The Coso Petroglyph Chronology

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Abstract

The following clarifies the current status of the authors' understanding of the Coso petroglyph chronology, starting with a review of the initial chronological schemes and concluding with a review of the chronometrics and rock art.

Introduction

The Coso Range contains one of the most remarkable archaeological records in the far west. Not only is there an impressive concentration of early sites around the margins of Pleistocene Lake China, but the Sugarloaf obsidian quarry is one of the largest volcanic glass sources in the Great Basin. The importance of these and other Coso archaeological resources is remarkable, yet Coso archaeology is world renowned for one main reason—the massive number of petroglyphs that stretch from Little Lake, on the western edge of the Cosos, to the Panamint Valley on the east. Arguably this is the largest concentration of rock art in North America. It is world renowned partly because of the aesthetic beauty of many of the engravings, in part because of the large quantity of art, but also because much has been written about this art during the last four decades. This includes especially Heizer and Baumhoff's (1962) monograph on eastern California and Nevada rock art (which used a Coso panel for its frontispiece), and Grant's (1968) more focused study on the Cosos alone.

Central to the published discussions about Coso rock art is chronology, a common archaeological topic, and the relationship of the art to the remainder of the archaeological record. As many readers will know, we have contributed to this body of literature in a series of papers that, among other things, represent the first application of chronometric techniques to rock art worldwide (Dorn and Whitley 1983, 1984; Whitley 1994, 2000; Whitley and Dorn 1987, 1988; Whitley, Simon, and Dorn 1999a, 1999b; Dorn 1994, 1998a, 2001; Cerveny et al. 2006). The research that is the basis for these papers includes a suite of 60 chronometric ages on petroglyphs from the Mojave Desert, including the Cosos, making this the best dated regional corpus of rock art in the world.

In addition to these papers, the Coso rock art chronology has figured in a number of recent papers by other authors (e.g., Gilreath 2007, Hildebrandt and McGuire 2002, McGuire and Hildebrandt 2005, Garfinkel/Gold 2006). This fact speaks to the growing importance of the Coso petroglyphs to diverse archaeological issues, and it is an encouraging circumstance for rock art research. Less positively, there are misunderstandings about the Heizer and Baumhoff (1962) and Grant (1968) chronologies, which extend to the current status of rock art chronometrics, and include misunderstandings of our research conclusions.

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The Heizer and Baumhoff Chronology

Heizer and Baumhoff's (1962) rock art monograph was influential on many levels, not the least of which was their proposed stylistic rock art chronology, which has been widely accepted for a cultural–historical scheme in North American rock art research (e.g., von Werlhof 1965; Grant 1967:105, 1968; Heizer and Clewlow 1973:23; Nissen 1974; Wellman 1979:58). Heizer and Baumhoff (1962) identified and assigned tentative ages to five "styles," one of which had three "variants:"

(1) Great Basin Pecked, with the variants of:
  (a) Representational, assigned an age from AD 1 to 1500;
  (b) Curvilinear Abstract, 1500 BC to AD 1500; and
  (c) Rectilinear Abstract, AD 1 to 1500;
(2) Great Basin Painted, AD 1000 to Historic;
(3) Great Basin Scratched, AD 750 to Historic;
(4) Puebloan Painted, 250 BC to AD 750; and
(5) Pit and Groove, 6000 BC to 3000 BC.

Their dating was admittedly inferential and speculative and there were, from the start, significant theoretical and empirical problems with their chronology. The first concerns the nature and definition of their central concept, "style," and thus the internal logic of their chronological construct.

They based their argument about styles on an article by Meyer Schapiro (1953). Quoting an introductory paragraph from his synthesis on this topic, this stated that style was expressed in formal motives [i.e., motifs] and patterns. But later in his article, Schapiro also was careful to emphasize that style is expressed in all of the arts of a particular culture, embodying therefore a range of variation in techniques, media, formal characteristics, contexts and themes (see Whitley 1982)—a fact that Heizer and Baumhoff had overlooked. Schapiro emphasized a point which had been recognized at least since Boas' (1905) much earlier study of Northwest Coast needle-cases. This is to say that the few formal attributes of rock art identified by Heizer and Baumhoff as diagnostic of cultural–historical styles, such as motif and technique of manufacture, are alone insufficient to define "styles" in Schapiro's cultural–historical sense. Indeed, Schapiro's definition precisely foreshadows the variability which Heizer and Baumhoff ignored. Heizer and Baumhoff's application of the style concept contradicts then the source they cited as their rationale for it.

Unfortunately, this fundamental point was not only misunderstood by Heizer and Baumhoff, but also by a series of subsequent researchers, all of whom have repeated Heizer and Baumhoff's quotation from the first page of Schapiro's lengthy article, apparently without ever independently examining the actual substance of his argument. The result is straightforward; Heizer and Baumhoff's theoretical justification for their stylistic chronology, along with that of numerous later rock art researchers, contradicts Schapiro's (1953) intended definition of the concept. From the outset, then, Heizer and Baumhoff's empirical use of the concept of style for rock art was inadequate.

Perhaps predictably, given this initial conceptual confusion, their chronological sequence has not withstood empirical scrutiny. Grant (1968), writing about the Coso Range petroglyphs just a few years later, for example, stated that, based on the relative revarnishing of motifs, there was no evidence supporting an evolution of styles from curvilinear to rectilinear and representational. He observed that

> no such change of style can be seen. The drawings in this country cover a very long time span and for the whole period the art tradition remained remarkably stable.... The style and subject matter of these petroglyphs vary but slightly from early to late (Grant 1968:16–17).

