The Role of Rock Art in Spatial Orientation on the Northern Colorado Plateau: Some Observations and Speculation

by

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Abstract

Accounting for the placement of prehistoric rock art on the landscape has intrigued researchers of the American Southwest for decades. Rock art observed on detached boulders in the arid canyon country of the Colorado River drainage of southeastern Utah may have helped aboriginal groups orient themselves geographically. The mobility demands of this environment required geographic knowledge of extensive areas. Boulders enhanced with petroglyphs served as reference stimuli for storing information about spatial locations and wayfinding.

Figure 1. Aerial view, Salt Creek Archeological District, Canyonlands National Park, Utah.

Figure 2. Colorado River drainage, Southeastern Utah, showing National Park Service units.

Figure 3. Petroglyphs on Boulder (42SA365), Glen Canyon National Recreation Area, Utah.

Figure 4. Petroglyphs on Boulder (42SA6364), Gypsum Canyon, Glen Canyon National Recreation Area.

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Introduction

Much of the recent investigation of rock art in the American Southwest is oriented toward an understanding of the role of images in the ideology and symbolic systems of those who produced these petroglyphs and pictographs (e.g., Olsen 1985, 1989; Young 1988; Schaafsma 1989; Cole 1989). Accounting for the placement of prehistoric rock art on the landscape, however, is a problem that has intrigued researchers for decades. Attempts to address questions of why petroglyphs and pictographs are found in the places we observe them today has produced speculative interpretations as well as formal analyses (e.g., Snyder 1966; Weaver and Rosenberg 1978; Ferg 1979; Wallace 1983; Ives 1986; Hamann and Hedges 1986; Martynec 1986), both of which are necessary to build postulates in theory construction (cf. Lewis 1989).

I have argued previously (Hartley 1989, 1991, 1992) that the aboriginal marking of places in the arid landscape of the Colorado River drainage of southeastern Utah was conditioned by population density, the social environment, and the resource structure of this environment. These investigations demonstrated that the information content of rock art assemblages differed according to their situation on the landscape[1]. I argued simply that the information content of rock art at rockshelters, the bases of cliffs (cliff

faces), and on detached boulders varied with the activities that went on there and the kinds of functions these places served in the social and economic systems of groups using this environment. For example, I attempted to explain an empirically observed association between the content of rock art and the above ground storage stuctures and semi-subterranean storage cists in rockshelters (Hartley 1991). It was suggested that petroglyphs and pictographs served individuals and social groups as a prelude and directive to behavior at places where storage facilities are actively tended. In this paper I explain the utility of placing rock art on detached boulders that are not associated with or in proximity to rockshelters, alcoves, or cliff faces, or other situations where rock art is usually found . I argue that a primary function of depiction at these places was communicative and for spatial orientation.

Several assumptions grounding this discussion should be made explicit here. First, the ability to use symbols and icons and to make judgements based on analogical reasoning evolved because they serve some adaptive function in social living. Secondly, rock art functioned as one means of conveying information among individuals and/or groups that enhanced their ability to manipulate social situations and acquire resources in the environment of southeastern Utah.

The Sociophysical Environment of Southeastern Utah

The Colorado River drainage in southeastern Utah lies within

the Canyonlands physiographic subdivision of the northern Colorado Plateau (Hunt 1974; Stokes 1977). This drainage is characterized by deep meandering canyons carved mostly in sandstone in the upper Paleozoic and lower Mesozoic formations (Figure 1). Nearly flat-lying sandstone formations that form bare, knobby, rock surfaces deeply dissected by narrow, rock-walled gulches and small canyons characterize the interior of this subdivision. Surficial deposits of sand cover the rock in many places, and both stablized and active dunes cover extensive uplands areas. The prehistoric sites examined in this paper are located within the National Park Service units of Canyonlands, Arches and Capitol Reef National Parks, Glen Canyon National Recreation Area, and Natural Bridges National Monument, all more or less contiguous along the Colorado River drainage in southeastern Utah (Figure 2). Almost 1.9 million acres are included in these parks. Less than 2% of this land area has been adequately inventoried for archeological sites, however. The discussion presented here is, therefore, preliminary in its interpretation, and aimed at generating hypotheses suitable for testing with additional data.

Aboriginal occupation and use of this landscape over the last 12,000 years is described conventionally in terms of general chronological sequences referred to as Paleoindian (ca. 12,000 - 6,000 B.C.), Archaic (ca. 6,000 B.C. - A.D. 500), and Formative (i.e., Anasazi and Fremont) (ca. A.D. 500 - A.D. 1300). Protohistorically, Shoshonean (Ute and Paiute) groups began to make use of this area.

