	0	0	0	0	0	0	0	1
302	Rock House	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
303	Rodda	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
304	Rogers	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
305	Round	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
306	Saddle	Yes	0	1	0	1	0	0	0	0	0	0	0	0	2

307	Sandstone_1	Yes	0	4	0	3	0	0	0	0	0	0	0	0	2
308	Santiago	Yes	0	0	2	0	0	0	0	0	0	0	0	0	1
309	Sara	Yes	0	0	0	0	0	0	1	0	0	0	0	0	1
310	Sarah K	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
311	Sarvis	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
312	Scharmen	Yes	0	1	0	1	0	0	0	0	0	0	0	0	2
313	Scott	Yes	0	12	0	0	0	0	0	0	0	0	0	0	1
314	Scotty	Yes	0	2	0	0	0	0	0	0	0	0	0	0	1
315	Sharlot Hall	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
316	Shepard	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
317	Sherrie	Yes	0	7	0	1	0	0	0	0	0	0	0	0	2
318	Shirley	Yes	0	1	0	0	1	0	0	0	0	0	0	0	2
319	Shorty Allan	Yes	0	1	2	7	0	0	0	0	0	0	0	0	3
320	Smokey Allan	Yes	0	1	0	1	0	0	0	0	0	0	0	0	2
321	SR AZN-7-311	Yes	1	0	0	0	8	2	0	0	0	0	0	0	3
322	Steve Jr	Yes	1	0	0	2	0	0	0	0	0	0	0	0	2
323	Stewart	Yes	1	0	0	0	2	0	0	0	0	0	0	0	2
324	Stewart_2	Yes	1	0	0	1	1	0	0	0	0	0	0	0	3
325	Stewart_4	Yes	1	0	0	2	0	0	0	0	0	0	0	0	2
326	Storm	Yes	3	3	1	5	1	0	1	0	0	0	0	0	6
327	Taverner	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
328	Thayer B	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
329	Thayer C	Yes	0	0	2	0	0	0	0	0	0	0	0	0	1
330	Thayer D	Yes	0	0	2	3	0	0	0	0	0	0	0	0	2

331	Theta	Yes	0	3	1	0	0	0	0	0	0	0	0	0	2
332	Tuesday	Yes	1	1	0	6	0	0	0	0	0	0	0	0	3
333	U	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
334	Van B	Yes	0	0	0	0	2	0	0	0	0	0	0	0	1
335	Vandervoort	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
336	Verde pithouse	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
337	Vicky Carter	Yes	0	0	0	0	0	0	0	0	0	0	0	3	1
338	Victoria West	Yes	1	0	0	2	0	0	0	0	0	0	0	0	2
339	Vinnie	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
340	Vista	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
341	Wallace	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
342	Wayne A	Yes	0	0	0	3	0	0	0	0	0	0	0	0	1
343	Wayne B	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
344	Wayne C	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
345	Wheeler_1	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
346	Wilma	Yes	0	1	0	0	1	0	0	0	0	0	0	0	2
347	Windy B	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
348	Wood_1	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
349	Worthington	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
350	WW AZN-7-308	Yes	6	3	1	5	2	0	1	0	0	0	1	0	7
351	Yarbro	Yes	2	0	0	2	0	0	0	0	0	0	0	0	2
352	Yarbro_2	Yes	1	0	0	2	0	0	1	0	0	0	0	0	3
353	Zebra	Yes	2	0	0	2	0	0	0	0	0	0	0	0	2
354	Zeta	Yes	1	1	0	0	0	0	0	0	0	0	0	0	2