Grant's failure to find evidence of Heizer and Baumhoff's stylistic chronology has been duplicated in other areas. Dickey (1994:13), for example, failed to find support for this sequence in an analysis of superimposed motifs at Paiute Creek, eastern California. Woody's (1996) analysis of superimpositions and "generations" of motifs (identified by relative revarnishing) at the Massacre Bench Site in western Nevada, likewise, failed to support the Heizer and Baumhoff (1962) chronology.

The relationship of the Pecked to the Scratched styles in the Heizer and Baumhoff (1962) chronology was further extended by Bettinger and Baumhoff (1982), in an attempt to correlate it with the Numic Spread Hypothesis—the theory that Numic speaking Paiute and Shoshone peoples migrated out of eastern California circa AD 1200–1300, replacing so-called "pre-Numic" peoples in Nevada and elsewhere. They argued that Scratched motifs post-date AD 1300 and represent Numic ritual defacement of earlier (Pecked) pre-Numic rock art, based on their assertion that Scratched motifs are always superimposed over Pecked designs.

Ritter (1994) conducted a careful superimpositional study at two western Nevada sites, partly to test the Bettinger and Baumhoff (1982) model. Ritter demonstrated that the ages of Pecked and Scratched style motifs overlap; sometimes Pecked motifs were placed on top of Scratched designs, and sometimes Scratched art was on top of the Pecked petroglyphs. Ritter's empirical evidence challenges Bettinger and Baumhoff's (1982) hypothesized Numic/pre-Numic distinction concerning Pecked versus Scratched motifs. We have made the same observations about Scratched and Pecked motifs in the Cosos and in the Mojave Desert more generally, confirming that Ritter's conclusions appear valid for more than just the sites that he studied.

More recently, Kaldenberg (personal communication 2007) has collected ethnographic information indicating that scratched motifs are still made in eastern California, in contemporary times, in non-ritual contexts. Whether all or some earlier scratched motifs were created ritually, or not, remains to be determined. More important at this stage is that Bettinger and Baumhoff's (1982) arguments about the Scratched style chronology and ritual defacement have been called into question.

The Grant Chronology

As the above quotation indicates, Grant's (1968) Coso chronology questions Heizer and Baumhoff's stylistic approach. Grant's chronology instead rested on a series of propositions and inferences, some reasonable, some not.

First, he posited a different view of style and rock art chronology than expressed by Heizer and Baumhoff. Based presumably on general knowledge of art history, perhaps due to his training as a commercial artist, Grant tacitly acknowledged that artistic abilities do not evolve over time from abstract to representational (as Heizer and Baumhoff [1962], following Steward [1929], assumed). His chronology, therefore, made no distinctions between "geometric" versus "representational" as temporally diagnostic, but instead incorporated so-called "naturalistic," "stylized," and "abstract" motifs in each of his three posited time periods:

Early (~1000–200 BC);
Transitional (200 BC–AD 300); and
Late (AD 300–1000).

This is to say that Grant provided a stylistic chronology that was in fact closer to Schapiro's (1953) definition of cultural-historical style than that Heizer and Baumhoff (1962) developed, even though he was apparently unaware of this fact. (Schapiro does not appear in his citations.)

Grant's insights as an artist, second, must be matched against his lack of archaeological knowledge, which contributed to confusions in his chronology and interpretation. Although admitted to be speculative, he based his chronology primarily on three lines of reasoning. The first was the sequence of hunting weapons portrayed in the art: specifically, the transition from atlatl to bow. Note, however, that he set this transition as a 500 year long period, running between 200 BC and AD 300. Yet prior to 1968, the basic outline of the Great Basin projectile point chronology had been worked out. The timing of the atlatl to bow transition was already well-established as a quick replacement occurring around AD 600, in part based on research at the Rose Spring Site, in the Coso Range region (Lanning 1963:268, 281; also Clewlow 1967). This date has been confirmed, with only minor modification, by more recent research (Yohe 1992). The implication of Grant's unfamiliarity with the then-understood Great Basin chronology and previous Coso Range research is two-fold. (Again, Lanning's Rose Spring report does not appear in Grant's bibliography.) By moving the atlatl-to-bow transition forward in time to its proper place, the length of Grant's Late Period is truncated almost in half, running from only AD 600 to 1000, making implausible his interpretation of the great fluorescence in art which he hypothesized to have occurred following the introduction of the bow. Equally problematical, this eliminates his Transitional Period altogether so that, correctly, Grant's chronology reduces to a two-phase sequence: Early (~1000 BC to AD 600), and Late (AD 600 to 1000).

Grant's second line of chronological reasoning was based on his acceptance of Heizer and Baumhoff's (1962) assertions that the art was all prehistoric, and that recent Native Americans knew nothing of it, matched against their admonition that all of the art was still (prehistorically-speaking) relatively late dating. Grant therefore truncated his petroglyph chronology—arbitrarily, as he admitted—at AD 1000, in general agreement with these earlier authors, as well as to coincide with his reading of Lamb's (1958) historical linguistical interpretation of Numic languages. And, while he left the starting point of the Coso petroglyph chronology somewhat open-ended, he nonetheless placed it in the vicinity of 1000 BC—only about three thousand years ago.

