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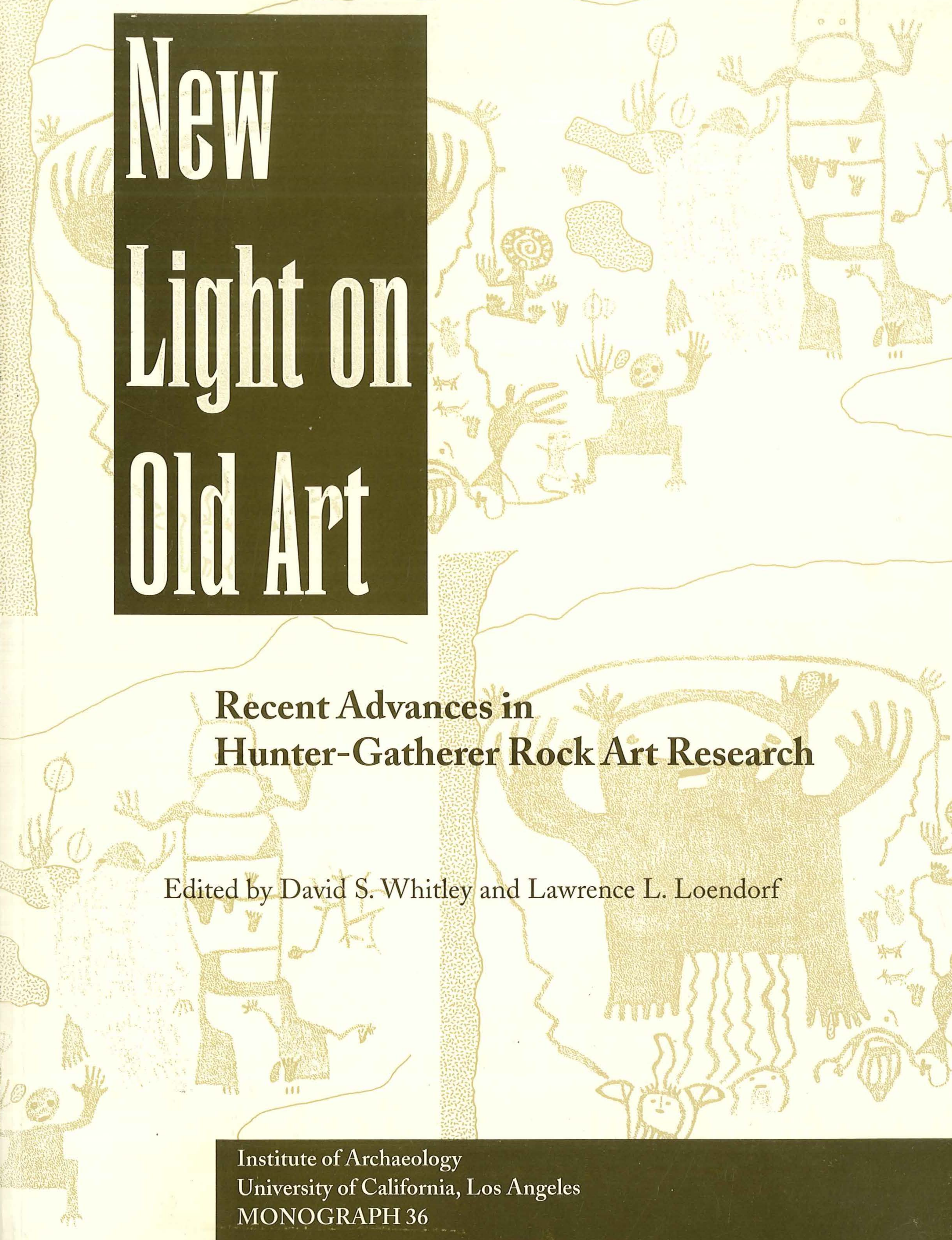

New Light on Old Art

Recent Advances in Hunter-Gatherer Rock Art Research

Edited by David S. Whitley and Lawrence L. Loendorf

Institute of Archaeology
University of California, Los Angeles
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PUBLISHED WITH THE ASSISTANCE OF THE UCLA ROCK ART ARCHIVE.

This volume is dedicated to
Professor Clement W. Meighan
and Mrs. Helen Michaelis,
in recognition of their considerable
contributions to American rock art studies.

Contents

Preface

THE INSTITUTE OF ARCHAEOLOGY AT UCLA publishes *New Light on Old Art: Recent Advances in Hunter-Gatherer Rock Art Studies* in recognition of the emerging importance of rock art in anthropological archaeology. This volume is dedicated to Professor Emeritus Clement Meighan and Mrs. Helen Michaelis.

Clem Meighan came to UCLA in 1952 as a young instructor of anthropology. He founded the UCLA Archaeological Survey, which was later transformed into the Institute of Archaeology, and developed an active research program in California archaeology. Among his many interests was a love of rock art, in which he conducted considerable research (Meighan 1966, 1979, 1981, 1982; Meighan and Pontoni 1978; Meighan and Sanger 1991; Meighan and Van Tilburg 1981). In 1977, with Billy Clewlow, Clem established the Rock Art Archive in the Institute of Archaeology and served as its director until his retirement in 1991.

Helen Michaelis was recruited in 1983 by Clem Meighan to be the Rock Art archivist, a position she held until 1993. Despite troubled times growing up in the Soviet Union and in Germany under the Nazis and eventually migrating as a young mother to the United States, she never lost an early love of archaeology. After a professional life, raising her son, and eventual retirement, Helen began her second life with the Institute. For ten years as the archivist, she was inseparable from Institute studies of rock art. Corresponding in many languages, she helped establish the Archive's international network of rock art scholars. Recently, she has given generously to endow the Rock Art Archive.

David Whitley (1982b), one of Meighan's best graduate students, wrote his anthropology doctoral dissertation on "The Study of North American Rock Art." At that time, serious academic research on rock art had become marginalized within anthropological archaeology (Whitley and Loendorf, Introduction). Methodologically, the radiocarbon revolution in dating in the 1950s transformed the field of archaeology, and studies of rock art styles as a means to establish time-space culture histories were discontinued. Because rock art could not then be dated by radiocarbon methods and because the association of rock art with other datable material was more tenuous than for other aspects of the archaeological assemblage, interest in rock art declined.

Freed from purely culture-historical studies, archaeology in the 1960s and 1970s was rapidly changing. The center of research, then called New Archaeology, focused on cultural ecology and evolution, a popular interest within anthropology at that time (for example, see Service 1962). Research emphasized the subsistence basis of human society, seeing culture as an adaptation to the environment, and a strict concern with quantification and scientific methodology came to the fore (Binford 1964). The humanist interests in prehistoric aesthetics suffered, and rock art largely became the purview of the amateur.

Since the heyday of New Archaeology, conditions have significantly changed, and these changes have encouraged a renewed interest in rock art, as illustrated in this volume. Dramatic breakthroughs concern the experimental work of dating rock art by direct ^{14}C dating (Chaffee, Hyman, and Rowe, chapter 2), by cation-ratio dating of varnishes (Dorn, chapter 3 and Francis, chapter 4), and by associated archaeological material recovered in careful excavation (Clottes, chapter 1; Loendorf, chapter 9). It is now recognized that rock art may be dated and that it demands to be incorporated into broader archaeological research.

An exciting recent development in archaeology has been the post-processual critique (Whitley and Loendorf, Introduction). Although often overzealous, this radical critique has raised important issues, reproving the narrowly adaptationalist approaches of New Archaeology and seeking to reintroduce humanist research interests into archaeology (Earle and Preucel 1987). Led especially by the seminal writings of Ian Hodder (1982a, 1984), the post-processual critique touched a sensitive nerve within the discipline, but post-processualists have been slow to move beyond the critique into the more difficult ground of archaeological practice. The renewed direction suggested by the post-processualists needs to confront the highly personal and meaningful area of prehistoric art. No field offers better opportunities for post-processual archaeology than the systematic research on rock art.

The goal of this volume is to put rock art research back into the mainstream of archaeology, to move it "off the cover and into the book." Two directions this volume promotes are the use of a direct historical approach and the investigation of a common human mental process. In a distinguished lecture in archaeology to the American Anthropological Association, George Cowgill (1992) recommended just these approaches for archaeology broadly. The direct historical approach uses historical records, early ethnographies, material culture, and archaeology to reconstruct traditional cultures. The approach allows issues of motivations and cognition, considered in early ethnographies, to be linked to the material record including rock art (Lewis-Williams 1981,1984). In this way, Whitley (1992b) documents the evidence from early ethnography for rock art among western hunter-gatherers. He argues that rock art represents shamanistic visions, a theme discussed by several authors in this volume.

An auxiliary approach focuses on common human mental processes as experienced in drug-induced shamanistic trances. It is argued that human brain physiology is universal such that drugged individuals experience similar sequences of images (Lewis-Williams and Dowson 1988). This suggestion helps to fill out Cowgill's (1992) proposal for a middle range theory (MRT) of the mind that may allow archaeological researchers to delve into the cognitive processes of human experience.

Rock art is part of the aesthetic experience, a means by which individuals, imbedded in social groups, express ideas that can be shared by their group. The role of rock art as a means of communication will vary with its institutional context, the nature and purpose of the ceremonies, and the events within which it operated. Rock art and other artistic media can thus be anticipated to vary according to the nature of a society's organizational structure.

The ensuing chapters emphasize the linkage of rock art to shamanistic practice, a reasonable connection for hunter-gatherer societies. In different contexts, other uses of rock art may occur. For example, rock art may serve as mnemonic devices, encapsulating historical narratives and myths. I am reminded of the pictorial representations of an Aztec codex that depicts mythic histories, retold as part of ceremonial events (Gillespie 1989). Similarly, the material goods held in the jawbone shrine of a dead African leader are used by the shrine's keeper to remember narrative about the ruler (Posnansky 1970). Rock art may be seen as part of human activities that are linked with a cultural landscape; individuals and groups are rooted in the encompassing environment by creating the cultural places bound to their social histories and myths. These places and the memory of their stories and experience become central to social reality.

Research has tried to determine the primary function of rock art, whether linked to hunting magic, vision quests, or shamanism. Single explanations of rock art are, however, unlikely. Rather, rock art must be conceived in a broader frame as a means of individual and group expression channeled through the universal human aesthetic experience. Variation within the function of rock art may well prove to fit within a broader understanding of human social evolution. As institutional structures evolve, it seems reasonable to expect that the use of expressive media, including rock art, will be transformed.

To bring rock art into the mainstream of anthropology, we must recognize that social institutions comprise aesthetic experiences to situate individuals within their group. Because the evolution of institutions must involve changes in the social and political functions of art, I call for understanding rock art within a broad evolutionary framework that considers how complex social systems involve control over the very creation and performance of culture.

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DAVID S. WHITLEY
LAWRENCE L. LOENDORF

Introduction

Off the Cover and Into the Book

FOR MUCH OF THE LAST CENTURY, rock art research has been marginal to mainstream Americanist archaeology. Although a number of distinguished archaeologists, including Julian Steward, Luther Cressman, Robert Heizer and Clement Meighan, have conducted occasional studies of pictographs or petroglyphs, these too often have been singular contributions in careers dedicated to other aspects of the archaeological record. Attractive rock art tracings are used as cover illustrations for excavation and settlement pattern studies, but typically the art never gets off the cover and into the text.

We believe that recent studies, however, now place rock art research at the methodological and substantive forefronts of archaeology generally and hunter-gatherer research more specifically. We also recognize that this claim may seem bold if not presumptuous, in part because certain of these advances have occurred outside Americanist research and may be unfamiliar to American archaeologists. Given that this collection of papers was prepared within the context of this very optimistic perception of rock art studies, we introduce this volume by briefly reviewing the historical factors that have contributed to the current marginalization of rock art research within Americanist archaeology , the importance of recent advances in rock art research, and how the essays in this volume contribute to the changing nature of rock art studies in North America.

History and Status of American Rock Art Studies

Given the impressive genealogy of rock art researchers cited above, it might be surprising, especially to archaeologists outside the US, that rock art studies are generally viewed to be of limited value by American archaeologists. In France, for example, the analysis of rock art is considered fully as significant an endeavor as lithic analysis, faunal studies, or ethnoarchaeology. Certainly, historical circumstances distinguish the American from the French case, particularly the fact that French archaeology concerns its own patrimony, whereas there has always been a cultural disjunction between Americanist archaeologists and their subject of study, the Native Americans' past (McGuire 1992).

Yet this disjunction alone does not explain why American rock art studies receded from mainstream to side current, a fact no better demonstrated than in existing histories of the discipline: Willey and Sabloff (1974) do not mention rock art at all, and Trigger (1990:69) has a single, one-sentence aside concerning eighteenth-century studies. Taking these two archaeological histories at face value, one would infer that no professional rock art research had ever occurred. A brief history of rock art research reveals, instead, that rock art studies had a primary place in the early growth of the discipline.

Thomas Jefferson is often credited with expressing the first academic interest in North American prehistory (for example, Willey and Sabloff 1974), but precedent in fact must be given to the New England intellectual Cotton Mather (Molyneaux 1977). Mather published the first North American archaeological report in 1714 with a description of Dighton Rock, a rock art site in Massachussetts. In keeping with the humanist and antiquarianist interests of that time, Mather considered philology and the analysis of historical relationships between languages the primary means for acquiring knowledge about the past, beyond the limits of written history. With rock art believed a written record of prehistoric languages, Mather and subsequent philologists, accordingly, thought it the "golden clue" to humankind's prehistory (Molyneaux 1977:18).

The philological approach continued through the nineteenth century with H.R. Schoolcraft (1847), at mid-century, representing its highpoint in what, otherwise, were romantic speculations about the art as the "mythic history" of ancient peoples. Although known for his support of the then-minority view that a historical connection existed between the creators of the Hopewell Mounds and modern Native Americans in the "Moundbuilders Controversy" (see Willey and Sabloff 1974:46–47), Schoolcraft made similar contributions to rock art studies: not only did he argue in favor of a recent Native American origin for the art but he also contended that it was best understood and interpreted within a directly relevant historical and ethnographic context.

Towards the latter half of the nineteenth century, archaeology fell increasingly under the positivist influences of geology (especially the deterministic geological principles of stratigraphy and uniformitarianism), the biological evolutionism of Darwin, and the cultural evolutionism of such anthropologists as Lewis Henry Morgan. Philology, as a preferred means of studying the past, was displaced, and archaeology became a discipline defined by the technique of stratigraphic excavation. The contribution of rock art to understanding the prehistoric record was slowly lost, and the place of rock art research in the history of the discipline was quickly forgotten. Although rock art studies continued to be produced, they were increasingly marginal relative to mainstream interests, which were progressively oriented towards the results of stratigraphic excavations.

Garrick Mallery (1893), as the next major American figure in rock art research, expressed both the movement away from the philological approach and the evolutionism that was current in archaeology at the turn of the century. As noted by Molyneaux (1977:49), Mallery believed that the evolution of forms, such as rock art motifs, "were subject to the laws of nature rather than by a progression of ideas." Formal analysis, devoid of historical documentation or archaeological context, therefore, could be applied to rock art research. Although Mallery's position is extreme, especially in light of the general rejection of evolutionism in archaeology in the early decades of the twentieth century, his influence on rock art studies has been considerable. Writing in the 1960s, for example, one author claimed that Mallery remained "the foremost authority on the subject" (Grant 1967:11). Even though exaggerated, this claim underscores one of the reasons for the marginalization of rock art in this century: Mallery's formal, evolutionary approach was at odds with the theoretical trends in the discipline as a whole.

In a series of important studies, Julian Steward (1929, 1937) extended Mallery's formal and classificatory approach in a distributional study of motif types in the far west. Not only did Steward shun the use of ethnographic context and data for interpretation, but he also strongly chided those who entered such a "speculative" realm (for example, 1937:405). His resulting conclusions were the definition of a series of rock art "areas" which, presumably, were intended to identify cultural units of some unspecified type. The adoption of Mallery's evolutionist approach, even though it was in disfavor among archaeologists at the time, is understandable in Steward's case. As an ethnographer, he was somewhat isolated from the intellectual trends of archaeology and, as the main proponent of cultural evolutionism, he was subsequently responsible for reintroducing evolutionist thinking in archaeology in the 1960s (for example, Steward 1955).

Steward's regional approach became the model for time-place systematics in rock art studies. Other, similarly structured analyses followed his lead, although rock art studies continued to be rare in the larger growth of archaeological research. In the far west, Cressman (1937) for Oregon, and Heizer and Baumhoff (1962) for Nevada and eastern California, provided the most significant major studies. Heizer and Baumhoff's (1962) research has probably been the most influential in North America since Steward's. Their research was heavily influenced by Steward, as well as by the evolutionist writings of French archaeologists studying the Upper Paleolithic, principally Abbé Henri Breuil. Not only does it express belief in a necessary evolution of forms from simple to complex (cupules and rubbings to geometric engravings to iconic engravings and paintings) but it also reintroduced interpretation into North American rock art studies. Hunting magic, for example, was introduced by Heizer and Baumhoff as an explanation of North American rock art—curiously, just as the French were rejecting it in Europe.

Heizer and Baumhoff's study was published during a period in which evolutionist approaches had returned to favor and great optimism was being expressed concerning what could be deciphered from the archaeological record. This might have resulted in the return of rock art studies to the professional mainstream, but there are at least two reasons why Americanist rock art research continued to diminish in importance. The first resulted from the invention and application of radiocarbon dating. Combined with earlier advances in dendrochronology, this development allowed a temporal exactness in archaeological reconstructions that is now a requisite for American archaeological interpretation. Although rock art researchers had been concerned with chronology since Julian Steward's (1929) analysis, the disparity between rock art chronologies based on intuitive stylistic and superpositional studies and the new "absolute" (as they were then called) radiometric ages was increasingly apparent. Why bother with an aspect of the archaeological record, many asked, that cannot be dated and, unlike the French case, cannot even be linked to other portions of the archaeological record and thereby at least be assigned relative ages. That is, time-place systematics had achieved a new level of precision; rock art was disadvantaged in falling outside the realm of datable cultural remains and contexts.

A second factor relating to the continued marginalization of rock art studies was the development of the New Archaeology in the 1960s. The New Archaeology reinvigorated American archaeology with a needed scientific rigor. It opened up new approaches to research with an emphasis on multidisciplinary techniques. It also gave archaeologists a renewed sense of purpose in their intellectual task. While emphasizing the primacy of techno-environmental concerns, it nonetheless acknowledged that the ideational and social realms also played their part in cultural processes. All aspects of the archaeological record, like rock art, should therefore play a role in archaeological reconstructions if not in nomothetic explanations. But, with very few exceptions, New (now processual) Archaeology failed to deliver the promise of fully integrating all aspects of the archaeological record into inclusive interpretations and explanations. Rock art seems to have been particularly ignored, largely because of problems in dating, we believe. That is, the emphasis on evolutionary processes further emphasized the need for exact chronological control. Since this control for all intents and purposes was lacking for the corpora of rock art, the perception was maintained that rock art had nothing to offer the profession. For the hunter-gatherer archaeologist, symbolism, art, and prehistoric ritual (with the sole exception of mortuary practices) were therefore excluded from analysis. Viewed as epiphenomenal, prehistoric rock art was conveniently forgotten.

Unfortunately,this perception that art and symbolism in general and rock art specifically are epiphenomenal—and therefore analytically irrelevant—has led some archaeologists to believe that, if art and symbolism have not been successfully incorporated into new (or processual) archaeological interpretations, they cannot be studied and analyzed scientifically. Certainly, this is a significant theme in the current processual v. post-processual debate, where many of the protagonists and antagonists share this false induction. Some post-processualists (for example, Hodder 1986) contend that science and symbolism are inimical, and therefore dismiss science; some processualists (for example, Binford 1987) agree but dismiss symbolic analysis. Both positions are demonstrably false; they tacitly agree on this false induction because ironically they also share a flawed (or at least out-of-date and narrow) perception of scientific method: mid-century logical positivism. (It is for this reason that many scientists now advocate realist, rationalist approaches: see Whitley 1992a:58–59). And it is partly through recent advances in rock art research, we optimistically propose, that the post-processualist debate may be amically resolved, underscoring one of the most important means by which rock art research can contribute to the discipline as a whole. That is, although we neither suggest rock art research as a panacea for all that ails archaeology, nor deny that rock art studies still have many methodological and theoretical difficulties to resolve, we nonetheless propose that rock art studies may provide the bridge within which processual and post-processual concerns may both be accomodated. In order to illustrate how this may be so, we now turn to three primary recent advances, all initiated in the 1980s, which have been central to the reemergence of rock art research as an intellectually viable topic in hunter-gatherer studies.

Rock Art and Chronometrics

The first major advance in recent rock art studies concerns chronometric dating. Unlike other developments in rock art study, the recent advances in rock art dating techniques have largely occurred in North America. An update on the latest developments in these techniques is provided here by Dorn for petroglyphs and by Chaffee, Hyman, and Rowe for pictographs. Rather than reiterate their comments, we review the history and larger implications of these technical advancements.

Chronometric dating of rock art—what chronometricians now refer to as "calibrated" or "numerical," but not "absolute," dating—achieved its first success in 1983 following Ronald Dorn's development of cation-ratio (CR) dating, a biogeochemical technique for assigning calibrated ages to the rock varnish that coats rock surfaces in many arid and semiarid regions. The first application involved the dating of a small number of petroglyphs from the Coso Range in eastern California (Dorn and Whitley 1983, 1984). Since the publication of these first experimental rock art ages, Dorn has been involved in what we presume will ultimately be a lifelong pursuit of improving CR dating, as well as developing new techniques for dating (and identifying the geomorphological implications of) rock varnish. He has established three independent techniques applicable to petroglyphs: CR (Dorn 1983; Dorn et al. 1990) and accelerator mass spectrometer (AMS) ^{14}C subvarnish dating (Dorn et al. 1986, 1992) for calibrated or numerical age assignment, respectively, and the examination of microstratigraphic varnish layering as a relative dating technique (Dorn 1986, 1990). Moreover, these techniques allow for chronometric assessments of geoglyphs (or intaglios), as well as petroglyphs (Clarkson and Dorn 1991; Dorn, Clarkson, Nobbs et al. 1992). Although a number of issues remain to be resolved concerning varnish dating, we now have suites of petroglyph ages from California, Colorado, Wyoming, South Dakota, Utah, Australia, and South Africa and dated geoglyphs from California and Peru.

A more recent revolution in pictograph dating is also under way, using AMS to radiocarbon date the organic components of rock art pigment. The first such AMS ^{14}C age assignment on a pictograph (Beta-9935: 9300 + 210 BP) was also obtained by Dorn and Whitley working in eastern California in 1985, but their chemical procedure for the extraction of organics was cumbersome. More recently, Marvin W. Rowe, Marian Hyman, Scott D. Chaffee, and Jon Russ have developed a sophisticated plasma extraction technique to obtain AMS ^{14}C ages for pictographs from Texas and Utah (Russ et al. 1990, 1991; Russ, Hyman, and Rowe 1992). Including the work of other researchers and laboratories, direct radiocarbon ages for pictographs have been obtained in South Africa (van der Merwe, Sealy, and Yates 1987), France and Spain (Valladas et al. 1992), Australia (Loy et al. 1990), and the western United States. Even while there are many technical obstacles still to be overcome in dating rock art, it is apparent that the period of rock art research in which temporal placement was constrained to stylistic and superpositional studies is behind us.

Rock Art and Interpretation

The second recent advance in rock art research has been the development of methodologically sound approaches to interpretation. By "interpretation" we indicate means for the substantive, sometimes symbolic, understanding of a corpus of rock art. There have been a number of these recently (for example, Conkey 1984; Whitley 1987). However, because of their depth, detail, and overall significance and influence, we emphasize here the contributions of David Lewis-Williams (for example, 1982, 1983) in reference, originally, to an ethnographically informed interpretation of southern African pictographs. More recently, he has used his southern African analyses and conclusions to build a functional, analogical model to address the temporally more remote Upper Paleolithic art of western Europe (Lewis-Williams and Dowson 1988; Lewis-Williams 1991).

From a historical perspective, it can be noted that the traditional absence of any clear ethnographic models for the production of rock art served as a strong impediment to the development of sound interpretations and interpretive approaches. That is, and irrespective of recent attitudes about the place of analogy in archaeological research (see below), without any ethnographic knowledge about rock art, interpretation floundered: there was neither a known range of ethnographic variability in rock art production from which some measure of the plausibility of an interpretation could be gauged, nor was there a reliable source from which new hypotheses concerning prehistoric corpora of art might be derived.

The once almost universal, turn-of-the-century hypothesis of sympathetic hunting magic provides an instructive example here. Although many rock art researchers believe it was founded on ethnographic analogies with Australian and Arctic cases, instead it was based on "vague and misguided notions of 'primitive mentality' rather than reliable ethnography" (Lewis-Williams 1982:430) and, by about mid-century, it had been discredited in Europe (Laming-Emperaire 1962; Leroi-Gourhan 1965, 1967; Bahn 1991). Rejection in other parts of the world followed somewhat later (Steward 1963, 1967; Lewis-Williams 1981, 1982, 1983; Whitley 1982a; Whitley and Dorn n.d.), but the elimination of this hypothesis, both for empirical reasons and because of its foundation in methodologically unsound formal analogies, presumably led many archaeologists to interpretive despair. Not only did these scholars believe that the art was undatable and could not be studied scientifically, they also concluded that there was no possibility for ever understanding what it might have meant. In part, this resulted from the false perception that meaning, especially symbolic meaning, can only be obtained with talking informants. This attitude, of course, has also played a role in the post-processual debate: many processualists apparently presuppose that symbolic analysis always requires talking informants, and is thereby unobtainable in archaeological research (Whitley 1992a:76).

Lewis-Williams (1981, 1982) demonstrated in the southern African case by using an explicitly anthropological approach that turn-of-the-century ethnographic reports can be used to inform a very detailed symbolic interpretation of protohistoric/historic, and perhaps even earlier, art in the region (for example, Lewis-Williams 1984b). His ethnographically informed interpretation illustrates that the San paintings were made by shamans and that they depict the visions and hallucinations shamans perceived during the altered states of consciousness (ASC) they experienced to access their supernatural world and thereby obtain supernatural power. The empirical success of Lewis-Williams' interpretive endeavor; his ability to relate the meaning of a material, yet symbolic, aspect of the archaeological record to larger issues in social theory (Lewis-Williams 1982); and his demonstration of a sound approach to interpretive analysis have inspired many of us to reconsider our local ethnographic records in building ethnographically informed, interpretive models. Certainly, his studies constitute one of the best examples yet of a truly anthropological archaeological investigation.

Rock art, then, can be interpreted and symbolic meaning deciphered following strict and rigorous scientific procedures, at least for recent examples of the art. But can truly prehistoric corpora—those floating somewhere in archaeological deep time—also be so interpreted? Lewis-Williams addressed this issue by confronting the Upper Paleolithic art of western Europe. He constructed a functional, analogical model of the universal mental imagery that results from ASC experiences and tested this neuropsychological model (see the discussions by Ritter and Whitley, chapter 5 and 8, respectively) against prehistoric art to determine whether it was shamanistically produced (Lewis-Williams and Dowson 1988; Lewis-Williams 1991).

Although the place of analogy in archaeological reasoning has long been a topic of discussion, and even though there are numerous examples of formal analogies inappropriately used for unsupportable interpretations, there is now widespread agreement that the careful construction of functional analogies is central to archaeological interpretation (Wylie 1982, 1985, 1988; Hesse 1991). Given this fact, and using Lewis-Williams' neuropsychological model for empirical tests of specific corpora of art and as a blueprint to construct other functional, analogical models, it is apparent that our ability to interpret rock art and other forms of symbolism is not limited to ethnographic cases. Thus, while the verdict is still out on whether or not the neuropsychological model explains the Franco-Cantabrian art, even a final, empirical disconfirmation of the hypothesis that the upper Paleolithic art was shamanistic would necessitate acknowledgment of the model's analytical utility. But right or wrong, what is important in the general case is that, through careful, functional analogical arguments, it is now possible for us to apply our interpretations of parietal art to the truly prehistoric past. Again, this is not to deny that much remains to be resolved, methodologically and theoretically, in rock art intepretations; instead, we simply affirm that rock art interpretations have now crossed a series of critical methodological thresholds, and that we can now approach the symbolism and cognition of prehistoric societies and cultures in scientifically defensible ways.

Rock Art and Scientific Method

The third recent advance in rock art studies concerns the philosophy of science and the place of scientific method in rock art research. Again, we turn to the research of David Lewis-Williams (1981, 1983; Lewis-Williams and Loubser 1986) as being exemplary of efforts to link interpretive analyses with the rigor of scientific method. Lewis-Williams' methodological contributions have demonstrated that: (1) interpretive hypotheses, including rock art theories, can be constructed to make empirical predictions; therefore, they may be empirically "tested" and thus meet the requirements of scientific hypotheses; and (2) there is a rational means for adjudicating among such competing interpretive theories. That is, his contributions show that there is nothing inherently inimical between science and symbolic analyses, or between studies of prehistoric cognition and ideology and scientific methodology, once one adopts a rationalist, as opposed to positivist, scientific method (Whitley 1992a).

Scientific rock art interpretations thus require systematics and rigor in data collection, just as is required in the scientific analysis of excavated data. They necessitate the construction of hypotheses that meet the canons of logic and are potentially falsifiable, in the sense of having empirical implications that are theoretically testable, just as is necessary for hypotheses concerning other types of archaeological evidence. But, rather than establishing "proof" through critical tests (for example, simple falsification), the best theories are rationally selected over their competitors by examining "criteria for the confirmation of hypotheses." In Kelley and Hanen's (1988) terms, scientific method can then be characterized as "inference to the best hypothesis." The criteria used to select a preferred hypothesis typically include the quantity and diversity of the kinds of data explained by a hypothesis (that is, its observational success); its ability to correlate with existing accepted theories and knowledge; and its predictive capabilities, internal consistency, simplicity, and plausibility. The result is the rational selection of the best hypothesis from among competitors given the evidence at hand. This process acknowledges the fact that evidence for and against many good hypotheses can be presented (Salmon 1982:37–38) and that, with new evidence or theories, a better explanation may be obtained. Scientific knowledge, then, is inherently corrigible and approximate, but this does not mean that it is entirely relative. Thus, Lewis-Williams' approach provides a scientific basis for studying rock art; in fact, a basis that is as philosophically well grounded as the approaches used in what is more typically considered "scientific archaeology."

The tensions in the processual v. post-processual debate can be resolved once the rhetoric is set aside and it is acknowledged that many of the post-processual criticisms of positivist, processual archaeology are largely correct at the methodological level and that the analysis of symbolism, art, and ideology is necessary, if we are to satisfy even the original agenda of New Archaeology. Resolution, however, also requires admitting that the need for scientific rigor and explanation, as sought by processual archaeologists, need not be eschewed even with these commitments. We believe that a realist, rationalist approach to analysis, using explicit scientific methodology to achieve interpretive and symbolic explanations, can mediate the false opposition between the scientific commitments of the processual archaeologists, on the one hand, and the interpretive concerns of the post-processualists on the other. We also contend that recent rock art research has conjoined the opposing positions in this increasingly rebarbative debate. This has placed rock art studies at the methodological forefront of archaeology in general and at the substantive lead of hunter-gatherer research specifically. This is not to deny the large theoretical and methodological hurdles this research continues to confront. Instead, we simply emphasize that the traditional complaints stating that rock art studies are inherently unscientific, methodologically weak, or theoretically depauperate are no longer valid.

In little more than a decade, then, at least the initial problems regarding chronometric control of rock art have been overcome. New interpretive models and approaches have been established and tested which allow us to examine, in a methodologically sound manner, substantive issues relevant to current archaeological debate. Rock art research has been at the forefront of introducing to archaeology the recent developments in the philosophy of science. All this points to the fact that rock art research has now reached a threshold where, we believe, it can finally move from cover art into text.

Chapters in this Volume

The chapters in this volume, which were originally presented at a symposium at the 1992 meetings of the Society for American Archaeology and, with one exception, emphasizing North American research, illustrate the direction in which American rock art studies are proceeding. At the technical level, particularly in reference to the development and application of chronometric techniques, they are breaking new ground. Not only do the dating studies demonstrate the technical feasibility of direct, numerical dating in rock art, but they are also revolutionizing our existing cultural-historical schemes for the art. In terms of analysis and interpretation, the chapters emphasize an anthropological, rather than evolutionary or ecological, perspective. Even though in some cases still tentative in their conclusions, they look for analytical inspiration in a wide range of literature. They not only consider theoretical developments in rock art research worldwide, but also developments in such areas as semiotics, gender studies, and neuropsychology. The chapters are organized according to two general themes: dating research, and analyses and interpretations.

Dating and rock art research

The chapters illustrating the current status of rock art dating range from overviews of chronometric techniques and substantive conclusions to the latest technical advances to specific chronometric studies.

In beginning with dating, we emphasize that chronometric control is still the most troublesome problem in rock art research. We are at once still in the cultural-historical stage in research while attempting to move beyond it with interpretive and explanatory studies. Though these chapters demonstrate that substantial advances have been made in dating, not all temporal and chronometric problems have been resolved. While we can now date rock art, the existing suite of numerical rock art ages—that is, actual empirical control of specific corpora of rock art—is exceedingly limited and is spread very thin across the world. Chronometric control is weak and will remain so until major regional dating projects are completed.

The first contribution in the volume, and the only non-North American study, is an appropriate introduction to dating research. Written by Jean Clottes, an authority on the Upper Paleolithic archaeology and rock art of the Franco-Cantabrian region, "Who Painted What in Upper Paleolithic European Caves" provides an overview of the techniques and approaches to dating European cave art and the substantive and technical conclusions to be drawn therefrom. Aside from simply providing an up-to-date summary of the age of Paleolithic art, Clottes' chapter illustrates one very important point from an historical perspective: the archaeological context of European art (usually in deep, sometimes sealed, caves) and the potential to relate wall art to mobiliary art excavated from stratified deposits have aided in the construction of rock art chronologies in this region in a way never realized in North America. This factor, in addition to historical circumstances, has favored the retention of rock art studies within the purview of mainstream French archaeology, even though direct rock art dating techniques have until very recently been unavailable there.

Clottes presents other messages, one a counterpoint to a theme underlying some of the analyses in Part II of this volume (specifically those of Turpin and Loendorf). This message is the necessarily close interplay between rock art and "dirt" archaeological research. Clottes shows how archaeological excavation has contributed to rock art studies in France and, in another important object lesson for American archaeologists, how underlying assumptions about the relationships between the stratigraphic and the parietal archaeological records can lead interpretation astray.

The second chapter, by Scott D. Chaffee, Marian Hyman, and Marvin W. Rowe, is "Radiocarbon Dating of Rock Paintings." Their recent work has focused on radiometrically dating pictographs. Using AMS ^{14}C dating and after tests using samples of known, constrained age, they have begun a program of substantive applications for two areas of North America: the Pecos River region of Texas and the Canyonlands of Utah. Results for six Pecos River–style samples indicate that this rock art was produced between 3000 and 4200 radiocarbon years ago—ages that are in agreement with previous archaeological estimates of the dates for the culture that produced this art. Although these substantive results are of great importance in their own right, there are larger technical implications. Because the finer ramifications of chronometric research may go unnoticed by readers more concerned with the archaeological rather than technical issues involved, some detail concerning the wider significance of their approach is warranted.

With the recent advent of AMS ^{14}C dating enabling the chronometrician to obtain radiometric ages on small organic samples, direct pictograph dating has become, in principle, feasible. But considerable technical difficulties, especially in extracting the organics (usually added as a binder) from the larger geochemical component (for example, mineral earth colorants) of the paint, have continued to plague those attempting pictograph dating. It has been difficult to separate the organic binder from the inorganic carbon that may also be present in a paint sample. For this reason, a number of previous AMS ^{14}C pictograph dating projects have considered only black paintings made with charcoal "crayons" (for example, van der Merwe et al. 1987; Valladas et al. 1992). No attempt has been made to assign numerical ages to paintings of other colors or to mineral-based pigments, where inorganic carbon is likely to be present.

That is, at least three components of a rock painting can yield radiocarbon ages: organic carbon, inorganic carbon, and oxylates. Postdepositional oxylate coatings can develop over paintings and contaminate a radiocarbon sample (Watchman 1987, 1991). Nonselective carbon extraction, usually used in pictograph dating (but see Loy et al. 1990 for an exception), does not allow us in all cases to isolate the pigment component that is archaeologically meaningful.

Chaffee, Hyman, and Rowe directed their theoretical and technical expertise toward techniques that allow precise, controlled extraction of organic materials from any kind or color of prehistoric pigments and that allow them to overcome at least some of the problems inherent in nonselective carbon extraction. The result has been the development and testing of oxygen plasma chemical extraction systems that selectively oxidize the organic component of paints and collect the carbon as CO_2. The CO_2 can then be radiocarbon dated using standard AMS ^{14}C techniques. Thus, by fractionating the different types of carbon in a sample, the most reliable and inferentially useful component can be selectively dated.

One other important advancement in Chaffee, Hyman, and Rowe's approach is that their plasma extraction system is nondestructive: it does not require burning the paint sample prior to AMS dating. For archaeological remains like rock art, this is a significant improvement over previous techniques, particularly given the reluctance of many researchers to allow any destruction of pictographs, even for scientific purposes. Granted, the sample must still be brought into the lab, but certainly there are examples of spalled rock fragments with paintings that could be profitably dated. Two such cases, controversial but of fundamental importance in cultural-historical terms, are the painted stones from the Apollo 11 cave in Namibia, claimed to be the earliest rock art in Africa (Wendt 1976), and spalled, painted fragments from Pedra Furada, Brazil, said to represent the earliest painted art in the New World (Guidon and Delibrias 1986).

Chapter 3, "Dating Petroglyphs with a Three-Tier Rock Varnish Approach" by Ronald I. Dorn, is an update of his techniques for providing minimum limiting ages for petroglyphs. The CR dating technique, developed by Dorn a decade ago, assigns consistently reliable calibrated ages to petroglyphs—ages that correlate well with radiocarbon ages—but suffers from certain limiting factors. The most important is that the geochemical processes measured in CR dating can, theoretically, reverse over time. Recognizing its limitations, as well as the fact that small amounts of organic matter (for example, lichen remains) become cemented in a varnish coating, Dorn next extracted and AMS ^{14}C dated this organic matter. The primary advantage of this numerical approach over CR dating is the greater accuracy radiocarbon dating provides.

Initially, AMS varnish dating involved chemically extracting the organics from approximately the bottom 10% of a varnish coating (Dorn et al. 1986) yielding a minimum-limiting age. By improving the techniques for sampling within the microstratigraphy of the varnish coating, Dorn can now extract "subvarnish" organic material that is present in the weathering rind or was sandwiched between the original rock surface and the first layer of varnish growth (Dorn et al. 1992). AMS ^{14}C dating of the weathering rind, as opposed to the varnish, then provides an age that is closer to the "true" age of the creation of the petroglyph. Dorn examines each of these developments, along with varnish microstratigraphy for relative temporal control. He also discusses certain controversies that have developed concerning varnish dating, demonstrating that these controversies have developed because of improper applications of the dating techniques rather than because of deficiencies in the techniques themselves.

Again, because of the highly technical nature of Dorn's research, we outline three of its more general implications. The first and perhaps most important implication, aside from increased accuracy in age assignments, is that subvarnish AMS ^{14}C dating will greatly facilitate field sampling. Previously, the sampling of rock engravings required the mechanical removal of a varnish sample in the field. Without considerable training and experience in this procedure, it is very difficult to obtain a sample that is sufficiently clean for reliable dating (or that will not require extensive sample preparation time in the lab). AMS ^{14}C dating of the weathering rind will enable archaeologists to collect and submit small core samples to the lab for preparation and dating.

This new approach may also have implications for dating pictographs. The painting of a motif over the weathering rind of a rock face should seal the cortical surface from additional organics and therefore could be used to cross-check an AMS ^{14}C painting age. It can then be predicted that the cortical age of the rock underlying a dated painting—as provided by Chaffee, Hyman, and Rowe in this volume and elsewhere by Loy et al. (1990)—should be slightly older than the age derived for the painting itself.

In no cases have the new techniques significantly altered earlier petroglyph age assignments (Dorn and Whitley 1983, 1984; Whitley and Dorn 1987, 1988). Certainly, they have been slightly revised, but this should be recognized as improvement in accuracy and not as substantive alteration of earlier age designations. Thus, even while Dorn's recent emphasis has been to improve AMS ^{14}C petroglyph dating, CR dating is still a viable approach to petroglyph age assessment (Loendorf 1991; Francis, this volume). Given that the cost of CR per date is approximately one-third that of an AMS ^{14}C petroglyph age, we feel it should continue to serve as an important, if not central, component in chronometric rock art techniques.

This fact is illustrated in chapter 4, Julie Francis's "Cation-Ratio Dating and Chronological Variation Within Dinwoody-Tradition Rock Art in Northwestern Wyoming." Francis considers the temporal placement of the renowned Dinwoody-style petroglyphs, found in a geographically restricted portion of the Wind River and Bighorn basins and traditionally considered to be principally Protohistoric-Historic in age. After constructing a descriptive typology of motif types, she determined the overall chronological range of these petroglyphs and whether any typological or stylistic variation in periods of production could be identified. Prior superpositional and stylistic studies had suggested the possibility that a chronological sequence of three styles might be present.

Francis obtained twenty-five chronometric age assignments for twenty separate motifs. All but one were direct, limiting ages obtained using the CR and AMS ^{14}C techniques. The exception was a stratigraphic date based on a conventional radiocarbon age derived from a deposit overlying one of the motifs. These assignments indicate that the Dinwoody petroglyphs were made from the early Archaic (before 5000 BP) into the Protohistoric period (less than 500 BP), a considerably longer span than previously hypothesized.

A number of implications arise from these results, not the least of which are questions concerning additional archaeological research. As Francis notes, one of the most important implications is the evidence presented by the chronometric data for interpreting this art as the manifestation of a true, and very long-lived, archaeological tradition. She suggests that the dates reflect an indigenous, very stable shamanistic practice that continued in this restricted region for the latter half of the Holocene. This practice apparently continued undiminished even while new traditions or styles of rock art (for example, shield-bearing warriors) were being introduced into the area of the high Plains and northern Rocky Mountains during the last one thousand years. Assuming there is a direct relationship between rock art styles and ethnolinguistic groups, it is apparent that this evidence may soon have considerable effect on interpretations of cultural continuity and change in the northern Plains.

Analytical and interpretive studies

Part II represents studies of various corpora of western North

American rock art. Although substantive emphases and analytical approaches vary, a few themes are common, the most prominent being the interpretation of North American rock art as shamanistic in origin. This is no new hypothesis. The ethnographer Alfred Kroeber (1925) made a strong case for it in his classic work *Handbook of the Indians of California*, written between 1911 and 1917, and it has been widely discussed since.

There have been two common reactions to Kroeber's hypothesis in the rock art literature. The first involves the use of formal analogies to link the art with so-called typical characteristics of other shamanistic arts and, thus, to test the hypothesis empirically. Shamanistic arts, for example, often include so-called horned figures. Similarly, because shamans entered ASCs, the phosphenes or form constants they experienced might also be in the art. Finding examples of such motifs is taken as proof of shamanistic art production.

The difficulty with this approach is not that it necessarily has led to the wrong conclusions; we suspect that many of the corpora of art examined with it, and contended on the basis of such formal analogies to be shamanistic, are, in fact, probably just that. Rather, this approach is methodologically weak. If the right conclusions have been reached, they have been achieved for the wrong reasons. To cite just one example of why this is so, we note that Viking warriors wore horned headdresses for no known shamanistic reasons. Finding formal characteristics like horned anthropomorphs in a corpus of art logically then could be attributable to Nordic, and not shamanistic, origins. Our point is not to disparage analogical reasoning but simply to emphasize that it must be based on functional relationships such as Lewis-Williams' and Dowson's (1988) neuropsychological model, not simply on unsystematically considered formal attributes.

The second reaction to the shamanistic hypothesis has been to accept it at the outset and then use it in a series of wide-ranging, functionalist conclusions concerning the place of shamanism and art in society. The "conclusions" reached in such an approach are inherent to structural-functionalist social theory and therefore are not conclusions in any analytical sense at all: they are simply restatements of the theoretical presuppositions (and biases) of the analyst. Moreover, as with most structural-functionalist approaches, they confuse consequence with cause and thus lack explanatory power. "All roads," as Lewis-Williams (1982) has rightly noted, "lead to social solidarity" in structural-functionalist interpretation.

The authors in this volume view the shamanistic hypothesis as a central interpretive concern but, from the analytical perspective particularly, in an entirely different light. The effort has been to proceed beyond the formal to the functional (but not necessarily functionalist), to explore the shamanistic theory as a starting point for considering other aspects of social relations, and to test it using accepted archaeological means.

A second theme is the relationship of rock art and stratigraphic archaeological records. Here, we see a direct benefit of the ongoing dating research as expressed in the first series of papers. Even while the interpretive analyses do not in all cases correlate specifically with the developing body of chronometric ages, there is a clear confidence that rock art is no longer temporally unknown, as if it floats somewhere in the unknown archaeological past. Instead, we can begin the task of tying it to the rest of the archaeological record. Certainly, this is a first step toward inclusive archaeological analyses in hunter-gatherer studies, where we truly begin to deal with the systemic interrelationships that underlie prehistoric cultures. For the rock art/"dirt" archaeological relationships are not, in these papers, simply questions of cultural-historical connections. Rather, they concern implications about other aspects of the archaeological record, such as subsistence, mobility, and gender relations, which more typically are considered only with stratigraphic evidence and interpretations.

The interpretive studies begin with a chapter by Eric W. Ritter, "Scratched Rock Art Complexes in the Desert West: Symbols for Socio-Religious Communication." His work represents a synthetic, analytical examination of the Scratched style of petroglyphs. His research began with a very detailed recording of two major petroglyph localities in Nevada, Pistone and Massacre Bench, reported elsewhere (Ritter and Hatoff 1990). In addition to describing the data systematically collected at these sites, he also considers published accounts of the occurrence of this style throughout the western states.

Using this corpus of primary and secondary evidence, Ritter addresses competing hypotheses about the production of this art. These hypotheses concern whether this style was solely a manifestation of a late "Numic [ethnolinguistic group] spread" that replaced earlier pecked art (see Bettinger and Baumhoff 1982); how it might relate formally, chronologically, functionally, and symbolically to mobiliary scratched art recovered from stratigraphic contexts; and whether the scratched petroglyphs support the neuropsychological model (see Lewis-Williams and Dowson 1988) and a shamanistic interpretation for Great Basin rock art (see Whitley 1992b, 1994). In each case, these hypotheses imply specific empirical predictions that can be examined against his body of evidence.

As Ritter also notes, these hypotheses are neither mutually exclusive in all cases nor equally testable with empirical evidence. Yet he attempts to sort through the available evidence in an effort to "infer to the best hypothesis." Ritter, thus, tacitly adopts a rationalist, as opposed to positivist, scientific method. His approach well represents one of the trends in rock art research described earlier: the application of scientific method to rock art studies, but the rejection of the largely repudiated, narrow program of logical positivism in favor of a more philosophically sound, rationalist approach (see Salmon 1982; Kelley and Hanen 1988; Whitley 1992a).

The second interpretive approach, "A Gendered Search Through Some West Texas Rock Art" by Patricia M. Bass, also considers the applicability of the shamanistic hypothesis to one of the more renowned corpora of pictographs in North America: the Pecos River style. Starting where most such interpretations conclude, Bass addresses one of the more topical issues in archaeological research worldwide: the androcentric bias that has suffused interpretation—especially in hunter-gatherer studies—since the inception of the discipline. Specifically, she considers the gender-based assumptions that underlie many analyses of the archaeological record, including rock art. As with Conkey and Spector (1984), she recognizes that these assumptions are typically nothing more than implicit and unrecognized analogies with our own sexual division of labor and cultural representations of gender. Because we often think of hunter-gatherer societies with a simplistic, unisexual "Man the Hunter" model, for example, and because religion in Western culture is almost entirely dominated by male ritual practitioners, shamanistically derived rock art necessarily becomes the product of male shamans. Perhaps, Bass avers, this is an proposition we should test, rather than assume from the outset.

Bass's intent is to develop a de-gendered model for the study of rock art. Her first step is to construct empirical expectations for the Pecos River iconography that might be found in either male- or female-dominated art production. Using semiotic principles for ritual communication (see Bass 1989), she examines the direct associations among specific motifs in the art in an initial test of her de-gendered model. Although her evidence does not allow her to conclude that the Pecos pictographs were necessarily female produced, neither does it indicate that the art was necessarily and exclusively male. This being the case, it certainly validates her original contention that our embedded assumptions should be examined before we delve too deeply into interpretation.

The examination of the Pecos River pictographs continues in Solveig A. Turpin's chapter, "The Were-Cougar Theme in Pecos River–Style Art and Its Implications for Traditional Archaeology." Turpin also begins with the hypothesis that the Pecos River art is shamanistic in origin and, using a formal iconographic model, demonstrates the continuing efficacy of this interpretation. Again, however, this interpretation serves as the starting point, rather than the conclusion, of her analysis, for if the Pecos River style can be defined by its thematic redundancy, as well as by the iconographic coherence of its representations, as Turpin illustrates, it follows that it is a manifestation of a unified prehistoric ideological system. She uses the distribution of this ideological system to examine existing models of hunter-gatherer adaptive systems. Her purpose is to demonstrate the basic complementary nature of traditional "dirt" archaeological research and rock art studies.

Turpin notes that, with southern Texas archaeological research having historically concentrated its efforts north of the Rio Grande, reconstructions of hunter-gatherer subsistence and adaptation have assumed that seasonal movements and exploitative patterns were necessarily constrained to the environment and natural resources of Texas. Recent rock art discoveries, specifically a substantial concentration of Pecos River style pictographs south of the Rio Grande, suggest that the current adaptive model is incorrect. More to the point, the northern Mexican evidence for the Pecos River pictographs is found in an environment in all respects different from the canyon country of the Rio Grande. Because the production of art apparently represents the activities of people who shared a common ideological system, the logical conclusion is that the limits of this art represent the limits of the movements of these peoples. This assumption implies that any realistic model of adaptation and subsistence must necessarily consider the rock art evidence: the range of these rock art-producing peoples was not restricted to southern Texas environments. Instead (and, perhaps, seasonally) they extended their range into entirely different kinds of environments with different kinds of resources. Alternatively, peoples following two different adaptive systems in different environments shared the same art and ideology; in either case, existing reconstructions of adaptation and subsistence are simply incorrect.

A concern with shamanism also underlies David S. Whitley's "Ethnography and Rock Art in the Far West: Some Archaeological Implications." His chapter builds on a lengthy review of the ethnographic evidence for rock art production in the far west (Whitley 1992b, n. d.a, n.d.b), defined for his purposes as California, the Great Basin, and the Columbia Plateau. Having spent the last few years combing the ethnographic record for evidence concerning the production of rock art, Whitley has found a very coherent, and essentially universal, pattern in the production of historical/ethnographic rock art. In all regions, the art displays spirits and spirit helpers perceived during ASC experiences, entered to obtain supernatural power; it is, throughout the far west, the result of vision quests, broadly defined. Moreover, although shamans were active producers of rock art in each region, there was some regional and sociological variation in production. In southern California and the Columbia Plateau, rock art was also produced by youths during puberty initiations, as well as by shamans.

Using this ethnographic data as a starting point, Whitley considers the archaeological implications concerning interpretations of corpora of rock art that lack ethnographic referents. As noted previously, the historical absence of ethnographic models for rock art production has, in the large sense, impeded archaeological interpretations of the art. The ethnographic record from the far west not only provides models useful for inspiring hypotheses about other corpora of rock art, but also allows us to critically examine existing inferences and analytical assumptions about rock art.

The final chapter, Lawrence L. Loendorf's "Traditional Archaeological Methods and Their Applications at Rock Art Sites," serves as a counterpoint to Whitley's contribution and continues an approach pioneered by Clement Meighan (1966), among others. Instead of using ethnographic data to interpret the art, Loendorf demonstrates the value of applying what archaeologists do best—so-called traditional archaeological techniques and analyses—to the study of rock art and rock art sites. These techniques include seriation to temporally order sites in a given region, experimental (actualistic) studies to better understand rock painting and engraving methods, and excavation at rock art sites. All these approaches are shown to have real analytical value and all are very familiar to the field-trained dirt archaeologist. The last area of concern, the excavation of rock art sites, particularly demonstrates the potential complementarity between rock art and excavation research, also illustrated by Turpin.

Cover Art versus Analytical Substance

Although a different perspective on these studies is provided in an afterword offered by George Frison to conclude this volume, it is appropriate to end the introduction with a point that perhaps better than any other illustrates the current status of rock art research in North America. It is that each study represents the interim conclusions of the authors' ongoing research projects. Thus, the conclusions are, in some cases, tentative, while in others all the implications have not been fully explored.

More to the point, however, the authors have made significant career commitments to rock art studies. These analyses are not simply one-off delvings into the potential of rock art investigations by professionals who spend most of their research time on other topics. Rather, there is finally a significant body of professional archaeologists and chronometricians who are rock art specialists with long-term rock art interests, projects, and goals. Rock art research, we believe, is thus coming of age. We hope that the number of specialists continues to increase.

This book demonstrates that rock art has more to offer the professional archaeologist than simply attractive cover art. Certainly, we can now chronologically relate it to other aspects of the archaeological record. In some cases, the interpretation of the art plays directly into such general archaeological concerns as the definition of group territories and inferred subsistence and adaptative systems. Viewed from other perspectives, it provides various kinds of information and allows types of inferences about the past that are not so accessible using traditional excavation and settlement pattern data. Regardless of the analytical point of view, the simple fact is that if, as New Archaeology averred, we wish to achieve systemic interpretations of prehistory that explicitly consider all interrelationships of culture, rock art simply cannot be ignored in hunter-gatherer studies. It remains for us the single most visible manifestation of prehistoric ritual many centuries, and in certain cases millenia, after it was produced. We can only reasonably infer that it held similar prominence for its creators and therefore equal importance in the prehistoric cultures we aim to study.

David S. Whitley
Lawrence L. Loendorf

1 Who Painted What in Upper Paleolithic European Caves

JEAN CLOTTES

WESTERN EUROPEAN PAINTED CAVES cover a span of about 20,000 years. Because different artists may have worked at different times in the same caves, a major problem is establishing the successive operational phases and assigning them to a given culture. New methods, such as multiple pigment analyses and direct radiocarbon dating, are being applied to solve this problem. This chapter deals with the changes these methods bring about in our outlook, as well as their limitations, and compares them with the traditional methods of stylistic sequences and archaeological contexts.

Classical Methods of Identifying Sequences

For the past ninety years, the same methods have been applied to identify historical sequences: studying superimpositions, defining a set of stylistic criteria that always appear in the same sequence, and finding points of reference to use as standards for comparison.

The study of superimpositions wherever they occur, particularly in caves with very complex wall art, is used to establish a relative chronology (fig. 1.1). Such a method assumes that each period has a distinctive set of themes, techniques, and/or conventions, just as each culture can be defined by a distinctive set of tools. This approach was an adaptation of the stratigraphic methods first evolved by geologists and adopted by the earlier prehistorians for the study of wall art. Cartailhac and then Breuil were the first to attempt such a study, by describing four successive stages for the art in the cave of Marsoulas (Haute-Garonne) in the Pyrenees: black outlined animals (attributed to Magdalenian III), black and incised animals with infilling (Magdalenian V), big polychrome paintings (Magdalenian VI), and series of signs such as dots (extreme end of Magdalenian VI) (Plenier 1984:449).

Defining a set of stylistic criteria that can be shown to appear always in the same sequence is the method that lies at the root of the schemes built by Breuil and later by Leroi-Gourhan. For instance, Breuil stressed the twisted perspective of horns, supposedly a characteristic of the earliest paintings. Leroi-Gourhan used several criteria, such as body shape and its distortions, the animation of animals, and the themes and techniques used.

Finding solid points of reference as to use as standards for comparing one case to the next in order to date stylistic conventions with some degree of precision is traditionally done by referring to caves considered well dated, by making comparisons between rock art and mobiliary art, and by making comparisons with rock art from caves dated by either of the preceding methods.

Caves are considered well dated if the entrances were blocked by archaeological layers that precluded later entrance (Pair-non-Pair, La Mouthe, Le Poisson), if the paintings or engravings inside a cave or rock shelter were covered by an archaeological layer (Angles-sur-Anglin, Marsoulas), or if fallen wall or roof panels bearing rock art were found in or under Upper Paleolithic strata.

Comparisons are made between rock art and mobiliary art in order to date the rock art. These comparisons, usually but not always conducted when both art forms were found on the same site, have been made since the first discovery of cave art at Altamira. The strong similarities Piette perceived between the Spanish cave and his first-hand experience of mobiliary art explain why he was the only leading French prehistorian to maintain that the Altamira rock art was genuinely Paleolithic. Later, this method was consistently used to date wall art whenever particular stylistic conventions appeared on both parietal figures and well-dated mobiliary art. For example, the ascription of the Gargas wall engravings to Gravettian relies heavily on the particular way bison horns were drawn on stone plaquettes found in the Gravettian levels at the entrance to the cave—a technique identical to that used in engraving bison on the walls (Barrière 1984:521). Similarly, the female outlines with large buttocks in profile, so far known only in the mobiliary art of Magdalenian VI sites (Petersfels, Gönnersdorf, Lalinde), have been widely used to set the chronology of wall art in such caves as Grotte Carriot (Lorblanchet and Welté 1987:37).

The third approach, comparisons made with rock art from caves dated by either of the preceding methods, although useful, must proceed with caution. For example, Breuil attributed the drawings in the Gallery of the Owls at Les-Trois-Frères (Ariège) to the Aurignacian, based on some "archaic" features

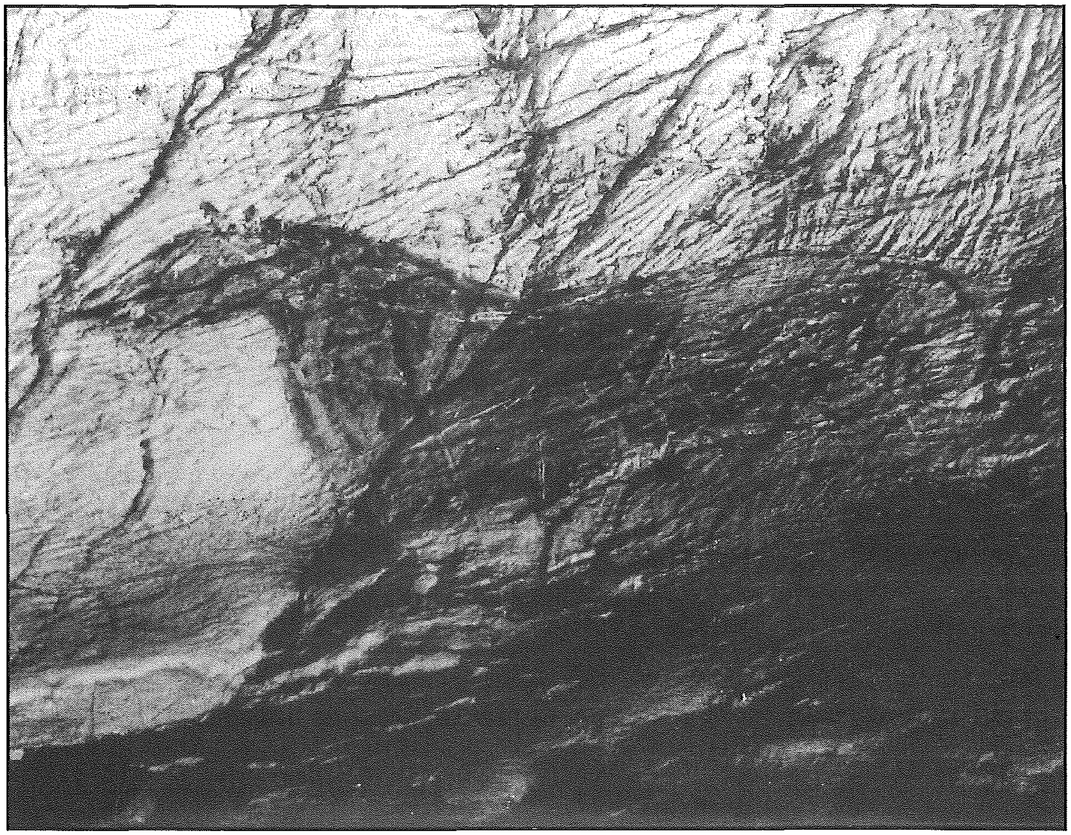

Figure 1.1 Cosquer Cave, Marseille, France. A horse was painted over several finger tracings. Then, undetermined lines were engraved on top of the horse. Though we have no way of knowing their absolute dates, three different stages are apparent. Maximum dimension: 82 cm. *Photo courtesy of the French Navy.*

he assigned to that culture. These drawings are now assigned to the Gravettian because the Gargas stylistic convention for bison horns (mentioned above) is found several times in the Gallery (Bégouën and Clottes 1987:187). We are probably right in inferring that the Gallery of the Owls is Gravettian rather than Aurignacian, but we have not *proved* it, further illustrating one of the numerous problems posed by the classical techniques used to date cave art.

Chronology of Paleolithic Art

Most chronological attributions rest on very slim evidence and are based mostly on stylistic comparisons, even though all specialists are acutely aware of the shortcomings of these comparisons. Leroi-Gourhan, who built a widely used interpretive system, insisted that "the thorniest terrain was that of the dating the figures" (Leroi-Gourhan 1965:31) and that "one looks in vain for a number of examples that is sufficient to provide chronological conviction" (Leroi-Gourhan 1971/1972:411). Few specialists state as bluntly as Barrière that "at the present moment, we are unable to date wall art in a valid way" (1989:111). Lorblanchet states that only twenty-five caves of the 275 with wall art known in the European Upper Paleolithic are well dated "in absolute chronology" (1990a:10). Even if this were true, and it might be an optimistic estimate, 1 in 10 may not be considered a sufficient statistical basis upon which to draw any sort of conclusions.

The actual number of caves dated without any doubt may be reduced if undiscussed assumptions in Lorblanchet's paper are examined more closely. He numbers among the twenty-five caves "in particular those whose figures are covered by an archaeological layer (1990a:10)." Using an archaeological layer as a basis is one of the most common and dangerous dating mistakes. Such a layer can in no way provide a date for the works of art it covers, only a *terminus ante quem.* The figures cannot be later than the layer, but they may be roughly contemporary or much earlier. We must resort to other means to know which, and we cannot take contemporaneity for granted. For example, Teyjat is always quoted as one of the best dated caves in Europe because of the engraved blocks that fell and were covered by Upper Magdalenian levels, but the distinction between the engravings that may belong to Magdalenian v or to Magdalenian vi is still hypothetical (Aujoulat 1984:234). In the cave of Sainte-Eulalie (Lot), engraved reindeer were covered by a Magdalenian vi layer, which led the excavator, Lemozi (1920), to assign them to that culture. Later, Breuil (1952:274) accepted the date and compared the reindeer to Teyjat. Leroi-Gourhan did the same (1965:319), making much use of Sainte-Eulalie to define his Late Style iv. Eventually, Lorblanchet (1984:479) made the commonsense remark that the engravings must have been made by people responsible for an earlier habitation, which, because of the position of the layers relative to the wall art, he took to be Magdalenian iii. This hypothesis is much more likely but in no way constitutes an absolute dating, even though Sainte-Eulalie is numbered among the best-dated caves (Clottes 1990:546).

In some cases, a faulty interpretation of the archaeological context has led to wrong conclusions about the wall art in a particular cave. Ucko (1987:18,41) argues that the comparisons consistently made between the stylistic conventions of wall art and mobiliary art rest on the undiscussed and unproved assumption that conventions used with different media should be the same. Be that as it may, a far more serious situation occurs when the mobiliary art being used is attributed to the wrong culture, as happened in the case of Labastide (Hautes-Pyrénées). There, an important Magdalenian IV habitation, most probably related to the wall art, was dubbed Magdalenian V (Leroi-Gourhan 1965:157-158; Sieveking 1987:185), a cultural stage that has never been found in the Pyrenees (Clottes 1989: 283).

Probably the most dangerous fallacy in our attempts to date cave rock art is the implicit belief that particular conventions or themes belong to a particular culture, as we have defined that culture from its material remains. We thus equate stylistic or cultural choices with fashions in tool or weapon making, although we usually have no way of knowing exactly how long those fashions endured or their duration in the realm of rock art. Correlating two largely unknown variables is bound to lead to gross errors, and we must ever be wary of wide-ranging generalizations. It is often difficult to proceed differently, however, because we can rarely say that a particular cave is proved, for example, to be Magdalenian IV, and the temptation to correlate that cave's art with the art of other less well dated caves is great.

New Methods and Their Limits

New methods of identifying operational phases fall into three categories: modern excavations and the archaeological context, direct radiocarbon dating, and pigment analysis.

Modern excavations and the archaeological context

Modern excavations, with their attention to detail, give us a wealth of information and sometimes direct proof of the relationship between art in a cave or shelter and its archaeological context. For instance, Combier (1984:597) found drops of red paint in the midst of a very thin layer right under a painted wall in the cave of Bidon (Ardèche), thus establishing a direct link between the art and the remains on the ground. The latter was dated 21,650 ± 800 BP (Ly 847), and the same date applies to the painted panel.

The location of paintings compared to the level of an archaeological layer can also provide useful assumptions, if not actual chronological proof (see Lorblanchet 1984 concerning Sainte-Eulalie). For example, in Le Placard (Charente), only Upper Solutrean strata are situated sufficiently close to the height of the paintings and engravings to make it physically possible to have placed them on the walls (Clottes, Duport, and Feruglio 1990; fig. 1.2).

Another strong inference of contemporaneity between rock art and archaeological context may be made when the artifacts found on the ground near the paintings are few in number and could not have resulted from a habitation at that spot. For example, when a cave is very deep and the art is localized in remote galleries, we can safely infer a relationship between art and context because we know, from numerous well-documented examples, that Paleolithic peoples did not usually live far underground. In the few exceptions where they stayed a few hundred meters from the entrances of caves for any length of time (for example, Labastide, Bédeilhac, Trois-Frères), the caves contain wall art. Thus, the artifact remains from the upper and perhaps middle galleries of Tuc d'Audoubert can be ascribed to the Magdalenians who created the art or went to the end of the cave to conduct ceremonies or other activities related to it (Bégouën and Clottes 1983).

Similarly, the painted and engraved chamber in the newly

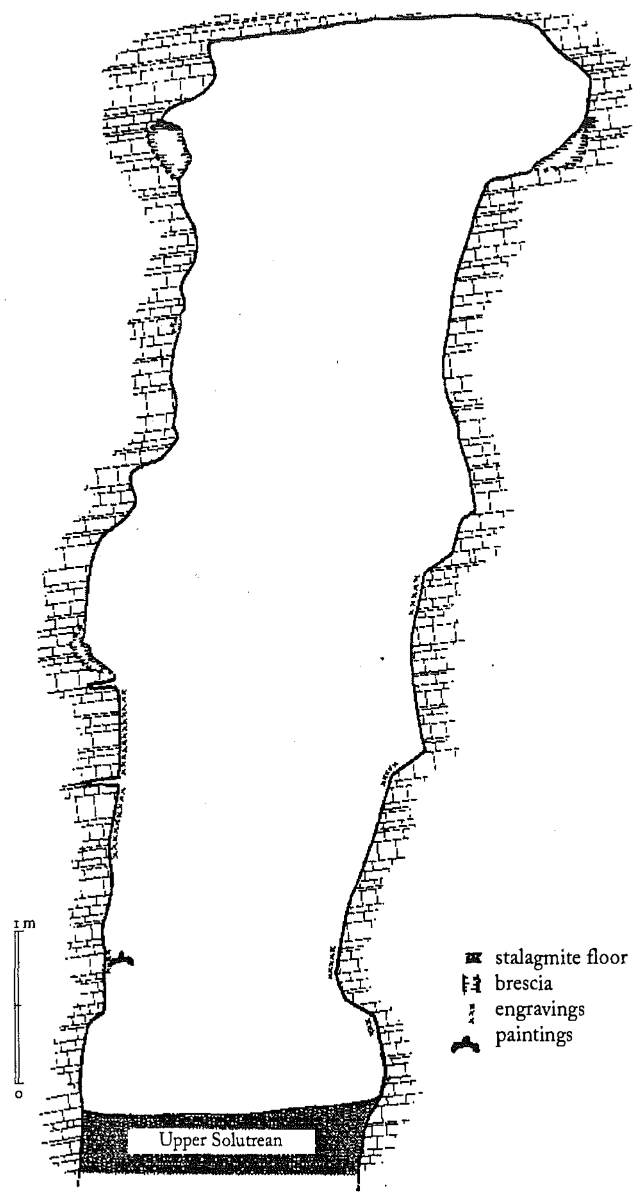

FIGURE 1.2 CROSS SECTION OF A GALLERY IN LE PLACARD CAVE, AT VILHONNEUR, CHARENTE, FRANCE. The brescia near the top was dated to the Middle Magdalenian. A Late Solutrean level was discovered about 3 feet under a painted sign and several engravings. Location of the art points to a Solutrean date. *Clottes, Duport, and Feruglio 1991.*

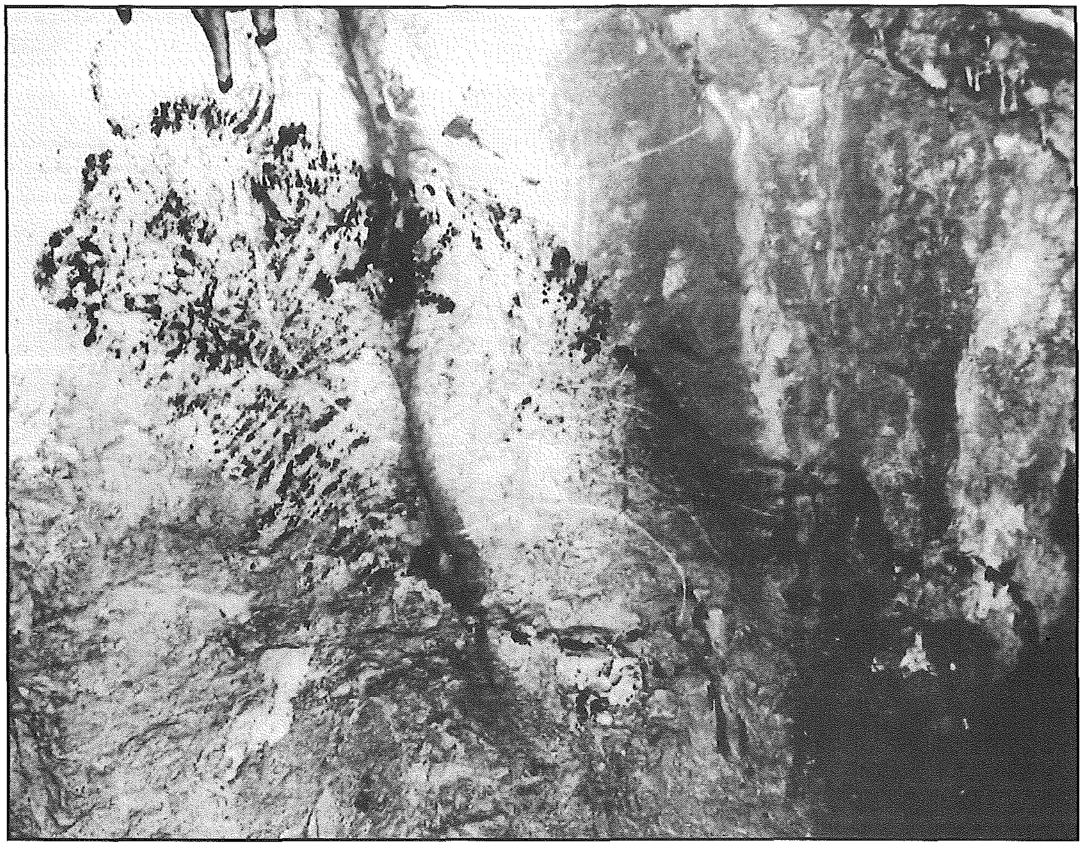

FIGURE 1.3 COSQUER CAVE, MARSEILLE, FRANCE. This black bison was radiocarbon dated twice: 18,010 ± 190 years BP and 18,530 ± 180 years BP. *Photo courtesy of the French Navy.*

discovered Cosquer Cave (Marseille) is 150 m from the entrance, down a long, narrow passage. The preserved ground of the chamber is strewn with charcoal, two very small hearths (30 cm in diameter), and only half a dozen flint blades. Both the location of these finds and their nature point to a close link between the art and the archaeological context: the chamber has not been lived in, the charcoal and hearths are better explained as light-giving devices, and the cave has been sealed by the sea since the end of the Würm glacial. Dating the charcoal may provide a date for some actions linked to the art, be it for its creation or for visits in relation to it. The ^{14}C date of 18,440 ± 440 BP (Ly 5558) obtained from some of the charcoal tallies very well with the stylistic conventions of the art. In the first stage of the study, however, the ^{14}C date was nothing more than a useful indication; it could not be considered *the* date (Beltràn et al. 1992; Clottes et al. 1992) until we could obtain several radiocarbon ages from the paintings themselves.