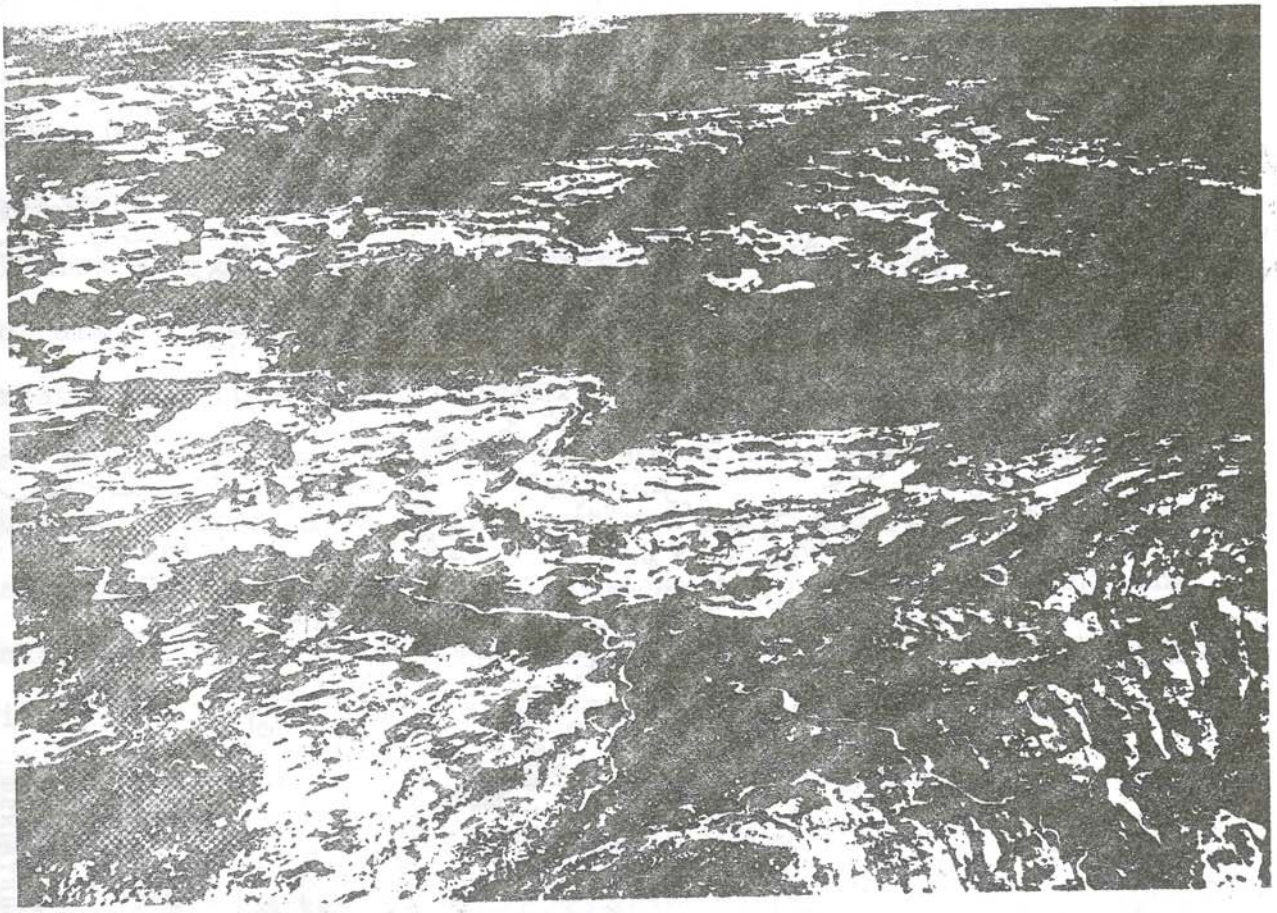
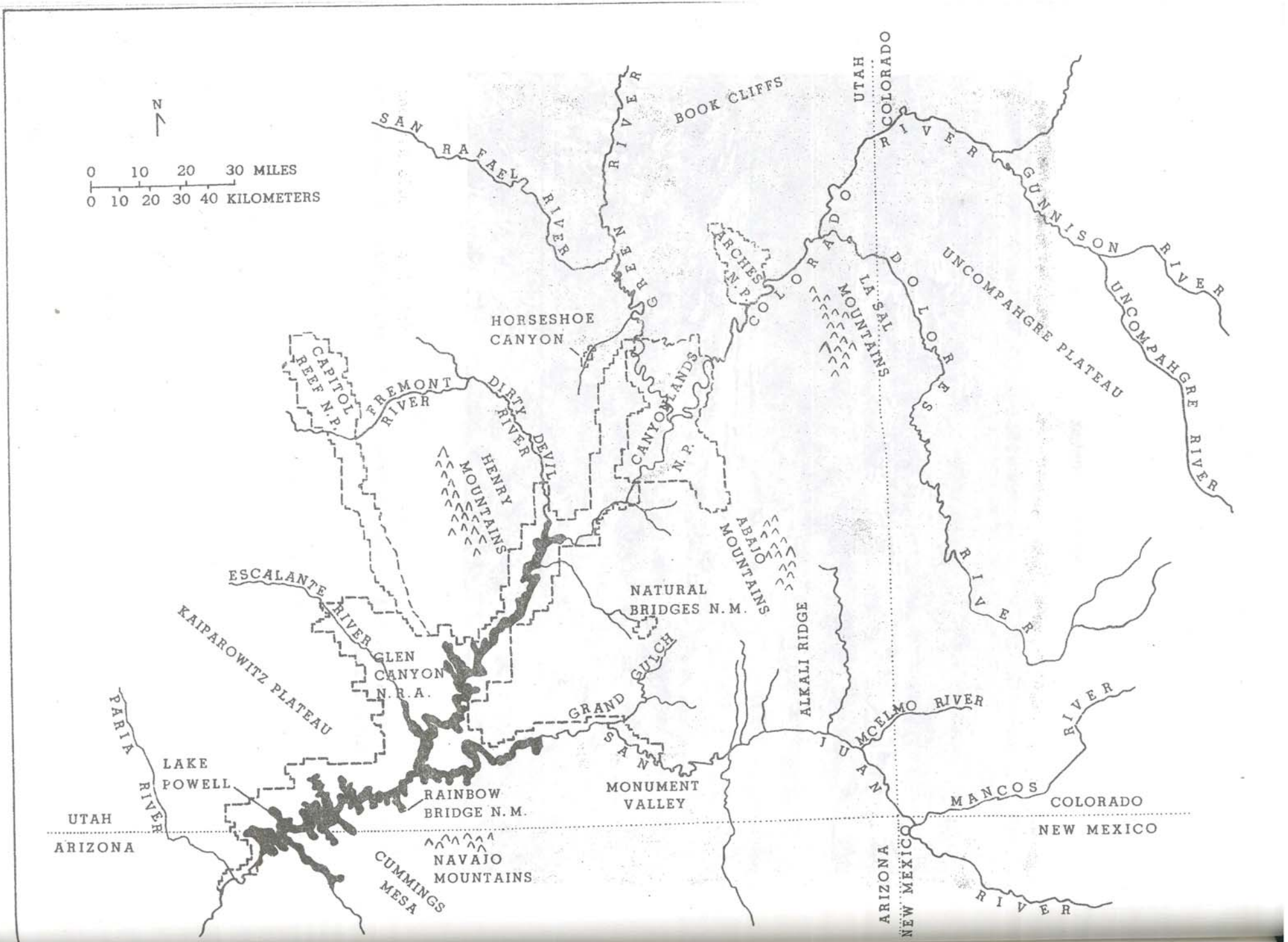