355	Zonia	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
356	NA10519 Wagner Hill	Yes	25	1	0	0	1	0	0	0	0	0	0	0	3
357	NA10520	Yes	9	0	0	0	1	0	0	0	0	0	0	0	2
358	NA10521	Yes	3	0	0	0	0	0	0	0	0	0	0	0	1
359	NA10522	Yes	1	0	0	0	1	0	0	0	0	0	0	0	2
360	Neural	Yes	12	0	10	6	0	1	1	0	1	0	0	0	6
361	Coyote ruin	Yes	23	3	4	0	1	0	1	0	0	0	0	0	5
362	Fairgrounds	Yes	4	0	1	2	0	0	0	0	0	0	0	0	3
363	Las Vegas	Yes	4	1	0	5	1	0	0	0	0	0	0	0	4
364	Sullivan	Yes	1	2	0	3	1	0	1	0	0	0	0	0	5
365	Bonnie	Yes	1	1	0	0	0	0	0	0	0	0	0	0	2
366	Stricklin	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
367	Crossing N:7:322	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
368	Matli Ranch	Yes	0	2	4	3	3	0	0	0	0	0	0	0	4
369	Wilkinson_Long	Yes	4	1	1	0	1	0	0	2	0	0	0	0	5
370	Homestead	Yes	11	0	0	0	0	2	0	0	0	0	0	0	2
371	Dyck Cave	Yes	88	0	0	1	0	16	0	0	0	0	0	2	4
372	Gray Fox Ridge	Yes	19	0	1	1	4	0	0	0	0	0	0	0	4
373	7-Up Spring	Yes	0	2	0	0	0	0	0	0	0	0	0	0	1
374	Agua Fria	No	0	0	0	0	0	0	0	0	0	0	0	0	0
375	Alto Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
376	Anderson Mesa	No	0	0	0	0	0	0	0	0	0	0	0	0	0
377	Apache Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0

378	AR-03-09-01-576	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
379	AR-03-09-01-579	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
380	AR-03-09-01-580	Yes	0	0	0	0	0	0	0	1	0	0	0	0	1
381	AR-03-09-01-581	Yes	1	2	3	16	0	0	0	2	0	0	0	0	5
382	AR-03-09-01-582	Yes	3	3	1	8	0	0	0	0	0	0	0	0	4
383	AR-03-09-01-653	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
384	AR-03-09-01-654	Yes	1	0	2	1	0	0	0	0	0	0	0	0	3
385	AR-03-09-01-659	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
386	AR-03-09-01-661	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
387	AR-03-09-01-663	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
388	AR-03-09-01-698	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
389	AR-03-09-01-905	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
390	AR-03-09-01-1162	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
391	AR-03-09-01-1533	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
392	AR-03-09-03-270	Yes	4	0	0	0	8	0	1	0	0	0	0	0	3
393	AR-03-09-05-93	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1

394	Arcosanti Pueblo	Yes	1	0	2	0	0	0	0	0	0	0	0	0	2
395	Arrastre Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
396	Baby Canyon	Yes	4	0	0	0	0	0	0	0	0	0	0	0	1
397	Badger Spring	Yes	7	0	1	0	0	0	0	0	0	0	0	0	2
398	Bannon Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
399	Bean Peak	No	0	0	0	0	0	0	0	0	0	0	0	0	0
400	Bear Canyon	Yes	1	0	0	0	3	0	0	5	0	0	0	0	3
401	Bear Canyon West	Yes	9	0	0	0	0	0	0	0	0	0	0	0	1
402	Bear Canyon West IO	Yes	4	0	0	1	0	0	0	0	0	0	0	0	2
403	Big Black Mesa	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
404	Big Black Mesa IO1	Yes	0	0	0	0	3	0	0	0	0	0	0	0	1
405	Big Black Mesa IO2	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
406	Big Black Mesa IO3	Yes	0	0	0	1	1	0	0	0	0	0	0	0	2
407	Big Black Mesa IO4	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
408	Big Black Mesa IO5	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
409	Big Black Mesa IO6	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
410	Big Black Mesa IO7	Yes	0	0	2	0	0	0	0	0	0	0	0	0	1
411	Big Rosalie Pueblo	Yes	9	0	0	0	0	0	0	0	0	0	0	0	1

412	Bishop Creek East	Yes	19	0	0	1	0	0	0	0	0	0	0	0	2
413	Bishop Creek West	Yes	8	0	0	0	1	0	0	0	0	0	0	0	2
414	Black Butte	Yes	0	6	0	0	0	0	0	0	0	0	0	0	1
415	Black Canyon	No	0	0	0	0	0	0	0	0	0	0	0	0	0
416	Black Jack Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
417	Black Mesa	No	0	0	0	0	0	0	0	0	0	0	0	0	0
418	Boulder Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
419	Bridgeport	Yes	5	0	0	0	0	0	0	0	0	0	0	1	2
420	Brooklyn Basin	Yes	5	0	0	0	0	0	0	0	0	0	0	0	1
421	Butcher Knife Canyon	Yes	1	0	6	8	0	0	0	0	0	0	0	0	3
422	Butler ballcourt	Yes	20	0	0	0	1	0	0	0	0	0	0	0	2
423	Cabin Wash	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
424	Camp Wood	No	0	0	0	0	0	0	0	0	0	0	0	0	0
425	Cedar Canyon	Yes	5	0	0	3	1	1	1	0	0	0	0	0	5
426	Chavez Pass	Yes	16	0	0	0	0	0	0	0	0	0	0	0	1
427	Chavez Pass North	Yes	7	0	0	0	0	0	0	0	0	0	0	0	1
428	Cherry Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
429	Collins Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
430	Connell Gulch	No	0	0	0	0	0	0	0	0	0	0	0	0	0
431	Connell Gulch 2	No	0	0	0	0	0	0	0	0	0	0	0	0	0
432	Copper Creek Pueblo	Yes	6	0	0	0	0	0	0	0	0	0	0	0	1

433	Cooper Wash	No	0	0	0	0	0	0	0	0	0	0	0	0	0
434	Copper Mountain	No	0	0	0	0	0	0	0	0	0	0	0	0	0
435	Cornville	Yes	9	0	0	1	0	0	0	0	0	0	0	0	2
436	Cotton Dam	Yes	3	0	5	2	3	0	0	0	0	0	0	0	4
437	Cottonwood Canyon	No	0	0	0	0	0	0	0	0	0	0	0	0	0
438	Cottonwood Springs	Yes	3	1	0	0	2	0	0	0	0	0	0	0	3
439	Cow Creek	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
440	Coyote Wash Pueblo	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
441	Del Rio Spring	Yes	3	0	2	1	2	0	0	0	0	0	0	0	4
442	Dillon Wash	No	0	0	0	0	0	0	0	0	0	0	0	0	0
443	Dog Ranch site	No	0	0	0	0	0	0	0	0	0	0	0	0	0
444	Fitzmaurice Ruin	Yes	17	1	1	6	4	0	0	1	7	0	0	0	7
445	Dripping Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
446	Duff Spring	Yes	1	0	0	0	2	0	0	0	0	0	0	0	2
447	Duff Spring pedistal	No	0	0	0	0	0	0	0	0	0	0	0	0	0
448	Eagle Nest Fort KNF	Yes	0	0	6	0	0	0	0	0	0	0	0	0	1
449	East Fort	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
450	East Sugarloaf	Yes	4	0	0	0	0	0	0	0	0	0	0	0	1
451	Flat Top	No	0	0	0	0	0	0	0	0	0	0	0	0	0
452	Fort Woolsey	Yes	3	0	0	1	0	0	0	0	0	0	0	0	2