Direct radiocarbon dating

Radiocarbon dating by accelerator mass spectrometry (AMS) has progressed to the point that about half a milligram of charcoal suffices for analysis and fixing a date. This achievement has been hailed as a huge breakthrough in rock art (Lorblanchet 1990a) because we can now acscertain dates from the art itself, specifically, from black drawings made with charcoal "crayons." The quantity of charcoal needed, however, will always limit the use of AMS. Even half a milligram of pure charcoal can represent a lot of "paint."

So far, the only ^{14}C dates available for samples lifted directly from black paintings come from five caves, two in Spain (three dates from Altamira, two from El Castillo) and three in France (three dates from Niaux, three from Cougnac, and seven from Cosquer).

Spain. *Altamira*: three different bison: 13,570 ± 190 BP(Gif A 91.178) ; 13,940 ± 170 BP (Gif A 91.179) ; 14,330 ± 190 BP (Gif A 91.181). *El Castillo*: two different bison: 13,060 ± 200 BP (Gif A 91.004) and 12,910 ± 180 BP (Gif A 91.172) (Valladas et al. 1992:69).

France. *Niaux*: two different bison: 12,890 ± 160 BP (Gif A 91319) (Valladas et al. 1992: 69) and 13,850 ± 150 BP (Gif A 92.501); and a sign: 13,060 ± 200 BP (Gif A 92.499) (Clottes et al. 1992). *Cougnac*: black dot: 14,300 ± 180 BP (Lorblanchet 1990b); female megaloceros: 19,500 ± 270 BP; male megaloceros: 23,610 ± 350 BP (Lorblanchet, quoted in Bednarik 1993); *Cosquer*: two dates for the same stencilled hand: 27,110 ± 390 BP (Gif A 92.409) and 27,110 ± 350 BP (Gif A 92.491); head of a feline: 19,200 ± 220 BP (Gif A 92.418) ; two dates for the same horse: 18,820 ± 310 BP (Gif A 92.417) and 18,840 ± 240 BP (Gif A 92.416); and two dates for the same bison (fig. 1.3): 18,010 ± 190 BP (Gif A 92.419) and 18,530 ± 180 BP (Gif A 92.492) (Clottes et al. 1993). These samples are too few to provide an alternative to the classical methods, but they do raise interesting issues, and their number is quickly growing.

We have known for decades that, as far as radiocarbon is concerned, "one date is no date." Therefore, as long as scores of dates for palaeolithic rock art are not available, we will remain wary of single results. One example from Australia proves this

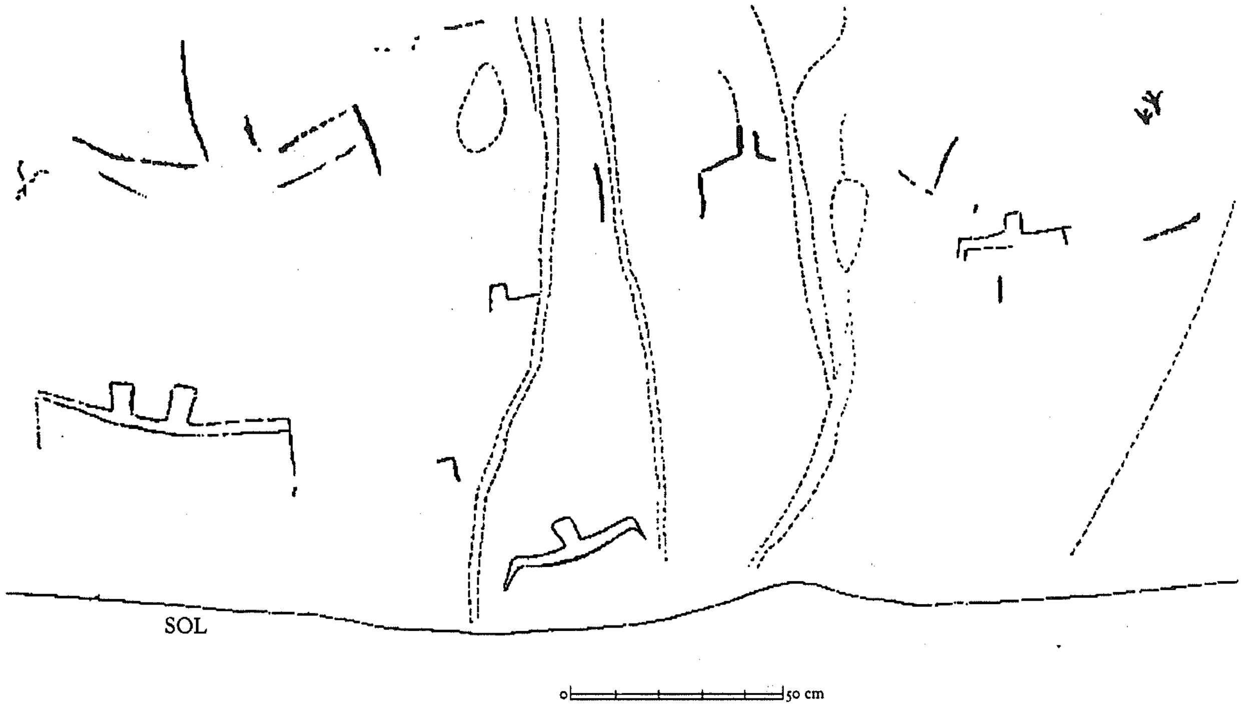

FIGURE 1.4 COUGNAC CAVE, PAYRIGNAC, LOT, FRANCE. A panel with several unique geometric painted signs. *Tracing by M. Lorblanchet.*

point in a spectacular way: two samples were taken from the *same* painting at Waterfall Cave and analyzed separately. The dates obtained were 6085 ± 60 BP (AA-5850) and 29,795 ± 420 BP (AA-5851). The authors, who cannot explain the extremely wide discrepancy, conclude, "The demonstration of conflicting dates from the same motif clearly indicates that caution is required in interpreting any AMS date received from charcoal pigments" (McDonald et al. 1990:91). Even if one date were reliable, it would apply only to the animal or sign sampled and not necessarily to the whole of the rock art panel.

Direct radiocarbon dating can produce results that are quite different than those derived from other data. For example, based on stylistic criteria, both Cougnac and part of Pech-Merle in Lot were thought to belong to the Late Solutrean or Early Magdalenian (Leroi-Gourhan 1965:266-267; Lorblanchet 1989:22). Lorblanchet had always considered the art of Cougnac to be stylistically homogeneous (1984:487)—until he obtained from a painting a radiocarbon date that was much later than expected (14,390 ± 180 BP) and that seemed to be confirmed by a second date (15,100 ± 300 BP) obtained from a bone found on the ground. In addition, very specific signs found in Cougnac (fig. 1.4) also exist in Pech-Merle. The Pech-Merle signs have been attributed to the same period as Cougnac. Several engraved and painted signs have also been found in the cave of Le Placard in the Charente (fig. 1.5). They have been dated, using various methods, to no later than the Upper Solutrean (their *terminus ante quem* is roughly 20,000 BP) (Clottes, Duport, Feruglio 1990, 1991). These signs are too particular and too few, however, to have been in use for thousands of years over a wide area. In fact, they have often been quoted as being typical of signs pertaining to a small group for a short time (Leroi-Gourhan 1981:524-525).

This new radiocarbon dating development, confirmed by two new dates for the Cougnac megaloceros, may be interpreted in different ways. If the late Cougnac date for the rock art must be taken at its face value, then there have been two widely spaced stages, at least in the painting of Cougnac. While supposition is possible (Lorblanchet 1990b:52), it contradicts the stylistic homogeneity of the cave because it implies that the same style in the same place remained absolutely unchanged for at least six thousand years. If, on the other hand, the Cougnac date is correct, but only refers to a very late and unspectacular occurrence, then someone went into the cave several millenia after it was painted, left a few bones, and made only a few drawings that were nondescript enough to fit among the oldest ones. Finally, for some unknown reason, the date may be "wrong" and too recent. This shows that, in rock art as in other provinces, a single radiocarbon date does not give us *the* date for the art; it just offers more data to be interpreted.

Pigment analysis

The chemical analysis of pigment has stirred great interest because the samples required to evaluate many paintings are minute, far less than that needed for an AMS dating. In the past two years, more than a hundred tiny samples of paint from several Pyrenean caves have been analyzed to ascertain their pigment content (Clottes, Menu, Walter 1990a, 1990b). Results show that the pigments were derived from either charcoal or manganese oxide for the blacks, and iron oxides, generally hematite, for the reds. They were mixed with a binder that could be determined in a very few cases (Pepe et al. 1991). An important finding is that Magdalenian artists used several binder formulas, sometimes adding an extender to improve the paint.

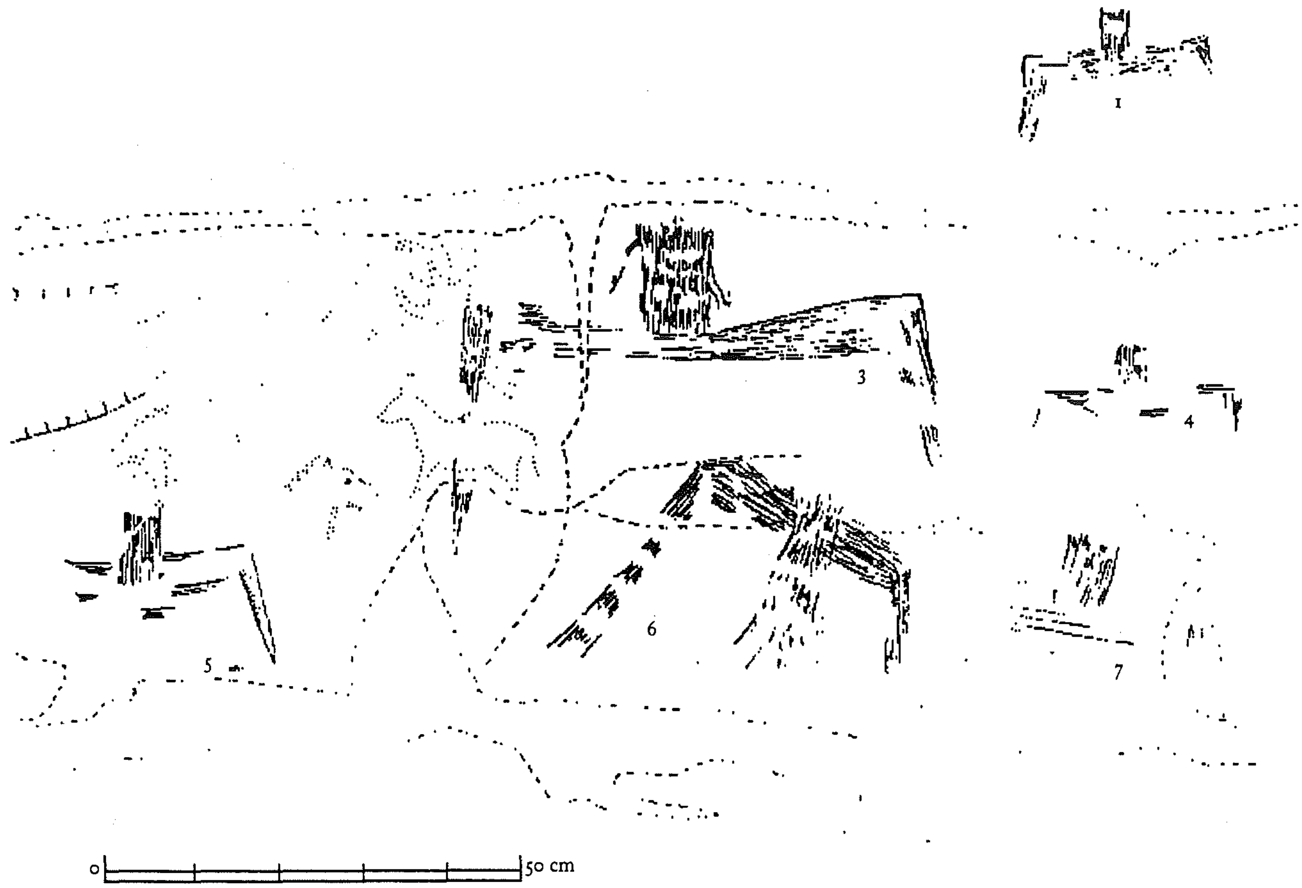

FIGURE 1.5 LE PLACARD CAVE. A panel with engraved signs identical to those in Cougnac. *Tracing by V. Feruglio.*

The two main extenders were potassium feldspar and biotite. To test whether there might be a chronological significance in the use of both extenders, seventeen more analyses were made of paint covering well-dated artifacts found in the Middle Magdalenian (Enlene, Mas d'Azil) and Late Magdalenian (La Vache) archaeological layers. Formula F (with potassium feldspar) was found only in the former and formula B (biotite) in the latter. It thus seems likely that one formula was used later than the other and might therefore provide a rough dating of the paintings analyzed. This supposition was confirmed by an AMS radiocarbon date for one of the Niaux bisons (previously thought to have been painted using formula B) that gave a date placing it, as was expected, in the Late Magdalenian (Valladas et al. 1992). However, in the same cave, another date for a different bison was about one thousand years older than expected. Many analyses will be required before a degree of certainty is achieved in this and other cases.

If the formulas were used over short periods, we can establish which paintings were made before others in the same cave or in different caves in the same region. However, the method has obvious limits: so far, the formulas have been found only in a restricted area (the Ariège), and it is not yet known exactly when they were invented and when they were abandoned (Clottes 1992). There may have been some overlap; therefore, we should use these formulas as relative indicators rather than precise dates.

Cross-dating

Cross-dating, based on the use of multiple lines of evidence using different dating techniques, is a useful comparative approach in rock art dating. Cross-dating methods were used in Niaux when one bison painting was AMS dated following analysis of its pigment. In the cave of Le Plachard (Vilhonneur, Charente), all available methods were used to date the newly found parietal art. An excavation of the living site next to the main engraved wall shows that only Upper Solutreans could possibly have created the art, as determined by the relative placement of the layers and engravings. The same fact is obvious at the entrance to a narrow passage on the opposite side of the chamber (fig. 1.1): an Upper Solutrean level is located about 1 meter under a painted sign that is identical to signs found in Cougnac and Pech-Merle; Middle Magdalenian breccia is still preserved some 15 feet above it. During the excavation of the Solutrean layers, two large chunks of rock covered with engravings, which had fallen from a wall, were found (fig. 1.6). These rocks showed that part, if not all, of the engravings had been completed before the Solutrean period. Finally, above some of the wall engravings, still preserved in situ, was a small burnt bone situated in a nook of a layer that had at one time covered the engraved panel. AMS yielded a date of 19,970 ± 250 BP (Gif-Tan. 9184): Upper Solutrean, if not earlier. In arriving at this

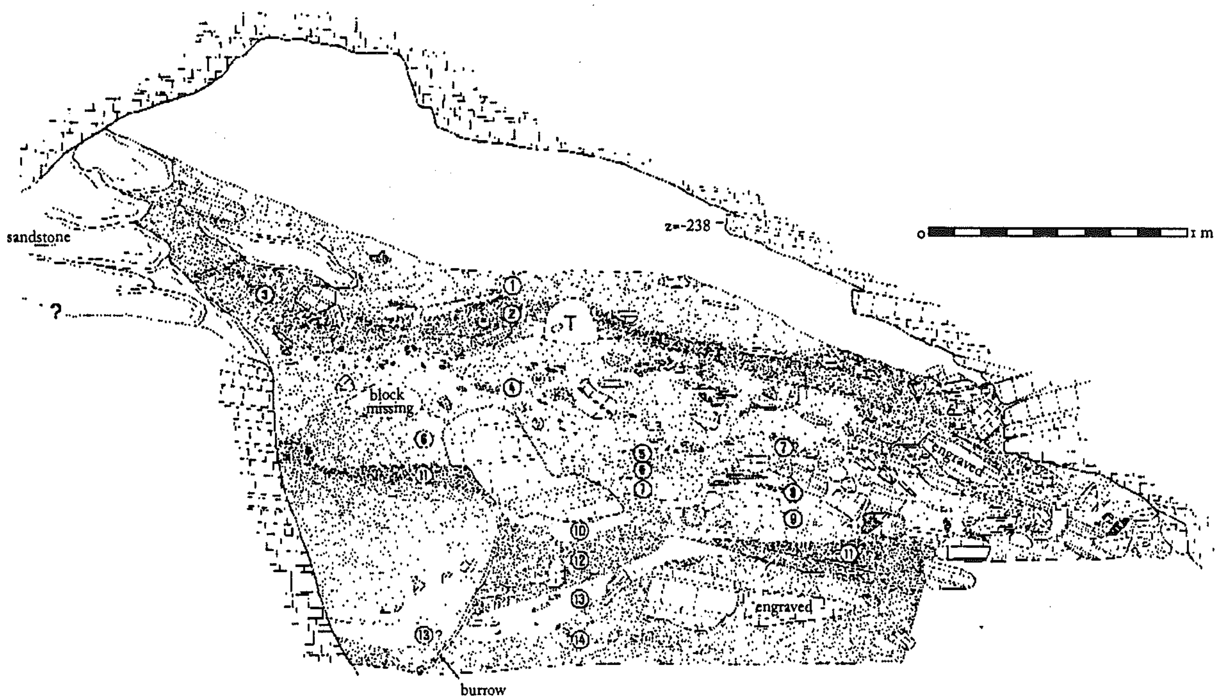

FIGURE 1.6 LE PLACARD CAVE. Cross section of the archaeological deposits next to the panel in figure 1.4. Two engraved rocks, fallen from the ceiling or one of the walls, were discovered. The lower one lay under several Upper Solutrean layers; the Upper Solutrean ended with layer 8. *Clottes, Duport, and Feruglio 1991.*

result, each method of analysis reinforced the evidence supplied by other methods (Clottes, Duport, Feruglio 1990, 1991). From that solid fact, inferences can be made as to the dating of other caves having the same sort of signs (see the preceding Cougnac-Pech Merle discussions).

By closely studying the context in Gargas and using the new AMS dating method, it became possible to obtain a date for the famous stencilled hand with missing fingers in that cave. Fragments of animal bone were found in a few cracks in the wall close to a panel of hand stencils. The obvious inference was that the bone had been deposited there in relation to the hands some time after the hands had been painted. Radiocarbon dating of one bone fragment revealed a date of 26,860 ± 460 BP (Gif A 92.369) (Clottes et al. 1992). This date matches that of a stencilled hand with missing fingers in Cosquer, precluding any coincidence and giving a long-awaited date for the Gargas hands.

Conclusion

The new dating methods bring us tools with which to precisely distinguish operational sequences in Upper Palaeolithic cave art, but each tool has its limitations and inconsistencies. None can be said to be *the* answer to our dating problems. It is only when several methods are cross-checked that we can reach a fair degree of certainty. Our aims have not changed: we must still endeavour to date stylistic ensembles as precisely as possible before trying to understand better the cultural aspects of Upper Palaeolithic people. It is useless to draw inferences from the art when, in most cases, we still have no way of knowing whether that art is the product of a single group or was painted over millenia by people who were completely unrelated to one another and who just happened to go to the same caves by chance or, in the best of cases, because vague memories brought them there. In the long run, some of the methods now being used will enable us to do a better and more precise job; meanwhile, they must be tested with the help of the time-honored ones.

Upper Paleolithic European cave art differs widely from North American rock art: in the choice of locations—caves as opposed to the shelters or petroglyphs on exposed rocks, or in themes or underlying motives—shamanism, for instance, does not seem to fit very well with most European painted and engraved caves. However, the problem of dating is the same.

The difficulties encountered in dating European cave art are compounded in the US on the one hand by the long-standing lack of professional interest in prehistoric or tribal art and on the other by particular conditions. For example, there is limited hope of finding a painted or engraved panel covered with an archaeological level or a painted cave blocked by archaeological deposits. Such well-known European dating methods are usually not appropriate in North America.

More to the point are the new dating methods, such as radiocarbon dating by AMS for pictographs painted with organic materials, pigment analysis, and the new methods being developed and tested now in the US—cation-ratio analysis, the extraction and dating of organic material found under varnish, and AMS radiocarbon analysis of minute samples (see chapters 2 and 3, this volume). Such methods are just beginning to be applied to North American rock art and are still in an experimental stage, so all the remarks concerning their limits in relation to European cave art apply directly to American rock art. This is all the more true because North American art is so various and was created in such widely different environments by groups that differed from one another culturally and in their modes of life. A great many dates by all available methods will be needed for each area and culture before a distinct pattern of evolution may be securely fixed. The richness and quality of North American rock art makes this a major, but necessary and exhilarating endeavour.

To an outsider, it would seem that we are now at the beginning of a new era in the study of American rock art. The technical means and methods are at hand. New interest is awakening to the possibilities rock art studies may bring to our understanding of past societies. Dating that art precisely is a prerequisite.

The dating work already performed on European Upper Paleolithic cave art, with its numerous trials and errors over several decades, may or perhaps should be of some methodological use in these new studies. It may not be irrelevant, for example, to stress a few of the pitfalls into which we have so often fallen, such as the difference between direct dates when pigments have been dated and the minimum limiting dates established through various methods (archaeological layers covering paintings or engravings, dating the varnish on top of the works of art). Other major dangers are the indiscriminate use of adjacent material to date rock art and the systematic equating of styles and material cultures without enough hard facts to support cultural attributions. Probably most important of all is that whatever the country, the cultural context, and the technicals means available, no rock art can be said to be well dated unless various lines of evidence have been cross-checked.

2 Radiocarbon Dating of Rock Paintings

Scott D. Chaffee, Marian Hyman, and Marvin W. Rowe

Direct radiocarbon dating of rock art presents a formidable challenge, with many factors contributing to make the job difficult. For radiocarbon dating to be possible, organic materials must have been used in creating the pictographs. If used, the materials must also survive in the paint for thousands of years. The organic matter remaining is thus likely to be only a fraction of that initially present.

Because too much of a pictograph would have to be sacrificed to obtain a conventional radiocarbon counting date, accelerator mass spectrometry (AMS) is used to measure the radiocarbon (van der Merwe, Sealy, and Yates 1987). The fact that only minute amounts of organic compounds are likely to have survived makes the effect of contamination much more severe. Some basal rocks that serve as canvases for the paintings have carbon as a major component. Limestone, the rock used for pictographs in many areas of the world, is comprised of calcium ($CaCO_3$) and magnesium carbonates ($MgCO_3$) and the thermal decomposition of limestone produces carbon dioxide (CO_2). In addition, minerals, sometimes of the same chemical composition as the rock, accrete over and intermix with the pigmented layer. This mineral overcoat varies in composition from site to site and from region to region, but silica, calcite (calcium carbonate, $CaCO_3$), and calcium oxalate (CaC_2O_4)are common (Watchman 1991; Chaffee et al. 1993a; Russ et al. 1993). Carbon is an integral component of the latter two minerals. Whatever method is used to extract the organic component from the paint must not extract the carbon from the inorganic components of the basal rock and the accretions. The basal rock also must not contain significant amounts of organic matter.

Finally, human activities that seriously contaminate the pictograph with organic materials may negate the possibility of direct radiocarbon dating. As examples of the types of intentional, carefully planned treatments that could render radiocarbon dates out of the question, we select three listed by Ford and Watchman (1990) for possible use in preserving and restoring rock art.

To counteract the deleterious effects of the freeze/thaw cycles that cause the spalling of rock art panels in many parts of the world, they propose spraying the panels with antifreeze and water-repelling compounds. However, antifreeze is a carbon-containing chemical, ethylene glycol [$C_2H_4(OH)_2$]. Spraying the painted surfaces with ethylene glycol would contaminate the sample to the extent that the radiocarbon age would be irretrievable unless a means could be devised to remove the chemical before dating is attempted. They also propose spraying rock art sites with biocides to remove algae, lichens, and other organisms that adversely affect the survival of the art. The biocides suggested are the persistent chemicals tributyl tin oxide and organochlorines, both of which contain carbon. They also propose impregnating crumbling rock surfaces with polymeric consolidants and water repellents to halt deterioration.

Unfortunately, most materials suggested to improve some aspect of deteriorating rock art contain organic materials. Chaffee et al. (1993b) recently detected a hydrocarbon derivative, probably kerosene, that had been applied to a pictograph, presumably to enhance photographic contrast. This practice, reported in the literature (Grant 1967; Kirkland and Newcomb 1967), makes radiocarbon dating impossible.

About two years ago, Loy et al. (1990) reported a technique that permitted them to date pictographs from Australia. Their method is restricted, however, to pictographs in which blood was used as a component of the paint. That same year, Russ et al. (1990) first reported the use of a plasma-chemical technique to date a pictograph sample from the Lower Pecos region of Texas. This technique has the advantage of selectively removing organic carbon without prior knowledge of the nature of the organic matter in the paint. The technique overcame some of the difficulties outlined earlier. It was not affected by carbonate- and-oxalate-containing materials, and the organic portion of the paint could be extracted without incurring contamination from those mineral sources. Yet the advantage of the Russ et al. technique could be a disadvantage in some cases. If organic contamination is present, the oxygen plasma will extract it as well as the organic components of the paint itself. This procedure would lead to an aberrant age for the pictograph. Chaffee et al. (1993c) found that sandstone from Utah, upon which pictographs were painted, contained organic material that would seriously affect dating attempts.

The first three dates for pictographs from the Lower Pecos region of Texas by Russ et al. (1992) were in general agreement with those expected on the basis of archaeological inference by Turpin (1990). Thus, we were encouraged to continue to test and further develop the argon/oxygen plasma technique in hopes of arriving at a reliable, accurate method for the direct radiocarbon dating of pictographs.

Experimental Technique

To extract the carbon from pictographs, we use a low-temperature, low-pressure oxygen plasma. We have constructed three independent plasma systems, with a fourth under construction which shares the liquid nitrogen sorption pumps with one of the existing systems. Experimental details are described elsewhere (Chaffee et al. 1993c) and are presented here only in general terms.

Oxygen plasmas have been used since the 1960s to react away the organic component of coal and other organic matter while leaving the mineral portions (including carbonates) unreacted (Gleit and Holland 1962; Gleit 1965; Hollahan 1966). The restrictions for radiocarbon dating on nonreactivity of carbonates in an oxygen plasma were, however, much more stringent than those for the coal studies. We therefore had to show that carbonate (and oxalate) decomposition was of no consequence for radiocarbon dating. Our experiments have shown that, under our operating conditions, none of these materials contributes significant carbon (fig. 2.1). Other practitioners of radiocarbon dating normally treat their samples with an acid wash to dissolve the carbonates, a precaution that is unnecessary with the plasma treatment.

We have taken several measures to minimize the possibility of contaminating the carbon being extracted. First, high-vacuum techniques are used to avoid contamination caused by adsorption of atmospheric carbon dioxide on the sample and chamber surfaces. Before inserting the pictograph samples, the plasma chamber is cleaned with a series of oxygen plasmas to remove potential organic contamination in the chamber itself. During the time the plasma chamber inlet port (a copper gasketed stainless steel flange) is open for sample loading, a positive pressure of high-purity argon is maintained to preclude the introduction of atmospheric carbon dioxide and/or air-borne organic contaminants to the plasma chamber. Once the sample is placed in the system and the entry port is sealed, the system is pumped down to high vacuum. Heat lamps shine on the sample and chamber walls to desorb carbon dioxide from the surfaces.

Oil-less vacuum pumps are used throughout to prevent oil back-streaming into the plasma system. As a final cleaning measure, the sample is subjected to an argon plasma. Because argon is a nonreactive gas, argon plasmas act as atomic sandblasters, dislodging any strongly adsorbed carbon dioxide molecules still remaining after vacuum pumping. Following this cleanup, the plasma system is tested to ensure that there are no significant leaks. When that test is passed, the sample and system are ready to begin the oxygen plasma extraction process.

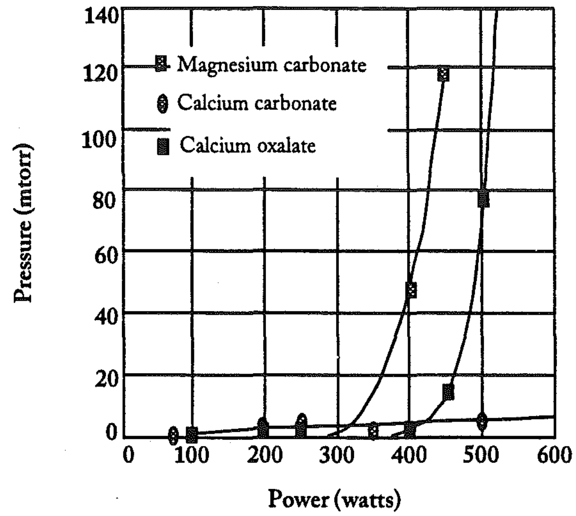

FIGURE 2.1 EFFECT OF DECOMPOSITION ON RADIOCARBON DATE. The decomposition of magnesium carbonate, calcium carbonate, or calcium oxalate has no significant effect on a radiocarbon date. No significant decomposition occurs at 100 watts, the standard operating power for the oxygen plasma.

The oxygen plasma operates at low temperature (less than 150°C) to oxidize all the organic material in a pictograph sample to gaseous carbon dioxide. The liberated carbon dioxide is collected in a glass tube at liquid nitrogen temperature (-192°C). The tube is then sealed off from the plasma system using a natural gas/oxygen flame. Radiocarbon dating of the carbon dioxide is conducted at the University of Arizona/National Science Foundation Accelerator Mass Spectrometry Facility. Typically, a second oxygen plasma extraction is performed to collect a backup sample, the sample is removed from the chamber, the system is closed, and the cleaning cycle is begun again. At its fastest, one pictograph extraction cycle takes a week; more typically, 3 weeks or more are required. The additional time can be attributed to difficulties in achieving good cleanup using oxygen and argon plasmas and pumping the initial vacuums to the requisite levels. Other determinations to check the background levels of various steps in the procedure, such as the amount of background carbon introduced by the argon plasma treatment or flushing the system with argon, can also take a few weeks to complete.

Results and Discussion

We looked for samples with narrowly constrained ages to cross-check our technique. One ideal sample with an accurately known radiocarbon content is the National Institute of Standards and Testing (formerly National Bureau of Standards) oxalic acid radiocarbon standard. Because it serves as the standard for radiocarbon measurements worldwide, it has the most frequently determined radiocarbon content of any material. However, an aliquot of the solid oxalic acid placed in our vacuum system slowly disappeared. We found that oxalic acid sublimes under the high vacuum of the chamber and therefore cannot be used to check the accuracy of the method.

We then obtained three samples of charcoal which had been previously dated by Beta Analytic Inc. (courtesy of Dr. M. Tamers). We subjected three portions of these samples to plasma chemical extraction and had the resulting carbon dioxide radiocarbon dated. In all three cases, satisfactory agreement was observed, as indicated in table 2.1. Two of the ages on the charcoal differed by less than 10 years from the Beta Analytic dates; the third date by the plasma technique was 125 years earlier than the Beta Analytic date, well within the one sigma standard deviations of the two values (± 75 years in each case). There is no reason to doubt the fundamental validity of the extraction procedure when the basal rock does not contain *organic* carbon.

We procured a sample of anthracite coal, whose geological age would indicate complete decay of the initial radiocarbon, to determine the possible background radiocarbon introduced by the oxygen plasma. Anthracite coal is not the best material for this purpose because it often has residual radiocarbon contamination that is difficult to remove. Petroleum would have been better, but we did not want to put a liquid hydrocarbon into the vacuum system for fear of serious contamination. Using the oxygen plasma technique on the coal, we obtained radiocarbon ages on three aliquots (table 2.1). The ages from two of the systems were sufficiently ancient, more than 41,700 BP. The results using the third system, 37,600 ± 1000 BP, indicated contamination of 0.9% modern (1950) carbon.

This background test was completed very early in the operation of the third system. We have since improved the procedure and the system and are preparing to measure radiocarbon-dead wood and charcoal samples supplied by John Southon of the Lawrence Livermore National Laboratory Accelerator Mass Spectrometer facility. These samples will provide more stringent tests than the initial ones, and we are confident that the results for background radiocarbon will be much lower than 37,600 BP.

Four separate samples of pictographs from the Lower Pecos region of Texas, all of the Pecos River style, have been radiocarbon dated (table 2.2). Five of the six aliquots dated fall near or within 3000 to 4000 BP, suggested by Turpin (1990A) as the range of ages expected for Pecos River-style pictographs based on archaeological inference. In one case, a follow-up oxygen plasma extraction released enough carbon dioxide to obtain a second radiocarbon age on the sample (41VV576-1a and 1b). In another, 41VV576-3, the sample was divided into two aliquots that were run separately (41VV576-3a and 41VV576-3b). For both sets, the extractions of the first of the series were thought to contain atmospheric contamination because the oxygen plasmas had a green tint indicative of nitrogen, the most abundant gas in the atmosphere. The ages of these two aliquots (41VV576-1a and 41VV576-3a) should be regarded as lower limits. No indication of the possible level of contamination was available. These samples were studied early on in our program, and we have since changed the systems and procedure so that atmospheric contamination is no longer a problem. The follow-up sample, 41VV576-1b, indeed resulted in the expected older age of 4200 BP compared to the lower limit on the first (1a) of more than 3355 BP. However, the duplicate of the 41VV576-3 sample (b) unexpectedly resulted in an age much less than the first: 1450 ± 75 BP for the second compared to more than 3000 ± 65 BP for the first. This unusually young age for a Pecos River style, particularly as the duplicate of a sample measured to be more than 3000 BP, is unexplained.

Table 2.1 Current status of known-age samples

Sample	Age or status	AMS number
Known-age charcoal	3665 ± 65 BP	ß-40497, ETH-7165
Beta analytic date	3655 ± 60 BP	(Tamers 1990)
Known-age charcoal	3285 ± 75 BP	AA-8357
Beta analytic date	3410 ± 75 BP	(Tamers 1990)
Known-age charcoal	3650 ± 75 BP	AA-8358
Beta analytic date	3655 ± 70 BP	(Tamers 1990)
Anthracite coal	46,800 ± 3100 BP	AA-8033
Anthracite coal	37,600 ± 1000 BP	AA-8241
Anthracite coal	46,000 ± 6000 BP	AA-8356
Expected age	*More than* 40,000 BP	

Table 2.2 Prehistoric pictograph dates from Texas and Utah

Sample	Age or status	AMS number
Texas, Pecos River style (expected ages 3000 to 4000 BP [Turpin 1990])		
41VV75-1	3865 ± 100 BP	ß-33586, ETH-5909
41VV576-1a	*More than* 3355 ± 65 BP*	ß-39107, ETH-6962
41VV576-1b	4200 ± 90 BP	AA-7063
41VV576-3a	*More than* 3000 ± 65 BP**	ß-39946, ETH-7047
41VV576-3b	1450 ± 75 BP	AA-8426
41VV50-3a	2950± 60 BP	AA-8699
Utah		
42SA1614-1a	755 ± 60 BP	AA-8359
42SA1614-1b	575 ± 70 BP	AA-8361

* Plasma abnormalities indicated possible atmospheric CO_2 contamination; thus, the ages represent lower limits.
** Contaminated with kerosene, presumably to enhance contrast for photography.

We are preparing an experiment with another sample of a Pecos River-style pictograph from the site of the original sample we dated, 41VV75. This sample will be divided into four aliquots: one-quarter will be run as usual; another quarter will also be run as usual; the remaining half will be thoroughly mixed and two equal aliquots will be dated. These four dates should yield more information on the reproducibility of the extraction technique for dating pictographs. Aside from the one unexplained low value (41VV576-3b), the ages of the Lower Pecos-style pictographs support the potential of the technique to provide accurate ages. Experiments planned for the near future should either confirm or deny our tempered optimism.

Another sample, from the All American Man pictograph at site 42SA1614 in the Canyonlands region of Utah, also supports our confidence (Chaffee et al. 1993a). The All American Man is a red, white, and blue shield figure associated with Pueblo II/III material remains (structural features, ceramics, and so forth). Nancy Coulam, Canyonlands National Park archaeologist, and Kathleen Hogue, Arches National Park conservator, asked us to date this enigmatic graphic. The sample they supplied came from a charcoal-pigmented portion of the pictograph, an area that appears blue. Under a microscope, the pigmented surface is an intimate mixture of charcoal and minute white particles of calcium oxalate and bassinite, a calcium sulfate mineral similar to gypsum. Whether these white particles were intentionally mixed with the charcoal to make a blue paint for kiva mural decorations, as documented by Smith (1952), is not known. These sulfate and oxalate minerals occur naturally on sandstone surfaces in the region and could be a natural deposition intermixed with the charcoal *after* the paint was applied.

During the extraction procedure, the charcoal pigment disappeared as the oxygen plasma was run. After 1 hour, the carbon dioxide produced was sealed in a glass tube for AMS dating. The plasma was then continued for an additional 3 hours; once again enough carbon dioxide was produced to allow radiocarbon dating. The two ages obtained, 755 ± 60 and 575 ± 70 BP, are considered to be in satisfactory agreement according to the agreed-upon standards of radiocarbon dating. The calibrated age range of AD 1275 to 1400, obtained by the intercept method based on the weighted average of the two radiocarbon dates (675 ± 50 BP), was calculated using the University of Washington Radiocarbon Calibration Program, CALIB, version 3.0 (Stuiver and Reimer 1993). The age of the pictograph expected on the basis of its association with Anasazi material remains was approximately AD 1000–1300. Agreement between the expected age and the measured age is adequate to once again give us confidence that the extraction method is valid.

Conclusions

The technique reported here is applicable to all pictographs as long as organic material was incorporated into the paint by the prehistoric artists. The dates presented were obtained on samples pigmented with red iron oxides (41VV75-1, 41VV576-3, 41VV50-3), black manganese oxide (41VV576-1), and charcoal (the All American Man, 42SA1614-1). No charcoal was used in the samples from the Lower Pecos (41VV samples), and it is not known whether the same organic material in the binder/vehicle was used in the red and the black paints. Unfortunately, the major advantage of the technique, that it can extract carbon from any organic matter, is also its major disadvantage: carbon will also be extracted from any organic contamination present. Great care must be taken to make sure that the sample is free of contamination, which is not always possible. We have found that sandstone from Utah, at least in Horseshoe Canyon, contains a background level of organic material high enough to rule out useful radiocarbon dates by our technique, unless charcoal is used as a pigment, which rarely occurs (Chaffee et al. 1993c). No other direct method can be applied to pictographs painted on this type of organic-bearing rock. However, when organic-containing rocks are avoided, the plasma method produces reliable radiocarbon ages for pictographs.

Acknowledgments

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3 Dating Petroglyphs with a Three-Tier Rock Varnish Approach

RONALD I. DORN

ROCK VARNISH is of interest to archaeologists because it accretes on stone surfaces that have been worked by humans. Within the past decade, more than a dozen new approaches to the dating of rock varnish have been explored (table 3.1). Of these, only three have seen widespread application: accelerator-radiocarbon dating, cation-ratio (CR) dating, and analysis of the development of layers in rock varnish. This chapter stresses the importance of using several different techniques in tandem. This approach allows the researcher to place greater faith in results that agree, or allows the research to isolate anomalies. As new varnish dating techniques are developed, further cross-checks will be made available.

In this chapter, the types of rock varnishes and why it is critical that the right type of varnish be sampled for dating are discussed. Then, the different dating techniques are explored. Last, examples of applications of petroglyph dating are given to show how different techniques are used in tandem.

Not All Rock Varnishes Are Alike

Typically less than 200 µm thick, rock varnish is analogous to a brick wall. The "bricks" in the varnish are composed of clay minerals cemented to the underlying rock by the "mortar" of oxides of manganese and iron (Potter and Rossman 1977, 1979). A common misconception is that rock varnish derives from the weathering of the underlying rock. Rock varnish is an accretion whose chemical and morphological characteristics are distinct from the underlying substrate (Dorn and Oberlander 1982; Perry and Adams 1978; Potter and Rossman 1977).

Beyond these generally agreed upon characteristics, rock varnishes differ greatly in structure and chemistry at all scales from kilometers to micrometers. Great differences exist among varnishes of different colors, among varnishes of similar color found in subaerial and nonsubaerial environments, and even among varnishes found in different types of subaerial environments. A field- and laboratory-based classification of rock varnishes is presented in table 3.2. Because this chapter concerns the dating of black (manganese-rich) varnishes found in a subaerial environment in drylands, table 3.2 emphasizes these varnishes.

Black varnishes are black because the upper few microns are greatly enriched in manganese, typically more than 10 percent MnO (Dorn and Oberlander 1982). Orange varnishes (Munsell 10R4/8, 2.5YR4/6 to 5/6, and 5YR7/6 to 7/8) generally have MnO concentrations of less than 0.2 percent throughout. Dusky brown varnishes (Munsell 10R3/3 to 4/4) are intermediate in surface chemistry: they have enough manganese to darken the color (in the range of approximately 0.5 to 5 percent), but not enough to give the varnish a black appearance.

Manganese-rich varnishes that do not form in contact with the atmosphere have different structures from subaerial varnishes (Dorn and Oberlander 1982; Dorn 1986). Trace element chemistries also differ. For example, varnishes that originally developed in rock crevices, but have been exposed by rock spalling, have much higher levels of barium than varnishes formed only in a subaerial environment. These elevated levels are caused by water being retained in these microenvironments for longer periods of time, and the manganese mineral that forms in even slightly mesic environments incorporates barium in the structure.

Even different types of subaerial black varnishes have very different stable isotope compositions (Dorn and DeNiro 1985), different manganese concentrations (Dorn 1990; Jones 1991), different micromorphologies (Dorn 1986), different degrees of interdigitation with silica skins (Dorn, Jull et al. 1992), different backscatter textures (Krinsley et al. 1990), and different trace element concentrations.

These differences are no trivial matter. Even geomorphologists who are new to rock varnish research have confused different types of varnishes (for example, Harrington et al. 1991; Reneau and Raymond 1991; Bierman and Gillespie 1992b; Watchman 1992). It is an easy, but important, error. Determining the way in which varnish originally formed is critical to obtaining a reliable varnish age. Archaeologists are interested in knowing when a surface was pecked or flaked by humans. If a rock surface has spalled or been exposed by soil erosion, the newly exposed varnish does not date the event of interest. Similarly, erosion of varnish by biochemical (for example, lichens) or mechanical (for example, wind abrasion) processes can yield inaccurate ages, as demonstrated in prior tests (Dorn 1989; Dorn, Jull et al. 1989). Identification of the right type of var-

Table 3.1 Methods of estimating age of rock varnish formation

Method	Theory	Precision level*	Indicator	Comments
Appearance	Varnish darkens over time	Relative	Subjective appearance	Controlled by factors other than time
Thickness	As varnish gets older, it grows vertically	Relative	Measurement with microscope	Also controlled by microenvironment
Cover of black surface varnish	Varnish grows laterally away from nucleation centers	Relative	Visual estimate of percent cover on exposed clasts	Derbyshire et al. 1984
Orange bottom varnish growth	As age increases, undersides of clasts are coated with Fe-clay rock varnish (Mn-poor)	Relative	Percent of clasts in desert pavement that have cover of orange bottom varnish	Derbyshire et al. 1984
Trace element trends	Assumes varnish derived from underlying rock; trace element profiles with depth reflect time	Relative	Scraped layers of varnish and underlying rock. Measured by neutron activation analysis	Bard 1979
Metal scavenging	Zn, Cu, Ni, and other metals increase over time as they are scavenged by Mn-Fe oxides	Relative	Concentration of trace heavy metals relative to Mn and Fe	Dorn, Jull et al. 1992
Paleomagnetism	Magnetic field aligned when Fe-oxides precipitate	Correlative	Profiles of paleomagnetic properties with depth	Clayton et al. 1990
Tephra-chronology	Glass fragments from known volcanic eruptions might be identifiable in rock varnish	Correlative	Possible tephra found in varnish but requires glass identification and geochemical correlations	Harrington 1988
Varnish layers	Sequences of chemical and textural changes correlated from site to site.	Correlative	Mn:Fe, Pb, $d^{13}C$, and textures	Dorn 1988, 1992b, 1992c
Stratigraphy	Dating material on or under varnish constrains varnish age	Correlative; Numerical	Radiocarbon dating of carbonate formed over varnish	Dragovich 1986
Cation ratio	Mobile cations are leached faster than immobile cations	Calibrated	Elemental ratio of (K+Ca)/Ti	Dorn 1989; Dorn, Cahill et al. 1990
K-Ar dating	As varnish clays accumulate, they may undergo diagenesis that refixes K; or date K in Mn-oxides	Numerical	K-Ar dating of radiogenic argon in varnish clays; ^{40}Ar-^{39}Ar of Mn-oxides	Dorn 1989; Vasconcelos et al. 1992
Uranium-series	Uranium precipitates with Mn-oxides and then decays	Numerical	U/Th measurements	Knauss and Ku 1980
Radiocarbon	Accreting varnish encapsulates underlying organic matter	Numerical	Accelerator mass spectrometry radiocarbon dating	Dorn, Clarkson et al. 1992

* Relative, correlative, calibrated, and numerical are Quaternary dating terms developed by Colman et al. (1987). "Absolute" is no longer advocated as a dating term.

nish for dating starts in the field, but it must be verified in the laboratory with studies of cross sections (for example, Krinsley et al. 1990). Testing the wrong types of varnish leads to wrong ages and only results in misunderstanding.

Sample Collection

As in any Quaternary dating method, the most important step is collecting the right type of sample in the field and testing it in the laboratory. My sample collection philosophy has been to avoid specific varnish characteristics and microenvironments that have produced results that are inconsistent with independent age controls. This approach is the result of years of discovering errors and refining the collection procedure. In summary, only subaerial varnishes are sampled, and then only the subaevial varnishes that do not have the characteristics listed in table 3.2. Then, the sample *must* be examined in the laboratory (Dorn 1989; Dorn et al. 1989; Krinsley et al. 1990; Dorn et al. 1992). Certainly for petroglyphs, it is easy and of minimal impact to sample a very tiny millimeter-sized sliver of varnish immediately adjacent to (or above) the spot being sampled for dating.

A critical factor in sampling petroglyphs for dating is the

Table 3.2 Different types of rock varnishes

I. *Black(Mn-rich) varnish*
- A. In Drylands
  - 1. Subaerial positions that occur:
    - Interdigitated with silica skins
    - Where water runoff occurs
    - Where water collects
    - With microcolonial fungi
    - With lichens
    - With filamentous fungi
    - With cyanobacteria
    - Where organic matter collects
    - Where dust collects
  - 2. Subaerial varnishes that contain:
    - Infilled erosional pits
    - Fractures refilled with Mn-Fe
    - Internal deformation of layers
    - Evidence of aeolian abrasion
    - Anomalous concentrations of K, Ca, Ti, Ba
    - pH values <6 and >9
    - Abundant botryoids
  - 3. At or within 10 cm of soil surface
    - Ground-line band in pavement
    - With cryptogamic soils
    - Where soil has been eroding
    - Where soil has accumulated
  - 4. Crack varnish
  - 5. Former crack varnishes exposed by recent spalling:
    - On talus
    - By cm-scale flaking
    - By granular disintegration
  - 6. Fractures in bedrock
  - 7. Underside of pavement cobbles
  - 8. Paleosols
- B. Outside Drylands

II. *Orange (Mn-poor) varnish*
(Munsell 10R4/8, 2.5YR4/6 to 5/6, 5YR7/6 to 7/8)
- A. In Drylands
  - 1. Crack varnish
  - 2. Bottom sides pavement cobbles
  - 3. Subaerial position
  - 4. Fractures in bedrock
  - 5. Paleosols
- B. Outside Drylands

III. *Dusky brown varnish*
(Munsell 10R3/3 to 4/4)
- A. In Drylands
  - 1. Crack varnish
  - 2. Bottom sides pavement cobbles
  - 3. Subaerial position
  - 4. Fractures in bedrock
  - 5. Paleosols
- B. Outside Drylands

realization that any spot of varnish will not do. Varnish should be sampled from micropositions where varnish first starts to grow, not from places where varnish started to form thousands of years after petroglyph manufacture. Ongoing studies of historical rock engravings and stones faced during historical construction reveal that colonization occurs after about 100 years—typically in small depressions and microfractures (Dorn 1989; Dorn et al. 1992).

When a new dating method develops, investigators often have their own approaches to sample collection. This is the case in rock varnish research. Some investigators note that they avoid obvious features like lichens or places where aeolian abrasion occurs (for example, Glazovskiy 1985; Zhang et al. 1990). Others indicate that they collect only "the darkest, smoothest varnishes from each locale" (Reneau et al. 1991; Reneau and Raymond 1991) or from "outcrops possessing the darkest, most consistent varnish at each site" (Raymond et al. 1991). Some work with unlayered varnish (Watchman 1992). Unfortunately, not all varnish researchers specify the type(s) of varnish they have analyzed (Pineda et al. 1988; Harrington et al. 1991).

The lack of quality control in sample collection has led to inaccurate comparisons in the published literature. Certainly, there is no evidence to indicate that any two varnish investigators have analyzed the same types of varnishes. This is not to suggest that data from any particular investigator(s) are invalid or unrepresentative of the type(s) of varnish analyzed. To the contrary, when varnish type is factored in, results among different groups appear to be consistent. Because varnish methods are in an infant stage of development, I urge investigators to specify the type(s) of varnish being analyzed in as detailed a fashion as possible. Until this occurs, readers interested in varnish studies need to be aware that "apples and oranges" are often compared, and often unknowingly.

Varnish Radiocarbon Dating

Radiocarbon dating is the most accurate and precise method of determining when rock varnish starts to grow, yet considerable uncertainties remain

Source of dated organic matter.

The creation of petroglyphs exposes a new rock surface by humans. An exposed rock surface is an open system with respect to the accumulation of organic carbon. New carbon is continually being added through the growth of organisms (fig. 3.1) and the deposition of organic detritus (Ketseridis et al. 1976; Simoneit et al. 1981). Some organisms are endolithic and chasmolithic (for example, Friedmann 1980, 1982; Dahlquist and Sommerfeld 1991), and some are epilithic (Cooks and Fourie 1990). The rock surface community may include lichens, fungi, bacteria, mosses, cyanobacteria, and algae (Jones and Goodbody 1982; Danin 1983).

Organic matter accumulates both at the surface and in a developing weathering rind. (Archaeologists frequently use the term "cortex" to describe what geomorphologists and soil scientists refer to as a weathering rind [for example, Chinn 1981].) As organisms die, some material remains in pockets and fractures (fig. 3.1). The net effect is an organic accumulation that is a mixture of new and old carbon—all of which presumably postdates the formation of an archaeological surface, and the development of a new varnish coating over this surface.

Dating organic matter that has been trapped underneath

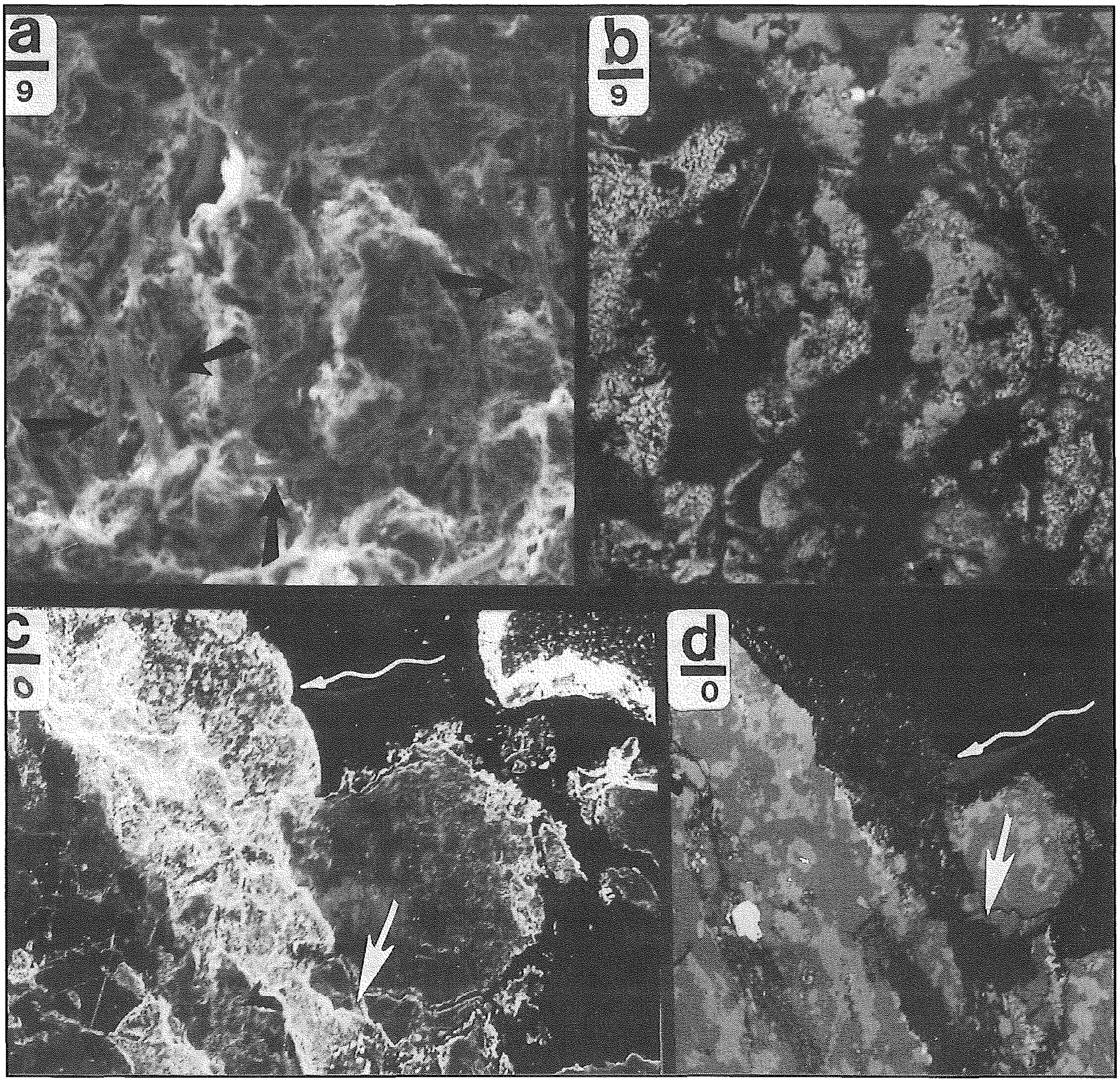


FIGURE 3.1 SCANNING ELECTRON MICROSCOPE VIEWS. Penetration of organic matter into weathering rinds is shown. Two types of SEM micrographs are used throughout this chapter. One is produced by secondary electrons (SE) and images topography. The other is produced by backscatter (BSE) and images net atomic number (Krinsley and Manley 1989). *a,* SE image and *b,* BSE image of weathering rind about 1 mm underneath the rock varnish of petroglyph WH5 from the Wharton Hill site in South Australia (Dorn, Clarkson et al. 1992). The arrows in *a* show what are probably fungal filaments, part of a mat of organic matter in the weathering rind. Yet in *b* the organic matter appears black because of its low atomic number. This contrast is typical of secondary electrons and backscatter secondary electrons: what is bright in the secondary electron image and is definitely present, but is black in the backscatter secondary electron image, has a low atomic number and is organic matter. The brighter mineral material (almost all silica, except for a small bright piece of iron) in *b* appears etched, owing to chemical weathering, and is characteristic of weathering rinds. *c,* SE image and *d,* BSE image of slightly different scales of the same view of an epilithic lichen penetrating into sandstone in the Phoenix region (sample collected by T. Paradise). Arrows show the exact same position. The lichen in *c* appears bright (because of charging) and in *d* black or composed of small dots (calcium oxalate in the lichens). The lichen not only grows on the surface (wiggly arrow) but also penetrates into the underlying rock (larger arrow). As is the case in all SEM micrographs, the scale is indicated in micrometers below the bars. Scales are in μm.

rock varnish is analogous to dating fragments of organic matter in a paleosol (fig. 3.2). Before burial, the soil is an open system with respect to organic carbon; new carbon is continually being added, while some older carbon is retained. "Mean residence time" radiocarbon measurements on soil organic matter (Birkeland 1984) provide an indication of the cycling of carbon in a soil. Similarly, radiocarbon ages for organic matter on a rock surface and in a weathering rind should indicate the cycling of carbon in a rock surface. Unfortunately, little data exist concerning the rates of carbon cycling of this material.

Models of dating organic matter in rock varnish

The first conceptual model for the radiocarbon dating of petroglyphs with rock varnish was presented in Dorn, Jull et

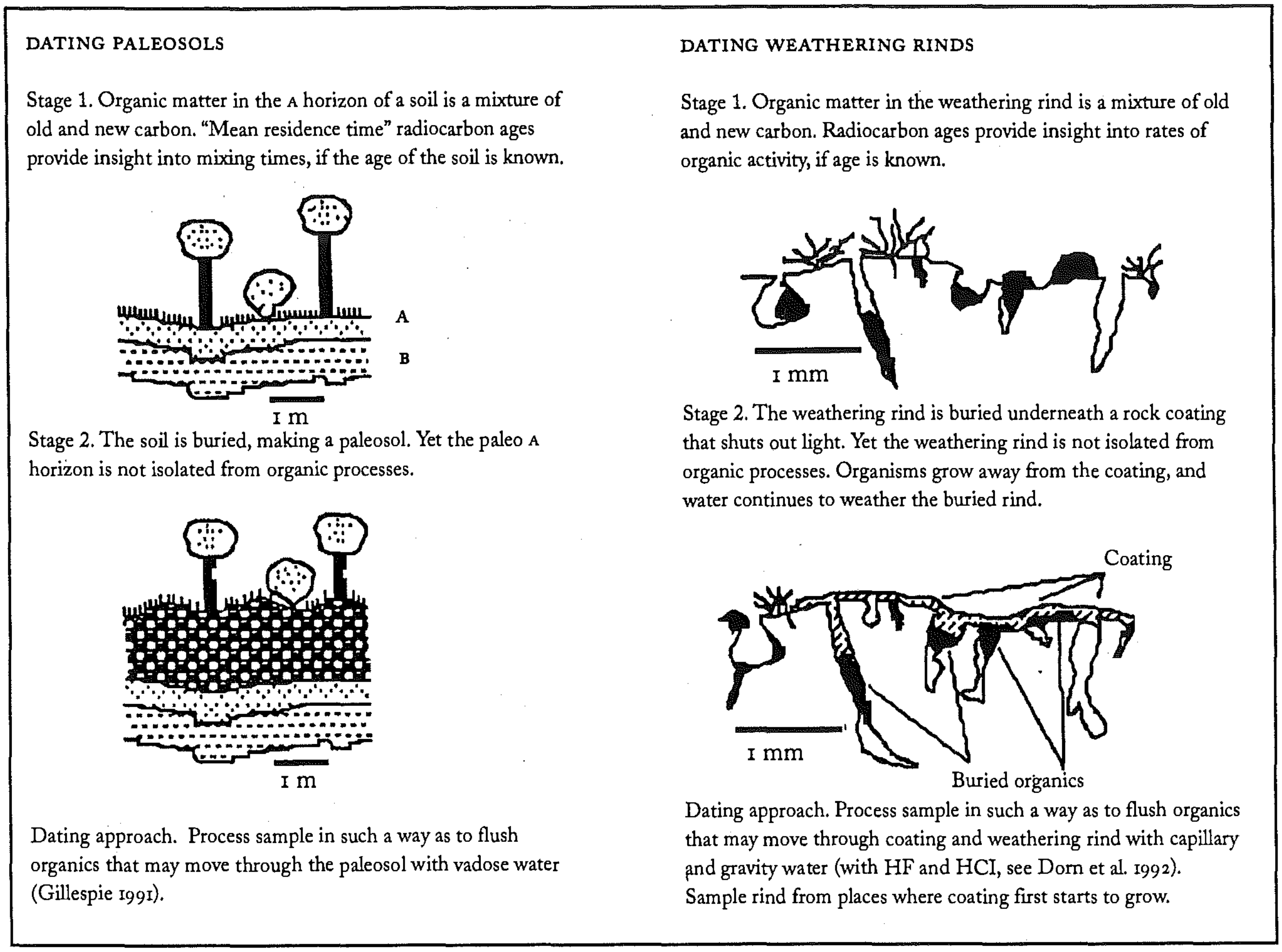


FIGURE 3.2 DATING PALEOSOLS AND WEATHERING RINDS. Analogy between dating organic matter in paleosols and dating organic matter encapsulated by rock varnishes.

al. (1989). In this model, first a petroglyph is made (from a dating perspective, this task cleans off the old varnish). Second, varnish starts to grow, incorporating organic material in the oxide structure and within the varnish. Third, researchers sample the bottom layer of the varnish (and the rock immediately underneath) and extract organic matter. This model was found to be inaccurate because comparatively little organic material is found within the varnish; actually, organic material trapped underneath the accumulating varnish was dated (Dorn, Clarkson et al. 1992).

A second conceptual model was presented in Dorn, Clarkson et al. (1992). First, a petroglyph is made. Second, organic matter begins to accumulate. Third, the growth of rock varnish encapsulates the organic matter (fig. 3.3) that is later extracted and radiocarbon dated by accelerator mass spectrometry (AMS) (see Linick et al. 1989). This conceptual model is still sound, but it must be modified to account for uncertainties associated with organic matter in weathering rinds that are found underneath the varnish.

It is first necessary to discuss the nature and age of organic matter in a surface environment, prior to the coating of the surface by rock varnish, oxalate, amorphous silica, pigment, or some other agent. I am aware of only three examples in which radiocarbon ages are available on organic material in weathering rinds that have not been coated:

Example 1. Filaments were sampled from a dead crustose lichen. The "roots" of the epilithic lichen had penetrated into the weathering rind of a cobble, where the cobble was exposed at the surface during the manufacturing of a quadraped geoglyph along the Colorado River. The AMS ^{14}C age for this dead lichen material is 205 ± 55 BP (AA-6902), where HF and HCl were used to pretreat the sample. On different cobbles from the same geoglyph, organic matter was extracted from underneath rock varnish. An older age of 1145 ± 65 BP (ETH 6575; Beta 37036) was obtained from the HF-HCl extracted organic matter (see Dorn, Clarkson et al. 1992). This result is consistent with a model in which uncoated organic matter is still in an "open system" that should postdate coated organic matter, even though rock surface exposure was virtually identical.