Figure 1. Aerial view, Salt Creek Archeological District, Canyonlands National Park, Utah.


N
0 10 20 30 MILES
0 10 20 30 40 KILOMETERS
SAN RAFAEL RIVER
BOOK CLIFFS
GREEN RIVER
UTAH
COLORADO
COLORADO RIVER
GUNNISON RIVER
UNCOMPAHGRE RIVER
UNCOMPAHGRE PLATEAU
ARCHES N.P.
LA SAL MOUNTAINS
DOLORES RIVER
HORSESHOE CANYON
CAPITOL REEF N.P.
FREMONT RIVER
DIRTY DEVIL RIVER
HENRY MOUNTAINS
CANYONLANDS N.P.
ABAJO MOUNTAINS
NATURAL BRIDGES N.M.
ESCALANTE RIVER
KAIPAROWITZ PLATEAU
GLEN CANYON N.R.A.
GRAND GULCH
ALKALI RIDGE
SAN JUAN RIVER
MCELMO RIVER
MANCOS RIVER
PARIA RIVER
LAKE POWELL
RAINBOW BRIDGE N.M.
MONUMENT VALLEY
UTAH
ARIZONA
COLORADO
NEW MEXICO
NAVAJO MOUNTAINS
CUMMINGS MESA
ARIZONA
NEW MEXICO