The third primary line of reasoning in Grant's chronology was based on his interpretation of the processes resulting in the genesis of rock varnish. This of course pertains to his starting date for the earliest petroglyphs. He argued that "optimum formation of patina [i.e., rock varnish] occurs only in areas where high summer temperatures and thundershowers occur together" (1968:44). This inference led him to argue that varnish in the Cosos principally developed after the "Great Pluvial," which he terminated at 4000 YBP, thereby suggesting that the petroglyphs—engraved into rock varnish—were less than 4000 years in age. However, it was a well-established fact, even in 1968, that rock varnish can form in sub-arctic and alpine environments, as was evident in the "desert varnish" literature at the time (e.g., historical review in Dorn 1998a). Rock varnish formation processes place no necessary limit on the age of the Coso petroglyphs, and belie Grant's argument about the maximum potential age of the Coso petroglyphs.

Unlike Heizer and Baumhoff's (1962) earlier effort, Grant's chronology did not ignore the obvious empirical evidence negating the curvilinear–rectilinear–representational evolutionary sequence propounded by these earlier authors. Grant in fact recognized that the Heizer and Baumhoff (1962) sequence could not be supported empirically, and he attempted to correct it. But Grant (1968) accepted Heizer and Baumhoff's (1962) argument for a short and late chronology, including their bias against any

connection between recent Native Americans and the petroglyphs.

The Revised Chronology

It is useful to turn next to the chronological revisions that we have proposed. This requires some minor corrections at the start. In a recent paper Garfinkel/Gold, for example, claimed that

> Whitley contends that most Coso drawings were produced after AD 1000 when a shift from mobile foraging to more sedentary seed gathering occurred (2006:208, emphasis by Garfinkel/Gold).

Somewhat earlier, Gilreath (2003) said much the same thing. She stated that "Whitley argues that the vast majority of the Coso petroglyphs date to the last 1000 years."

These statements misrepresent our position in a small but significant fashion (e.g., Whitley 1998a:58). It is easiest to clarify our arguments in this regard by summarizing our evidence, in detail. This involves four kinds of data: ethnography, dateable subject matter, petroglyph condition, and chronometrics.

Ethnography

Much of the debate over the age of the Coso petroglyphs concerns the question of whether there is any ethnographic evidence about this art. Hildebrandt and McGuire (2002) and Gilreath (2007) combine this question with a slightly different problem—the separate issue of what the ethnographic data mean symbolically. Since Whitley's interpretation of these data with reference to the origin and meaning of the art has already been outlined (e.g., Whitley 1992, 1994, 1998b, 1998c, 2000, etc.), here we address just two specific issues:

(1) whether there are ethnographic data on the creation of the Coso petroglyphs, regardless of how one might wish to interpret these data; and
(2) whether these data have any chronological implications.

The answer to both questions is an unqualified "yes." Not only are there multiple ethnographic accounts of the creation of petroglyphs, but these accounts include details about the recent creation of the motifs. For example, anthropologists documented that some of the art was historical in age, including a few statements by consultants who claimed to have seen artists in action, or others who observed that it was made during their 'grandfather's time' (e.g., Steward 1933, Kroeber in Chalfant 1933, Driver 1937, Stewart 1942). More common however are attributions of the origin of the petroglyphs to spirits, and this was recognized as an ongoing, not ancient, phenomenon. These accounts are particularly common for the Coso region.

Referring to the "water baby" spirit helper, Kerr for example recorded that:

> [Rock art] is not written by the Indians but by a baby or something like a baby called *pah* or *oh*. Some of the old Indians saw the baby write on the rocks. When they saw the baby they did not live very long. Sometimes the rock bawls like a baby; that is why the Indians know it is the baby that writes on rocks.
>
> Another informant claimed that the spirits which made rock writings are different from water babies. Indians hear pounding on rocks as spirits make fresh petroglyphs; the rock writings are continuously being made (Irwin 1980:32).

The comments recorded by Kerr date to the early part of the 20th century, but the belief in the ongoing production of the petroglyphs by spirits has been recorded by other anthropologists from additional informants: "Sometimes they would notice a new rock drawing which had not been there previously. The spirit who made this new drawing would expect to be fed." (Brooks et al. 1979:94)

A similar observation was obtained from a Timbisha Shoshone consultant:

> [The Coso area] is a very spiritual place, a source of supernatural power…It is also a place where petroglyphs are known to occur, with new ones added by spiritual forces all the time (Fowler, Dufort, and Rusco 1995:55).

Belief in the ongoing creation of the art by the spirits is further confirmed by an account collected by Harrington (1950). His informant claimed that a short-statured spirit made rock art and that it continued to be produced into the 20th century. This informant said he had tabulated 26 motifs on his first visit to a specific site, but there were six new engravings on his next, emphasizing this chronological point.

More recently, Russell L. Kaldenberg interviewed Harold Bevers, concerning the Coso petroglyphs. Mr. Bevers, a Coso Shoshone man, was born in the Indian Village at Darwin, California, and grew up at Indian Springs Garden, on China Lake Naval Air Station. He is about 76 years in age. According to Kaldenberg (personal communication 2005), Mr. Bevers said that:

> His mother thought that they were made by bad spirits (doctors). And, every time they heard a peck, peck, pecking (petroglyphs being made), his mother would reach into a bag of flour and scatter flour all over the inside of their house.

There are a number of ethnographic accounts concerning the making of Numic rock art, in other words, including a series specifically from the Coso Range. These all are internally consistent; they were derived from multiple informants by different anthropologists; and they all claim that rock art production is a historical, and not an ancient, phenomenon. Furthermore, these accounts are matched by equivalent statements from other parts of Numic territory. Harold Driver (1937:86) interviewed three Shoshones, all of whom told him that "baby" made rock art. Driver clarified this attribution by noting that this was "The Shoshonean water baby, *pau'ha"* (ibid:126). Äke Hultkrantz, similarly, recorded a Wind River Shoshone account, from Wyoming, over a thousand kilometers northeast of the Coso Range, stating that: "The rock drawings are supposed to represent spirits and have been made by the spirits themselves. Each spirit draws its own picture" (1987:49).

The Southern Paiute also maintained similar views about the origin of rock art. Writing about the Chemehuevi, Carobeth Laird noted that: "Petroglyphs…are said to be *tutuguuvo?pi*, marked by *tutuguuviwi* [spirit helpers]" (1976:123).

Elsewhere in the same publication she stated that: "*tutuguuvo?opi* – "animal familiar marked, i.e., marked by animal familiars; said of all rocks which bear paintings or carvings" (1976:328). Maurice Zigmond (1977:71, 1986:406–407) recorded parallel information for the Kawaiisu. The Kawaiisu attributed rock art to "Rock Baby," who was also said to dwell in the rocks. Zigmond's information confirmed earlier data recorded by Driver (1937:86): his Kawaiisu informant likewise attributed rock art to this "baby."

Starting with Heizer and Baumhoff (1962), some archaeologists have ignored or argued away these statements (e.g., Bettinger and Baumhoff 1982,

Hildebrandt and McGuire 2002, Quinlan and Woody 2003), in support of the claim that there is no cultural connection between contemporary Numic speaking tribes and the rock art. Yet, as a wider ranging review of the evidence has shown, the attribution of religious phenomena to supernatural agency is a common feature of all religions. Moreover, the claim that spirits created rock art is present among a dozen different tribes, across North America, and even among Australian aborigines (Whitley 2006).

While the correct symbolic interpretation of these ethnographic statements may be debated, the fact that Numic peoples expressed knowledge of the creation of the art, and stated that it was contemporary to them, cannot be ignored. Our point is that we cannot fully interpret religious beliefs in terms of the university taught paradigm of western science alone—nor should we expect religious beliefs to be described in scientifically understandable terms by non-western cultures. There is substantial, internally consistent Numic ethnography concerning rock art, and widespread acknowledgment that it was created into the recent past. To claim otherwise is misleading and appears to promote an anti-Native American bias that detracts from understanding rock art (Trigger 1980).

Subject Matter

The recency of some rock art, as demonstrated in the ethnographic record, is confirmed by the subject matter portrayed. Historical motifs, including horse/mule and riders and anthropomorphs wearing Euro-American cowboy hats, have been identified at a number of both petroglyph and pictograph sites (Benton 1978; Garfinkel/Gold 1978; Ritter, Brook, and Farrell 1982; Whitley 1982; Quinlan and Woody 2003). These include sites in the Coso Range and environs (Fig. 1A and 1B). From this evidence there can be little question that both pictographs and petroglyphs continued to be made into the historical period.

Subject matter is also useful for determining earlier aspects of the age of the art. The importance of the sequence of weapons as age indicators in the Coso petroglyphs was noted above. Grant's (1968:120–121) tabulations for the Coso Range indicate that only 4% of the humans with weapons are shown using atlatls; the remainder hold the bow and arrow. This suggests that the depiction of weaponry in the art was primarily a post–AD 600 phenomenon.

Petroglyph Condition

A third attribute of rock art that may provide some indication of age is condition. All things being equal, older motifs on a panel should show evidence of greater weathering relative to other motifs on the same panel, subjected to the same microenvironment. Likewise, in gross terms, older petroglyph motifs should show greater degrees of revarnishing than younger motifs, albeit micro environmental factors also influence varnish growth. Because factors of condition are so micro environmentally specific (Dorn 2007), any explicit estimate of age, such as those proposed by Heizer and Baumhoff (1962) and Grant (1968), are unsupportable. Still, a broad idea of temporal relationships can be obtained by an examination of relative condition.

Whitley (1994) estimated the relative degree of revarnishing on 392 anthropomorph and 352 sheep from the Coso Range based on a systematic visual examination of the motifs. Some confusion concerning his results has developed in the literature, as noted above, and this warrants a full clarification of his findings here.

Whitley's samples represent 21% and 5.2%, respectively, of the totals for Coso anthropomorphs and sheep, using Grant's (1968) tabulations. Although it

Fig. 1A. Horse and rider petroglyph, Birchum Springs Site, Coso Range. (photo by D. S. Whitley).

1B. Cowboy-hatted human figures and bighorns, Las Vegas area, Nevada. (photo by D.S. Whitley).

is clear that Grant's totals are likely off by (roughly) an order of magnitude, these nonetheless can be considered statistically representative sample sizes. Using a simple three category scale of (i) little or no visible revarnishing, (ii) moderate revarnishing, and (iii) complete revarnished, the following estimates resulted:

Anthropomorphic figures–
- Little or no revarnishing–56%
- Moderate revarnishing–35%
- Complete revarnishing–8%

Bighorn sheep motifs–
- Little or no revarnishing–81%
- Moderate revarnishing–18%
- Complete revarnishing–1%