Example 2. Uncoated organic matter from the upper 3 mm of a weathering rind was extracted from petroglyph WH1, a possible *Drominorthid* track, from the Wharton Hill site in South Australia (see Dorn, Clarkson et al. 1992). The HF-HCl extractable AMS ^{14}C age of this organic matter is 687 ± 84 BP (NZA 2275). In other parts of the petroglyph, a coating of rock var-

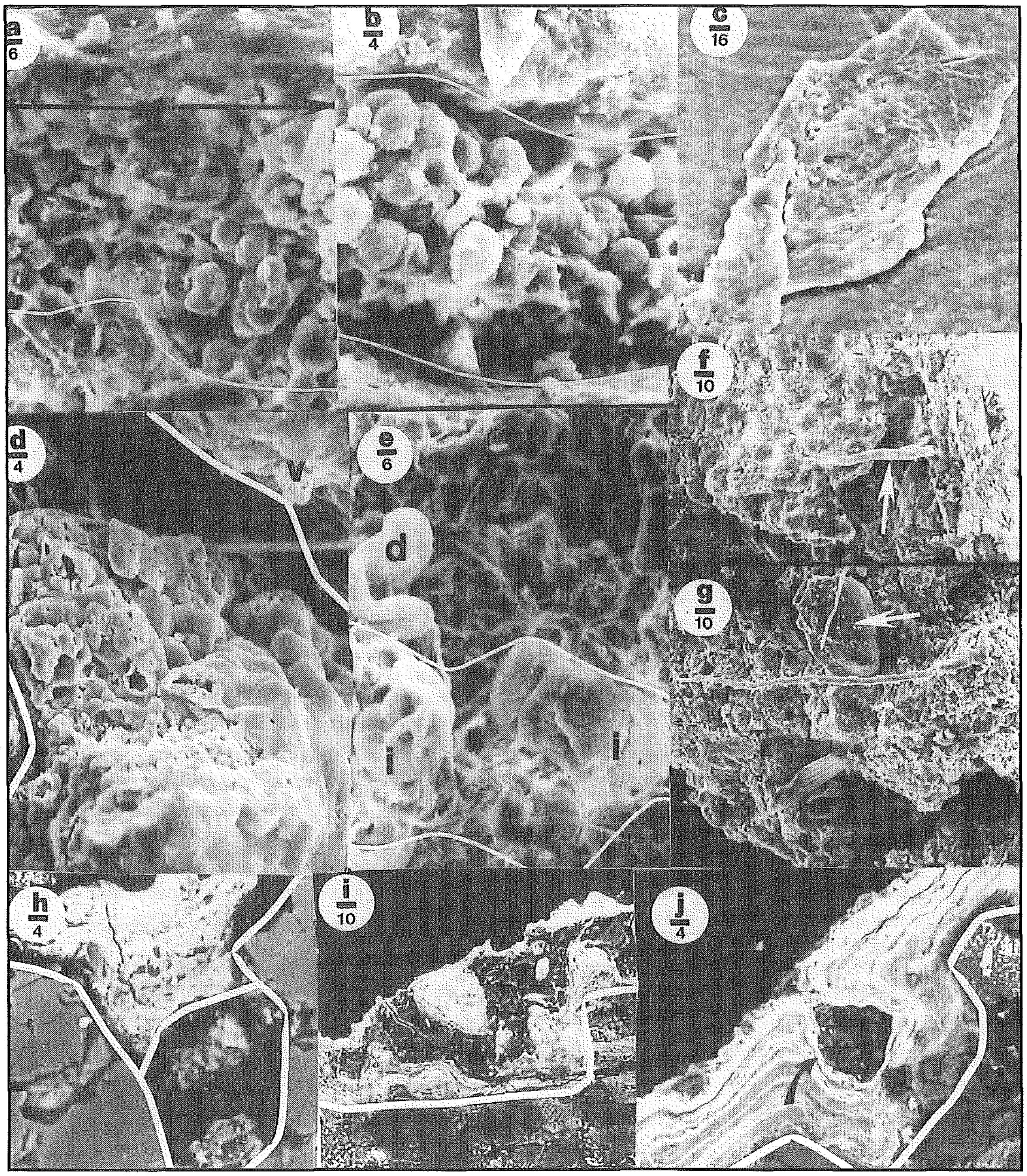
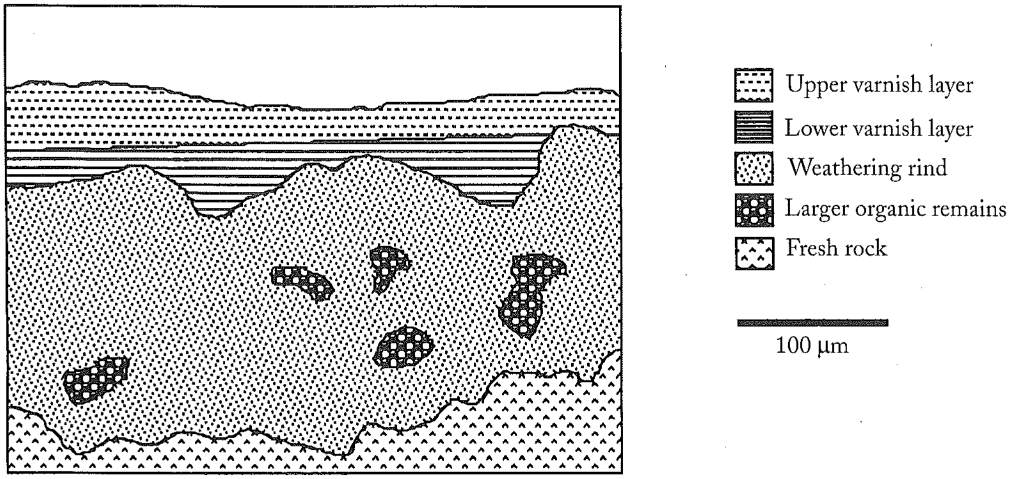
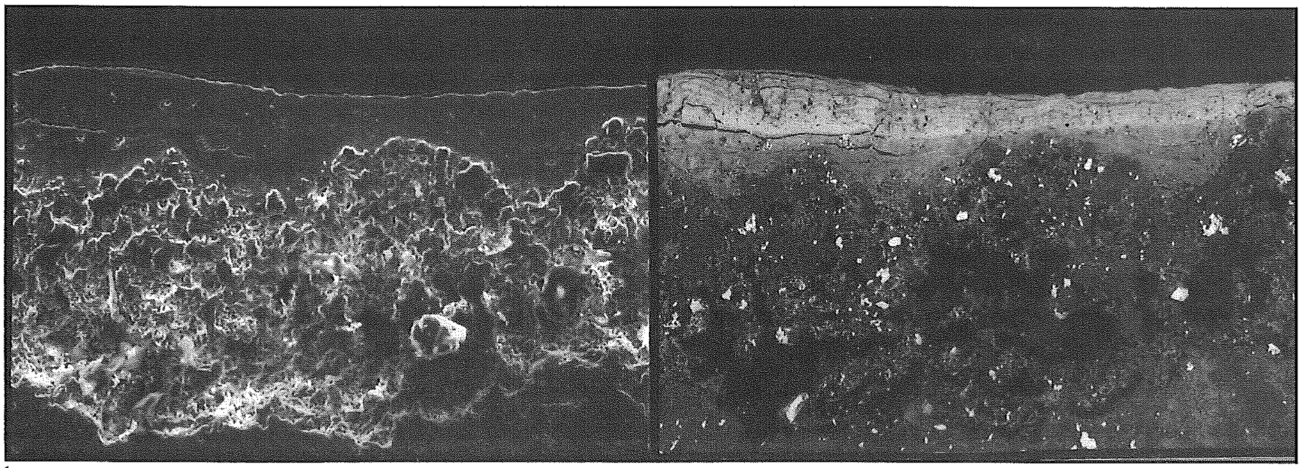


FIGURE 3.3 SUBVARNISH ORGANIC MATTER SEEN IN ROCK VARNISH CROSS SECTIONS. These are scanning electron microscope images. The organic matter-rock boundary is underneath. In images *a* –*d* and *h*, the upper line separates the varnish from the subvarnish organic matter. In *i* and *j*, the line separates varnish and rock. Organic matter was distinguished by morphology, low counts with energy-dispersive analysis of X-ray, very low characteristic varnish peaks (for example, manganese, iron, silica, and aluminum) in spot X-ray analyses, and the similarity of these spectra to organic matter resting on the surface of rock varnishes. *a,* Organic matter under varnish on cobble from a geoglyph in Nazca, Peru. *b,* Organic matter under varnish from South Australian petroglyph K24. *c,* Mat of subvarnish organic matter removed from South Australian petroglyph H5. *d,* Organic matter under rock varnish (upper right) and on top of rock (lower left) from cobble in a Colorado River geoglyph. *e,* From Mojave Desert artifact 85-8, where the organic matter and varnish formed in a vesicle-like feature. The letter "i" indicates organic matter (perhaps pollen grains) imbedded in the varnish, and the letter "d" identifies a grain that may have become detached during sample preparation and may not be in situ . *f,* Subvarnish organic matter attached to a rock fragment scraped from South Australian petroglyph K23. Arrow indicates an organic filament attached to an organic mat. *g,* Subvarnish organic matter scraped from South Australian petroglyph K26. The arrow points to a fragment of underlying rock still attached to the organic matter. *h,* BSE micrograph of polished cross section of varnish, from South Australian petroglyph WH1. *i,* BSE image of polished cross section of South Australian petroglyph K15, illustrating abundant silica skin (electron microprobe measurements indicate content of approximately 91 percent silica dioxide) interlayering with brighter rock varnish. *j,* BSE of polished cross section of South Australian petroglyph WH5, illustrating an unusual example of organic matter that is not subvarnish (indicated by arrow) but has been incorporated as varnish and accreted in layers. Scales are in micrometers. Scales are in μm.



a



b c

FIGURE 3.4 GENERALIZED MAP CORRESPONDING WITH IMAGES BY SECONDARY ELECTRONS AND BACKSCATTER SECONDARY ELECTRONS OF VARNISH AND THE UNDERLYING WEATHERING RIND. *a,* Map of polished cross section. *b,* Secondary electron micrograph (topography is imaged). *c,* Backscatter electron micrograph (brighter material indicates higher net atomic number). Sample collected by T. Liu from a boulder on Starvation Canyon alluvial fan in Death Valley, California.

nish and silica glaze had formed over the weathering rind. The HF-HCl extractable organic matter, also from WH1, that had been encapsulated by the silica glaze and rock varnish yielded a much older age of 14,910 ± 180 BP (NZA 1367) (Dorn, Clarkson et al. 1992). Again, this result is consistent with the model in which uncoated organic matter is an open system, but the clock can start when organic matter is coated.

Example 3. WH5 is an oval petroglyph from the Wharton Hill site in South Australia (see Dorn, Clarkson et al. 1992). A thick rock varnish coats most of the engraving. In a small part of the petroglyph, however, the weathering rind had spalled off sometime in the past, leaving a few centimeter-sized patches of exposed rock. Some discontinuous and patchy rock varnish had reformed over the spall. The HF-HCl extractable ^{14}C age of organic matter in the upper 5 mm of a weathering rind from this spall is 4162 ± 41 BP (NZA 2154). Radiocarbon ages are also available for the portion of the weathering rind that never spalled. The radiocarbon age for just the weathering rind (that was coated by a thick varnish), at an approximate depth of 3 to 5 mm below the varnish cover, yielded an age of 35,530 ± 650 BP (NZA 2361). This example is consistent with the model in which new organic matter is added to a reexposed weathering rind; this example also demonstrates that coated organic matter can be in a closed system where less than 2 percent ^{14}C occurs. (An illustration of this microspalling is presented in Appendix 3a and the dating of WH5 is discussed later.)

These examples, although limited, highlight five general concerns that can potentially influence the radiocarbon dating of rock art, whether the organic matter is associated with rock varnish, pigment, oxalate, amorphous silica, or other material:

Organic carbon in the matrix of the rock. Some rocks contain organic carbon, and different rocks have different concentrations of organic carbon. Carbon is most abundant in rocks with clays (Parker 1967; Timofeyev et al. 1980), but there is uncertainty concerning the carbon content of such igneous rocks as basalts and granites. Some researchers claim they contain 100 to 300 ppm (Vinogradov 1962), while others estimate almost no carbon (Turekian and Wedepohl 1961). Often, the amount of organic carbon measured is a function of the procedure (see Timofeyev et al. 1980).

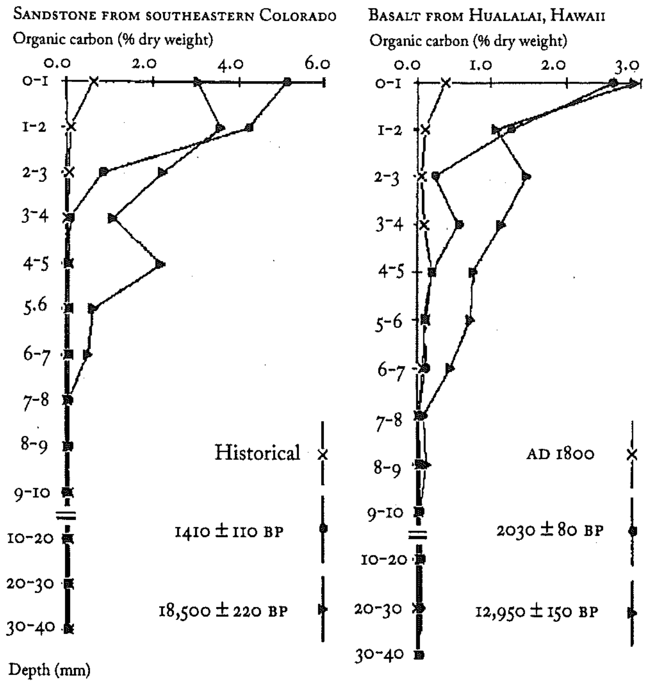


FIGURE 3.5 DEPTH PROFILES OF ABUNDANCE OF ORGANIC CARBON IN SUBAERIAL WEATHERING RINDS. Samples are from southeastern Colorado (Loendorf 1991) and Hualalai, Hawaii (Dorn et al. 1992). Samples were collected from surfaces either historic in age or with indicated radiocarbon ages that are described in Dorn et al. (1991) and Dorn, Jull et al (1992). Organic carbon is determined by the method described in Dean (1974). Results are given in percent dry weight. A surface area of 0.4 m² was scraped to different levels, starting with the top of the varnish and ending at a depth between 30 and 40 mm below the original rock surface. The organic carbon content of the top of the historic rock surface in southeastern Colorado is 2.06 percent and 1.05 percent for the AD 1800 lava flow in Hawaii. The organic carbon content for the top of the varnish (including organisms currently growing on the varnish) was 4.77% for the 1410 BP sandstone site, 3.43 percent for the 18,500 BP sandstone site, 3.16% for the 2030 BP basalt flow, and 1.85 percent for the top of the 12,950 BP flow. The organic carbon content for the rest of the varnish (not including the top layer) from these sites is 0.54 percent, 0.66 percent, 1.25 percent, and 0.84 percent, respectively. Because this was a study of organic matter in weathering rinds, no attempt was made to constrain the samples to only layered varnishes.

Any organic carbon in a rock matrix could potentially contaminate the radiocarbon signal in the rind through the addition of "dead" carbon. Fortunately, the amount of potentially contaminated rock matrix can be tested by sampling the unweathered rock at places well below weathering rinds. First, a sample of the unweathered control is examined in thin section or cross section to assess whether it is truly unweathered. Second, the control sample is subjected to the same procedure used to extract carbon from the rind. For example, in the aforementioned case studies, no HF-HCl extractable organic carbon in the rock matrix could be recovered, even though the control samples were more than twenty times the dry weight of the weathering rind samples. The key is using the same extraction procedure for both the weathering rind and unweathered rock.

Lag time between surface exposure and organic matter accumulation. I have collected and measured detrital organic carbon in dust on rocks exposed only for hours. Certainly, the amount of time required for organisms like lichens to grow is considerably greater, and it varies among environments. It also probably varies over time; in a desert, for example, a more moist climatic period would favor the colonization of lichens that could not grow in a drier period (Danin 1983). The lichenometry literature is full of examples of the lag time between exposure and lichen colonization, where it is felt that the "rate of establishment is normally related to the time when thalli first become visible and this is usually in the range of 10-20 years" (Worsley 1990).

The implications are two-fold. First, the radiocarbon age on organic matter in a weathering rind would always yield a minimum age for the exposure of the rock surface to weathering (as long as there is no measurable organic carbon in the rock matrix). Second, although the radiocarbon age for an active rind would reflect a combination of time and cycling rates, not enough is known about cycling rates in an active rind to obtain an age.

Location of sampling. The biogeography of organisms growing on a rock surface and into a weathering rind is poorly understood. Yet, the timing and manner of growth on a rock surface is most relevant to the dating of a weathering rind. For example, if a portion of a weathering rind had not been colonized for several thousands of years, it would yield an older radiocarbon age than a portion of a weathering rind with an actively growing association of organisms. This issue is analogous to sampling organic matter in a soil. A location in which a desert scrub plant with active roots is now growing would yield a younger "mean residence time" radiocarbon age than a spot where roots last grew thousands of years ago.

Timing of a "sealing" event. The development of a rock varnish coating can stop the penetration of organic material into a weathering rind (figs. 3.3 and 3.4). This is analogous to burial of a soil; the development of an A horizon stops and the solum becomes a paleosol (fig. 3.2; Birkeland 1984). This is not to say that weathering of paleosol material or a weathering rind stops when burial takes place. Vadose water continues to flow through a paleosol, and capillary water continues to flow through a weathering rind. However, the nature and processes of organic diagenesis change.

Exfoliation of a weathering rind. Weathering rinds are unstable (for example, Friedmann 1982). When portions of the weathering rind spall, the overlying rock coating erodes with the rind. Sometimes the coating grows back on top of the eroded rind,

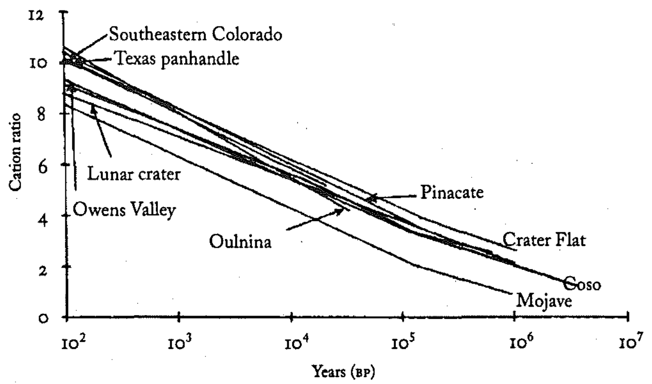


FIGURE 3.6 CATION-LEACHING CURVES. These curves were constructed by PIXE analyses of rock varnishes removed from surfaces of known age. Sites for the different curves are described in Dorn et al. (1988) for the Oulnina curve in South Australia and in Dorn (1989) for the other sites in western North America.

as a partial coating did in example 3. In other circumstances, the grain-by-grain disintegration of the rock material is too rapid to permit regrowth of the coating. The implication for radiocarbon dating is that new organic matter is added upon reexposure of the weathering rind. I must emphasize to those interested in dating organics encapsulated by rock coatings that microspalling is a very realistic and a very likely source of error, especially for those inexperienced in sampling.

Assumptions for radiocarbon dating petroglyphs

How does the above relate to archaeology and rock art dating? The model of organic matter encapsulation is critical to interpreting the ^{14}C age measured by AMS. The current model has a series of assumptions that must be met for radiocarbon dates of organic material associated with rock art to be used in archaeology. These assumptions are outlined next, and uncertainties associated with them are indicated:

1. A cultural process exposes a new surface to the atmosphere. (This is the petroglyph manufacturing event that is of interest.) Uncertainties associated with this first assumption can be controlled in specific tests.
   a. All the previous weathering rind must have been removed. In the case of petroglyphs, the necessary depth of removal must be checked by examining the adjacent natural surfaces. Figure 3.5 shows examples of depth profiles of organic matter in weathering rinds of varying ages and in different rock types. For a petroglyph to be dated, the previous weathering rind must have been removed when the petroglyph was made. If the previous weathering rind was not removed, carbon contamination would derive from the older, previous rind. One implication is that shallow "scratched" petroglyphs, for example, may not be radiocarbon dateable.
   b. The underlying rock must have no organic carbon (or concentrations too small to contaminate the sample). As noted before, this concentration can be tested by examining the unweathered rock material.
   c. The processing method does not include in situ ^{14}C. In situ ^{14}C is not organic radiocarbon but radiocarbon in the mineral structure that is produced by cosmic rays interacting with mineral material in the upper meter of the earth's surface (Jull et al. 1989). Fortunately, the concentration of carbon is extremely low at low altitudes, and an extraction technique that excludes in situ ^{14}C can be used.
2. The organic matter added to the cultural surface is contemporaneous with it. In other words, older carbon (carbon with an ancient radiocarbon age) is not incorporated into the surface organic matter. This applies to both organic matter that penetrates into the weathering rind (figs. 3.1 and 3.4) and organic matter found at the surface (figs. 3.1 and 3.3). The contemporaneity of the organic matter, when it is added to a rock surface, has not yet been fully explored by radiocarbon dating specialists. It is possible to envision hypothetical scenarios in which ancient organic matter comes to rest on a rock surface, perhaps bits of soil organic matter, fossil pieces of pollen deflated from ancient lake sediments, or bits of ash from a fire that burned ancient wood, all of which, *theoretically*, are possible contaminants. A complete study of the contemporaneity of organic matter in a surface context is a vital next step in the radiocarbon dating of petroglyphs and pictographs.

   At present, however, available data suggest that the ^{14}C age of the organic matter encapsulated by rock coatings is contemporaneous with the time of deposition. First, two AMS ^{14}C ages are available on historical control surfaces. Dust and cyanobacteria growing on a cut-faced stone wall of Fort Piute, built in 1864 in the Mojave Desert, showed no contamination from older carbon (Dorn, Clarkson et al. 1992). Second, there is no indication that organic carbon in uncoated weathering rinds consists of anything other than carbon that was contemporaneous when it was added. Third, all tests of encapsulated organic matter reveal radiocarbon ages that are always younger than geological controls (Dorn, Jull et al. 1989; Bach et al. 1991).
3. The type of organic matter extracted for AMS ^{14}C dating can yield a reliable radiocarbon age. An important lesson learned during the last four decades of radiocarbon dating is that the material being dated does matter: the type of organic matter extracted must act as a closed system. Unfortunately, few studies of the type of organic matter dated have been conducted. Dorn and DeNiro (1985) found that the stable carbon isotope composition reflects the adjacent plant community. Nagy et al. (1991) found that an amino acid composition in one sample of rock varnish was consistent with a bacterial origin, with organic material also coming from the adjacent environment. Dorn, Jull et al. (1989) found that samples not treated with HF yielded ages much younger than the controls. Until the nature of the dated organic matter is adequately characterized, empirical tests

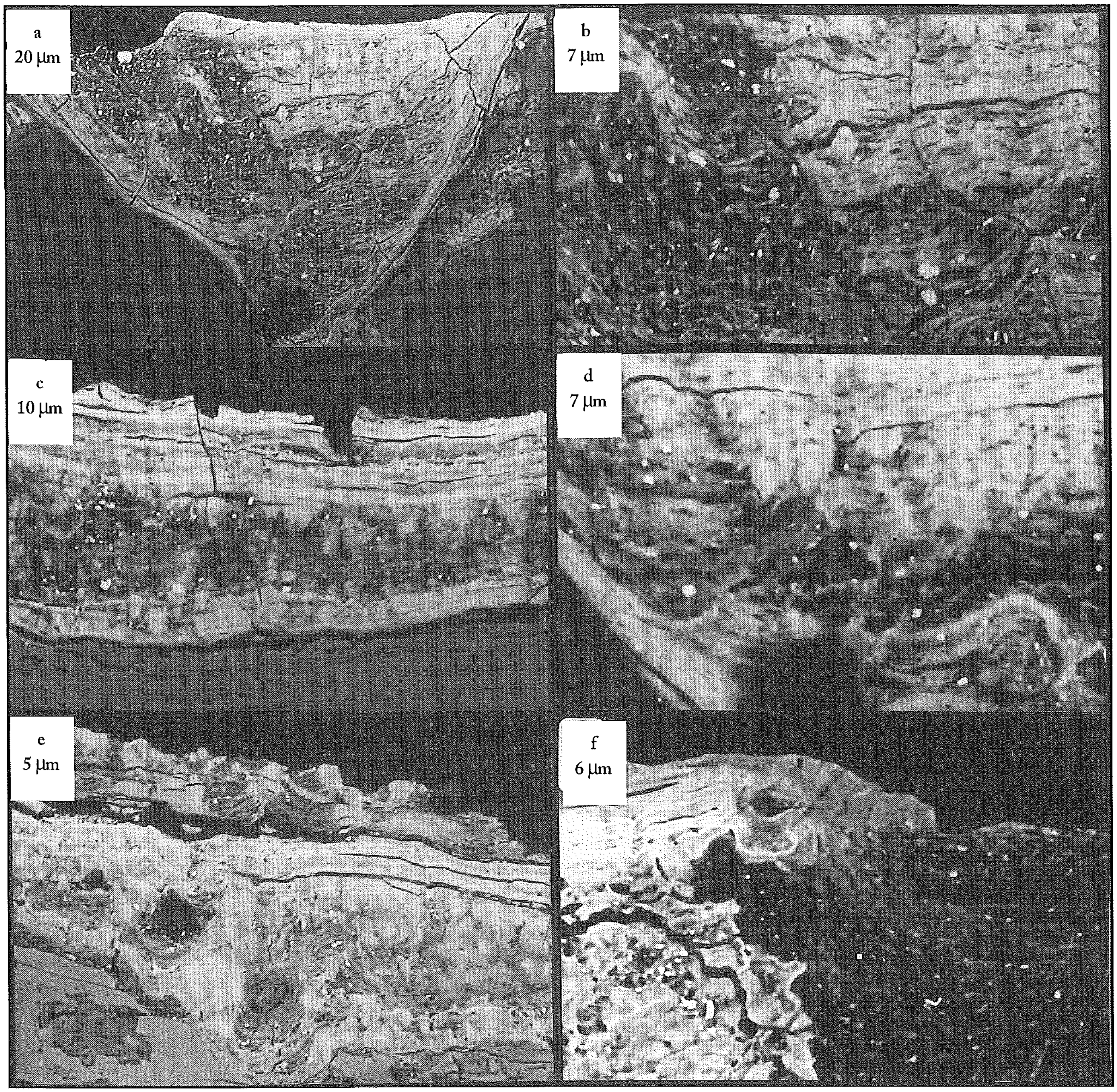


FIGURE 3.7 POLISHED CROSS SECTIONS OF ROCK VARNISH SHOWING CATION LEACHING. The images, derived by backscatter electron microscopy, show that layered varnishes are brighter because they have not been leached by water moving through the varnish. In contrast, the porous varnishes are darker because they have been leached of manganese, calcium, potassium, magnesium, and other elements. Also the porous zones are discontinuous. The samples are *a*, from petroglyph WH5 in South Australia; *b*, a close-up of *a*; *c*, a surface artifact from the Mojave Desert with varnish radiocarbon age of 3690 ± 65 (ETH 6573) Dorn, Clarkson et al. 1992; *d*, from petroglyph K23 in South Australia; *e*, a surface artifact from the Mojave Desert with varnish radiocarbon ages of 13,655 ± 105 BP (AA 6547) and 14,840 ± 115 BP (ETH 6577) Dorn, Clarkson et al. 1992 and Whitley and Dorn 1993; and *f*, rock varnish on an alluvial fan boulder from Death Valley (sample from T. Liu). Scales are in µm.

(Dorn, Jull et al. 1989; Dorn, Clarkson et al. 1992) stand as the only evidence of the reliability of the subvarnish organic matter for radiocarbon dating.

4. The rock coating that encapsulates the organic matter (figs. 3.3 and 3.4) forms a closed system. If this assumption is correct, radiocarbon dating the organic matter encapsulated by a rock coating has the potential to provide a *close minimum age* for the exposure of the underlying surface. If this assumption is incorrect, newer organic matter that penetrates the coating would contaminate the signal with younger material. In either case, any radiocarbon date for the coating would be a minimum age for the underlying petroglyph (as long as the first three assumptions are met).

Uncertainty regarding this fourth assumption is whether organic matter dated under a rock coating is truly

COLLECTION
Collect only from surfaces that reflect timing of erosion or deposition, from positions that do not influence a CR age estimate.

↓

PREANALYSIS SCREENING
Screen for microscopic factors that alter a CR age; for example, anomalous abundance of microcolonial fungi, lichens, erosion of varnish, anomalies of K, Ca, or Ti, or other factors (see Krinsley et al. 1990).

↓

SEPARATE VARNISH FROM ROCK
After being scraped from a petroglyph, samples are examined under 10x to 45x magnification. The rock particles are cleaned off. A subsample is examined by SEM to evaluate the amount of contamination by volume and chemistry that has remained after the cleaning (Dorn 1989).

↓

MEASURE CATION RATIOS
If inductive couple plasma or wavelength dispersive electron microprobe are used, the scrapings are homogenized for a bulk chemical analysis. If PIXE is used, the scrapings are attached to a Kapton subtrate.

↓

ESTIMATE CATION RATIO AGE
Using a cation-leaching curve, a calibrated age is assigned (see fig. 3.9).

FIGURE 3.8 STEPS IN CR DATING. Generalized steps in the collection, laboratory evaluation, and analysis of samples.

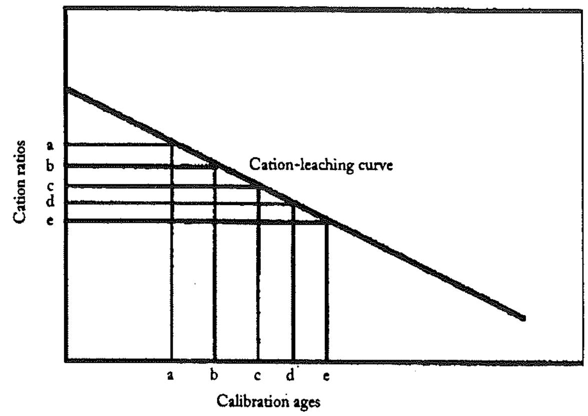
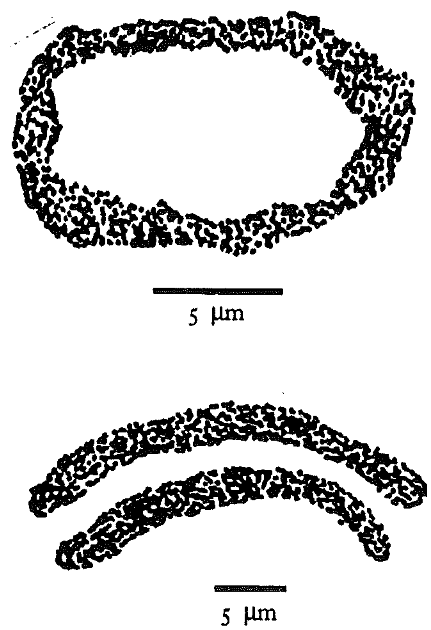


Figure 3.9 PREFERRED METHOD OF ASSIGNING CALIBRATED AGES TO ROCK VARNISH CRs. First, the semi-log least-squares regression (cation-leaching curve) is constructed from CRs on surfaces of known age. Second, individual CRs are obtained for different pockets of varnish on the surface of unknown age (ratios a, b, c, d, and e). Third, each individual CR is assigned a calibrated age based on the cation-leaching curve. Fourth, the average of the individual ages comprises a mean age for the surface, and the standard deviation of these ages forms the uncertainty estimate.



a

b

FIGURE 3.10 PETROGLYPHS FROM SOUTH AUSTRALIA. Discussed here as case studies for a three-tier approach to dating petroglyphs with rock varnish. Context is provided in Nobbs and Dorn (1993). *a*, Petroglyph WH5 from the Wharton Hill site. *b*, Petroglyph PN6 from the Panaramitee North site.

in a closed system. There is excellent evidence that capillary water does continue to move through the overlying rock coating and therefore through the underlying weathering rind. Krinsley et al. (1990), O'Hara et al. (1989, 1990), and Dorn and Krinsley (1991) demonstrated that the elements in rock varnish are mobilized by water. They also showed that continued weathering of the underlying rock can allow varnish to collapse into a growing void.

Dating varnish is then analogous to dating charcoal in a paleosol or charcoal from an archaeological excavation. Like varnish, a paleosol is not a closed system to water flow (fig. 3.1). Water carries young organic molecules that can then be adsorbed onto the paleosol charcoal, weathering rind organics, or clay minerals (Burchill et al. 1981). The key to dating the organic matter in the paleosol is proper chemical pretreatment to eliminate invading younger organics. Gillespie (1991), for example, found it was necessary to pretreat charcoal in a soil in a very harsh fashion to obtain accurate ages.

To obtain subvarnish ages slightly younger than geological controls, Dorn, Jull et al. (1989) found that treatment with HF and HCl was necessary. HF is used to remove loose organics that can adsorb to clays (Burchill et al.

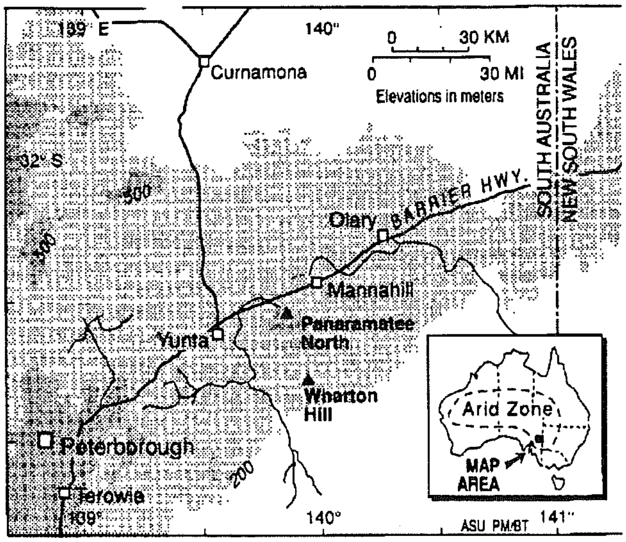


FIGURE 3.11 LOCATION OF WHARTON HILL AND PANARAMITEE NORTH SITES IN THE OLARY PROVINCE OF SOUTH AUSTRALIA.

1981; Hedges and Hare 1987). Treatment with 20 percent HCl is necessary to remove carbonate. If samples are not treated with HF, organic molecules loosely adsorbed onto the clay minerals can contaminate a sample and produce too young an age (Dorn, Jull et al. 1989; Gillespie 1991). Empirical support for the assumption of a closed system for subvarnish organics that are extracted by HF-HCl is also found in radiocarbon ages of more than 35,000 years (see example 3 above; Dorn, Jull et al. 1989; Dorn, Clarkson et al. 1992).

This entire discussion highlights my contention that the approach to dating organic matter in a surface context maintains a number of uncertainties, and is still experimental. Appendix 3a graphically illustrates some of these important lessons that I have learned the hard way during this research. Many details of organic matter in a surface context require further study. Only by continued application of these methods can these assumptions be tested.

Cation-Ratio Dating

CR dating assigns relative or calibrated ages to rock varnishes (Dorn 1983, 1989). The ratio of cations (positive ions) of (potassium+calcium)/titanium decreases with age. If this ratio is measured at sites with known exposure ages in a region, a calibration called a "cation-leaching" curve can be constructed. The CRs in unknown samples are then compared with this curve and a CR age is assigned.

Since the first development of CR dating, the trend of decreasing CRs with known age has been duplicated by five different groups around the world (see Glazovskiy 1985; Harrington and Whitney 1987; Pineda et al. 1988, 1990; Zhang et al. 1990; Bull 1991). Figure 3.6 presents examples of cation-leaching curves. Differences among the curves are due to variations in the chemistry of airborne fallout and environmental factors. Here I explain why CR dating works and how ages are assigned to petroglyphs; I will also try to explain the associated controversies.

Cation leaching

The simplest hypothesis to explain lowering of the CR of $(K^{+}+Ca^{2+})/Ti^{4+}$ with time is cation leaching (Dorn 1983), where potassium and calcium are more mobile than titanium in the geochemical environment where varnish forms.

The existence of cation leaching was verified in two laboratory experiments (Dorn and Krinsley 1991): exposure of varnish scrapings to leaching solutions and exposure of varnishes still attached to the rock to leaching solutions. Because these tests were carried out in less than a year they are not completely analogous to natural processes taking thousands of years. The evidence gathered indicates, however, that leaching does occur, and that the rate of leaching is influenced by temperature and the types of coatings that interdigitate with rock varnish.

It is possible to see sites of cation leaching by using backscatter electron microscopy (BSE) that images chemistry along with texture (Krinsley and Manley 1989). Figure 3.7 presents BSE textures of leached rock varnish, compared to adjacent varnish that has not been leached. Brighter (unleached) varnish has a higher atomic number, and the darker porous (leached) material has a lower atomic number. The porous textures in the figure are from the leaching of layered varnish. This leaching is indicated by a gradient of increased porosity away from the layered varnish, the disintegration of layering in the porous zone, the presence of fractures that channel capillary water, and the lowering of manganese, iron and CRs in the porous material (see the geochemical data in Dorn and Krinsley 1991).

An important implication of seeing the "pockets" of cation leaching adjacent to regions of layered varnish is that the cation leaching occurs discontinuously. Some regions of leaching are close to the varnish-rock contact; other leached zones are in the middle of the varnish. This discontinuity explains why bulk chemical measurements are necessary to detect changes in CRs. It is no wonder that micron-scale measurements do not show evidence of cation leaching (see Reneau and Raymond 1991); they should not. The discontinuous nature of cation leaching also means that bulk samples of as much volume as possible would yield the most reliable results because larger samples would yield the most representative results.

The generalized explanation for the decline in the rate of CR change at progressively older sites is that it becomes increasingly difficult to remove fewer and fewer calcium and potassium cations, all while titanium remains (Dorn 1989). This decline has been found in the leaching experiments of Dorn and Krinsley (1991). Sometimes potassium, calcium, and manganese are lowered. In other cases, however, titanium is increased relatively in the porous zones because progressive weathering concentrates titanium (Akimoto et al. 1984; Morad and Aldahan 1986; Harden 1988).

Methods of the ASU dating laboratory

The approach Arizona State University (ASU) Dating Laboratory uses in CR dating starts with sample collection (fig. 3.8). Certain variables that can influence a CR, other than time, are avoided in sampling (table 3.3). (As discussed earlier, there is no evidence to indicate that other researchers collect the same types of varnishes we do.) Once samples are collected, we examine them in cross sections to avoid factors that would interfere with a varnish date (Krinsley et al. 1990). This examination is particularly easy to do for petroglyphs: take a millimeter-sized sliver for sectioning next to the spot where the sample is taken for CR dating.

I cannot overemphasize the importance of working with the right type of sample. Watchman (1992), for example, decided to use varnishes without layering. He writes regarding South Australian varnish: "In cross-section, the Karolta varnish is highly variable in thickness. It is unlaminated and no 'lowest layer' could be discerned in any of the samples examined." Yet, he still presented CR results, tried to make sense of them, and decided that the technique did not work. Radiocarbon dating of charcoal will not work if modern roots are included in the sample, just as CR dating will not work if the wrong type of varnish is sampled.

Also implicit in our approach is collecting and analyzing relatively large volumes of samples. The microchemical variability that occurs at the scale of microns (see Dorn 1989; Dorn and Oberlander 1982; Dragovich 1988; O'Hara et al. 1989, 1990; Raymond et al. 1991; Reneau and Raymond 1991) is reduced when greater volumes are analyzed.

Once samples are preselected in the laboratory, there are two approaches to the measurement of varnish chemistry. One is based on the mechanical removal of varnish from the underlying rock and analysis of cubic millimeters to cubic centimeters (Dorn 1989; Zhang et al. 1990). A second is to use a scanning electron microscope (the SEM technique) for in situ analysis of cubic microns of varnish still attached to the underlying rock (Glazovskiy 1985; Harrington and Whitney 1987).

Most groups that use CR dating rely on the bulk chemistry of cubic millimeters to cubic centimeters of varnish (Dorn 1989; Pineda et al. 1990; Zhang et al. 1990). The philosophy behind analyzing large samples is to average in the porous zones of leaching and the unleached layered varnish to obtain representative CRs (see fig. 3.7). Bulk samples can be analyzed using various techniques. I have used PIXE (particle-induced X-ray emission), wavelength dispersive electron microprobe (probe), and inductively coupled plasma (ICP). These techniques are elaborated in Dorn, Cahill et al. (1990). Currently, the ASU Dating Laboratory uses an electron microprobe because the technique yields reliable analyses (Bierman and Gillespie 1991a) and it costs less to measure varnish CRs.

The SEM technique, in contrast, analyzes a much smaller volume—on the scale of cubic microns. The defocused SEM beam is aimed from above at the surface of the varnish. The resulting X-rays are analyzed with an energy dispersive detector (Dorn 1983:58; Glazovskiy 1985; Harrington and Whitney 1987). Because the SEM technique analyzes only the very surface layer (less than 5 μm) of the varnish (Dorn 1989:575; Reneau et al. 1991), the CR is derived from a measurement of X-rays generated in the upper few cubic microns by the SEM beam.

I prefer the mechanical removal of the varnish from the underlying rock and its analysis by a bulk chemical method for several reasons. Scrapings can be cleaned of most rock contamination; what rock material is left can be determined quantitatively and independently by analyzing the varnish scrapings (Dorn 1989). The same scrapings can be analyzed by different methods, scraping does not destroy archaeological material, and greater volumes of varnish can be analyzed less expensively and more rapidly. And as stressed below, scraping larger volumes of samples will allow the investigator to measure both leached and unleached sections.

Lastly, variability in varnish thicknesses and the irregular rock/varnish boundary make it extremely difficult and time consuming to rule out the generation of X-rays from the underlying rock, especially on a routine basis (Dorn 1989:575; Reneau and Raymond 1991). For example, the SEM operator who is looking down at the surface of a varnish has no idea whether the depth of the underlying rock is less than 1 or or more than 200 μm. Great variations in thickness can occur over distances of less than 1 mm, sometimes due to different lithologies, sometimes to the favorability of the microtopography for varnish development, and sometimes to the time-transgressive behavior of varnish colonization.

Then, using a cation-leaching curve (fig. 3.6), CR ages are assigned (Dorn 1989; Dorn, Cahill et al. 1990). There is some disagreement concerning the procedure used to assign CR ages (for example, Lanteigne 1991; Bierman et al. 1991), but the matter is easily resolved. Instead of using an average and standard deviation of several combined CRs, we treat each CR as an independent indicator of age. Each CR of varnish on the surface of unknown age is therefore assigned a separate age (fig. 3.9). These separate CR ages for a given surface are then averaged to assign a mean age for the surface, and the uncertainty is derived from the standard deviation of these ages.

This approach is superior because it requires fewer assumptions: only that the calibration curve is the best estimate of CR age and that CR ages are normally distributed. In essence, this approach keeps the assignment of calibrated ages as close to the raw data as possible. The controversial alternative uses the mean and variation of multiple CR measurements; this implies that the different samples being grouped together have the same exposure history. For example, if a petroglyph were to be dated with the approach suggested by Bierman et al. (1991), different collections of varnish from different parts of a petroglyph would be treated as a mean with a variation. However, varnish growth is time-transgressive, starting in one place and growing vertically and horizontally. By treating each CR as a separate time indicator, intersample variability can be treated as indicating time-transgressive growth.

Controversy in cation-ratio dating

Issues under contention in the CR dating literature are summarized in table 3.4. My contention is that most of these issues have a root cause: different investigators collect different types of varnishes. The debate over the cause of CR change over time shows this nicely. There is no question that varnish CRs decrease over time (Dorn 1983; Glazovskiy 1985; Harrington and Whitney 1987; Pineda et al. 1988, 1990; Zhang et al. 1990; Bull 1991). At issue is why the CR dating method works. The hypothesis preferred here is cation leaching (Dorn 1983; Dorn and Krinsley 1991).

The alternative hypothesis for CR change over time is contamination from underlying rock (Reneau and Raymond 1991). After collecting the "darkest, best developed varnishes," Reneau and Raymond (1991:937) found a "lack of evidence for leaching." This is contradicted by the published results of O'Hara et al. (1990), Krinsley et al. (1990), Krinsley and Dorn (1991), and Dorn and Krinsley (1991) who found ubiquitous textural and geochemical evidence of cation mobility in subaerial black varnish.

These seemingly discordant results can be readily explained by different researchers examining different types of varnishes. The varnish research group at Los Alamos National Laboratory collects crack varnish and ground-line band varnish, not subaerial varnish. "Dark," "smooth varnishes," and "best developed" are *the* only published sampling criteria of the Los Alamos varnish group (Reneau et al. 1991; Raymond et al. 1991; Reneau and Raymond 1991). Recently exposed crack varnishes are usually the "darkest" due to high manganese concentrations in their outermost layers and the "smoothest" due to their formation on a planar fracture surface. Ground-line bands are typically the darkest, best developed, and smoothest varnishes because growth occurs in such favorable microenvironments (for example, see Dorn and Oberlander 1982:359-60). The texture and chemical profiles of the types of varnishes collected by the Los Alamos group (characterized in Raymond et al. 1991: figs. 2 and 3) are very similar to varnishes from crevice positions that I have examined.

While subaerial positions are exposed to alternating conditions of dust deposition, water flow, and acid-producing organisms, crack varnishes formed in rock crevices and exposed by later spalling provide an environment of wetting and drying buffered by long-term contact with collected alkaline dust. The crack varnish environment promotes superior varnish cementation, all while avoiding exposure to the acidity of rainfall and rock-surface organisms in the subaerial environment. The tight layering found in crack varnish does not expose itself to leaching the way only subaerial varnishes do.

The collection and analysis of crack varnishes helps place perspective on the "barium debate" (see table 3.4). Crack varnishes contain a barium-manganese oxide romanechite (Potter and Rossman 1979:1221), which is consistent with the barium-manganese correlation found by Los Alamos (Harrington et al. 1991; Raymond et al. 1991). My data are consistent with these data: varnishes that developed in rock crevices and have subsequently been exposed also have relatively high barium levels, strong barium-manganese correlations, and a surface layer enriched in manganese. In contrast, the manganese mineral found in subaerial varnishes is birnessite, which does not contain barium (Potter and Rossman 1979). This finding is consistent with observations of low barium concentrations in many types of subaerial varnishes.

Other issues of contention will continue to appear as long as investigators do not specify the types of varnishes they are collecting, how the particular areas analyzed for dating are preselected in the laboratory, or whether investigators compared different types of varnishes (for example, Watchman 1992 compared unlayered and layered varnishes). To avoid future confusion, varnish researchers should specify as explicitly as possible at least (1) the type of environment from which the sample was collected (for example, Dorn and Oberlander 1982:359-60; Dorn 1989:568-9; Dragovich 1984, 1987, 1988; Jones 1991; Potter and Rossman 1979; Whalley et al. 1990; White 1990; Zhang et al. 1990); (2) cross-sectional textures and surface micromorphologies of varnishes selected for chemical analysis (for example, Krinsley et al. 1990); and (3) the volume of material analyzed.

Accuracy of CR measurements

Another issue has beeen raised by Bierman and Gillespie (1991a, 1992a, 1992b), revolving around the accuracy of CR measurements made by PIXE by the Air Quality Group at the Crocker Nuclear Laboratory (CNL) at the University of California at Davis. I used PIXE for many years (but, as explained earlier in this paper, the ASU Dating Laboratory now uses the electron microprobe). While I would prefer to sweep this issue away, it is a published part of the varnish dating literature and deserves a clear explanation.

Bierman and Gillespie (1991a) claim that the PIXE analyses from the CNL are not valid, specifically that PIXE at CNL misanalyzes titanium by inadvertently adding barium to it. Therefore, Bierman and Gillespie claim, the CR of (K+Ca)/Ti is far too low and was inaccurately measured. Bierman and Gillespie prepared an "artificial varnish" of known composition in the laboratory and sent nine samples of this material to the Air Quality Group at the University of California at Davis, led by Professor Tom Cahill. Cahill (1992) informed Bierman and Gillespie in writing that the analyses would only be qualitative because a dedicated run on geological material was not

Table 3.3 Factors (other than time) known to influence cation ratio of black (Mn-rich) rock varnish

Variable	Effect and probable cause
Lichens	Lower CR from acidification
Microcolonial fungi	Lower CR when they actively erode into varnish. No alteration when CR adventitious.
Water runoff	Lower CR, unless source of water runoff is locale where alkaline dust collects.
Basin of water collection	Lower CR due to enhanced leaching effect of longer water contact
Organic matter in contact with varnish	Lower CRs due to secretion of organic acids.
Aspect	Northeast facing aspects in North American deserts tend to have lower ratios than south-southwest aspects, probably due to cumulative effect of more mesic conditions.
Filamentous fungi	Lower CRs when surface area greater than ~5% due to secretion of organic acids.
Varnish w/ low pH values	Varnishes with acidic pH values (<6) tend to have CRs lower than near neutral varnishes.
Ground-line band varnish	Sites where dust collections in depression have cumulic aeolian (loess) soil. Ground-line band created at soil-varnish-atmosphere interface that has slightly lower CRs than adjacent varnishes.
Titanium anomaly	Local environments can contain abundant titanium detritus which, once incorporated into varnish, decreases CR.
Cryptogamic soil	Varnishes collected near soil surface of cryptogamic algae, fungi, lichens, and mosses have lower CRs.
Varnish that interlayers with oxalate skins	Although quite rare, when rock varnish interlayers with films of oxalate, CRs decrease.
Crack varnish	Varnish that begins in rock crevices and is exposed by spalling of overlying rock tends to have much higher CRs than adjacent subaerial varnishes.
Soil proximity	Varnishes collected within few centimeters of soil surface have higher CRs due to capillary flow of salts.
Calcium anomaly	Local environments can contain abundant calcium carbonate detritus which, once incorporated, increases CR.
Potassium anomaly	Local environments can contain abundant potassium-rich detritus which, once incorporated, increases CR.
Varnish w/ high pH values	When varnishes have alkaline pH values (<9), CRs increase.
Overhang	Where varnishes are collected from underside of overhangs, CRs increase probably due to less leaching.
Abundant botryoids	Varnishes with uncommonly great abundance of botryoids have slightly lower CRs due to greater leaching between stromatolitic-like structures.
Irregular topography of underlying rock	Varnishes collected from lava flows with very rough and irregular surface have higher CRs.
Varnish that interlayers with amorphous silica	Interdigitation of amorphous silica skins greatly decreases rate of leaching and increases CR.
Rock weathering	When rock surface weathers by spalling, flaking, granular distintegration, or block breakage, newly exposed rock surface has higher CRs than unweathered surfaces of same landform.
Time transgressive growth	If sampled from locations where varnish does not grow initially, CRs are higher for varnish that spreads out from initial colonization point.

feasible for only nine samples. Bierman and Gillespie responded that this was sufficient and to proceed. The samples were analyzed and qualitative data were sent. Bierman and Gillespie (1991a) then published absolute values to discredit the validity of CRs measured by PIXE at the CNL. The implication of Bierman and Gillespie's claim is that all prior PIXE analyses of my varnish samples are invalid because their test samples were not analyzed properly. Cahill (1992:469) writes in response:

> The data in Bierman and Gillespie (1991[a]) Table 1, described as "PIXE UCD" did not in fact come from us. They appear to have been prepared by Bierman and Gillespie from "reduced" and "raw" X-ray spectra that was clearly labelled "The Raw Values In These Tables Are Incorrect" (written communication to Bierman, June 18, 1990). I deeply regret that they were used to generate Table 1, since we notified Bierman and Gillespie in the memo that "there is no way to obtain absolute or relative values" without particle size or proper standards, and "Ba is not in the tables we used for this run." These data were provided to Bierman and Gillespie with an explicit written prohibition against their publication....In fact, many elements reported in Table 1 as "PIXE UCD" appear to have been erroneously taken from minimum detectable limits for fine aerosol particles....

Bierman and Gillespie (1992a:470) responded:

> Data and detection limits in our Table 1 are taken directly from UCD outputs and were used only after Bierman traveled to UCD, reviewed the PIXE analyses with Cahill, and was given permission for publication.

There is a clear contradiction in statements. Cahill explains that his data were misrepresented; Bierman and Gillespie claim otherwise. Bierman and Gillespie have no written documentation to support their claims; Cahill has written communication to support his contentions.

The issue should be dead here, except for further misrepresentation in Bierman and Gillespie's (1992b) reply to my comment on their paper (Dorn 1992a). I group my concerns into five broad issues. First, Bierman and Gillespie's discussion of barium in rock varnish is contradictory. Bierman and Gillespie (1991a) first claim that the CNL PIXE cannot measure barium. Then they quote CNL PIXE barium data from four papers (Bierman and Gillespie 1992b) and explain that these measurements are consistent with other published values for barium in rock varnish! The contradiction is clear: if CNL PIXE did not measure barium in my samples (the original problem), how then can the PIXE barium measurements be consistent with other data? The answer is CNL PIXE did measure barium in

Table 3.4 Issues of contention in cation-ratio dating

Issue	Los Alamos and U of Washington	Arizona State University	Resolutions
Theory to explain reductions in CRs over time	CRs are reduced over time, but not due to cation leaching. Samples analyzed show no evidence of elemental mobility. Reduction must, therefore, be due to changes in primary composition of surface layers in varnish for SEM method (Reneau and Raymond 1991). Reduction, as measured by scraped samples, is probably due to less contamination from underlying rock over time as varnish thickens.	CRs are reduced over time in subaerial varnishes due to cation leaching, as documented in this chapter. However, places of cation leaching occur below surface of varnish. Because SEM method analyzes only top of varnish, cation leaching cannot explain why SEM method works. SEM method may work because of different length of time since crack varnishes analyzed by Los Alamos have been exposed.	Have independent laboratory replicate leaching experiments reported here. Have proponents of SEM method develop theory to explain why chemistry in surface layer of varnish would change over time.
Varnish samples may contain contamination from underlying rock	SEM method analyzes only upper few microns of varnish (Dorn 1989:575; Reneau et al. 1991), so contamination is unlikely in well-developed, thick varnishes. Scraping varnish produces fragments from underlying rock that cannot be "picked out."	No method has been proposed to independently evaluate amount of contamination in X-rays generated by SEM. Presence of topographic high in rock under area of analysis cannot be tested. In contrast, amount of rock contamination in scrapings is evaluated by independent means (Dorn 1989).	Run experiment on shared samples.
Destruction of archaeological samples	No discussion of this issue.	SEM method must take fragments of archaeological samples, requiring mechanical breaking or coring. Scraping varnish for bulk chemical analysis can be done in field and does little to influence appearance of cultural artifact.	No argument at present that preservation of archaeological samples is more important than using destructive experimental methods.
Chemical analyses by different analytical methods.	No discussion of this issue.	SEM method cannot be replicated by other analytical methods (Dorn 1989).	Varnish scrapings can be analyzed using several different methods (Dorn, Cahill et al. 1990).
Volume of material analyzed	Enough volume can be analyzed by SEM method to be representative of chemistry of varnish on given surface.	Micron-scale chemical variability too extreme to use SEM to obtain representative chemistries, especially since depth of penetration is only a few microns. Philosophy behind approach of removing material is to analyze as much volume as possible to obtain most representative chemistry.	Clear determination of how much volume of material is necessary to dampen variability seen in micron-scale analyses.
Young samples	SEM method can analyze pockets of varnish that are just starting to form, whereas removing this material is too difficult.	SEM results on few spots of varnish not as representative as collecting varnish from hundreds of pockets. Working with young varnishes is easier because places where varnishes start to grow first are easily identified. Furthermore, blind tests on late Holocene samples indicate this approach yields valid results (Loendorf 1991).	Share samples from same young surface. Young varnishes will have best potential to compare results from different methods because they are relatively thin.
Statistical determination of CR ages	Statistics of assigning error term to CRs should be based on expected variation of mean CR (Bierman et al. 1991).	CR ages should not be assigned based on average and error term of CRs. Each CR should be assigned separate single age, using least-squares regression. Age uncertainty should be based on variability in individual age assignments because each location of varnish has separate history.	They are based on different assumptions. Using an expected variation of mean assumes that all subsample CRs belong to same population. Using individual CRs assumes only that each CR represents age signal of that varnish.
Surface stability	Fire spalling can restart varnish clock (Bierman and Gillespie 1991b); desert pavements are too unstable to warrant use of CR dating of artifacts (Harry, Bierman et al. 1993).	It is relatively simple to avoid fire spalling by careful field selection. Artifacts are dated from stable pavements. Sources of surface degradation other than fire spalling need to be considered in sampling (Dorn 1989).	Avoid surface textures produced from weathering. Avoid unstable geomorphic contexts.
Blind tests of results	No blind intercomparisons are reported for SEM method of CR dating.	Several blind tests of varnish radiocarbon and varnish CR dating by bulk methods are presented here.	Have proponents of SEM method agree to participate in series of blind tests.
Barium in rock varnish can interfere with measurement of titanium by energy dispersive X-ray detectors (Dorn 1989:575).	Harrington et al. (1991) acknowledged that prior SEM-EDS measurements of Ti were influenced by Ba, but they claim that new SEM method deconvolutes X-ray signal in polished cross sections. They also claim that Dorn's PIXE measurements were also affected by Ba, based on indirect reasoning. This claim was supported by PIXE data from PIXE and SEM-EDS data on standards.	(1) Bierman and Gillespie misrepresented PIXE data given to them by U.C. Davis (Cahill 1992). (2) Reanalysis of varnish samples previously measured by PIXE with ICP and microprobe show similar results (Dorn, Cahill et al. 1990). (3) Ba concentrations in varnishes used for CR dating are low. (4) Bierman and Gillespie (1992b) contradict themselves by first claiming that PIXE method does not measure Ba, then citing Ba data from PIXE to show that Ba is present in rock varnish. (5) Blind tests of PIXE-based CRs match control ages.	(1) An offer by Dorn (1992a) to share samples previously analyzed by PIXE was rejected by Bierman and Gillespie (personal communication, October 1990). (2) Sharing of samples previously analyzed by SEM method would permit claims of accurate deconvolutions to be tested by independent party. (3) All parties avoid energy dispersive detectors. For example, all new CRs are determined by methods not susceptible to Ba-Ti overlap: ICP and wavelength dispersive electron microprobe.

my samples, as Cahill (1992) explains and as my publications have shown long before this controversy emerged (for example, Dorn 1989; Dorn et al. 1990). The topic of the distribution and abundance of barium in rock varnish is in its infancy. Certain types of varnish have high barium values; other types have virtually no barium, as discussed earlier. Little is served by the approach of Bierman and Gillespie—of not accounting for the type of rock varnish in presenting analytical data. It is easy to mislead by dumping a mix of "apples, peaches, pears, and oranges" into the same barrel; it is far more difficult to sort them.

Second, Bierman and Gillespie have refused to participate in an independent test. I conducted independent tests of PIXE analyses before this controversy arose (Dorn 1989:576; Dorn et al. 1990). I conducted my own tests of PIXE by remeasuring, using different techniques, the exact same material originally analyzed by PIXE. This approach is a better test than sending samples to be run by a different system, as Bierman and Gillespie did. In 1990, I offered to Bierman and Gillespie samples previously analyzed by PIXE to test their claims. They stated, in an October 1990 memo, they were unwilling to analyze these samples. Bierman and Gillespie (1992b) again stated they are unwilling to analyze these samples. Scientific method is not well served by this approach.

Third, there are four blind tests of varnish CR dating, in which CRs analyzed by PIXE are consistent with independent ages obtained well after the PIXE analyses. Such successful test results are incompatible with Bierman and Gillespie's interpretation of misanalysis of varnish chemistry by PIXE. These blind tests are:

Mauna Kea, Hawaii. The vast majority of CR measurements from Mauna Kea are consistent with independent data derived well after the original PIXE measurements (Dorn et al. 1991). Bierman and Gillespie (1992b) claim that in situ ^{14}C data from Jull et al. (1992) contradict the Mauna Kea tests (Dorn et al. 1991), but they omit that Jull was a co-author of that paper and that all available contradictory data (site 5) were added in the proof stage. Reasons were presented in Dorn et al. (1991) why the CRs and ^{36}Cl data were not consistent with the in situ ^{14}C data: rolling of the sampled boulder would lower the in situ ^{14}C, but it would not affect the varnish age signal.

Tioga moraines in Sierra Nevada. The original PIXE measurements are consistent with new information from conventional ^{14}C and from ^{10}Be and ^{26}Al, but Bierman and Gillespie falsely write that we "did not date Tioga moraines by cation ratio." Tioga moraines were indeed assigned CR ages (Dorn et al. 1987:44, Dorn et al. 1990:187–188).

Petroglyphs in southeast Colorado. Loendorf (1991) presented several tests of CR dating using PIXE. Bierman and Gillespie claim that Loendorf's paper was incomplete in presenting relationships. I encourage the interested reader to read Loendorf's paper. The point remains: the CRs measured by PIXE are consistent with new information.

Independent measurements of CRs in Australia. Watchman's (1992) ICP analyses of varnishes formed on petroglyphs from Karolta in South Australia are in the same range as those originally measured by PIXE (Dorn et al. 1988). If the CNL PIXE did not measure barium, the CRs should be vastly different. They are not.

It is naive and incorrect to assume that every CR age will match every future test. Yet, there are many blind tests in which PIXE measurements have matched newer and independent age constraints. If Bierman and Gillespie were correct in their claims, this would be an impossibility.

The fourth issue regards replication. Bierman and Gillespie (1992b) claim that "others have been unable to reproduce his [Dorn's] results or verify the accuracy of analyses on which his ages are based." Five different groups have also found a decrease in the varnish CRs with time (Glazovskiy 1985; Harrington and Whitney 1987; Pineda et al. 1988, 1990; Zhang et al. 1990; Bull 1991). [Bierman and Gillespie (1992b) even claimed that I misadded and that one of the five groups is my own. It is a trivial point, but please count for yourself.]

The fifth issue regards a different approach to science. In their reply to my comment, Bierman and Gillespie (1992b) directly implied omissions of data and attempts to mislead readers on my part. I have tried throughout my publications to point out potential problems with my work, as well as the work of others. I am not claiming, and I will never claim, that all the CR ages I have produced will stand tests over time. As I noted earlier, the CR method is the weakest in the baggage of varnish techniques. When I have evidence that previous ages are incorrect, I publish these data as soon as possible (for example, Dorn et al. 1990 revision of CR ages for glacial moraines).

Bierman and Gillespie persist in their claim that PIXE analyses of varnish by the CNL are bad, in spite of extensive independent contradictory evidence, written documentation by Cahill (1992) that they misrepresented data, and their unwillingness to run independent tests on real varnish samples.

Perspective on cation-ratio dating

There is no question that CR dating is a controversial method. I have stressed that it is based on chemical changes that are subject to a multitude of environmental influences, which are very difficult to control and can interfere with a time signal.

So why use CR dating? Because it can access time beyond the circa 40,000 BP limit of the radiocarbon method, some petroglyphs cannot be dated by the radiocarbon method (for example, where old weathering rind was not completely removed), it is much less expensive, it has performed well when subject to blind tests (for example, Loendorf 1991), and it can be used to preselect the best samples to analyze by more expensive analytical methods, such as radiocarbon dating.

Relative Dating by Layers in Rock Varnish

Perry and Adams (1978) first observed continuous orange (manganese-poor) and black (manganese-rich) layers in rock varnish. Dorn (1990) and Jones (1991) established that manganese:iron (Mn:Fe) microlaminations are most likely caused by fluctuations in alkalinity experienced on rock surfaces. When alkalinity levels are high (for example, from deposition of aerosols deflated from margins of saline playas), varnish chemistry is not enriched in manganese and has an orange appearance. Manganese enrichment occurs with near neutral conditions.

There are other paleoenvironmental signals in rock varnish, besides Mn:Fe microlaminations, that can also be used to indicate relative time. Variations in micromorphology, stable carbon isotopes, lead, and other environment-dependent indicators exist (Dorn 1992b). Micromorphological variations have been used in the southwestern United States (Whitley and Dorn 1987) because a dramatic change occurred at many sites between the late Pleistocene and Holocene between botryoidal and lamellate varnishes (Dorn 1986).

Because varnish grows so slowly in drylands, the time needed to develop a distinctive layer is typically on the order of 10^3 to 10^4 years. This technique, therefore, is not very useful for younger petroglyphs in North America because they have relatively thin layers of mostly Mn-low varnish. The value of this approach, however, is in providing a cross-check for the older ages provided by radiocarbon and CR dating. Older petroglyphs at any given site should have experienced more fluctuations in alkalinity and should have a more complicated sequence of layers. Appendix 3a shows examples of layered varnish, as does Dorn (1992b, 1992c).

Petroglyph Dating with Rock Varnish

Rock engravings are an ideal system with which to work. Artists have chosen to use a blackboard of a well-varnished natural surface, one that enables a pool of varnish-forming bacteria (see Dorn and Oberlander 1982) to colonize the newly exposed engraving quickly. Petroglyphs are readily distinguished from natural rock weathering. They are also characterized by small hollows that collect organic fragments, which are, in turn, encapsulated by rock varnish.

CR dating of petroglyphs has seen widespread application. The method was initially applied in the Coso Range (Dorn and Whitley 1984; Whitley and Dorn 1988) and the Cima Volcanic field (Whitley and Dorn 1987), both in eastern California. These results showed that individual panels can have a history of use lasting several thousands of years, and that the time sequence of curvilinear abstract, rectilinear abstract, and representational that had been assumed by some individuals is not necessarily correct.

CR dating has been used extensively in southeastern Colorado. In addition to the CR ages reported by Loendorf (1991) and highlighted by him in chapter 9, Dorn, McGlone et al. (1990) presented analytical results concerning controversial motifs in this same area, allowing individuals interested in this controversy to have access to an independent time framework by which to consider controversial hypotheses about this art.

Extensive CR and radiocarbon dating work is in progress in two parts of Wyoming. J. Francis in chapter 4 presents results from the Bighorn Basin area. I have also been working with A. Tretebas in the western Black Hills of Wyoming, where chemical analyses on some of the darkest petroglyphs in North America are now in progress. When these projects are completed, we will have a much better idea of the behavior of the varnish system in this region, as well as having estimated the radiocarbon and CR ages of more than a hundred motifs in Wyoming.

Varnish analysis of petroglyphs has also been conducted in Australia. CR dating of petroglyphs in South Australia (Dorn et al. 1988) presented CR ages for the last 30,000 years for petroglyphs of similar style from the Karolta site in South Australia. Subsequent skepticism concerning the CR method has reduced the effect of finding such ancient rock art, as well as finding a similar so-called style over tens of thousands of years. These CR results have been subsequently reexamined by radiocarbon dating (Dorn, Clarkson et al. 1992).

Next, I highlight the approach to multiple varnish dating techniques, using my work with M. Nobbs on what are apparently the two oldest known petroglyphs in the world. The region is the Olary Province in South Australia (Dorn et al. 1988). WH5 (fig. 3.10a) is from the Wharton Hill site and PN6 (fig. 3.10b) is from the Panaramitee North site (fig. 3.11).

Relative ages as indicated by layering

Both petroglyphs are completely revarnished with a series of complex layers. Progressively younger petroglyphs from the sites have fewer layers (Appendix 3a).

Calibrated ages from cation-ratio dating

The CRs obtained for PN6 and WH5 are the lowest for petroglyphs in the region. (These ratios are similar to those Watchman [1992] obtained in ICP measurements of petroglyphs in the region, although he did not examine layered varnishes.) Varnishes on WH5 yielded a CR age of 45,000 ± 5000 BP, and varnishes on PN6 yielded a CR age of 39,000 ± 5000 BP.

Numerical ages from radiocarbon dating

Two AMS radiocarbon ages for two different subsamples of subvarnish organic matter from PN6 yielded ages of 43,140 ± 300 BP (AA 6898) and more than 43,100 BP (AA 6920). The samples were a composite of material sandwiched between the varnish and weathering rind, combined with the upper 3 mm of the weathering rind.

Four AMS radiocarbon ages have been obtained from WH5. One sample was previously reported in Dorn, Clarkson et al.

(1992): 36,400 ± 1700 BP (NZA 1356). A second sample was split and sent to two different laboratories, yielding ages of 37,890 ± 820 BP (NZA 2180) and more than 42,700 BP (AA 6907). As explained in example 3, the oval petroglyph (WH5) from Wharton Hill, just the weathering rind below the varnish cover yielded an age of 35,530 ± 650 BP (NZA 2361). These ages are not contradictory, even the two measurements on the split sample. Differences may be owing to the way in which background levels are treated by different laboratories, and it is quite reasonable that small amounts of ^{14}C are truly present in different amounts of the subsample. These four measurements average a ^{14}C concentration of about 1 percent, with a range of less than 2 percent.

Taken at face value, all three signals point to an ancient age for the petroglyphs—only slightly younger than the colonization of Australia by humans (Roberts et al. 1990). Based on the uncertainties noted above, each separate signal can be questioned. For example, even though the petroglyphs were engraved to a depth well below the previous weathering rind, I could legitimately point to the fact that a noncontemporeneous source for the carbon cannot be ruled out. Similarly, the CR ages could be challenged because they are older than any of the calibration points on the cation-leaching curve; I assume the curve extends in a linear fashion for another ten thousand years. And I could argue that finding more layers in PN6 and WH5 than any of the surrounding petroglyphs only affirms a relative age sequence. Yet, taken in tandem, it is difficult to explain all these results in any fashion other than minimum ages for very ancient rock art in South Australia. Certainly, a conservative interpretation would be that both petroglyphs are older or right at the limit of the radiocarbon method, making these two petroglyphs the oldest known rock art in the world.

The Future of Varnish Dating of Petroglyphs

The trials and tribulations associated with the explosion of new Quaternary dating methods within the past few decades have taught several valuable lessons that are quite relevant to the future of varnish dating of petroglyphs.

Work with the right type of material

Individuals cannot expect to run out, grab any old sample, scrape it or section it, analyze it, and arrive at the right age. I have certainly made errors in working with the wrong type of samples. I have tried to communicate these (for example, Dorn 1989; Dorn et al. 1989; Krinsley et al. 1990; Dorn et al. 1992), and the literature is full of careful work by people who have identified similar or other problems (for example, Dragovich 1984, 1987, 1988; O'Hara et al. 1989, 1990; Jones 1991; Nagy et al. 1990). For petroglyphs, it is easy to extract a sliver of intact varnish next to the sample for dating—and look at it carefully before conducting the analysis. If it is the wrong type of sample, don't use it! There are no short cuts; not testing the right type of sample will produce GIGO (garbage in, garbage out). See Appendix 3a.

Keep cross-checking

The key to any dating effort is cross-checking using multiple methods. To rely on any single dating method, even radiocarbon, is to court future problems. The cross-check may be something as elegant as stratigraphic relationships or as new as the ^{40}Ar-^{39}Ar dating of rock varnish (Vasconcelos 1992). By using the microstratigraphy of varnish layers, radiocarbon, and CR dating, we have greater faith in the accuracy of our results. We would like to compare our rock varnish dating results with pigment dating (see Russ et al. 1990, 1991, 1992) or oxalate dating (Watchman 1991) in circumstances where there is a morphostratigraphic relationship.

Keep a perspective on reliability and the inherent problems the various techniques present

In the end, the best a varnish date can provide is a close minimum age for the underlying rock art. An inherent limitation is the time lag between petroglyph manufacturing and the deposition of organic matter or the onset of varnishing. This is analogous to the inherent time lag between the deposition of an artifact in a stratigraphic sequence and the deposition of datable charcoal above.

Take my least favorite varnish age determination method, CR dating. CR dating is like any other chemical dating method (for example, obsidian hydration, lichenometry, or amino acid racemization). The method suffers from the inherent limitation of being susceptible to a multitude of environmental influences that can interfere with the time signal (Dorn 1983); this is far more serious than any problems identified in table 3.4. The advantage is that CR can access time beyond the approximate 40,000 BP cap of the radiocarbon method, and it is much less expensive than radiocarbon dating.

These varnish findings affect other approaches to dating

Varnish is not the only surface dating approach useful for rock art. Oxalate, amorphous silica, and rock art pigment are found in similar contexts. The concerns outlined here certainly have serious implications for dating these materials at the surfaces of rocks (Appendix 3a).