Occupation and use of the Colorado River drainage in southeastern Utah during the prehistoric period was dependent on aboriginal knowledge of the resource structure and the social environment in concert with the ability to be opportunistic and mobile. Groups using this environment during the pre-Formative period (i.e., pre-500 A.D.) are believed to have fluctuated from a warm season, residentially mobile adaptation to a more sedentary logistically mobile adaptation during the cold-season. These groups also are believed to have had extensive (ca. 10,000 km^2), overlapping ranges (Hartley 1992:43-46). During the movement of these small, highly mobile groups about the landscape, rock art served as a source of raw "information" about the presence of past human activities. In association with material remains and the locale, the rock art was assigned some "meaning" relative to the social environment and the activities that took place there. Several researchers have attributed the creation of diverse representative and abstract morphological shapes of petroglyphs and pictographs to those using this area during the pre-Formative period (e.g., Turner 1963; Schaafsma 1971,1980; Cole 1990).

Human population density likely fluctuated in response to local environmental conditions but intermittently increased through time until early in the thirteenth century (Lipe 1970; Dean et al. 1985; Plog 1986; Euler 1988; Matson, Lipe, and Haase 1988:255-259). As the resource base and population density fluctuated, the resulting imbalance required relatively rapid adaptive responses. Environmental conditions affected the temporal and spatial

distribution of primary biomass such that range size decreased, residential mobility decreased, and horticulture became more important.

Environmental Knowledge as a Solution to Spatial Problems

All organisms acquire information through their various senses. The visual acuity of humans is that sense which is most relied upon in the acquisition of information in the natural environment. This visual mode of attention provides information that could be provided by smell, touch, taste, and sound as well. However, the visual mode is the one humans tend to trust (Spoehr and Lehmkuhle 1982; Kaplan and Kaplan 1982).

A channel of information, referred to by Margalef (1968:98) as "ethological" or "cultural," allows rock art to be of communicative use by humans[2]. Like all organisms, people acquire information through physical elements in the environment and subsequently filter, process, and interpret this information. Meaning is assigned to this information for the purpose of constructing knowledge that can be utilized in making decisions while operating in a given environment. The mobility of small subsistence-level groups in arid and semi-arid environments, for example, is often conditioned by the information acquired by observation of the regional environment, especially when food resources are mobile and/or seasonally available (e.g., Gould 1969; Lee 1976; Harpending and Davis 1977; Silberbauer 1981). As I've argued elsewhere (Hartley 1992), rock art has the potential to

provide, to aboriginal observers encountering it, valuable information about previous activities at a place, the identity of past visitors to that place, and the potential for resource procurement.

The dynamic process of "cognitive mapping," as studied in animal psychology and geography, is central to research on human spatial orientation. In reference to maps in human wayfinding Downs and Liben (1987:202) emphasize that " maps are the primary mechanism in humans for storing information about spatial locations, for determining one's location at a particular time, for planning routes, for monitoring the process of wayfinding, and for realizing the successful attainment of one's goal." The acquisition of environmental knowledge through exploration and the solution of spatial problems are the two fundamental functions of the cognitive mapping process (Thinus-Blanc 1987:15).

A body of knowledge about large scale environments is acquired by integrating observations gathered over time. This cognitive spatial description or "map" is consequently used in route finding and to determine the relative positions of places (Kuipers 1982:203). The cognitive representation of places, assigned some significance, accummulate to build networks of places, but do not necessarily provide additional information concerning the intervening terrain (see Kuipers 1983). Ultimately, however, repetitive experience in that environment results in highly familiar terrain and new landmarks are identified between old ones, yielding a cognitive spatial description of increasing density.

Kaplan and Kaplan (1982:45) point out that cognitive maps of highly familiar terrain are often packed with salient information. The accumulation of a chain of sacred places representing the track of an ancestoral being of the Western Desert (Australia) Aborigines can be argued to function in this manner (e.g. Berndt 1972; Lewis 1976). Gould (1990:153) discusses places with rock art that serve as "check-points during movements across the desert terrain," assisting in orientation to locales of water or other necessary resources. Components of places that are not "natural" most often serve as the clearest landmarks in the natural environment. Distinctive features near places on the landscape where navigation choices need to be made tend to be selected as landmarks (Kaplan 1976; Allen 1987:277-279).