453	George Wood Cyn	No	0	0	0	0	0	0	0	0	0	0	0	0	0
454	Gold Basin	Yes	9	0	0	1	0	0	0	0	0	0	0	0	2
455	Gospel Hollow	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
456	Government Canyon	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
457	Government Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
458	Granite Basin 03-270	Yes	4	0	0	0	5	0	1	0	0	0	0	0	3
459	Granite Creek wall	No	0	0	0	0	0	0	0	0	0	0	0	0	0
460	Grapevine Gulch ballcourt	Yes	2	0	0	4	1	0	0	0	0	0	0	0	3
461	Hackberry Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
462	Halfway_1	No	0	0	0	0	0	0	0	0	0	0	0	0	0
463	Halfway_2	No	0	0	0	0	0	0	0	0	0	0	0	0	0
464	Halfway_3	No	0	0	0	0	0	0	0	0	0	0	0	0	0
465	Halfway_4	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
466	Halfway_5	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
467	Halfway_6	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
468	Halfway_7	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
469	Henderson_1	Yes	7	0	0	0	0	0	0	0	0	0	0	0	1
470	Henderson_2	Yes	5	0	0	0	2	0	0	0	0	0	0	0	2
471	Henderson_3	Yes	5	0	0	0	0	0	0	0	0	0	0	0	1
472	Henderson_4	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0

473	Las Vegas Ranch West	Yes	2	2	0	6	1	0	0	0	0	0	0	0	4
474	Hyde Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
475	Indian Hill	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
476	Indian Mesa	No	0	0	0	0	0	0	0	0	0	0	0	0	0
477	Indian Peak	Yes	0	2	6	5	0	0	0	1	0	0	0	0	4
478	Indian Spring 3	No	0	0	0	0	0	0	0	0	0	0	0	0	0
479	Indian Springs site	No	0	0	0	0	0	0	0	0	0	0	0	0	0
480	Janet site	No	0	0	0	0	0	0	0	0	0	0	0	0	0
481	Joes Hill East	Yes	6	2	0	0	0	2	0	0	0	0	0	2	4
482	Joes Hill South	Yes	13	0	1	0	0	0	0	0	0	0	0	0	2
483	Joes Hill West	Yes	9	0	0	0	0	0	0	0	0	0	0	0	1
484	Jones Mtn	No	0	0	0	0	0	0	0	0	0	0	0	0	0
485	King Canyon	Yes	14	0	0	0	0	0	0	0	0	0	0	0	1
486	Kirkland Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
487	Lake Mary	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
488	Lake Montezuma	Yes	7	0	0	0	0	0	0	0	0	0	0	0	1
489	Larry Creek	Yes	4	0	0	0	0	0	0	0	0	0	0	0	1
490	Las Vegas Ranch East	Yes	1	0	0	2	0	0	0	0	0	0	0	0	2
491	Lee Spring 01-355	Yes	1	5	1	4	1	0	0	0	0	0	0	0	5
492	Limestone Peak	No	0	0	0	0	0	0	0	0	0	0	0	0	0
493	Little Granite Mtn	No	0	0	0	0	0	0	0	0	0	0	0	0	0

494	Little Sycamore	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
495	Long Canyon	No	0	0	0	0	0	0	0	0	0	0	0	0	0
496	Lousy Canyon East	No	0	0	0	0	0	0	0	0	0	0	0	0	0
497	Lousy Canyon North	Yes	4	0	0	0	0	0	0	0	0	0	0	0	1
498	Lousy Canyon South	Yes	9	0	0	0	0	0	0	0	0	0	0	0	1
499	Lower Walnut Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
500	Lynx Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
501	Meath Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
502	Meath Wash	No	0	0	0	0	0	0	0	0	0	0	0	0	0
503	Mescal Spring	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
504	Milk Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
505	Moana Ranch	No	0	0	0	0	0	0	0	0	0	0	0	0	0
506	Moonshine Canyon	No	0	0	0	0	0	0	0	0	0	0	0	0	0
507	Montezuma Castle	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
508	Montezuma Well	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
509	Muldoon Canyon	Yes	8	0	1	1	0	0	0	0	0	0	0	0	3
510	New structure	No	0	0	0	0	0	0	0	0	0	0	0	0	0
511	Oak Creek	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
512	Old Camp Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0

513	Old Camp Farm	Yes	0	5	1	6	1	0	0	0	0	0	0	0	4
514	Orme Ruin	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
515	Orme Shrine	No	0	0	0	0	0	0	0	0	0	0	0	0	0
516	Packard Pueblo	Yes	24	0	1	1	1	0	0	0	0	0	0	0	4
517	Packard Ranch	Yes	8	0	6	0	0	0	0	0	0	0	0	0	2
518	Paddock Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
519	Page Flat	Yes	8	0	0	3	2	0	0	0	0	0	0	0	3
520	Parker Flat	No	0	0	0	0	0	0	0	0	0	0	0	0	0
521	Peavine	No	0	0	0	0	0	0	0	0	0	0	0	0	0
522	Peck's Lake	Yes	11	0	0	1	0	0	0	0	0	0	0	0	2
523	Perkinsville AZN:4:2	Yes	1	0	1	0	0	0	0	0	0	0	0	0	2
524	Perkinsville	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
525	Perry Tank Canyon 2	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
526	Perry Tank Canyon	Yes	7	0	0	2	0	0	0	0	0	0	0	0	2
527	Pine Creek wall	No	0	0	0	0	0	0	0	0	0	0	0	0	0
528	Pueblo LaPlata	Yes	9	0	0	0	0	0	0	0	0	0	0	0	1
529	Quarry Roomblock	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
530	Railroad	Yes	0	0	1	0	0	0	0	0	0	0	0	0	1
531	Rattlesnake	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1
532	Red Tank Draw	No	0	0	0	0	0	0	0	0	0	0	0	0	0
533	Richinbar Pueblo	Yes	9	0	0	0	0	0	0	0	0	0	0	0	1

534	Richinbar East	N/A	0	0	0	0	0	0	0	0	0	0	0	0
535	Rio Verde 2	No	0	0	0	0	0	0	0	0	0	0	0	0
536	Rock Butte	No	0	0	0	0	0	0	0	0	0	0	0	0
537	Rock Spring	No	0	0	0	0	0	0	0	0	0	0	0	0
538	Rocking Chair	Yes	11	0	0	0	0	0	0	0	0	0	0	0	1
539	Round Mountain ballcourt	Yes	20	0	0	0	3	0	0	0	0	0	0	0	2
540	Ruin Tank	No	0	0	0	0	0	0	0	0	0	0	0	0
541	Sacred Mountain	Yes	5	0	0	0	0	0	0	0	0	0	0	0	1
542	Sampson	No	0	0	0	0	0	0	0	0	0	0	0	0
543	Seldom Seen	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
544	Silver Creek	No	0	0	0	0	0	0	0	0	0	0	0	0
545	Sinks	Yes	0	0	1	1	0	0	0	0	0	0	0	0	2
546	Sinks North Bank	Yes	1	0	1	2	1	0	0	0	0	0	0	0	4
547	Sinks South Bank	Yes	1	1	1	10	2	0	0	0	0	0	0	0	5
548	Skull Valley	No	0	0	0	0	0	0	0	0	0	0	0	0
549	Skull Valley 2	Yes	0	0	0	2	0	0	0	0	0	0	0	0	1
550	Smith Fort	No	0	0	0	0	0	0	0	0	0	0	0	0
551	South Campbell Pueblo	Yes	7	0	0	0	0	0	0	0	0	0	0	0	1
552	South Cornville	Yes	3	0	0	0	0	0	0	0	0	0	0	0	1
553	Spring Valley	Yes	5	0	0	0	0	0	0	0	0	0	0	0	1
554	Squaw Creek	Yes	4	0	1	0	0	2	0	0	0	0	0	0	3

555	Squaw Creek Mesa	Yes	6	0	0	0	0	0	0	0	0	0	0	0	1
556	Stoddard Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
557	Strickland Wash 01-1533	Yes	1	0	0	1	0	0	0	0	0	0	0	0	2
558	Stringtown Wash	No	0	0	0	0	0	0	0	0	0	0	0	0	0
559	Sugarloaf	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
560	Sullivan	Yes	4	0	15	5	0	0	0	0	0	0	0	0	3
561	Sullivan Canyon	No	0	0	0	0	0	0	0	0	0	0	0	0	0
562	Sunrise Peak	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
563	Sycamore Basin	No	0	0	0	0	0	0	0	0	0	0	0	0	0
564	Sycamore Tank	Yes	4	0	0	0	0	0	0	0	0	0	0	0	1
565	T19N_R6W_S21	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
566	T20N_R6W_S19	No	0	0	0	0	0	0	0	0	0	0	0	0	0
567	Tailholt locus 1	Yes	0	0	0	11	0	0	0	0	0	0	0	0	1
568	Tailholt locus 2	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
569	Tailholt locus 3	Yes	0	0	0	0	0	0	1	0	0	0	0	0	1
570	Tailholt locus 4	Yes	0	1	0	0	0	0	0	0	0	0	0	0	1
571	Tangle Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
572	Tank Creek IO1	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
573	Tank Creek IO2	Yes	1	1	0	0	0	0	0	0	0	0	0	1	3
574	Tank Creek South	Yes	14	0	0	1	0	0	0	0	0	0	0	0	2
575	Tonto Mtn	No	0	0	0	0	0	0	0	0	0	0	0	0	0
576	Tonto Wash	Yes	1	0	0	3	2	0	3	0	0	0	0	0	4

577	Tonto Wash 2	Yes	0	2	1	0	0	0	0	0	0	0	0	0	2
578	Tovera	No	0	0	0	0	0	0	0	0	0	0	0	0	0
579	Townsend Butte	No	0	0	0	0	0	0	0	0	0	0	0	0	0
580	Tucker Canyon	No	0	0	0	0	0	0	0	0	0	0	0	0	0
581	Turkey Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
582	Tuzigoot	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0
583	Upper Hackberry	Yes	6	0	0	0	0	0	0	0	0	0	0	0	1
584	Upper Verde	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0
585	Upper Verde 2	No	0	0	0	0	0	0	0	0	0	0	0	0	0
586	Wagner Hill	Yes	9	0	0	0	0	0	0	0	0	0	0	0	1
587	Wagner Hill trail	Yes	1	0	1	0	0	0	0	0	0	0	0	0	2
588	Wagner Hill trail 2	Yes	0	0	0	0	1	0	0	0	0	0	0	0	1
589	Walavudu	Yes	2	0	0	0	8	0	0	0	0	0	0	0	2
590	Walnut Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
591	Walnut 2	Yes	1	0	1	1	0	0	0	0	0	0	0	0	3
592	Walnut 3	Yes	0	1	2	4	0	0	0	0	0	0	0	0	3
593	Watson Lake	No	0	0	0	0	0	0	0	0	0	0	0	0	0
594	West Brooklyn Pueblo	Yes	12	0	0	1	0	0	0	0	0	0	0	0	2
595	West Clear Creek	Yes	3	0	0	0	0	0	0	0	0	0	0	0	1
596	West Turkey Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0

597	Whiskey Spring	No	0	0	0	0	0	0	0	0	0	0	0	0	0
598	Wilhoit	No	0	0	0	0	0	0	0	0	0	0	0	0	0
599	Willow Creek	No	0	0	0	0	0	0	0	0	0	0	0	0	0
600	Yavapai Ranch IO-06	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
601	Yavapai Ranch IO-25	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
602	Yavapai Ranch IO-26	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
603	Yavapai Ranch IO-32	Yes	1	0	0	0	0	0	0	0	0	0	0	0	1
604	Yavapai Ranch IO-39	Yes	0	0	0	1	0	0	0	0	0	0	0	0	1
605	Yeager Canyon site	No	0	0	0	0	0	0	0	0	0	0	0	0	0
606	Young Mtn	No	0	0	0	0	0	0	0	0	0	0	0	0	0
607	Youngs North ruin	Yes	5	0	0	0	0	0	0	0	0	0	0	0	1
608	Youngs South ruin	Yes	2	0	0	0	0	0	0	0	0	0	0	0	1