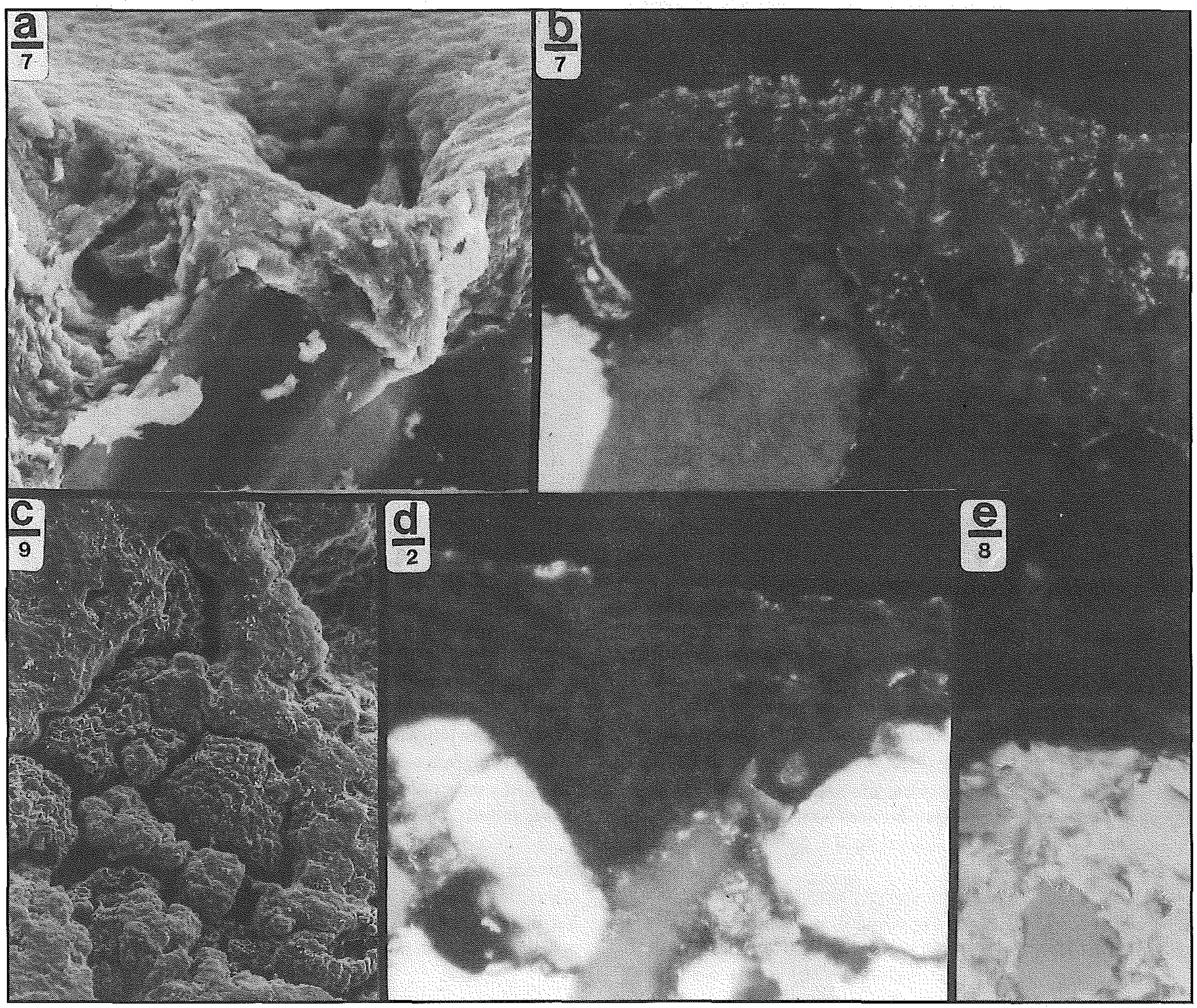
The methodological discovery and dating of organic matter in weathering rinds has great potential to aid in the dating of other surface coatings that may also seal the weathering rind—for example, amorphous silica (for example, Watchman 1990). It is also possible that paint pigment may "seal" weathering rind organics. If so, we would predict that ages for the pigment should be similar to (or slightly younger than) the organics in the underlying weathering rind.

Research into the dating of different components of the rock varnish system has shown that the type of organic matter dated does matter. Currently, we use chemical processing with HF and HCl to extract the most stable fraction. When the most stable fraction is not used, too young an age is produced compared to controls (Dorn et al. 1989). Russ et al. (1991, 1992) also extracted different carbon fractions with their nondestructive approach to dating pigments. I have been experimenting with extracting organic carbon from within and underneath rock varnish, using focused lasers aimed at cross sections. An inherent problem with this approach is the inability to separate the different carbon fractions. Inorganic carbon in carbonate is ablated, along with loosely adsorbed organic molecules and detrital carbon. Thus far, chemical pretreatment of samples with HF and HCl has not yielded a usable cross section (the varnish and weathering rind disintegrate in vacuum). This issue is relevant not only to rock varnish dating but also to any effort using lasers to ablate carbon in situ. Until pretreatment procedures of cross sections are worked out, the researcher will not know what carbon fraction is being dated.

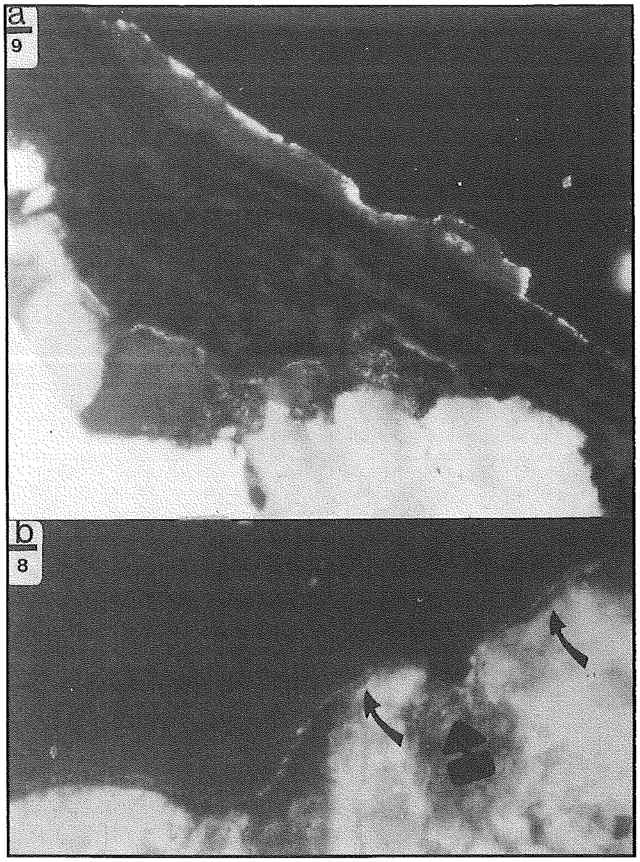
Acknowledgments
Supported by National Science Foundation Presidential Young Investigator award. Thanks to A. Bach, M. Bees, J. Bell, J. Clark, D. Dragovich, D. Elliott-Fisk, J. Francis, T. Liu, L. Loendorf, N. Meek, R. Moore, M. Nobbs, F. Phillips, D. Tanner, P. Trusty, D. Whitley, E. Wolfe, and M. Zreda for comments, and field and laboratory assistance; B. Trapido for graphical assistance. The ASU microprobe was purchased, in part, by NSF EAR 8408163.

Appendix 3a

Lessons Learned from Radiocarbon Dating Organic Matter Associated with Coatings on the Surfaces of Rocks

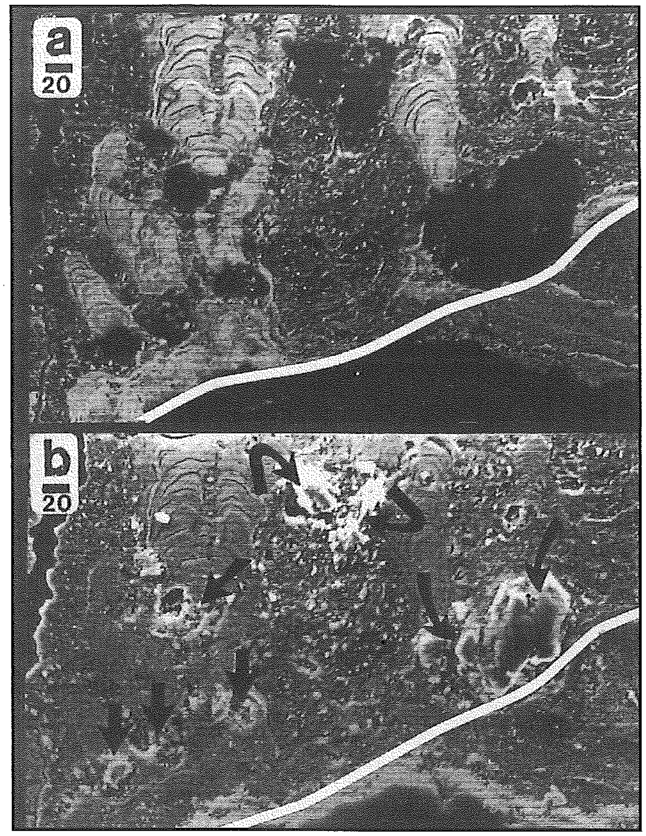


Lesson 1: The stratigraphy of the rock coating must be undisturbed. *a,* Pitting of rock varnish from Death Valley, California, where the left pit has been refilled and the right pit has not. This shows that pit development occurs at different times. *b,* Unlayered varnish on petroglyph PN6 from the Panaramitee North site in South Australia. The arrows identify pits eroded into the varnish. This type of an unlayered sample yields radiocarbon ages far younger than controls in test situations (Dorn, Jull et al. 1989) and yields incorrect CR ages (Dorn 1989; Watchman 1992). *c,* An example of an agent that creates these pits, in this case microcolonial fungi from Crater Flat in southern Nevada. *d,* Layered varnish on petroglyph PN6. [Radiocarbon ages on subvarnish organic matter of 43,140 ± 300 BP (AA 6898) and more than 43,100 bp (AA 6920).] *e,* Varnish on petroglyph PN4 [radiocarbon age on subvarnish organic matter of 5635 ± 90 BP (AA 6549)] that has fewer layers than the older PN6 petroglyph. Scales are in µm.



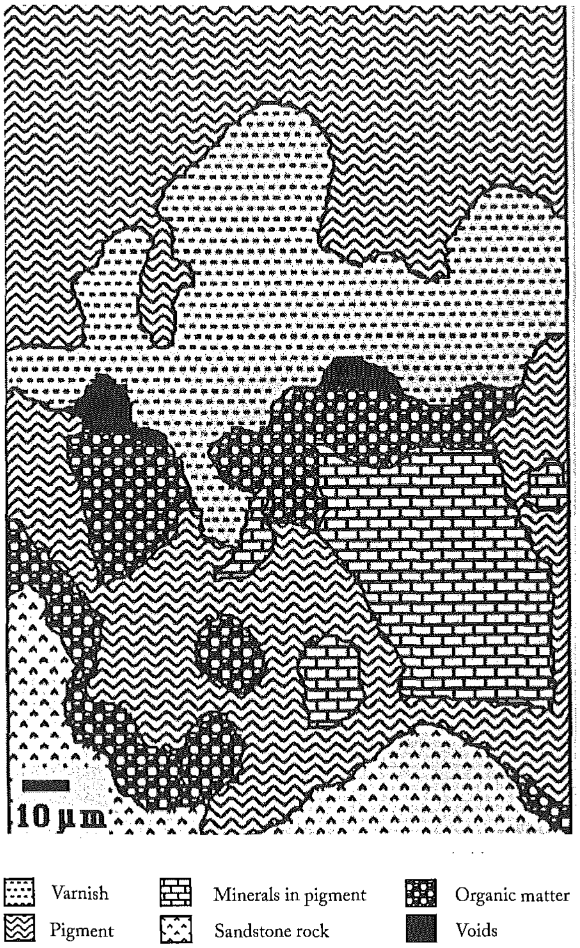
Lesson 2: Avoid spalling of the rock coating. Weathering rinds are typically more prone to erosion than the rock varnish that forms over them. When portions of the weathering rind spall, the overlying rock coating erodes with the rind. Image *a* shows layered varnish on petroglyph WH5 from the Wharton Hill site in South Australia. Image *b* shows a portion of the same petroglyph where the weathering rind had spalled off. Sometimes a partial coating grows again on top of the eroded rind (small arrows). In other circumstances, the grain-by-grain disintegration of the rock material is too rapid to permit regrowth of the coating (large arrow).

Microspalling is a very realistic and very likely source of error, especially for those inexperienced in sampling, and it can greatly affect the radiocarbon age. The HF-HCl extractable ^{14}C age of organic matter in the weathering rind (under the varnish) from this spall is 4162 ± 41 BP (NZA 2154). The HF-HCl extractable ^{14}C age for just the weathering rind (under layered varnish) is 35,530 ± 650 BP (NZA 2361). This age is consistent with a model where new organic matter is added to a reexposed weathering rind; this example also demonstrates that coated organic matter can occur in a closed system, as evidenced by a ^{14}C content under 2 percent. Scales are in μm.



Lesson 3: Avoid organics within the accumulating rock coating. Most layered rock varnishes suitable for dating do not have abundant organic matter. Yet, some do, and unlayered varnishes with abundant evidence of pitting (Lesson 1) can collect a lot of organic matter in these pits. This intravarnish organic matter represents additions of carbon well after the petroglyph was made. The potential hazard of intravarnish organics emphasizes that varnish ^{14}C dates must be interpreted as minimum ages for the underlying petroglyph.

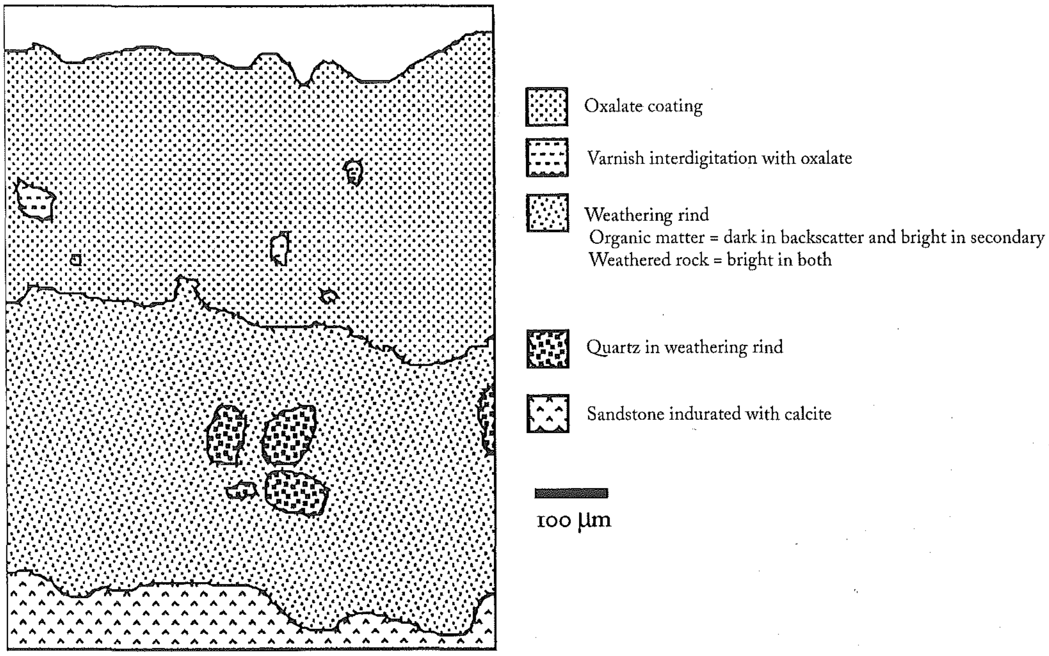
In this example of a grid-shaped petroglyph from Petrified Forest National Park, Arizona, the backscatter electron micrograph *a* shows the organic matter as black because of the low atomic number of carbon. Yet, in the secondary electron micrograph *b* that shows topography, the organic matter is white and charging (arrows). Scales are in μm.



a

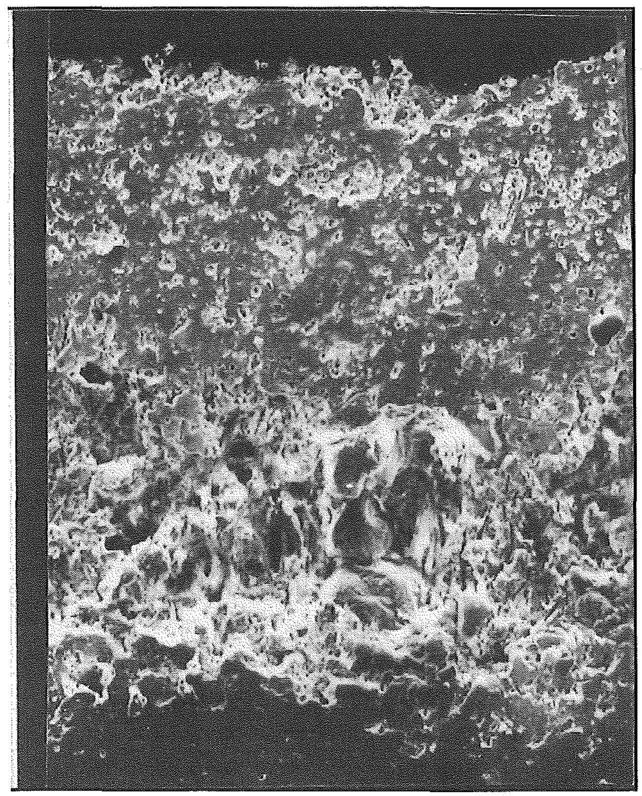
b

Lesson 4: Hazards associated with dating rock coatings are not unique to rock varnish. Take, for example, this complex interaction of pigment, varnish, organic matter, and underlying rock on a petroglyph sampled by L. Loendorf. First, the petroglyph was engraved and a weathering rind developed with organic matter that has a ^{14}C age of 1195 ± 56 bp(nza 2152). Second, a red pigment (containing clay minerals, bits of rock material, and bits of organic matter) was applied. These components can be seen in the backscatter image *b* and the corresponding map *a*. (The pigment sealed the underlying weathering rind and its organics, much like varnish.) Third, varnish grew on top of this pigment. Then, more pigment was applied on top of the varnish. *(continued on next page)*



c

d



e

Lesson 4, continued: Another example is this oxalate coating on a Bighorn sheep petroglyph from the Black Hills, collected by A. Tretebas in Wyoming. The generalized map of a cross section *c* matches the backscatter image *d* (where brightness provides chemistry) and the secondary image *e* (which gives topography). The very bright spots in the oxalate coating are rock varnish that is rich in manganese and iron (high atomic number). The abundant organic matter in the weathering rind (only the largest pockets are mapped) is black in backscatter but is bright in secondary. Currently, there is no evidence to indicate whether oxalate coatings can or cannot seal the organic matter in the underlying weathering rinds. However, the nature of the organic matter in the weathering rind must be explored before a reliable radiocarbon age of the oxalate that formed over the petroglyphs can be obtained.

4 Cation-Ratio Dating and Chronological Variation Within Dinwoody-Tradition Rock Art in Northwestern Wyoming

JULIE FRANCIS

AMONG THE MOST WELL-KNOWN ROCK ART from the state of Wyoming is a complex of extremely elaborate pecked figures which has been termed Dinwoody style (Wellmann 1979:132). This group of petroglyphs, which occurs only in the Wind River and lower one-third of the Bighorn River drainages in northwestern Wyoming, is best known for its unique interior line human figures. There is a great deal of diversity, the complex including both interior lined and fully pecked anthropomorphic and zoomorphic forms. Based on an analysis of several sites in the study area, Dinwoody petroglyphs can be grouped into several mutually exclusive descriptive types.

The initial results of AMS radiocarbon and cation-ratio (CR) dating at several Dinwoody sites indicate that these petroglyphs were manufactured over a nearly 6000-year time span, from the Early Archaic through the Protohistoric periods (Francis et al. 1991). Temporal analysis by descriptive type suggests an evolutionary sequence from relatively simple fully pecked human figures to intricate life-size figures. Analysis of the zoomorphic types also suggests systematic changes in both the manufacturing technique and the specific types of animals depicted through time.

Dinwoody Rock Art

Perhaps because it is so unusual, Dinwoody rock art has long been documented and described. The earliest recording dates to 1873 with the documentation of several glyphs along the Little Popo Agie River (Jones 1875; Putnam 1876; Hendry 1983). In 1931, E.B. Renaud described another panel of Dinwoody figures along Twin Creek in Fremont County (Renaud 1936:17–20). Also in the 1930s, extensive excavation and interpretation of the rock art was conducted at the "type site" (48FR109) located in Dinwoody Canyon in the upper Wind River drainage as part of the Works Projects Administration (Sowers 1941).

Dinwoody rock art is sufficiently distinct that Wellmann (1979:132) has termed it the Dinwoody style. It is always pecked, and one of its hallmarks is near life-size, elaborate human figures (fig. 4.1). These figures often have some type of headdress, such as one or more sets of horns, helmets, or crowns, suggestive of ceremonial paraphernalia. In some instances, a single body will exhibit two or more heads. Limbs often have bizarre orientations, occasionally winding around rock surfaces and boulders. Multiple sets of arms and limbs may be depicted on one torso. Occasionally, a figure may have no arms and only one foot. Torsos may be fully pecked, stipple pecked, or characterized by intricate patterns of finely pecked interior lines. A few figures have suggestions of clothing, such as belts at the waist or fringe at the base of the torso between the legs. Some of the human figures contain smaller, secondary humans pecked in the interior of the torso. Gender is not often indicated; however, there are a few instances where it can be inferred. In many cases, wavy lines dangle or radiate from the hands, feet, and head, suggestive of an aura. These lines sometimes completely surround the figure. Notably lacking at Dinwoody rock art sites are the shield-bearing warrior and v-necked human motifs that characterize much of Plains rock art (Francis et al. 1991).

Animals are often associated with these elaborately pecked humans. Most often, they are quite realistic, with details of antlers, horns, and genitalia accurately depicted. Artiodactyls, dogs, and unknown quadrupeds are the most common taxonomic categories. In most cases, the animal figures are much smaller than the human figures, and no explicit hunting scenes are depicted. In some cases, humans and dogs are seemingly connected by a leash (fig. 4.2).

A shamanistic origin has frequently been suggested for Dinwoody rock art (Sowers 1941; Francis and Frison 1990; Hendry 1983). Certainly, many of the figures evoke supernatural images. Many elements of Dinwoody rock art can be classified as entoptic phenomena, which Lewis-Williams and Dowson (1988) suggest are associated with hallucinations experienced during shamanistic trances. Many of the "human" figures may actually be therianthropes, that is, incorporating both human and animal characteristics. Some panels evoke images of flying or out-of-body experiences, often described by shamans (see Lewis-Williams 1984b:226–231). In addition, recovery of carved steatite tubes, inferred to be shaman sucking tubes (Frison and Vannorman 1991) from the base of Dinwoody panels certainly suggests that these sites were used for ritual or ceremonial purposes.

Spatial distributions

One of the more unusual aspects of Dinwoody rock art is its restricted spatial distribution (fig. 4.3). Gebhard (1969) notes

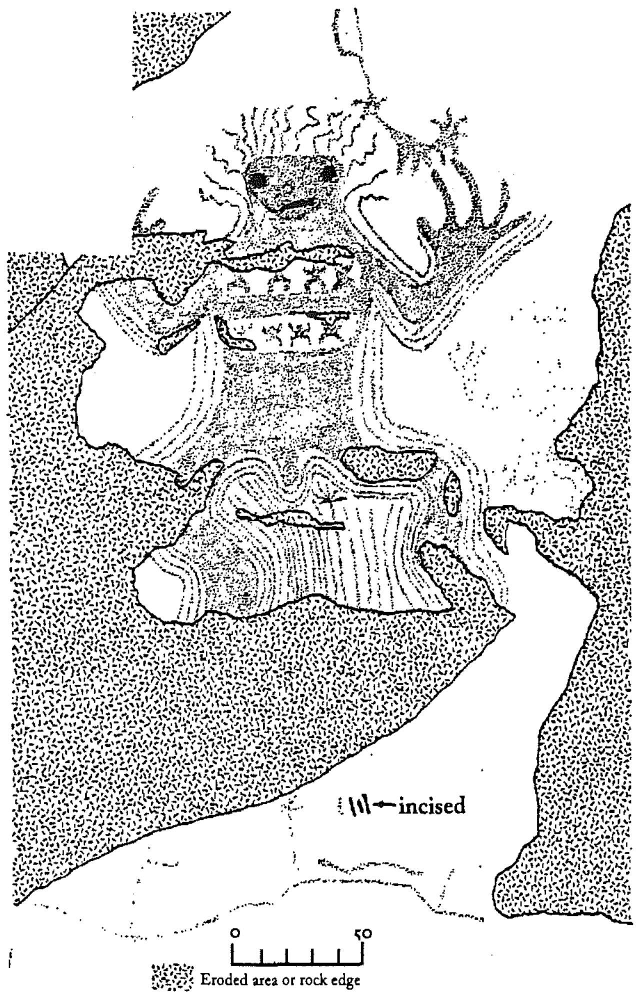


FIGURE 4.1 PANEL 3 AT 48FR373. This figure exhibits many of the hallmarks of Dinwoody-tradition anthropomorphs. *Tipps and Schroedl 1985.*

its occurrence along the creek valleys north and south of Dinwoody Canyon in the Wind River Mountains, with particularly fine examples in the vicinity of Trail, Torrey, and Ring Lakes (Swaim 1975). Numerous examples are also found downstream along the Wind River and its tributaries to Boysen Reservoir (Wheeler 1958; Stewart 1989; Tipps and Schroedl 1985). Gebhard (1969) notes the occurrence of Dinwoody sites in the southern Bighorn Basin—after the Wind River turns north and emerges through Wind River Canyon as the Bighorn River—along Owl Creek, Cottonwood Creek, Black Willow Springs, Wagon Gulch Creek, and Grass Creek, all of which drain off the eastern side of the Absaroka Mountains and flow into the Wind River. Dinwoody petroglyphs do not occur east of the Bighorn River and apparently are no farther north than the Gooseberry Creek drainage. This circumscribed area essentially corresponds to the valley system of the Wind River and the western portion of the upper Bighorn River (Gebhard 1969:20).

It is notable that, within the area encompassed by Dinwoody rock art, other types of rock art, such as shield-bearing warriors and v-necked figures, do not occur. In other words, within the Wind River and lower Bighorn River drainages, Dinwoody rock art appears to be the only rock art present.

Chronological data

In the absence of direct dating techniques, most researchers hypothesized that Dinwoody rock art is a relatively recent phenomenon. Based on studies at the Dinwoody site and several other sites in the Bighorn Basin, Gebhard (1951, 1969) defined three "styles" of pecked human and animal forms: Early Hunting, Interior Line, and Late Plains Hunting. He suggested a chronological sequence of these styles based on cases of superimposed figures (1969), with Protohistoric and Historic period dates ascribed to the majority of the art. Likewise, Hendry (1983) suggested that Dinwoody rock art was Historic period in age and was associated with the formation of the Wind River Indian Reservation in 1872. This inference was based on the spatial distribution of known rock art sites around the reservation and the apparent stylistic similarities of many glyphs to symbols of the historic Ghost Dance Cult.

More recent investigations have provided new chronological data for several Dinwoody sites. In 1988, charcoal-bearing sediments that partially buried a Dinwoody human figure at the Legend Rock site (48HO4) were radiocarbon dated to 1900 BP (Walker 1989:30). Sediments from well below the base of the figure were radiocarbon dated to around 2100 BP (Walker 1989:30). These dates bracket the manufacture of the figure and indicate that this Dinwoody figure was created during the Late Archaic period, approximately 2000 years ago (Francis 1989:193–194). In 1990 and 1991, studies were undertaken to develop a calibration curve for CR dating of rock art throughout the Bighorn Basin in Wyoming and Montana (Loendorf et al. 1991; Francis et al. 1991). AMS radiocarbon and CR dating have been used successfully to establish petroglyph chronologies in the Great Basin, southeastern Colorado, arid South Australia, and the Bighorn Basin of Wyoming (Dorn and Whitley 1984; Loendorf 1989; Dorn et al. 1988). Detailed discussions of these techniques are presented in those studies and are not reiterated here.

Briefly, however, petroglyphs in arid and semi-arid regions start to accumulate a coating of rock varnish (Dorn 1992d) soon after they are engraved. Rock varnish is a dark, thin accretion of manganese and iron oxides, clay minerals, and more than 30 major and minor trace elements. Its formation is catalyzed by manganese-oxidizing bacteria (Krumbein and Jens 1981; Dorn and Oberlander 1982; Palmer et al. 1985). AMS can be used to obtain direct ^{14}C measurements on the organic matter coated by the accreting varnish, thus providing a minimum radiocarbon age for the petroglyph. AMS dating also enables researchers to calibrate the CRs of the varnish.

The chemical composition of the varnish can be precisely and accurately measured through the use of particle-induced X-ray excitation (PIXE) and the wavelength dispersive electron microprobe. A ratio of potassium plus calcium divided by

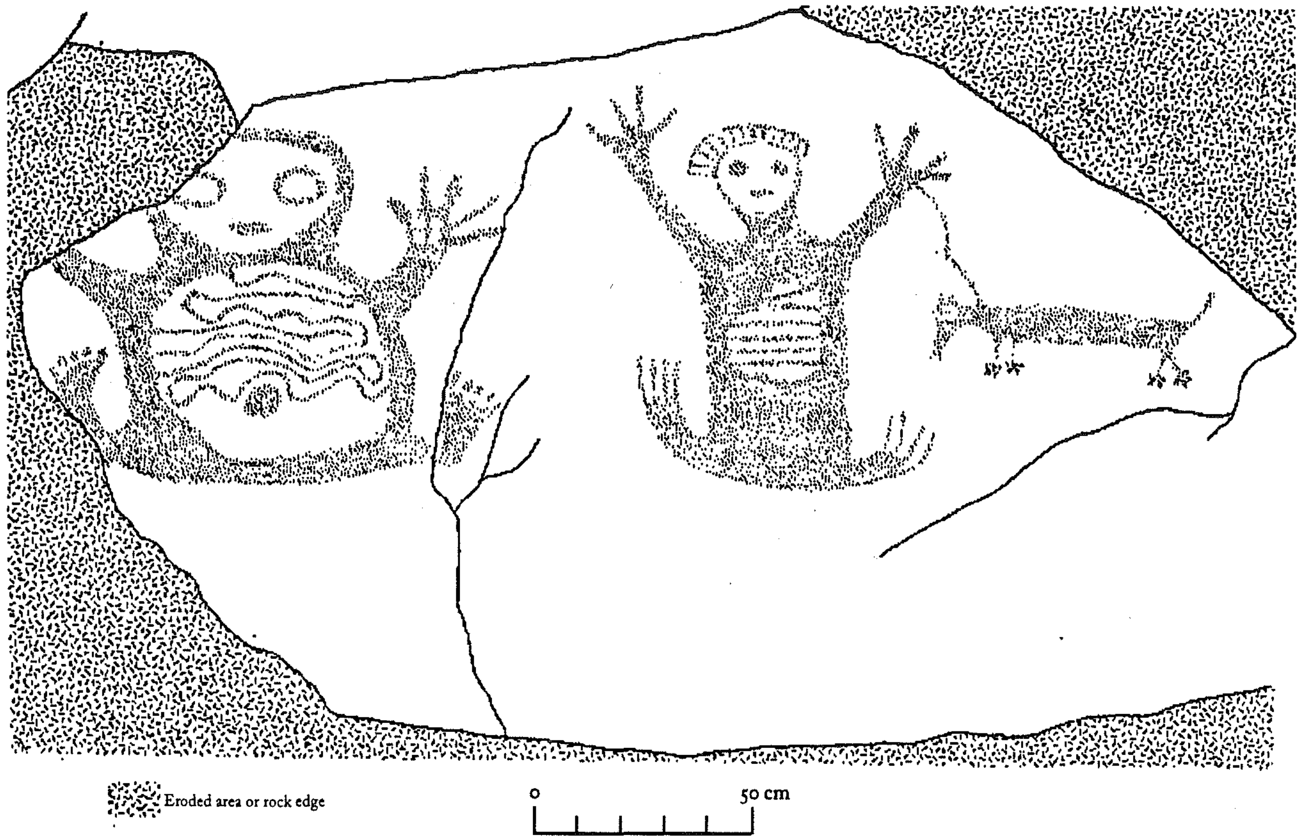


FIGURE 4.2 PANEL 1 AT 48FR43. A Dinwoody anthropomorph is connected to what appears to be a canine figure. *Tipps and Schroedl 1985.*

titanium ([K + Ca]/Ti) is used as an indicator of relative age. The potassium and calcium leach out of the varnish over time; thus, the ratio of (K + Ca)/Ti decreases systematically. These CRS are calibrated by measuring radiocarbon dates and the (K + Ca)/Ti from the same varnish. A semi-log, least squares regression of the CRS and radiocarbon ages is computed to develop a calibration curve. The CRS for petroglyphs of unknown age can then be compared to the curve and a calibrated age assigned.

One of the important findings of the varnish dating study concerns the more recent petroglyphs. Cation-ratios for petroglyphs less than 1000 years old do not appear to follow the same curve as those for petroglyphs older than 1000 years (Francis et al. 1991). The specific cause of this deviation is being investigated, and, as a result, calibrated ages are given only for those petroglyphs older than 1000 years. When available, AMS dates are used for the younger petroglyphs; when only CRS are available, these glyphs are listed simply as younger than 1000 years.

The 1990 study resulted in five AMS radiocarbon dates and thirteen CR ages ranging from 6000 to 200 BP. These data suggest that manufacture of Dinwoody-style petroglyphs may have occurred continuously from the Early Archaic to the Protohistoric period (Frison 1991; fig. 4.4). Dates for shield-bearing warriors at other sites in the Bighorn Basin are no older than about 900 BP (Loendorf 1990a; Francis et al. 1991), indicating that these motifs are fairly recent introductions or developments in the area, dating to no earlier than the Late Prehistoric period.

The extremely long time span for the manufacture of Dinwoody petroglyphs, as well as their limited spatial distribution, suggest that Dinwoody rock art is an indigenous, highly specialized tradition with a great deal of internal continuity or stability (Francis et al. 1991). During the last 800 to 900 years, Dinwoody rock art is coeval with, but spatially separate from, other art forms. The Archaic age of Dinwoody forms, with their bizarre lines and disconnected body parts, may be the representation of a stable, shamanic tradition practiced in the Wind and upper Bighorn River drainages for thousands of years. The continuity of the shamanic elements through time suggests that the rock art tradition may have been very slow, if not resistant, to change and external influences. Nevertheless, the wide variety of Dinwoody forms indicates internal variation, and the extremely long time span suggests the possibility of evolutionary change within the tradition.

Descriptive Types

The initial impetus for this study came from the 1988 investigations at the Legend Rock site (48HO4). As part of cultural resource management studies associated with development at the proposed state park, test excavation and extensive docu-

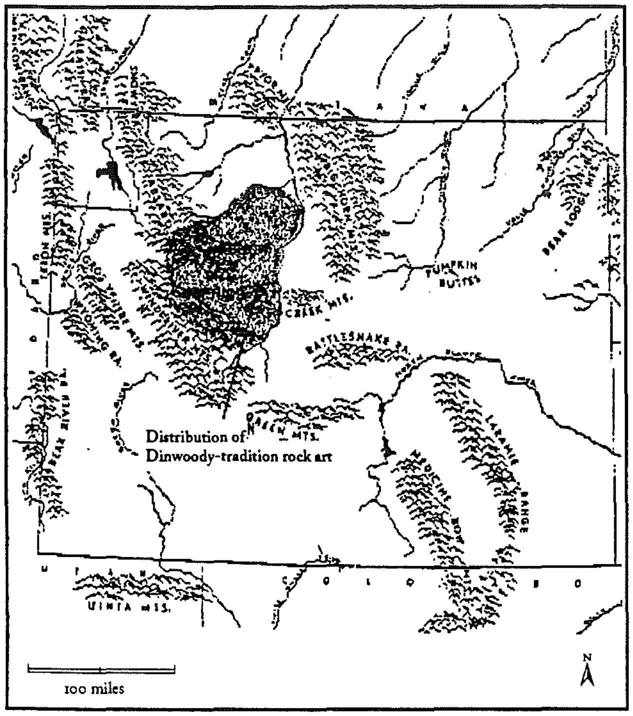


FIGURE 4.3 MAP OF WYOMING. distribution of Dinwoody-tradition rock art is shown.

mentation of the rock art was undertaken (Walker and Francis 1989). In addition to the radiocarbon dates obtained for the partially buried Dinwoody anthropomorph discussed previously (Francis 1989:154–187), 283 glyphs recorded were classified into three types of zoomorphic figures, six types of anthropomorphic figures, abstract designs, and Euro-American graffiti. The vast majority of these glyphs are Dinwoody figures that encompass two zoomorphic types and three anthropomorphic types (Francis 1989:175).

Subsequent to these studies, the CR dating project was initiated in 1990 (Francis et al. 1991) and continued into 1991. Numerous Dinwoody sites were visited. Varnish samples for both AMS radiocarbon and CR dating were collected at five sites. In addition, detailed recording was undertaken at two other localities in 1991. It became apparent that the Dinwoody figures at Legend Rock encompassed only a small portion of the range of variation. Consequently, the classification system was expanded using the same guidelines as those employed for the original Legend Rock study.

The general guidelines and terminology for the Dinwoody art used here were previously used in the original Legend Rock study (Francis 1989:154). Following Sundstrom (1984:55), "glyph" or "figure" refers to a single carving (incised or pecked) or painting. A panel is a group of one or more glyphs on a single rock surface. Following Loendorf and Porsche (1985:61–63), a "descriptive type" designates a group of glyphs with explicitly defined attributes. Using the criteria of subject matter, method of manufacture, and several other specific attributes, six anthropomorphic types and three zoomorphic types have been defined. These types most likely do not include the entire range of variation within Dinwoody rock art. Likely as not, as more sites are intensively studied, the classification system may be expanded and refined. It is not difficult to envision hierarchically ordered subtypes within major categories being developed by future studies. What is important to emphasize at this point is that the classification system can be replicated by other investigators and can be used for any Dinwoody site, thus enabling valid comparative studies.

The principal criteria used for defining the anthropomorphic types are method of manufacture, body shape, and the presence of some type of horns or headdress. The distinguishing criteria are incorporated into the type name, as discussed next.

Fully pecked horned anthropomorphic type

The fully pecked horned anthropomorphic type is distinguished by fully pecked torsos and horns or a horned headdress and other forms of head decoration (fig. 4.5). This type was first defined at the Legend Rock site (Francis 1989:176) and comprises one of the more common types of figures there.

These anthropomorphic figures tend to be fairly large, with mean maximum height of 46.63 cm and a mean maximum width of 30.03 cm (Francis 1989:176). Bodies tend to be rectangular shaped and squat; there are examples, however, of more elongated forms. In many cases, the neck and head are not depicted; instead, the head is formed by the horns or headdresses and is an extension of the torso, with little indication of a neck. The treatment of the head includes a single set of horns, multiple sets of horns, horns surrounding some other type of headdress, or a helmet-like representation. Arms are typically extended and have a variable number of fingers. Legs, when present, are short. Frequently, only the feet at the bottom of the torso have been pecked. The number of toes is also variable, giving these glyphs the appearance of a spread-legged sitting position. The view is always frontal, and gender is rarely indicated.

Composite anthropomorphic type

The composite anthropomorphic type is also fairly common at the Legend Rock site. The distinguishing characteristic is at least one small secondary human figure pecked into the torso of a larger human figure (fig. 4.6). This type was included within general interior lined or outline pecked human figures (Francis 1989:178). These anthropomorphic figures seem distinctive enough, however, to warrant a separate designation.

Most commonly, the bodies are fully pecked or lightly stipple pecked, with the secondary figures pecked into a blank or unpecked area, generally in the lower portion of the torso. The arms and legs of the secondary figures often protrude from the body of the primary figure. Thus, at first glance, these figures give the appearance of having multiple set of arms and legs and of being upside down. Hendry (1983:36, 61) has termed this type of figure either the double composite or host satellite

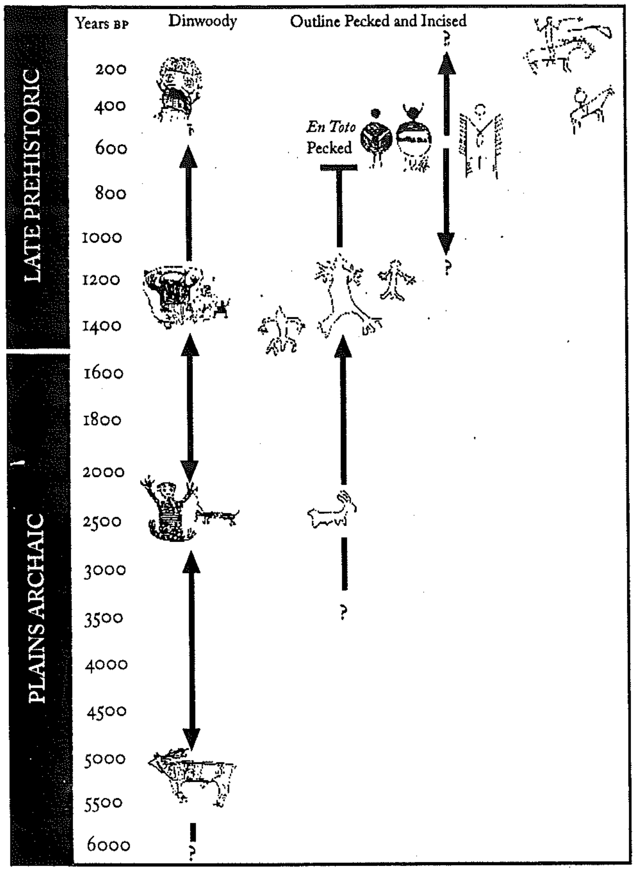


FIGURE 4.4 ROCK ART CHRONOLOGY FOR THE BIGHORN BASIN, NORTHERN WYOMING AND SOUTHERN MONTANA. Based on AMS and CR dating. Rock art figures are not to scale.

design. Body shapes are generally rectangular. The arms of the main figure are sometimes extended and have a variable number of fingers. The feet of the main figure are often fully pecked, with no toes depicted.

These figures are generally quite large. Examples from the Legend Rock and Amazon sites (48HO39) are more than a meter tall. Heads are occasionally more clearly represented, as compared to the fully pecked figures, and these figures always seem to have some type of headdress or hairstyle. Horns are the most common type of head treatment. One unusual example at the Legend Rock site is a head treatment that is reminiscent of the "squash blossom" hairstyle worn by Hopi women.

Elongate interior line anthropomorphic type

The elongate interior line anthropomorphic type of figure can probably be considered the hallmark of Dinwoody rock art; the term "interior line style" is practically synonymous with Dinwoody rock art (Gebhard 1969; Tipps and Schroedl 1985). Its distinguishing characteristics are the pecked interior lines in the torsos of human figures and the overall body shape in which the length is greater than the width (fig. 4.7). Francis (1989:181) included interior line figures within the outline pecked horned anthropomorphic type defined at the Legend Rock site.

Many of the elongate interior line anthropomorphs are quite large. At the Legend Rock site, the mean height of these figures is nearly 70 cm (Francis 1989:167). Other examples, such as those from the Coal Draw site (48HO469), are more than a meter tall. The interior lines within the torsos form many patterns, most commonly a series of vertical lines running from the shoulders to the base of the torso. Vertical and horizontal lines, forming a criss-cross pattern, also occur. Occasionally, the interior lines run at all angles, forming a complex pattern of interlocking geometric shapes. In some examples, portions of the shoulders or the outer edges of the torso are fully pecked or stipple pecked.

The elongate interior line anthropomorphs often have heads; however, specific facial features are not depicted. On most examples, a horned headdress is present. Where not specifically represented, the head may be depicted by one or more sets of horns. These figures are always shown in frontal view in what appears to be a standing posture. Many figures show short pecked lines, resembling fringe at the base of the torso, and it is tempting to suggest that this represents some type of clothing. Hands, arms, legs, and feet are depicted in a variety of ways. Arms are generally extended with a slight bend at the elbow. Variable numbers of fingers are present. In some cases, the arms are simply represented as a series of curved, parallel lines, more similar to wings than actual human arms. The feet can be depicted in minute detail, showing features of ankles or toes, or as claws. In many cases, wavy lines dangle from the arms and in some cases completely surround the human figure.

Many attributes of the elongate interior line figures epitomize the shamanistic elements of Dinwoody rock art. The large, intricately pecked figures often embody both human and animal characteristics, with suggestions of flying or other "out-of-body" phenomena. The wavy danglers and lines surrounding the body often give the impression of an aura, and the interior body lines suggest internal body parts. The various combinations of these attributes give Dinwoody rock art the surreal character that seems to have no parallel in other rock art in the Northwestern Plains.

Attenuated human figures

One of the more unusual types of Dinwoody anthropomorphic forms is a class of figures in which the body is formed by a long, single, wavy line (fig. 4.7). Thus far, these figures have only been documented at the Legend Rock site (Francis 1989:181–183). They are generally quite tall, with a mean height of nearly 1 m. The head consists solely of a horned headdress formed by bifurcation of the body line. Arms are stubby, and hands have a variable number of fingers. As with the headdress, legs are formed by bifurcation of the body line. Feet and toes are often carefully pecked, with minute details represented. In a few cases, a single foot has been pecked at the base of the body line.

The attenuated figures are always associated with the fully pecked or elongate interior line glyphs; they do not occur in

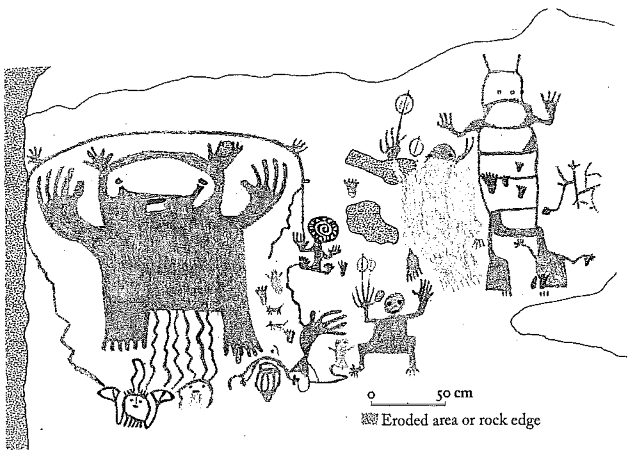


FIGURE 4.5 PANEL 1 AT 48FR372. The large human figure at the left side of the panel is an example of the fully pecked horned anthropomorphic type. *Tipps and Schroedl 1985.*

isolation. Often the body lines weave around rock surfaces or other anthropomorphic figures in what appears to be an integral part of the overall panel. Occasionally, the arms and legs of the main figure in a panel will be formed by the attenuated figure. The single lines representing the arms or legs curve around rock surfaces with bizarre orientations and terminate with a horned headdress.

Wide body anthropomorphic figures

The final type of Dinwoody anthropomorphic figure is termed "wide body," owing to its distinctive body shape. The total height and width of the torso are nearly equal or width may exceed height, and the head is incorporated into the torso (fig. 4.8). The top of the body is rounded and the base is flat, giving these figures a "bullet-shaped" appearance. Occasionally, facial features are represented at the top of the body, and headdresses are rare. These figures may be either fully pecked or interior lined. Hands and feet are depicted as lines resembling wings or claws. Legs are rarely present, giving the impression of sitting figures. Overall, these figures tend to be shorter than the other types of Dinwoody anthropomorphs. One example from 48HO354 is only about 50 cm tall. Based upon examination of site report forms, these figures seem to be most common around Boysen Reservoir and farther upstream on the Wind River. They seem to be relatively rare in the Bighorn Basin.

Some Dinwoody human figures are not included in the types defined. In these cases, only a single example of such a figure has thus far been documented, and the occurrence of one figure is not felt to be sufficient to define a descriptive type. For example, one of the figures dated by this study is a round bodied, interior lined human figure from the Legend Rock site (fig. 4.9). Concentric circles form the body, and the arms and at least one leg wrap around rock surfaces, forming attenuated human figures. This figure also has a headdress formed by two nested sets of horns. The circular body shape is most unusual. This figure is probably most closely akin to the elongated interior line type; however, it cannot be classified within this type.

Zoomorphic types

Zoomorphic figures are an integral part of Dinwoody rock art. Animal figures occur in combination with the anthropomorphic types as part of the same panel, as panels composed solely of animal figures, and as single isolated figures. The zoomorphic types do not exhibit the same degree of diversity as the human figures, and they differ greatly from the human figures in that animals are depicted with a great deal of realism and detail. For the most part, they seem to lack the supernatural characteristics of the human figures and can be considered representational. The three types of figures are discussed next.

Outline pecked zoomorphic figures are among the most distinctive and striking. They are not particularly common, and the best examples have been documented at the Legend Rock site (Francis 1989:157, 168). Gebhard (1969:17–18) has classified these types of figures as either the Interior Lined or Late Plains Hunting styles.

The distinguishing characteristic is outline pecking of the body (fig. 4.10). In some figures, fine vertical lines have been pecked into the body or torso area. In others, very light, diffuse

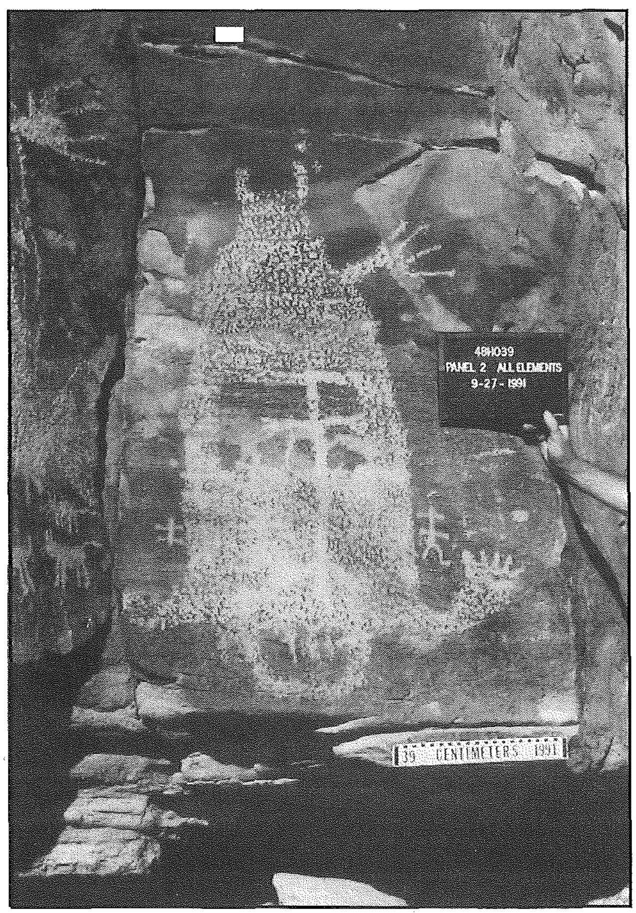


FIGURE 4.6 PANEL 2 AT 48HO39. The dominant figure is an example of the composite anthropomorphic type.

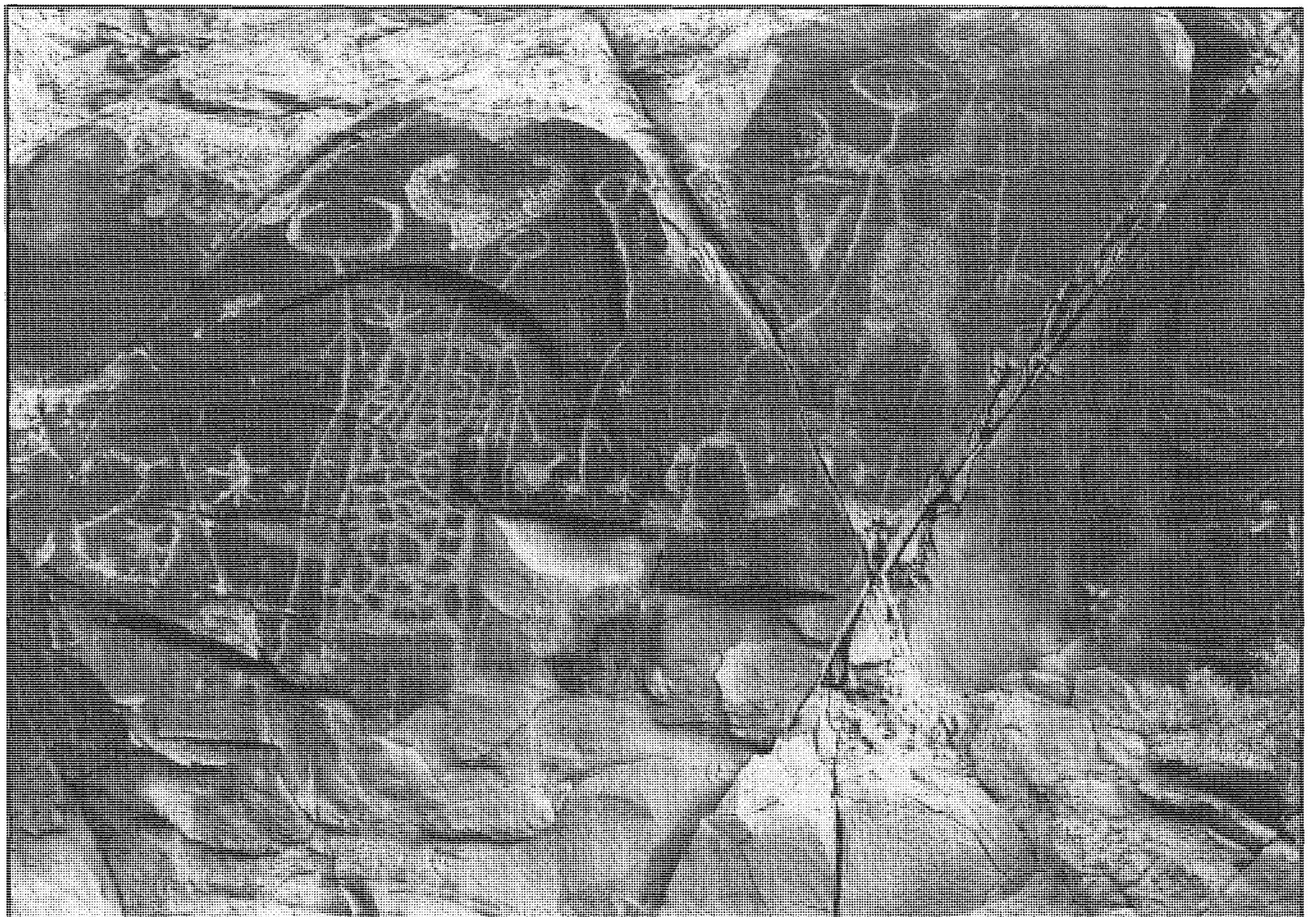


FIGURE 4.7 PANEL 61 AT 48HO4, LEGEND ROCK SITE. At the left side of the panel is an example of the elongate interior line anthropomorphic type, with attenuated human figures on either side. The elongate interior line anthropomorph is 98 cm tall.

pecking occurs throughout the body area. Heads are often fully pecked, and the animals are shown in profile with either two or four legs represented. Hooves, when present, are rendered as fully pecked or as outline pecked circles. Horns and antlers are carefully executed, and many figures are "anatomically correct," with detailed depictions of genitalia. Compared to other zoomorphic types, these figures are large. At Legend Rock, they have a mean height of more than 26 cm and a mean width approaching 34 cm (Francis 1989:157). Outline pecked zoomorphs are predominantly large artiodactyls, such as bison, elk, and possibly deer. Of the 29 figures documented at Legend Rock, 20 were identified as large artiodactyls (Francis 1989:157). The remaining figures include 1 possible canid and 8 whose species were unidentifiable.

Fully pecked animals appear to be the most common Dinwoody zoomorphic type. As the name implies, this type is distinguished by fully pecked realistic figures (fig. 4.11). They are part of what Gebhard (1969:15) termed the Early Hunting Style and what Sundstrom (1984:100) refers to as the Pecked Realistic Style. Fully pecked Dinwoody animals can be distinguished from Loendorf's (1984) en toto pecked style by their direct association and apparent contemporaneity with Dinwoody anthropomorphs and their greater realism.

Fully pecked Dinwoody animals tend to be significantly smaller than the outline pecked animals. At Legend Rock, the fully pecked figures have a mean height of less than 18 cm and a mean width of 23 cm (Francis 1989:168). Animals are most often shown in full profile, with either two or four legs represented as straight lines; in many cases, the animal figures appear to be running. Special attention is paid to renderings of antlers or horns.

Fully pecked animals differ from the outline pecked figures in both the diversity and types of animals represented. Many different species are included in the fully pecked type: large artiodactyls, medium artiodactyls, canids, birds, rabbits, felines, and lizards. Medium artiodactyls, with clear representations of mountain sheep, deer, and pronghorn antelope, are the most common. The species of many fully pecked animals cannot be positively identified. They are all quadrupeds; some have ears or horns, and tails that extend straight out. They may be canids or possibly a medium-sized artiodactyl. When associated with the Dinwoody human figures, the fully pecked animals are often dwarfed by the large size of the human figures (fig. 4.7). The animals typically appear at the base of or around the sides of the principal human figure. Explicit hunting scenes are not apparent.

The final zoomorphic type defined is termed fine line pecked. These figures (presumably animal) are formed by a se-

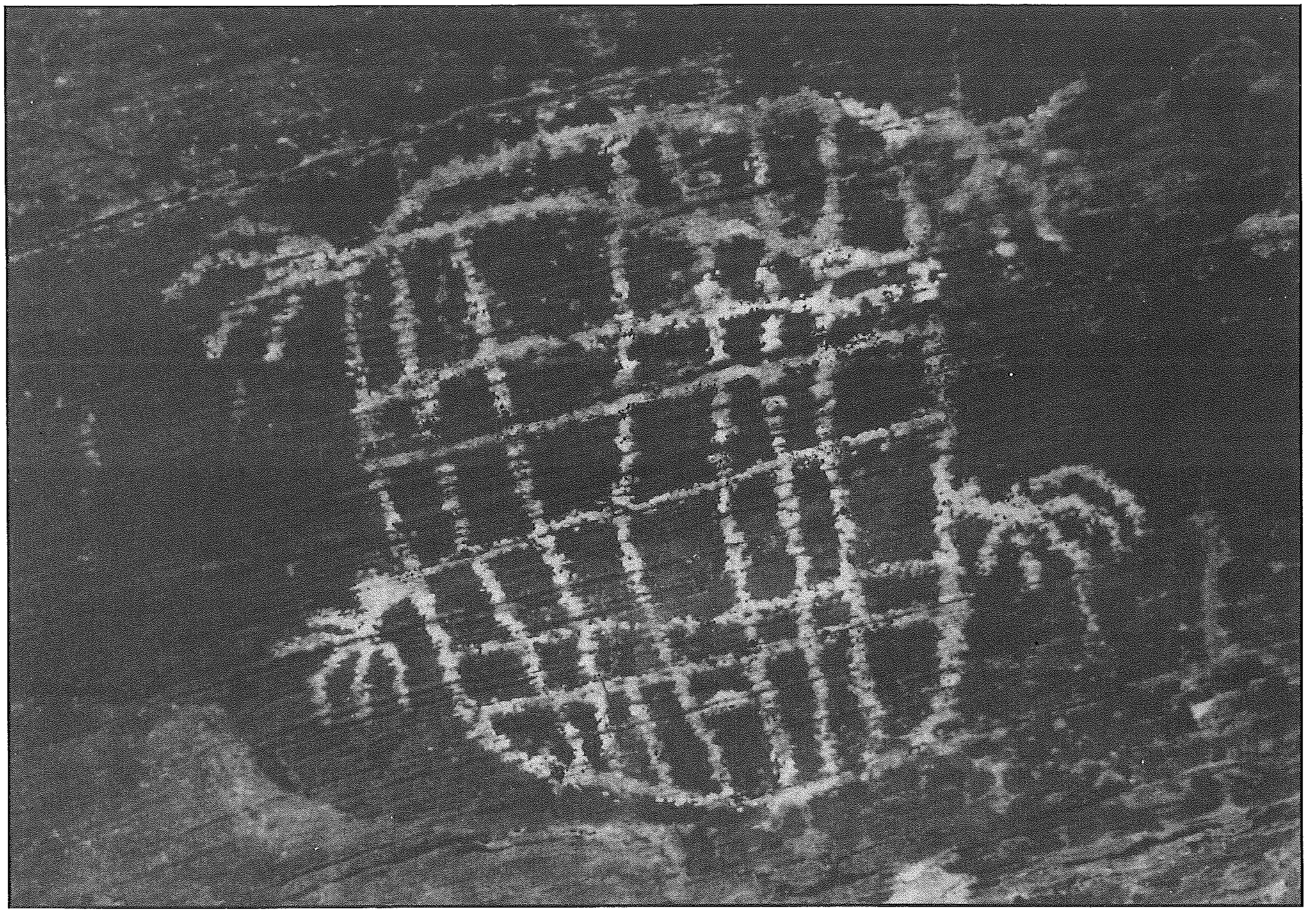


FIGURE 4.8 WIDE BODY FIGURE FROM 48HO354. This 56-cm-tall figure yielded a CR date of less than 1000 BP.

ries of finely pecked lines radiating from a central point (fig. 4.12). No specific body shape is outlined, and certainly no species are identifiable. The overall shape is one of a fan or some sort of insect, and they may not even represent an animal. Finely pecked appendages also occur. These figures, which are not particularly common, are found in the Bighorn Basin at Coal Draw (48HO469) and around Boysen Reservoir.

Temporal Variation and Patterning

Twenty-five dates are available for Dinwoody figures (table 4.1), including 24 AMS or CR dates and 1 conventional radiocarbon date for the partially buried figure at the Legend Rock site. These 25 dates represent 20 different petroglyphs from five sites (48HO4, 48HO354, 48HO469, 48FR194, and 48FR372). Samples from different portions of three figures were taken to check for internal consistency. In addition, there is considerable evidence that many Dinwoody figures were repecked following their original manufacture. Thus, for two of the figures, samples were collected from both the original and repecked sections. All dated Dinwoody figures are used in this study. No dates were disregarded because they "did not seem to fit."

It should be emphasized that statistical sampling procedures were not used to obtain these data; rather these are entirely judgmentally derived samples. For the varnish dating study, sites were judgmentally chosen for specific reasons: other types of chronological data were already available, unusual artifacts had been found with the rock art, or sites could be easily relocated and accessed from other investigator's maps and field notes. Specific petroglyphs within each site were also judgmentally chosen for sampling. The primary criterion was well-preserved varnish. Every effort was made to obtain samples from the different descriptive types, as defined in the original Legend Rock study. Because of the pioneering nature of the varnish dating project, only a few dates are available for each descriptive type, and, likely as not, the available dates do not necessarily encompass the entire range of chronological variation within any one type.

Of the 25 dates, 4 can be considered Early Archaic (older than 5000 years), 10 are Late Archaic (3000 to 1500 BP), 8 are Late Prehistoric (1500 to 500 BP), and 3 are Protohistoric (less than 500 years). This distribution may well be due to some sampling bias and differential preservation, rather than to variation in the intensity of manufacture. At the Legend Rock site (which yielded all 4 Early Archaic dates), there was a concerted effort to sample "old-looking" petroglyphs or petroglyphs that exhibited well-preserved varnish. The low frequency of Protohistoric period figures may well be due to the fact that varnish suitable for dating simply has not had time to develop. The paucity of figures dating in the 4000- to 3000-year range or Middle Archaic period may be due to a low frequency of

Table 4.1 Dated Dinwoody rock art figures

Type	Site	Sample #	Age (BP)	Dating technique
Anthropomorphic figures				
Fully pecked horned	48HO4	WP-90-15	2400 ± 350	CR
	48HO354	WP-91-4	2500 ± 300	CR
	48HO4	Panel 70	1900 - 2100	^{14}C dating of sediments burying glyph
Composite figures	48HO4	WP-90-6	2600 ± 300	CR
		WP-90-9*	2750 ± 200	CR
	48HO4	WP-90-11	1500 ± 100	CR
		WP-90-12**	1600 ± 200	CR
Elongated interior line	48HO469	WP-90-1	225 ± 60	AMS
	48HO469	WP-90-2	310 ± 70	AMS
	48HO354	WP-91-2-1	2500 ± 300	CR
		WP-91-2-2***	1700 ± 200	CR
	48HO354	WP-91-3-1	1500 ± 200	CR
		WP-91-3-2***		
Wide body	48FR194	WP-90-19	< 1000	CR
	48HO354	WP-91-1	< 1000	CR
Circular interior line	48HO4	WP-90-18	2200 ± 200	CR
Attenuated	48HO4	WP-90-5	2200 ± 200	CR
Zoomorphic figures				
Outline pecked	48HO4	WP-90-4	5775 ± 80	AMS
		WP-90-4	6005 ± 105	AMS
	48HO4	WP-90-8	2500 ± 300	CR
	48HO4	WP-90-10	5600 ± 600	CR
Fully pecked	48HO4	WP-90-14	5200 ± 500	CR
	48HO4	WP-90-17	295 ± 55	AMS
Fine line pecked	48HO469	WP-90-3	< 1000	CR
	48HO372	WP-90-20	1820 ± 65	AMS

* Sample from same figure as WP-90-6.
** Sample from same figure as WP-90-11.
*** Sample from repecked section of previous figure.

manufacture, poor preservation, or climatic factors that influenced varnish preservation (Francis et al. 1991). Varnish dates provide a *minimum* age estimate. Thus, petroglyphs for which varnish is dated to the Late Archaic could be somewhat older, and varnish simply did not develop until the Late Archaic period.

The oldest dates are from the outline pecked zoomorphic type, and all are from panel 48 at the Legend Rock site (fig. 4.10). Two AMS samples from an outline pecked buffalo (WP-90-4) yielded Early Archaic age determinations. Sample WP-90-10 is from an engraved set of antlers found at the base of this panel. Unfortunately, the lower portion of the figure had exfoliated. Based on the morphological similarity between these antlers and those of complete outline pecked animals, it is assumed that sample WP-90-10 is the remnant of an outline pecked zoomorphic figure. The calibrated CR age is approximately 5600 BP, also Early Archaic. Sample WP-90-8 from the outline pecked elk yielded a CR age of approximately 2500 years, falling into the Late Archaic period. Of the three dated outline pecked zoomorphs, two figures date to the Early Archaic.

Manufacture of the fully pecked zoomorphic type appears to span thousands of years. Sample WP-90-14 is from a fully pecked quadruped (possible canid) on panel 74 at Legend Rock (fig. 4.13). The calibrated CR age is about 5200 BP, only slightly younger than the outline pecked figures on panel 48. Sample WP-90-17 is from the much photographed Legend Rock rabbit (fig. 4.14). The AMS age, one of the youngest in the entire study, suggests that this figure was manufactured around 300 years ago. The fine line pecked zoomorphic figures also appear to be quite young, with one date around 1800 years ago at the boundary of the Late Archaic and Late Prehistoric periods, and the other less than 1000 years.

The anthropomorphic types generally appear younger than the zoomorphic, with the majority of these dates falling into the Late Archaic and Late Prehistoric periods. The composite and fully pecked horned anthropomorphic types exhibit the oldest dates. Samples WP-90-6 and WP-90-9 are from the body and foot of a single composite figure on panel 48 at the Legend Rock site (fig. 4.10). These CR dates overlap almost completely, suggesting that this figure was manufactured around 2600 to 2700 years ago. These dates also overlap sample WP-90-8, the outline pecked elk, which is to the immediate right of the composite anthropomorph. This proximity clearly demonstrates the association of the anthropomorphic figures and the outline pecked animals. The one dated attenuated figure (WP-90-5), also on this same panel, is about 2200 years old.

All three dated fully pecked horned anthropomorphic figures are Late Archaic. They include two CR age determinations from Legend Rock and 48HO354, as well as the partially buried figure dated in 1988 at the Legend Rock site. Samples were taken from other anthropomorphic figures of this type; however, these figures proved to be undatable because of the recent chalking. This was also the case with a fully pecked figure on the same panel as sample WP-90- 14, the Early Archaic canine, at Legend Rock (fig. 4.13). The varnish development on the anthropomorph is very similar to that on the animal figure, suggesting a quite ancient age for the human figure, one quite possibly contemporaneous with the animal. However, this contemporaneity remains to be demonstrated.

The elongate interior line and wide body anthropomorphic figures tend to be more recent than the other anthropomorphic types. Only one (WP-91-1-1) of four dated interior line figures is Late Archaic. Repecking of this figure (sample WP-91-1-2) apparently occurred around 1750 BP. A second interior line figure at the same site was first manufactured during the early part of the Late Prehistoric period (sample WP-91-3-1) around 1400 years ago, with some repecking occurring within the last 1000 years (sample WP-91-3-2). The two interior line figures dated at the Coal Draw site (48HO469) are extremely recent, having been manufactured between 200 and 300 years ago. The two wide body figures are also less than 1000 years old.

Figure 4.15 graphically presents the age ranges thus far available for each Dinwoody descriptive type. The thin vertical lines represent a single date. The thicker vertical lines represent multiple overlapping dates from the same type, with the

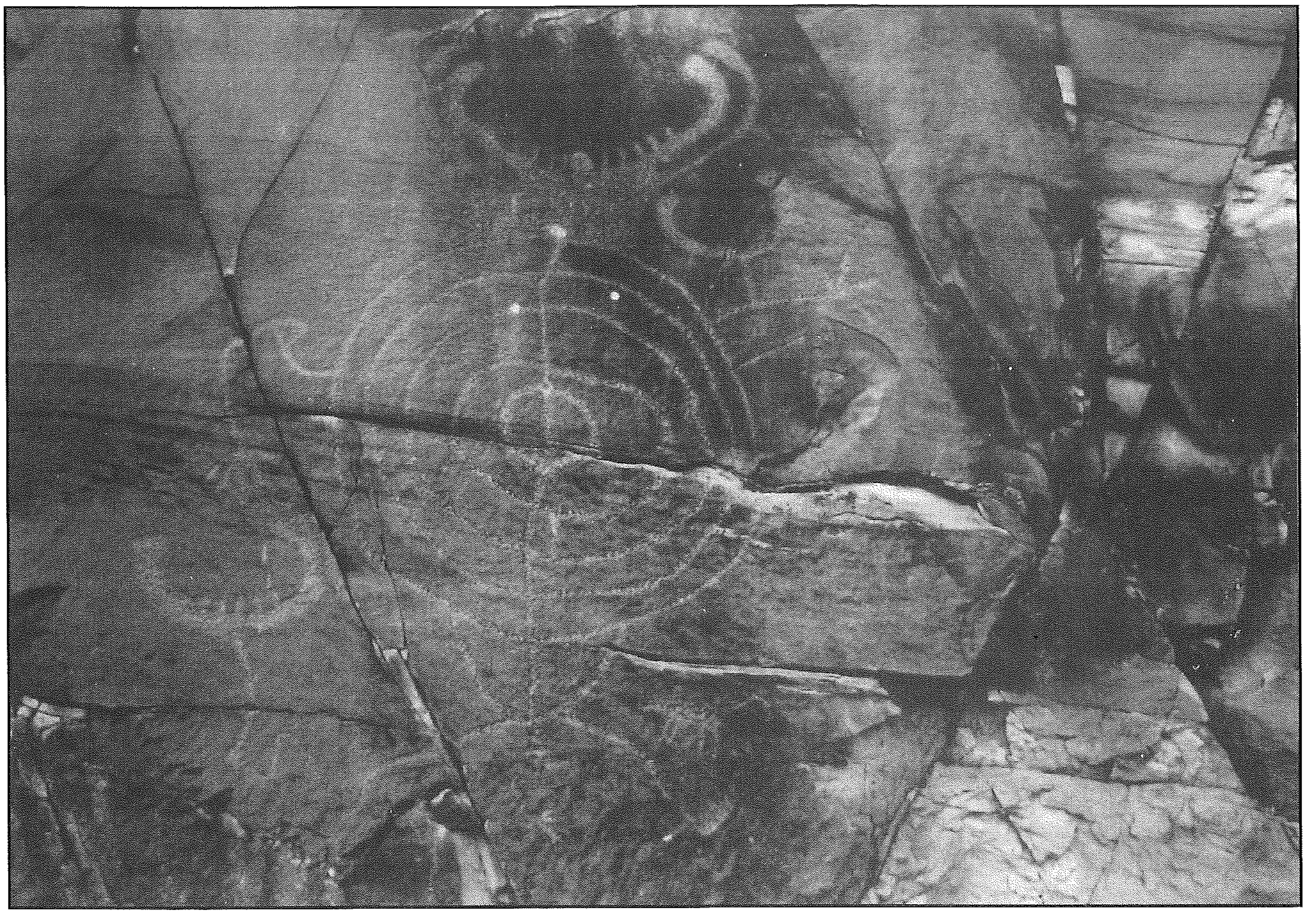


Figure 4.9 Round-bodied Dinwoody figure (panel 40) from 48HO4, Legend Rock site. This is one of the few Dinwoody tradition figures with a round body shape. It is 106 cm tall from the top of the horns to the base of the feet.