The differentiation of places in an environment can form landmarks useful in utilizing the resource structure of a given area most efficiently. Localized markers in the environment are usually distinctive stimulus sources which can be used as reference points. To many animals visual markers are very important in terrestrial navigation. Ethologically, a "trail" is considered as a series of markers strung together in a row that often conveys specific information about its maker (Schone 1984:31-32,158). Human knowledge of routes and places appears to function in one of two ways: the ability to navigate from place to place is built on a foundation of knowledge of where things are; or, knowledge of where things are is built on a foundation of knowledge of how to navigate from one place to another (Kuipers 1982:207).

The marking of places by humans with signs, symbols, or icons is an ability taken for granted in our modern sociocultural systems. The functions of this marking include spatial orientiation, social identifiers, informational directives, boundary delimitations, etc. The modification of places in the natural environment can also help create a "setting" in which specific individuals share recurring patterns of activity and experience (Wicker 1979; Stokals and Shumaker 1981). Modifications like rock art help enhance the assigned functional meaning of a place in the sociocultural system. For example, rockshelters used for the slaughter and consumption of meat by Masai men are accentuated with pictographs representing cattle brands and clan identity (Gramly 1975). These places are enhanced with rock art to ensure their use is associated with specific patterns of activity within the social system.

In reference to Australian Aborigine concepts of "place" Rapoport (1977:49) emphasizes that "the making of places is the ordering of the world, the clarification of the difference between places some of which are more significant that others." Environmental psychologists argue that places acquire "social imageability," that is, the capacity to evoke vivid and collectively held social meaning among users of a place when regularly and/or predictably associated with particular patterns of individual or collective behavior (Stokals and Shumaker 1981:446). Interpretative, as well as documentary, cross-cultural reference is often made toward the role of rock art in socially

imageable places (e.g., Lewis-Williams 1982; Deacon 1988; Conway and Conway 1989; Gould 1990). Sociocultural "meaning" of the rock art is difficult to ascertain, however. Furthermore, assignments of "meaning" to petroglyphs and pictographs is vulnerable to variability and change among prehistoric and contemporary peoples alike. Is it possible, then, to further our understanding of the role of rock art placed in particular topographical situations without assigning a prehistoric sociocultural meaning to the images?

Marking Places with Rock Art

The utility of using petroglyphs and pictographs as landmarks for terrestrial navigation in arid and semi-arid environments is recognized in the ethnographic and ethnohistoric record of Australia and the American Southwest. Although the depth and detail of this record in the Southwest is far less rich than that of the Australian Aborigines, several studies refer to rock art functioning in this manner (e.g., Hayden 1972; Britt 1973; Weaver and Rosenberg 1978; Geib and Bungart 1988:42-47). Informant references to this use of rock art are exemplified for the Hopi by Turner (1963:71) and the Zuni by Young (1988:54-57).

As emphasized earlier, the extensive range utilized by early aboriginal groups in southeast Utah probably required the institution of reference stimuli that enhanced the natural topographic variation as a means to help orient movement. One of the most well documented examples of rock art used as a landmark

is that of the Willowsprings site (Na994) in northern Arizona (Colton and Colton 1931; Titiev 1937; Simmons 1963:235-236; Michaelis 1981). After the fall harvest a small group of Hopi would undertake a highly ritualized pilgrimage to procure salt from a source near the confluence of the Colorado and Little Colorado rivers near the Grand Canyon. Along the route were places established as "shrines" at which specific proceedings were to take place in honor of totemic ancestors. At a place known as Tutuveni each man of the group was to carve a petroglyph of his clan symbol, make a deposit of cornmeal and prayer feathers, and simulate the act of copulation with the rock. Michaelis (1981) documents the site as having over 2,000 petroglyphs on forty boulders at the base of a north-south running cliff.

In the previous examination of 388 sites with petroglyphs and pictographs in National Park Service units along the Colorado River described above, 45 (11.5%) rock art sites were situated on detached boulders (Figures 3 and 4). The rock art assemblage at these sites yielded an average measure of information (.522 Rel.H_n) that is significantly greater than that of rock art situated in rockshelters (.363 Rel.H_n) and on cliff faces (.372 Rel.H_n). It was suggested in that study that these detached boulders accumulated a broad range of rock art images through time while functioning as landmarks for orientation during movement about the landscape. This functional interpretation does not, of course, negate any evidence or interpretation of these sites as being used for ritual activities or as "shrines". Nor does it suggest that other sites

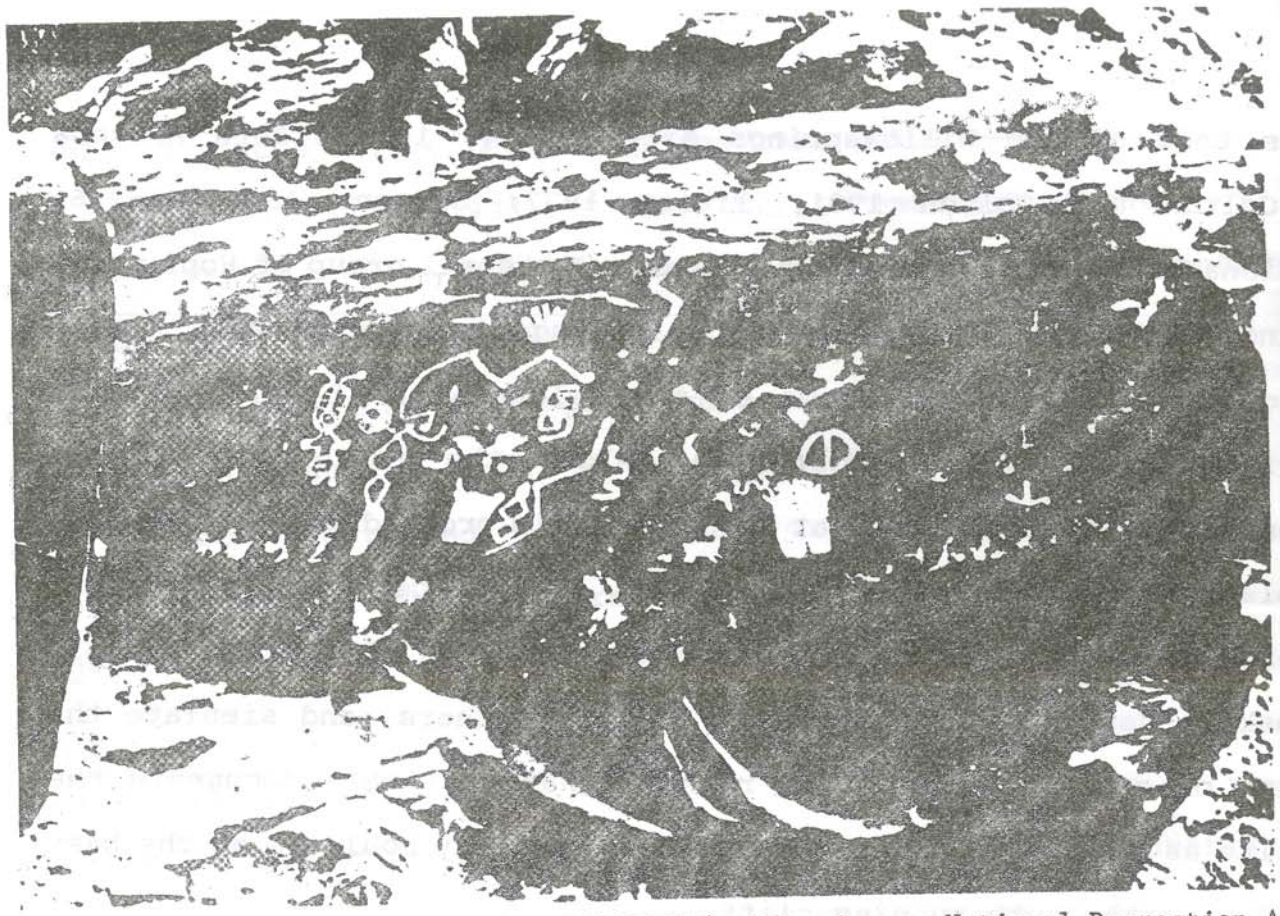
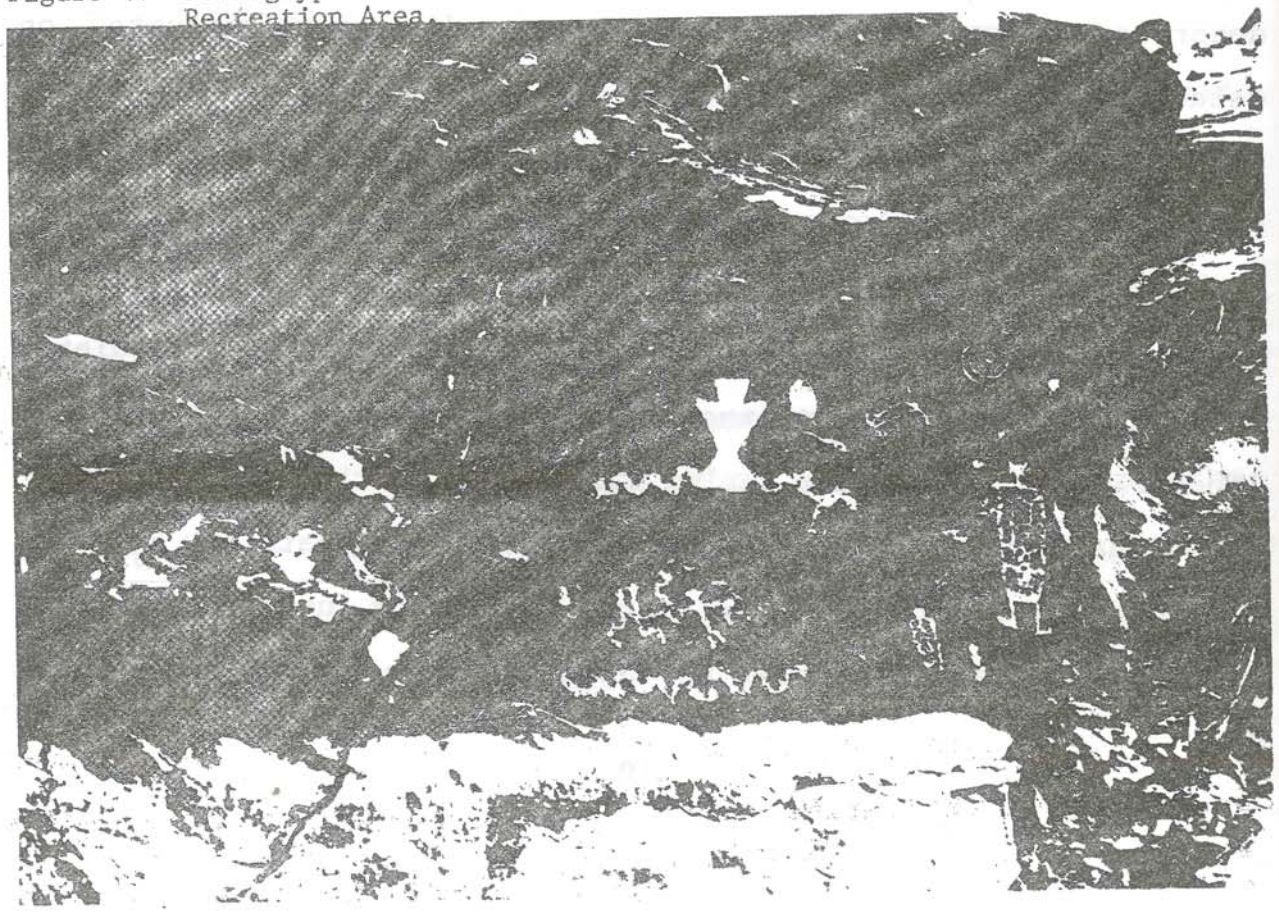


Figure 3. Petroglyphs on Boulder (42SA365), Glen Canyon National Recreation Area, Utah.

Figure 4. Petroglyphs on Boulder (42SA6364), Gypsum Canyon, Glen Canyon National Recreation Area.



with petroglyphs or pictographs did not assist in spatial orientation.

For the purpose of exploring the situational context and the content of rock art on these boulders in more detail, the location of 44 sites was examined with reference to their position on the landscape. One of the original boulder sites is considered to have been a boundary marker (see Hartley 1992:110-111) and therefore has been eliminated from this study. Three topographical situations were found to exist among the remaining 44 sites: (1) the detached boulders were situated on prominent, highly visible places on the landscape (32 sites); (2) the rocks were along, or in close proximity to, trails known to have been used historically or documented ethnographically (e.g., Navajo) (17 sites); and (3) the rocks were situated at the confluence of creeks, rivers, or unnamed drainages (6 sites). In some cases boulders were observed to be situated at high prominent places above a trail (8 sites) or positioned so as to be highly visible from a distance at the confluence of major drainages (3 sites). Rock art associated with routes or trails is assumed to be underrepresented here. Routes of travel along ridges or terraces in canyons probably accounts for more of those sites where rock art is situated on prominent boulders. Rock art that is large or otherwise highly visible on the faces of cliffs probably also served to help orient travelers as well.

Petroglyphs and pictographs from these boulder sites were categorized into fourteen classificatory units described in Table

1. The classification scheme used here was made with reference to that of previous rock art research in the area (Turner 1963; Schaafsma 1971, 1980; Olsen 1983, 1985); however, I have categorized those images not representational of anthropomorphs or zoomorphs in a more parsimonious manner.

The frequency of sites with specific petroglyph images associated with all three topographical situations suggests that some kinds of images were more commonly produced at these boulders than others (see Table 2). For example, anthropomorphic images are found at over 82% of those sites associated with existing trails and at over 72% of those boulders in prominently visible places that we might speculate were in proximity to routes of travel. Anthropomorphic images were also found at two-thirds of those boulders located at the confluence of creeks and rivers. Depictions of mammals are also well represented in all three of these contexts. Anthropomorphic and zoomorphic representations are common to all rock art panels of this area, however, regardless of site topographic situation. Nevertheless, if the detached boulders examined here accumulated petroglyphs through time, similar to the activities at the Willowsprings site described above, then the high frequency of anthropomorphic and mammalian representations might suggest significance of the place to individuals, or more likely, to small sub-groups of populations (cf. Heizer and Baumhoff 1959; Olsen 1985). Furthermore, the encountering of these boulders by those having little or no knowledge of the sociocultural significance of the images provided "raw" information that could

Table 1. Rock Art Element Classification.

Element	Description
anthropomorphic	where the human figure is represented in its entirety.
fragmentary anthropomorphic	where only a portion of a human figure is depicted, e.g., torso, headless figure.
human hand	where the figure depicts the human hand, positive or negative image.
human feet	where the figure depicts the human foot, positive or negative image.
human head	where the figure depicts the head of a human.
mammalian figure	where the figure seemingly represents a mammal.
mammalian "tracks"	where the foot (or feet) of a mammal is represented.
bird figure	where the figure seemingly represents a bird.
bird "tracks"	where the foot (or feet) of a bird is represented.
reptilian figure	where the depiction suggests a reptile, e.g., snake, lizard.
rectilinear	non-representational figures characterized by straight lines; formed or bounded by straight lines.
curvilinear	non-representational figures consisting of or bounded by curved lines.
concentric	figures having a common center or common axis, e.g., circles, spirals.
abstract geometric	motifs or outlines that are characterized by both straight and curved lines but that bear no resemblance to natural forms.

Table 2. Frequency of sites and glyphs at three geographical situations.

	Prominent Position	Trails	Confluence of drainages
Anthro.	23(101)*	14(64)	4(10)
Frag. anthro.	12(18)	9(13)	2(4)
Hand	0(0)	1(2)	2(5)
Feet	2(15)	1(13)	1(2)
Hand	2(9)	0(0)	1(1)
Mammal	10(41)	11(27)	6(57)
Mammal track	4(16)	5(26)	0(0)
Bird	3(5)	5(11)	1(1)
Bird track	2(9)	1(2)	3(7)
Reptile	4(11)	5(7)	2(5)
Rectilinear	14(46)	11(38)	5(22)
Curvilinear	14(38)	10(27)	5(15)
Concentric	10(21)	6(21)	3(6)
Abstract geometric	22(63)	13(60)	6(32)
$\bar{x}$ Rel. Hn	.4885	.6221	.5203

*Total number of glyphs of this category.

be assigned some association with the place and with similar images observed at other places. Similarity in images observed at various sites could have helped "outsiders" form a "map" of the spatial activities of the producers of the rock art (cf. Blundell 1974, 1982; Conkey 1984).

Another general category of rock art images well represented on these boulders is the non-representational element, especially those classified as "abstract geometric[3]." Interpretations of some intricate rock art as "maps" of the landscape are very appealing (e.g., Steward 1963:58; Gortner 1988, 1989) and in some cases convincing (e.g., Smith 1981, 1985, 1987). The use of aboriginal artistic ability to communicate spatial knowledge is well documented (e.g., Blackmore 1981), and the human ability to conceive of space with reference to a cartographic map, as opposed to experience only, is known to greatly increase the potential for locating landmarks (e.g., