Beyond Correlation to Causation in Hunter-Gatherer Ritual Landscapes: Testing an Ontological Model of Site Locations in the Mojave Desert, California

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Article

Beyond Correlation to Causation in Hunter-Gatherer Ritual Landscapes: Testing an Ontological Model of Site Locations in the Mojave Desert, California

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Abstract: Why are rock art sites found in certain places and not others? Can locational or environmental variables inform an understanding of the function and meaning of the art? How can we move beyond observed patterning in spatial associations to a credible explanation of such meanings and ensure that we are not confusing correlation with causation? And what variables were most relevant in influencing site locational choices? These and related problems, whether recognized or not, are the subtext of the last three decades of rock art site distributional and landscape studies. They are now especially important to resolve given the need for accurate predictive modeling due to the rapid transformation of certain regions from undeveloped rural areas into rural industrial landscapes. Partly with this problem in mind, Whitley (2024) developed a descriptive model that provides an explanation for the location of Native Californian rock art in the Mojave Desert. It identifies the variables most relevant to site locations based on ethnographic Indigenous ontological beliefs about the landscape. These concern the geographical distribution of supernatural power and its association with certain landforms, natural phenomena and cultural features. His analysis further demonstrated that this model can account for two unusually large concentrations of sites and motifs: the Coso Range petroglyphs and the Carrizo Plain pictographs. But unanswered was the question of whether the model was applicable more widely, especially to smaller sites and localities made by different cultural groups. We documented and analyzed three petroglyph localities with seven small petroglyph sites in the southern Mojave Desert, California, to test this model. These sites are attributed to the Takic-speaking Cahuilla and Serrano tribes. Our study revealed a good fit between the expected natural and cultural variables associated with rock art site locations, with the number of such variables present at any given locale potentially correlated with the size of the individual sites. In addition to the research value of these results, this suggests that the model may be useful in predictive modeling of rock art site locations for heritage management purposes.

Keywords: archaeology; landscape; rock art; site distributions; Native Americans; predictive modeling

1. Introduction

Rock art is "landscape art" in that it comprises images that are placed on natural geological rather than culturally-created surfaces (Whitley 1998a:11). The relationship of motifs and sites to their associated landscapes, perhaps because of this defining characteristic, has then long-comprised a key topic in international research (e.g., Bradley 1991; Carden 2008; Díaz-Andreu 2002; Honoré 2019; Nankela 2017; Nash and Chippindale 2004; Nash and Troncoso 2017; Pillay et al. 2020; Sognnes 1994; Whitley 1998a; Wyndham 2011). Yet despite the centrality of this issue, the significance and meaning of site and motif distributions and their relationship to landscape features are not always self-evident (Bradley et al. 1994).

An example of the inferential difficulties that sometimes problematize landscape and distributional studies is provided by influential research published over a half-century ago in far

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western North America, our research region. Heizer and Baumhoff (1959, 1962) argued that the locations of Great Basin sites correlated with game trails and, because of this association, they could confidently infer the art's function as resulting from hunting magic. Despite the impact of their claim on regional research (e.g., von Werlhof 1965; Grant 1968; Nissen 1982; Garfinkel et al. 2010), their interpretation contradicted the ethnographic record, given that hunting magic was categorically denied by the local tribes (Whitley 1994a). The game trails Heizer and Baumhoff identified, furthermore, result from deer-use while the primary animal depicted in the art is the bighorn sheep, a non-migratory species (Whitley 1998b; Keyser and Whitley 2006), rendering illogical the functional inference of hunting magic based on this putative locational association. Equally troublesome, however, is the fact that rock art sites are found in many places beyond deer trails, including in villages (Steward 1963).

Aside from the anecdotal nature of the presented evidence and their misunderstanding of animal behavior, Heizer and Baumhoff's underlying error was a confusion of correlation with causation, a potential logical fallacy in any distributional study. Given the growing use of and need for GIS-based and predictive-modeling studies of rock art locations (e.g., Fairén-Jiménez 2007; Garate et al. 2020; Garces et al. 2024; Lace et al. 2018; Pillay et al. 2020; Vatin and Bianchi 2014), the potential for this type of inferential error has become all the more pressing. Yet it is essential that we develop means for understanding the associations and correlations of sites and motifs with landscape features—both for purposes of better supporting the logic of distributional patterns as clues to meaning, and to improve the development of our predictive models themselves. This would result by more accurately identifying the variables originally influencing decisions about site locations. We consider this last issue critical given the ongoing, rapid transformation of previously undisturbed regions, like the North American desert west, into rural industrial landscapes due to renewable energy development. Better means for constructing predictive models, based on culturally-meaningful causal rather than Western-imposed variables, are essential if we hope to adequately preserve and protect rock art sites.

How do we identify the causal variables that influenced the locations of sites and, potentially, contributed to their meaning? Based on published ethnographic data, Whitley (1992; 1994b, p. 7; 1998a; 2000; Whitley et al. 2004; Whitley and Whitley 2012) first pointed out that Native Californian site distributions were tied to the perceived distribution of supernatural power on the landscape. His observation has been supported by subsequent studies in other North American regions (e.g., Arsenault 2004; Creese 2011; Loendorf 2004), indicating that the distributional relationship between the sites and such power was widespread across Native America. This empirical fact supports Bradley et al.'s (1994) contention that landscape studies need to move beyond the functionalist biases that are common in archaeology, as well as Ouzman's (1998) characterization of landscapes as 'mindscapes;' i.e., cognitive constructs reflecting a specific cultural worldview, in this case ontological beliefs about the association of supernatural power and landscape features.

These studies have been useful for conceptualizing the factors that influenced if not determined site locations. Yet none of them operationalized these concepts to the degree that they could be deployed, as identifiable or measurable variables, to improve predictive models of rock art site locations, despite the potential importance of just such an effort. Whitley (2024) recently developed a descriptive model partly with this aim in mind. This was based on earlier published anthropological reports combined with data provided by a series of recent ethnographic studies conducted by Richard Stoffle and his colleagues, directed at documenting landscape use and knowledge maintained by contemporary Indigenous informants (e.g., Carroll et al. 2004; Carroll 2007; Stoffle and Arnold 2003; Stoffle et al. 2001, 2022; Van Vlack 2012; Van Vlack et al. 2013). These recently-collected data correlate closely with the information in earlier published ethnographies, demonstrating the retention of substantial traditional knowledge from the nineteenth into the twenty-first century (Whitley 2024). The resulting model provided the kinds of information about specific landscape features and other natural phenomena that should enable better predictive modeling. Whitley used this model to examine and explain a rarely considered yet significant problem in rock art research.

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This concerns the uneven geographical distribution of sites: why certain locations have extremely large site concentrations while other areas have few or none. He demonstrated that two such major California site agglomerations, the Coso Range in Numic (Shoshone and Northern and Southern Paiute) territory and Carrizo Plain (Chumash) comprise clusters of the natural geological, geomorphological, hydrological and geophysical features that themselves were thought especially imbued with or founts of this power. These results were encouraging but left unanswered the question of whether this model also explains the locations of smaller sites, including those made by other tribal groups in California's Mojave Desert, and thus how generalizable it may be.

This study is directed towards resolving this last problem. We documented three petroglyph localities in the southern Mojave Desert made by the Takic-speakers (Cahuilla and Serrano) in part to determine whether their settings include the types of natural features and associations that the model specified as associated with supernatural power. We start, accordingly, with a discussion of the descriptive ethnographic model before turning to details about these localities and our fieldwork on them, concluding with an analysis of their settings and suggestions for future research on this topic.

2. Metaphysical Beliefs and Supernatural Power

The distribution of Native California rock art was based not on environmental variables tied to subsistence practices but on epistemological and ontological principles and beliefs. The central such metaphysical postulate involves supernatural power, which was considered both sentient and the principle causative agent in the universe (Bean 1975; Miller 1983a, 1983b, 1985; Stoffle and Zedeño 2002). All actions, reactions and events were caused by this special force. Success (or failure) in any specific endeavor was thus a sign of the presence (or absence) of the types of power associated with those activities, while unusual actions and phenomena were thought expressions of it: "The presence of power explained all unusual talents or unusual events and differences in cultural attainments" (Bean 1978, p. 582).

Power was first released at the creation and, though it has diminished over time due to entropy, it is still present, to varying degrees, in all living things. This includes the earth which, itself, is considered alive (Kroeber 1907; Stoffle et al. 2022; Van Vlack 2012a). Unlike the Judeo-Christian concept of grace, however, power is ambivalent: it is implicated in both positive and negative circumstances, and could be employed for beneficial or adverse ends. Power is then quixotic and unpredictable, and therefore potentially dangerous to those unschooled in its use and control:

> power is dangerous. Failure to obey [its] commands and instructions will lead to sickness and even death (Whiting 1950, p. 42).

> Since man is never absolutely certain whether or not anything is a power source until it is tested or reveals itself, he lives in a constantly perilous world fraught with danger (Bean 1975, p. 26).

Power, importantly, is differentially distributed both across the landscape and among humans (ibid). It is attracted to certain kinds of places, including mountain tops, caves, and, especially, water, but unusual phenomena or events also bring power into the world of humans (Waterman 1910; Bean 1975; Miller 1983). As noted by Miller:

> Power remains diffused everywhere while also concentrated in web-like pathways. It can still be encountered accidentally while travelling, provided that close attention is paid to surroundings. The location of power concentrations can be predicted from the distribution of water and life forms, but it can only be contacted through dream, vision, fasting, meditation, trance, or vigil. Only then can it be understood and controlled for the greatest good (1983, p. 82).

Stoffle and Van Vlack (2006, unpaginated) thus state that "The concept of power argues that the fundamental meaning of a place derived from the *Puha(s)* [powers] it exhibits." The implication is that a dialectical relationship existed between Native Californian's ontological beliefs and the landscape: "landscapes and objects communicate to people how they are intended to be used" (Stoffle et al. 2015, p. 100). Rather than some kind of a natural *tabula rasa*, then, landscape itself had agency

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affecting, if not determining, its ritual use (cf. Liwosz 2017, 2018). These power locations were sacred spots and, like all such locations throughout Native America, were interfaces with, and portals into, the supernatural realm (Blackburn 1975; Applegate 1978; Walker 1991, 1996; Van Vlack 2012a; Stoffle et al. this issue).

Combinations of certain geomorphological features, sometimes including particular spots where specific but unusual natural events had been observed, were especially potent places that functioned as conduits of power (Whitley 2024). Because all living things have some degree of power, it also is concentrated where people gather, including in villages. And because all things may possess power, humans are never certain where it may reside or be stored. Importantly, however, this uncertainty was mediated by cultural practices which signaled the sacred (and therefore potentially dangerous) nature of certain places, as well as their potential for ritual use:

> When ceremony or power seeking is successful at such places, they are selectively marked so future human visitors can more fully understand the purpose of the place (Stoffle et al. 2011a, p. 11).

> The logic was simple—if knowledge resides in powerful places, then let us return to those places where we can recapture it (Carroll et al. 2004, p. 141; emphasis in original).

The creation of rock art is a primary though not the only means for signaling the presence of supernatural power at a particular location. Other evidence of real or perceived ritual activities could also serve this purpose, including rock cairns and alignments, deposited offerings, and vision quest structures. These last features include both rock rings and cleared circles in desert pavement, sometimes called "prayer circles." As Carroll et al.'s (2004) quote above implies, once a place was marked as sacred, this fact alone promoted its continued use for religious purposes.

Rock art throughout Native California was created by shamans who had been trained in the control and use of supernatural power (Whitley 1992, 2000). This relationship was encoded linguistically among Numic speakers, for example, with shamans known as *puhagunts*, 'man with power,' from *puha*, 'power.' Rock art sites were then called *puhaghani*, 'house of supernatural power' (Malouf 1974; Shimkin 1992; Van Vlack 2012a; Stoffle et al. this issue), with the depicted motifs portraying the visionary imagery shamans experienced during their altered states of consciousnesses (ASC), from which they obtained their power, usually in the form of animal spirit helpers:

> In the night, his medicine [spirit helper] speaks to him and counsels him. It may tell him how he ought to paint (Lowie 1909, p. 224).

> Shamans painted their "spirits (*anit*) on rocks to show themselves, to let people see what they had done. The spirit must come first in a dream" (Driver 1937, p. 126; quotation in original).