Right, Figure 4.10 Panel 48 at 48HO4, Legend Rock site. The bison at the top of the figure (AMS dates ranging between 6000 and 5700 BP) and the elk (CR date of 2500 BP) are examples of the outline pecked zoomorphic type. This panel also contains examples of composite and attenuated human figures, which have been CR dated to between 2700 and 2200 BP. Scale is 50 cm.

actual number indicated above the vertical line. Although the sample size is too small to constitute a precise seriation, some possibly significant trends and patterns are apparent.

The outline and fully pecked zoomorphic types are clearly the oldest. Dates available for the outline pecked type suggest its inception occurred during the Early Archaic period, at least 6000 years ago. There are no data to suggest that these figures were manufactured much later than 2000 years ago. The manufacture of fully pecked animals likely spans the entire time range of Dinwoody rock art. The two available dates are close to the oldest and youngest figures. This type of figure is common and, given its close association with anthropomorphic figures known to be more recent, fully pecked animal figures may have been manufactured more or less continuously for nearly 6000 years. The fine line pecked figures, thus far, are no older than 2000 years.

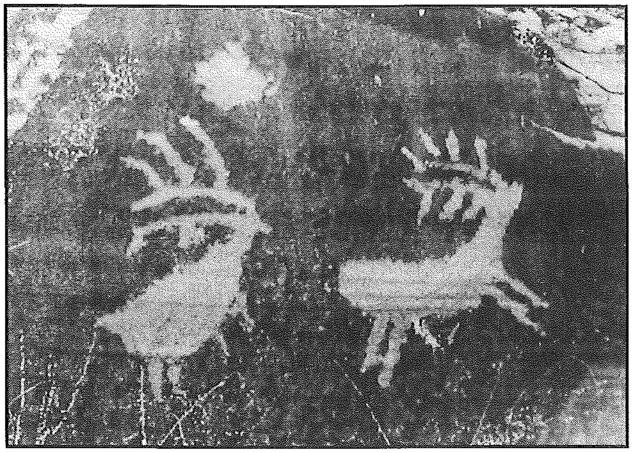


FIGURE 4.11 PANEL 15 AT 48HO4, LEGEND ROCK SITE. Fully pecked zoomorphic figures, each about 35 cm long from the tip of the nose to the tip of the tail.

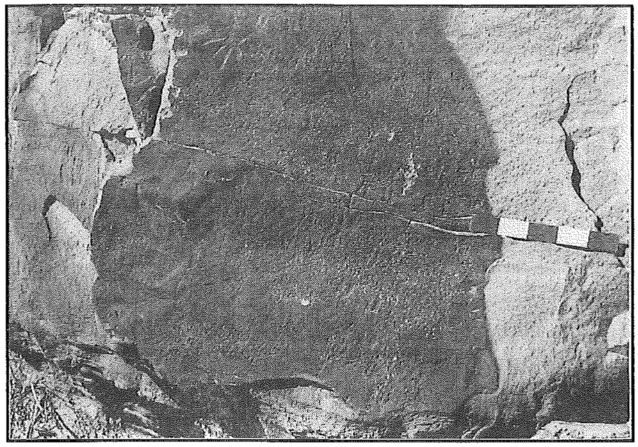


FIGURE 4.13 PANEL 74 AT 48HO4, LEGEND Rock site. The fully pecked canine figure at the lower right of the panel yielded a varnish date of about 5200 BP. Scale is 50 cm.

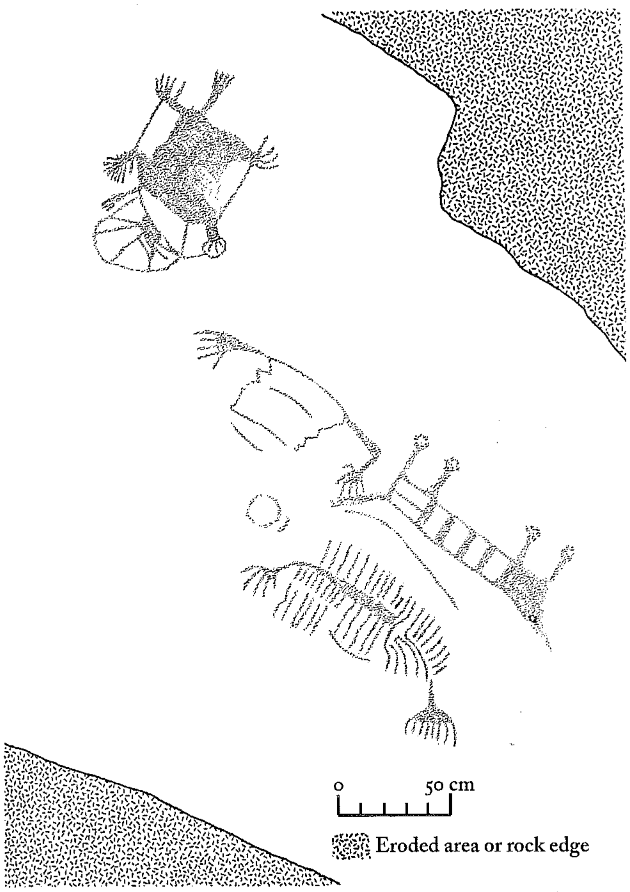


FIGURE 4.12 PANEL 5 AT 48FR372. The bottom figure on this panel is an example of the fine line pecked zoomorphic (?) type and has been AMS dated to 1820 ± 65 BP. *Tipps and Schroedl 1985.*

FIGURE 4.14 PANEL 78 AT 48HO4, LEGEND ROCK SITE. This fully pecked rabbit has been AMS radiocarbon dated to about 300 BP. It is 19 cm tall from the top of the ears to the feet.

Several patterns are also apparent with the human figures. First, the fully pecked horned anthropomorphic type appears to be the oldest. Available dates for this type cluster between 2750 and 2000 years ago. It is quite likely that fully pecked human figures have a much greater antiquity, given their close association with and varnish development similar to animal figures that are more than 5000 years old. The current data suggest that these figures were not manufactured in any great numbers more recently than 2000 years ago. The composite anthropomorphic type appears to be primarily Late Archaic in age; available dates range from 3000 to 1225 BP.

It is suggested here that the elongated interior line and wide body anthropomorphs are primarily Late Prehistoric and Protohistoric. Only one of three figures dates to the Late Ar-

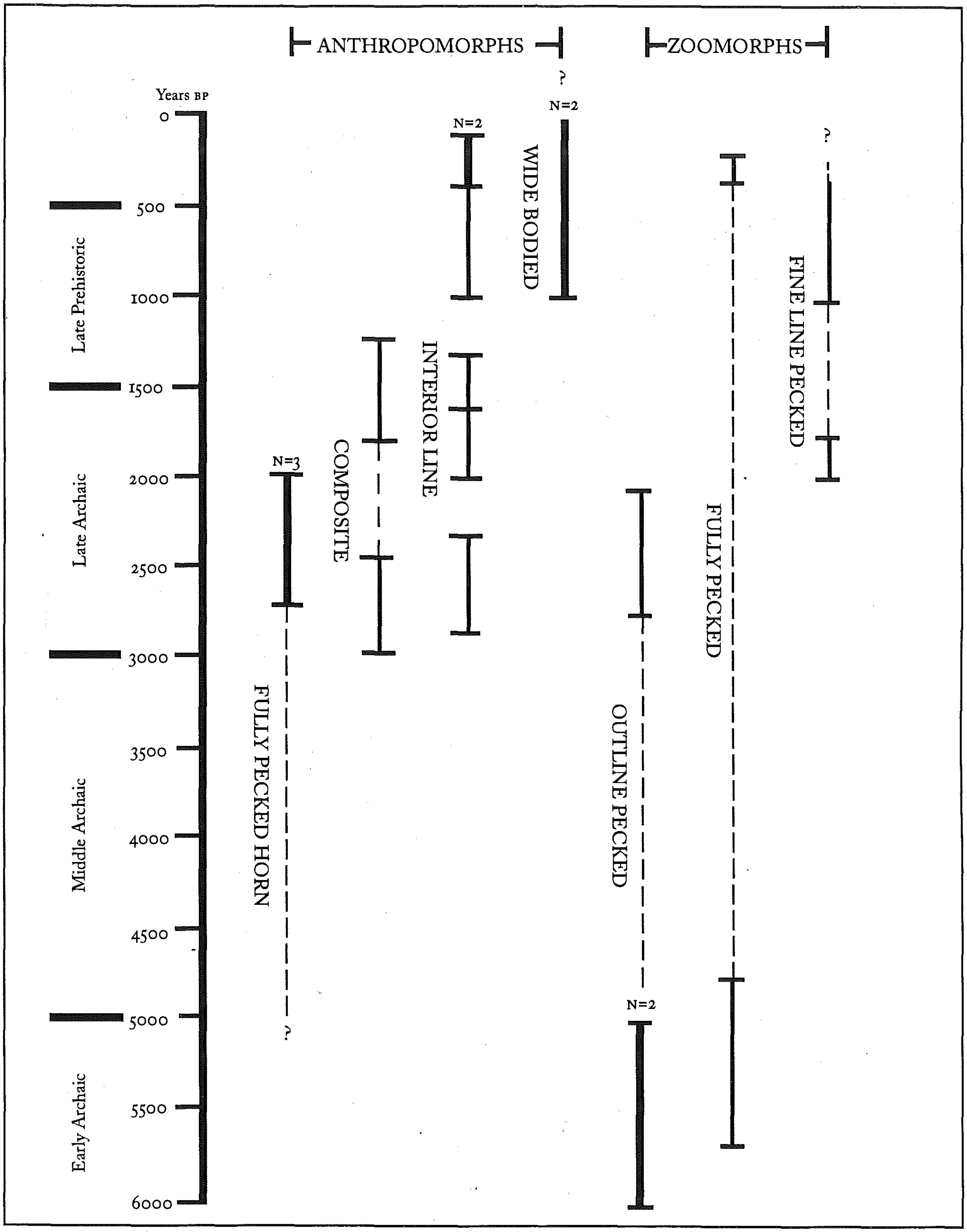


FIGURE 4.15 AGE RANGES FOR DINWOODY TRADITION ROCK ART TYPES.

chaic. The remaining three figures are more recent, with two AMS dates falling into the Protohistoric period. There is also no evidence to suggest that the wide body figures are any older than 1000 years.

Discussion and Conclusions

The chronological data thus far available for Dinwoody rock art suggests an evolutionary scheme for morphological change in both human and animal figures. In a nutshell, there appears to be a trend from the early manufacture of relatively simple, fully pecked human figures to the manufacture of the large, elaborate interior lined figures in more recent times.

The fully pecked horned human type is certainly the earliest and appears to be predominantly an Archaic phenomenon. These figures are firmly dated to the Late Archaic period and may well date to the Early Archaic. At some point, most likely during the Late Archaic period, manufacture of the composite and interior line figures began. While these two types are easily distinguished, they share a common characteristic in that features on the interior of the torso are illustrated in some fashion, whether it be a small, fully pecked secondary figure or complex interior lines. A relatively simple evolutionary sequence, starting at fully pecked figures, changing to multiple interior figures, and changing again to patterns of interior lines, is entirely plausible.

In a very general sense, there also appears to be a similar sort of sequence with the zoomorphic figures. The development of the elaborate fine line pecked type seems to parallel the development of the interior line human figures. The pattern of simple to complex does not seem to hold, however, for the outline pecked and fully pecked types. In one sense, the outline pecked animals are far more elaborate than the fully pecked animals. They are larger, more realistic, and often exhibit fairly complex interior line characteristics. They appear to be older and span a relatively shorter time period than the fully pecked type. In other words, for the predominant zoomorphic types, there is a trend from complex to simple, a pattern completely opposite that observed for the human figures.

The findings of this study provide several important insights into the nature of Dinwoody rock art. It is suggested here that Dinwoody rock art can be considered a tradition, as defined by Willey and Phillips (1958:37). "An archaeological tradition is a (primarily) temporal continuity represented by persistent configurations in single technologies or other systems of related forms." Certainly, the time depth and continuities of the pecked rock art types occurring in the Wind River and upper Bighorn River drainages meet this definition.

It is also suggested that the Dinwoody tradition represents the material culture expression of ideological and shamanistic beliefs of prehistoric hunter-gatherers in the Wind River and Bighorn Basins and surrounding area. Why this tradition is focused in the Wind River and southwestern one-third of the Bighorn River drainage is unknown, but the spatially circumscribed area in which the tradition occurs argues strongly that this region was extremely important spiritually to prehistoric peoples (Whitley 1994; chapter 8.)

The Dinwoody tradition exhibits a great deal of internal cohesion in that symbolism expressed in the rock art was seemingly uninfluenced by the introduction of new art forms (shield-bearing warriors, v-necked figures) sometime after 900 years ago. The tradition survived for at least 6000 years, up to the Historic period and including the associated influences of Euro-American culture. Yet there is clear evolutionary change within the tradition. Anthropomorphic forms changed from relatively simple fully pecked figures to the extremely elaborate interior line types. Zoomorphic forms apparently changed from elaborately pecked large artiodactyls to smaller, simpler medium artiodactyls and dogs. This modification argues strongly that the relationship between humans and animals changed through time and that the role of specific types of animals in the spiritual world changed as well. The extremely late Late Prehistoric and Protohistoric anthropomorphic figures are also the most intricate and elaborate. This complexity perhaps suggests that prehistoric shamanistic practices reached their zenith immediately prior to Euro-American contact, at which time Native American cultures experienced a crisis from which they have yet to recover.

Admittedly, the sample of dated Dinwoody-tradition petroglyphs is small and, as further research is conducted, the patterns observed may well change. The ideas offered here should be considered hypotheses to be tested and challenged. The insights gained from this analysis certainly demonstrate, however, that the ritual and spiritual aspects of prehistoric hunter-gatherers in this region may well have been richer and far more complex and elaborate than is reflected by other aspects of the archaeological record.

5 Scratched Rock Art Complexes in the Desert West: Symbols for Socio-Religious Communication

Eric W. Ritter

In this chapter, I will demonstrate that a relatively consistent pattern of rock scratching is found throughout much of the Desert West; that is, the California Desert, Baja California, Great Basin, and Southwest. A proposed tradition of motifs, shapes, and distribution, including potentially varying ideas, intentions, and perceptions (Conkey and Hastorf 1990:2), is postulated. In examining alternative hypotheses regarding the use and meaning of scratched rock art, I have diligently tried to adhere to Ockham's razor: "An explanation of the facts should be no more complicated than necessary" (Jeffreys and Berger 1992:64)—easier said than done.

Basis for Analysis

It was decided that a quantifiable and qualitative examination of widely separated localities was necessary for the identification of the pattern. Two locations that provide suitable scratched rock art material for detailed analyses are the Massacre Bench locality in northwestern Nevada and the Pistone locality (26Mn2001) in west-central Nevada, some 360 km apart (fig. 5.1). These locations were selected for their accessibility, known rock art complexity (including abundant scratched rock art), and supporting archaeological information. Information is also available from the ethnographic record and from various other sources regarding scratched petroglyph sites within the Great Basin, Southwest, California Desert, and Baja California (for example, Heizer and Baumhoff 1962; von Werlhof 1965; Davis et al. 1965; McCarthy 1978; Kaufman 1978; Ferg 1979; King 1981; McKern 1983; Crosby 1984:103; Simonis 1986; Martynec 1986; Wallace and Holmlund 1986; Dickman 1986; Hedges 1989; Robin and Ewing 1989; Christensen 1990; Cole 1990; and Stoney 1990).

The two localities examined here include various smaller sites that have been systematically sampled. For sites from a broader area, beyond central and northwestern Nevada, the sampling of scratched rock art sites has been more arbitrary, raising questions about data comparability and reliability. (Exceptions are Kaufman 1978; Ferg 1979; King 1981; and Wallace and Holmlund 1986.) My research at scratched sites has also led me to recognize that the rare, elaborate panels found only at a few sites provide critical interpretive keys to scratched art as a whole, further complicating the sampling problem. Finally, time constraints during the fieldwork at the two scratched rock art localities prevented the thorough recording of other forms of rock art, as well as the environmental and cultural context of the scratched art. Based on all these potentially confounding factors, any broad-based interpretations presented at this time must be recognized as preliminary.

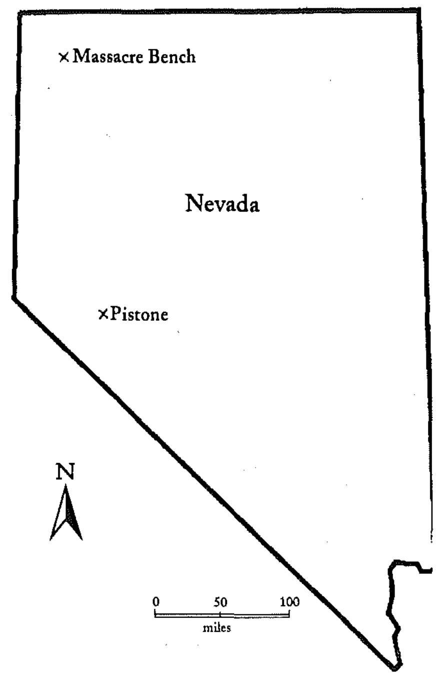


Figure 5.1 Map of Nevada. Location of the two principal study localities, Massacre Bench and Pistone, is shown.

A number of hypotheses are presented here concerning portable and parietal scratched rock art from the Desert West, certain of which have been previously offered (for example, Heizer and Baumhoff 1962; Bettinger and Baumhoff 1982; Thomas 1983a, 1983b; Lewis-Williams and Dowson 1988; and Whitley 1988a, 1988b; 1990, 1992a). These hypotheses are not mutually exclusive nor are they equally testable. First, scratched petroglyphs in the Great Basin are the result of expanding Numic speakers who frequently superimposed the scratched motifs over earlier Prenumic pecked designs, apparently with the deliberate intention of obliterating them (Bettinger and Baumhoff 1982:494). Such defacement is hypothesized as "attempts either to neutralize or purify potentially malevolent magic thought to be associated with Prenumic designs (for example, Steward 1933; Gifford 1940:154), thus permitting site use or, alternatively, to disrupt the activities of Prenumic groups still using them as hunting locations when Numic groups entered..." (Bettinger and Baumhoff 1982:494).

Second, the parietal scratched rock art is fundamentally different from both the mobiliary scratched rock art and the parietal pecked rock art in aspects other than technique, such as temporal placement, location, and motif assemblage.

Third. scratched rock art in portable and nonportable forms served magico-religious purposes related to success in hunting and gathering activities. The two forms of scratched rock art served as "symbolic correlates in the dramatization of concepts relevant to a cultural system which coordinated plant food gathering and cooperative hunting into a complementary spatial and temporal scheme" (Thomas 1983a:352).

Fourth, scratched and pecked motifs together represent phosphenes and other entopic phenomena executed on the rock as a result of shamanic or other individual trance-state experiences (Lewis-Williams and Dowson 1988; Whitley 1988a, 1988b).

The approach taken here includes empirically based inferences combined with a search for intracultural meaning (ideology, social action, and cognition), as discussed by Watson and Fotiadis (1990:620–621). The tests of these four hypotheses include a systematic documentation of sample sites and various panel characteristics, a look at each site's environmental and archaeological context, an examination of the ethnographic record for possible analogous situations, a consideration of the data and arguments presented by other researchers cited previously, and a regard for certain universal human neuropsychological principles related to entoptic imagery.

Environmental Setting

The two test localities are situated within volcanic areas of the Great Basin physiographic province, although the broader distribution of this proposed rock art tradition is found throughout much of the Desert West. The Pistone locality is located on Black Mountain at the northern end of the Wassuk Range at an elevation near 2200 m (figs. 5.1, 5.2). This upland zone is covered with stands of pinyon pine and juniper, with a sagebrush understory. Mule deer, coyote, feral horses, and jack rabbits frequent the location where a population of Desert Bighorn sheep once roamed (Hall 1946). The Massacre Bench locality, north of the farthest extent of pinyon pine, is at an elevation of around 1900 m (fig. 5.1). It is composed at its lower elevations of sagebrush-grass steppe that supports a juniper woodland at the higher elevations. Wild horses, antelope, and mule deer are found there. In both localities, springs, ephemeral lakes, and intermittent tanks within ephemeral drainages provide water. Apparently influential climatic and vegetation changes occurred over the span of human occupation in the western Great Basin and beyond (Elston 1982).

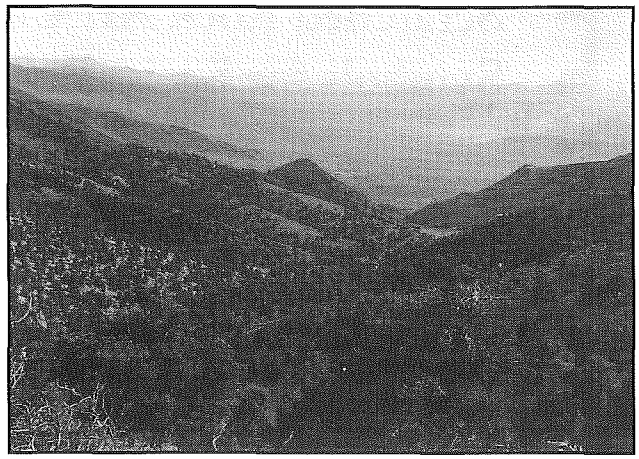


FIGURE 5.2 PISTONE, NEVADA. Rock art locality (NV-MN-2001) is shown looking southerly.

Field Methods

A detailed discussion of the field methods used at the Pistone locality has been presented by Ritter and Hatoff (1990). Briefly, two of the most extensive rock art loci at this site were studied following the guidance of Pendleton, Thomas and Associates (1988) as set forth in their management research design, the author's experiences, and direction provided by Swartz (1981) and Sanger and Meighan (1990). Recording groups worked systematically through each petroglyph field, documenting each scratched panel in sequence according to its general position in the talus. Forms were used to record aspect and inclination, manufacturing technique, depth, patination/varnish, definition of elements, superpositioning, vandalism/natural defacement, Munsell color readings, association, rock type, and special notes concerning such characteristics as curvature of the rock face, artifact, or feature associations. A scaled drawing was made of each panel and photographs were taken. A 10x hand lens was used to assess superpositioning. Cursory examinations were conducted at three other loci with rock art, and a detailed record was made of one elaborate panel found at one of these loci. Probably more than 50 percent of the rock art complex was visited and nearly that much documented. During the systematic sampling at Pistone, 462 petroglyph panels were found, with sixty-two, or just over 13 percent, containing scratched rock art.

At the Massacre Bench locality (fig. 5.3), nine separate petroglyph loci were systematically documented as described above: Biebe Spring, Indian Spring, Massacre Lake (26wa69), Massacre Rim, Post Canyon Spring, Sage Hen Spring, South Post Canyon, Tuffy Spring, and an unnamed location. All these loci are located within about 9000 hectares. Of the 1158 petroglyph panels evaluated along cliff walls and in boulder fields, 116 contained scratched petroglyphs. This number represents 10 percent of the total, although by locus the percentages range from none where only a few panels are present, to less than 1 percent at Biebe Spring where 135 panels were examined, to 40 percent at the Massacre Rim site where four of

Table 5.1 Distribution of motif categories by locality

Category	Pistone	%	Massacre	%	Total
Crosshatched	19	26	132	30	151
Vertical parallel	7	10	33	7	40
Diagonal/ horizontal parallel	26	36	101	23	127
Radiating lines	4	6	16	4	20
Arcs/nested arcs	6	8	37	8	43
Zigzags/ chevrons	3	4	24	5	27
Triangles	3	4	3	1	6
Anthropomorphs	2	3	5	1	7
Miscellaneous	2	3	96*	21	98
Totals	72	100	447	100	519

* Includes such motifs as tics and dashes in rows, feather-like designs, ladders, rakes, scrolls, circles, a spoked circle, loops, wavy lines, meanders, squiggles, isolated straight lines, a pecked circle with scratched rays, a zoomorph with scratched tail, two possible deer, xs, and scratched digits on pecked anthropomorphs.

ten panels were scratched.

In other Desert West studies, scratched panels or motifs are generally found in the same characteristic low frequency. For example, at Tumamoc Hill in southern Arizona, where Ferg (1979:97) has defined a Hohokam Scratched style, 10 percent of the 420 "glyphs" were scratched. Wallace and Holmlund's (1986:66, 210) sample from the nearby Picacho Mountains revealed less than a 1 percent occurrence out of 4152 designs. Their comparative data base from southern Arizona discloses less than a 2 percent occurrence among twenty-five sites, with twenty sites apparently lacking scratched rock art (assuming scratching was identified in the first place). In central Baja California at the Los Pozos site, Kaufman (1978) reports that nearly 4 percent of 2420 elements were scratched. Heizer and Baumhoff (1962:94, 208) report that only four sites out of ninety-eight in the Great Basin and eastern California had scratched petroglyphs. Many more scratched sites are now known to occur in this physiographic province, however (Stoney 1990).

Examining the Data

A subjective classification of the scratched design motifs was produced using previous definitions for stationary and mobiliary scratched art from the western United States (Heizer and Baumhoff 1962:381–392; King 1981; Thomas 1983a, 1983b; Wallace and Holmlund 1986:226; McGuire 1989). The common motifs found at several sites are all geometric and include (1) simple (fig. 5.4) and (2) three-way crosshatched patterns (fig. 5.5), along with banded crosshatched designs (fig. 5.6); (3) vertical (fig. 5.7) or (4) diagonal/horizontal series of straight parallel lines (fig. 5.8); (5) radiating lines (fig. 5.9); (6) zigzags and chevrons (fig. 5.10); (7) arcs (fig. 5.11); (8) tics or dashes in a series (fig. 5.12); (9) feather-like designs (fig. 5.12); and (10) ladders (fig. 5.12). Various curvilinear designs are less frequent, including loops and scrolls, circles and ovals, meanders, rakes, squiggles, triangles, and anthropomorphs (figs. 5.13, 5.14, table 5.1). The unique or rare motifs are principally present at major, densely scratched panels (fig. 5.15). Simonis (1986) suggests that

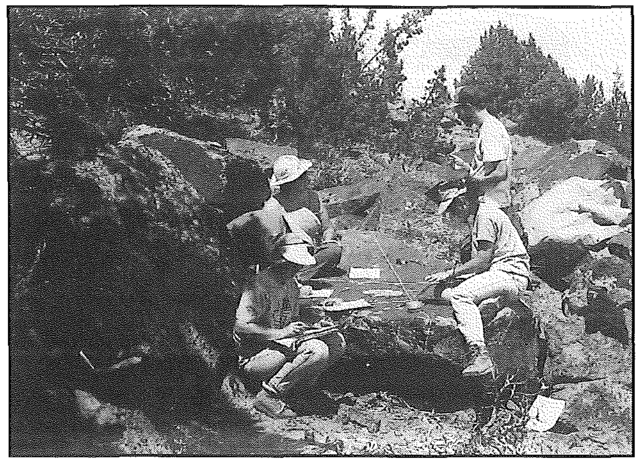


Figure 5.3 Post Canyon Spring at the Massacre Bench locality. Study team is shown recording large complex scratched boulder.

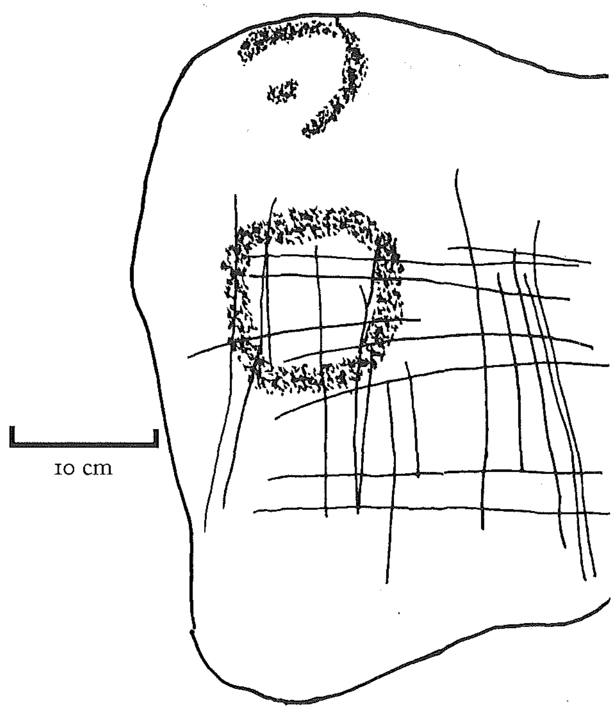


Figure 5.4 Simple scratched crosshatching. Example from the Pistone locality. Stippled area represents pecked designs.

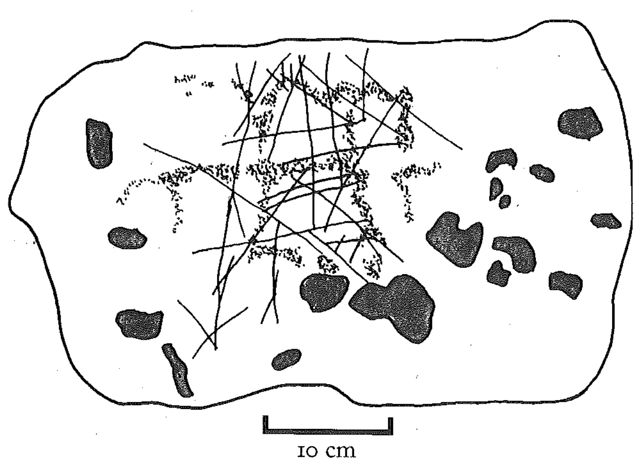
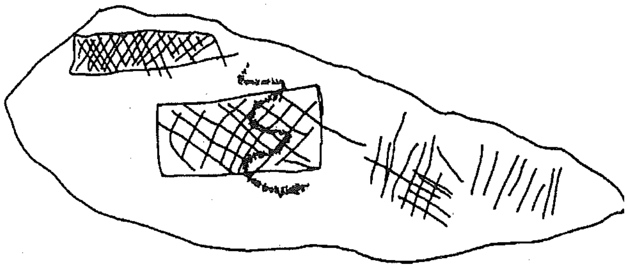
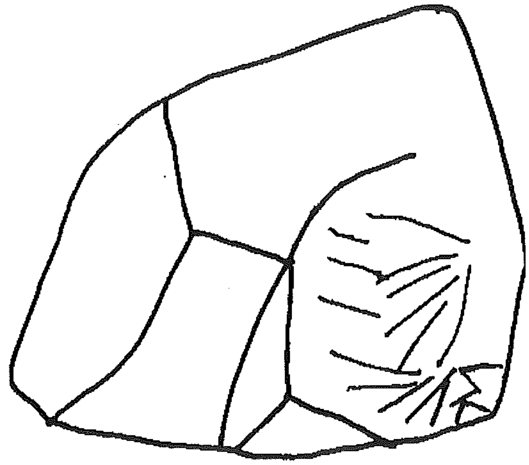


Figure 5.5 Three-way scratched crosshatching. Example from the Pistone locality. Darker areas represent rock spall zones.



10 cm

FIGURE 5.6 BOUNDED SCRATCHED CROSSHATCHING, SIMPLE CROSSHATCHING, AND DIAGONAL PARALLEL SCRATCHED LINES. Example from 26WA69, Massacre Lake locus, Massacre Bench locality.



10 cm

FIGURE 5.9 RADIATING AND ZIGZAG SCRATCHING. Example from the Pistone locality.

10 cm

FIGURE 5.7 MOSTLY VERTICAL PARALLEL SCRATCHING. Example from the Pistone locality.

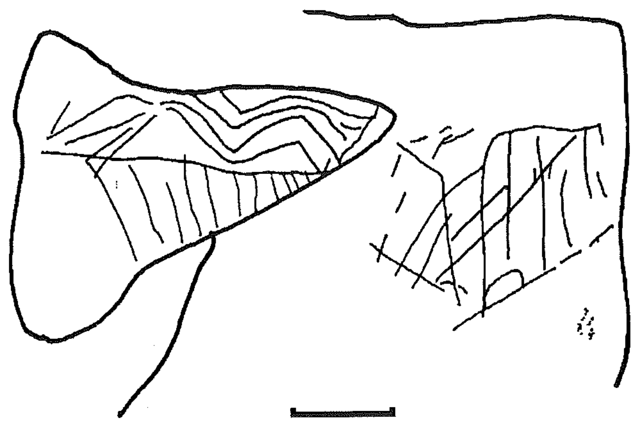


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FIGURE 5.10 SCRATCHED CHEVRONS, PARALLEL LINES ON A BASELINE, AND CROSSHATCHING. Example from the Pistone locality.

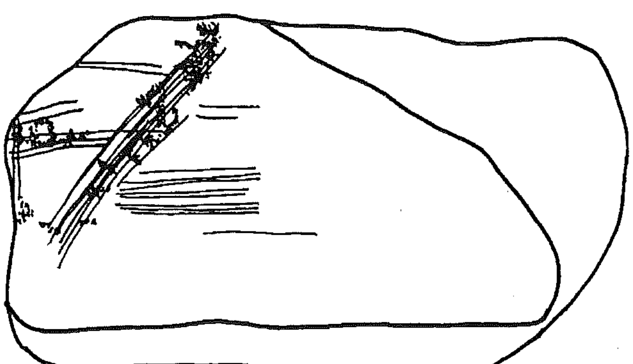

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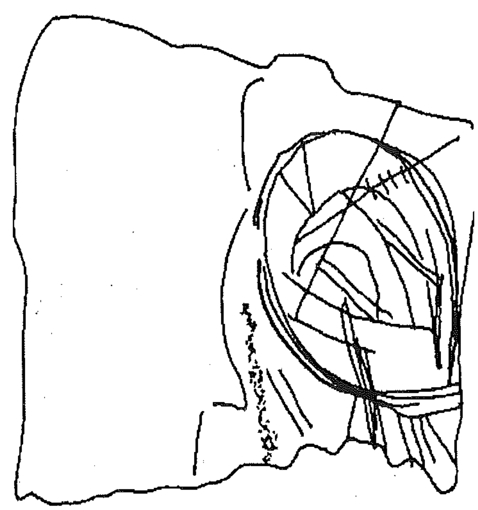
FIGURE 5.8 HORIZONTAL AND DIAGONAL PARALLEL SCRATCHED LINES. Example from the Pistone locality.



10 cm

FIGURE 5.11 SCRATCHED PANEL. From 26WA69, Massacre Lake locus, panel shows arcs, parallel line sequences, and tics or dashes in a row.

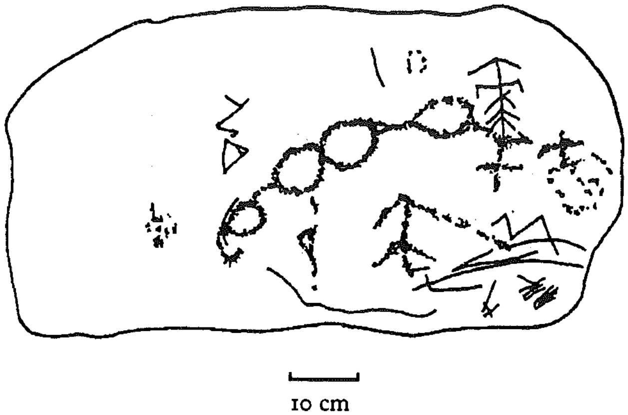


FIGURE 5.12 SCRATCHED FEATHER OR LADDER-LIKE DESIGN, ZIGZAG, TRIANGLE, AND OTHER SCRATCHED AND PECKED ELEMENTS. Example from the Sage Hen Spring locus, Massacre Bench locality.

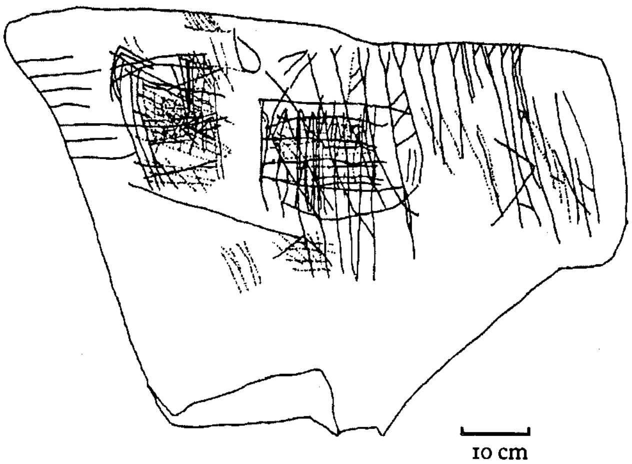


FIGURE 5.13 COMPLEX SCRATCHED PANEL. Example from Post Canyon Spring on the Massacre Bench. Dotted lines are older scratching.

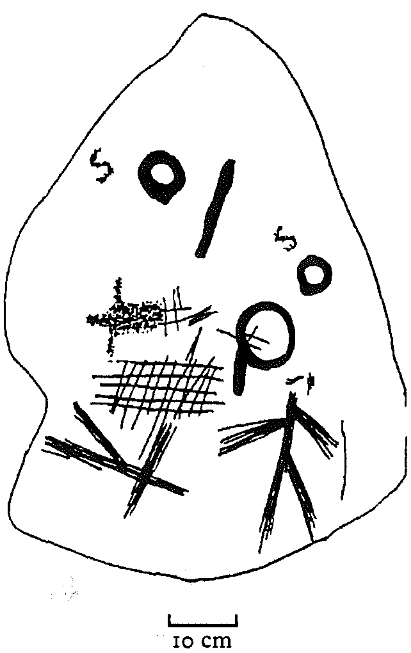


FIGURE 5.14 SCRATCHED ANTHROPOMORPHS, CROSSHATCHING, AND OTHER DESIGNS. Example from NV-WA-69, Massacre Lake site. Stippling represents lighter patinated figures, while solid designs are older.

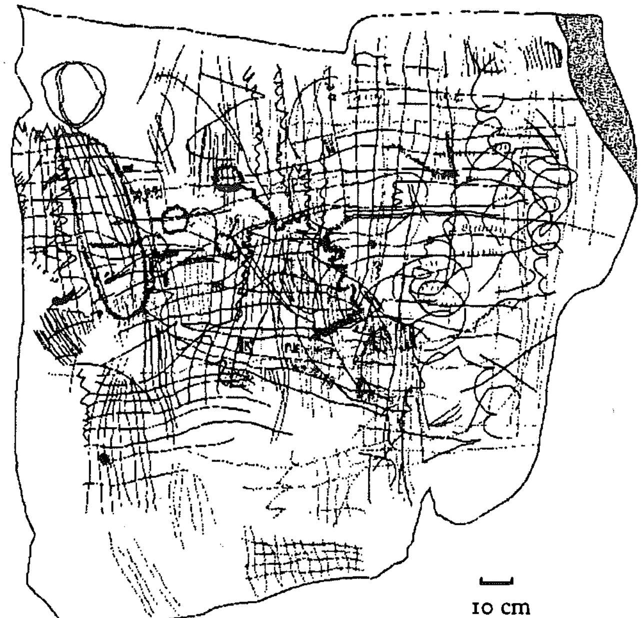


FIGURE 5.15 MASSACRE RIM SITE PANEL. One of the most complex scratched panels observed in the Massacre Bench locality, it has older (dotted) and more recent scratched motifs.

near Kingman, Arizona, haphazard-looking scratched designs are actually a series of superimposed grids, with up to a dozen or so designs present.

Testing the six most common motifs at the main study sites shows no significant difference between the two localities (chi-square = 4.1, df = 5). Comparing only arcs and zigzags by locality also suggests they do not differ (Fisher's Exact, p =0.52). However, the Massacre Bench loci, with a larger sample, exhibit many more one-of-a-kind motifs in comparison to the Pistone locality (table 5.1). As a further test, only the large Massacre Lake locus, of the Massacre Bench locality, was compared to the Pistone locality in terms of the four most common motifs present (with various crosshatched and parallel line motifs lumped) (table 5.2). No significant differences are apparent (chi-square = 3.6, df = 3).

Within the Massacre Bench sample, motifs were divided into five geometrically related categories and compared by sublocality: (1) crosshatching; (2) straight line sequences; (3) ladders, feathers, and rakes; (4) zigzags and triangular motifs; and (5) curvilinear motifs, including arcs, loops, circles, ovals, scrolls, and meanders. Northerly loci (Massacre Lake, Tuffy Spring, and Sage Hen Spring) were correlated with southerly loci (Post Canyon Spring, South Post Canyon, and Massacre Rim). The testing (chi-square = 19.07, df = 4) reveals an apparent significant difference within the locality, primarily due to the higher proportionate numbers of ladder, rake, and feather designs and curvilinear motifs at the southern sites where several very complex panels are found (table 5.3, fig. 5.15).

Further afield, the common motifs found at the two western Nevada localities are also common in other areas of the Desert West (for example, Heizer and Baumhoff 1962; Davis

Table 5.2 Comparison of major motif categories

Motif	Massacre	%	Pistone	%	Total	Total %
Crosshatched	37	35.5	19	33	56	34.5
Vertical parallel	23	22	7	12	30	18.5
Diagonal/horizontal parallel	34	32.5	26	45	60	37
Arcs/nested arcs	10	10	6	10	16	10
Totals	104	100	58	100	162	100

Table 5.3 Comparison of Massacre Bench sublocalities by motif

Motif	Sub. 1*	%	Sub. 2**	%	Total	%
Crosshatched	69	34	63	27	132	30
Parallel and radiating lines, ticks	93	46	87	38	180	42
Ladders, feathers, rakes	7	4	20	9	27	6
Zigzags, triangles, chevrons	17	8	15	6	32	7
Curvilinear***	17	8	47	20	64	15
Totals	203	100	232	100	435	100

* Includes Tuffy Spring, Sage Hen Spring, and Massacre Lake
** Includes Post Canyon Spring, South Post Canyon, and Massacre Rim
*** Includes arcs, circles, loops, meanders, scrolls, and ovals.

Table 5.4 Overlap (%) between pecked and scratched designs

Category	Pistone	%	Massacre Bench	%	Total	%
No pecking	7	12	23	20	30	17
0% overlap	12	21	15	13	27	16
<25% overlap	16	28	39	34	55	32
25 to 75% overlap	13	23	29	25	42	24
>75% overlap	9	16	10	9	19	11
Totals	57	100	116	100	173	100

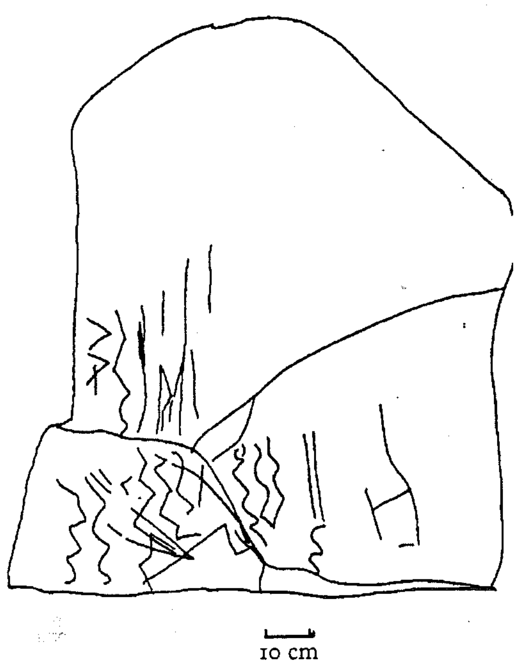


FIGURE 5.16 SCRATCHED PANEL. This example from South Post Canyon, Massacre Bench, exhibits chevrons, parallel lines, meanders, and other motifs.

et al. 1965:330; McCarthy 1978; Ferg 1979; Wallace and Holmlund 1986; Hedges 1989; Stoney 1990; Christensen 1990). However, differences—apparently more naturalistic designs—are apparent as one proceeds east toward northern Arizona (Christensen 1990), Utah, and Colorado (McKern 1983:table 2; Cole 1990:209–211; 225, 239). Farwell and Wening (1985) note that some Pueblo rock art in New Mexico is embellished with scratches. The frequency of occurrence is apparently rare even further east, as in the Pecos rock art of southwest Texas. Scratched rock art in Los Angeles County, California (King 1981) shows some similarities but appears overall more complicated and diverse. Hyder and Oliver (1986) discuss apparently similar scratched rock art from the Chumash area outside the Desert West.

Recent unpublished observations in the central highlands of Baja California by Eve Ewing of La Jolla, California (verbal communication, November, 1992) include several painted grids enhanced by scratching, scratched grids, a scratched cobweb, scratched fish, and pecked lizards and anthropomorphs with scratched digits on their feet. Kaufman (1978:93–94) reports scratched feet and "scratching" and "scratching special" from the Los Pozos site in the same area. Robin and Ewing (1989) report scratched ladders and a grid from a site along the west coast of northern Baja California.

A very important consideration central to testing the hypotheses is the relationship of scratched rock art with pecked or rubbed petroglyphs. At Pistone, 12 percent of the scratched panels contain no pecked art (figs. 5.9, 5.10), and 20 percent of the panels from Massacre Bench lack pecking (figs. 5.13, 5.16). Taking this analysis one step further, an examination was made of the extent of overlap between pecked and scratched designs by panel. At each locality, approximately one-third of all panels with scratching either lack pecked designs or show no overlap between techniques. About two-thirds of the sample panels exhibit no pecking, no overlap, or less than 25 percent overlap between scratched and pecked figures; this is generally true by locus or site within each locality (table 5.4). The conclusion is that significant overlap or obliteration was not essential in the production of scratched petroglyphs. What seems more understandable is that the maker was sometimes creating a "co-occurrence" where the design (scratched or pecked) overlap was purposeful, but a high proportion of overlap was not paramount to the desired display or effect (figs. 5.4, 5.6).

It seems clear that some of the pecked and scratched petroglyphs were executed at the same time. At both test localities, the following co-occurrences are found: pecked circles with interior crosshatching or scratched lines (fig. 5.17), a pecked concentric circle with scratches radiating out (fig. 5.18), a scratched and pecked circle around a milling slick, an anthropomorph with scratched digits on its hands (fig. 5.19), an insect or lizard-like figure with a scratched tail (fig. 5.20), and various juxtaposed or tangential scratched and pecked figures usually showing no variation in revarnishing.

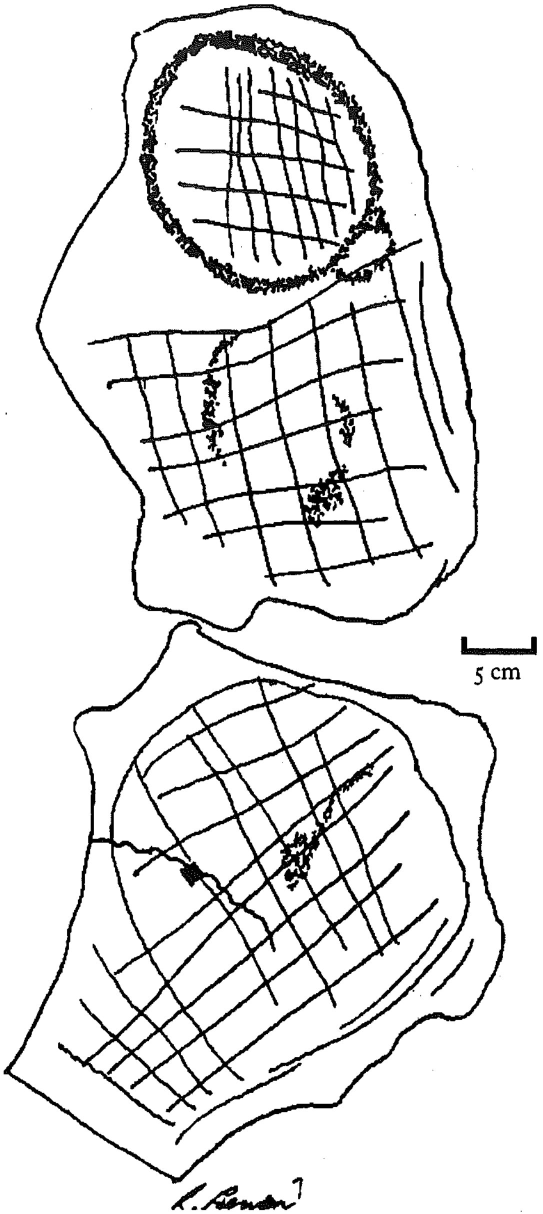


FIGURE 5.17 COMPLEX SCRATCHED AND PECKED PANEL. This portion of the panel, which is from the Pistone locality. It illustrates the close interplay of the two rock art techniques and motifs that show no patina differentiation.

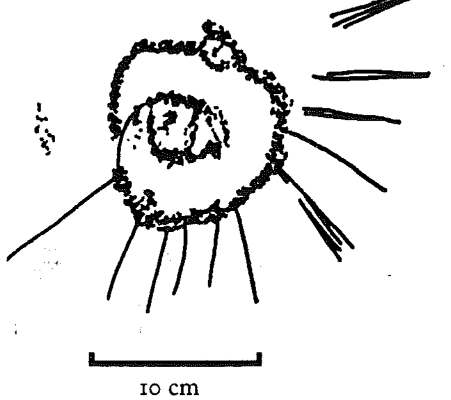


FIGURE 5.18 PECKED CONCENTRIC CIRCLES WITH SCRATCHED RADIATING LINES. Located at the Sage Hen Spring site, Massacre Bench locality.

Table 5.5 Scratched/pecked design superpositioning at Massacre Bench*

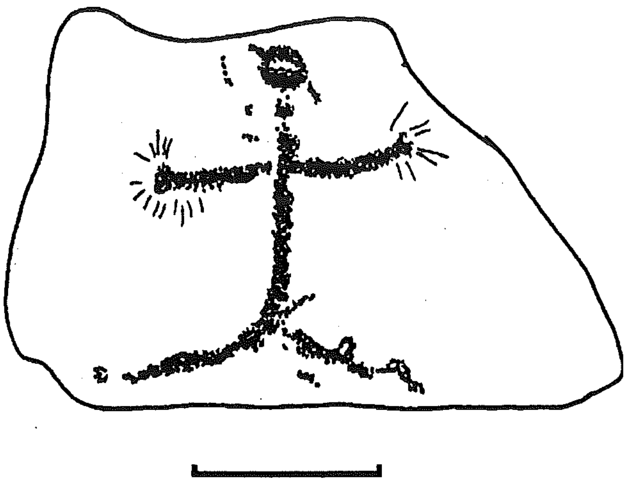
Site	Scratch/ pecking	Pecking/ scratch	Scratch/ scratch	Pecked/ pecked	Total
NV-wa-69	12	3	?	19	34
Tuffy Spring	4	1	0	3	8
Sage Hen	5	1	0	2	8
Biebe Spring	0	0	0		0
South Post	0	1	0		1
Post Canyon	2	1	3		6
Massacre Rim	1	1	1		3
Totals	24	8	4	24	60

* Does not include those panels where superimpositioning could not be determined (45) nor panels with multiple stages of pecked varnish development or obvious design repecking.

Heizer and Baumhoff (1962:208), in discussing the Great Basin Scratched Style, state that "the scratching seems usually to be later than the pecked petroglyphs, and is so shallow that desert varnish would obliterate it in a very short time." Later, Busby et al. (1978:97) assumed that Heizer and Baumhoff were implying that the scratching was done over the pecked designs. In their experimental replications, they found that "with shallow petroglyphs the scratched lines should be visible on top of the pecked areas. However, when the scratching was made first with pecking over it, the scratched design could also be considered to be superimposed" (1978:98).

Thomas (1976:72), in a study of two Nevada scratched sites (Northumberland, 26NY304, and Hickinson Summit, 26NY304), found that superimposition is rare at both and "in those rare cases, Scratched motifs never overlay pecked and/or incised motifs; Scratched motifs are, however, superimposed by pecked and/or incised motifs." Heizer and Baumhoff (1962:231) note that at Whiskey Flat (26MI5) scratched petroglyphs overlay pecked ones twice, pecked overlay scratched once, and painted designs overlay scratched twice. Stoney (1990:4) found scratched glyphs over and under pecked glyphs at Aikens Wash in the California Desert and over and adjacent to pecked rock art at Sloan Wash (26Ck2240) near Las Vegas.

Determining the superpositioning of techniques in the two study locales is difficult and somewhat subjective despite the use of a hand lens. At the Pistone locality, scratching occurs over pecking in 13 cases, pecking is over scratching in 6 instances, and one panel had both kinds of superpositioning. At the Massacre Bench locality, more than half the cases could not be determined. Of the remainder, there are three times as many cases of scratching over pecking as pecking over scratching, with no significant differences by locus (table 5.5) or sublocus (Fisher's Exact, $p = 0.42$ on a comparison of 26WA69 versus all other Massacre Bench study loci). In addition, at the Post Canyon Spring and Massacre Rim loci, there is unequivocal evidence of more recent episodes of scratching overlying older scratches. Statistical comparisons between the two localities in terms of the presence or absence of pecking on scratched panels, the absence of superimposition, and the amount of superimposition show no significant differences (chi-square = 5.1, df = 4; table 5.4).



10 cm

FIGURE 5.19 PECKED ANTHROPOMORPH. Example from the Pistone locality. Scratched lines radiate from the hand areas.

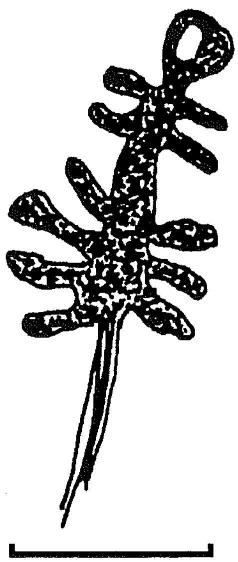


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FIGURE 5.20 PECKED FIGURE. Example from South Post Canyon, Massacre Bench locality. Scratched lines form "tail."

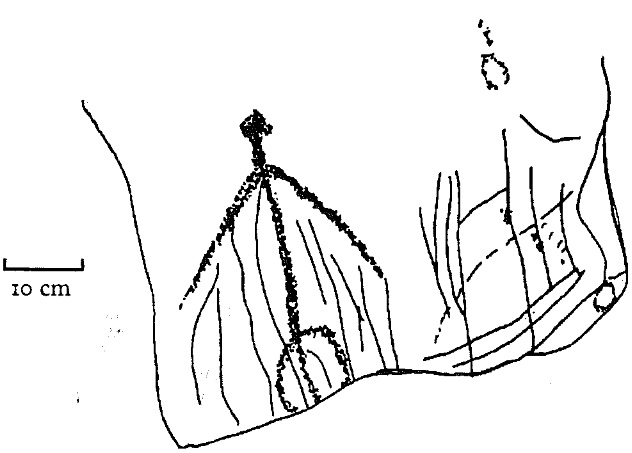


FIGURE 5.21 PECKED ANTHROPOMORPH WITH SCRATCHED "FRINGES." Example from NV-WA-69, Massacre Lake site.

There are, however, apparent differences in episodes of pecking at the two localities. Almost all the pecked glyphs at Pistone appear, with several exceptions, to be very recent and to represent a single period of manufacture. At the Massacre Bench locality, of the ninety-four scratched panels with pecking, 39 percent of the pecked motifs have as many as three stages of revarnishing. About one-fourth of these have superpositioning of pecked designs.

Just as important to the study of superimposition is the analysis concerning which pecked motifs are associated on a panel with scratched designs. This analysis is somewhat hampered by the absence of quantified information regarding the displays on nonscratched panels, although an intuitive evaluation is possible. At both localities, more than 40 percent of the scratched co-occurrences have pecked circular or curvilinear abstract designs (see figs. 5.4 through 5.7, 5.12, 5.14, 5.15, 5.17, and 5.18), whereas pecked rectilinear motifs constitute 20 percent. A relatively large number of scratched panels, nearly 25 percent at Pistone and 12 percent at Massacre Bench , co-occur with general pecking. Pecked stick-figure anthropomorphs occur at 6 percent of the scratched panels at each locality (figs. 5.19, 5.21). There are minor variations between the two localities in the rarer pecked motifs associated with scratching. This variation is due to the larger sample from Massacre Bench and this locality's more complex pecked panels of multiple ages (table 5.6). Only at Massacre Bench are pecked dot sequences, zigzags, rubbing on the panel, and a number of unique naturalistic and geometric figures associated with scratching (table 5.7).

The relative percentage of scratched motifs with pecked anthropomorphs at both localities seems high in terms of the overall number of anthropomorphs present. Lizard forms, relatively rare at Massacre Bench, do not appear with scratched designs except in one possible instance. There is no apparent occurrence of scratched motifs with "hunt scenes" or big game figures at either locality, with the exception of one reported scratched figure within an "antelope trap" petroglyph.

Another potentially useful measure for comparing localities is the complexity of the scratched designs, not only what motifs are displayed on a single panel but the size, number of lines, and spacing. A subjective evaluation of panel complexity at each locality was made. Single or several simple motifs on a panel with a low number of lines are classified as simple (for example, fig. 5.9), whereas multiple motifs of larger size with numerous lines are labeled complex (for example, fig. 5.13). At each locality, more than three-fourths of the scratched panels were judged to be simple (table 5.8). There were three very unusual and very complex panels from three of the sites in the sample, two at Massacre Bench and one at Pistone (fig. 5.15).

The spacing of the scratched figures differs between the localities. In both study locales, approximately one-third of the panels are widely spaced (1 to 2 cm or more between lines). Two-thirds of the Pistone panels are closely spaced (1 cm or less), while a little less than half of the scratched panels from the Massacre Bench sites fall into this category. Only 3 percent of the Pistone panels have mixed spacing, compared with nearly 25 percent of the Massacre Bench panels. This disparity is probably due more to multiple visitations to certain panels at the Massacre Bench sites, perhaps a product of longer use of the locality or more intense utilization at certain places (figs. 5.13, 5.15). Visually, the overall impression is that the figures at both localities are closely spaced, especially in comparison to pecked figures.

At the Massacre Bench complex, Sage Hen Spring and Post Canyon Spring stand out as loci of complex composition, and one panel at the Massacre Rim locus is exceedingly complex (fig. 5.15). Only one panel at the Pistone locality approaches the Massacre Bench panels in complexity.

The mean number of lines per panel by site and locality is one of the most variable in the comparative analysis. The Pistone loci compare closely with the Massacre Lake, Tuffy Spring, Sage Hen Spring, and South Post Canyon loci of Massacre Bench, with the mean number of panel lines ranging between sixteen at Upper Pistone and twenty-eight at Sage Hen Spring, and the standard deviation being fairly close, between eleven and twenty (table 5.9). At two Massacre Bench loci with relatively low numbers of total panels (scratched and nonscratched), there are individual boulders with large numbers of lines, up to 1500 or more, with resulting high means. The one unusual and complex boulder at the Pistone locality has 215 lines, the most found at this locality. This find again appears to demonstrate that select boulders or cliff faces were subjected to repeated and intense use by many individuals, perhaps intermittently over hundreds of years, judging from varnish differences.

There is a significant difference between the localities and within the Massacre Bench locality in the dimensions of the scratched rock art loci (table 5.10). Overall, the scratched loci at Massacre Bench appear to be 40 to 50 percent larger than at Pistone. Two loci, Post Canyon Spring and Massacre Rim, have very large, complex panels, both in contrast to the other Massacre Bench loci and to the two Pistone loci. One panel at Pistone—not recorded as part of the systematic sample—rivals the larger panels at the Massacre Bench locality; yet its scratched designs are far less complex. This variation may reflect the size of available panel faces but it could also relate to the number of drawing episodes or visits to a given panel. Pistone appears less used than the Massacre Bench sites as a whole.

Other factors that appear to be related more to the local topographic and geologic conditions than to cultural differences include inclination of panel face and orientation. At Pistone, most of the panels are on talus boulders, with the utilized face mainly close to the angle of the talus slope (30 to 50°) but with a wide variation depending on suitable boulder faces, including near-horizontal faces. These panels generally face southerly and westerly (72 percent), or downslope. The Massacre Bench panels are mostly on vertical or near-vertical cliff faces facing easterly and southerly (78 percent), with only 13 percent facing northerly or westerly (generally avoiding aspects conducive to heavy lichen growth). Importantly, however, 9 percent are on slightly inclined boulders, including several of the most elaborate faces recorded (fig. 5.3). With major exceptions, these scratched panels face toward canyons or flat benches (as do many unused suitable escarpments). The exceptions, particularly at Massacre Bench, are clear loci where scratched panels are clustered. These clusters are found at the top of the rim rock on small boulders that are not clearly visible until one is nearly on top of them (Massacre Lake locus). They are also located within a rimrock section and talus boulder cluster just below (Post Canyon Spring) where scratched boulders are near

Table 5.6 Scratched panel pecked design association

Pecked association	Pistone	%	Massacre Bench	%	Total
General pecking	16	25	26	12	42
Circle and curvilinear	21	32	94	44	115
Rectilinear and lines	13	20	39	18	52
Other	15	23	57	26	72
Totals	65	100	216	100	281

Table 5.7. Pecked designs at Massacre Bench scratched panels

Motif	wa69	Tuffy	Sage Hen	Biebe	So. Post	Post	Rim	Total
Circles	26	5	11	1	3	2	1	49
Anthropomorph	8	1	3	1				13
Curvilinear	31	7	5		1	1		45
Rectilinear	10		2		1			13
Dots	15	1	1					17
Zigzags	5		1					6
Tallys	2							2
Meanders	2		1				1	4
Grid	1	1						2
Linear	17	1	1		1	2		22
Obscure	4	1	1					6
Pecking	17	3	5		1			26
Rubbing	1	1				1	1	4
Star	1							1
Lizard	1							1
Vulva		1						1
Wavy lines	1							1
Triangle			1					1
Digitate figure					1			1
Ladder/feather		1						1
Battered edge						1		1
Totals	142	23	32	2	8	7	3	217

Table 5.8 Subjective evaluation of complexity of scratched panels

Locality	Simple #	%	Complex #	%	Total	%
Pistone	50	88	7	12	57	100
Massacre Bench	89	77	27	23	116	100

Table 5.9 Number of scratched lines by panel

Site	# of panels	Min.	Max.	Mean	Std. dev.
26wa69	68	2	80	21	18
Tuffy Spring	14	5	44	23	12
Sage Hen Spring	16	5	72	28	20
South Post Canyon	5	5	37	23	11
Massacre Rim	4	2	600	169	288
Post Canyon Spring	6	23	≈1500	373	556
Lower Pistone	44	4	56	20	13
Upper Pistone	13	3	38	16	11
Pistone Talus No.3 large panel	1	≈215			

Table 5.10 Scratched panel area dimensions by site (in cm)

Site	# of panels	Max.	Min.	Mean	Std. dev.
Length					
26WA69	68	160	10	56	33
Tuffy Spring	16	132	16	54	32
Sage Hen Spring	18	198	8	55	45
South Post Canyon	5	95	12	56	37
Massacre Rim	4	188	42	83	70
Post Canyon Spring	6	280	45	141	80
Lower Pistone	45	65	10	27	15
Upper Pistone	13	115	5	35	28
Width					
26WA69	68	110	5	38	22
Tuffy Spring	16	80	12	32	21
Sage Hen Spring	18	142	8	33	31
South Post Canyon	5	90	2	41	32
Massacre Rim	4	183	20	66	78
Post Canyon Spring	6	170	25	87	58
Lower Pistone	45	53	7	19	12
Upper Pistone	13	113	4	24	28
Pistone Talus					
No.3 large panel	1	180 long by 165 wide			

horizontal (fig. 5.3). The treatment of scratching on given faces is clearly purposeful with respect to the larger rock art site.

A consequential, but somewhat difficult, characteristic to judge is the relative degree of revarnishing and weathering of the petroglyphs. A factor that makes such an evaluation even more difficult is the thinness of the lines, generally around 0.5 to 1 mm, but sometimes as wide as 2 to 3 mm. Furthermore, sometimes the design does not appear to have broken completely through the varnish, and some of the lines are not continuous, as if the maker hit only the high spots or undertook the process so rapidly that the line became broken. Most lines appear to have been made with a flake tool; others may have resulted from gouging or acute angle strikes from a sharp chisel-like tool. Using a hand lens and a Munsell color chart, every effort was made to arrive at objective color and revarnish estimations. Other influencing factors include rock chemistry differences and the color and state of the original varnish.

Both study localilities are within basalt volcanic fields, although the lithologies appear to vary somewhat. The varnished boulders and cliff faces deviate significantly in color within each locality. Faces are often mottled, including black (5YR 2/1, 2.5YR 2/0, 10YR 2/1); dark reddish gray (10r 3/1); dusky red (2.5YR 3/2); dark reddish brown (2.5YR 2/4, 5YR 2/2, 5YR 3/3); red (2.5YR 5/6); and even yellowish red (5YR 5/6). Scratched and pecked designs at Pistone are mostly light and recent appearing, including reddish brown (2.5YR 6/4, 5YR 6/3), pinkish gray (5YR 6/2, 5YR 7/2), and pink (5YR 7/3). At the Massacre Bench sites, the scratched line colors are more variable, including scratched motifs that exhibit considerable revarnishing. Colors include light gray (10YR 7/1, 7/2); very pale brown (10YR 7/3); pinkish gray (7.5YR 7/2, 7/4; 5YR 7/2); light reddish brown (5YR 6/4); and, for some of the older appearing scratches, dusky red (2.5YR 3/2). Generally, the pecked designs parallel the scratched designs in color at the Pistone locality. They have a higher range from light to dark at the Massacre Bench sites—from reddish brown (2.5YR 4/4) to light brown (7.5YR 6/4), pinkish gray (5YR 8/2, 7.5YR 7/2), pink (7.5YR 7/3), and pinkish white (7.5YR 8/2).

Light color readings favor a predominantly late, single time period for the Pistone rock art. This belief is supported by other aspects of the local archaeology discussed below. The combined evidence supports the proposition that the pecked and scratched rock art were often made together. At the Massacre Bench complex, on the other hand, the varying degrees of revarnishing point toward several periods of use, at least two involving scratched rock art and three or four pecked art. Other archaeological data strongly suggest a multiperiod use of the locality (Leach 1988).

Chronology and Other Archaeological Considerations

The interpretation of the scratched rock art from the Pistone and Massacre Bench localities is aided by consideration of other kinds of archaeological data obtained from the localities and their surrounding regions. These data provide a larger cultural context within which to consider the art, as well as chronological information about the prehistoric occupation of the two regions generally. The chronological information is particularly useful for evaluating the potential age of the art, because of the inability to obtain direct chronometric dates.

In the Wassuk Range, where the Pistone complex is located, Rhode (1987) recorded a number of Late Prehistoric (AD 600 to 1800) camps and special purpose sites. The Pistone locality itself was surveyed and test excavated by Johnson (1985, 1987). Johnson excavated two of the midden-filled rock rings that are adjacent to the petroglyph fields. The excavations yielded an array of lithic debitage, a Late Prehistoric projectile point, and burnt artiodactyl bone, indicating a food preparation area. Johnson also recorded other Late Prehistoric and Protohistoric (AD 1800 to 1860) camps and special purpose sites nearby.

At Pistone, rock art is dispersed in talus slopes containing numerous pits and "dummies" or piles of boulders. Nearly 40 percent of the scratched panels occur within 15 m or less of these pits (proposed hunting blinds), and nearly all the scratched rock art is within 100 m of the pits. One panel of scratching is partially obliterated by a milling slick. Other slicks occur with pecked rock art on the same boulders. Johnson (1985:23) also reported that one locus contains a pecked petroglyph illustrating a putative antelope trap with a scratched anthropomorph inside the trap. Twenty or more rock circles are adjacent.

Leach (1988) has undertaken a detailed study of settlement-subsistence in the Massacre Lakes region which includes the Massacre Bench rock art locality. Her extensive obsidian hydration, projectile point, and settlement analyses led her to propose a model of marked increase in population densities from the Pre-Archaic through the Late Archaic. She postulates (1) intensified exploitation of all resource zones, including Late Archaic settlements in the uplands near springs, often at rock art locations, and (2) possible increases in logistical foraging and residential sedentism over time.

At Massacre Bench, possible hunting blinds occur in the general vicinity of nearly all the sites, although there is no scratched rock art within 50 to 100 m of the blinds, nor often at even greater distances. This situation appears generally true for the pecked rock art as well. This locality is generally rich in natural obsidian. All the rock art loci exhibit obsidian flakes, and evidence of biface reduction is often found nearby. Most of the Massacre Bench study loci include apparent occupation deposits. At Sage Hen Spring, a tufaceous tubular pipe, possibly from a shaman, was recovered from a midden located just below the petroglyph-bearing escarpment. Projectile points found in the vicinity of the rock art include types from multiple periods, ranging from Early to Late Archaic (Pinto/Gatecliff, Humboldt, Elko, Rosegate, and Desert series). Hunting blinds are generally located away from camp areas. Bedrock milling slicks occur at rock art loci with nearby camps. While camps are often present in the vicinity, the scratched rock art may be hundreds of meters distant. Overall, all scratched rock art loci at the Massacre Bench locality contain Late Archaic or later dating points or have art that is relatively recent appearing. Some of these scratched loci, however, also appear earlier in time. Certainly, some of the nearby camps may have been used as early as 6500 years ago, although more likely the figure is 3000 to 4000 years ago (see Leach 1988).

Beyond the two study localities, there is indirect information regarding the possible dating of scratched rock art. Waters (1982) describes a trail shrine in the California Desert containing "a large number of incised basalt blocks..." Based on associated ceramic evidence, this site is assigned a Patayan I affiliation, approximately AD 700 to 900. Simonis (1986) suggests that ceramic types at scratched trail locations in western Arizona date from AD 1550 to 1850. Ferg (1979:107) dates the scratched petroglyphs of Tumamoc Hill in southern Arizona to approximately AD 1200 to 1450 based on cross-dated associated ceramic designs but also suggests that pecked and perhaps scratched petroglyphs may date earlier, to around AD 900. Wallace and Holmlund (1986:210) ascribe some of the scratched rock art in southern Arizona to the Hohokam periods, sometime just after AD 600. Scratched petroglyphs in central Baja California may be coeval with the Great Mural art tentatively dated from European contact to around AD 500 (Meighan 1978:11; Crosby 1984:182; Ritter et al. 1982:53). At one Great Mural site (La Soledad or Pajaro Negro), Crosby noted a scratched grid superimposed on a painting (1984:62–64).

The design parallels between scratched boulders, cliff faces, and portable scratched rocks are numerous (see Thomas 1983a, 1983b); mobiliary art has been in the Great Basin for at least 4500 to 5300 years (Thomas 1983a:346) and perhaps 7500 (James 1983) to 8700 years (Castleton 1978:5). Heizer and Baumhoff (1962:234) believe scratched parietal rock art postdates AD 1000. More recently, Bettinger and Baumhoff (1982) attributed the scratched style to expanding Numic peoples, after AD 1000 (or AD 1300 to 1400 in the two study locales following the Young and Bettinger (1992) computer simulation model). The conclusion that seems most obvious is that scratched petroglyphs in the Desert West date predominately within the last 1000 to 1500 years, most likely are older in some regions, and probably range into at least the Middle Archaic in parts of the Great Basin.

Locational Analysis

In the Desert West, scratched petroglyphs are found in both upland and lowland settings. Heizer and Baumhoff (1962:table 6) note their association with trails, draws, a spring or tank, locations suitable for an antelope corral, and "hunting blinds." Stoney (1990) discusses two southern Nevada and one California Desert scratched sites, all within canyons. Certainly, these patterns fit with the two study locales where favorable big game hunting and seed gathering opportunities were available. For instance, Leach (1988:45) notes that, in the Massacre Lakes region, virtually all spring sources, whether temporary or permanent, were the focus of habitation, often in association with petroglyphs (and usually with scratched glyphs). Furthermore, she states that "rock art sites often appear in settings similar to upland temporary camps or hunting stations, particularly where water occurs. Canyon rims or isolated basalt boulders, often in drainages, near springs, or at overlooks above game trails are frequent locales" (Leach 1988:46).

At a location in the California Desert, Dickman (1986:144) found scratched boulders concentrated on mesa tops rather than in the nearby canyons where other rock art occurs. Davis et al. (1965), Waters (1982), and Simonis (1986) note the occurrence of scratched rock art by apparent shrines along desert trails.

Scratched petroglyphs at several sites in southern Arizona (Ferg 1979; Wallace and Holmlund 1986; Martynec 1986) are usually found on rocky hills. Ferg's (1979) and Wilcox et al.'s (1979) studies of Tumamoc Hill suggest the petroglyphs were associated with defensive refuges where limited occupation occurred, although hunting and plant food gathering were also practiced on the hill. Portable incised rock art also occurs in settings different than the parietal scratched rock art, including rockshelter trash deposits and piñon camps.

Similarities and Differences in Techniques and Motifs

Before considering the hypotheses about scratched rock art outlined at the beginning of this chapter, it is valuable to summarize briefly some of the similarities and differences in scratched art from various regions of the Desert West. While there are widespread similarities in techniques and motifs from different sites, considerable variation in overall motif assemblage contents, placement, setting, and archaeological and environmental associations are also evident. These differences are particularly apparent when sites from different geographical provinces are compared.

Scratched rock art was produced relatively rapidly, creating mostly small, sometimes even minute, designs. Rare and significant exceptions are known in the western Great Basin and probably occur more broadly. These exceptions consist of complex, often overlapping designs as well as other unusual figures.

Scratched rock art constitutes a small percentage of the petroglyphs at sites where pecked techniques (and rarely rubbed) predominate. Many pecked petroglyph sites seem to lack scratching altogether, although recognition has often been proclaimed a problem. Some trail sites within the Colorado Desert, however, appear to have only scratched rocks. Pecked and scratched rock art often occur on the same panel, sometimes clearly manufactured as part of a larger composition. Superimposition of techniques is common, but infrequently pervasive, and scratched motifs can be both under and over pecked motifs. At the two study localities, scratched petroglyphs co-occur mostly with circular and other curvilinear pecked figures, with general pecking, but apparently never with animals or obvious weapons, although such figures can sometimes be found on nearby pecked panels.

Different stages of scratching have been noted at several sites, with distinct cases of multiple levels or revarnishing at the Massacre Bench loci (figs. 5.13, 5.15). Dating is somewhat problematical for many scratched sites, relying primarily on artifact associations and subjective assessments of revarnishing.

At many Great Basin scratched sites, the general association of scratched rock art with hunting locations and features seems common, although camps can also be nearby. Not coincidentally, many scratched rock art sites are near springs and trails. Some southern Arizona scratched panels appear associated with at least one defensive camp, but this location is also suitable for hunting and gathering.

Scratched rock art appears mostly in clusters of panels, but these panels can also be more generally scattered across a rock art site. With some exceptions, scratched petroglyphs do not appear to have been made at secluded locations, although the clustering suggests that special places within larger complexes, at least in the Massacre Bench locality, were reused for some time. Mostly, though, scratched panels appear to be single episode events. On at least one boulder in central Baja California (near Guajademi) known to the author and at trail sites visited by Simonis (1986) near Kingman, Arizona, scratched designs are hidden under boulders. Small scratched pebble inclusions in volcanic rock shelters are also known from a village setting in the Owens Valley of California (Robert Bettinger, verbal communication, August, 1990). Mostly, however, scratched panels, especially in conjunction with pecked designs, would be obvious to those in the vicinity.

Many of the scratched motifs have design analogs in both prehistoric and historic basketry from the Desert West (ceramic and other art analogs are not explored in this paper). The various twined and twill-twined weaves, in gathering and burden baskets, seed beaters, and winnowing and parching trays (Fowler and Dawson 1986), resemble crosshatched designs. Decorations, including parallel lines, zigzags, and diamonds, are also found on basketry, often with gender associations (Fowler and Dawson 1986:710, 712, 714, 723, 724). Among the Northern Paiute and Owens Valley Paiute, cradle board shades with diagonal lines denoted boys, while zigzags or diamonds were the patterns for girls (Fowler and Dawson 1986:710, 714).

Adovasio (1986:197) notes that, for prehistoric basketry in the Great Basin, "twining design styles in the Western region are more varied than those from the Northern region, but most are essentially geometric with triangles, zigzags, wavy lines, linear bands, and vertical bars." Some basketry weaves, basketry designs, and scratched stones and boulders have similar imagery or configurations, and some of the imagery and construction has been around for at least 4500 years (see Thomas 1983a:346).

In the desert fringes of the southern Sierra Nevada mountains of California, Whitley's (1988b:40–41) study of rock art symbolism led him to find that, while "there is no correspondence between basket designs and rock art motifs... both symbolize the source of supernatural power in the world of aboriginal southern Sierra Nevada: the dream or trance state that gave access to the Master of the Game." Whitley (1988b:36) also notes that there was "a woman's basketry gambling tray which was used by shamans in a ritual to ceremonially 'bring' supernatural power down from the sky onto the earth."

Jones (1986:164–165), in a discussion of pictographs from a California Desert rockshelter that he believes served as an observatory, noted a correspondence between the linear paintings and regional basketry from historic contexts. He proposes, however, that "The images on the baskets are profane and created by people using environmental and mythological elements in symbolic form to create a pleasing pattern. The pictographs are sacred and painted by shamans with blood from the heart of *Mukat* (Cahuilla Creator), using similar symbolic elements to represent or call power."

Though Whitley's and Jones' assertions about a lack of correspondence in basketry and rock art designs may be applicable to a certain set of rock art sites in the Desert West where their studies have been concentrated, they may not apply in a broader sense to some of the other Desert West pecked and scratched rock art combinations.

Testing the Hypotheses

There are exceptions to the general patterns in scratched rock art motif types, associations, contexts, and similarities to other classes of art. Sufficient similarities exist, however, to allow a preliminary examination of the interpretive hypotheses pertaining to this art.

Hypothesis 1

The relationship of scratched rock art to the Numic expansion, as proposed by Bettinger and Baumhoff (1982), does not appear valid. The hypothesized "cancellation" of the power of older petroglyphs through the superimposition of scratched designs is hard to support considering that scratched rock art occurs alone or next to some pecked rock art, was seemingly made concurrently on some panels, and often only partially superimposes pecked elements. This condition, of course, does not preclude Numic manufacture of some Great Basin scratched panels, although the scratched tradition clearly also occurs outside the Numic boundary.

Other circumstances may also illustrate the potential relationship of the scratched rock art to the Numic. Bettinger and Baumhoff (1982) proposed that Numic speakers had an economic advantage over Pre-Numic peoples, due to the Numic use of woven seed beaters to collect high-cost seed resources. The importance of these basketry seed beaters to the Numic might be reflected partly in the similarities between basketry and scratched motifs. A few panels of scratched rock art, however, are partially obliterated by milling slicks, which are another proposed Numic trait (Bettinger and Baumhoff 1982). If the scratched art is truly Numic in age, then milling slicks may pre-date Numic times. Any relationship of basketry designs and milling slicks to scratched petroglyphs and an expanding Numic population is, then, problematical considering the extensive time during which milling slicks and other basketry forms may have been used.

Hypothesis 2

Whether the scratched mobiliary art is a complement of the same tradition as the parietal scratched rock art in terms of age, motif assemblage, manufacturing technique, etc., is an important question when evaluating interpretations. While this issue needs exploration exceeding that offered here, a few comments are in order.

Many scratched rock art motifs have general parallels in the mobiliary art, in rock drawings or sketched pictographs (Hedges 1989), and in pecked rectilinear abstract or geometric rock art (Thomas 1983a:346). My comments here are confined to a comparison of portable and parietal scratched art. Differences between the two are apparent concerning the arrangement and percentages of motifs. Thomas (1983a:345), for example, noted that at Gatecliff Shelter, Nevada, only "50 percent of the motifs incised into the portable stones have been painted, pecked, or scratched onto walls at rock art sites throughout the area." However, 75 percent of Heizer and Baumhoff's (1962) scratched motifs from the Hickison Summit (26La9) and Northumberland Canyon (26Ny304) sites are present in the Gatecliff Shelter portable stone motif inventory (Thomas 1983a:346).

At the two study localities, the contrast with portable art assemblages is greater. Scratched anthropomorphs are present at the study localities but not in the portable art; similarly, datum lines and motif appendages are nearly absent in the parietal art but present in the portable. Most importantly, mobiliary art has higher percentages of zigzag, chevron, and triangular motifs and lower percentages of crosshatching than at the study localities. On the other hand, there are closer similarities between the Gatecliff Shelter scratched stone assemblage (Thomas 1983a, 1983b) and the assemblage of parietal scratched rock art from Agua Dulce, southern California (compare King 1981:fig. 5.5, 5.6). Although there are similarities in the motif assemblages between the kinds of art, then, no one-to-one correspondence in motifs types exists, and variations in the degree of correspondence occur when the assemblages from different sites are compared. Differences are also seen in manufacturing techniques. Portable scratched art exhibits much technical variability, including mid-motif tool changes, use of single or double-tipped tools, and motifs created by "rocked dots" or simple incising (Thomas 1983a:348; 1983b:251). Technical variability such as this is rare or absent in the parietal art.

Because the parietal scratched rock art is poorly dated, it is difficult to make chronological comparisons between the scratched and incised portable forms. Spatially, distribution of the two forms differs across the Desert West (compare Stoney 1990; Klimowicz 1988:fig. 2). For instance, no incised portable art is known from northwestern Nevada where considerable parietal scratched art is present, as reported here. Furthermore, pecked petroglyphs occur with scratched petroglyphs. These comparisons alone suggest that the two forms of scratched rock art differ physically in a number of respects and probably in function.

Hypothesis 3

The hunting magic hypothesis is virtually a straw man argument. It has been dissected and rejected on good grounds by many researchers (for example, Lewis-Williams 1982; Rector 1985; Bahn 1991). There are aspects of the argument, however, that deserve further exploration in light of the scratched rock art data, the associated pecked art, and their context. Obviously, there is explanatory merit in viewing the interrelationships of various aspects of the archaeological and environmental record. Such relationships are not necessarily causal, nor do they imply simply an inductivist empiricism. What is apparent is that scratched rock art—at several western Great Basin sites at least (also see Nissen 1982)—generally occurs in locations especially suited for big game drives and ambushes, although the specific hunting blind or hypothetical drive line may be scores or hundreds of meters distant. These sites also have water, making them suitable for ambush. A hunting location with art nearby does not necessarily imply a direct hunting relationship with the rock art, however. In the Massacre Bench region, Leach (1988:149) notes that "Late Archaic populations were not so concerned with preserving water sources for game as Pre-Archaic populations since hunting had become relatively less important (not unimportant) in the diet." Leach (1988:45) also discovered hunting-related sites, which lack petroglyphs, throughout the region. Moreover, because such hunting was episodic, animal drives could be periodically or seasonally directed to suitable ambush locales near the camps, whether occupied or temporarily abandoned at the time of the hunt (for example, Fowler 1989:16–17). In this respect, I see no conflict with occupational debris near potential hunting-related petroglyphs.

Miller (1983:78) considers Great Basin rock art as mnemonic, based on ethnographic information he obtained from distant Interior Salish (Columbia Plateau) informants. Such petroglyph sites "were selected to notify the Animal People about human intentions there, rather than to work some nebulous hunting magic." One cannot assume this implies that hunting magic, directed toward hunting at these specific sites, occurred. Blank panels suitable for rock art also occur near presumed hunting blinds at both Pistone and Massacre Bench, but, once again, they could be considered part of a larger complex. Another consideration is that there are water sources and gathering areas in the same "catchment," although few milling tools were found at the test localities during the incomplete survey. Also of interest is the general absence of obvious weapons and of zoomorphs within the scratched petroglyphs, although such imagery is present at Pistone in the proposed antelope drive scene (see Johnson 1985:23).

Further afield, scratched panels along trails at purported shrines (located in areas not conducive to hunting) demonstrate that this hypothesis, if true, was certainly not universal. McKern (1983:31) found scratched petroglyphs in the Mesa Verde area, mostly on surfaces associated with horticulturalists' buildings. This motif assemblage appears very different, however. The southern Arizona scratched examples, within hills adjoining defensive settlements (but with nearby proposed hunting blinds and gathering zones), may be another exception. Therefore, while hunting and gathering areas can co-occur with scratched and scratched and pecked rock art, no causal connection can be assumed.

Hypothesis 4

The neuropsychological model of Lewis-Williams and Dowson (1988) and Whitley (1988a; chapter 8), as applied to some Great Basin pecked art, can be applied to scratched rock art sites as well, especially when documentation has been rigorous. This model, which concerns shamanistic arts originating in trance imagery, predicts a display of the most common phosphenes and entopic patterns (grids, parallel lines, dots and short flecks, zigzag lines, nested catenary curves, thin meandering lines, and the spiral/vortex). The model also includes seven principles of perception, by which the patterns are perceived: replication, fragmentation, integration, superpositioning, juxtapositioning, reduplication, and rotation (Lewis-Williams and Dowson 1988:203). Finally, the model specifies three progressive stages in the development of the trance imagery: an experience incorporating phosphene and entoptic phenomena alone; an elaboration of phosphenes and entoptics into iconic forms; and a hallucinatory shift to vivid iconic imagery, "often projected against a background of geometric forms" (Siegel 1977:134; Lewis-Williams and Dowson 1988:203–204).

An increasing body of data suggests that some of the Great Basin rock art, at least in the ethnographic past and for an unknown time previously, was produced by shamans (or others) during trance-state experiences (Whitley 1988a, 1988b; 1992b, 1994, n.d.a). These experiences are also documented for Great Basin antelope hunting ritual (Fowler 1989:15). A serious consideration, however, is that in the Massacre Bench locality at least and in southern Arizona there are well documented prehistoric culture changes. Some of these changes are based on subsistence and adaptation, while others concern population replacement or assimilation—and the ethnographic link weakens. Despite the apparent refutation of the scratched rock art/Numic expansion connection in the Great Basin, linguistic, archaeological, and other evidence (see Young and Bettinger 1992) suggests that some cultural changes came with the late prehistoric expansion. Furthermore, the proposed Archaic cultural changes are more of degree than of kind. Nevertheless, Lewis-Williams, Dowson, and Whitley see the neuropsychological model as transcending cultural and temporal boundaries.

There is a relatively strong correlation between phosphenes and rock art motifs in the scratched rock art from the two study localities, and an even stronger correlation when probable scratched and pecked combinations are considered. Certainly, the dominant motifs of crosshatching (grid) and parallel lines are in accord with the grids and parallel lines mentioned in hypothesis 4. Dots or short flecks are rare or absent in the scratched art, unless the "tallies" at one of the Massacre Bench loci are considered (fig. 5.15). Furthermore, pecked dots and general pecking are relatively common on pecked and scratched panels. Scratched zigzags are infrequent at the principal study localities; they do occur in the pecked art. Arcs and nested arcs, or catenary curve variations, are present in the scratched art at both study locations. Thin meandering lines are quite rare at these sites, being virtually absent at Pistone. Curvilinear motifs and infrequent isolated meanders are relatively common in the pecked art associated with scratches. The concentric circle and spiral or circle-related scratched designs are, overall, relatively rare in the scratched rock art, but common in the large, complex panels. As indicated previously, circular imagery is dominant in the pecked rock art associated with scratching at the two test locations.

In the southern Arizona examples, crosshatching is most frequent at Tumamoc Hill (Ferg 1979), followed by zigzags and parallel and wavy lines. At the Picacho Mountains sites (Wallace and Holmlund 1986:210), the few scratched motifs fall into the straight, zigzag, and wavy line categories. Crosshatched grids and parallel line sets are most frequent in southern Nevada and the California Desert sites (see Stoney 1990 and Dickman 1986).

At different trail sites, crosshatching is either the only motif or the most dominant motif present (Davis, et al. 1965; Simonis 1986). All these examples fit with phosphene imagery, although a multitude or variety of such imagery is not always present.

In central Baja California, there is crosshatching, iconic and integrated images, and superpositioning of scratched forms. Robin and Ewing (1989), who found a northern Baja California site with pecked patterns and scratching (ladders and a grid), note that "death and rebirth during shamanic transformation is paralleled in the symbolism of the summer solstice events at San Carlos Mesa" and view such practices as giving balance to life's oppositions, such as male and female, life and death, and summer and winter (Robin and Ewing 1989:35). Scratched spider webs in Baja California (Crosby 1984:103) and northern Arizona (Christensen 1990) may have religious meaning, as discussed by Miller (1983:80). Scratched designs in the Mesa Verde area of Colorado include spirals and "indeterminate" forms, but they are predominantly scratched human and animal figures and foot and hand forms (McKern 1983:31). Concerning the scratched mobiliary art of the Great Basin, Thomas (1983a:341) indirectly implies there may be a phosphene connection.

Looking at the principles of perception, a number of the unusual, uncommon geometric images at the two study localities may be explained in this manner: Ladder-like and rake-like forms may, for instance, be fragmented grids. Feather-like figures could be phytomorphs, feathers, and integrations of parallel lines or fragmentations of zigzag lines. The feathered-fringe occurrence with anthropomorphs could be an example of integration, as could the stick anthropomorph with a rake-like headdress at Post Canyon Spring. These forms, incidentally, occur almost exclusively in the large, complex, intensely used and revisited panels. At the Massacre Bench and Pistone localities and as far away as central Baja California, pecked anthropomorphic figures or foot or hand appendages appear with scratched digits (fig. 5.19).

The various scratched sites further support the principles of perception. Pecked and scratched figures appear integrated on a number of panels from the two test localities, at La Soledad in Baja California and at Fate Bell Cave in southwestern Texas, where painted and scratched integration or superpositioning is present. Superpositioning and juxtapositioning of scratched and pecked images and scratched–over scratched designs from a number of sites in a myriad of locations in the western Great Basin and Southwest have been described in some detail. Reduplication, with a series of loops, scrolls, and linked ovals, is notable in a few instances.

Following the neuropsychological model, most of the scratched rock art would fit within one or more stages of mental imagery development. There may be a variation within some sites and regions, as in Baja California and around Mesa Verde, if other explanations, such as totem or clan symbols and charms, ultimately prove more viable.

Conclusions

From this examination of Desert West scratched rock art, it would appear that mobiliary and parietal forms differ in the obvious: medium and archaeological context with some similarities in the motifs and method of manufacture. This scratched art co-occurs over much of the Great Basin, although not in all regions of the Desert West. These art forms may be coeval over the later part of prehistory, and each may have considerable time depth in some localities. Possible socio-religious functions are more difficult to compare. Thomas (1983a:351) may be on the right track in noting that, for the Great Basin, the symbolic correlates between the portable and nonportable scratched rock art are related to subsistence scheduling and a hunting-plant food (male-female) dichotomy. In her interpretation, one would accept geographical specificity (nonmobile art) as a criterion for communal hunting localities, and nonspecificity (mobile art) as a hallmark of plant-gathering locales. Thomas' adaptive interpretations fail to account, however, for discontinuities in geographical distributions and possible temporal variations, nor do they consider the manufacturers' roles in the various rock art production processes. Additionally, there is no consideration of possible gender variations in manufacture. Finally, the interpretations do not address the deeper issues related to socio-religious power, control, and direction of human behavior as discussed below.

The data do not support the rock art portion of the Numic expansion hypothesis of Bettinger and Baumhoff. It is almost certain, however, that Numic speakers manufactured at least some of the Great Basin scratched rock art, although the tradition obviously extends beyond proposed Numic boundaries. Manufacture of scratched rock art in the likeness of Numic-introduced seed beaters and other basket forms (including Pre-Numic types), and similarity to basketry decorations is intriguing. This proposition, however, seems less likely than the phosphene/entoptic argument. Notwithstanding, there could be some congruence between phosphene and iconic (basketry-related) forms in the perception and manufacture of the figures.

The best fit of those hypotheses tested is the neuropsychological model, with the scratched petroglyphs being created primarily by individuals in a trance-state or similar condition, at least for the study localities and probably for the remainder of the Great Basin, southern Arizona, and Baja California sites. The very limited occurrence of crosshatching on boulders at trail shrines found along ethnographically sacred routes could represent a replication of imagery by traders or travelers from other regions. The more logical explanation is that they represent part of the trance-state experienced by a shaman or other traveler at especially sacred, perhaps logistically important, points along the trail.

In addition to Whitley's (1988a, 1988b; 1992b, 1994) ethnographic examples of shamanic-rock art connections throughout the Great Basin and beyond where phosphene-iconic imagery was produced, Ute religious practitioners in Utah (Phillips

1986) indicate that the range of rock art imagery variously represents traditional religious beliefs and practices (unspecified), personal and familial identification and history, and observations on the natural environment. The important point is the disclosure of a shamanic association, but one with variability in context and content. Among some horticulturalists, as at Mesa Verde and in New Mexico, the manufacture of scratched rock art may have nonshamanic origins. Wallace and Holmlund (1986:v) see the Gila-style petroglyphs (including scratched) as resulting from individual rituals related to possible human fertility, geographical mapping, and curing ceremonies.

The frequent location of scratched and pecked rock art near springs suggests—near the time of contact at least—a spirit/power supernatural relationship. Shamans controlled the power-energy source after it was conferred to the individual by a spirit in a dream (Miller 1983:69). Spirits (water babies) closely associated with shamans were believed to inhabit springs (Miller 1983:75; Whitley 1994, n.d.a).

If the shamanic-trance state/scratched parietal art connection is correct, then what purpose did this art serve society and the individual? These sites appear to be largely communication centers situated near camps, trails, and primary hunting and foraging locations. The larger petroglyph fields (scratched and pecked) appear to represent an alliance between the shaman and life's spiritual and physical sustenance. The visual reminder reinforced lifeways. It is tempting to see the scratched parietal (and possibly mobiliary) art as female related, because there were female shamans, albeit fewer than male shamans in ethnographic times (see Whitley 1992a, 1992b, 1994).

The two forms of parietal art, especially the scratched form and its strong correlation with basketry weaves and decorations, were influenced by a concept like the "dream world that represents access to the Master of the Game" (Whitley 1988a:40). Perhaps then, the pecked, scratched, and combined scratched and pecked symbols helped maintain a system of inequality by masking differences between the sexes (Whitley 1988a:42; 1992a, 1994). The hunting-gathering dichotomy of Thomas (1983a) between parietal and mobiliary scratched art can thus be taken to a higher level: a gender-based distinction reflecting larger relationships between the sexes in society. In this scenario, however, males could be manufacturing both forms of parietal rock art to emphasize the sexual inequalities.

Expanding on Whitley's (1992a, 1992b, 1994, n.d.a.) ideas, then, the scratched and pecked rock art sites are shamanic (or at least male) trance-state creations in which male hunting success was due to ritually produced supernatural power, and the images relate symbolically to hunting (pecked) and gathering (scratched). Thus, "the engravings helped to mystify the unequal and asymmetrical relationships both between the sexes, and between shamans and non-shamans" (Whitley 1992a:87), and perhaps female and male shamans, or at least between male and female power seekers (see Spier 1930:93–97).

Because of difficulties in maintaining the human ecological and, hence, spiritual equation owing to climatic changes (see Layton 1985:195), human intrusions (Bettinger and Baumhoff 1982, Young and Bettinger 1992), and variations in plant and animal foods and water sources, the conscious and spiritual search for social and economic well-being and maintenance may have been served in part by graphic displays (both open and more hidden; see also Foin and Davis 1987:9–10). Such displays occur at certain trail shrines, near camps and food sources, close to water, and in mobiliary forms in rockshelters and at piñon camps where they form talismans or charmstones.

The scratched tradition is obviously widespread but with some meaningful variability in content and context. There are, perhaps, separate traditions in different regions (for example, Mesa Verde, Pueblo area, California coast/interior).

In its parietal form, scratching has apparently been around for centuries, even millennia, and it shares many relationships with the mobiliary art, but with differences in meaning. Most likely this scratched rock art tradition spread at different rates to differing regions, not even reaching some locations. That different cultures could independently develop the same techniques of scratched display and symbolism, notwithstanding universal neuropsychological-based imagery, is entirely possible. But the contention here is that cultural mechanisms of transmission from group to group are also a likely explanation for its spread over much of the Desert West. The cultural contexts are clearly varied, and there is probably no universal explanation for its socio-cultural meaning throughout all areas, although a shamanic-power place association seems likely for much of the art. Clearly, some scratched petroglyph locations and individual rocks were more sacred among the sacred.

6 A Gendered Search Through Some West Texas Rock Art

PATRICIA M. BASS

In rejecting art-for-art's sake . . . [we need to] stress how works of culture belong to the larger struggles of their societies.
– Gregory S. Jay,
Chronicle of Higher Education, B2

MOST PEOPLE WHO STUDY ROCK ART, that category of material culture which includes such palaeolithic and archaic art as paintings, drawings, engravings, and figurines, as well as more recent visual endeavors by varied indigenous groups, would agree that interpretation, in all its dimensions, is in the eye of the beholder. Thus, a modern-day pictorial interpretation of a large image on a cave wall along the Rio Grande River might be a panther/cougar, a visual representation frequently found in west Texas rock art. However, a second examination of such an image, along with its nearest associated image, might suggest a human figure and horned cattle. How do we—not the original users—know which is the "right" pictorial image? And how do we know what the image signifies—its symbolic interpretation? At the very least, such varied and inconclusive interpretations offer yet another reminder to never underestimate context and viewer bias when offering interpretations of ideological artifacts.

The importance of context and bias as they affect rock art research and thus the models and interpretations, particularly symbolic interpretations, is briefly investigated here. A deliberate focus is the study of gender content in the art by examining motif associations and panel compositions, and using symbolic and semiotic models, to identify visual patterns and repetitions in the rock art of the Pecos region of west Texas.

West Texas Rock Art

Most of the twenty-four sites from which data were recovered and which are examined here contain only a few scattered paintings. But in some of the large shelters, pictographs, often superimposed, almost completely cover the walls for more than 100 feet. Nearly all the Pecos River style pictographs (those generally considered to be the oldest in the west Texas region and the primary stylistic corpora of data examined here) are found in shelters associated with refuse heap deposits and artifacts, or are immediately adjacent to such archaeologically significant materials. The pictographs are painted in several colors, including a dark red (the most common color), yellow, black, white, and blue. One color is often used to outline another, and alternating lines of color are common.

The images most often depicted include anthropomorphs, animal forms, plants, geometric figures, and abstractions or images that are not immediately recognizable. The anthropomorphic images are the most elaborate, conspicuous, and numerous. The basic shape of the earliest depictions is an elongated oval with roughly parallel to slightly converging sides. Some images have squared-off shoulders, and a smaller number are a definite rectangular shape. Arms are usually extended and slightly raised. Legs are sometimes present and often show toes. Most anthropomorphs face front and show little or no movement. The bodies of the anthropomorphs, which are extremely varied and often headless, are generally outlined and may be filled with vertical lines, stripes, circles, rectangular forms, and solid colors. Their average size is under 6 feet, although some are 10 to 15 feet tall.

Therianthropomorphic figures,[1] those combining human and animal attributes, are not as numerous. Projections or "antlers" often protrude from the head area. Several figures display wide, squared-off "wings" that extend horizontally outward at shoulder height. Anthropomorphs are visually dominant in size and location and are usually surrounded by animal, plant, geometric, and abstract images. Birds in flight and small-size deer are occasionally depicted. Cougars and panthers are numerous and often large, up to 15 feet across, and placed in commanding spatial positions.

Images of plant-like forms that seem to resemble native vegetation are also drawn. Designs that are similar to the flowering stalks and other features of sotol and agave, which probably provided the bulk of the wild plant food for the prehistoric artists, are depicted. Many examples of ribboned or wavy lines, rectangular or oval forms, small circular shapes, and hand prints are also shown (Bass 1989:86–88).

Previous interpretations

Early analyses of rock art, including that of the Pecos River region of west Texas, interpreted these images as representing an Archaic Indian sympathetic-hunting-magic cult (Bass 1989:45–46). This inference was based on the visual presence of game animals in the rock art and ethnographic analogies drawn from contemporary foraging groups. Archaeological evidence of stone tools and other artifacts was attributed to a division of labor between the hunter and the hunter's paraphernalia and the gatherer and the gatherer's equipment. The art itself was explained as depicting figures of "a god-of-the-chase surrounded by animals pierced with arrows" (Kirkland and Newcomb 1967:65). This notion of a hunting cult was eventually dismissed because deer were not the only animals hunted. The art also included animals that were not hunted (such as the visually impressive cougars) and seemed to have a more complex meaning than a prey or even a predator (Bass 1991:5).

The pictographs were next considered to have originated in shamanic practices. Early researchers such as Kirkland and Newcomb suggested that the "anthropomorphic beings. . .[were] shamans or perhaps members of medicine or dance societies." They cited T.N. Campbell who had noted "that 'the chances are good' that a mescal bean cult was involved in the scenes depicted in the Pecos River style paintings" (Kirkland and Newcomb 1967:65). The distinctive red mescal bean (*Sophora secundiflora* seeds) has been found at numerous archaeological sites in the region, along with more limited evidence of peyote use (Kirkland and Newcomb 1967:70–71; Shafer 1986:223). This "shamanistic-society" hypothesis, it was argued, explained the presence of the cougars in the pictographs: "some shamans, or perhaps members of a 'cougar society' received power from this animal." The shamanistic-society hypothesis also explained the extensive overpainting found in Pecos River style pictographs—shamans would return to their "old traditional places where their forerunners had been in successful communication with the supernaturals." The conclusion was that the custom of painting shelter walls in the region of the lower Pecos "may have originated when a shaman emerging from a trance. . .attempted to visualize his hallucinations or dreams by a rude painting" (Kirkland and Newcomb 1967:79–80).

Gender bias

Most current explanations, as with many corpora of rock art, offer shamanic-related interpretations. Yet, even with shamanic interpretations, we might be ignoring a cultural construction of our own: gender. Earlier interpretations seem to have progressed from hunting-cult to shamanic-society hypotheses without seriously considering the tacit presumption of an explicitly male-based art. We no longer routinely assume these images are male gendered; after all, there are no physical attributes in the Pecos River style rock art to indicate one sex or the other. The analytical assumptions used are no longer obviously gender related. Nevertheless we may have replaced our more blatantly gendered explanations of a hunting cult with a nonetheless androcentric bias because of a focus on the undoubtedly important shaman images. It may now be "necessary to reconsider simplistic interpretive assumptions to the effect that 'hunting' artifacts are indicative of the presence or activities of men" (Wylie 1992:27).

Researchers in this area have found it difficult, however, to develop methods that encourage examination of shamanic and other images that might reflect a less exclusive explanation of this rock art. This, in turn, may lead us to ignore the nonshamanic images that may help break our androcentric interpretive mind-set and influence our course of inquiry in a de-gendered way.

Problems with androcentric bias

One way to make our methodology more inclusive is to acknowledge our androcentric bias and our reliance on ethnographic analogy. Archaeologists are supposed to be cautious about simplistic ethnographic analogies, but we have not been with regard to gender (Conkey and Spector 1984). If we continue emphasizing "shaman" images with "set repertoires of accessories" (Turpin 1991A:271), traditionally interpreted as atlatls and beating sticks or hunting equipment (Shafer 1986:159), are we still not maintaining an implicit and perhaps unnoticed man-the-hunter gender bias? Shafer (1986:159) is correct in urging us not to "assume that. . .[the images] relate to men's activities alone," but a broader ritual interpretation of the art should not be limited to "boys' initiation rites" (Shafer 1986:25, 142) as it must also include the possibility of female rites. Thus we continue to generate gender-exclusive, rather than gender-inclusive, reconstructions. Furthermore, with the Pecos rock art and its unclear ethnographic antecedents, are we not assuming ethnographic analogs and the universality of the sexual division of labor as we now see it?

Because we are using ethnographic models, why not examine those that might offer a more inclusive treatment of all the images? In other words, ethnographic examples can be used to aid direct interpretations or, in a case such as the Pecos River rock art, to help us see in a heuristic fashion. There are ethnolinguistic records where women were recorded as shamans. Kroeber, in his *Handbook of the Indians of California*, talks about certain ethnolinguistic groups and the fact that the "shaman was almost invariably a woman" (Kroeber 1925:853, 423).

Recent work by David Lewis-Williams (1982) offering a shamanic explanation for rock art in southern Africa suggests the presence of female shamans. In applying his shamanistic interpretation to Paleolithic art, he notes, however, that "in some societies the shaman is an exceptional and solitary figure, whereas in San society about half the men and a third of the women are shamans. . .We shall therefore have to achieve a broad and comprehensive view of shamanism before we try to ascertain some of the features of Upper Paleolithic shamanism" (Lewis-Williams 1989:51).

Thus we may propose that rock art may be shamanistic but not male. Furthermore, certain ethnographic cases demonstrate that females made rock art in the context of "shamanic" art: James Teit recorded female puberty rites and rock art among the Thompson River Indians of the Columbia Plateau in 1896 (Teit 1896: 227–230). The Huichol,[2] a group living in northwest Mexico with possible cultural antecedents in the Southwest and pre-Columbian cultures, produce art of peyote visions or representations envisioned in an hallucinatory state and shamanic initiation (Eger 1978:39).

Although women shamans are rare, "the duties and obligations of the shamanic quest are so intense that the effort must be a joint undertaking of husband and wife" (Eger 1978:47). Furthermore the woman's religious knowledge is encoded in her art (Eger 1978:51). "Through ingestions of peyote, the completed woman also develops the ability to 'dream' her designs and remember them. . . .Her handiwork is drawn from the same reservoir of shamanic knowledge and power" (Eger 1978:52). These shamans, in an effort to communicate their understanding of the world, have given birth to these art forms (Bean and Vane 1978:124).

David Whitley has provided yet another example of female-based rock art. He describes southern California puberty rites in which some motifs are explicitly "female." They show helpers as seen in altered states during female initiation ceremonies (Whitley 1992b:95). According to Whitley, using an ethnographically informed analytic approach, there are at least two separate traditions of rock painting in the locale he describes, but "when the metaphoric and symbolic foundations of various traditions are examined," they fundamentally concern vision-questing (Whitley 1992b:92, 94). "The first rock painting tradition involved formalized puberty rites, conducted separately for male and female initiates of the so-called chinigchinich or jimsonweed cult" (Whitley 1992b:94). Paintings were made by initiates concluding a period of deprivation and stress, the administration of hallucinogens, ceremonial dancing and so on.

This puberty-painting tradition constituted a fundamentally shamanistic initiation in which initiates "apparently painted the spirit helpers they received during this initiation" (Whitley 1992b:94). Female initiates "principally painted zigzag and diamond chain motifs whereas. . .evidence for the male initiates suggests circles and curvilinear motifs. This fits the general gender-based distinction in 'decorative motifs' for far western North America: diamond, zigzags and diamond chains were 'female' designs, while other geometric patterns were 'male'" (Whitley 1992b:95). Furthermore "the Southern California female initiates' zigzags and diamond chains have specifically been identified as 'rattlesnake' drawings. . .correlating with a gender-based pattern that characterized far western North America as well" (Whitley 1992b:95). Thus, the rattlesnake was a shaman spirit helper for the female initiate, and we may propose that rock art is produced not only by shaman ritual specialists, but by the shamanically aided nonspecialist in a ritual context.

Applications of Interpretive Models

Trying to ascertain the features of the shamanic rock art of west Texas has led to a variety of endeavors to illuminate and explain this art, some indicated above. Proving that these pictographs are a product of shamanic events is not, however, the focus of this paper. Rather, the art may be shamanic and female based. Therefore, the focus must now shift to a restructuring of the data to produce a de-gendered or more inclusive interpretation of this corpora of rock art.

Models of association

The primary method used to examine symbolic interpretation, or what the images might signify, evolved from studying the evidence gathered from twenty-four west Texas rock art sites[3] and models of association adopted to illuminate semiotic communication patterns (Bass 1989:54–79; 1992:409). After adapting and trying to work with several different models designed to elucidate associations among images, criteria were developed to define the relationship between two or more pictographs. This effort necessitated a visual classification of approximately sixty motif types that was refined and modified over a three-year period. The images were counted and categorized according to this pictograph typology and analyzed using criteria consisting of eleven types of association. The data relating to two of the association criteria, images designated D1 or D2—those whose logical relationship is perceived by the viewer either by connection by lines or objects or by sequential action—have been analyzed for this de-gendering task (Bass 1989:99–100, 1992; table 6.1).

As a visual example of what is meant by "association," we begin with a very simple combination of images found at Coyote Shelter (fig. 6.1). On a wall above the Rio Grande River, we find a zigzag painted in association with reverse hand prints and two small animal figures sometimes identified as coyotes. The scene's shamanic origin may be suggested by using Lewis-Williams and Dowson's (1988) neuropsychological research, which indicates that the zigzag is an entoptic image seen by the artist, who was a shaman, upon entering a trance phase. One very small panel of Red Monochrome style rock art paintings along a river in Texas, however, does not offer persuasive evidence for use of Lewis-Williams and Dowson's (1988) neuropsychological model, and I would rightly be castigated

Table 6.1 Results of direct association search for "zigzag" motif

	Frame	Pictograph typology	Direct association
1987	FB18	57	D1:60(9)
	FA3	55	E:57
	PA8	24(5)	C:57(2)
	PA9	57	D1:30:54
1988	CC1*	57	D2:2

* Art is not Pecos River style.

Notes: This example of a search for a zigzag motif type, number 57 (in boldface type), shows how "direct association designation," that is D1 or D2, appeared in conjunction with motif type 57 two times in the 1987 data and one time in the 1988 data. FB18 means Fate Bell Shelter, frame 18, where we found one "zigzag" motif directly associated (D1) with nine depictions of motif "60", which are human figures. The second direct association is found in Parida Annex, frame 9, one zigzag association with a "spear" (30), and another unidentifiable image (54). The zigzag motif association found in the 1988 data is located at Coyote Shelter. Red Monochrome style art. Motif 57 is associated with motif type 2, a quadruped with tail (see figure 6.1).

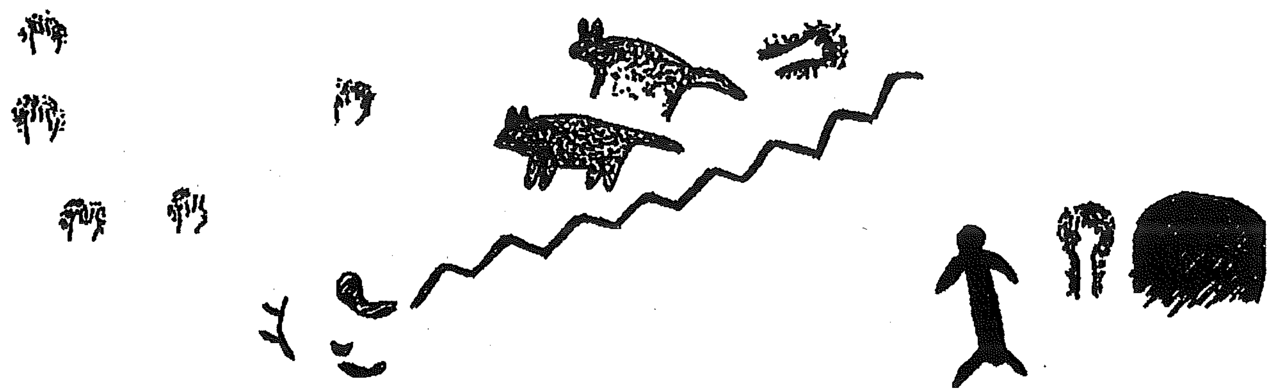


FIGURE 6.1. COYOTE SHELTER. Located under an overhanging bluff on the west side of the Pecos River. Red Monochrome. Scale ¼ inch to 1 foot. *Drawn from Kirkland and Newcomb 1967:20, pl. 4, No. 1.*

for my lack of "concern for the empirical content of the interpretation" (Watson and Fotiadis 1990:620). More importantly, it does not begin to address the issue of gender. I have, therefore, returned to my original data to search for images using "gender as an analytical concept" and, at the very least, expose gender bias in my inquiries (Gero and Conkey 1991:4–5).

De-gendering the interpretations

It is hard to focus on metaphors and the gendering of cultural products when dealing with prehistoric pictographs. Ann Solomon, in her study "Gender, Representation, and Power in San Ethnography and Rock Art," examines San texts and stereotypes to interpret the iconic content of San rock art and illuminates culturally constructed gender conventions in compass directions, form (round versus elongated), and orientation (left versus right) (Solomon 1992:291–329).

Whitley also considers gender in terms of social relations among the so-called egalitarian Numic hunter-gatherers of the prehistoric Great Basin of the western United States. He argues that a literal reading of Coso rock engravings would seem "to emphasize hunting, an activity of reduced importance to [the seed-gathering Numic]." By examining the social context, Whitley interprets the engravings as "response to the threat to established gender relations precipitated by. . .[a] change in subsistence" (Whitley 1994: 368).

I find it much harder, however, to point out the complexity of gender relationships, as represented iconographically, using only the visual depictions of rock art. In examining the Pecos data, with the aim of "finding" women in this archaeological context (Gero and Conkey 1991:5), several assumptions become apparent. There is no visual justification for the androcentric bias in interpreting the Pecos River art. Even the anthropomorphic images, which we may acknowledge to be shamanistic, have no sexual referents: they fail to show any primary (sexual organs, mammalia) or secondary (facial hair) sexual characteristics. Nor do the zoomorphs show any sexual characteristics (such as penis sheaths or testicles on profile-view quadrupeds and panthers).

Additionally, by emphasizing "shamanic" figures, have we ignored other motifs with potential sexual associations? There seem to be traditionally interpreted men's artifacts in depictions of "hunting paraphernalia," but have we overlooked artifacts traditionally ascribed to women?

Lastly, acknowledging this latter simplistic interpretive assumption, do the motif association patterns show possible links between gender-associated pictograph types and other motifs, particularly the shamanic figures? That is, do the shamanic images in fact co-occur with "male" weaponry or possible "female" motifs, or are there other associational clusters that might inform an interpretation of the art? (For more information about the direct association models used here, refer to Bass 1989:99–100.) If we accept a shamanic origin for the art, then we should be aware that "trance draws on gendered symbols" (Solomon 1992:316). De-gendering does not equate with no gender representations—if gender is important, then not all representations should be male.

Analyzing and interpreting the Pecos River art

The data gathered from the west Texas rock art sites do not display distinguishable physical sexual characteristics. The usual image categorized as an anthropomorph/shaman figure consists of an idealized body shape, sometimes with a head form, and often holding a variety of "typical" implements (fig. 6.2). Thus, none of the 673 images classified as shaman figures (Bass 1989; 1992:410) can be directly interpreted as "male," except by interpreting their equipment as being male based.

Male-associated art. Nevertheless, the male-based equipment was entered into the data base as representational motifs depicting:

Type 30 – spear with fletching

Type 31 – atlatl (must be curved with notch suggested)

Type 36 – hunting stick

Using circular reasoning, we classified type 36 as a "hunting stick" because it was typically held by the shaman figure; in other words, a straight-line depiction was counted as a "hunting stick" if, and only if, it was held by an anthropomorph. A composition of images was then calculated. It showed that the vast majority of these representational motifs, held fairly equally in either the right or left arm of the anthropomorphs, were directly associated with shaman figures (Bass 1992:411). While these representational associations might plausibly suggest at least some male art, it is important to note that less than one in six anthropomorphs/shamans actually carried this traditional hunting equipment (116 were counted).

Female-associated art. A further examination of the images associated with the shaman figures indicated that another 134 images were not what we had assumed were male-associated images. These depictions had been interpreted as shamanic equipment, but not necessarily as hunting tools, and classified as:

Type 20 – rounded pads connected to stalks

Type 21 – rounded pads (without stalks)

Type 22 – oblong corn-like or wheat-like images

In addition to taking note of non-hunting shamanic equipment, I began to track associations of such motifs as plants, that might plausibly be interpreted as female associated:

Type 23 – sunbursts (14 depictions found)

Type 24 – thistles (100 images found) (fig. 6.3)

Type 25 – other plant-like (24 counted)

Type 26 – plant-like (52 counted)

Geometric images. To determine whether there were other image association clusters, I searched for the following abstract images:

Type 44 – vertical squiggles

Type 45 – horizontal squiggles

Type 46 – diagonal squiggles

Type 51 – circles or concentric circles

Type 57 – zigzags (fig. 6.4)

Type 58 – helix-like images

There are, of course, other abstract images in the Pecos River and Red Monochrome style pictographs, but I chose to track those nonshamanic images that depicted shamanic or entoptic features in other rock art corpora. In addition to locating these images, I investigated their associations with other images—that is, their semiotic/communication patterns. Data gathered from the sites revealed 123 vertical curvilinear designs of the Pecos River style, 1 image associated with the Red Monochrome style painting, and 84 horizontal and 46 diagonal curvilinear designs. The circles/concentric circles numbered 243, with an additional 8 painted in the Red Monochrome style. The zig-

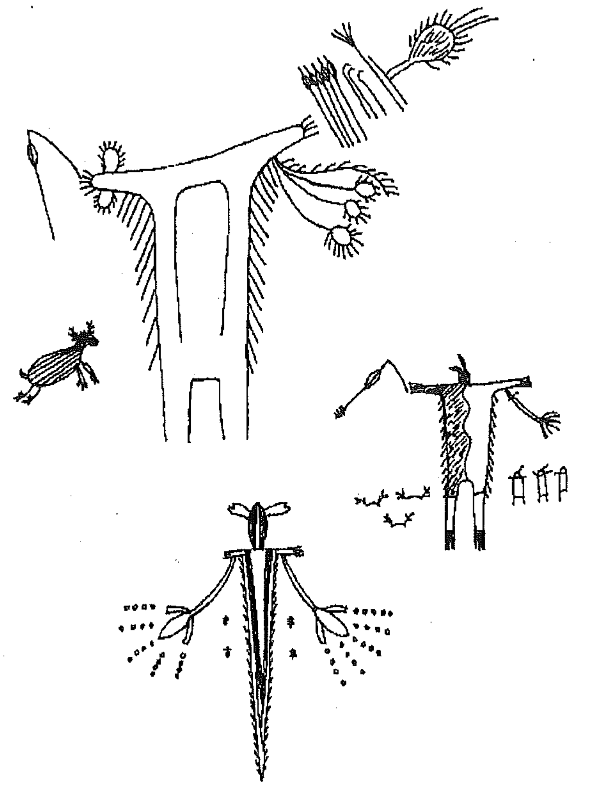


Figure 6.2 Anthropomorph/shaman figures. Schematic drawing of Pecos River style rock art. *Drawn from Kirkland and Newcomb 1967:45, fig. 1.*

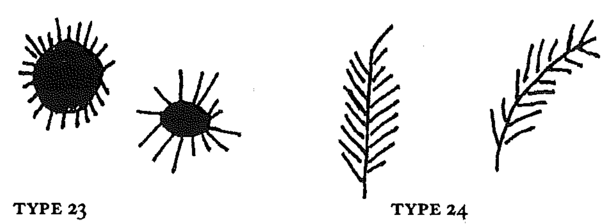


Figure 6.3 Sunburst and thistle motifs. Schematic drawings of idealized types of motif forms classified as type 23, sunburst and type 24, thistle. *Bass 1989:111.*

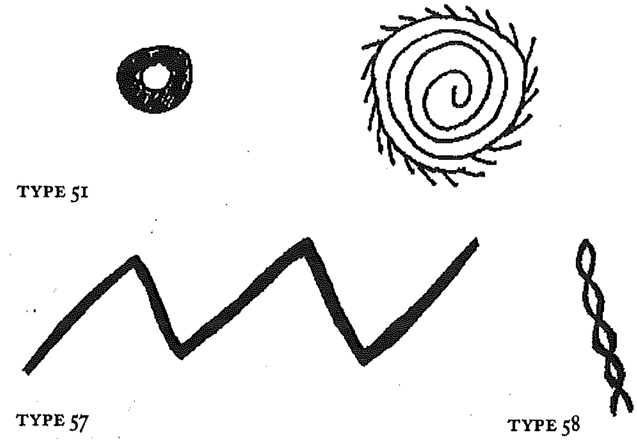


Figure 6.4 Circle, zigzag, and helix motifs. Schematic drawings of idealized types of motif forms classified as type 51, circle; type 57, zigzag; and type 58, helix. *Bass 1989:114,117.*

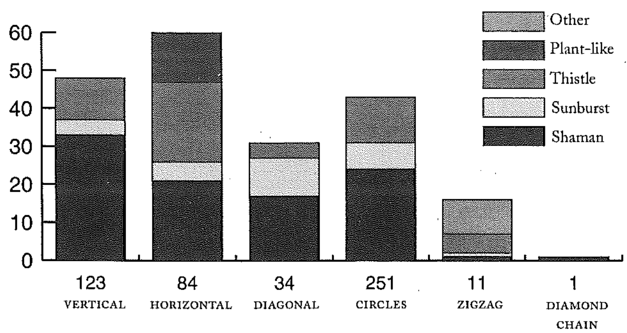


FIGURE 6.5 DIRECT ASSOCIATION GRAPH. Direct association between abstract motif types and iconic image forms found at twenty-four Pecos River rock art sites. The numbers below the abstract motif types are the total number of representations of that type found in the four-year data base. The numbers at the left of the graph represent the absolute numbers of direct associations with the indicated iconic form. "Other" includes representational forms such as quadrupeds and human figures.

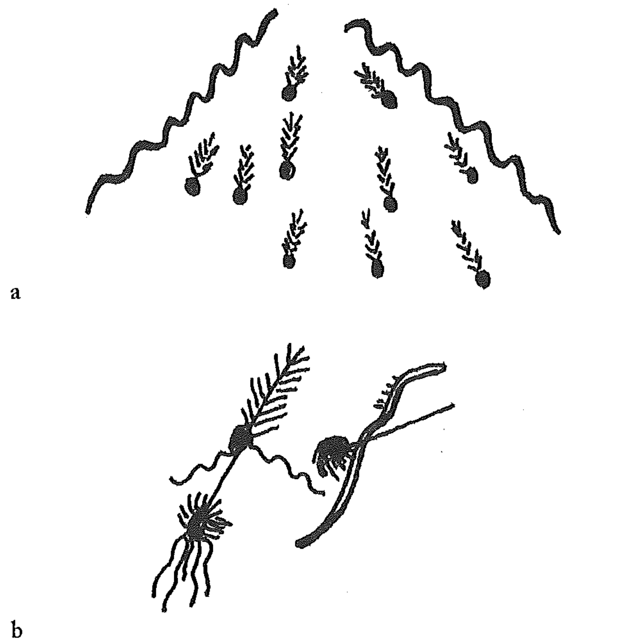


FIGURE 6.6 PANTHER CAVE. Examples of association of the horizontal curvilinear design and plant-like images. *a,* scale ¼ inch to 1 foot; *drawn from Kirkland and Newcomb 1967:66, pl. 26, No. 2. b,*scale ¼ inch to 1 foot; *drawn from Kirkland and Newcomb 1967:62, pl. 23.* The primary color for both drawings is reddish-brown.

zag figures numbered only 11, and 1 image described as helix-like might also be described as a chain of diamonds.

Further Interpretations

What explanations might we pursue using these numbers? Obviously, there are many more shaman images than abstract images, and thus our bias towards the emphasis of these figures, whether androcentric or not, may be understandable. The numbers of geometric images, interpreted as possibly entoptic, are small and may not seem to provide very strong evidence for neuropsychological experiences. Yet, we know from the archaeological evidence that trancing did occur and we should still feel confident in a shamanic origin for the art. The Pecos River style and Red Monochrome style rock art do contain a number of circles and curvilinear designs of various kinds but not many zigzags or diamonds. Is this adequate evidence for inferring some sort of initiation rite depictions as seen in California and other areas of far western North America? Does examination of these images as single figures allow us to design more inclusive de-gendered models for studying rock art images?

The short answer is that looking for these selective single images, even combined with an assumption of entoptic renderings and thus shamanic origins and initiation rite depictions, may not be too useful for such rock art as the Pecos River style which appears to be without direct ethnographic references. Indeed, such an effort would move beyond heuristic use to result in nothing more than an ethnographic analogy lacking any sort of continuity.

It becomes necessary, therefore, to look at the composition of these images in their context. Using the direct association rules developed to frame and contextualize this art, we find that the 123 vertical curvilinear designs are associated with 33 shaman figures, 4 sunburst figures, and 11 thistle images (fig. 6.3). The 84 horizontal designs are associated with 21 shamans, 5 sunburst figures, 21 thistle images, and 13 plant-like images (what the Rice recording team called "vegemorphs"). The 34 diagonal curvilinear designs are associated with 17 shamans, 10 sunburst figures, and 4 thistle images. The circles, numbering approximately 251, are associated with 24 shamans, 7 sunburst figures, and 12 thistle images, plus various quadrupeds, humans, and crenelated lines. These pictographs are also found in association with one another. The 11 zigzags are most often associated with human figures—9 times with 1 shaman, 1 sunburst figure, and 5 thistle images. The diamond chain image is associated with a shaman (fig. 6.5).

A close examination of the curvilinear designs associated with the shaman images suggests that they are, in fact, part of the shaman itself—the "undulating streamers. . .flowing down from their upstretched arms" (Turpin 1991a: 271). Thus, these particular images do not seem to be geometric forms.

However, all of these images, except the diamond chain, were associated with thistle motifs, plant-like figures, and sunbursts that might also be interpreted as possible plant elements. Thus, the context of these abstract figures often appears to be plant-like images of a limited variety. For example, the horizontal curvilinear design is associated with 49 plant-like types (21 thistle forms, 5 sunburst figures, and 13 plant-like depictions; fig. 6.6) but only 21 shaman figures.

What we may be seeing are repeated patterns of a constellation of restricted visual images representing some shamanic features. There is a lack of variety in the kind and number of images represented, as well as the way in which they are depicted. Furthermore, these pictorial and associational limitations seem to imply that these are not individually inspired images but rather culturally imposed and curated as a meaningful set over long periods of time. Are stylistic differences hiding a unity of visual themes? These patterns, or constellations of forms, even extend over time in the depiction of circles, some curvilinear designs, and zigzags that are rendered in the Red Monochrome style, traditionally considered more recent than the Pecos River style.

This is not, of course, a new idea, though I am not suggesting a mere form and distribution study. Maybe it is time to look again at traditional motif distribution studies, but combine such evidence with other cognitive archaeology models. Can we determine rules for the use of visual symbols that suggest initiation knowledge or the presence of some other integrating social institutions?

It has been suggested, for example, that the hundreds of masking traditions that produce headdresses, helmet masks, and face masks throughout 3000 miles of West and Central Africa derive from the transmission of a mosaic of forms resulting from a shared history (McNaughton 1991). An example closer to west Texas may be found in the typical inhabitants of northwest Mexico in archaic times. They were subsistence farmers who owed their basic culture to Mesoamerica even though they "had no interaction with that civilization in their daily life" (Phillips 1989:395). The significance of these interpretations is that a limited set or restricted variation of visual symbols may alert us to some of a society's strongest held beliefs. Solveig Turpin has recorded feline shaman images in northern Mexico which are similar in style to the Pecos River shaman. She believes that the feline images indicate a "unified belief system" (1991A:267). Perhaps we need to remind ourselves that prehistory is a process that includes multiple motivations, agents, and activities. This process enables people to obtain and adapt objects, institutions, and points of view from other people. Furthermore, these "other people" could be hundreds or thousands of miles away and never directly encountered (McNaughton 1991:49).

We must, of course, exercise caution against the use of selective single images. It would seem unnecessarily exclusive to focus on single images when our association models suggest we should be looking for a combination of images deliberately curated for their symbolism. Thus, using one constellation of images examined above—curvilinear abstract designs, zigzags, diamond chains, and plant-like figures—we can search for that symbolic reservoir in rock art corpora between west Texas and southern California. For example, in the Alamo Hueco Mountains of southwest New Mexico, the Chihuahuan polychrome abstract paintings depict diamond chains associated with long rakes (often interpreted as representing winged transformations) (Schaafsma 1980:51). At Painted Grotto in New Mexico, we find "fringed concentric ovals, rakes and possible flower elements" (Schaafsma 1980:53). In Grand Gulch, southeastern Utah, depictions of polychrome rakes, zigzags, circles, and thistle-like plant designs are found (Schaafsma 1980:53).

These visual similarities may not be mere happenstance but instead the result of a history we might begin to understand (McNaughton 1991:41). A choice of motif arrangements within a culture is far from random. The use of the direct association tests described above was two-fold: to provide a more inclusive way of viewing the images to get beyond an ethnocentric perspective of seeing this art as androcentric; and, trying to determine whether these "forms" signal some cognitive aspect shared beyond itself, something functional, conceptual, or symbolic (McNaughton 1991:45).

Conclusions

Although I recognize that it imposes western and feminist perspectives, this interpretation is offered as a way of addressing and assessing the presumed male dominance in this prehistoric culture. If we use a cross-cultural framework anyway, should we not develop models that allow archaeological researchers to compare groups in different ecological, economic, or social contexts to better understand the expression and sources of variations in gender (Wylie 1992:27) and other social constructs?

Keeping in mind that "reliance on multiple lines of evidence is an important and general feature of archaeological reasoning; archaeologists rarely ascribe evidential significance to items taken in isolation" (Wylie 1992:28), future research seems to suggest:

- Corpora of data should be compared to fill in the geographical map of the Southwest, beginning with what David Phillips (1989:374) calls Northern Mexico and moving westward to those bodies of rock art and their associated ethnographic information in southern California and far western North America.
- odels that allow us to track constellations of images and how they change through time and across distance should be developed. We see examples of such constellations of images in the feline figures and the bighorn sheep, as well as in the geographically and chronologically continuous depictions of the zigzag, circle, curvilinear designs, chains of diamonds, and plant-like images.
- The constellation of images should include analyses of the different winged figures and their associations. These images, including the winged shamans, birds, rakes, and fringes, have already been interpreted as possible "spirit helpers" (Schaafsma 1980:71) and should therefore favor an associational model approach as I have suggested.
- Other corpora of art, such as painted pebbles, should perhaps be reexamined. We may be limiting ourselves by analyzing the abstract images on different media and comparing them solely with one another rather than across the different techniques.
- Lastly, models that reflect the gender inclusiveness of ethnographic data, that is, a de-gendering of our unstated as-

> sumptions which bias the emphasis on certain specific rock art images for our interpretive studies, should be developed. While meaning in rock art "cannot be seen in isolation from dominant social relations" (Solomon 1992:293), we may have gender-linked some rock art, such as the Pecos River pictographs, where such linking may not have been intended.

I have not been able to show definitively that this art is female associated or made by women. But neither can I conclude that it is male associated or made by men. Therefore, the androcentric bias against which I have been disclaiming from the outset must be recognized and overcome. We must, finally, pay gender-inclusive attention to the centrality of symbolic behavior.

Acknowledgment
I wish to thank Dave Whitley for his suggestions, editing, and encouragement in the preparation of this chapter.

Notes

1. Therianthropomorphs were included in the "anthropomorph" motif types, such as "anthropomorph with horned or spiked head" or "anthropomorph with feathered head" and "winged," because they might also depict costumes on people. However, rather than concluding that these were only costume depictions, we grouped together all these images, realizing anthropomorphs might not be the most appropriate description for them but that such a classification provided an easy and useful motif-type device. Thus the term anthropomorph, as used in the data analysis and in this chapter, includes the grouped-motif categories, including therianthropomorphs. We also decided to group together interpretations and explain the images as either "a shaman" or "a shamanic-aided experience" depiction.
2. Because it has been suggested recently that Huichol-like people may have produced the Pecos River style rock art (Boyd 1993), I have included this example despite the fact that the art being produced by the Huichol is not rock art. It is not my purpose to address the visual comparabilities or the necessary assumption of a shared "ideology/cognitive set" across time and space but rather to de-gender that interpretation.
3. The twenty-four sites include non-Pecos River style rock art sites. Usually classified as "Red Monochrome style" rock art, these forms are traditionally deemed to have been produced at a later date than the Pecos River style rock art. For compositional analysis, it was important to count associations of like with like, that is Pecos River style rock art with Pecos River style rock art.

7 The Were-Cougar Theme in Pecos River–Style Art and Its Implications for Traditional Archaeology

Solveig A. Turpin

Its flawed perception of self as the poor relative of archaeology is a major problem affecting North American rock art research. Beset by trepidation and in fear of criticism from the more virile member of the family, "dirt archaeology," rock art researchers have reacted to the excesses of the highly imaginative by concentrating on methodology and descriptive reporting. As a result, many recent publications are basic catalogs of regional rock art styles with an occasional interpretive aside. Conversely, archaeologists often ignore or reject information derived from rock art research (Schaafsma 1985, Turpin 1990b) to the detriment of the discipline as a whole. Both sides have perhaps failed to recognize that traditional archaeology and rock art research are both complementary and synergistic, each contributing to the definition of the cultural system that validates them both. This case study in complementarity relies upon the interpretive dimension of rock art research to direct future traditional archaeological study in the Lower Pecos River region of Texas and Mexico.

The traditional or descriptive approach is also in part an overreaction to excessively simplistic interpretations of rock art iconography that resulted in the rejection of ethnographic analogy, the only appropriate forum for the analysis of the majority of prehistoric North American rock art. Recently, more sensible minds prevailed and ethnographic analogy was restored to grace (Wylie 1985) as long as it could be proved relevant (Lewis-Williams 1986; Schaafsma 1985), often by some unspecified standard. In the case of the art of long-vanished people, the most appropriate tests of relevancy are the archaeological context and the iconography itself. Both, however, require that two uniformitarian principles be accepted—first, that there are constants or universals in human behavior and, second, that processes observable in the present can explain the past (Bailey 1983:3; Conkey 1984:258). These modest steps justify interpretive studies that, in turn, provide the familial bond between the art and its archaeological and social context.

Researchers in the European and African arenas have been more adventuresome in their dealings with the far distant Paleolithic past and the ethnographically recent San. A casual review of this more theoretical literature finds considerable discussion devoted to the adequacy or deficiencies in approaches attributed to adaptationalists (Conkey 1978, 1984; Halverson 1987), empiricists (Lewis-Williams 1984a), functionalists (Lewis-Williams 1982), historicists (Conkey 1984), iconologists (Davis 1985), innatists (Halverson 1987; Lewis-Williams 1982; Willcox 1984), literalists (Lewis-Williams 1986), marxists (Lewis-Williams 1982), materialists (Conkey 1984; Davis 1982, 1985; Lewis-Williams 1982), neuropsychologists (Lewis-Williams and Dowson 1988), numericists (Lewis-Williams 1984), positivists (Davis 1985), postprocessualists (Hodder 1982a, 1987), presentists (Conkey 1984), processualists (Conkey 1984; Hodder 1982a, 1985), structuralists (Conkey 1980, 1984; Hodder 1982a), and vitalists (Conkey 1978), much less those who are inclined toward space travel or Ogam trade networks. The trend is toward structuralism and contextualism, with the recent addition of interest in neuropsychology, but what this list of "ists" really implies is that rock art research is still striving to develop a mature body of theory that can encompass its diversity as well as its commonalities.

An Example of Complementarity

An example from the Lower Pecos River region of Texas and Mexico (fig. 7.1) illustrates the complementarity between rock art research and the more traditional approaches used by dirt archaeologists to achieve what is purported to be a common goal: reconstructing past cultural systems. The Lower Pecos cultural area, as currently defined, is barren rangeland cut by numerous entrenched tributaries to three major rivers whose confluences are now inundated by Lake Amistad—the Pecos, the Devils, and the Rio Grande. Twelve thousand years of human occupation and a remarkable body of Native American art have been preserved by the arid climate and the protection afforded by dry rock shelters and overhangs. This wealth of data has produced a picture of the Lower Pecos people as classic Archaic hunters and gatherers, almost ideally adapted to a near-desert environment (Turpin 1990b). Decades of survey and excavation oriented toward technology, chronology, and environmental adaptation provide a context for the analysis of one of the largest, oldest, and most diverse assemblages of pictographs in the New World.

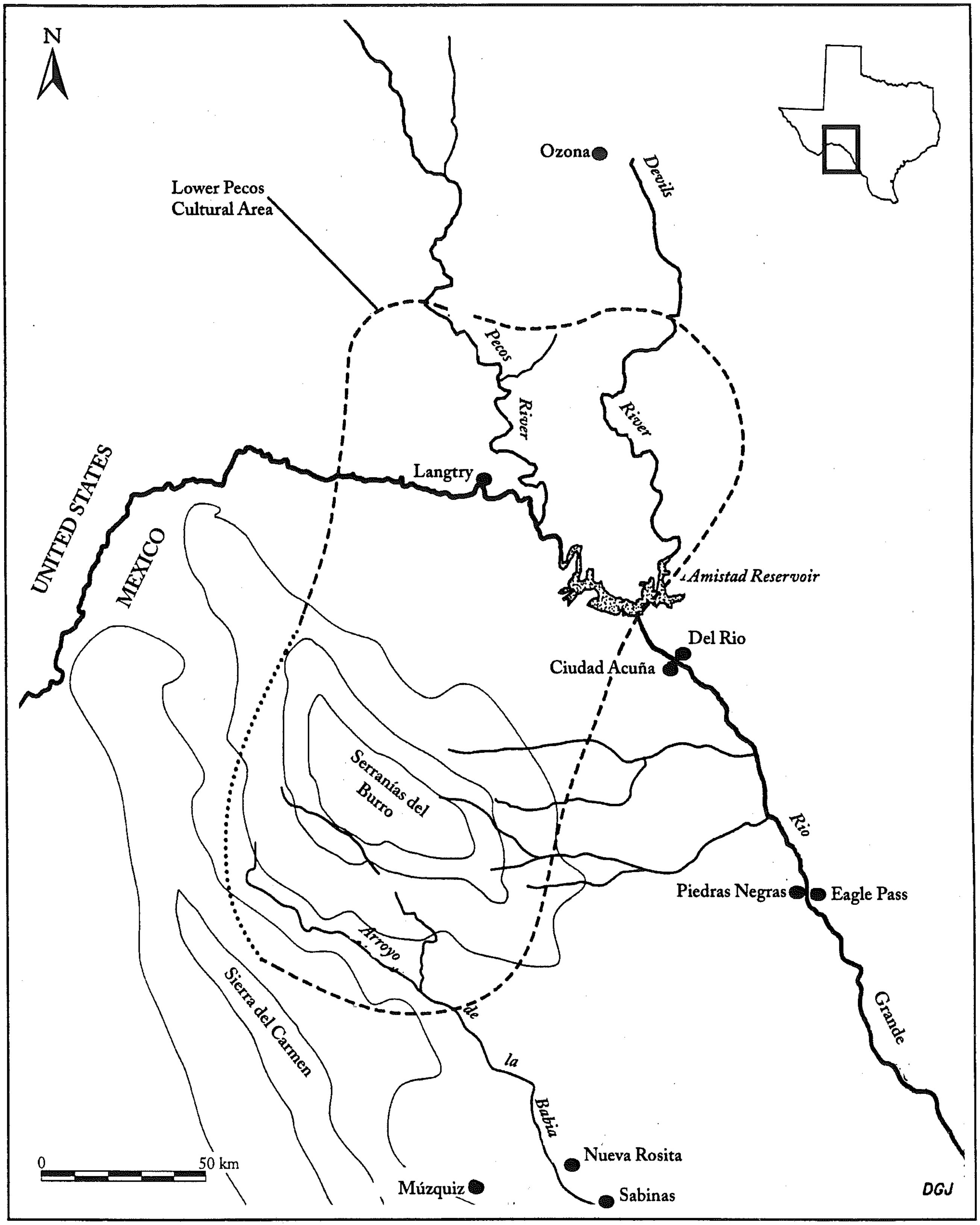


FIGURE 7.1 LOWER PECOS RIVER REGION OF TEXAS AND NORTHERN MEXICO.

Four major prehistoric pictograph styles have been defined in this area. The rock art sequence, as it is currently perceived, depends upon the cultural-historical framework provided by traditional archaeology for relative dating and relevancy to cultural systems (Turpin 1984, 1990b). In turn, the extent of the Lower Pecos cultural area is most often defined by the distribution of its oldest and most elaborate art form, the 3000- to 4000-year-old Pecos River style (Turpin 1990a; Chaffee, Hyman, and Rowe, chap. 2 of this volume). The large number of panels available for study and the complexity of design make this style more amenable to interpretation than the more schematic minor styles (Donnan 1976:9–10), and it is the interpretive dimension that can best be brought to bear upon questions raised by recent rock art recordings emanating from the mountains of northeastern Mexico. The larger distribution of this distinctive art style informs traditional archaeology that ecological models must be expanded or revised through implementation of the basic tools of survey and excavation in this very different environmental zone.

The Art as the Manifestation of a Belief System

The Pecos River style has long been considered ritual and religious art (Kirkland 1939; Kirkland and Newcomb 1969). The supernatural qualities of these multicolored paintings suggested to some that they were portraits of deities, to others that they were the product of hallucinogenic visions. Its ritual nature is most obvious in its thematic redundancy (Conkey 1985) and its reliance on rules of expression (Donnan 1976:5; Rowe 1967:78). The same characters people the paintings, repeating the iconographic message over and over in hundreds of sites. In addition to its stereotypic themes, this art style is monumental and elaborate, implying an input of communal energy appropriate to ritual or ceremonial activities.

More specifically, the origin of the Pecos River style in a shamanic religious tradition has also long been recognized (Kirkland and Newcomb 1967). Building upon Campbell's (1958) hypothesis that the paintings were associated with mescal bean visions, Newcomb identified the focal characters as shamans or members of social groups equivalent to historic medicine societies (Kirkland and Newcomb 1967). Newcomb's hypothesis was largely drawn from ethnographic analogy, but shamanistic principles are clearly evident in the iconography (Turpin 1991b). For the purposes of this discussion, however, the significance of this redundancy is not that the art is shamanistic per se. Rather, consistency is emphasized to demonstrate that a shared belief system is the defining characteristic of this cultural area. Confirming that the art is part of a shamanistic system makes it easier to recognize as an ideological phenomenon, that is, a body of doctrine, myth, or symbol, thus carried in the mind's eye of the artist and the audience.

Iconographic Confirmation of the Shamanic Hypothesis

Three of the basic precepts of shamanism that are conventionally illustrated in Lower Pecos art identify the pictographs as manifestations of this unified belief system. The most common is the ability of the shaman to assume animal form (Eliade 1972), a process illustrated over and over again in several variations (Turpin 1991b). This is obviously the dominant theme of the Pecos River style, repeated so often that it verges on obsessive. Most dramatic is the human-feline composite, the were-cougar. These figures are two-legged, upright human beings with cat ears, claws, striped underbelly, and blank face (fig. 7.2). They hold their weapons—spear throwers, darts, and fending sticks—in their upraised clawed fists but often stand on human feet. To make it perfectly clear that this is the shaman in his feline incarnation, the artist sometimes relied on composition, placing the human between two confrontational felines (fig. 7.3). Feline attributes may have become some kind of shorthand for shaman as many figures other than the were-cougar are shown with claws or bristling hair. In his analysis of Chavin, another early great religious art style of the Americas, Rowe (1967:78) likened this figurative elaboration to kenning, a concept borrowed from Nordic epic poetry wherein attributes come to stand for a real object. The specialized knowledge needed to decode the transferred meanings is symptomatic of a structured ideology.

Figure 7.2 Were-cougar of Panther Cave. This site is one of the most visited on the Rio Grande below the mouth of the Pecos River. Typically, this figure has a blank face, pointed ears, striped underbelly, and claws. This example is approximately 2.3 m tall.

Following the were-cougar in popularity are humans with characteristics of birds, serpents, deer, rabbits, and combinations thereof. It is the bird, however, that leads to the second telling characteristic of shamanism in Pecos River–style art, the ability of the religious practitioner to fly (Eliade 1972:140). Two conventions most clearly illustrate the manner in which the shaman traveled between his earthly and spiritual domains.

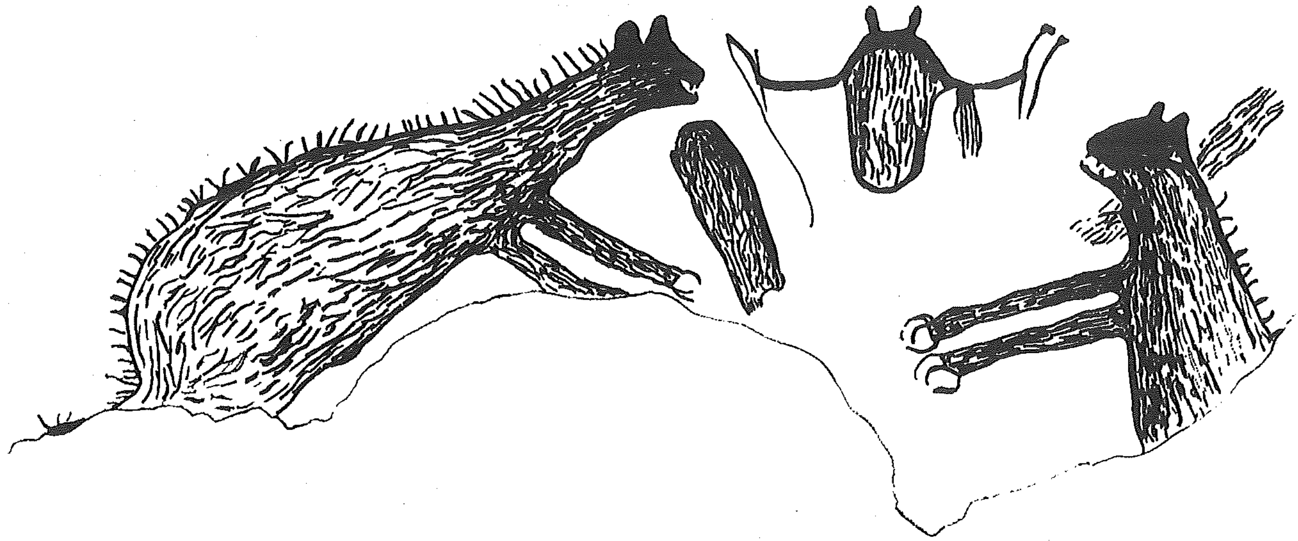
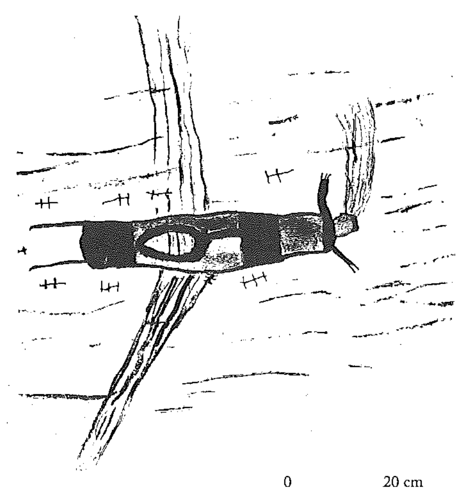


FIGURE 7.3 LEAPING PANTHERS SITE ON THE PECOS RIVER. Confrontational panthers flank a were-cougar. This composition is repeated at minimally four sites within a 10-mile radius.

Right top, FIGURE 7.4 PANTHER CAVE. Bird shaman arising from the "hole in the universe" and superimposed upon the Cave's eponymous mountain lion. From top of headdress to toes, this winged figure is approximately 1.3 m tall.

Right bottom, FIGURE 7.5 BROWN RANCH SITE ON THE PECOS RIVER. Horizontal figure with upswept hair flying through a cloud of dashed lines. The lines emanate from a circular design that probably implies the hole in the universe or passage between two worlds.

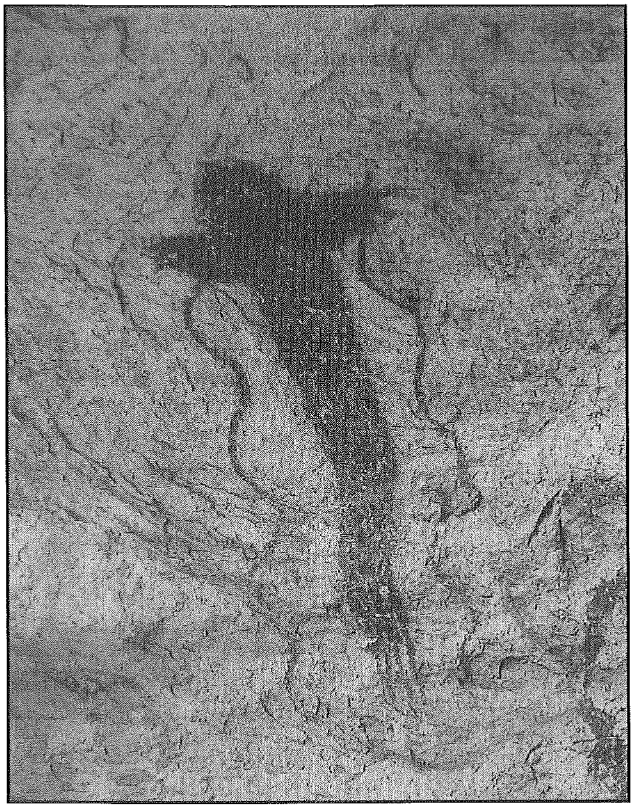


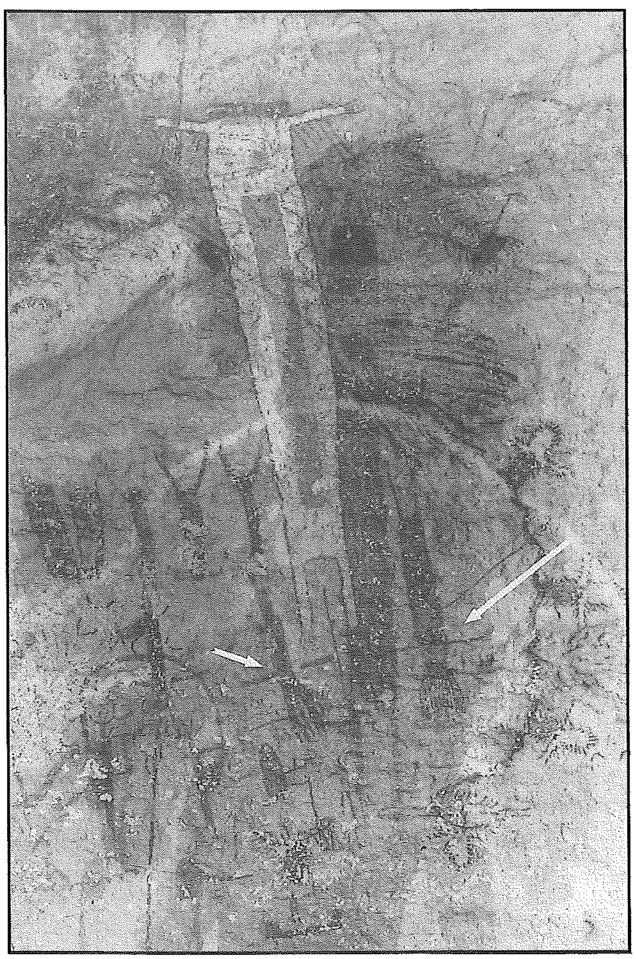
The direct approach equips the shaman with wings, or more schematically, with feathers (fig. 7.4). Less commonly, he is oriented horizontally to the plane of the earth, his unbound hair streaming upward as a measure of gravity or velocity (fig. 7.5). Often, the flying shaman emerges from a circle that may represent the passage between the two worlds, often called the hole in the universe. A third, much simpler demonstration of the aerodynamic abilities of shaman is their position on the curvature of the shelter walls where they appear to soar over the observer (fig. 7.6). Visual conventions like upraised arms, trailing streamers, and the omission of legs and feet add to the impression of ascendancy.

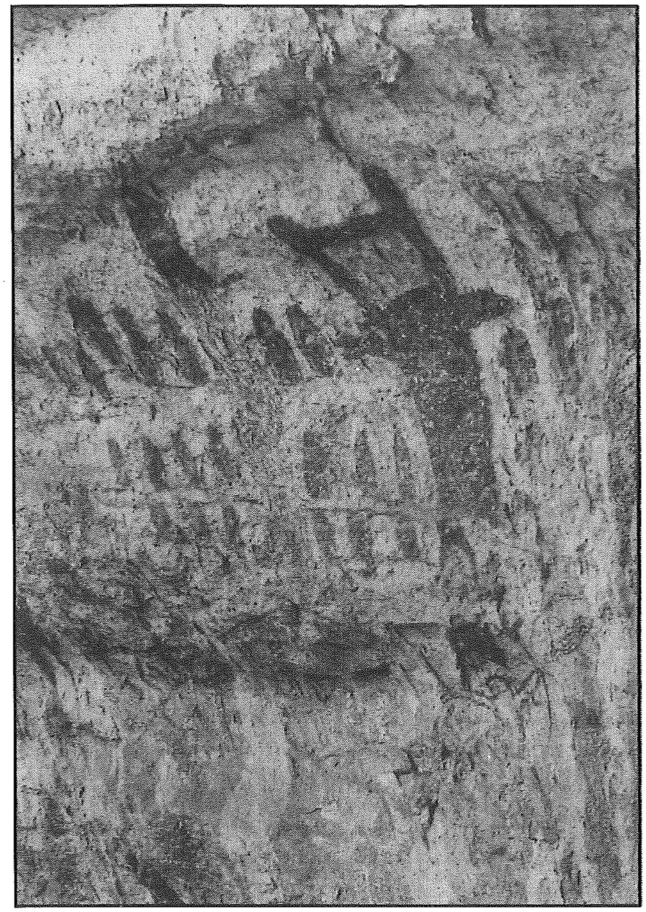
Another way of conveying magical flight, ecstatic trance, and the return to consciousness and the mortal world also incorporates a third shamanic belief. Inverted figures with cascading hair, often subordinate to a central character, are sometimes thought to portray death (fig. 7.7). In my opinion, they illustrate symbolic death as it is experienced by the shaman in his trance state. The belief that the shaman figuratively dies and is reborn from his bones, the most enduring part of his body (Eliade 1972: 160; Furst 1977:16), is more clearly manifested by a very few figures that are reduced to the skeletal condition (Turpin 1991b).

Implications of Shared Beliefs

These three basic principles of shamanism clearly stamp the Pecos River style as religious art whose stereotypic consistency







Left top, FIGURE 7.6 SAN VICENTE, MEXICO. This location is the largest Pecos River style site yet recorded in northern Mexico. This solid red soaring shaman figure is approximately 1.5 m tall.

Left bottom, FIGURE 7.7 WHITE SHAMAN. Arrows point to inverted or falling figures flanking the White Shaman, one of the most publicized sites on the Pecos River just above its confluence with the Rio Grande. Note the unbound hair seen here and in figure 7.5. The falling figures are about 50 cm tall.

Above, FIGURE 7.8 SIN NOMBRE. Were-cougar panel, on the southern side of the Serranias del Burro 90 miles south of the mouth of the Pecos River. Although shorter and stubbier than his northern prototype, this figure shares the blank face, stubby ears, claws, and solid body characteristic of the were-cougar wherever found. The were-cougar is about 1 m tall.

in theme and style reflect a unified belief system that centered on the Rio Grande and its tributary rivers. Because monumental rock art is not portable, it can be assumed that the geographical distribution of this style reflects the area occupied or traveled by people united by a religious tradition—painters who carried a clear concept of their ideological system in their mind's eye. Perhaps equally as important is that ritual art composed in such open air settings is public performance, implying communal participation rather than individual expression. It is here, in the immutability of this ritual art, that its most pragmatic contribution to archaeology's goal—the reconstruction of past cultural systems—is found.

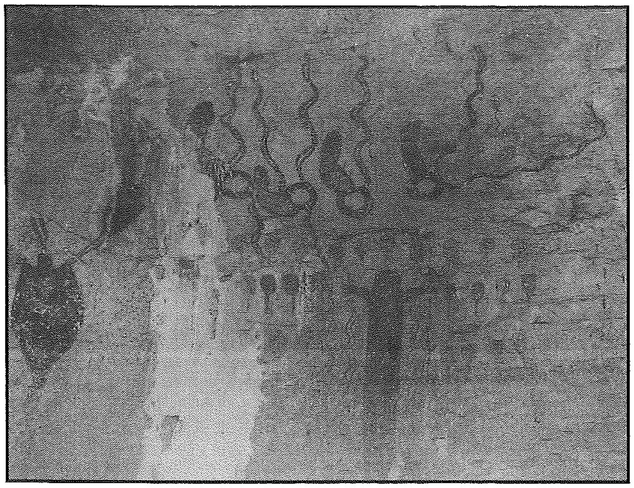


FIGURE 7.9 SAN VICENTE, MEXICO. Billowing streamers float above a shaman figure. This design has been documented at four of the Mexican sites but not in Texas. The central anthropomorph is about 1.3 m tall.

The concentration of archaeological research on the American side of the Rio Grande demonstrated a correlation between the extent of the Pecos River style and the classes of material culture preserved in dry rock shelter deposits. The latter, especially stone tools and the fiber industry, have a much wider distribution; so, the defining characteristic of the cultural area, "the Lower Pecos River region," is effectively rock art, specifically the Pecos River style. However, the preservation of so many perishables and the rich yields of stone tools from deep cultural deposits excited an intense interest in what is now called dirt archaeology. The area was the ideal arena for the antiquarian collectors of the 1930s, the cultural materialists of the 1960s, and the ecologists or environmental archaeologists of the 1970s. The inevitable parallels with the desert cultures led to the view of the lower Pecos Archaic people as archetypal arid lands hunters and gatherers notable for the stability of their cultural system (Turpin 1990b). Despite the historic contributions of artist Forrest Kirkland, archaeologist A.T. Jackson, art historians David Gebhard and Terrence Grieder, and anthropologist W.W. Newcomb, Jr., rock art research was usually treated as incidental, even though the pictograph sequence demonstrates cultural diversity that contrasts with the monotony of the static adaptive model.

The Were-Cougar in Mexico

The last few years have seen a relaxing of strictures on the exchange of information across the Rio Grande, including reports of several pictograph sites on both sides of the Serranías del Burro, a small mountain range that rises south of the Rio Grande (Turpin 1991b). On their southern flank, 90 miles from the mouth of the Pecos River and the heartland of the Pecos River style, the most easily recognized figure is the shamanistic standard bearer, the were-cougar (fig. 7.8). In the same site, a horizontal figure flies through a hail of dashed lines, mirroring the concept first seen high on the Pecos River. Nine sites are now known in and beyond the mountains of northern Mexico. The redundant depiction of anthropomorphic central figures so typical of the Pecos River style is tempered by the noticeable absence of realistic animals, such as the deer and cats so common north of the Rio Grande. The Mexican shamans are unarmed, unlike their northerly prototypes. Instead, billowing multicolored streamers float above several figures (fig. 7.9), a convention not shared with the Texas sites. These minor differences may reflect the dilution of core ideas with distance from the artistic heartland, but the basic template is undoubtedly Pecos River style.

The mountainous zone is topographically, geologically, hydrologically, and biotically different from the canyon country of the Rio Grande. There are no rivers with their concentrated population zones to explain the production of ritual art. Instead of caliche flats and entrenched tributaries, there are high plateaus and montane resources. Instead of being in large open rock shelters with deep cultural deposits, the pictographs are high on the slopes under overhangs devoid of occupational debris. Iconography and style identify the artists as Pecos River cognoscenti but cannot explain how they came to be there, much less their strategies for exploiting this very different habitat. The traditional tools of archaeology, survey and excavation, can now be brought to bear upon the issues raised by the newfound distribution of a well-known interpretable rock art style.

The first goal must be to locate the habitation sites to identify the domestic component of the settlement patterns and its relationship to natural resources. Resource procurement studies are essential to establishing the ecological context. Site and artifact typology will provide a cultural-historical framework for the analysis of the art, as well as the other components of the social system.

This brief summary is but one illustration of the complementarity between rock art research and dirt archaeology. Through a series of steps that began with ethnographic analogy in the broadest sense, the analysis of one highly distinctive art style has identified a problem domain that mandates revision of the environmentally driven model of hunter-gatherer adaptation in this region. How did the different distribution of essential resources in the mountainous zones of Mexico affect the settlement patterns, subsistence strategies, technology, and seasonality of movements as they are known to us from decades of survey and excavation on the north bank of the Rio Grande? The broad parameters of time and space have been established by the art, thus setting the stage for interdisciplinary scientific inquiry into the more mundane world of the Pecos River artists and their audience.

8 Ethnography and Rock Art in the Far West: Some Archaeological Implications

David S. Whitley

The ethnographic record of the rock art of far western North America is arguably the most complete and detailed of any in the world. It identifies not only those who made the art in this region but also the context in which the art was produced and what it was intended to symbolically and ideologically portray. Although archaeologists and anthropologists have been aware of these ethnographic data for some time (Kroeber 1925:936–939; Steward 1929:224–227), they have only been tangentially cited and considered in more recent regional syntheses (for example, Heizer and Baumhoff 1962; Hedges 1970; Heizer and Clewlow 1973; Wellman 1979), and their implications little explored. That is, although this record may offer the archaeologist the best ethnographic model for rock art production and meaning in the world, and therefore the best source of hypotheses for the interpretation of other corpora of parietal art, it has largely been ignored in favor of inductive hypotheses, many of which were founded on dubious evidence and obscure trains of logic (for example, see critiques of the plausibility of Heizer and Baumhoff [1959, 1962] and von Werlhof's [1965] hunting magic hypothesis by Steward [1963, 1967], Rector [1985], Whitley [n.d.a], and Whitley and Dorn [n.d.]).

This failure to use the ethnographic record has resulted in part for methodological reasons, discussed below, and in part because no thorough compilation of the data was previously available. Building on recently completed analyses of this evidence (Whitley 1988a, 1988b, 1992b, 1994, n.d.a, n.d.b), here I consider in detail some of the archaeological implications of this record for rock art production in the far west—the hunter-gatherer cultures of California, the Great Basin, and the Columbia Plateau. Specifically, and after reviewing the methodological problems critical to interpreting the ethnographic record as well as this substantive interpretation itself, I consider the issues of chronology, an explanatory neuropsychological model for the origin of motifs, the problem of style, the archaeological definition of ethnolinguistic groups, and the cultural resource management implications.

Ethnographic Interpretation

Although it is clear that archaeologists like Julian Steward, Robert Heizer and Martin Baumhoff were aware of the existence of some ethnographic data on rock art from the far west, one might deduce that their failure to make use of it resulted from their particular epistemological approach to anthropology. This approach assumed that ethnographic data represented complete and final exegesis of the ethnographic past; that ethnographic statements were, in effect, pure observations whose meanings were straightforward and whose comprehension required no interpretation. Thus, when they approached the ethnographic record (or, in Steward's case, an ethnographic informant) and asked the questions "Who made rock art?" or "Why was it made?," their expectations were for explicit and final explanations—complete and straightforward answers to their questions. Unfortunately, this is not the manner in which much ethnographic data are expressed, especially data pertaining to topics like religion, belief, and symbolism, and particularly when filtered through a data recording process involving an ethnographer, translator, and informant.

Instead, and at least since Radcliffe-Brown's (1922) ethnography of the Andaman Islanders, many (if not most) anthropologists have recognized that ethnographic accounts simply constitute raw data that, like a table of potsherd frequencies or a histogram of site-size distributions, must be analyzed and interpreted prior to establishing their inferential meaning. An analysis of ethnographic accounts is required because most informants are often not capable of articulating the deeper meanings of their customs and beliefs (Grimes 1976), even if they in fact understand them, which is by no means certain (see Morphy 1977). Moreover, confusion often ensues due to problems in the translation of meaning.

The problem of translation is more than simply a technical issue that can be resolved by a linguist who is fully fluent in both languages of concern, and capable of providing an exact literal translation of a text. For the uses of language—and the meanings that words, terms, and descriptions encode—are much more complex than a perusal of a standard translating dictionary would suggest. This complexity results because all cultures and languages, including our own, rely heavily on the use of metaphors in verbal and written expressions. So literal translations—which many of our ethnographic records comprise, exactly because they have been transcribed and translated as "objectively" as possible (and because they are recognized by their transcribers as raw data)—often do not provide the sense or meaning of an informant's comments at all—that is, unless one is familiar with the linguistic metaphors commonly used in a particular culture.

The result is that the ethnographic analysis of rock art did not make headway of any consequence until David Lewis-Williams—not incidentally, trained as a cultural anthropologist and not an archaeologist—began his seminal studies of the San paintings of southern Africa (for example, Lewis-Williams 1981, 1982). As he has noted (Lewis-Williams 1983), the key to using ethnographic records in interpreting rock art is to employ what he terms a "metaphoric model" in interpreting the ethnography, and to use this to inform an understanding of the art (see Lewis-Williams and Loubser 1986). Once it is acknowledged that many ethnographic comments are expressed metaphorically, and an effort is made to decipher relevant metaphors in texts that pertain to rock art, a coherent interpretation of otherwise enigmatic ethnographic statements can be obtained.

Two examples from the far west illustrate this principle in action. Throughout the Great Basin and regions peripheral to it, ethnographers recorded comments that rock art was made by a particular being variously named a "rock baby," "water baby," "mountain man," or "mountain dwarf" (for example, Lowie 1924:296; Driver 1937:86; Voegelin 1938:61; Steward 1943:282–283, 286; Zigmond 1977:71; Irwin 1980:32; Sutton 1982:151; Hultkrantz 1987:49). Based on this attribution, Voegelin (1938:61) dismissed her informants' knowledge of rock art as inconsequential because she likened their rock babies to our own fairies or wood sprites. Steward (1968:viii), in a similar vein, inferred that his informants knew absolutely nothing of rock art and concluded that the art must be very ancient. But, in fact, a more detailed examination of the ethnographic record indicates that these beings were very powerful spirit helpers that a shaman obtained in an altered state of consciousness (ASC) vision quest (Park 1938:15, 78–79; Harris 1940:60; Steward 1941:258, 262, 264, 1943:283; Stewart 1941:444; Zigmond 1977:71, 1980:33; Riddell 1978:75, 77; Miller 1983:75). Informants stated that the art was made by these supernatural beings because no semantic, linguistic, or epistemological distinction was made between the actions of a shaman, his dream helper, and his visionary ASC (Gayton 1948:32; Applegate 1978:27; Siskin 1983:22). To claim that the art was made by a rock baby was simply to metaphorically assert that it was the product of a shaman. Thus, in the Southern Paiute region, rock art sites were called *tutuguuvoʔpi*, "marked by the tutuguuviwi," the spirit helpers (Laird 1976:123). Moreover, by stating that the art was made by one of these spirits, informants avoided the taboo against naming shamans who were deceased (Laird 1984:302).

Another commonly used metaphor relevant to an ethnographic interpretation of far western rock art is "death." When an informant stated that an individual had died, it was not necessarily implied that he or she was mortally deceased, in our sense of the term. Depending on context, "death" was a metaphor used throughout the far west to indicate entering an ASC or trance (Dixon 1908:23; Cline 1938:172; Turney-High 1937:13; Gayton 1948:34, 44; Kroeber 1957:226, 228; Zigmond 1977:72, 1980:33, note 1). A person who had "died" might be said to be in a dream or trance, and therefore in the supernatural world. The importance of this metaphor relative to rock art is revealed in the Northern Paiute word *tutaigep*. This word was translated by Willard Park's informant as "paint, poison" and has the etonym -tai, "to die" (Fowler 1989:158). Given that "In native thought, poison is [supernatural] power first and only secondarily used for evil ends" (Applegate 1978:19), *tutaigep* can be understood to linguistically encode three metaphoric concepts: paint and therefore rock art; poison and thus supernatural power; and death or a trance state. "To die," then, was "to enter an ASC," as well as "to paint rock art"; again, emphasizing the lack of distinction between the action of the shaman, his trance, and his spirit helpers. And, of course, Northern Paiute *tutaigep* ("paint, poison, death") is cognate with Southern Paiute *tutuguuvoʔpi* ("petroglyph, made by a spirit helper").

From these two examples it should be clear that informants had much to tell ethnographers about rock art, but that they expressed their comments in metaphors and linguistic codes that were universal to them but were misunderstand or mistranslated by some anthropologists. However, it must also be emphasized that not all ethnographic information concerning rock art was metaphorically "disguised." A small but important portion of the data was expressed in terms that should be completely understandable to Euro-American archaeologists. These direct (as opposed to metaphoric) references to rock art either have been simply overlooked or their importance has been downplayed due to confusions caused by misunderstanding the more common metaphoric references. They are, nonetheless, particularly valuable because they provide an independent check on our translations of the metaphors.

One of Gifford's informants, for example, stated that a rock art site "depicted a man's dream" (1932:52). Driver's informant confirmed this by stating that the art was made by shamans and that "They painted their 'spirits' on rocks to 'show themselves, to let people see what they have done'. The spirit must come first in a dream" (1937:126). Riddell's informant similarly noted that "snake elements were put on by those who had an understanding of snakes" (1978:84); that is, by rattlesnake shamans (who, not incidentally, had a rattlesnake as a spirit helper; see Kelly 1939:156; Stewart 1941:414; Steward 1943:285; Hultkrantz 1987:54). Thus, these three references confirm the metaphoric and linguistic inferences presented above: that the rock art in this particular region (the western Great Basin and southern Sierra Nevada) was made by shamans, it was associated with their ASC vision quests, and it depicts the spirit helpers they received during these quests.

Interpretations of Far Western North American Rock Art

Using the ethnographic record for the far west and the methodological approach pioneered in rock art studies by David Lewis-Williams, a detailed ethnographic interpretation of the rock art has been developed. This interpretation addresses who made the art, under what ritual contexts it was made, and what symbolic and ideological meanings it encoded (Whitley 1988a, 1992b, 1994, n.d.a, n.d.b). This interpretation can also be synthesized in reference to a series of geographical "research domains" within the far west to serve as a foundation for the discussion of some archaeological implications of this record.

The underlying basis for all historic rock art production throughout the far west was a vision quest, broadly defined, which was undertaken to experience an ASC to receive a vision or "dream", and to gain supernatural power through the acquisition of a spirit or dream helper. Rock art was created after this trance to depict graphically the visions seen in the ASC, principally to fix the images in the dreamer's mind (Whitley 1992b:107), for a failure to remember the vision in all its detail was believed to result in sickness or death (Kelly 1932:194, 1939:152; Hultkrantz 1987:55). Although there naturally was much individual variation in these dream experiences, considerable local cultural-conditioning influenced the dream-seeker's trance experiences (see Dobkin de Rios 1984:197), resulting in clusterings of specific subject matter and rock art motifs in certain regions. Still, all of these different motifs appear to represent simply variations on the ASC theme that more expresses local environment and ecology than any widespread differences in ritual and belief. Indeed, the ethnographic record indicates that the origin of rock art in the far west followed an almost universal pattern, with just a few regional variations (Whitley 1992b:107).

In south-central California (the southern Sierra Nevada and south-central coast, or Yokuts and Chumash region), the art appears to have been produced exclusively by male shamans (Steward 1929:226; Driver 1937:86; Gayton 1930:392–393, 1948:33–34, 112–113; Aginsky 1943:426; Applegate 1975:15, Blackburn 1975a:127; Latta 1977:600), most of whom entered an ASC by ingesting native tobacco, a strong hallucinogen (Wilbert 1987). Rock art sites were known as "shaman's caches" or "shaman's spirit helper places," and it was believed that they (and rocks and caves more generally) served as entrances into the supernatural world (Gayton 1948; Latta 1977). Grizzly bears were probably the most powerful of the shamans' spirit helpers in this region and are common in the art. However, it is also true that the grizzly and the rattlesnake were believed to be paired as guardians of the supernatural world (see Blackburn 1975b:197–199; Zigmond 1977:59-95), and so they are sometimes juxtaposed at sites, not to represent specific spirit helpers but to signal the site as an entrance to the supernatural (Whitley 1992b:101–102). Aquatic motifs and themes are also common in this region (for example, frogs, beavers, fish, and kelp), both expressing the metaphor of an ASC as an "underwater experience" (Kroeber 1925:514; Gayton 1948:113; Blackburn 1975b:85–86, 234) and serving as spirit helpers in the specific sense (Whitley 1992b:105–106).

In the Great Basin and the Bighorn Basin region, the art was produced by male shamans who went to rock art sites for vision quests (Lowie 1924:295; Shimkin 1953:409; Hultkrantz 1961:201, 1987:49, 54–55; Malouf 1974:81–82). As in south-central California, the quests occurred at locations believed to be numinous and imbued with supernatural power. Because the distribution of power generally corresponded to the distribution of high peaks, rock outcrops/caves, and permanent water sources (Miller 1985:58–59), rock art sites cluster in these kinds of locales (Whitley n.d.a). Also as in south-central California, tobacco was the primary psychotomimetic used to enter an ASC (Driver 1937:103; Aginsky 1943:444; Zigmond 1977:93–94, 1980:175–179; Hultkrantz 1987:53), although ritual deprivation through physical exertion and fasting also played a part. In the Basin, the bighorn sheep was considered a particularly powerful spirit helper, especially for the shaman's weather control (Whitley 1994, n.d.a; see also Kelly 1936:139, 142, 1939:165; Steward 1941:259), and it dominates the art in many regions, especially the Coso Range. In fact, "to kill a bighorn," as is sometimes depicted in the so-called "hunt scenes" of this art, was a metaphor for exercising the shaman's weather control power (Whitley 1994, n.d.a).

In the southwestern coastal province of California (that is, the Luiseño, Diegueño, and Cahuilla region), individual shamans produced and owned sites in the same manner as those from south-central California (Hedges 1970:72; Romero 1954:2; Bean 1972:75; True and Waugh 1986:270–272). The art made at their sites varies in thematic content, with no clearly dominating motif forms (Hedges 1970). Additionally, different kinds of sites were painted by female and male initiates to conclude puberty rites after a period of ritual deprivation and the ingestion of jimsonweed (*Datura wrightii*; see Rust 1906; DuBois 1908a:96; Kroeber 1908:240-242, 1925:675; Sparkman 1908:209–210, 224–225; Waterman 1910; Steward 1929:227; Strong 1929:118, 173, 257, 298–299; Drucker 1937; Driver 1941, True 1954; White 1963:141; Hill and Nolasquez 1973:35; Oxendine 1980:39, 43, 48; True and Grisset 1988). The girls' art emphasized zigzag and diamond chain "rattlesnake" motifs, reflecting the fact that the rattlesnake was considered the apposite spirit helper for females (Whitley 1992b:95; see Strong 1929:298, 314; Patencio 1943:43; Oxendine 1980:43). The boys' art is less known, but appears to have differed in the motif forms and spirit helpers depicted (Oxendine 1980:48), though, again, the ethnography is clear in demonstrating it as the portrayal of supernatural spirits received in ASCs (Whitley 1992b:95). Moreover, as in the south-central region, rock outcrops and rock art sites in southwestern California were believed to be sources of power and entrances to the supernatural (DuBois 1908b:231; Patencio 1943:54; Kelley 1977:127; True and Waugh 1986:270–272; Bean et al. 1991:9).

On the Columbia Plateau (including the Modoc region of California), rock art was produced in two contexts by different groups of the population, paralleling in certain ways the rock art of southwestern California. First, young women and men created rock art at remote locales during essentially private puberty ceremonies (Teit 1896:227, 1900:317, 320–321, 1906:282, 1909:590, 1918, 1930:194, 282–283; Cline 1938:138, 144; Driver 1941:146; Boreson 1975:48–52). Second, shamans also painted or pecked sites, again typically at remote locales (Cline 1938:143–144; Malouf and White 1953; Hill-Tout 1978:48). There is considerable thematic and stylistic variability in the resulting art (see Keyser 1992), with the strongest pattern apparently present in the girls' puberty art. This pattern emphasizes rectilinear arrow and tree-like motifs, described as "red fir" (Teit 1896). Red fir was the spirit to whom females directed their prayers during their puberty isolation (Hill-Tout 1978:112, 148–149) and was associated with good health and long life. It represents the spirit helper received by the girls during their vision quests for, as with both the boys' and the shamans' rock art, the Columbia Plateau art represents the spirit helpers obtained by vision questing supplicants (Teit 1918). Further paralleling the circumstances in other portions of the far west, rocks, mountains, and especially rock art sites were believed to serve as entrances to the supernatural world (Dixon 1908:23; Turney-High 1937:33; Hill-Tout 1978:153; Teit 1918).

The ethnography thus emphasizes an underlying connection between rock art and vision questing for the entire far west, even though certain differences exist from region to region. Furthermore, it suggests that the rock art represents the images seen as part of the ASC experiences of shamans or puberty initiates, including the spirit helpers they obtained in these rituals. During the prehistoric past, the functions and origins of rock art in far western North America may have differed from those described for the ethnographic period, but no compelling or plausible hypotheses have been presented to support alternative functions or origins for rock art in the far west, and there is no chronometric evidence yet to suggest that major changes in rock art production occurred in this region.

Some researchers have investigated possible archaeoastronomical alignments and relationships in southern California, but (aside from the absence of ethnographic support) the evidence is extremely equivocal to say the least (see Whitley 1989). Similarly, arguments were made in the earlier literature that the Great Basin petroglyphs may have served in some capacity for a vaguely defined "hunting magic." There is no support for this hypothesis in the archaeological or ethnographic or rock art data (Steward 1963, 1967; Rector 1985; Whitley n.d.a; Whitley and Dorn n.d.). Finally, some have suggested that the art may have served as territorial boundary markers. Kroeber probably summarized the argument against this interpretation best when he stated: "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). Thus, although additional evidence and analyses may require adjusting this current ethnographic interpretation, or reveal that rock art was also produced in other contexts, the vision quest hypothesis is currently our best explanation for far western North American rock art.

Chronological Implications

The first archaeological implication of the ethnographic data on far western rock art is that, indeed, at least some of it must be historical/protohistoric in age. Not only is this strongly implied by the ethnographic analysis synthesized above, but it is confirmed by a number of ethnographic informants, who quite simply admitted production of the art into the recent past when queried on this point (for example, Teit 1896; Kroeber 1908:240-242; Sparkman 1908:209–210; Strong 1929:118, 173, 257, 298–299; Chalfant 1933:25; Cline 1938:143–144; Driver 1937; Stewart 1941:321, 348; Aginsky 1943; Gayton 1948; Malouf 1974; Latta 1977:600; Laird 1976:103, 123, 1984:302–304; Riddell 1978:84). This may seem no stunning conclusion to those unfamiliar with the North American rock art literature. Those familiar with this literature will recognize, however, that it contradicts the contentions of many scholars who have argued that because they could not find any readily decipherable ethnography on rock art, the art must necessarily be prehistoric.

The best example of this contention occurred in the Great Basin. Heizer and Baumhoff (1962), Grant (1968), Steward (1968), Heizer and Clewlow (1973), and Wellman (1979) all argued that there was no ethnography concerning (particularly the Great Basin pecked) rock art. They therefore concluded (1) that the art was prehistoric in age and (2) that it indicated that a cultural loss, vis-a-vis the historic populations, had occurred in the Great Basin. Steward (1968) even went so far as to use this last argument to discredit Jesse Jennings' (1957) concept of the Desert Culture. More recently, Bettinger and Baumhoff (1982) employed this same reasoning in their "Numic spread" hypothesis, contending that Great Basin petroglyphs were made by Pre-Numic peoples and that, with the appearance of Numic speakers around AD 1300, the production of the Prenumic art ceased. Given the strength of these early contentions, it is not surprising that many researchers, myself included (see Whitley 1987), initially accepted the inferred prehistoric age for, and absence of ethnography about, far western rock art. The ethnographic data now identified for the far west in general and the Great Basin specifically, of course, belie this exclusively prehistoric chronological placement of the art.

The recent origin of some of the art from the far west is, moreover, confirmed by chronometric and relative dating (Whitley 1982a, 1982b, n.d.a; Dorn and Whitley 1983, 1984; Whitley and Dorn 1987, n.d.). Direct calibrated ages on petroglyphs from the western Great Basin indicate that the manufacture of curvilinear and rectilinear engravings continued at least into the last 300 years. In addition, Euro-American themes and motifs, such as horses, carts, and western hats, are present in the art at certain sites (Benton 1978; Garfinkel 1978; Ritter et al 1982; Whitley 1982a, 1987; Whitley and Dorn 1987), further demonstrating, with certainty, that some of the art is historical in age. Thus, although it must be emphasized that dating research indicates that far western North American rock art is also older than was initially hypothesized, it would be simply wrong-headed to insist, at this point, that at least some of it is not historical/ethnographic in age.

The Neuropsychological Model for Shamanistic Art

Through his research on San rock art, David Lewis-Williams has developed an important functional and analogical model to explain the origin of certain motif forms (Lewis-Williams 1986, 1991; Lewis-Williams and Dowson 1988). This model of the mental (and ultimately graphic) imagery that may result from an ASC is based on the premise that the human neurological system is a biopsychological universal. The neuropsychological effects of ASCs, therefore, are universal and cross-culturally experienced because all Homo sapiens sapiens are "hard-wired" in the same way. Corpora of art that originate in ASC experiences, in the sense of depicting trance-state visions, can then be predicted to exhibit graphic similarities because the human body reacts to an ASC in certain limited ways. And since shamanism is defined as a religious system predicated on ASCs (Eliade 1972), it then follows that we can use this model to test whether prehistoric rock art corpora, about which we lack ethnographic data, may have originated in shamanism.

The neuropsychological model was developed using various cross-cultural and laboratory studies of ASC imagery. It was subsequently tested against the southern San paintings and the Coso Range engravings of the Great Basin, which represent empirical cases of ethnographically documented shamanistic arts. The model consists of three parts: (1) types of "entoptic" phenomena (including "form constants" and "phosphenes"), which are the percepts generated by the visual and nervous systems during an ASC (fig. 8.1; see also Blackburn 1977); (2) the principles that guide perception during the ASC; and (3) three cumulative stages in the progression of an ASC (fig. 8.2).

A complete description of the model is provided by Lewis-Williams and Dowson (1988), who used it to test the proposition that the art of the European Upper Paleolithic was shamanistic in origin. Although they concluded in the affirmative, their results have not been universally accepted by other scholars. This lack of acceptance has resulted in part because many researchers would like to see additional source-side support for the analogical component of the model (see Wylie 1988). That is, prior to acceptance, many feel it necessary to support the model with evidence from additional ethnographically known cases of shamanistically produced rock art to demonstrate that the model itself has widespread empirical applicability and thereby bolster the originating case for the analogy.

Far western North American rock art, accordingly, can be profitably used to examine further the source-side support for the Lewis-Williams and Dowson neuropsychological model. I have selected the pictographs of the southern Sierra Nevada as such a test case. As summarized above, the ethnographic record is particularly rich for this region. Steward (1929:226), Driver (1937:86), Gayton (1930:392–393, 1948:33–34, 112–113), Aginsky (1943:426) and Latta (1977:600) recorded that southern Sierra rock art was made exclusively by shamans. Voegelin (1938:58) and Zigmond (1977:71) also recorded this fact, but in a metaphoric form. Moreover, both Gifford (1932:52) and Driver (1937:86) were told that the art depicts the visions experienced in an ASC, including the "spirits" seen while in the supernatural world. In agreement with Gifford and Driver, one rock art motif was identified to Latta (1977:199) as an "evil" (that is, powerful) supernatural spirit, and therefore something seen only in an ASC, and rock art sites were widely recognized as entrances to the supernatural world, typically "owned" by individual shamans (Gayton 1948:113).

This interpretation has been amplified by recent ethnographic fieldwork that I have completed. My informant, a male Yokuts about 35 years old, has been receiving traditional training in preparation for becoming a shaman. In 1991, I accompanied him to the complex of painted panels and site loci at Rocky Hill outside Exeter, Tulare County, California. He described the first panel encountered at the site as the "door" to the sacred (that is, supernatural) world. He stated that paintings at the site represented "shamans' marks," with the complex, polychrome images made by "full-fledged" shamans (fig. 8.3), and the simpler (single-line geometric) monochrome paintings the product of shaman initiates. One particular panel/site locus, which he stated was "owned" by his family, was described as depicting a "shaman's dream"; that is, as representing a shaman's ASC vision. Included in this panel were motifs he described as wehechit (fig. 8.4), indicated to be a malevolent (again, powerful) supernatural being, and "blue heron dancers"[1] (fig. 8.5). This information independently confirms the interpretations derived from the analysis of the ethnographic data, as well as indicating that significant traditional religious knowledge is still maintained within the Yokuts community.

Using a typology of thirty motif types from eighty-nine sites in this region and representing more than fifteen hundred individual paintings (see Whitley 1982b, 1987), I compared the motifs present in the southern Sierra corpus with the expectations of the Lewis-Williams and Dowson model, both in quantitative and qualitative terms, as shown in table 8.1. The results of this comparison are straightforward. The universal perceptual constants predicted by the model (that is, the entoptic forms and the principles by which they are perceived) account for all the "geometric" types in this typology. While "iconic" forms are analytically more intractable than geometric images—be-

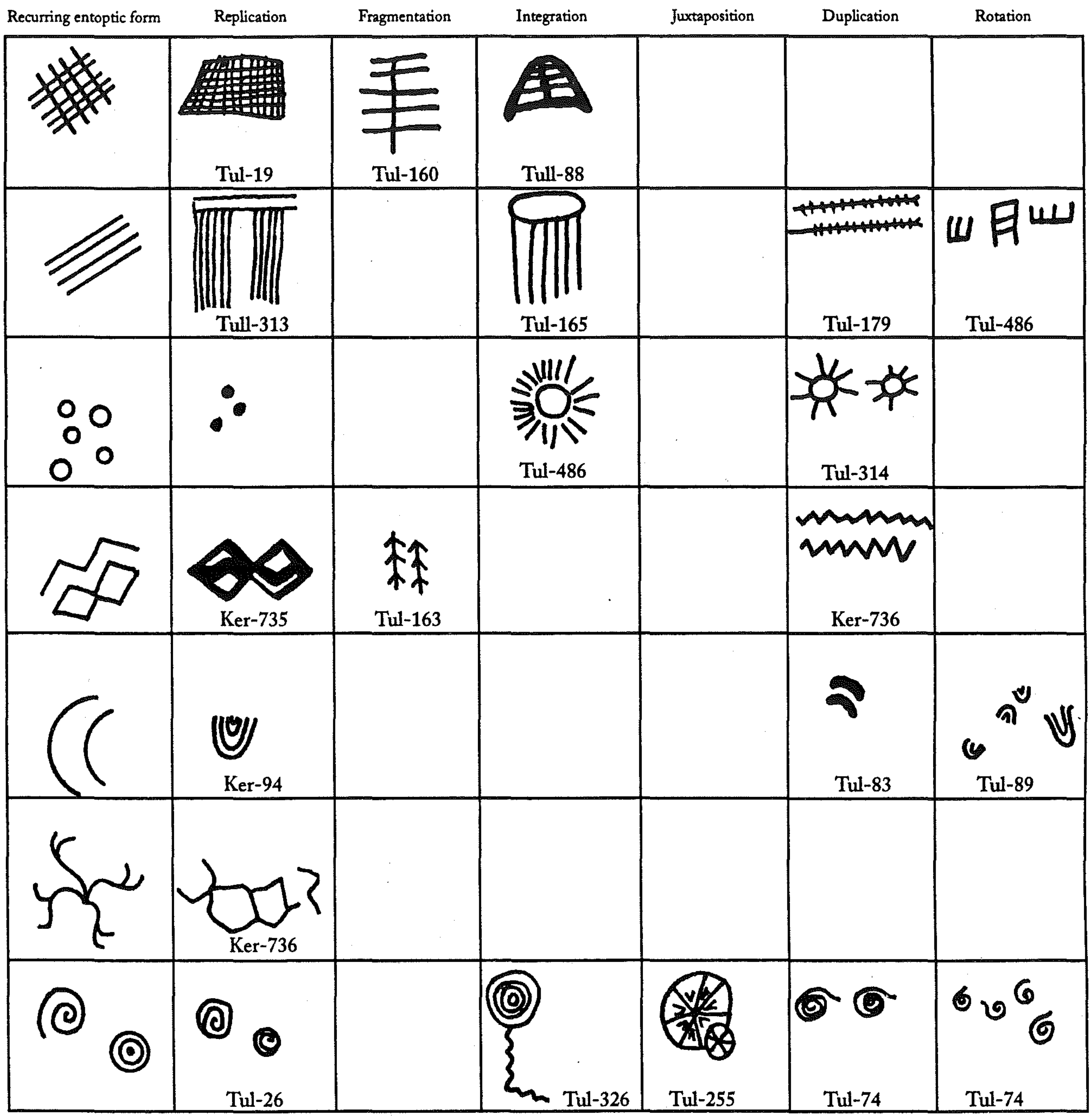


FIGURE 8.1 PRINCIPLES OF PERCEPTION. Neuropsychological model (Lewis-Williams and Dowson 1988) in reference to geometric motifs (table 8.1), showing two of its components: the seven recurring entoptic forms (left column) and six of the seven principles by which the entoptics are perceived in an ASC. Painted motifs from southern Sierra Nevada sites illustrate the entoptic forms, with the site from which each motif was derived designated. Not included is the principle of superimposition, which occurs at numerous sites. Simple circles and dots are also found at many sites in the region. Motifs are depicted in various scales.

cause of the culture-specific conditioning upon which they are predicated—the figurative imagery of the southern Sierra nonetheless can also be said to meet the expectations of the neuropsychological model. Specifically, and at a more qualitative level, the principles of perception experienced during an ASC and its cumulative stages are also graphically represented in the iconic art (for example, see fig. 8.2).

The southern Sierra rock art, in other words, provides strong originating or source-side support for the analogical component of Lewis-Williams and Dowson's neuropsychological model. It demonstrates that rock art known ethnographically to have been produced by shamans, and to represent the ASC images these individuals experienced, matches very closely the predictions of the neuropsychological model. This matching, however, does not directly support their contentions concerning the European Upper Paleolithic art, the veracity of which rests entirely on how well data from that region fit their model. But the southern Sierra case does bolster the notion that the neuropsychological model represents a valid explanatory theory

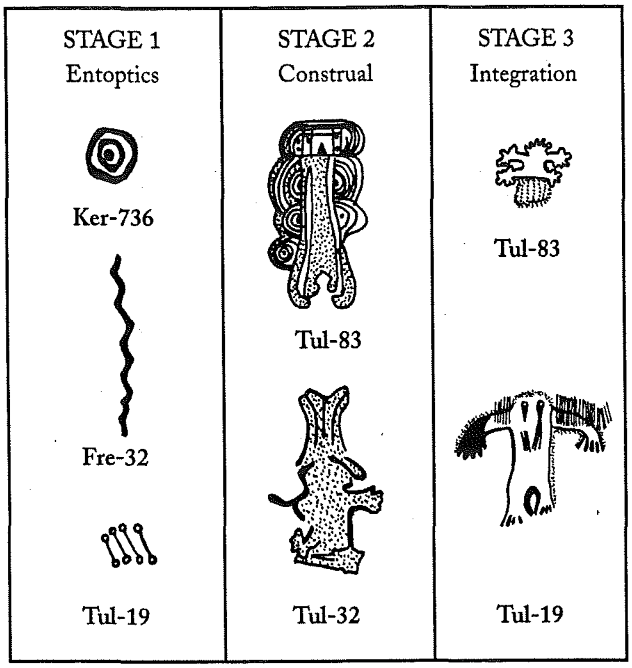


FIGURE 8.2 STAGES OF AN ASC. Neuropsychological model (Lewis-Williams and Dowson 1988), showing the three progressive stages of an ASC. As in figure 8.1, examples are from southern Sierra Nevada sites. In stage 1, entoptic forms alone are perceived (fig. 8.1). In stage 2, entoptics are construed as iconic images, as in the geometric pelt and anthropomorph figures shown. In stage 3, iconics and entoptics integrate, as indicated by the anthropomorph from CA-TUL-83 and the grizzly bear from CA-TUL-19 (see Whitley 1992b). Motifs are depicted in various scales.

for the origin of motif forms, and it thereby further documents our ability to analyze rock art and prehistoric belief systems in a scientifically sound manner.

Ethnography and Style

The ethnographic record and its support for the neuropsychological model have important and specific implications for the concept of style, as used in rock art studies. As discussed at length elsewhere (Whitley 1982b, Whitley and Dorn n.d.), "style" traditionally has served as the principal cultural-historical taxon in rock art research. There have been numerous problems with this fact, not the least of which is that we have about as many defined rock art styles in any given region as researchers working there. More to the point, archaeologists have widely cited a definition of style (in Schapiro 1953) that suggests a taxonomic equivalence with an archaeological "culture" in the cultural-historical sense, and then have proceeded to completely ignore the definition operationally, meanwhile retaining its cultural-historical implications (for example, Heizer and Baumhoff 1962; Hedges 1982; Schaafsma 1985). The resulting "styles" often then represent something more akin to art historical styles, defined on a very few aesthetic or technical attributes, and reduce the concept to the taxonomic level of a class of artifact types rather than to a cultural-historical unit. Cultural-historical styles, properly following Schapiro (1953), should not only implicate chronological placement and cultural assignment but should also be defined based on all the arts and manufactures of a given culture. Thus, they can be expected to incorporate a range of variation in formal, technical, thematic, and aesthetic attributes.

The best example of this conceptual muddle is provided by the most widely known and cited stylistic study of American rock art: Heizer and Baumhoff's (1962) synthesis for the Great Basin. Great Basin styles, defined as manifestations of specific prehistoric cultures, were identified solely in terms of technique and form. Pecked engravings were said to include three styles (or style "variants"): curvilinear, rectilinear, and representational. Technique distinguishes these from the painted and scratched styles. Cultural-historical placement was then deduced from these styles, so that a tautological loop was closed: inductively define styles, infer cultural-historical placement, and then support these placements based on differences in (inductively defined) style.

Aside from the conceptual congestion, the empirical evidence has always suggested that the Heizer and Baumhoff stylistic analysis was implausible: the almost invariable presence of all the engraved styles at many of the petroglyph sites in the region implies at the outset that these "styles" may well have resulted from the same prehistoric culture, if not the same artists. Even more to the point, all chronometric evidence, including direct cation-ratio (CR) and AMS ^{14}C numerical ages, as well as relative dating, fails to support any putative temporal differentiation in these Great Basin styles. Each style was produced from the latest Pleistocene into at least the last 500 years, while historical motifs (horse and riders) indicate creation of representational art into the last few hundred years (Whitley and Dorn 1988, n.d.). Similar chronological problems with traditionally defined styles have been found in the rock art of Australia (Dorn et al 1989) and southern Africa (Whitley 1992c).

The ethnographic evidence and the neuropsychological model explain the absence of a correlation between styles, as typically defined by a very limited set of formal and technical attributes, and cultural-historical units (that is, archaeological cultures). The ethnography demonstrates that the art was made to depict visions from ASCs; indeed, one of Lowie's informants stated that, during his vision, a man's "medicine" (that is, spirit helper) "may tell him how to paint" (1909:224). The neuropsychological model indicates that the mental and therefore graphic imagery of ASCs will contain a variety of geometric and iconic forms, and that this imagery will change as an individual progresses through the three stages of trance. We then should expect a corpus of shamanistic art that may combine iconic and geometric motifs; incorporate polychromatic and monochromatic paintings, or fully-pecked, outline-pecked, and fine-line engravings; vary from simple to complex graphic imagery; exhibit considerable variation in graphic conventions (for example, solid outlining versus dotted borders); and include a relatively wide range of subject matter (for example,

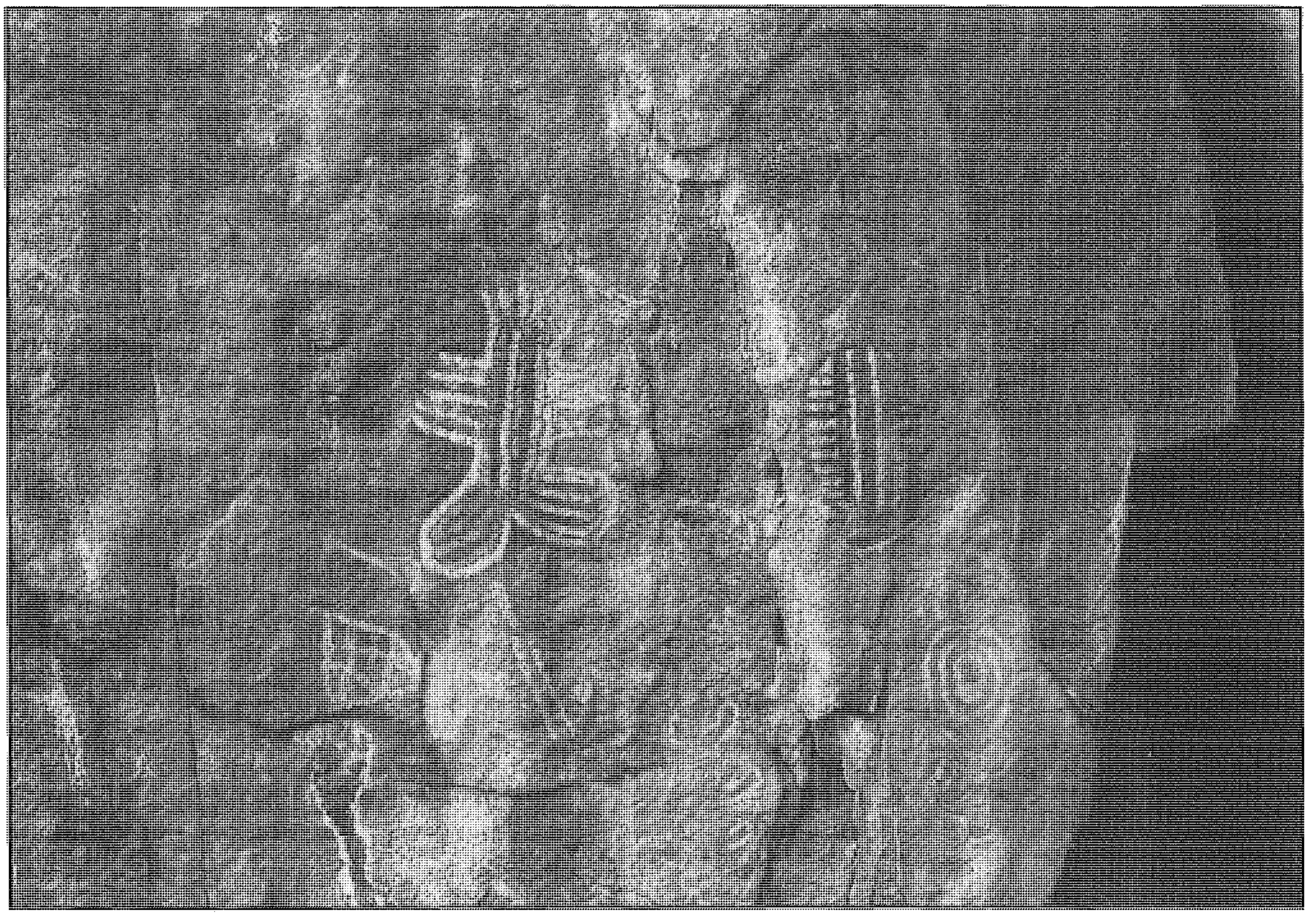


FIGURE 8.3 PAINTED PANEL AT ROCKY HILL, EXETER, TULARE COUNTY, CALIFORNIA. The pelt figure at left center was identified by a modern Yokuts ethnographic informant as a "full-fledged shaman's mark," representing the shaman himself (as an anthropomorphic figure); a smaller, monochromatic, single-line geometric on the same panel (at left, immediately outside this photo) was said to represent a shaman-initiate's mark. Colors: white and red. Size of center left motif: approximately 40 cm.

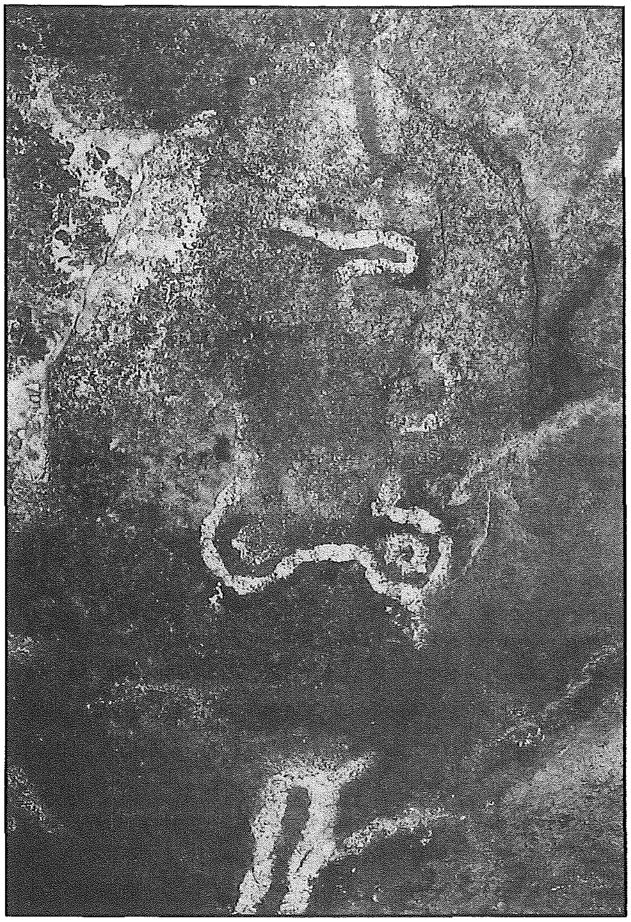
from "nonrepresentational" through zoomorphic and anthropomorphic themes). Instead of signaling different cultural-historical styles, that is, attributes such as these may be expected as the internal variation within a specific rock art style.

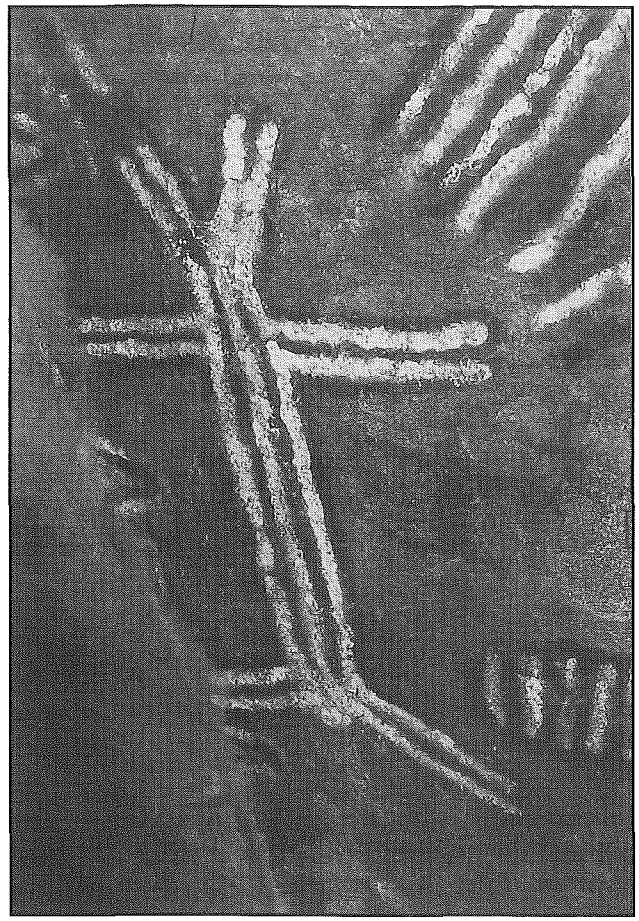
I do not imply, then, that no rock art styles exist, nor that stylistic analysis has no contribution in research—nor for that matter, that stylistic evolution may never have occurred. Instead, it is important to emphasize that the ethnography and its implications in the neuropsychological model alone potentially explain most of the styles defined for the far west as manifestations of a single prehistoric culture (certainly, at least, the three engraved "styles" from the Great Basin). For this region, accordingly, styles must be constructed with the graphic implications of this model in mind. I would also suggest that, if the goal is cultural-historical classification, stylistic studies should include chronometric evidence. Since this evidence is now available (see chapter 2 and 3), it can no longer be contended that rock art is undatable and that cultural-historical placement must proceed, therefore, in an entirely inductive manner.

Rock Art and Ethnolinguistic Groups

The issue of style also plays upon a recent archaeological concern with the identification of prehistoric "ethnolinguistic groups," a phrase apparently intended to mediate the fact that we have returned to the traditional archaeological interest in the definition of prehistoric cultures: "processual archaeologists" look for "ethnolinguistic groups"; "old archaeologists" sought "cultures." There is a danger in this sort of jargon-based mystification of our research goals: ignoring the concept of culture because we assume it analytically intractable not only does not absolve us of the real problems the concept poses for the archaeologist but also contributes the additional danger of not recognizing that we still have those same problems (Whitley 1992a). If we are truly anthropological archaeologists, I can only assume that we are not yet ready to jettison our mother discipline's unifying and central concept. Moreover, as the perennial debate over the Sapir-Whorf hypothesis demonstrates, the relationship of language to culture is as unresolved as the relationship of the archaeological record to cultural behaviors (hence, our ongoing concern with middle-range theory). We gain little or nothing in inferential or analytic terms by defining our archaeological interests in reference to language groups instead of cultures, and run the risk of even further confounding our classificatory goals.

The real issue, then, is the definition of prehistoric cultures, which clearly relates to the question of the cultural-his-





Left, FIGURE 8.4 ROCKY HILL, EXETER, TULARE COUNTY, CALIFORNIA. Motif identified as *wehechit*, said to be a malevolent (supernaturally powerful) being seen in a shaman's ASC. Located on the ceiling of the ethnographically identified "shaman's dream" panel/cave. Color: red. Size: approximately 20 cm.

Right, FIGURE 8.5 ROCKY HILL, EXETER, TULARE COUNTY, CALIFORNIA. A "blue heron" *(huhuna),* dancer, also from the "shaman's dream" cave. The *huhuna* was apparently a shaman-specialist who participated in the first ritual display of shamanistic power at the annual Yokuts Mourning Ceremony. Like other shamans, he was required to dream of his blue heron spirit helper before exercising shamanistic powers or participating in shamanistic dances. As with the shaman figure in figure 8.4, this ethnographic identification confirms that the so-called southern Sierra pelt figures are actually anthropomorphs. Colors of central figure: black and white; figures immediately to the left and top left, within an area eroding due to water: red and white. Size of central figure: approximately 1 m.

torical style. There are additional important theoretical implications to a concern with culture, not the least being one's preferred culture theory, but these have been discussed elsewhere (Whitley 1992a) and I will not elaborate on them here. Instead, to keep this essay directed toward lessons from ethnography, I consider a practical question in the use of rock art to identify "cultural boundaries" in a broad sense. Does the ethnography support the contention that rock art sites are placed within the boundaries of the cultures (or ethnolinguistic groups) that produced them? Can we, in other words, use the distribution of rock art sites and styles to geographically bound prehistoric cultures?

Irrespective of the theoretical question of whether different cultures abut as distinctive units or grade together (see Hodder 1982; Evers 1989), the ethnography from the far west gives us an unconditional *maybe* in answer to this question. That is, it appears this approach might work in some cases, but it is clear that it will not work in others. "Stylistic distribution" as a surrogate for "cultural" or "ethnolinguistic distribution," then, cannot be assumed to have universal applicability as an analytical approach—at least with rock art.

This fact results simply from differences in the ways vision quests were conducted in the far west. In California generally (that is, the south-central and southwestern regions), vision quests were held near an individual's village or relatively close to home. There was no formalized practice of traveling any great distance to a special location to receive a spirit helper. Thus, this activity is typically not referred to as a vision quest in the literature. Individual shamans specifically owned particular rock art sites (Gayton 1948:113), almost invariably located close to their home village (Latta 1977:600; Whitley 1987, 1992b). Indeed, the standard pattern was for the shaman to ingest a hallucinogen before retiring to his hut, awaken when the ASC occurred, then stay awake the rest of the night so the visions and "instructions" would not be forgotten, and go in the morning to the rock art site to record the images. Further-

Table 8.1 Correspondence between neuropsychological model and "geometric" motif types in southern Sierra Nevada

Basic entoptic pattern and principle of perception*	Corresponding "geometric" type**
Replication	
Grid/lattice	——
Parallel lines	Type 26, rakes/ladders
Dots/flecks	Type 21, simple circles; type 28, chains
Zigzags	Type 28, chains
Nested catenary curves	Type 25, U-shaped motifs
Filigrees/lines	Type 28, chains
Spirals	Type 16, spirals
Fragmentation	
Grids/lattice	Type 26, rakes/ladders; type 29, shields
Integration	
Dots/flecks and filigrees	Types 17 through 20, 22, and 28
Superpositioning	Present in numerous cases
Juxtapositioning	Occurs with geometric and iconic types
Reduplication	Types 17 and 27 through 29
Rotation	Type 25, U-shaped motifs and iconic motifs

* As specified by Lewis-Williams and Dowson (1988).
** Southern Sierra Nevada pictograph motif types as described by Whitley (1982b, 1987).

more, it was considered necessary to complete the paintings before noon, putting a real limit on the distance between the village and the shaman's rock art site (Driver 1937:142; Gayton 1948:108–109; Harrington n.d.).