It is impossible to provide realistic estimates of age for the moderate and complete revarnishing categories, since varnish darkness is not solely a function of age (Dorn 2007). Whether or not there is any visible revarnishing, on the other hand, is more straightforward. Importantly, all of the examples of anthropomorphs displaying bow and arrows were categorized in the little or no revarnishing group. Inasmuch as these motifs are a maximum of 1400 years old, based on their weaponry, a rough estimate of less than 2000 years in age for the little or no revarnishing category seems reasonable. This suggests that the majority of both of these motif classes are relatively late dating. When it is recognized that the bighorn petroglyphs were tabulated as 51% of the total assemblage by Grant (1968), and 81% of the bighorn sample displayed little or no revarnishing, this inference can be broadened to the corpus as a whole. The bighorn motifs estimated by this approach to be less than 1500 to 2000 years old can be calculated as constituting roughly 41% of the Coso assemblage as a whole. Likewise the anthropomorphs with little or no revarnishing represent about 7% of the assemblage (based on Grant's estimate that the anthropomorphs constitute about 13% of the total). Examples of these two motif classes with little or no visual evidence of revarnishing, then, represent about half of all of the Coso petroglyphs. If additional motif classes (such as geometric designs) were included, it is clear that the majority of the Coso petroglyphs would fall within this rough age grouping.

It is thus reasonable to infer that a very significant intensification in petroglyph production occurred within roughly the last 1500 to 2000 years. This is of course supported by the fact that 96% of the humans with weapons carry bows, and not the older atlatls. But it is not possible, given the inexact nature of this kind of analysis, to infer that this intensification only occurred after AD 1000 as both Gilreath (2003) and Garfinkel/Gold (2006) have claimed we have suggested.

Chronometrics

The fourth kind of evidence useful for dating Coso rock art involves direct chronometric techniques. Three of these have been applied to petroglyphs: cation-ratio (CR) dating, weathering rind organics (WRO) AMS radiocarbon dating, and the analysis of varnish microlaminations (VML; Dorn 1994, 2001). WRO AMS radiocarbon dating has proven unreliable (Dorn 1995, 1997, 1998b; Welsh and Dorn 1996; Whitley and Simon 2002a, 2002b; Whitley 2008) and is no longer used, but CR and VML continue to provide reliable petroglyph ages. We discuss these two techniques, and their results, in turn.

CR dating is a calibrated technique that is based on the empirically demonstrated fact that, over time, mobile cations such as calcium and potassium are leached out of rock varnish coatings more rapidly than less mobile cations, specifically titanium (Dorn 1983, 1989; Dorn et al. 1990). The ratio of [Ca+K]/Ti is measured in the bulk chemistry of a sample scraped from within the revarnished area of a petroglyph using an electron microprobe. Based on a previously established regional cation-leaching curve, a calibrated age is then assigned to the sample based on the semi-log regression equation which describes the change over time in these chemical relationships. Generally, three to five separate bulk chemical readings are taken, per petroglyph, and averaged to determine a petroglyph's CR ratio.

CR dating is disadvantaged over certain other chronometric techniques (especially radiocarbon dating) because it sometimes yields relatively large standard errors. While this fact has been criticized, it needs to be emphasized that, even with its relatively

large standard errors, CR dating often results in age estimates as precise as those provided by the Great Basin cultural historical sequence (which itself is primarily based on temporally diagnostic projectile point types). CR ages are thus adequate for most temporal analyses because such analyses still involve comparisons between different temporal periods rather than moments in time.

Research on rock art dating has included sampling in the Coso Range (N=24), the Cima volcanic field (N=13), the Rodman Mountains (N=8), and on Fort Irwin (N=15; Dorn and Whitley 1983, 1984; Dorn 1998; Whitley and Dorn 1987, 1988; Whitley et al. 1996a, 1996b, 1998, 1999a, 1999b). Our initial interests were directed towards evidence for early rock art, and our Coso, Cima and Rodman results primarily emphasized the ancient end of the chronology (Whitley, Simon, and Dorn 1998). Dating at three Fort Irwin petroglyph sites, in contrast, was more systematic in the sense of sampling a much wider range of engravings present, and it provides a better indication of the full chronological extent of the art. Our work has yielded a total suite of 60 CR ages from these four localities.

Note that, as the CR calibration has been revised with additional research, the estimated ages of the different petroglyphs have been adjusted. Based on the most recent calibration revision, the ages of the representational motifs (N=21) range from 16500 ± 1000 to 250 ± 100 calendrical years. The range for the geometric motifs (N=39) is 15100 ± 1600 to 300 ± 100 calendrical years. As is immediately clear, these fully overlap, and they demonstrate petroglyph production from the Late Pleistocene into the recent past.

Our Pre-Clovis CR petroglyph ages are, understandably controversial. We believe there are good reasons to accept them, however. They include a depiction of an extinct Pleistocene species, independently identified in a blind test by a paleontologist, for example, and we have obtained confirming results using multiple independent chronometric techniques (e.g., Whitley 1999). But for our purposes here we emphasize the latter end of the time scale—specifically, the last 2000 years. Eighteen of our 60 CR ages are 2000 years or younger in age. (This is 30% of our total, a significant proportion given the fact that much of our dating work emphasized attempts to obtain early art.) Eight of these are representational, and three of the representational motifs—all bighorn sheep—are 350 years or less in age. Of the remaining ten geometric designs, fully five are less than 700 years old, and three of these date to the last 400 years.

The implications of the CR ages are straightforward. They falsify the stylistic chronology of Heizer and Baumhoff (1962), confirming Grant's (1968) contention concerning the absence of any stylistic evolution in the art. They also disprove the short chronologies that these researchers proposed which, as they carefully admitted, were speculative to start.