Rock art sites were thus created by shamans during vision quests, sometimes conducted as pilgrimages involving experienced shamans as well as initiates (Lowie 1924; Park 1938; Shimkin 1953, n.d.; Hultkrantz 1961, 1981, 1986, 1987; Malouf 1974; Brooks et al. 1979; Riddell 1978; Voget 1984; Trenholm and Carley 1964; Fowler 1992; Zedeño et al. 1999; Stoffle et al. 2000, 2011a; Carroll 2007; and Van Vlack 2012a). These quests were conducted at locations that were themselves associated with spirits and that provided portals into the spiritual world.

Puberty initiates also made rock art among certain Native Californian tribes, including especially the Takic-speaking Cahuilla, Serrano, Tongva and Luiseño and the Quechan-speaking Mojave and Quechan (Whitley 1992, 2000, 2006). These rituals too were associated with obtaining supernatural power in the form of a spirit helper after an ASC experience: all people needed some degree of power to be successful in life; shamans simply had much more (including more spirit helpers) than non-shamans, and were trained in its manipulation and use. Puberty initiations typically occurred in or adjacent to large villages when the annual Mourning Ceremony was held (Benedict 1924). These involved the attendance of large groups of people from different clans, moieties and villages, necessarily therefore resulting in a temporary concentration of power due to this the gathering of people.

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3. Natural Features Associated with Ritual Site Locations

The ethnographic model for rock art site locations recently presented by Whitley (2024) identifies a series of the specific kinds of landforms, hydrological features and natural phenomena that were believed to contain or to constitute expressions of unusual amounts of supernatural power, thus signaling appropriate locations for rock art sites. As noted by Stoffle et al.:

> Southern Paiute people use their cultural knowledge to understand the logic behind how and why different kinds of places are located throughout a particular landscape by reading the land for cultural indicators of [supernatural power] (2022, p. 47).

These include caves, water sources and hydrological features, mountains, unusual geological outcrops, and locations frequently associated with certain geophysical phenomena, among others (Table 1). Volcanic landscapes are the first and perhaps most important variable with respect to site locations in the Mojave Desert and Great Basin. These were considered especially potent places (Van Vlack 2012b; Van Vlack et al. 2013; Ruuska 2014; Stoffle et al. 2015). This partly resulted from the volcanoes themselves which are, literally, "places where the earth is renewed and reborn" (Arnold and Stoffle 2006, unpaginated). But many of the features commonly associated with volcanic landscapes were also recognized as powerful, creating a synergistic relationship contributing to the perception that concentrations of these features were unusually potent. They include hot springs, basalt flows, cinder cones, obsidian sources, fumaroles, talus slopes, and lava tubes/caves:

> Volcanoes have a special place in Southern Paiute epistemology, and Southern Paiute people are strongly culturally attached to volcanic places and events. Volcanic episodes are distinctive moments when *Puha* [supernatural power] moves from lower to higher levels of existence and causes the power to accumulate in these areas…*Puha* moves from the lower portions of the Earth to form hot springs, mountains, volcanic cones, basalt mesas, lava tubes, basalt bombs, and obsidian deposits…Southern Paiute people respect and interact with places of volcanic activity because these places contain powerful forces, spiritual beings who can balance human society at local, regional, and world levels. As one Southern Paiute elder said, 'Volcanoes are sacred mountains. The old people knew it was alive, like the mother earth is alive. We have a song about the rocks shooting out of a volcano near home' (Van Vlack 2012b, p. 224; quotation in original).

> Religious leaders pass through initiation stages on volcanoes, which often provide visions, songs, and even physical objects such as obsidian, paint, crystals, and turquoise. The pilgrimage paths to volcanoes are repeatedly traversed. Offerings mark key places along the trail, thus building a permanent record of devotional behavior (Stoffle et al. 2015, p. 100).

Talus slopes, for example, are common features in volcanic landscapes, especially around basalt flows. Talus slopes are commonly unstable and, for that fact, their constituent rocks move downhill, thereby demonstrating agency and a 'will to act' (Bean 1975) as key additional indicators of supernatural potency. Because such movements are understood as a demonstration of their inherent power, talus slopes are appropriate places for the rituals creating petroglyphs.

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Table 1. Ethnographic Support for Associations Between Natural Landscape Features & Phenomena and Supernatural Power.

Features/Phenomena	**Ethnographic Support**
Volcanic Landscapes	Arnold and Stoffle 2006; Van Vlack 2012b; Van Vlack et al. 2013; Ruuska 2014; Stoffle et al. 2015; Stoffle and Van Vlack 2022
Rocks/Rock Outcrops	Blackburn 1975; Zigmond 1980; Stoffle et al. 2011a; Van Vlack 2012a;
Caves	Park 1938; Harris 1940; Steward 1941; Malouf 1974; Laird 1976; Riddell 1978; Miller 1983a; Fowler and Liljeblad 1986; Liljeblad 1986; Kelly and Fowler 1986; Fowler 1992; Brewster 2003
Mountain Peaks	Lowie 1909; Kelly 1932; Park 1938; Steward 1941; Stewart 1941; Applegate 1974; Laird 1976; Olofson 1979; Hudson and Underhay 1978; Riddell 1978; Miller 1983a; Shipek 1985; Walker 1991; Fowler 1992; McCarthy 1996; Perry 2007; Arnold and Stoffle 2006; Van Vlack 2012b; Stoffle, Arnold and Van Vlack 2022
Talus Slopes	Lowie 1924; Kelly 1932; Steward 1941; Stewart 1941; Whiting 1950; Fowler and Fowler 1971; Bean 1975
Water	Kelly 1932, 1936; Driver 1937; Park 1938; Harris 1940; Steward 1941, 1943; Aginsky 1943; Gayton 1948; Whiting 1950; Fowler and Fowler 1971; Bean 1975; Blackburn 1975; Applegate 1977; Zigmond 1977, 1980; Hudson et al. 1977; Hudson and Underhay 1978; Zigmond 1977, 1980; Hultkrantz 1987; Walker 1991; Fowler 2002; Van Vlack 2018
Earthquakes	Kroeber 1907, 1976; DuBois 1908; Kroeber 1908a; Hooper 1920; Spier 1923, 1930; Drucker 1937; Driver 1939; Gayton 1948; Heizer 1955; Redi 1958; Blackburn 1975; Zigmond 1977; Ruuska 2014; Stoffle 2022

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Lightning & Aerial Lights	Sparkman 1908; Waterman 1910; Gifford 1918; Hooper 1920; Benedict 1924; Kelly 1932, 1939; Park 1938; Harrington 1942; Patencio 1943; Gayton 1948; Whiting 1950; White 1963; Hill and Nolasquez 1973; Bean 1974; Blackburn 1975; Laird 1974, 1976; Zigmond 1977; Harrington 1978; Bean et al. 1991

Lava tube caves are also common in volcanic landscapes and these, as well as caves more generally, were widely thought powerful places:

deep caves on slopes are sacred because they shelter life and collect water by seepage while remaining moist and dark like the initial world…Hence caves are sacred, vital in the flow of power (Miller 1983, p. 78).

[There] are a number of sacred places known to the people as places where power resides . . . some of these places (usually caves) were visited by men and women wanting to become doctors [shamans]. But they could also be visited by persons wishing to increase their luck in hunting or gambling, or by persons who wanted children or other special favors. . .The power found at each of these places was specific to it; i.e., it was localized there (Fowler 1992, p. 176).

Certain caves were "places of power and mystery" (Laird 1976, p. 38), in part because spirits lived in them. The important Cahuilla spirit *Takwitc*, discussed below for example, was said to live in a cave in Lilly Rock, immediately adjacent to Tahquitz Peak above the town of Idyllwild (Gifford 1918; Hooper 1920; Patencio 1943; White 1963; Bean 1974; Bean 2017).

Large or unusual landforms, including rocks and outcrops more generally, were considered the abodes of spirits, and portals into the supernatural (cf. Stoffle et al., this issue):

Any large rock formation in the Cahuilla area is likely to be such a transformed [mythic] personage, or a place of residual supernatural power from the Cahuilla beginnings (Bean et al. 1991, p. 15).

[A man seeking power] ate tobacco and got drunk on it [i.e., entered an ASC]. At the hole there was a rock that opened and closed. He waited, and at a moment when the rock opened, he slipped through quickly and went in…The man saw water that was like a window. He could see the mountains through it. But it wasn't water. He passed through it and did not get wet. When he was outside, he looked back and saw the 'water' again (Zigmond 1980, p. 177; quote in original).

There are moments during pilgrimage when pilgrims leave the physical world and enter into a spiritual one. This transition most frequently occurred at petroglyphs and rock paintings. For example, during a pilgrimage to an old volcano in southern Nevada, pilgrims sought the *Puha* [power] from a mountain sheep-head petroglyph by entering into the image through a hole in the rock where the mountain sheep's eye was located. Pilgrims inserted their finger, covered in red paint (*oompi*), into the eye hole. This act transitioned them into the rock and its spiritual dimension (Van Vlack 2012b, p. 133).

Hydrological features such as springs, pools, streams, and the ocean, all of which were widely believed inhabited by spirits (Strong 1929, p. 132; Blackburn 1975; Applegate 1978), are another key determinant of the distribution of power. Water was as a 'primary element' (Miller 1983), and was especially important symbolically to Native Californians. It was "a purifying agent . . . spoken of as being like the human breath" (Whiting 1950, p. 40) and water sources were visited for vision questing:

"Sleeping at certain places where there is water gave dreams of a water baby [spirit helper]" (Steward 1941, p. 258; see also Kelly 1932; Steward 1943).

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Springs may harbor *Pa?ahniwat*, who may take a form of a serpent or a water baby, that could often be heard crying out. He also acted as sponsor [i.e., spirit helper] for *puvalem* [shamans] (Bean 1974, p. 167).

While streams themselves were places of power, areas where water pooled or concentrated were even more potent. As then observed by Stoffle et al.:

When *Puha* [power] is dispersed, it clusters in certain areas such as narrow and constricted places, stone water tanks, mountain peaks, caves and at points of convergence of hydrological systems (2011b, p. 47).

Dramatic vistas, including especially views of sacred mountains, finally, were another landscape variable that influenced the locations of sacred places (Keyser and Whitley 2000; Van Vlack 2012b; Van Vlack et al. 2013; Stoffle et al. 2015):

[W]e have always relied on the vast vistas that we have. See that's one thing that people have always talked about especially in Nevada. When you're doing doctoring, you need those big long areas where you can see because you are calling things from extremely far away, somethings could even be in the past that you need to call upon and bring into your doctoring activities (Stoffle et al. 2011c, p. 32).

4. Natural Events and Supernatural Power

Locations where certain natural phenomena commonly occur were also associated with supernatural power, creating another category of places, in addition to the landscape features, which constituted sacred places. One of these, especially important to Takic speakers like the Cahuilla and Serrano, involves aerial light displays: lightning, ball lightning and earthquake lights (Whitley 2024). Although these are all transient phenomena that can happen anywhere, their distribution is in fact

geographically patterned overall. Lightning strikes, for example, are associated with seasonal storm patterns that themselves typically follow certain routes. The highest density of lightning strikes in California is in the deserts. This is not on the highest mountain peaks, as one might expect, but between 2700-3000-meters elevation specifically, below the tallest mountains. Basalt scarp edges also differentially attract lightning due to converging magnetic field lines, resulting in a greater charge potential between the earth and the atmosphere (Cummins 2012; Mayet et al. 2016)

The Takic spirit and mythic first shaman *Takwitc*, mentioned above, is closely associated with lightning and meteors (e.g., Sparkman 1908; Kroeber 1908b; Waterman 1910; Gifford 1918; Benedict 1924; Bean 1974) and is said to reside at the eponymous Tahquitz Peak. The elevation of this mountain falls within the band of maximum lightning strike density, whereas the highest peak in this range, Mount San Jacinto, rises above it and has no known resident spirit.

More important with respect to rock art site locations, however, are earthquakes (Ruuska 2014). These were widely thought caused by the movements of subterranean spirits (e.g., Hooper 1920; Spier 1923, 1930; Drucker 1937; Blackburn 1975) and were associated with shamans, who were said able to predict earthquakes and, sometimes, control them (e.g., DuBois 1908; Kroeber 1908a; Gayton 1948). Ethnography from the San Andreas fault zone, for example, demonstrates that this was considered a location of great supernatural power and mystery, and the two largest concentrations of Chumash rock art occur within this rift zone. The Coso Range petroglyphs, similarly, are located on the Walker Lane/Eastern California Shear Zone, currently the most seismically active region in California (Whitley 2024). This locality has the largest concentration of rock art in the Americas, and one of the largest in the world.