Similarly, rock art produced during puberty rites in southwestern California was painted relatively close to the village where the inductees lived and where the rituals occurred. The initiates raced from the village to the rock art site as the culmination of the ceremonies and, arriving at the site, painted the spirits they had received during their ASCs (for example, Strong 1929:118, 173, 257, 289–299; Oxendine 1980:39, 43, 48). Again, a close association between the rock art site and the habitations of the people producing this art can be seen. In California, then, rock art might define boundaries between cultures or ethnolinguistic groups.

In the Great Basin and the Columbia Plateau, the circumstance is not so straightforward because vision questing sometimes involved traveling great distances to specific locales. These locales were believed to be particularly powerful or to provide a special type of shamanistic power; they were therefore used by many individuals (Park 1938:26; Kelly 1939:156). This phenomenon apparently explains certain very large concentrations of rock art in the Great Basin; for example, the Coso Range in eastern California. The Cosos were renowned as part of *Tiwiinyarivipi*, "Sacred Land, Mythic Country" (Laird 1976:7, 87, 134, 147, 1984:269; see also Chalfant 1933:57). The common bighorn sheep engravings in this region represent a spirit helper that imparted control over rain and reflect the importance of this region in obtaining weather control power. This control was recognized not only by the locally resident Coso Shoshone but also by a series of different ethnolinguistic groups, including the Kawaiisu, Owens Valley Paiute, and Chemehuevi in the western Great Basin/eastern California region and the Yokuts, Tubatulabal, and Tataviam in south central California (see Powers 1877:372; Kroeber 1925:511–512; Chalfant 1933:39; Steward 1933:311; Voegelin 1938:64; Gayton 1948:150; Riddell 1955:94–96; Zigmond 1986:406).

The ethnographic practice of traveling beyond one's home territory for ritual purposes is further emphasized by the activities of Bob Rabbit, the last living Kawaiisu rain shaman, who was one of Maurice Zigmond's ethnographic informants in the 1930s. I located and visited the remains of Bob Rabbit's homestead, in upper Kelso Valley in the southern Sierra Nevada. Zigmond recorded that Rabbit left his home in Kelso Valley, within Kawaiisu territory, to travel to Coso Hot Springs, within Coso Shoshone territory (1977:89), for rain-making ceremonies. The distance is about 65 km by air and roughly 125 km by then existing roads. The Coso region (and especially the Coso Hot Springs) are said to have been regularly used for rituals by Northern Paiute shamans who traveled from as far away as Nevada, Bishop, and even further north in Mono County. One account even records its use by Julius Murray, a shaman from the Fort Duchesne Ute Reservation in Utah (Brooks et al 1979:98, 101).

The result is that in the Great Basin, at least, rock art/vision quest sites sometimes fell outside an individual's immediate band, if not ethnolinguistic or cultural territory. To cite additional examples, *nagobin* or "Swimming Mountain" (possibly Warren Peak, Modoc County, California, but at any rate within Achomawi territory) was used by Northern Paiute and Achomawi vision questers (Kelly 1932:190; Riddell 1978:75). Charleston Peak (near Las Vegas) was similarly considered an important vision quest destination (fig. 8.6), and was visited by the Chemehuevi and Las Vegas Southern Paiute groups, at least (Kroeber 1908, 1925; Kelly 1936:134, 1964; Goss 1972; Miller 1983, 1985; Laird 1974:21, 25, 1976:122). Certainly we would consider the Chemehuevi and Southern Paiute as culturally equivalent (although they represent different Paiute bands). The Chemehuevi also visited Kwinavi Mountain, across the Colorado River in Yavapai territory, Arizona (Kelly 1936:129; Laird 1976:37, 39, 133), and may have traveled as far as Wheeler Peak in east central Nevada (Laird 1976:38–39, 132–133, 328) for vision quests. The circumstance relative to the Chemehuevi traveling on vision quests into Yavapai territory is straightforward: not only did they go beyond their band and ethnolinguistic territories, they ventured into an entirely different "culture area," in the large sense of the term, for vision quests.

The ethnography from the Columbia Plateau is not as specific about the vision questing destinations where rock art was produced, but generally the Plateau and Basin patterns appear similar. For example, among the Flathead (Salish) of Montana, young boys were sent to locales toward the west because it was felt that sending them onto the Plains, in the direction of the supernatural power to the east, was too dangerous (Turney-High 1937:27). In this instance, again, it was supernatural concerns, not territorial considerations, that determined where a vision quest was conducted.

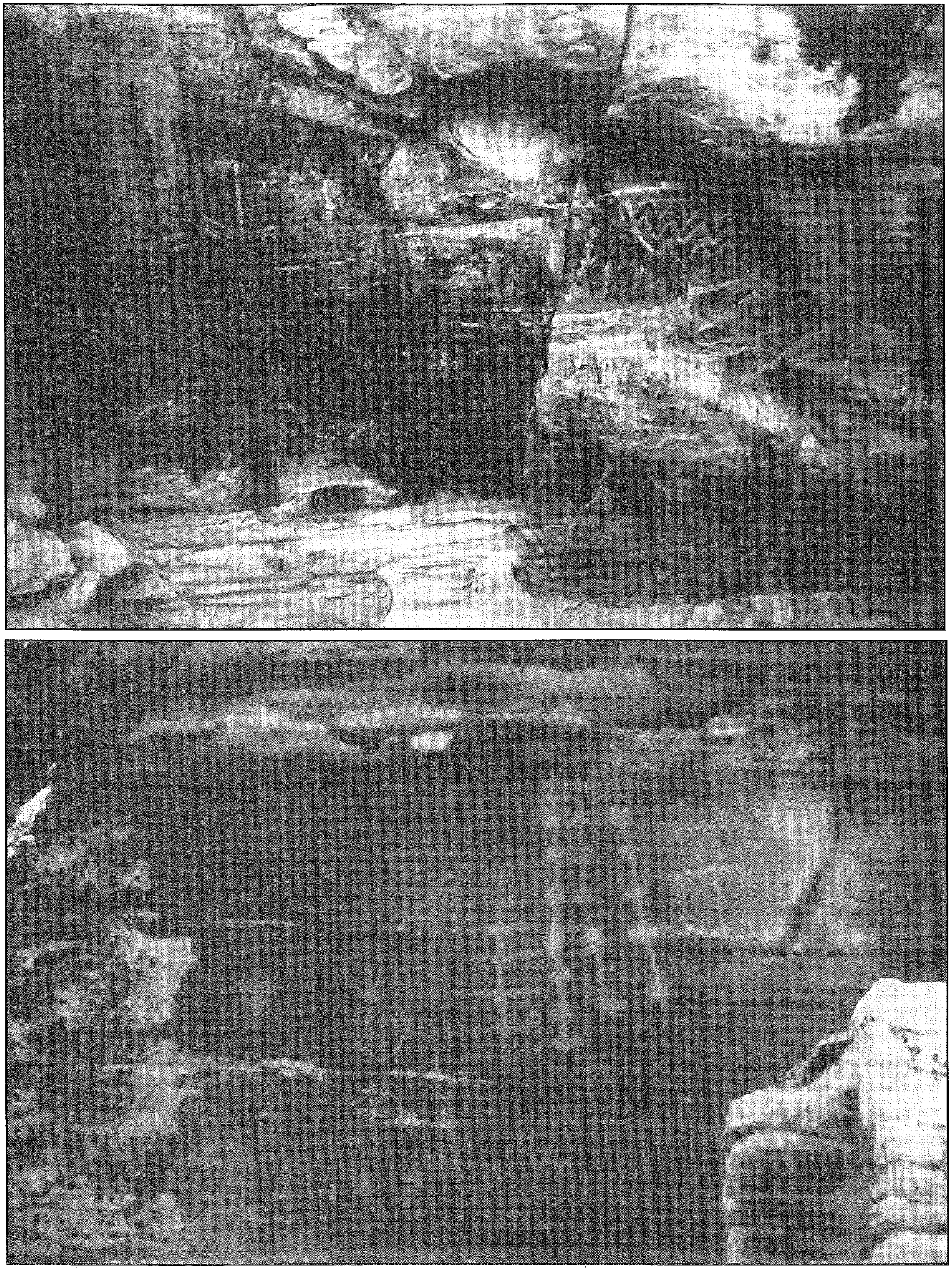


FIGURE 8.6 BROWNESTONE CANYON, CHARLESTON PEAK REGION, NEAR LAS VEGAS, NEVADA. This was an important vision quest locale for inhabitants of the southern Great Basin. *Top,* Painted, polychrome motifs (black, red, white, and yellow). *Bottom,* Pecked petroglyphs. Different scales. *Photos courtesy of Stu Conner.*

Thus, while hesitating to contribute gray to an assumption that has been seen as black and white by many archaeologists, I must conclude that the ethnography does not support the notion that rock art distributions necessarily define cultural or ethnolinguistic distributions. Typically, in regions where rock art sites are relatively small and are located near village sites, there may be a direct relationship between the home of the artist and the place of production. Where very large concentrations of rock art are found, it seems likely that individuals came from wide distances, and perhaps from different cultural or ethnolinguistic territories, to produce the art.

Cultural Resource Management Implications

A few cultural resource management (CRM) issues and implications of the ethnographic data concerning far western rock art should be mentioned briefly. They are particularly important in light of the fact that CRM, whether measured by dollars expended, personnel employed, or reports and documents produced, is now as important a branch of professional archaeology as the academic/pure research side of the discipline.

First, because of its visual and artistic appeal, a rock art locale is much more engaging to the general public than other types of archaeological sites in areas inhabited by hunter-gatherers. Therefore, if we have a mandate to interpret archaeology for the benefit of the public, rock art is probably the best place to start. As the ethnography demonstrates, we no longer need to believe that the art is unknowable, enigmatic, and uninterpretable. In fact, it is very interpretable, and probably in ways that may be more meaningful to the lay public than our more traditional interpretations of subsistence and settlement. So I argue that rock art should be a major, if not central, focus of any archaeological interpretive plan.

Second, it should also be clear that rock art sites were in fact "sacred places" and not, as some archaeologists have recently claimed, simply the "doodlings" of the ancients. Therefore, I believe they maintain a significance (in the 36 CFR 60.4 sense of the word) that justifies their preservation in most circumstances. Because rock art sites are now interpretable (as well as datable), their scientific research potential is likewise enhanced. This potential further emphasizes the fact that they should be treated as significant cultural resources on the cultural landscape.

Finally, it should be clear from recent legislation that decisions regarding the management, curation, conservation, and study of certain classes of archaeological remains—specifically, those pertaining to Native American religions—no longer rest wholly with archaeologists and museums. These legal mandates require us to solicit the participation of local Native American communities in the management of these cultural resources. It is also apparent that rock art sites should be classified within the category of Native American religious remains. Indeed, it is now apparent that much more traditional knowledge about the religious significance of these sites was maintained by ethnographic and historical populations than archaeologists initially recognized. Judging from the very significant and clearly traditional knowledge about rock art sites that I obtained from my Yokuts informant, it is also clear that much concern and interest in these sites is maintained by modern Native American groups. In administering rock art sites, it then follows that we should make every effort to invite Native American participation in the decision-making process.

Art and Ethnography

In considering the analytical and interpretive implications of the far western North American ethnography, a final summary point should be emphasized: the ethnography universally and unequivocally supports a connection between rock art, ASCs, and shamanistic beliefs and practices. Granted, there are a number of important variations on this theme: while shamans everywhere appear to have painted and pecked rock art, not all rock art was made by these ritual specialists. Among a number of groups, the art was also made by male and female puberty initiates, in formal group ceremonies or individual private rites. On the Columbia Plateau, art was sometimes created simply by adult males during life-crisis vision quests (Driver 1941). But in all instances, the intent was to gain supernatural power by acquiring a spirit or dream helper.

The importance of this interpretation of far western rock art is underscored when it is recognized that essentially identical ethnographic interpretations have been demonstrated for the rock art of the Great Lakes (Conway and Conway 1990) and eastern Woodlands (Snow 1977), for the Tukano in South America (Reichel-Dolmatoff 1967, 1971), and for the San in southern Africa (Lewis-Williams 1981), while a very strong archaeological case has been made for the Pecos River art of south Texas (see Turpin, chapter 7). In each region not only was the art made to depict the visionary spirits of the supernatural world but the metaphors used to express the ASC experience (death, flight underwater/drowning, sexual intercourse) are in each instance duplicated. Certainly not all recent hunter-gatherer rock art may be shamanistic; Australia could well be one exception. In reference to North America, however, it appears that a shamanistic/ASC rock art origin was widespread among hunter-gatherer groups.

While one should avoid the pitfalls of the "age-area hypothesis," it is nonetheless true that, at a general level, the pervasiveness of this pattern implies that it may represent a fundamental aspect of New World religions. I would suggest that it is probably the first hypothesis that should be tested relative to other areas of the continent and that, with this widespread pattern beginning to emerge, our next step in rock art studies should be to identify how these shamanistic practices articulated with other aspects of prehistoric societies.

Notes

1. "Blue heron dancers" apparently refer to the Yokuts *huhuna* dancer who

performed the first ritual dance during the annual Mourning Ceremony. I have inferred this attribution based on the following facts. The *huhuna* dancer is described as wearing a bird-like costume with two feathers protruding from the head (Gayton 1948:43, 127–128, 135). Among at least one group, the *huhuna* was described as imitating "long-billed birds called *yakeyaknan*, perhaps loons" (Gayton 1948:31); Gayton elsewhere suggested that the *huhuna* may be an owl dancer due to the horn-like projections (1948:127–128). Latta (1977:677–678) also described the *huhuna* dancer's costume, which he likened to a "fish crane." It included a "long pretty blue dress" and "long, blue wing feathers" (1977:677-678).

A number of facts support the identification of *huhuna* as a "blue heron" rather than a loon, fish crane, or owl dancer, and thus link the ethnographically described blue heron paintings with the *huhuna* ritual. Loons are neither long-billed nor found in Yokuts territory. Cranes (presumably, the Sandhill Crane, *Grus canadensis*, which winters in the San Joaquin Valley) are frequently mistaken for herons but, like owls, do not have blue feathers, and thus would not be represented by blue wing feather costumes. Although the projections on the head of the *huhuna* dancer are described by Gayton and Latta as looking like a horned owl, the Great Blue Heron also has two projecting feathers from its head, unlike the Sandhill Crane, which simply has a red head. Moreover, the vocalization of the heron is close to "*yakekaynan*," presumably an onomatopoetic rendering of its call which is used as a species name (Udvardy 1977:424–425). Accordingly, the Great Blue Heron (*Ardea herodias*) is most plausibly the bird species imitated by the *huhuna*.

Although the *huhuna* dancer was not always a shaman, in at least certain known cases a shaman served in this capacity, while the dance itself involved a display of shamanistic powers (typically, a shaman's contest in which the *huhuna* was "killed" with "airshot" propelled by an opposing shaman, and then cured). Moreover, the *huhuna*'s spirit helper "had to be dreamed about as well" (Gayton 1948:127–128). Thus, it is likely that the "blue heron dancer" motifs described by my ethnographic informant depict the spirit helpers of a shaman/*huhuna* dancer, as seen in an ASC.

After I completed the above analysis, Mary Gordon noted that I had overlooked a direct reference to the blue heron in one of Latta's place-name attributions. According to Latta, there is a "grey, granite-strewn hill about two miles east of Woodlake [that] resembles the Yokuts blue heron clown [that is, dancer] when he had fallen during his dance, so the Wukchumne called it Ho-hu-no" (1977:14). This confirms my inferred link between the *huhuna* dancer and the blue heron.

9 Traditional Archaeological Methods and Their Applications at Rock Art Sites

Lawrence L. Loendorf

Rock art studies have lagged behind other archaeological topics in North America. Wellmann (1979:14) quotes researchers from Mallery (1886) to Gebhard (1963), each decrying the lack of emphasis on rock art research in North America. Steward (1937) believes that, in the absence of professional research, nonarchaeologists undertook the study of rock art and put forward many wild and unsubstantiated hypotheses. These crackpot ideas further alienated the professional community, which chose not to associate with the lunatic fringe.

Whatever the reasons, until the past fifteen years, not many trained archaeologists have pursued the study of rock art in North America. There are notable exceptions, such as Robert Heizer and Martin Baumhoff in Nevada, Clement Meighan in Baja California, and James Swauger in Ohio, but the majority of the credible research has been completed by artists, art historians, and persons in other professions. Polly Schaafsma, Campbell Grant, David Gebhard, Klaus Wellmann, and Stuart Conner, none of whom is a trained archaeologist, have completed major studies on North American rock art. Without their work, major rock art sites would have been lost to vandalism and other forms of destruction. Nonetheless, these pioneers in rock art research have been reluctant to use archaeological methods simply because they were not trained to do so. Only archaeologists excavate sites to recover information.

This chapter is intended to encourage the use of more traditional archaeological methods at rock art sites. In a recent paper, Odak (1991) argues that rock art research should be conducted as a separate discipline and even goes so far as to suggest the name "Ppefology" for the new discipline: "P" for pictographs; "p" for petroglyphs; "e" for engravings on egg shell, bone, or other surfaces; and "f" for other kinds of figures on bone or stone. Before we invent a new discipline to study rock art, we need to use our existing skills as trained archaeologists.

Using Seriation for Relative Dating

In many parts of North America, petroglyphs and pictographs are not included in research schemes because of the difficulty in establishing their ages. There is a tremendous need to establish regional rock art chronologies, and even after numerical dating methods improve, there will continue to be questions concerning chronology. Seriation can be used to develop nascent chronologies in regions or areas where there is no existing temporal placement of archaeological phenomena.

Seriation has been used, although not extensively, to study rock art in North America. King (1978) used a three-pole regression-type seriation for four rock art sites in Baja California, and Whitley (1982b) presented another example for four sites in California. Both of these pioneering studies appear to have ordered the rock art sites correctly.

Seriation was also used at six southeastern Colorado sites to establish the relative order of a series of petroglyphs (fig. 9.1; Loendorf 1989:338–340; Loendorf 1991:248; Loendorf and Kuehn 1991:262–265). In these studies, seriation was strengthened by AMS ^{14}C dates and cation-ratio (CR) varnish dates that established numerical ages for the petroglyphs in the same

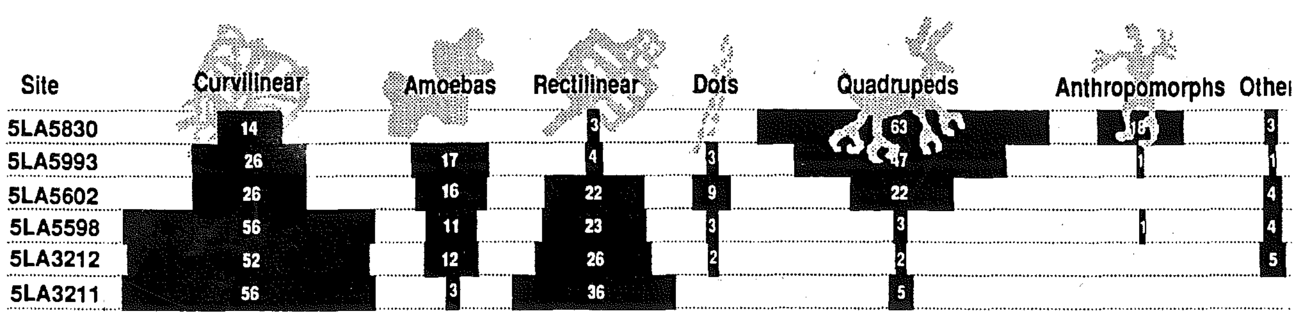


Figure 9.1 Seriation of rock art forms occurring on six sites in southeastern Colorado. Numbers within the black bars are percentages.

chronological order. Thus, even though there are known problems with using seriation, the method is helpful in establishing emerging chronologies. Seriation, of course, depends upon typology, a hallmark of basic archaeology. To successfully study rock art, more of the basic methods must be used.

Experimental Archaeology

Experimental or actualistic studies replicate prehistoric technologies and production methods and provide information on labor investments, cognitive strategies, and so on. Experimental studies in the production of rock art are much better developed in Europe than in North America (see Leroi-Gourhan 1982 and Bahn and Vertut 1988:100–108 for examples). In Australia, the indigenous populations still produce rock drawings, so their techniques can be studied. Many things are learned from experimental rock art manufacture: for example, the kinds of tools used and the residue resulting from that use. By learning the components of a rock artist's tool kit, archaeologists can gain insight into the sorts of artifacts they might recover when excavating rock art sites. If the experimental production of petroglyphs had been undertaken in North America with the same enthusiasm that researchers have given to the study of the manufacture of chipped stone tools over the past twenty years, we would most likely have considerable knowledge regarding the contents of the rock artist's tool kit.

Unfortunately, only a handful of studies have been completed in North America, and most of these were aimed at learning the difficulty involved in making a petroglyph rather than in trying to understand the tools used to make it (Bard and Busby 1974; Busby et al. 1978). Among these studies are those by Christy Turner, although it is not clear whether he actually made experimental petroglyphs. Turner assumed that pecking was completed through one of two methods:

> ...(1) hammerstone and chisel, which resulted in very accurate removal of the surface stone and equidistant placement of each pecked dint and, (2) sharpened hammerstone, which gives a sloppy appearance imposed by varieties of muscular coordination. . . . [Turner 1963:2]

Turner also suggested that using stone, stick, or bone to abrade or incise the rock surface can produce deep lines. These basic distinctions between methods have been accepted by rock art specialists in North America with very little modification.

The conclusion that a hammerstone and a punch produce more accurate and detailed petroglyphs was supported by experimental petroglyph manufacture completed by Busby et al. (1978), but little was learned about the wear on the tools used to make the petroglyphs or the residue produced in the process. Vastokas and Vastokas (1973) used a sharp gneiss pebble to peck a petroglyph circle. In the process, they learned that blows from a low angle following the direction of the groove served as an effective means of making a petroglyph.

In experimenting with rock art production at Petroglyph Canyon (site 24CB601) in Montana, we selected a slab of Cloverly Formation Sandstone having the same degree of varnish as many of the rock surfaces in the canyon. Cloverly Sandstone has a hardness ranging from 2.5 to 3.5 on the Mohs scale. We created experimental petroglyphs using objects that were as hard as or harder than the sandstone and with tools that were logical possibilities or available locally. Using an ink marker, we simply drew a series of circles on the rock and pecked out the interior of each one using a different technique. All the residue from each experiment was kept to isolate possible artifacts that might typically be found in test excavations at the base of petroglyph panels (Loendorf 1984:99–105).

Thirteen separate petroglyphs were made using different combinations of tools as percussors, either hand-held or used to direct a blow onto a punch. Deer antler tines simply shatter when used either as a hand-held percussor or as a punch and were probably not used for pecking. Belemnites, locally available on the surface at the site, were used as percussors, with the same result as the deer antler. Nodules of hematite with small protruding points were very effective, as were small pointed gastroliths with good silica content. Locally available at the site, these latter tools worked well as hand-held percussors or as punches with indirect percussion. Although the gastrolith point became noticeably dull when used on more than one experimental petroglyph, the tool did not fracture.

In the second part of the experiment, we excavated at the base of four petroglyph panels. Although hearths and chipped stone artifacts were discovered, no tools could be identified as those used in the making of petroglyphs. This result may reflect a lack of knowledge about tools used to manufacture petroglyphs, but the excavated area was small and probably inadequate as a sample of the site. We concluded that excavation at the base of petroglyph panels should be increased in future research.

Another experiment in rock art production was initiated at the Piñon Canyon Maneuver Site, a military training area in southeastern Colorado. At the Painted Tipi Cave site (5LA5563), an exposed seam of yellow sandstone or limonite was noted near a hearth area where fragments of this material had been heated until they turned a deep red. This red pigment matches the red paint used to make a pictograph of a tipi with a banded red and black design (Loendorf and Kuehn 1991). To explore this heat-induced color change, two fist-size samples of the yellow sandstone were removed from the cave, wrapped in foil, and baked overnight in an open fire. Both chunks changed from yellow to red. One chunk was not as bright as the paint in the tipi pictograph, but the other was a fairly close match.

Then, three separate binders were prepared to make paint. First, the reddened pigment was pulverized into a fine powder and mixed with rendered kidney fat. Jennifer Galindo, who completed the work, learned this technique from Lakota Indi-

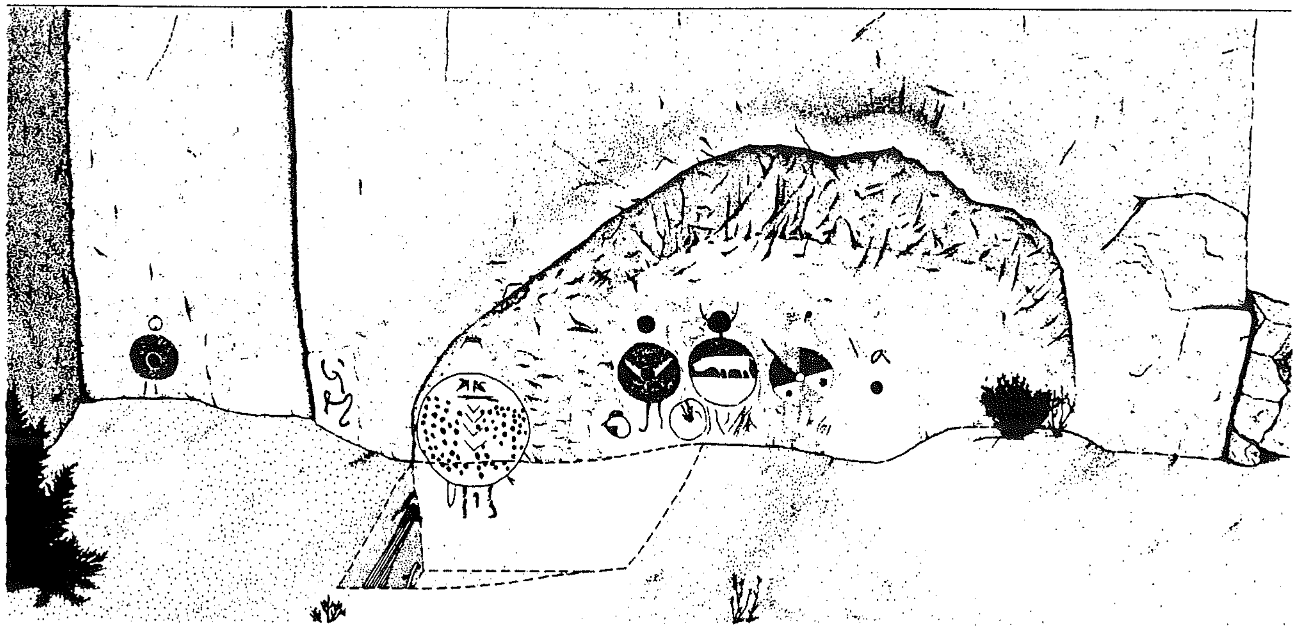


FIGURE 9.2 VALLEY OF THE SHIELDS. Main panel, including the rock art uncovered by excavation.

ans at Pine Ridge, South Dakota. The three paints, differing slightly in color and in the degree to which the pigment had been pulverized, were applied with a finger to make designs J1, J2, and J3 on a slab of sandstone that was then placed under a low rock overhang at Crowder Ranch. Completed in 1989, the three painted figures look nearly as fresh today as when they were first made. The experimental pictographs will continue to be monitored to explore any deterioration that occurs.

Excavation and Rock Art Studies

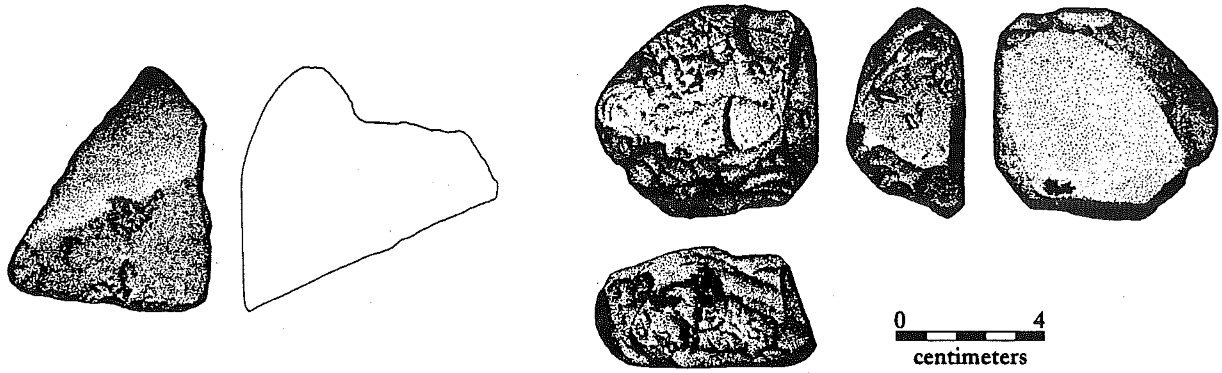
As with experimental studies, excavation at rock art sites is much more common in Europe than in North America (Clottes et al. 1990; Lorblanchet et al. 1990), partly because European paintings are located deep in caves. These underground sites afford good opportunity to find artifacts that can be clearly associated with the artists. Sites in open-air settings, on the other hand, do not have boundaries that restrict their access; consequently, individuals who are not the artists have greater opportunity to visit or use these sites Thus, the chances of finding artifacts that are not related to the rock art are increased.

Usually, excavation at rock art sites in North America has been conducted because the sites contained remains other than rock art. Thus, cave sites were excavated to explore their stratified deposits, and remnants of houses were excavated to learn about their contents rather than adjacent rock art panels. Nonetheless, information about the rock art was obtained in the course of these excavations. For example, Mulloy (1958:70) found wooden paint applicators or brushes that were likely to have been used in making the pictographs in Pictograph Cave, Montana. Through associated excavated materials, Turner (1963:5) confirmed parts of the dating scheme established for rock art in the Glen Canyon Basin, Arizona.

Excavation directed toward understanding or learning about rock art as the primary intent is not as common. Breternitz, albeit unsuccessful, directed an excavation at the base of the rock art panel in Swelter Shelter (site 42UN40), Dinosaur National Monument, Utah, in an attempt to recover Fremont artifactual materials that could be associated with the petroglyphs (Breternitz 1970:159). The work of Meighan (1966) in Baja California is another good example of excavations aimed at learning about cave paintings.

Excavations at rock art sites have increased more recently. For example, work directed toward understanding the rock art has been undertaken at the Gotschall site in Wisconsin (Salzer 1987), the Mud Glyph Cave in Tennessee (Faulkner et al. 1984), and the Mud Portage site in Ontario (Steinbring et al. 1987). Excavations at the Coal Draw site in Wyoming resulted in the discovery of six steatite tubular pipes, or sucking tubes (Francis and Frison 1990). Walker and Francis (1989:193–194) recovered datable charcoal in deposits covering a partially buried petroglyph at the Legend Rock site, a few kilometers west of Coal Draw.

The excavation of deposits near rock art panels has considerable potential to yield information useful in understanding the artwork. Tools used to make the rock drawings can be recovered and stratigraphically dated to establish the age of the rock art. In some situations, organic material in deposits covering rock drawings can be dated to aid the dating process. It is important to recognize that, through standard archaeological recovery, one not only assigns an age to the artwork, but the resultant date can be useful in understanding the accuracy of other direct experimental dating methods, such as CR or AMS ^{14}C dating. For example, during excavation at the Valley of the Shields site in southern Montana, we exposed a partially buried panel of shield-bearing warrior figures (fig. 9.2). These fig-



a b

FIGURE 9.3 SANDSTONE ABRADERS. These abraders were recovered at the Valley of the Shields, *a*, larger abrader and *b*, smaller abrader, dorsal view (upper left), lateral view (center), grinding surface (upper right), and view of paint on one end (lower left).

ures were made through an elaborate process that started with the artists abrading the sandstone canyon wall to create a smooth surface. The outline of the figures was incised into the wall, and then various segments or parts were painted in one of several colors (Loendorf 1990a).

We also found a small hearth about a meter below the surface and near it two chunks of sandstone with smoothed and abraded surfaces (fig. 9.3). Both of these abraders are stained by a red paint that is the same color as parts of the pictographs. This stain is so evident on one of the abraders that it appears the artist(s) picked it up to use while applying paint. The artist may have used it to smooth a surface or to apply paint. Whatever its use, we established the age of the shield warrior figures in the rock art panel as AD 1100 because we were able to date the hearth, and we are now attempting to directly date shield warrior figures elsewhere, using AMS ^{14}C. This first date will provide an empirical expectation to gauge subsequent AMS ^{14}C ages.

In a second example, a panel of petroglyphs extends below the ground surface of the Carved Rock site (5LA5846), a small rockshelter near the Purgatoire River in Colorado (fig. 9.4). During excavation, charcoal and other artifactual remains were recovered from deposits covering the panel (Loendorf and Kuehn 1991:93–106). Two CR dates for the panel have an average age of 1825 ± 275 BP, while the age of the charcoal recovered from the overlaying deposits is 1220 ± 130 BP. The dates, in correct sequential order, offer secondary support for the validity of the CR dating method.

Test excavations, located near ten petroglyph boulders at sites along Van Bremer Arroyo in the Piñon Canyon Maneuver Site in Colorado, yielded mixed results (Loendorf et al. 1988). The petroglyphs are found on small basalt boulders strewn across the terraces on both sides of the arroyo. Because many of the petroglyph boulders are small enough to be portable, a goal of the excavation was to learn if they had been moved, perhaps for ceremonial purposes. No conclusive information was recovered to support this idea because there were no petroglyphs or other evidence of use on unexposed surfaces.

The excavations did produce some evidence regarding the tools used to make the petroglyphs: quartzite and basalt core tools and large flake tools with pointed projections were found in the excavations. On site 5LA5602, a large basalt boulder core was uncovered in an excavation about 50 cm from a basalt boulder that contained a petroglyph (fig. 9.5). Total excavation revealed that the boulder core and the petroglyph boulder were conjoinable pieces, with the matching faces exhibiting a dark varnish. Negative flake scars on the core boulder indicate it was struck to remove large spall flakes. The degree of revarnishing on the flake scars and the petroglyph is similar, suggesting they may have been removed at the same time. Experiments indicate that the stout projections on the basalt flakes are adequate for making a petroglyph, and it is not unreasonable to assume that the flakes struck from the boulder core were used to make petroglyphs at the site.

However, because the tougher and less brittle quartzite would need less resharpening, it would probably work better for pecking stones. Two possible quartzite pecking stones were found, one in an excavation near a petroglyph boulder on 5LA5602 and the other on the surface of 5LA3212. Both are fist-size chunks of quartzite with pointed projections that exhibit dulling, perhaps from grinding along the groove during pecking.

At the Peterborough petroglyph site in Ontario, 30 hammerstones or abraders were recovered from crevices and pits adjacent to the petroglyphs. The tools most likely used to make the petroglyphs are of gneiss, with angular shapes and corners that are rounded from use.

> The stones that show the greatest wear easily fit the human hand in a manner that would allow the delivery of blows at a right angle to the axis of the arm. In some instances, however, the angle of the worn surface is such as to suggest that the gneiss tool would strike the limestone surface like an adze, combining the advantages of impact and abrasion. [Vastokas and Vastokas 1973:18]

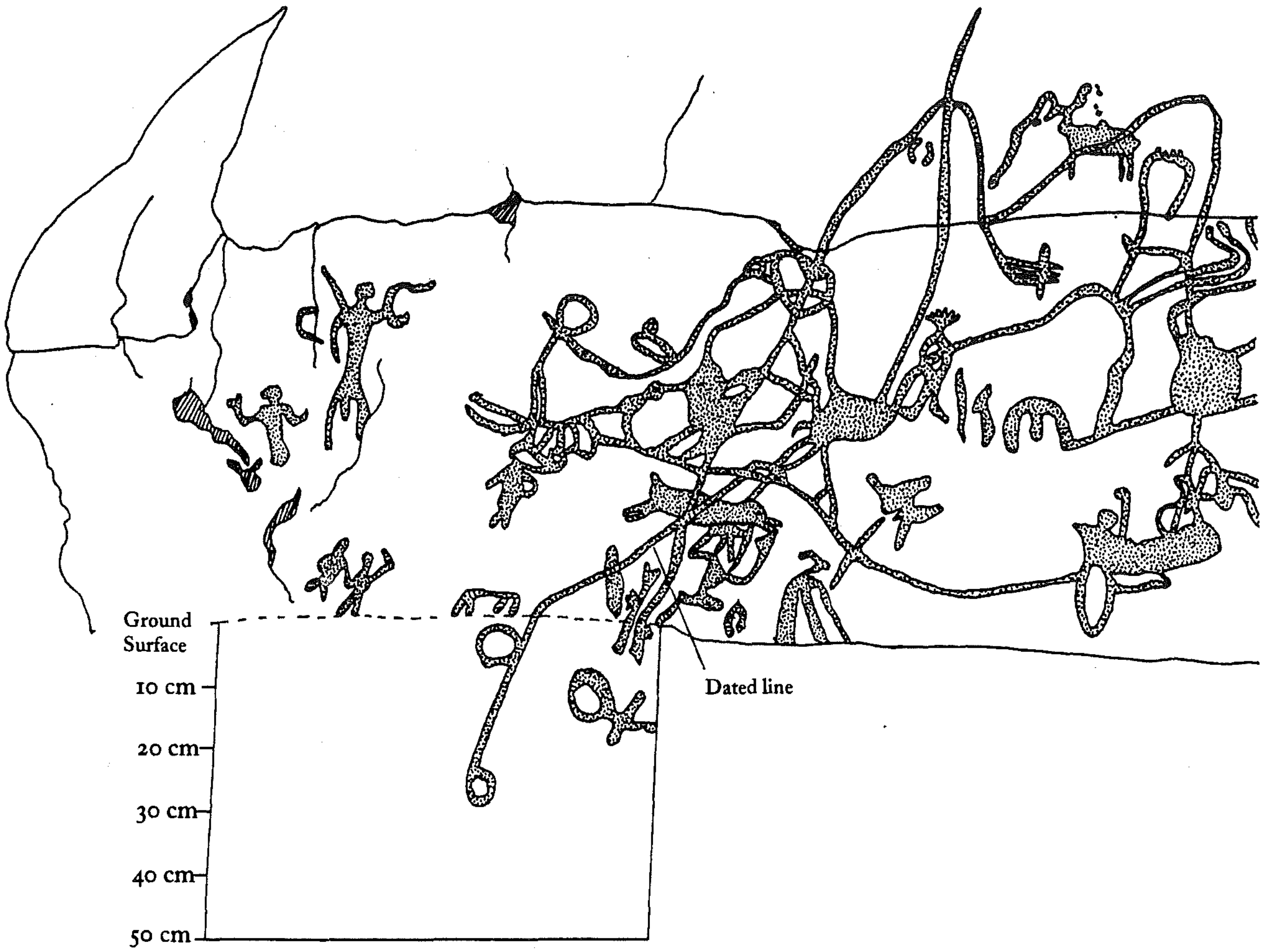


FIGURE 9.4 CARVED ROCK SITE, COLORADO. Sketch of approximately the eastern third of a rock art panel in a small rockshelter at the Carved Rock site, including the part of the panel exposed during excavation. View is to the south. Sketch is not to scale. The two CR dates are from the indicated meandering line.

These tools are very similar to those found near the petroglyph boulders at Piñon Canyon. In further excavations, aided by the experimental manufacture of petroglyphs, it should be possible to isolate the tools in the petroglyph artist's kit.

In another excavation at the boulder sites, fragments of a broken petroglyph were recovered about a meter from the boulder exhibiting the parent petroglyph. Unfortunately, the broken spalls were near the surface, and it was not possible to establish the age of the deposits in which they were found. Nonetheless, this find points to the possibility of recovering parts of the pictographs or petroglyphs in datable deposits through excavation.

Palynology and Rock Art Studies

The collecting of pollen samples for analysis is a routine part of archaeological research but not a common practice at rock art sites in North America. Nonetheless, pollen sampling at North American rock art sites has produced significant results. In southeastern Colorado, they offer considerable supporting evidence for the assumption that some petroglyphs represent Apache Gans figures. In Montana, the pollen may represent plants that were part of a shaman's medicine kit. Although neither example offers absolute certainty that the rock art was associated with ceremonial plant use, they offer a compelling argument for the use of palynology at rock art sites.

At site 5LA5586, on a basalt dike in the Piñon Canyon Maneuver Site, three well-defined rock features have been recorded. These features are of two types: one constructed by removing the blocky basalt chunks from the sides of the dike to create a sheltered alcove, and the other made by stacking the blocky basalt boulders into a low wall that attached to a side of the dike near its top.

Petroglyphs near these features include figures that resemble the Gans (fig. 9.6), or Mountain Spirits, of the Apachean tribes who have inhabited the region since about AD 1500. CR age estimates for these figures confirm their temporal association with the Apache (Loendorf and Kuehn 1991:269–270). Curiously, CR dating for petroglyphs in other panels at the site indicates they were made many millennia prior to Apache habitation of the region. This means that Apache use of the site began after it was already a rock art location for prior cultures. Currently, we do not know which generations of users built the rock wall features, but, through the use of palynol-

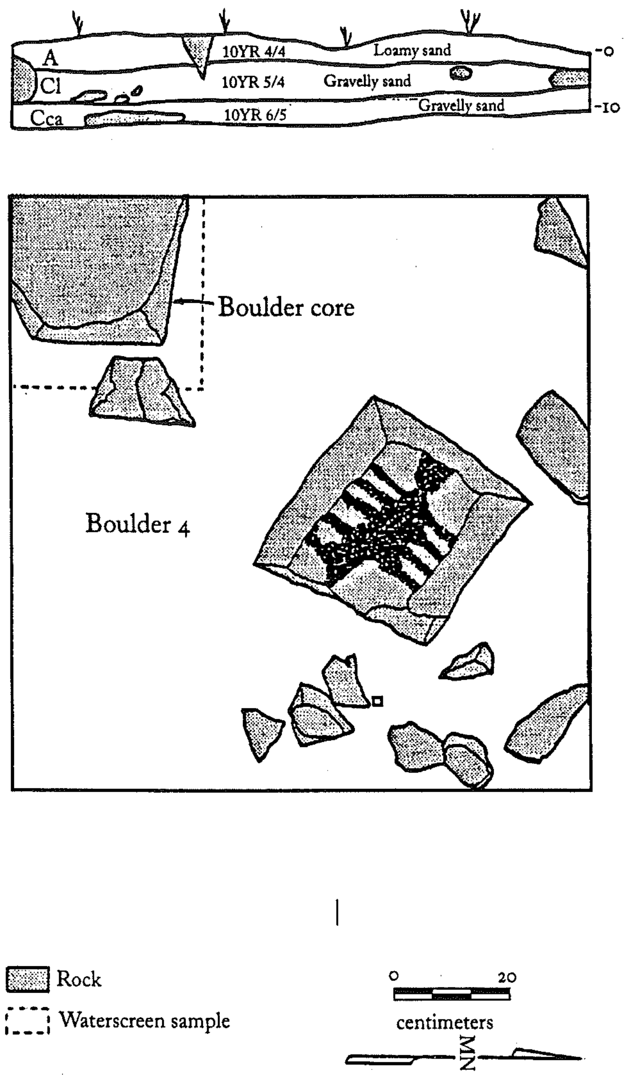


FIGURE 9.5 PLAN VIEW AND WEST WALL PROFILE DRAWINGS, LEVEL 1, XU1 AT 5LA5602. The positions of the boulder core and the basalt boulder with the petroglyph are shown.

ogy, it is fairly certain that the Apache visited the site. They quite possibly used the rock wall features in their visits (Loendorf 1990b).

Ethnographic accounts indicate that the Apache used cattail (*Typha latifolia*) pollen extensively in their ceremonies. Bourke (1892) offers a complete description of this use, indicating pollen was involved in various ceremonies, including those in which the Gans, or Mountain Spirits, were invoked. Three pollen samples collected near the surface inside the rock structures at site 5LA5586 showed cattail pollen intermixed with an array of other pollen.

In prior research on the dike by University of Denver researchers, pollen samples were collected from stratified sample blocks (Scott 1984:4–9). Two of these blocks are in the same setting and within a kilometer of site 5LA5586, but they do not exhibit cattail pollen. In fact, the only cattail pollen found in the Piñon Canyon region is from settings where the plants currently grow, suggesting a localized dispersion pattern (Cummings 1990). Thus, it is doubtful that the cattail pollen found in the rock structures at 5LA5586 got there through any means other than human use.

Quite likely the rock structures served as ceremonial prayer stations or as fasting beds in a ritual—something like the vision quest of other western American tribes. The features compare favorably with the structural remains of the vision quest found in Montana (Conner 1982), and there is no reason to suspect they did not function in a similar manner.

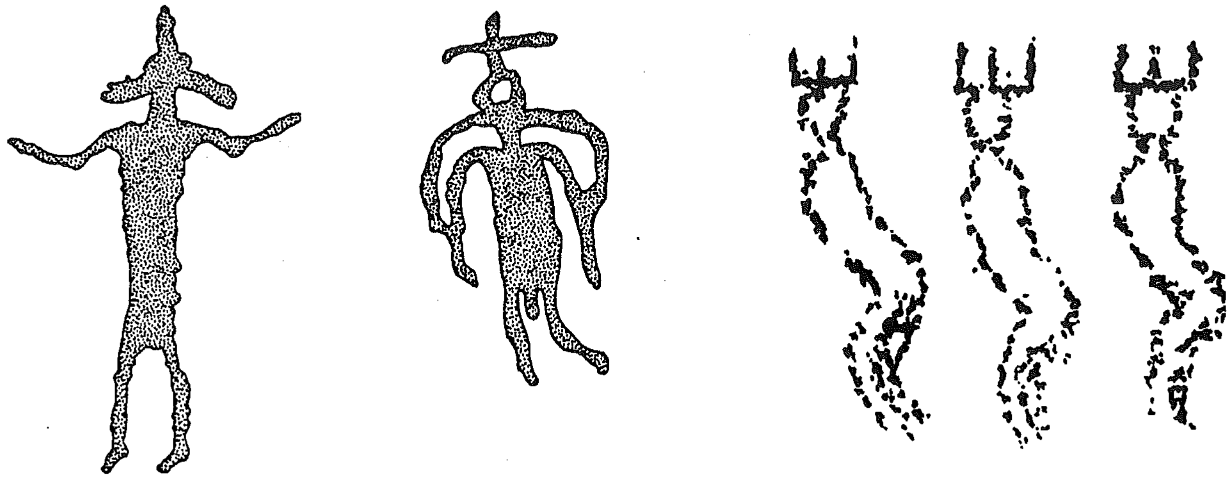
Pollen at Frozen Leg Cave in Montana suggests certain plants may have been associated with the cave paintings. This site is situated high in the west wall of Big Horn Canyon, offering a spectacular view of the canyon bottom. Paintings are found in separate grottos within the cave system. Plant-like figures, found on the south wall of a chamber, are strikingly reminiscent of the icons used for tobacco by the Crow Indians.

Tobacco, more than any other plant, has an essential role in Crow Indian creation and survival (Lowie 1919; Nabokov 1988). In a version of the Crow creation narrative, Batseesh is the Rockman, the original being on earth. In his wanderings, Batseesh encounters Coyote and tells him he is lonely. Coyote advises Batseesh to go to the Tobacco plant, where he will find a mate. Batseesh heeds this advice, mating with Tobacco to produce the first generation of Crow (Wildschut 1975:97). Other narratives vary, but, in all of them, the sacred tobacco of the Crow (*Nicotiana multivalvis*) is of prime importance. The Crow planted and harvested tobacco according to elaborate ritual.

On moccasins and medicine bags of Tobacco Society members among the Crow, Nabokov (1988) recognized a series of icons that represent tobacco. Several of these icons (fig. 9.7a–c) are similar to the plant figures held in the hands of an anthropomorph portrayed on the wall of Frozen Leg Cave (fig. 9.7d).

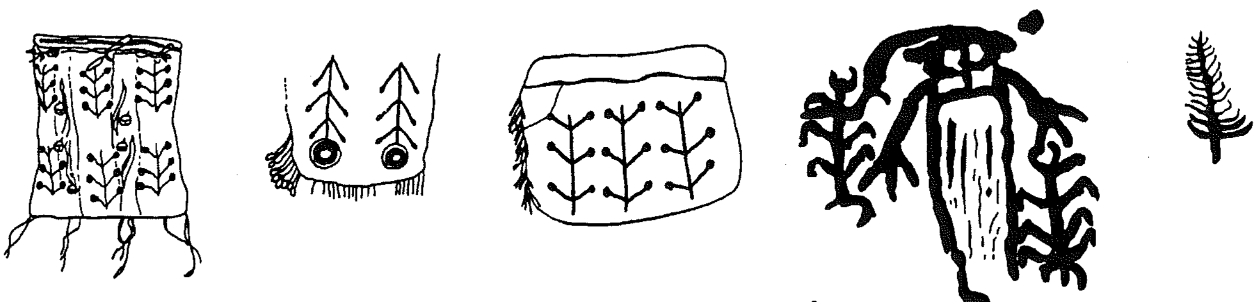
Reasoning that the pictograph represented tobacco, we wondered if there might be tobacco pollen in the cave. To test this possibility, three samples were collected from locations beneath the pictograph panels after surface dust and debris were scraped away. A bone disc bead found in one of the samples suggests that all three samples were from prehistoric levels (Reinhard 1991). To study the pollen content further, two samples were divided, with one portion sent to one laboratory and the other to a second laboratory (Cummings 1991). The results from the two laboratories are very similar, except that only one laboratory found tobacco and that was after a much longer counting procedure than normal (tables 9.1 and 9.2). Although tobacco is present in the cave, it is not abundant.

Perhaps more important is the surprisingly rich array of plants represented by pollen in the cave. Many of the plants have known medicinal properties, and they may represent the contents of shamans' medicine bags. The Solanaceae pollen, for example, is used extensively in western America for decoctions, infusions, and poultices (Moerman 1986:335–336, 460–



a b c

FIGURE 9.6. PETROGLYPH FIGURES. They resemble Apache Gans, or Mountain Spirits. *a*, from site 5LA5586, CR dated at less than 300 BP; *b*, from 5LA5846, CR age estimate is 375 ± 100 BP; *c*, Gan Dancer site near 5LA5586; middle figure was dated at 400 ± 74 BP; each form about 25 cm high.



a b c d

FIGURE 9.7 PICTOGRAPHS. *a–c*, Crow tobacco icons found on medicine bags (Nabokov 1988), *d*, anthropomorphic pictograph on the wall of Frozen Leg Cave, Montana.

461). Medicinal uses have been recorded for many of the other plants, but there are problems with the conclusion that shamans used the cave for curing ceremonies.

Much of the pollen can be identified only to the family level, and almost all families of plants in western North America include a species or two that shamans used for curing or healing. Any rich assemblage of pollen could be construed to represent plants used for ceremonial purposes. Perhaps a greater problem was the lack of a control sample from nearby caves that do not contain pictographs. Because all the samples were from Frozen Leg Cave, we did not know if other nearby caves might contain similar pollen; therefore, we had no assurance that humans carried the plants into the cave, or whether the pollen got into the cave by some natural process.

To test the possibility that pollen entered the cave by a natural process, soil samples from overhangs and caves in the same canyon wall and at the same elevation as Frozen Leg Cave were processed for their pollen content. The samples contained much less variety of pollen. By comparing the samples, Cummings (1991) made several significant observations. Plants with wind-transported pollen recovered in the samples near the petroglyph panels include "Alnus, Betula, Corylaceae, Rutaceae, Ephedra nevadensis-type, Saxifraga, and, to some extent, Centaurea, Rosaceae, Amelanchier, Holodiscus, Plantago, and Umbelliferae" (Cummings 1991:6). Some of this pollen may have come from nearby floral communities that differed from those growing today. For example, the Alnus, Betula, and Corylaceae pollen could have their origins in a more riparian habitat, perhaps the slopes of Big Horn Canyon prior to the construction of the dam and reservoir.

However, various of the plants represented are neither in the control samples nor the product of wind transportation. Their pollen is usually insect-transported, or, in this case, may have been brought into the cave by humans carrying plants for ceremonial use. These plants include "Campanulaceae, Caryophyllaceae, Labiatae, Leguminosae, Onagraceae, Gaura, Opuntia, Phlox, Solanaceae, and Nicotiana" (Cummings 1991:7).

Pollen analysis cannot demonstrate that any of these plants were used for ceremonial purposes or in association with the pictographs. On the other hand, the paintings of plants re-

Table 9.1 Pollen count of samples from Frozen Leg Site, Montana (PaleoResearch Laboratories)

Scientific name	Common name	SAMPLE 1 #	SAMPLE 1 %	SAMPLE 2 #	SAMPLE 2 %	SAMPLE 3 #	SAMPLE 3 %
Arboreal pollen							
Alnus	Alder					*	*
Betula	Birch	1	0.5	2	1.0	1	0.5
Corylaceae	Hazel family					1	0.5
Juniperus	Juniper	6	3.0	4	2.0	2	1.0
Picea	Spruce	*	*	*	*	*	*
Pinus	Pine	116**	58.0	106**	53.0	31	15.5
Pseudotsuga	Douglas fir			2*	1.0*		
Rutaceae cf. *Ptelea*	Rue family cf. Hop tree					1	0.5
Nonarboreal pollen							
Campanulaceae	Bellflower family			1	0.5	2	1.0
Caryophyllaceae	Pink family			*	*	1	0.5
Cheno-ams	Includes amaranth and pigweed family	10	5.0	15	7.5	9	4.5
Sarcobatus	Greasewood	1	0.5	2	1.0	4	2.0
Compositae	Sunflower family						
Artemisia	Sagebrush	23	11.5	22**	11.0	84**	42.0
Centaurea						1	0.5
Low-spine	Includes ragweed, cocklebur	5	2.5	2	1.0	10	5.0
High-spine	Includes aster, rabbitbrush, snakeweed, sunflower	10	5.0	11**	5.5	33	16.5
Liguliflorae	Includes dandelion & chicory	*	*			1*	0.5*
Cruciferae	Mustard family			1	0.5		
Ephedra nevadensis-type	Mormon tea	*	*				
Eriogonum	Wild buckwheat	*	*				
Gramineae	Grass family	12	6.0	16**	8.0	8**	4.0
Labiatae	Mint family					*	*
Leguminosae	Legume or pea family			1	0.5	1	0.5
Onagraceae	Evening primrose family					1	0.5
Gaura	Gaura					1	0.5
Opuntia	Prickly pear cactus					*	*
Phlox	Phlox					*	*
Plantago	Plantain					1	0.5
Polemoniaceae	Phlox family	1	0.5				
Anacardiaceae/ Rhamnaceae	Sumac/Buckthorn families	4**	2.0	3	1.5	2	1.0
Rosaceae	Rose family	8	4.0	6	3.0	1	0.5
Amelanchier-type	Service berry	1	0.5	1	0.5	2	1.0
Holodiscus	Spirea, ocean spray			1	0.5		
Saxifraga	Saxifrage	*	*	1	0.5	1	0.5
Solanaceae	Potato/tomato family	2	1.0				
Nicotiana	Tobacco					*	*
Umbelliferae	Parsley/carrot family			1	0.5	*	*
Indeterminate***		1	0.5	3	1.5	2	1.0
Spores							
Selaginella densa	Little clubmoss	1	0.5			4	2.0

* Indicates the pollen type was observed outside the regular count while scanning the remainder of the microscope slide.
** Indicates the presence of pollen aggregate. Aggregates were included in the pollen counts as single grains.
*** Includes pollen grains that are folded, mutilated, and otherwise distorted beyond recognition. These are included in the total pollen count because they are part of the pollen record.
Source: Cummings (1991:1, 10-12).

Table 9.2 Pollen counts from Frozen Leg Site, Montana (University of Nebraska, Lincoln)

Taxa	Common name	Sample 1*		Sample 2**	
		#	%	#	%
Apiaceae	Parsley family	1	0.5		
Asteraceae	Sunflower family				
Low spine	Ragweed type	12	6.0	30	15.0
High spine	Sunflower type	6	3.0	15	7.5
Fenestrate	Dandelion or chicory	3	1.5	3	1.5
Artemisia	Sage	14	7.0	48	24.0
				4 3,3,2,20***	
Brassicaceae	Mustard family	1	0.5		
Celtis (?)	Hackberry, probable	1	0.5		
Cheno Am	Goosefoot family and pigweed	5	2.5	10	5.0
Ephedra navadensis type	Mormon tea	1	0.5		
Fabaceae	Bean family	8	4.0	5	2.5
				1 7***	
Fagaceae	Beech, oak, chestnut family			2	1.0
Fern		4	2.0	2	1.0
Juniperus	Juniper	17	8.5	10	5.0
Lamiaceae	Mint family			2	1.0
Onagraceae (*Oenothera* type)	Evening primrose family			1	0.5
Pinus	Pine	95	46.0	36	18.0
		1 2***			
Poaceae	Grass family	15	7.5	14	7.0
		2 2, 2***			
Polygonaceae (*Eriogonum* type)	Smartweed family			1	0.5
Quercus	Oak	5	2.5	5	2.5
Rhamnaceae	Buckthorn family	2	1.0	4	2.0
Rhus	Sumac			1	0.5
Saxifragaceae	Saxifrage family			3	1.5
Typha/ Sparganum	Cattail or bur-reed	2	1.0	1	0.5
Unidentifiable		15	7.5	6	3.0
Unknown		1	0.5	3	1.5
Total		208		202	

* Collected directly beneath the panel depicting the plants.
** Collected below the main rock art panel.
*** Indicates the presence of pollen aggregates. The number of aggregates is indicated by the bold figure. The numbers following indicate the numbers of pollen grains composing each aggregate.
Source: Reinhard (1991:2, 9–12).

semble the icons used in Crow Indian tobacco rituals, and tobacco pollen was found near the pictographs. Obviously, the tobacco got into the cave deposits through human use, possibly left as an offering or ritually smoked by visitors. It is not known whether these visitors were the artists who painted the pictographs, but the array of medicinal plants certainly suggests that the cave was used for ceremonial purposes.

Conclusions

One of the main problems with the study of rock art in North America is the lack of attention by trained archaeologists. If an increased effort were devoted to understanding this art form, considerable progress could be made in a short time. More excavations at the base of rock art panels are needed to recover the tools used in making the drawings or the offerings left there in a lifetime of use. This conclusion is not meant to spur those who study rock art into a frenzy of digging because, at the very least, any excavations should be coordinated with well-planned experiments in the manufacture of rock art.

All rock art specialists need to recognize, however, the need for controlled excavation at sites. Archaeologists need to collect information concerning the relationship between drawings and soil deposits at the base of rock art panels. The surface of the ground at the base of panels should be carefully examined before treading on it. Frequently, the paintings or engravings attract one's attention to such an extent that secondary aspects of the site, such as the deposits at the base of the panel, are ignored. Unfortunately, in tromping up to a rock art panel, one may be destroying spalls of paint pigment or other artifacts.

Half a dozen new and experimental dating methods are being developed to establish the numerical ages of rock art. One important thing archaeologists can offer through excavation is information that can confirm these new dating methods. In most areas of archaeology, more than one dating method is used as a cross-check to validate another method, and it is argued that to successfully date rock art researchers need to complete all the dating schemes that can be devised (Loendorf 1991:254).

The lack of understanding of North American rock art is not a problem that is beyond resolution. It is, instead, a problem that awaits the enthusiasm and ingenuity of trained archaeologists. Simply dedicating time and effort to the study of rock art will resolve many of the unknowns that surround it.

Afterword

Prehistoric Rock Art and the Study of Archaeology

EARLY IMPRESSIONS of natural and other phenomena can shape our thinking and approach to lifelong activity. The flanks of the Bighorn and Wind river basins of northern Wyoming are formed of sedimentary sandstones and have been deeply dissected by both intermittent and permanent streams. The result has been the formation of numerous perpendicular walls ideal for the placement of prehistoric and protohistoric rock art. Contact with these phenomena on an almost daily basis from early childhoodto made it almost inevitable for me develop an interest in them and to speculate on their origins and meanings.

My first remembered contact with Native American rock art was at the age of six. My grandfather and I were riding for cattle on the western slopes of the Bighorn Mountains, and we stopped for lunch at a spring. After eating, we tied our horses and climbed a steep slope to a small rockshelter. Inside were a number of charcoal drawings of animals, geometric forms, and lines. In answer to my queries, I was informed that this was Indian writing. Further inquiries as to their age or meaning yielded only a shrug of the shoulders: only the original artist could supply this information.

Not far from this location were other sandstone walls, some with painted, incised, and pecked figures. Even at this early age, I could begin to detect certain similarities between some of the figures. These included, for example, long series of tracks, presumably bear; v-necked human figures; and human body appendages protruding from behind round objects, possibly shields. Some large animals (bison, elk, and deer) appeared to have arrows penetrating their bodies. Certainly these similarities had to reflect some kind of message being passed on to someone, not just random musings of the artist.

A year or so later, a Native American burial from a rock crevasse yielded, among numerous other objects, the metal parts of a flintlock firearm. The brass patch plate contained the carefully incised figure of a horse. On a sandstone wall several kilometers distant was a large painted figure of an identical but much larger horse. The stylistic lines incorporated in both left little doubt that they were products of the same individual. Some information was possible from this. The horse and flintlock parts indicated a protohistoric age, and the figure on the brass plate indicated a connection with a human who had apparently lived and died in the immediate area.

The Crow Indian Reservation is situated immediately adjacent to the area, and it was common at that time (the 1930s) for groups of Crow to travel south during the summer months down the flat, open country adjacent to the high mountain peaks of the Bighorn Mountains. Such a group was encountered one day, and was questioned about the figures on the sandstone walls. The Crow people disclaimed any knowledge of their origin or meaning and suggested they were probably made by people other than the Crow.

Yellowstone National Park is near this area and was becoming a tourist destination at about this same time. Highways were being constructed in response to the budding tourist industry. Rustic log cabin camps were the order of the day, and anything that could be advertised in the way of an attraction to travelers was immediately exploited. A small town at the base of the western slopes of the Bighorn Mountains boasted the improbable name ofTen Sleep. Local folklore claimed the name to be of Native American origin: supposedly it was ten days (sleeps) from the Yellowstone River in Montana and ten more days south to the North Platte River in southern Wyoming. On a sandstone wall in the vicinity, a local filling station and rustic cabin operator saw what he interpreted as a conical tipi with two handprints nearby. He spread the word that "Indian Writing" could indeed be read and here was the proof. A sign was painted with a tipi and two hands and was placed in the center of town as proof of the origin of the name. The local entrepreneur even organized tours to see the evidence. To this day, some claim the pictographs were not authentic but were painted there by the supposed discoverer. Unfortunately, the evidence was blasted away by road construction over four decades ago.

Another interpretation of the origin of the name Ten Sleep is attributed to Joseph Medicine Crow, a highly respected Native American Crow indian ethnographer. He argues that the name derives from the experiences of a group of Crow indians, including his great grandmother, in protohistoric times. The group was forced to seek shelter from a bad storm in a nearby canyon for ten days. There is good archaeological evidence of a Crow indian campsite at the designated location.

Still another sandstone wall in the area contains over six hundred separate painted, pecked, and incised figures. A visitor to this location many years ago concluded they were representations of Spanish soldiers wearing armor. Not far away are deep prehistoric quarry trenches and pits excavated for high-quality stone flaking materials. Some still believe and will argue that the two manifestations are closely related, that the figures are Spaniards, and the pits were dug by them in search of precious metals. The location of the pits was even named Spanish Point. They argue further that Native Americans were inherently too lazy to have dug the pits.

On the opposite side of the Bighorn basin and over the Owl Creek Mountains into the Wind River basin are innumerable pecked figures that cannot help but fuel the imagination of any observer. These are known as the Dinwoodie petroglyph style (see Gebhard and Cahn 1950), and stylistically they are very different from the petroglyphs farther to the north and east. Located in traditional Shoshoni territory, they are probably related to the Shoshoni group. Much of the area is on or adjacent to the Wind River Indian Reservation.

Questioning the present-day Wind River Shoshoni about the meaning of the figures yields very little information. This has led to the local belief that they probably know very little about them, which is probably not the case. The Wind River Shoshoni take their native beliefs very seriously and, whether or not they are actually aware of the meanings of the figures, they do resent outsiders, especially whites, probing into their rituals and religious life.

Rock art has not been a highly regarded part of archaeological research and study because of the problem of relating the figures on the walls to the levels in the ground. The problem was expressed very well by Mulloy (1958:119) nearly four decades ago in response to his analysis of the painted figures at Pictograph Cave along the Yellowstone River in Montana.

Peoples who have inhabited this area have known the concept of incipient pictographic writing so some of these pictures may be true pictographs. Their pictographic significance must remain obscure, however, for such symbolism is a highly individualized matter, capable of decipherment only by the original artist and his community. Some of the pictures suggest merely aimless scribbling.

Though archaeologically we cannot cope with their meanings, petroglyphs still can offer cultural information for they illustrate objects of material culture and present stylized motifs which suggest cultural relationships.

In retrospect, it is perhaps of some value to look at the status of faunal analysis at about the same time (1958). The concept of taphonomy in archaeology was not yet used, and most faunal evidence was given little interpretive value. The mechanics of bone fracture and carnivore versus human and natural damage was not recognized. The concept of animal behavior and how this determined animal procurement and in turn affected human group size and social interaction was not yet part of archaeological analysis and interpretation. Seasonality determinations through the analysis of faunal remains had not yet been attempted. Bone beds were not analyzed because the methodology of analysis had not yet been developed.

The lack of progress at that time in the use of lithic technology as an aid in analysis of prehistoric cultural activities, rather than for the replication of tools and weaponry, can also be documented. Rock art studies are very likely at about the same stage of development and acceptance as faunal and lithic technology studies were nearly two decades ago. The methodologies did not just appear out of the blue; it required the thinking and trials and errors of many innovative researchers to achieve their present stage of development.

The visibility of rock art has encouraged the participation of observers from every walk of life. Unfortunately for some, there is always the temptation to add a line or otherwise artificially alter some feature that will further support the preconceived ideas of the observer. Consequently, the data base is continually and sometimes unwittingly and unintentionally being altered. Chalking figures for clarity, once a widespread technique, is now known to be bad because of the chemical reaction of chalk with chemicals in the rock. However, the greatest danger lies in interpretations based on our own western European cultural values rather than those of the original artists. Too many persons look upon rock art as another Register Cliff or Independence Rock where travelers on the Oregon Trail left their signatures as they passed through. Others, in the tradition of the person who looked at the pictures of Spanish soldiers, developed their own interpretations that became crystallized as the only possible interpretation.

It may be that the most valuable and useful work done in rock art up to the relatively recent past is faithful recording of data so that future researchers will have a reliable data base, not one altered by chalking, rearrangements of lines, and substitution or addition of elements for supposed clarity. There have been a few outstanding efforts to do more: the analysis of Medicine Creek Cave in northeast Wyoming (Buckles 1964) is one example, and a number of highly dedicated avocational archaeologists have aided in recording, protecting, and preserving rock art for future study (see Conner and Conner 1971).

An encouraging development, however, is the utilization of new interpretive frameworks. The idea that rock art may be pictorial representations of shamans' activities that can be corroborated by ethnological observations adds a new dimension. The application of archaeological techniques to careful stratigraphic work and to locate and document artifacts in the ground that can be directly related to the pictures on the walls above has great potential to expand data bases. The use of the principles involved in art history in which one figure is presented as the progenitor of a later figure is an innovative approach that needs to be better studied and critiqued (see Hendry 1983). The trend toward developing these kinds of methodologies is a positive sign that the old caveat that the limits of interpretation of rock art have been reached is false and no more the truth in rock art research than it was in faunal analysis or lithic technology over two decades ago.

Perhaps the most encouraging development in rock art research is the potential to actually date the petroglyphs through radiocarbon analysis. As in the case of archaeological investigations, the first concern is to be able to place the petroglyphs in their proper chronological order. Although the dating methods are still in the beginning stages, the potential is there for them to become more reliable. The same criticism was leveled at radiocarbon dating of archaeological deposits nearly four decades ago, but continual refining of techniques has had positive results. I fully expect the same to develop in the dating of rock art.

Consequently, rock art research appears to be ready to become a more and more important segment of archaeological study. The publication of this symposium is an indication of significant progress in this direction. We are closer to being able both archaeologically and ethnologically to deal with the true meanings of the many various forms of rock art, based on an acceptable methodology rather than opinions derived from pure speculation and our own cultural conditioning.

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New Light on Old Art

Rock art is the most visible aspect of the prehistoric hunter-gatherer archaeological record. Covering cave walls, cliff sides and boulder faces with painted and engraved designs, it challenges the archaeologist to address the symbolic, aesthetic, and religious sides of the past. Though traditionally marginalized in mainstream archaeology, recent advances in chronometric dating and interpretive techniques, along with the development of cognitive archaeology, have brought rock art studies to the substantive and methodological forefront of the discipline.

The contributors to this volume discuss a series of these technical, methodological and substantive issues in the analysis of hunter-gatherer rock art. Principally emphasizing North America, the contributions provide summaries of advances in the dating of pictographs and petroglyphs, and interpretations of the art using ethnohistorical, iconographic, stratigraphic, and comparative data, with approaches informed by symbolic, semiotic, and gender studies.

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