CR dating has been criticized (e.g., Bierman and Gillespie 1991, Watchman 1992, Harry 1995), like most advances in science (including obsidian hydration dating which, after four decades of use, continues to pose technical problems [e.g., Rogers 2006, 2007]). Detailed responses have been provided to these criticisms (e.g., Dorn 1998b, 2001; Cahill 1991; Bamforth 1997), demonstrating that they were based on confusions and misuses of analytical data, and there is no point in reiterating them here. More important is the fact that CR dating has been replicated by numerous labs around the world (e.g., Bull 1991; Dragovich 1998; Glazovskiy 1985; Jacobson, Pineda, and Peisach 1989; Pineda, Peisach, and Jacobson 1988, 1989; Pineda et.al.1990; Whitley and Annegarn 1994; Whitney and Harrington 1993; Zhang, Liu, and Li 1990). It

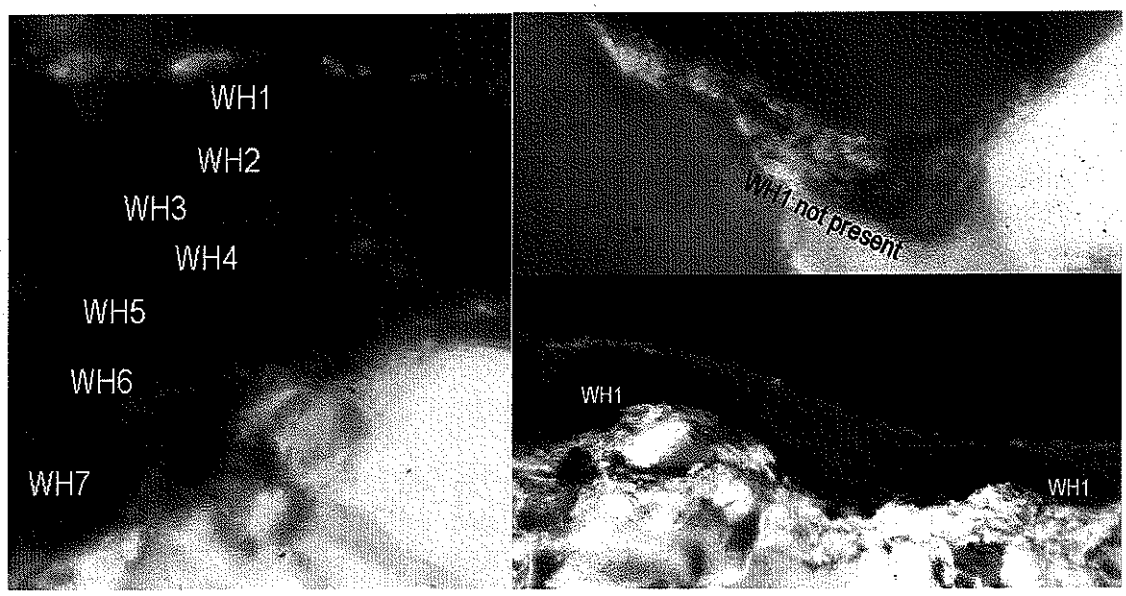

Fig. 2. Varnish microlaminations: Left image is from the Coso Range and Right image is from Fort Irwin.

has also successfully passed a blind test (Loendorf 1991, cf. Faris 1995).

Perhaps most importantly, the CR results have recently been verified by an independent chronometric technique, VML dating. This is a relative and correlative dating technique. It is based on the fact that major changes in climate effect the chemistry and optical characteristics of varnish and that, with significant environmental changes, these changes may be visible as micro-stratigraphic signatures in thin sections of rock varnish (Dorn 1990, 1992; Liu 1994; Liu and Dorn 1996; Liu and Broecker 1999, 2001, 2007a, 2007b; Liu et al. 2000; Fig. 2). Initially only Late Pleistocene VML signatures were recognized and dated, limiting the archaeological applicability of this chronometric approach. But its utility has been extended and its accuracy verified recently, in a series of studies published by Tanzhuo Liu. The reader is referred to publications on the VML Dating Lab web site: http://www.vmldatinglab.com.

These studies include the completion of a blind-test of the technique, matched against cosmogenic ages (Liu 2003; Phillips 2003). As a commentator on this blind study concluded: the "[r]esults of the blind test provide convincing evidence that varnish microstratigraphy is a valid dating tool to estimate surface exposure ages" (Marston 2003:197).

Figure 2 shows varnish microlamination (VML) dating of varnish formation on three bighorn sheep petroglyphs from the Coso Range (left images) and Fort Irwin (right images). The Coso image was manufactured after the Wet Holocene 7 (WH7) interval about 6500 calendar years ago. The two Fort Irwin bighorn motifs formed during the Little Ice Age (WH1) about 500 calendar years ago (lower right), and less than 300 (upper right) calendar years ago, after the Little Ice Age.

The technique has also been extended into the Holocene with a calibrated micro-stratigraphic layering sequence. These consist of discrete chronometric markers that allow age assignments from about 11100 to 300 calendrical years BP (Liu and

Broecker 2007a, 2007b). The technique can now be used to independently date Holocene petroglyphs, assigning them to paleoclimatic phases that average less than 1000 years in length. In a similar fashion, the technique can be used to assess the veracity of CR dates that have previously been obtained, if samples of the rock varnish from the engravings are available for thin-section analysis.

In a blind-test, we obtained 16 VML ages on previously CR dated petroglyphs from Tanzhuo Liu (Whitley n.d). These were Terminal Pleistocene to recent in age, based on the CR analyses, with dates ranging from 12000 ± 600 to 250 ± 100 calendrical years. We obtained statistical overlap for each of these 16 sets of CR–VML ages, providing independent support for the CR dating technique and confirmation of the CR ages. Our oldest of a total of five submitted representational motifs, a lizard design, had a CR age of 6100 ± 1200 calendrical years. The independent VML age estimate was 6,500 calendrical years. Our youngest submitted representational image, a bighorn sheep, had a CR age of 250 ± 100 calendrical years. Liu's VML analysis yielded <300 calendrical years. The geometrics (N=11) ranged from CR 12000 ± 600 calendrical years (VML 11220 ± 460) to CR 350 ± 175 calendrical years (VML <300).

Note that half of our CR–VML ages are 1500 calendrical years or less in age, and five of these are 500 calendrical years or less old. These results are consistent with our claim for ritual intensification in roughly the last 2000 years, and verify that Numic speaking peoples created rock art during the last 700 years.

Agreements and Disagreements

We have dated eastern California rock art in four different ways. First, ethnographic data collected from multiple informants by different anthropologists demonstrate that the creation of petroglyphs was understood as a contemporary occurrence among Numic tribes, including among the Coso Shoshone. Admittedly, the way they explained rock art was through reference to their religious beliefs, and their comments are not necessarily understandable from the perspective of literal western science. Most (if not all) religious beliefs are not testable in scientific terms, but this fact does not invalidate these beliefs as indicators of cultural traditions and practices.

Second, there are clear historical depictions in the art, and these can only date to the last few hundred years. Dateable subject matter in the form of weaponry, similarly, consists of 96% bows and arrows, and these are a maximum of 1400 years old. Third, a systematic analysis of the relative degree of motif revarnishing suggests that most of the petroglyphs were created in the last 1500 to 2000 years. Fourth, we have chronometrically dated the petroglyphs using two fully independent techniques, and we have cross-checked these results, obtaining good chronometric overlap. Taken as a whole, our suite of 60 dated petroglyphs is not a systematic sample and cannot be used to chart the intensity of ritual activity over time, at least in any precise way. But it does tell us three important facts:

(1) Petroglyphs were first created during the Late Pleistocene;
(2) There is no identifiable chronological distinction between geometric and representational images, including no evidence for stylistic evolution of any kind; and
(3) A substantial number of petroglyphs were made during the last 700 years, during the Numic Period.

As we have emphasized earlier, these conclusions are not new. Although we have presented important new chronometric evidence above, this additional information is fully consistent with our

previous chronological interpretation (e.g., Whitley 1994:360–361, 1998c:58). Despite the depth and breadth of the evidence we have presented, Hildebrandt and McGuire (2002), McGuire and Hildebrandt (2005) and Garfinkel/Gold (2006) still have contested this chronological revision. Perhaps, a review of the points of agreement and disagreement between our different positions, will help to clarify them.

The Heizer and Baumhoff (1962) and Grant (1968) chronologies shared some important emphasizes, despite their differences over stylistic evolution. This includes their joint recognition that much, maybe most, of the rock art is relatively recent in age. Heizer and Baumhoff (1962) limited the age of Pecked petroglyphs to the last 3500 years; Grant (1968) narrowed this to the last 3000 years. This created complications for their chronologies, as we have emphasized above, because they failed to recognize the significance of the existing ethnographic commentary about the art and were not aware of the historical motifs. Based on this failure, they were forced to truncate their already short chronological sequences prior to the ethnographic period. Still, Heizer and Baumhoff believed the Pecked art was made during the Numic period.

Hildebrandt and McGuire (2002) and McGuire and Hildebrandt (2005) argue that all, or most of, the Coso petroglyphs date to the Middle Archaic, which they set at 4000 to 1000 YBP. They base this primarily on an association between rock art panels with archaeological deposits containing hydration-dated obsidian. They assert that the peak production of obsidian at these sites is between 2500–1000 years ago, and that this dates the rock art. Although archaeological associations of this kind can contribute to rock art dating (Keyser 2001, Whitley 2005), they are far from conclusive. Correctly, they should only be used in combination with other lines of evidence, and these archaeologists present no additional evidence that supports this associational inference. Further, it seems that they ignore some associational data. Hillebrand (1972:126), for example, found Numic-aged materials in association with the Junction Ranch Site (CA-INY-1535) petroglyphs. Based on Hildebrandt and McGuire's (2002) logic and singular use of evidence, Hillebrand's data should prove that rock art production continued into the last 700 years.

Furthermore, Hildebrandt and McGuire's (2002) ignore the recent chronometric results along with the presence of historical motifs. They also did not consider the fact that 96% of the weaponry consists of bows and arrows, and thus post-dates AD 600. One potential implication of this last point is an intensification in petroglyph production, not between 4000 to 1000 YBP as they infer, but from only AD 600 to 1000. This is implausible at the outset.

As we understand his argument, Garfinkel/Gold (2006) has promoted an updated but minimally revised version of Grant's (1968) original chronology in order to re-cycle Grant's re-statement of Heizer and Baumhoff's (1962) hunting magic hypothesis. Garfinkel/Gold's chronology, predictably, suffers from the same empirical problems as Grant's—as well as Hildebrandt and McGuire's (2002). One of these problems is the emphasis on bows and arrows in the weaponry images, which for Garfinkel/Gold implies ritual intensification primarily from AD 600 to 1300. Garfinkel/Gold claims that projectile point petroglyphs support this chronology. He states that

> Further validation of the dating scheme comes from an analysis of the projectile points depicted in Coso petroglyphs. The drawings of realistically rendered arrow points were interpreted as analogs of either Rose Spring Corner-notched or Eastgate Expanding Stem forms (Garfinkel/Gold 2006:227).

Garfinkel/Gold's assertion overlooks the key point: Eastgate points post-date AD 1300 and are associated with Numic peoples. Contrary to his claim, the arrow point petroglyphs provide little information with respect to this specific chronological issue.

Yet, Garfinkel/Gold's range from AD 600 to 1300 is slightly more plausible than the more extreme implications of Hildebrandt and McGuire's (2002) argument, but not much. Garfinkel/Gold also ignores the ethnographic data along with the chronometric results and the historical motifs.

But two points are important here. We all agree that ritual intensification and thus accelerated petroglyph production occurred relatively late in the prehistoric past. We primarily disagree over the beginning and end of this intensification, and even here our differences are not necessarily great.

This fact is emphasized when our own argument is acknowledged. We contend that intensification began roughly 1500 years ago, not after 1000 years ago (as Gilreath [2003] and Garfinkel/Gold [2006] claim is our interpretation). We suggest instead approximately 1500 years of ritual intensification, including a continuation of this practice into the ethnographic period. Further, we concur with Hildebrandt's and McGuire's general argument concerning the significance of the Medieval Climatic Anomaly (cf. Whitley, Simon, and Loubser 2006), and suggest that it was at least in part an impetus for this process.

Second, the largest point of disagreement then concerns the termination of the period of ritual intensification. Hildebrandt and McGuire (2002) and Garfinkel/Gold (2006) cite no affirmative evidence demonstrating that rock art production did not continue into the ethnographic period. Arguments of this type are weak because, as we all know, 'an absence of evidence does not always show evidence for an absence.' More important is the fact that there is affirmative evidence, in multiple forms, for petroglyph manufacture during the Numic period. This includes:

- A widespread oral tradition acknowledging that rock art, throughout Numic territory, was recognized as a contemporary cultural phenomenon;
- Historical petroglyph motifs that can only have been made in the last few hundred years;
- Direct CR dates that demonstrate petroglyph production in the last 700 years; and
- Independent VML dates that both confirm the last point, and that are consistent with the CR ages.

All of the archaeological and ethnographic evidence points to the fact that rock art production continued in the Coso Range into historical times.

Our final point involves the fact that Hildebrandt and McGuire (2002) and McGuire and Hildebrandt (2005) acknowledge that the Coso archaeological record, including its rock art, reflect the wider processes and events that occurred in prehistoric California and the Great Basin. The fact that Coso obsidian was widely traded in the far west supports this general point, demonstrating that the Coso inhabitants were linked economically to the region as a whole. In contrast, Grant (1968), Garfinkel/Gold (2006) and Gilreath (2007) argue that the Coso petroglyphs are a unique phenomena and, apparently for this fact, that this art can only be understood in its own terms. The implication is that the Coso prehistoric past is somehow singular and distinct from the rest of the western Great Basin.

We concur with Hildebrandt and McGuire on this important point, due to the empirical and logical problems with the alternative position. These start

with the fact that, throughout the entirety of the prehistoric past, the Coso archaeological record is otherwise equivalent to the archaeological record in the remainder of the Great Basin. Although there are predictable minor variations, reflecting local adaptive requirements and regional resource conditions, these variations are no greater than the regional variation that is common across the Basin as a whole. If the archaeological record tells us anything about ethnicity and culture, everything in the Cosos but the rock art was effectively the same as the rest of the Great Basin, for 10000 or more years. This is why the same chronological sequence and temporal diagnostics apply throughout eastern California and across Nevada. And this is why the same historical linguistic models are relevant to the Cosos and these other areas.

Moreover, the only differences between the Coso petroglyphs and those found elsewhere in eastern California involve motif quantities at sites and assemblage emphases, not differences in the iconography itself or the style of the art. ("Coso style" bighorn sheep, for example, are present throughout eastern California and southern Nevada.) These are differences of degree, not kind. Indeed, rock art researchers as disparate as Gebhard (1969), Loendorf (1999) and Keyser and Klassen (2001) have cited similarities in the style and iconography of the Coso and Dinwoody, Wyoming, petroglyphs as evidence that they are both manifestations of the same widespread Shoshonean cultural tradition. Instead of uniqueness, these rock art researchers see artistic, cultural, and ritual continuity across this broad region. Even the Coso rock art, in other words, needs be understood as one end of the variability that was present in the Great Basin, not as somehow distinct from this larger pattern and tradition.

But the argument for the uniqueness of the Coso prehistoric past implies that the Cosos stood apart from surrounding regions as culturally unique up until about AD 1300. Then, inexplicably, the Coso inhabitants responded to, and participated in, exactly the same demographic, linguistic and adaptive processes as the rest of the Great Basin, contributing to the appearance of the Western Shoshone who, on the basis of material culture and religious beliefs, are virtually indistinguishable from the remainder of the historical Numic speakers. We can envision no plausible series of events that could explain this circumstance—which, basically, maintains that prehistoric Coso culture was unique, until the point that it suddenly became fully equivalent to Numic culture throughout the Great Basin. This makes no sense.

The sub-text of this discussion of course is the Numic spread, and whether there was a demographic migration outwards from eastern California about 700 years ago. At best this is still an open question, archaeologically, theoretically, and linguistically (see contrasting views in Madsen and Rhode 1994). But the rock art evidence, from the Coso Range and elsewhere (e.g., Loendorf 1999, Francis and Loendorf 2002), certainly does not support this hypothesis, at least in terms of the simplistic model promoted by its archaeological proponents.

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