5. Cultural Factors Associated with Supernatural Power

Natural features and phenomena alone however were not the sole determinants of rock art site locations. Acoustic properties of given locations could influence the selection of certain spots as appropriate for ritual (Liwosz 2017, 2018), for example, although these characteristics would be difficult to identify and employ in a regional predictive model. More generally, but impossible to

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measure, spiritual revelation could in theory occur anywhere, making any place potentially appropriate for creating rock art. Predictive models of ritual site locations are thus unlikely to be 100% accurate, with some otherwise unexplained outliers potentially always occurring.

That said, however, certain cultural variables stand-out as particularly significant. The first is villages, especially larger aggregation-phase residential sites. This results because power is attracted to all living things, including humans (Bean 1975), and it necessarily therefore concentrates where large numbers of people come together. Aggregation phase villages are always associated with water sources, furthermore, increasing their appropriateness as rock art site locations. Mojave Desert rock art sites, accordingly, are commonly found at or adjacent to villages (Steward 1963).

The second such cultural variable, briefly noted above, is previously marked places. These specifically include rock art sites, indicating that (like graffiti) 'rock art begets rock art'. As Carroll (2007) has illustrated in this respect, rock art sites were commonly used for the late nineteenth century Ghost Dance exactly because of the visible demonstration of their association with supernatural power, making them especially appropriate ceremonial locales when this millenarian renewal cult appeared in the late nineteenth century. Similarly, while rock art sites were made by shamans, they were in fact used subsequently by non-shamans for a variety of ritual purposes, including prayer and healing (Whitley 2000; Whitley and Whitley 2012).

But physical evidence of previous ritual activities involved more than just rock art. It could also include cairns, rock alignments, deposited offerings and vision quest structures, all physical results of vision questing, pilgrimages and other ritual activities:

> "They came up here to do their spirit seeking. Have to be a group—the seeker needs helpers. There were no women in these camps. The rock piles are where they stayed to seek their vision/medicine. A person who received the medicine made the pile. The later ones would use the same piles. They have been reused for thousands of years" (Buttram 2006: unpaginated).

Vision quest structures range from talus pits to low rock circles and walls to 'prayer circles:' cleared circular areas in desert pavements. This last category of ritual marking is particularly important in understanding the logic behind the locations of two of our study locales, discussed below, illustrating the interactions of natural and cultural factors that sometimes influence site locations.

6. Rock Art Site Documentation

We documented seven clerically-designated petroglyph sites on the Marine Corps Air Ground Combat Center (MCAGCC) in the southern Mojave Desert, California, for this study (Figure 1). These sites range from very small (e.g., a single rock art panel with one petroglyph motif, at CA-SBR-10865) to very large (CA-SBr-161, 276 panels with over 1,000 individual motifs). They cluster in three geographical localities which we have employed for analytical purposes. The sites in each locality are as follows:

- Southern – CA-SBa-161 (the Foxtrot site)
- Northeastern – CA-SBr-7898
- Northwestern – CA-SBr-10396, -10864, -10865, -11669 and -14199

Note that these sites and localities are isolated in the sense of distant from significant aggregation-phase village sites. This circumstance suggests that the sites originated in individual shamans' visions quests rather than group puberty initiations which were conducted during the annual mourning ceremony at major villages.

Fieldwork at the three study localities, primarily directed towards site management concerns, involved high-precision GIS mapping, documentation of rock art panels using state-of-the-art three-dimensional (3-D) photogrammetry, and traditional rock art recording techniques. The 3-D documentation was intended to provide a digital archive that would allow for future management uses and research purposes. Traditional documentation provided a second digital photographic

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archive and allowed us to conduct an in-field analysis of the sites and panels, including evaluating aspects of the integrity of each panel.

FIGURE 1 – About Here

LOW RESOLUTION PLACE-HOLDER

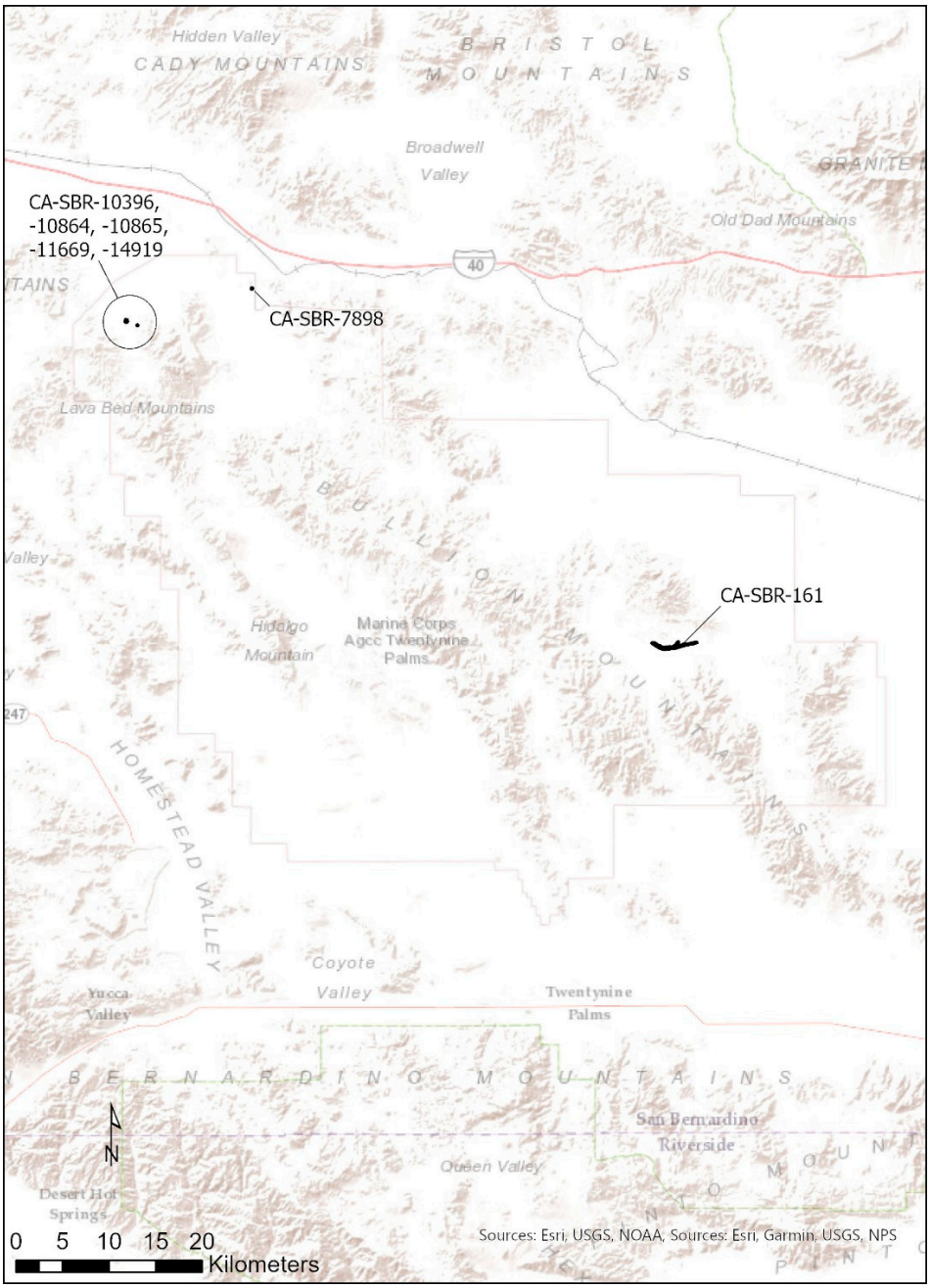

Figure 1. The southern, northeastern and northwestern study locales within the Twentynine Palms Marine Corps Air Ground Combat Center, southern Mojave Desert, California.

Three-dimensional models of the rock art panels were generated using Structure-from-Motion (SfM) photogrammetry. Photogrammetry is the process in which the 3-D geometry of a subject is digitally recreated from a set of two-dimensional images captured using a camera (Luhmann et al. 2014; Figure 2). The camera can be operated aerially (e.g., aircraft or Unoccupied Aerial Vehicles [UAV]), or at ground level (e.g., using a hand-held digital camera). Photogrammetry involving images that were captured using a camera operated in proximity to a subject is also referred to as close-range photogrammetry, which was employed in our documentation project.

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FIGURE 2: ABOUT HERE
LOW RESOLUTION PLACE-HOLDER

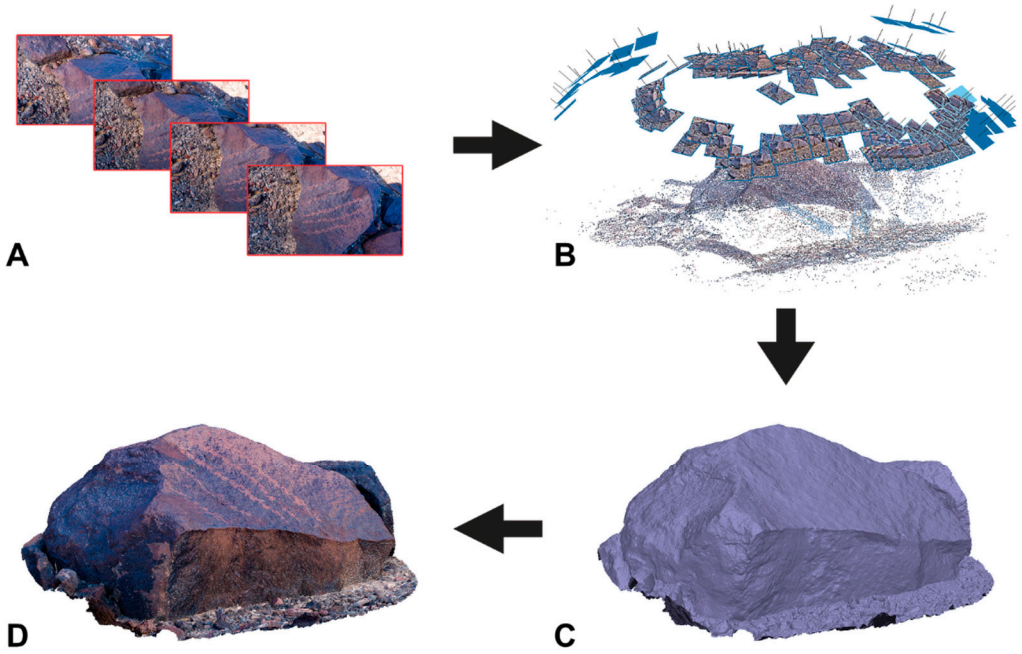

Figure 2. Graphical representation of photogrammetric workflow used for this project. The process includes acquisition of field photos with high overlap (A) and post capture processing of these images; alignment of photos through the creation of tie points and building of a sparse point cloud (B); filtering of the resulting point cloud and construction of a 3-D mesh (C); and finally, creation of 3-D model with photo textures (D).

The results of the photogrammetric and traditional documentation are as follows.

6.1. Southern Locale/CA-SBR-161:

CA-SBr-161, the Foxtrot site, is the largest site in the southern Mojave Desert. It is located at the south end of a large basalt flow where this flow abuts a large intermittent stream. The petroglyphs extend for approximately 3.2 kilometers long the limits of this geological formation (Figure 3). Acknowledging that there are significant differences in how rock art panels and motifs are defined and tabulated between researchers, we documented 276 panels at this site/locality, and 1,067 individual motifs (Figure 4). These are primarily engraved motifs but they also include 21 panels with one or more pictographs. All of the paintings were simple geometric designs with the exception of two hand-prints.

We classified 134 of the motifs (~13% of the total) as identifiable iconic or figurative designs. These consist of 74 bighorn sheep (55% of the iconics and 7% of the total number of motifs); 42 anthropomorphs (31% and 4% respectively); and 12 lizards (9% and 1% respectively); with six additional iconic engravings. The bighorns have side-facing horns and either stick-figure or oblong bodies. The anthropomorphs are predominantly simple stick-figure shaped motifs. The remaining motifs are all geometric designs.

Figures 3 & 4 About Here
LOW RESOLUTION PLACE-HOLDERS

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Figure 3. CA-SBr-161, the Foxtrot site, looking west. Petroglyphs are dispersed along the basalt flow and talus slopes for about 3.2-kilometers, fronted by the intermittent sandy wash.

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Figure 4. Petroglyph panel A1 at CA-SBr-161 showing a variety of geometric motifs and a digitate anthropomorph at lower-center of photo.

Certain of the geometric motifs, however, are also diagnostic in the sense of having ethnographically-assigned symbolic meanings or cultural associations (see Whitley 1994b, 2000). These included 41 petroglyphs (4% of the site assemblage) consisting of 21 zigzag/rattlesnakes (51% of the diagnostic geometrics and about 2% of the total); 13 concentrics/spirals/whirlwinds (32% and 1% respectively); with three diamond chains/rattlesnakes, three hourglasses, one outline cross and one possible atlatl motif (included in geometrics because of uncertainty in its identification). Given that both zigzag and diamond chains motifs symbolize rattlesnakes ethnographically, these two patterns represent fully 58% of the diagnostic geometrics and about 2% of the total assemblage.

6.2. Northeastern Locale/CA-SBr-7898

This is a moderately-sized site located on a low hill covered with basalt boulders, cobbles and desert pavement (Figure 5), north of the Lavic Lake mud playa. A total of 41 panels were documented at this site (Figure 6). These include 52 motifs total, with the majority of the panels at this site consisting of individual small boulders rather than flat weathering planes on larger lithic exposures. Only one diagnostic geometric, a diamond pattern representing a rattlesnake, was present, with no iconic images at the site. The remaining motifs were all a variety of geometric patterns.

Figures 5 & 6 About Here

LOW RESOLUTION PLACE-HOLDERS

Figure 5. CA-SBr-7898, the northeastern study locale, from the south.

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Figure 6. Panel 8 at CA-SBr-7898. All motifs at this site are geometric patterns.

6.3. Northwestern Locale/CA-SBr-10864, -10865, -10396, -11669 and -14919

This locality consists of five clerically-defined sites located along two drainages on the north side of Sunshine Peak (Figures 7 and 8). The western drainage has a cluster of three of the sites while the other two sites are found along the eastern stream. In both cases the clusters are on a series of natural grano-diorite dikes that cross the streams perpendicularly, creating aquitards that impede the downslope movement of underground water.

Figures 7 & 8 About Here

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Figure 7. CA-SBr-10396, a component of the western cluster of sites in the northwestern study locale, viewed from the east. Petroglyphs are located on the three linear dikes that cut-across the intermittent wash.

Figure 8. CA-SBr-14919, the western site cluster in the northwestern study locale, viewed from the south.

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The three cluster of western sites (CA-SBR-10864, -10865 and -10396) are located on three parallel dikes crossing a drainage. The sites range from a single panel with a one motif to 24 panels with a total of 71 petroglyphs (Figure 9). The cluster overall has 30 panels total with 83 engravings. There is an oblong-bodied, side-facing horns bighorn sheep, two diamond/rattlesnake, three zigzag/rattlesnake and one concentric circle/whirlwind motifs. The remainder are all a miscellany of undiagnostic geometric designs.

Figure 9 about here

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Figure 9. Panel B3, the largest and most complex grouping of engravings at CA-SBr-10396 in the western site-cluster in the northwestern study locale. The large majority of motifs in this site cluster are geometric patterns as are seen here.

The two sites in the eastern cluster (CA-SBr-11669 and -14919) have a total of 25 panels with 55 petroglyphs (Figure 10). All of these are miscellaneous, non-diagnostic geometric motifs.

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Figure 10 About Here
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Figure 10. Panel 7 at CA-SBr-14919, the largest panel at this site in the western site-cluster of the northwestern study locality. All panels at this site are geometric designs like those shown here.

7. Regional Analysis of Dominant Motifs

The original development and application of the descriptive model of locational variables influencing site distributions considered two major rock art concentrations: the Coso Range in Numic territory, and the Carrizo Plain in Chumash lands (Whitley 2024). Although the sites considered in this current study ranged from very small to large, they are located in a boundary region between different language groups and tribes, with the Numic-speaking Southern Paiute and Kawaiisu generally to the north, the Takic-speaking Cahuilla and Serrano towards the south and west, and the Quechan-speaking Mojave on the east. The cultural affiliation(s) of the sites' creators was thus uncertain. We conducted a comparative analysis of our site motif assemblages to other sites in the region to assist in resolving this question, and to ensure that this study adequately considered whether the descriptive model could be applied beyond the original Numic and Chumash examples.

The traditional approach to regional rock art analyses, based on the definition of descriptive art styles, largely has proven to be a failure: there are almost as many stylistic typologies as researchers providing them, with little clear indication of what significance (if any) each may have. As noted by Whitley (2014) for Mojave and Quechan rock art along the nearby Colorado River corridor, moreover, these groups made and used three distinctive styles of rock art, based on the social group involved and the functions of the art, not on the time period or cultural group involved, as is typically assumed to be signified by descriptive rock art styles. Recognizing these problems, Hampson (2016) developed a regional comparative approach based not on putative stylistic differences, or even quantitative analyses and comparisons of rock art assemblages as a whole, but instead by focusing on the key or *dominant* motifs found at rock art sites. Dominant symbols are "pervasive, common and may hold

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multiple meanings" (Whitley 2005:82), with the specific intended meaning in any given case defined by the context in which they are presented or employed. This context may be their use in association with another symbol or the location where they are displayed. These contextual factors are known as *instrumental* symbols. In the case of rock art, the site itself represents a portal into the supernatural realm and it serves as the instrumental symbol defining the specific meaning of a particular rock art motif (Whitley 1988). An example of this use of symbols is provided by Yokuts rock art from the southern Sierra Nevada. Certain animal motifs, in one context, depicted an individual's moiety or totemic association. Those same motifs at rock art sites, in contrast, symbolized a shaman's spirit helper (Whitley 1992, 2000, 2005).

Dominant symbols are then repeated and relatively common and, for rock art, they must exhibit visual clarity: they must stand-out as distinctive and, while there may be minor variations in the way that they are depicted, their identification nonetheless must be clearly recognizable. These traits contrast, for example, with the myriad circle and line patterns at our studied sites, which are very numerous with a wide variety of forms and combinations, and little or no iconographic consistency. A comparative focus on the dominant symbols rather than a statistical analysis of all of the motifs at the sites avoids the problem of masking the important distinctions between iconographic assemblages due to the overwhelming numbers of highly variable geometric images common at all sites, like the numerous variations on circles and lines at our sites.

We identified the dominant symbols at our rock art sites and compared them to surrounding rock art localities in order to better define the external cultural relations of these localities. Two motifs appear to be the dominant symbols, based on their distinctiveness, clarity and easy recognizability: bighorn sheep, portrayed either with stick-figure or oblong bodies and with side facing horns; and digitate stick-figure anthropomorphs (see Figures 11 and 12). We documented a total of 75 bighorn motifs at the seven sites, representing about 6% of the total assemblage. All but one of these had side-facing horns and all either had stick-figure or oblong bodies. There are also 42 anthropomorphs in the assemblage, all from CA-SBR-161; 11 of these are digitate, comprising about 1% of the motif count total.

Figures 11 and 12 About here

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Figure 11. Stick figure bighorn sheep motif, Panel A13 at CA-SBr-161.

Figure 12. Digitate anthropomorph, Panel D92. CA-SBr-161, southern study locale. This motif is interpreted as a unique depiction of a female based on the presence of breasts and a possible vagina.

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We compared the dominant motifs at the sites to data from the following rock art sites and localities:

- Two sites along the Colorado River, Inscription Rock ("Davis Camp petroglyphs," F:14:12) and the Scratched Glyph site (26CK5231), to the east and northeast of our study area (Whitley 1995);
- Black Canyon, a locality with numerous rock art sites (Turner 1994), and three sites on Fort Irwin National Training Center (CA-SBR-5249, CA-SBR-5383, and CA-SBR-8268; Whitley and Simon 1995), all in the central Mojave Desert to the northwest;
- The Coso Range petroglyphs on the China Lake Naval Air Weapons Station (Grant 1968), in the northern Mojave Desert; and
- Multiple small sites in the immediate McCoy Springs area (McCarthy 1993), in the Colorado Desert southeast of the study area.

Details of this comparative study are presented elsewhere (Whitley et al. 2024); a summary of the resulting patterns will suffice here. The first point is that bighorn sheep are present, to varying proportions, at all of these sites/localities, including oblong and/or stick-figure, side-facing horns examples. This suggests that this was a widely recognized dominant symbol whose significance transcended cultural areas, specific tribal groups and religious practices. The presence of this motif alone, in the side-facing horns and stick- or solid oblong-body shape, does not assist in defining external cultural relationships, because this image was so widely shared.

This does not mean that bighorn motifs more generally do not provide information useful for analyzing iconographic – religious – cultural relationships however. Notable in this respect are the front-facing horns sheep, including those that have boat-shaped bodies, and especially the "patterned-bodied sheep" found in the Coso Range, but not present at our study sites. Grant (1968) first highlighted the significance of front-facing horns/boat-shape bodied sheep in the Cosos. The "patterned-body sheep", bighorns whose oblong or square bodies contain internal geometric patterns, are also diagnostic. These are very much like the body patterns on the more elaborate anthropomorphs that are also found in the Cosos, and almost certainly were intended to imply a symbolic relationship between sheep and humans.

The anthropomorphs reveal another pattern. The Scratched Glyph site had very distinctive anthropomorphs that are common at other sites in southern Nevada, but unlike any anthropomorphic rock art in the rest of the Mojave Desert, likely reflecting Puebloan occupation or at least influences. Elaborate patterned-body anthropomorphs, in contrast, are found at three localities in this data set: Coso, Fort Irwin and Black Canyon, all in the northern or central Mojave Desert. Digitate anthropomorphs are limited to the sites in our study area and McCoy Springs, to the south, creating a third cluster. None of the anthropomorphs at Inscription Rock fall into these first three groups. This may signal the presence of a fourth group to which it would belong, or instead simply reflect the small sample size from that site.

The northern – central Mojave cluster appears to be the strongest from the perspective of the data in its support, given that it is based on three motif types: front-facing horns sheep, "patterned body anthropomorphs" and "patterned body sheep". This is essentially a Coso pattern, and it is associated with Numic speakers. The grouping of our study sites and McCoy Springs, in contrast, apparently represents a Colorado Desert-oriented pattern. This itself is not surprising: digitate anthropomorphs have long been recognized as a Colorado Desert rock art characteristic. What is more surprising is the inclusion of our sites in this grouping, suggesting that the use of digitate anthropomorphs was a Desert Takic (Cahuilla and/or Serrano) phenomenon that extended north, beyond the Colorado Desert into the southern Mojave Desert.

The data and analysis presented here then suggest that the creators of our study sites differed culturally from those responsible for the Numic and Chumash rock art site concentrations which, as previously demonstrated, could be explained by the descriptive model of site locational variables

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(Whitley 2024). That is, our studied sites provided the opportunity to determine the applicability of this model not just to smaller sites, but also to another cultural group with different ritual practices including, in certain cases, certain varying beliefs.

8. The Distribution of Supernatural Power and Rock Art Site Locations

The rock art sites included in this study all are at locations that have one or more attributes signaling the presence of supernatural power and verifying the applicability of the ethnographic model to this additional cultural region and to the smaller sites included in this analysis. We summarize the associated features and characteristics at each of the three localities below.

8.1. Southern Locale/CA-SBr-161:

CA-SBr-161 is at the terminus of a basalt flow that extends southeast for approximately five kilometers from a single volcanic cone to the site area, where minor talus slopes and volcanic caves are present. The site is thus in a volcanic landscape, a key indicator of the presence supernatural power. This basalt flow is also fronted by a wide intermittent stream, a hydrological feature that is also strongly associated with potency.

An (ostensibly) cultural variable that is present and that signals previous ritual behavior at this site may have also contributed to its recognition as supernaturally potent. This is a very large field of cleared circles, located on the desert pavement on top of the basalt flow, immediately above the petroglyph site (Figures 13 and 14). These circles are in an area that is about 3.5-kilometers long by 400-meters wide, covering approximately 140-hectares or 345-acres.

Figures 13 &14 – about here

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Figure 13. Cleared circles on desert pavement immediately above site CA-SBRr-161. Tribal members who assisted with our fieldwork identified these are prayer or vision quest circles.

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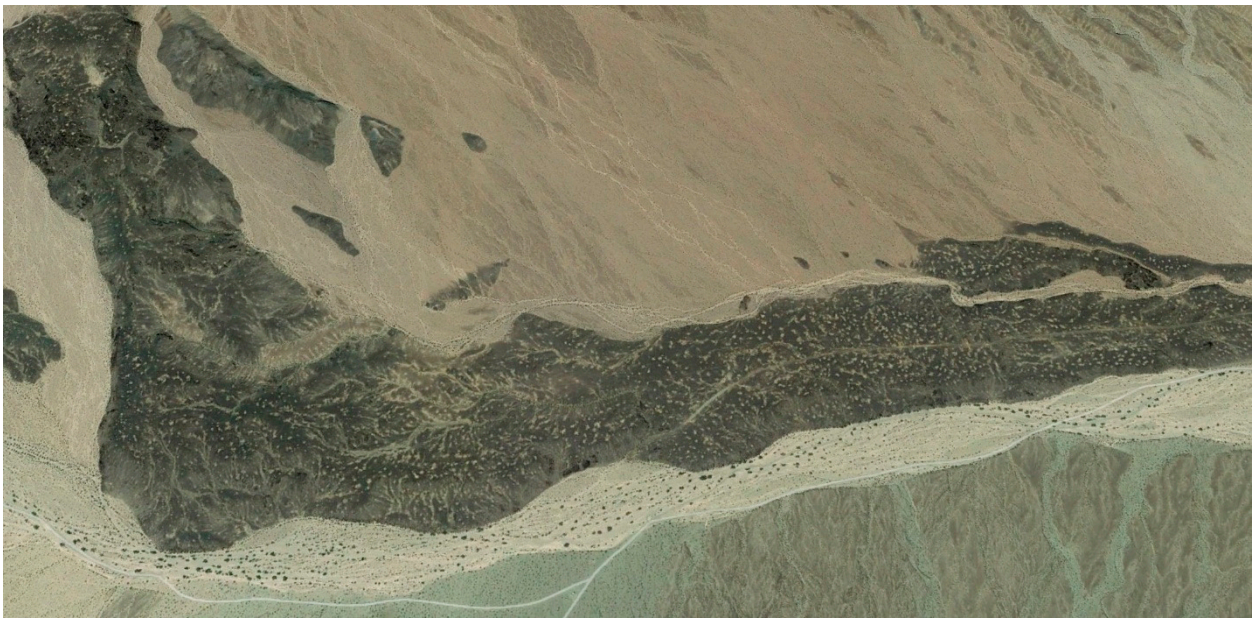

Figure 14. Air photo of CA-SBr-161, along the south/lower side of the basalt flow, and the numerous cleared circles (lighter dots) on the dark desert pavement immediately to the north of the edge of the basalt flow.

There appear to be hundreds of these features present at CA-SBR-161—more, in fact, than can be easily counted. Located on the elevated terrace created by the basalt flow, these features have dramatic vistas of all of the mountains in the distance. Such a viewshed, as noted above, was essential so that supplicants could call in, and see, approaching spirits from a long distance, and was characteristic of many places with supernatural power.

According to the ethnographic record, cleared circles were created for vision questing and prayer, and any such circle is interpreted in this fashion by contemporary Native Americans (e.g., Stoffle et al. 2011a), as the tribal participants in our fieldwork confirmed during the project. These circles are typically about two meters in diameter and lack associated artifacts. Cleared circles on desert pavements can however result from natural processes as well as cultural activities (McDonald et al. 2004; Caldwell et al. 2011). They may be caused by bioturbation, including by insects (Viles et al. 2021; cf. Walsh et al. 2023 for a parallel in 'fairy circles'). Others may represent surficial scars from now-dead plants, most likely creosote bushes (*Larrea tridentata*), the dominant member of the plant community in this region, with a field of such scars resulting from a major plant die-off. We hypothesize that many of the cleared circles associated with this site represent plant scars given their number, density and occasional lack of a regular outline.

The creosote bush is well-known as an especially long-lived clonal species, persisting on the order of thousands of years (Vasek 1980). When and why the loss of these plants occurred is unknown, but climate change, including any possibly related shifts in subsurface hydrological conditions, or fire are potential causal explanations (Brown and Minnich 1986; McDonald et al. 2004; although fire can also sometimes result in increased vigor in creosote growth, cf. Molinari et al. 2019). Desert pavements can form and re-form relatively quickly, in archaeological terms, on the order of a few thousand years (von Werlhof et al. 1995; Ahlstrom and Roberts 2001). Given this last fact, this field of plant scars may be less than a few thousand years old.

Although the plant scar field may not pre-date the earliest production of rock art at the site, and thus may not represent the initial impetus for the use of this location for vision questing, we believe that the appearance of these features at some point created the impression of intensive prior ritual use of this location, greater than actually occurred, contributing to its perception as especially imbued with supernatural power. The combination of these features at CA-SBr-161—a volcanic landscape with talus slopes and caves along with the stream adjacent to the site, an expansive viewshed and the

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large of number of apparent vision quest circles—contributed towards making this locale especially appropriate for ritual.

8.2. Northeastern Locale/CA-SBr-7898

CA-SBR-7898 similarly has multiple features associated with supernatural power. These start with its location in a volcanic landscape dominated by three Late Pleistocene cinder cones. Pisgah Crater is the tallest of these. It is currently about 100 meters in height but it was historically mined for cinders and its original elevation is unknown. It was the source of the Lavic Lake basalt flow, which covers an area about five by four kilometers in size, west of the site, which includes both pahoehoe and a'a lava. A large and well-known lava tube is present in the pahoehoe portion of the flow, towards its west side.

The site specifically is on the slope of a basalt cobble and boulder-covered ridge a few hundred yards from the basalt flow and approximately 5.4 kilometers southeast of the Pisgah Crater. The flow in this area consists exclusively of a'a lava: crumbly, very fragmented, and lacking flat surfaces that are required for petroglyph engraving. The site is then located in a volcanic landscape at a spot where the creation of rock art was possible, unlike on the flow itself in this area.

The site, further, is above the Lavic Lake mud playa. This contains a wide lake following winter rain storms, creating an intermittent hydrological feature that also would be considered a source of supernatural power. Another natural feature of CA-SBr-7898 that contributed to its supernatural associations is viewshed: the site has a vista of Pisgah Crater to the northwest, as well as the surrounding mountains. As noted above, such viewsheds were needed to call-in the spirits during rituals.

The final natural characteristic of the site contributing to its association with supernatural power involves a geophysical phenomenon: earthquakes. Supernatural spirits are associated with earthquakes, and places that are especially seismically active, and thus that experience frequent minor quakes as well as occasional major tremblers, are themselves associated with shamans and shamanic activities. These locations were thought supernaturally powerful and were considered appropriate for ritual. CA-SBr-7898 is in a very seismically-active area; specifically, near the Lavic Lake fault which resulted in the 1999 Hector Mine M_w 7.1 earthquake, the epicenter of which was in the Lavic Lake playa (see Witkosky et al. 2020). This fault system, moreover, is within the Eastern California Shear Zone (Jones et al. 1998; Lee et al. 2001) which is currently the most seismically-active rift zone in California, a state well-known for its earthquakes.

There are also cultural features associated with the site that supported the perception of it as a place of supernatural power: cleared circles. There are fewer of these at this location than at CA-SBr-161, and they are much more widely dispersed, but those near CA-SBr-7898 are larger: many are approximately double the size of those at the first site (Figure 15). It is unlikely that the circles associated with CA-SBr-7898 are plant scars given that the ground surface on this landform is covered by basalt cobbles and small boulders that are too large to be moved by bush movement alone. Such large cleared circles can result however from ant colonies which undermine the surface layer of rocks, including the kind of clasts present on this landform, causing them to gradually sink into the soil, thereby creating a cleared area. Many of the cleared circles at CA-SBR-7898 ultimately may have this origin. Regardless of whether natural or cultural in origin (or a mix of both), the cleared circles at CA-SBr-7898 contributed to the natural signals indicating that this was an appropriate place for rock art, including a location in a volcanic landscape and an association with water and earthquakes.

Figure 15 about here

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Figure 15. Cleared circles at CA-SBr-7898. These circles are notably larger than those at CA-SBr-161. They are also more widely dispersed with a lower overall density. The size of the basalt clasts at this location, furthermore, preclude clearing due to windblown plants suggesting instead that they may represent former ant nest locations.

8.3. Northwestern Locale/CA-SBr-10864, -10865, -10396, -11669 and -14919

The five sites within the Northwestern locale are all found on intermittent drainages and are thus associated with water. The three western cluster sites (CA-SBR-10864, -10865 and -10396) and CA-SBr-14919 in the east, furthermore, are located on dikes cross-cutting their respective drainages. Although the drainages have eroded through the dikes, these formations still serve as aquitards that impede the downslope movement of underground water, causing it to pool on their upslope side where it is easily accessible with minimal digging. A puddle of water was in fact present in a shallow hole, about one foot deep, at CA-SBr-14919 when we conducted our fieldwork. This had been excavated by wildlife, probably deer judging from hoofprints in the sand.

During wetter climatic regimes it is likely that seasonal pools were present at these two locations. Currently the dike at CA-SBr-14919 collects water at least during the winter. The site location also is a pinch-point or constricted spot in the stream (Figure 16) which, as noted above, is considered a place where power accumulates.

Figure 16 About here

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Figure 16. CA-SBr-14919 in the western cluster of sites in the northwestern study locale. Two parallel dikes crossing the stream in a perpendicular trajectory are shown here; those with petroglyphs are towards the rear (with human for scale). The dike in the foreground serves as an aquitard for downslope water movement. Water was puddled at about one foot below the groundsurface during our fieldwork; wildlife had apparently dug out the pit allowing the water to surface.

The three western sites and CA-SBr-11669 all look down on Pisgah Crater (Figure 17) in the Lavic Lake basin below. The viewshed of these sites likely contributed to the utility of these places as appropriate for ritual activities. All five of the northwestern locality sites, finally, fall within the Eastern California Shear Zone which, as noted above, is a major system of earthquake faults that has witnessed the greatest seismic activity in the state for the last three decades. Multiple natural factors and features then indicate that these sites are located at spots that would be understand as associated with supernatural power.

Figure 17 about here

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Figure 17. Viewshed is also a variable important in ritual site location. The single panel at CA-SBr-10865, in the western site cluster of the northwestern study locale, illustrates this characteristic with Pisgah Crater (low rise in the shadows) visible to the north. This volcanic cone was mined for cinders historically and its original height is unknown but was almost certainly more prominent than it is today.

9. Discussion and Conclusions

Traditional archaeological perceptions of ritual landscapes, including rock art, often reflected one of two lines of thought. The first was the attempt to explain site distribution in functionalist terms (Bradley et al. 1994): sites marked water, or territories, or otherwise were in certain locations due to their relationship to subsistence practices, effectively confusing correlation with causation. California ethnographer Alfred Kroeber in fact discredited such explanations, and the logic on which they are based, a century ago:

> It has sometimes been conjectured the symbols served as boundary markers, direction signs, or for some analogous practical purpose. Yet this interpretation fits neither their character, their location, nor the habits of native life. The Indian knew the limits of his territory and his way around it; and as for strangers, his impulse would have been to obscure their path rather than blazon it (1925: 939).

The second has been the tacit (usually unexpressed) bias that there is no underlying logic to site locations: 'rock art is where you find it.' This reflects Western science's long dismissal of religion as a mode of thought in competition with science (Midgley 2001, 2002, 2003). Since science is rational and logical, this opposition implies that religion is intrinsically irrational (e.g., Dawkins 2006; Dennett 2006). And if religious beliefs and practices are fundamentally illogical, it follows that there may be no specific logic to or pattern behind beliefs, ritual practices, symbolism, or the structure of ritual landscapes.

The problem with this last position is that it conflates two separate issues: the epistemic question involving the truth-value of gods and spirits, versus the larger issue concerning the *structure* of religious thought: whether the cognitive processes that underlie beliefs are irrational or instead

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similar to everyday, non-religious thought. If religious thought is structured like normal inferential processes, it follows that there may be logic—and thus patterning—behind the lay-out of ritual landscapes and thus the distribution of rock art sites.

Three decades of research in the cognitive science of religion have now demonstrated, conclusively, that religious thought operates under the same principals as everyday (even scientific) thinking (White 2021). Note that even scientific thought may sometimes be wrong in its empirical inferences; hence the frequency of academic debates, emphasizing again that the issue here is structural rather than substantive or factual. These normal thought processes include the use of deductive and inductive logic and analogy; the confusion of correlation with causation; confirmation bias; and promiscuous teleology—the idea that everything has a deeper (usually "higher") cause. There is, then, every reason to assume that the distribution of rock art sites might be systematic and patterned, following identifiable specific natural landscape and locational characteristics and features. This itself reflects the larger fact, as Marshall Sahlins has emphasized, that "the symbolic system is highly empirical" (1985: xiii).

We found that all seven of our investigated sites are associated with two or more features that were thought imbued with supernatural power and thus they are logically appropriate locations for ritual activities. This verifies the point that there is an identifiable structure and logic to the distribution of ritual practices beyond the two previously considered major rock art site concentrations created by Numic and Chumash peoples. It is certainly possible that some ritual sites may have no such associations: spiritual revelation in theory can happen, spontaneously, anywhere, and thus may not be predictable. But this current study confirms the wider applicability of the descriptive ethnographic model to smaller sites and to additional cultural groups, beyond those considered in the original study.

It is important however to emphasize that additional investigations should be conducted to confirm the results from our small sample-size study, to ensure the widespread applicability of the descriptive ethnographic model to larger regions and greater numbers of sites, and to demonstrate the predicative value of this descriptive model. This would require the inclusion of previously mapped geological and geophysical variables that were associated with supernatural power, such as volcanic landscapes/basalt formations, seismically-active areas and locales that experience frequent lightning strikes, in addition to standard hydrological variables, in a GIS predictive model. Some localized but potentially important natural features, such as caves, of course may not be identifiable on existing topographical and geological maps alone, and hence could not be included in a predictive model. But it is hoped that the larger scale landscape features alone will provide adequate information for the development of a predictive model that would improve regional heritage management planning.

Given the importance of previous cultural marking in influencing ritual locations, the predictive variables could also include the presence of concentrations of cleared circles, as were found at CA-SBr-161 and -7898. These are visible in air photos and potentially may be identifiable across large regions using artificial intelligence (cf. Sakai et al. 2024). Although we have not conducted a systematic examination of the association between these visible features and rock art site locations, it is worth noting anecdotally that such a concentration of cleared circles is also present (and is readily visible in aerial photographs) at the Painted Rock Reservoir site, near Gila Bend, Arizona, another major rock art site. Given that this last site is outside of the Native California cultural area, and that the association of rock art sites with supernatural power seems to have been widespread across Native America (see Arsenault 2004; Creese 2011; Loendorf 2004), it is possible that the ethnographic descriptive model may prove widely useful. Again, however, additional testing should be conducted to verify this possibility.

Acknowledgments: Delete for peer review.

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References

1. Aginsky, Burt W. 1943. *Culture Element Distributions: XXIV, Central Sierra*. Anthropological Records. Berkeley: University of California, vol. 8, pp. 393–468.
2. Ahlstrom, Richard V.N. and Heidi Roberts. 2001. Desert pavement and buried archaeological features in the Arid West: A case study from southern Arizona. *Journal of California and Great Basin Anthropology* 23: 1-26.
3. Applegate, Richard B. 1974. Chumash Placenames. *Journal of California Anthropology* 1: 186–205.
4. Applegate, Richard B. 1975. The Datura cult among the Chumash. *The Journal of California Anthropology* 2: 7–17.
5. Applegate, Richard B. 1978. *Atishwin: The Dream Helper Complex in South-Central California*. Anthropological Papers #13. Socorro: Ballena Press.
6. Arnold, Richard, and Richard W. Stoffle. 2006. Puha Path to Black Mountain. Paper presented at 30th Great Basin Anthropological Conference, Las Vegas, NV, USA, October 19–21.
7. Arsenault, Daniel. 2004. Rock-art, landscape, sacred places: attitudes in contemporary archaeological theory. In *The figured landscapes of rock art: looking at pictures in place.* Edited by George Nash and Christopher Chippindale. Cambridge: Cambridge University Press, pp.69-84.
8. Bean, Lowell John. 1975. Power and Its Application in Native California. *Journal of California and Great Basin Anthropology* 2: 25–33.
9. Bean, Lowell John. 1978. Cahuilla. In *Handbook of North American Indians*, Vol. 8, California, R. F. Heizer, editor, pp. 575-587. Smithsonian Institution, Washington, D.C.
10. Bean, Lowell John. 1972. *Mukat's People: The Cahuilla Indians of Southern California*. Berkeley: University of California Press.
11. Bean, Lowell John. 2017. *Mukat's Last Gift: Mortuary Customs among the Cahuilla Indians*. Menlo Park: Malki-Ballena Press.
12. Bean, Lowell John, Sylvia Brakke Vane, and Jackson Young. 1991. *The Cahuilla Landscape: The Santa Rosa and San Jacinto Mountains*. Menlo Park: Ballena Press.
13. Benedict, Ruth F. 1924. A brief sketch of Serrano culture. *American Anthropologist* 26: 366–92. [CrossRef]
14. Blackburn, Thomas. 1975. *December's Child: A Book of Chumash Oral Narratives*. Berkeley: University of California.
15. Bradley, Richard, 1991. Rock art and the perception of landscape. *Cambridge Archaeological Journal* 1(1):77-101.
16. Bradley, Richard, Felipe Criado Boado, and Ramon Fabregas Valcarce. 1994. Rock art research as landscape archaeology: A pilot study in Galicia, north-west Spain. *World Archaeology* 25(3): 374-390.
17. Brewster, Melvin G. 2003. Numu Views of Numu Cultures and History: Cultural Stewardship Issues and the Punown View of Gosiute and Shoshone Archaeology in the Northeast Great Basin. Ph.D. dissertation, University of Oregon.
18. Brooks, Cecil R., William M. Clements, Jo Ann Kantner, and G. Y. Poirier. 1979. *A Land Use History of Coso Hot Springs, Inyo County, California*. NWC Administrative Publication 200. Ridgecrest: China Lake Naval Air Weapons Station.
19. Brown, David E., and Richard A. Minnich. 1986. Fire and changes in creosote bush scrub of the western Sonoran Desert, California. *American Midland Naturalist* 116(2): 411-422.
20. Buttram, Mance E. 2006. Puha Path: Tippipah Spring to Scrugham Peak. Paper presented at the Great Basin Anthropological Conference, Las Vegas.
21. Caldwell, Todd, Eric McDonald, Steven Bacon, Rina Schumer, and Thomas Bullard. 2011. Cleared Circles: Anthropogenic or Biogenic? Use of Non-invasive Geophysical Techniques to Determine Origin. *Symposium on the Application of Geophysics to Engineering and Environmental Problems*. January 2011:581-581. https://doi.org/10.4133/1.3614205
22. Carden, Natalie, 2008. Territories among hunter-gatherers and the ritual dimension of landscapes: the central Patagonian plateau, Argentina. *Before Farming 2008*(1): 1-19.
23. Carroll, Alex K., M. Nieves Zedeño, and Richard W. Stoffle. 2004. Landscapes of the Ghost Dance: A cartography of Numic ritual. *Journal of Archaeological Method and Theory* 11: 127–56. [CrossRef]
24. Carroll, Kristen Jean. 2007. Place, Performance and Social Memory in the 1890s Ghost Dance. Ph.D. dissertation, Department of Anthropology, University of Arizona, Tucson, AZ, USA.

 doi:10.20944/preprints202501.0611.v1

25. Creese, John L., 2011. Algonquian rock art and the landscape of power. *Journal of Social Archaeology* 11(1): 3-20.
26. Cummins, Kenneth L. 2012. On the relationship between terrain variations and LLS-derived lightning parameters. Paper presented at 31st International Conference on Lightning Protection (ICLP), Vienna, Austria, September 3–7.
27. Dawkins, Richard. 2006. *The god delusion*. Boston: Houghton Mifflin.
28. Dennett, Danial C. 2006. *Breaking the spell: religion as a natural phenomenon*. New York: Viking.
29. Díaz-Andreu, Margarita, 2003. Rock art and ritual landscape in central Spain: the rock carvings of La Hinojosa (Cuenca). *Oxford Journal of Archaeology* 22(1): 35-51.
30. Driver, Harold E. 1937. *Cultural Element Distributions: VI, Southern Sierra Nevada*. Anthropological Records. Berkeley: University of California, vol. 1, pp. 53–154.
31. Driver, Harold E. 1939. *Cultural Element Distributions: X, Northwest California*. Anthropological Records. Berkeley: University of California, vol. 1.
32. Drucker, Phillip. 1937. *Culture Element Distributions: V, Southern California*. Anthropological Records. Berkeley: University of California, vol. 1.
33. DuBois, Constance G. 1908. *The Religion of the Luiseño Indians of Southern California*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 8.
34. Fairén-Jiménez, S., 2007. British Neolithic rock art in its landscape. *Journal of Field Archaeology* 32(3): 283-295.
35. Fowler, Catherine S. 1992. *In the Shadow of Fox Peak: An Ethnography of the Cattail Eater Northern Paiute People of Stillwater Marsh*. Cultural Resource Series No. 5. Carson City: USDI Fish and Wildlife Service.
36. Fowler, Catherine S. 2002. What's in a Name? Some Southern Paiute Names for Mojave Desert Springs as Keys to Environmental Perception. Conference Proceedings, Spring-fed Wetlands: Important Scientific and Cultural Resources of the Intermountain Region. Available online: http://www.wetlands.dri.edu (accessed on 1 October 2023).
37. Fowler, Catherine S., and Don D. Fowler, eds. 1971. *Anthropology of the Numa: John Wesley Powell's Manuscript on the Numic Peoples of Western North America*. Smithsonian Contributions to Anthropology 14. Washington: Smithsonian Institution.
38. Fowler, Catherine S., and Sven Samuel Liljeblad. 1986. Northern Paiute. In *Handbook of North American Indians 11: Great Basin*. Edited by Warren D'Azevedo. Washington: Smithsonian Institute, pp. 435–65.
39. Garate, Diego, Iñaki Intxaurbe, and Javier Moreno-García. 2020. Establishing a predictive model for rock art surveying: The case of Palaeolithic caves in Northern Spain." *Journal of Anthropological Archaeology* 60: 101231.
40. Garcês Sara, Dionysios Danelatos, RF Anastácio and George Nash. 2024. GIS Applications in Rock Art. In *The Prehistoric Rock Art of Portugal: Symbolising Animals and Things*. Edited by George Nash and Sara Garces. London: Routledge, pp. 346-363.
41. Garfinkel, Alan P., David A. Young and Robert M. Yohe II, 2010. Bighorn hunting, resource depression, and rock art in the Coso Range, eastern California: a computer simulation model. *Journal of Archaeological Science* 37(1): 42-51.
42. Gayton, Anna H. 1948. *Yokuts and Western Mono Ethnography*. Anthropological Records. Berkeley: University of California, vol. 10.
43. Gifford, Edward W. 1918. *Clans and Moieties in Southern California*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 14, pp. 155–219.
44. Grant, Campbell. 1985. *The Rock Paintings of the Chumash: A Study of a California Indian Culture*. Berkeley: University of California Press.
45. Hampson, J., 2016. *Rock art and regional identity: a comparative perspective*. London: Routledge.
46. Harrington, John Peabody. 1942. *Culture Elements Distributions: XIX, Central California Coast*. Anthropological Records. Berkeley: University of California, vol. 7, pp. 1–46.
47. Harrington, John Peabody. 1978. *Annotations to Chinigchinich: A Revised and Annotated Version of Alfred Robinson's [1846] Translation of Father Gerónimo Boscana's Historical Account of the Belief, Usages, Custom and Extravagancies of the Indians of this Mission of San Juan Capistrano Called the Acagchemem Tribe*. Edited by Geronimo Boscana. Banning: Malki Museum Press.
48. Harris, Jack S. 1940. The White Knife Shoshoni of Nevada. In *Acculturation in Seven American Indian Tribes*. Edited by Ralph Linton. New York: D. Appleton-Century, pp. 39–116.

 doi:10.20944/preprints202501.0611.v1

49. Heizer, Robert F., editor. 1955. California Indian Linguistic Records: The Mission Indian Vocabularies of H.W. Henshaw. *Anthropological Records* 15(2). Berkeley.
50. Heizer, Robert F. and Martin Baumhoff. 1959. Great Basin Petroglyphs and Prehistoric Game Trails. *Science* 129(3353): 904-905.
51. Heizer, Robert F. and Martin Baumhoff. 1962. *Prehistoric Rock Art of Nevada and Eastern California*. University of California Press, Berkeley.
52. Hill, J.H. and R. Nolasquez, editors. 1973. *Mulu'wetam: The First People: Cupeño Oral History and Language*. Banning: Malki Museum Press.
53. Honoré, Emannuelle, 2019. Prehistoric landmarks in contrasted territories: Rock art of the Libyan Desert massifs, Egypt. *Quaternary International* 503: 264-272.
54. Hooper, Lucille L. P. 1920. The Cahuilla Indians. Master's thesis, University of California, Berkeley, CA, USA.
55. Hudson, D. Travis, and Ernest Underhay. 1978. *Crystals in the Sky: An Intellectual Odyssey Involving Chumash Astronomy, Cosmology and Rock Art*. Socorro: Ballena Press.
56. Hudson, D. Travis, Thomas C. Blackburn, Rosario Curletti, and Jan Timbrook, eds. 1977. *The Eye of the Flute: Chumash Traditional History and Ritual as Told by Fernando Librado Kitsepawit to John P. Harrington*. Santa Barbara: Museum of Natural History.
57. Hultkrantz, Åke. 1961. The masters of the animals among the Wind River Shoshoni. *Ethnos* 26: 198–218. [CrossRef]
58. Hultkrantz, Åke, 1981. *Belief and Worship in Native North America*. Syracuse: Syracuse University Press.
59. Hultkrantz, Åke, 1986. Mythology and Religious Concepts. In *Handbook of North American Indians, Volume 11,*
60. 429*Great Basin*. Edited by Warren D'Azevedo. Washington, D.C., Smithsonian Institution, pp. 630-640.
61. Hultkrantz, Åke. 1987. *Native Religions of North America: The Power of Visions and Fertility*. San Francisco: Harper and Row.
62. Jones, Laura E. and Donald V. Helmberger. 1998. Earthquake source parameters and fault kinematics in the eastern California shear zone. *Bulletin of the Seismological Society of America*. 88(6): 1337-1352.
63. Kelly, Isabel T. 1932. *Ethnography of the Surprise Valley Paiute*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 31, pp. 67–210.
64. Kelly, Isabel T. 1936. Chemehuevi Shamanism. In *Essays in Anthropology, Presented to A.L. Kroeber in Celebration of His Sixtieth Birthday*. Berkeley: University of California, pp. 129–42.
65. Kelly, I. T., 1939. Southern Paiute Shamanism. *Anthropological Records* 2(4):151-167. Berkeley.
66. Kelly, Isabel T., and Catherine S. Fowler. 1986. Southern Paiute. In *Handbook of North American Indians Vol. 11: Great Basin*. Edited by Warren D'Azevedo. Washington: Smithsonian Institute.
67. Keyser, James D. and David S. Whitley, 2000. A New Ethnographic Reference for Columbia Plateau Rock Art: Documenting a Century of Vision Quest Practices. *International Newsletter of Rock Art* 25:14-20.
68. Keyser, James and David S. Whitley. 2006. Sympathetic Magic in Western North American Rock Art. *American Antiquity* 71(1):3-26.
69. Kroeber, Alfred L. 1907. *The Religion of the Indians of California*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 4, pp. 319–56.
70. Kroeber, Alfred L. 1908a. *Ethnography of the Cahuilla Indians*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 8, pp. 29–68.
71. Kroeber, Alfred L. 1908b. Origin Tradition of the Chemehuevi Indians. *Journal of American Folklore* 21: 240–42.
72. Kroeber, Alfred L. 1925. *Handbook of the Indians of California*. Bureau of American Ethnology Bulletin 78. Washington: Smithsonian Institution.
73. Kroeber, Alfred L. 1976. *Yurok Myths*. Berkeley: University of California Press.
74. Lace et al. 2018
75. Laird, Carobeth. 1974. Chemehuevi religious beliefs and practices. *Journal of California Anthropology* 1: 19–25.
76. Laird, Carobeth. 1976. *The Chemehuevis*. Banning: Malki Museum.

 doi:10.20944/preprints202501.0611.v1

77. Lee, Jeffrey, Spencer, Joel, and Owen, Lewis, 2001. Holocene slip rates along the Owens Valley fault, California: Implications for the recent evolution of the Eastern California Shear Zone. *Geology* 29(9): 819-822.
78. Liljeblad, Sven. 1986. Oral Tradition: Content and Style of Verbal Arts. In *Handbook of North American Indians,*
79. 577 *Volume 11, Great Basin*. Edited by W.L. D'Azevedo. Washington, D.C., Smithsonian Institution, pp. 641-659.
80. Liwosz, Chester R. 2017. Petroglyphs and *puha*: How multisensory experiences evidence landscape agency. *Time and Mind* 10: 175–210. [CrossRef]
81. Liwosz, Chester R., 2018. *Benchmarks: Ontological considerations at two Mojave Desert petroglyph labyrinths*. Ph.D. dissertation, University of California, Santa Cruz.
82. Loendorf, Lawrence L., 2004. Places of power: the placement of Dinwoody petroglyphs across the Wyoming landscape. In *The Figured Landscapes of Rock Art: Looking at Pictures in Place*. Edited by Christopher Chippindale and George Nash. Cambridge: Cambridge University Press, pp.201-216.
83. Lowie, Robert H. 1909. *The Northern Shoshone*. Anthropological Papers. New York: American Museum of Natural History, vol. 2.
84. Lowie, Robert H. 1924. *Notes on Shoshonean Ethnography*. Anthropological Papers. New York: American Museum of Natural History, vol. 20.
85. Luhmann, T., S. Robson, S. Kyle, and J. Boehm, editors, 2014. *Close-Range Photogrammetry and 3D Imaging*, 2nd edition. Berlin/Boston: De Gruyter.
86. Malouf, Carling. 1974. The Gosiute Indians. In *The Shoshone Indians, American Indian Ethnohistory: California and Basin-Plateau Indians*. (No editor). New York: Garland Press, pp. 25–172.
87. Mayet, Nasreen, Jasper Knight, and Stefan W. Grab. 2016. Spatial and temporal patterns of lightning strikes in the eastern Lesotho Highlands, southern Africa. *South African Geographical Journal/Suid-Afrikaanse Geografiese Tydskrif* 98: 321–36. [CrossRef]
88. McCarthy, Daniel. 1993. Prehistoric Land Use at McCoy Springs: An Arid-Land Oasis in Eastern Riverside County, California. M.A. Thesis, University of California, Riverside.
89. McCarthy, Helen. 1996, Ethnographic Study Mount Pinos: *Iwhinmu'u*. Unpublished manuscript. Los Padres National Forest.
90. McDonald, Eric, Hamerlynck, Eric, McAuliffe, Joseph and Caldwell, M. Todd, 2004. Analysis of Desert Shrubs along First-Order Channels on Desert Piedmonts: Possible Indicators of Ecosystem Condition and Historic Variation. *SERDP Seed project# CS1153, Final Technical Report*. Desert Research Institute, Nevada.
91. Midgley, Mary. 2001. *Science and poetry*. London: Routledge.
92. Midgley, Mary. 2002. *Evolution as a religion: strange hopes and stranger fears*, revised edition. London: Routledge.
93. Midgley, Mary. 2003. *The myths we live by*. London: Routledge.
94. Miller, Jay. 1983a. Basin Religion and Theology: A Comparative Study of Power (*Puha*). *Journal of California and Great Basin Anthropology* 5: 66–86.
95. Miller, Jay. 1983b. Numic Religion: An Overview of Power in the Great Basin of Native North America. *Anthropos* 78: 337–534.
96. Miller, Jay. 1985. Shamans and Power in Western North America: The Numic, Salish and Keres. In *Woman, Poet Scientist: Essays in New World Anthropology Honoring Dr. Emma Lou Davis*. Edited by Great Basin Foundation. Anthropological Papers No. 29. Socorro: Ballena Press, pp. 56–66.
97. Molinari, Rebecca Lee, Tara B.B. Bishop, Matthew F. Bekker, Stanley G. Kitchen, Loreen Allphin, and Samuel B. St. Clair. 2019. Creosote growth rate and reproduction increase in postfire environments." *Ecology and Evolution* 9, no. 22: 12897-12905.
98. Nankela, Alma M. 2017. *Rock art and Landscape: an empirical analysis in the content, context and distribution of the rock art sites in Omandumba East and West, Erongo Region-Namibia*. Doctoral dissertation, Museum national d'histoire naturelle-MNHN PARIS; Universidade de Trás-os-Montes e Alto Douro, Portugal.
99. Nash, George and Christopher Chippindale, editors. 2004. *The figured landscapes of rock-art: Looking at pictures in place*. Cambridge: Cambridge University Press.
100. Nash, George and Andres Troncoso. 2017. The socio-ritual organisation of the upper Limarí Valley: Two rock art traditions, one landscape. *Journal of arid environments*143: 15-21.

 doi:10.20944/preprints202501.0611.v1

101. Pillay, Patricia, Gerard O'Regan, and Joshua Emmitt. 2020. A locational analysis of rock art in the North Island, Aotearoa New Zealand. *Journal of Pacific Archaeology* 11(1): 71-82.
102. Nissen, Karen M. 1982. *Images from the past: an analysis of six Western Great Basin Petroglyph Sites*. Ph.D. dissertation, University of California, Berkeley.
103. Olofson, Harold. 1979. Northern Paiute shamanism revisited. *Anthropos* 1/2: 11–24.
104. Park, Willard Z. 1938. *Shamanism in Western North America: A Study in Cultural Relationships*. Studies in the Social Sciences No. 2. Evanston: Northwestern University.
105. Patencio, Francisco. 1943. *Stories and Legends of the Palm Springs Indians*. Palm Springs: Palm Springs Desert Museum.
106. Perry, Jennifer E. 2007. Chumash ritual and sacred geography on Santa Cruz Island, California. *Journal of California and Great Basin Anthropology* 27(2):103-124.
107. Ouzman, Sven. 1998. Toward a mindscape of landscape: rock-art as an expression of world-understanding. In *The archaeology of rock-art.* Edited by Christopher Chippindale and Paul Taçon. Cambridge: Cambridge University Press, pp. 30-41.
108. Reid, Hugo. 1958. *The Indians of Los Angeles County: Hugo Reid's Letters of 1852*. Edited by Robert F. Heizer. Southwest Museum Papers 21. Highland Park.
109. Riddell, Francis A. 1978. *Honey Lake Paiute Ethnography*. Occasional Paper 3, Part I. Carson City: Nevada State Museum.
110. Ruuska, Alex K. 2014. Rock Writing Performances in the Great Basin: Ghost Dancing and the New Animism. Paper presented at the Society for American Archaeology Meetings, Austin, TX, USA, April 23–27.
111. Sahlins, Marshall. 1985. *Islands of History*. Chicago: University of Chicago Press.
112. Sakai, Masato, Akihisa Sakurai, Siyuan Lu, Jorge Olano, Conrad M. Albrecht, Hendrik F. Hamann, and Marcus Freitag. 2024. AI-accelerated Nazca survey nearly doubles the number of known figurative geoglyphs and sheds light on their purpose. *Proceedings of the National Academy of Sciences* 121, no. 40: e2407652121.
113. Shimkin, Demitri. n.d. Letter to Whitley dated September 28, 1992, enclosing sections on Shoshone religion deleted by editor from original Shimkin (1986) manuscript. September 28.
114. Shimkin, Demitri, 1953. The Wind River Shoshone Sun Dance. *Anthropological Papers* 41. Bureau of American
115. 757. Ethnology, Bulletin 151:397-484.
116. Shimkin, Demitri. 1986. Eastern Shoshone. In *Handbook of North American Indians, Volume 11, Great Basin*. Edited by Warren L. D'Azevedo. Washington: Smithsonian Institution, pp. 308–35.
117. Shipek, Florence. 1985. Kuuchamaa: The Kumeyaay Sacred Mountain. *Journal of California and Great Basin Anthropology* 7: 67–74.
118. Sognnes, Kalle, 1994. Ritual landscapes. Toward a reinterpretation of stone age rock art in TrØndelag, Norway. *Norwegian Archaeological Review* 27(1): 29-50.
119. Sparkman, Phillip. 1908. *The Culture of the Luiseño Indians*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 8, pp. 187–234.
120. Spier, Leslie. 1923. *Southern Diegueño Customs*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 20, pp. 297–358.
121. Spier, Leslie. 1930. *Klamath Ethnography*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 30.
122. Steward, Julian H. 1941. *Culture Elements Distributions: XIII, Nevada Shoshoni*. Anthropological Records. Berkeley: University of California, vol. 4, pp. 209–359.
123. Steward, Julian H. 1943. *Culture Element Distributions: XXIII, Northern and Gosiute Shoshoni*. Anthropological Records. Berkeley: University of California, vol. 8, pp. 263–392.
124. Steward, Julian H., 1963. Review of *Prehistoric Rock Art of Nevada and Eastern California* by R.F. Heizer and M.A. Baumhoff. *American Anthropologist* 65, 976-7.
125. Stewart, Omer. 1941. *Culture Element Distributions: XIV, Northern Paiute*. Anthropological Records. Berkeley: University of California, vol. 4, pp. 361–446.
126. Stoffle, Richard W. 2022. Native Hawaiians Believe Volcanoes Are Alive and Should Be Treated like People, with Distinct Rights and Responsibilities. *UA@Work*. December 22. Available online: https://uaatwork.arizona.edu/lqp/native-hawaiians-believe- volcanoes-are-alive-and-should-be-treated-

 doi:10.20944/preprints202501.0611.v1

people-distinct-rights-and#:~:text=As%20in%20most%20Native%20American,is%20like%20the%20Earth's%20mother (accessed on 20 May 2023).

127. Stoffle, Richard W., Lawrence Loendorf, Diane E. Austin, David B. Halmo and Angelita Buletts
128. 2000 Ghost dancing the Grand Canyon: Southern Paiute rock art, ceremony and cultural landscapes. *Current Anthropology* 41(1):11-38.
129. Stoffle, Richard W., and Maria Nieves Zedeño. 2002. The Concept of "Power" in Numic and Yuman Epistemologies. *High Plains Applied Anthropologist* 22: 172–93.
130. Stoffle, Richard W., Kathleen A. Van Vlack, Hannah Z. Johnson, Phillip T. Dukes, Stephanie C. De Sola, and Kristen L. Simmons. 2011a. *Tribally Approved American Indian Ethnographic Analysis of the Proposed Amargosa Valley Solar Energy Zone*. Tucson: Bureau of Applied Anthropology, University of Arizona.
131. Stoffle, R.W. and Arnold, R., 2003. Confronting the angry rock: American Indians' situated risks from radioactivity. *Ethnos* 68(2): 230-248.
132. Stoffle, R. W., K. A. Van Vlack, H. Z. Johnson, P. T. Dukes, S. C. De Sola, and K. L. Simmons, 2011a. *Tribally Approved American Indian Ethnographic Analysis of the Proposed Dry Lake Solar Energy Zone*. Bureau of Applied Anthropology, University of Arizona.
133. Stoffle, R. W., K. A. Van Vlack, H. Z. Johnson, P. T. Dukes, S. C. De Sola, K. L. Simmons, 2011b. *Tribally Approved American Indian Ethnographic Analysis of the Proposed Milford Flats South Solar Energy Zone*. Bureau of Applied Anthropology, University of Arizona.
134. Stoffle, Richard W., Kathleen A. Van Vlack, Hannah Z. Johnson, Phillip T. Dukes, Stephanie C. De Sola, and Kristen L. Simmons. 2011c. *Tribally Approved American Indian Ethnographic Analysis of the Proposed Delamar Valley Solar Energy Zone*. Tucson: Bureau of Applied Anthropology, University of Arizona.
135. Stoffle, R.W., R. Arnold, M. Frank, B. Cornelius, L. Miller, J. Charles, G. Kane, A.K. Ruuska and K. Van Vlack.
136. 2015. Ethnology of volcanoes: Quali-signs and the cultural centrality of self-voiced places. In *Engineering mountain landscapes: An anthropology of social investment*. Edited by L.L. Scheiber and M.N. Zedeno. Salt Lake City: University of Utah Press, pp.99-115.
137. Stoffle, Richard W., Richard Arnold, and Kathleen Van Vlack. 2022. Landscape is Alive: *Nuwuvi* Pilgrimage and Power Places in Nevada. *Land* 11: 1208.
138. Stoffle, R.W., and K.A. Van Vlack. 2006. *Puaxant Tuvip* Puha Paths: Southern Paiute Pilgrimages on the Arizona
139. Strip. Paper presented at 30th Great Basin Anthropological Conference, Las Vegas, NV.
140. Stoffle, R.W., Zedeño, M.N. and Halmo, D.B. 2001. *American Indians and the Nevada test site: A model of research and consultation*. US Government Printing Office, Washington, DC.
141. Strong, William Duncan. 1929. Aboriginal Society in Southern California. *University of California Publications in American Archaeology and Ethnology* 26. Berkeley.
142. Trenholm, Virginia Cole, and Maurine Carley. 1964. *The Shoshonis: Sentinels of the Rockies*. Norman: University of Oklahoma.
143. Turner, Wilson G., 1994. The Rock Art of Black Canyon. *San Bernardino County Museum Association Quarterly* 41 (1& 2).
144. Van Vlack, Kathleen A., 2012a. *Puaxant Tuvip*: Powerlands—Southern Paiute Cultural Landscapes and Pilgrimage Trails. Ph.D. dissertation, University of Arizona, Tucson.
145. Van Vlack, Kathleen A. 2012b. Southern Paiute Pilgrimage and Relationship Formation. *Ethnology* 51(2): 129-140.
146. Van Vlack, Kathleen A., Richard Stoffle, Evelyn Pickering, Katherine Brooks, and Jennie Delfs. 2013. *Unav-Nuquaint: Little Springs Lava Flow Ethnographic Investigation*. Tucson: Bureau of Applied Anthropology, University of Arizona.
147. Van Vlack, Kathleen A. 2018. *Puha Po* to Kavaicuwac: A Southern Paiute Pilgrimage in Southern Utah. *International Journal of Intangible Heritage* 13: 130–41.
148. Van Vlack, Kathleen A. 2022. Dancing with Lava: Indigenous Interactions with an Active Volcano in Arizona. In *Anthropological Perspectives on Environmental Communication*. Edited by Amelie Sjolander-Lindqvist, Ivan Murin and Michael E. Dove. Cham: Palgraves McMillan, pp. 29–53.
149. Vasek, Frank C. 1980. Creosote bush: Long-lived clones in the Mojave Desert." *American Journal of Botany* 67(2): 246-255.

 doi:10.20944/preprints202501.0611.v1

150. Vatin, Gabriel and Nicoletta Bianchi. 2014. SIG des Merveilles: analysing rock art distribution with a web cartographic platform. *Archeologia e Calcolatori*, *Supplemento* 5: 190-200.
151. Viles, Heather A., Andrew S. Goudie, and Alice M. Goudie. 2021. Ants as geomorphological agents: A global assessment. *Earth-Science Reviews* 213: 103469.
152. Voget, Fred W. 1984. *The Shoshoni-Crow Sun Dance*. Norman: University of Oklahoma Press.
153. Von Werlhof, Jay, 1965. *Rock Art of Owens Valley, California*. University of California Archaeological Research Facility Monograph 65. Department of Anthropology.
154. Von Werlhof, Jay, Harry Casey, Ronald I. Dorn, and Glenn A. Jones. "AMS 14C age constraints on geoglyphs in the lower Colorado River region, Arizona and California." *Geoarchaeology* 10, no. 4 (1995): 257-273.
155. Walker, Deward E., Jr. 1991. Protection of American Indian Sacred Geography. In *Handbook of American Indian Religious Freedom*. Edited by Christopher Vecsey. Chestnut Ridge: Crossroads Publishing Co., pp. 100–15.
156. Walker, Jr., D. W., 1996. Durkheim, Eliade and Sacred Geography in Northwestern North America. In *Chin Hills to Chiloquin: Papers Honoring the Versatile Career of Theodore Stern*. Edited by D. Dumond. University of Oregon Anthropological Papers 52. Eugene, pp. 63-68.
157. Walsh, F., Bidu, G.K., Bidu, N.K., Evans, T.A., Judson, T.M., Kendrick, P., Michaels, A.N., Moore, D., Nelson, M., Oldham, C. and Schofield, J., 2023. First Peoples' knowledge leads scientists to reveal 'fairy circles' and termite *linyji* are linked in Australia. *Nature Ecology & Evolution* 7(4): 610-622.
158. Waterman, Thomas T. 1910. *The Religious Practices of the Diegueño Indians*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 8, pp. 271–358.
159. White, Raymond C. 1963. *Luiseño Social Organization*. Publications in American Archaeology and Ethnology. Berkeley: University of California, vol. 48, pp. 91–194.
160. Whiting, Beatrice B. 1950. *Paiute Sorcery*. Viking Fund Publications to Anthropology No. 15. New York: Wenner Gren
161. White, Claire. 2021. *An Introduction to the Cognitive Science of Religion*. London: Routledge.
162. Whitley, David S. 1988. Bears and Baskets: Aspects of Shamanism in North American Rock Art. In *The State of the Art: Advances in World Rock Art*. Edited by Thomas A. Dowson. Johannesburg: Archaeology Department, University of the Witwatersrand, pp. 34-45.
163. Whitley, David S. 1992. Shamanism and Rock Art in Far Western North America. *Cambridge Archaeological Journal* 2:89-113.
164. Whitley, D. S., 1995. Rock Art on the Lower Colorado River: Analysis of the Inscription Rock and Scratched Glyph Sites. Report on file, Bureau of Reclamation.
165. Whitley, David S. 1998a. Finding rain in the desert: Landscape, gender, and far western North American rock art. In *The Archaeology of Rock Art*. Edited by Christopher Chippindale and Paul S. C. Taçon. Cambridge: Cambridge University Press, pp. 11–29.
166. Whitley, David S. 1998b. Meaning and Metaphor in the Coso Petroglyphs: Understanding Great Basin Rock Art. *In Coso Rock Art: A New Perspective.* Edited by Elva Younkin. Ridgecrest: Maturango Museum, pp.109-174.
167. Whitley, David S. 2000. *The Art of the Shaman: Rock Art of California*. Salt Lake City: University of Utah Press.
168. Whitley, David S. 2005. *Introduction to Rock Art Research*, 1st edition. Walnut Creek: Left Coast Press.
169. Whitley, David S. 2006. Rock Art and Rites of Passage in Far Western North America. In *Talking with the Past: The Ethnography of Rock Art*. Edited by James D. Keyser, George Poetschat, and Michael W. Taylor. Portland: Oregon Archaeological Society, pp. 295-326.
170. Whitley, David S. 2024. Ontological Beliefs and Hunter-Gatherer Ritual Landscapes: Native Californian Examples. *Religions* 15:123. https://doi.org/ 10.3390/rel15010123.
171. Whitley, David S., JD Lancaster and Andrea Catacora. 2024. Desert Crossroads: An Interpretive Context and Management Recommendations for Selected Petroglyph Sites at the Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, California, N62473-19-2-0012. Administrative report on file, Natural Resources and Environmental Affairs Division, MCAGCC.
172. Whitley, David S., Johannes H. N. Loubser and Donald Hann. 2004. Friends in Low Places: Rock art and landscape on the Modoc Plateau, In *The Figured Landscapes of Rock Art: Looking at Pictures in Place*. Edited by Christopher Chippindale and George Nash. Cambridge: Cambridge University, pp. 217-238.

 doi:10.20944/preprints202501.0611.v1

173. Whitley, David S., and Tamara K. Whitley. 2012. A land of visions and dreams. In *Issues in Contemporary California Archaeology*. Edited by Terry Jones and Jennifer Perry. Walnut Creek: Left Coast Press, pp. 255–314.
174. Whitley, David S., Joseph M. Simon, 1996. Archaeological Survey and Recordation of Rock Art on "The Whale," Fort Irwin NTC, San Bernardino County, California. Report on file, Fort Irwin NTC Environmental Affairs.
175. Witkosky, Rebecca A., Joann M. Stock, David M. Tratt, Kerry N. Buckland, Paul M. Adams, Patrick D. Johnson, David K. Lynch, and Francis J. Sousa. 2020. The Lavic Lake Fault: A Long-Term Cumulative Slip Analysis via Combined Field Work and Thermal Infrared Hyperspectral Airborne Remote Sensing. *Remote Sensing 12*: 3586. https://doi.org/10.3390/rs12213586
176. Wyndham, Felice S., 2011. The semiotics of powerful places: rock art and landscape relations in the Sierra Tarahumara, Mexico. *Journal of Anthropological Research* 67(3): 387-420.
177. Zedeño, Maria Nieves and K. Hamm. 2001. The Ethnoarchaeology of the Pahute and Rainier Mesas. In *American Indians and the Nevada Test Site: A Model of Research and Cooperation*. Edited by Richard W. Stoffle, Maria Nieves Zedeño and David B. Halmo. U.S. Government Printing Office, Washington, D.C., pp. 98-121.
178. Zigmond, Maurice. 1977. The supernatural world of the Kawaiisu. In T.C. Blackburn, editor, pp. 59-95, *Flowers of the wind: Papers on ritual, myth and symbolism in California and the Southwest*. Socorro, Ballena Press.
179. Zigmond, Maurice. 1980, *Kawaiisu Mythology: An Oral Tradition of South-Central California*. Socorro, N.M., Ballena Press.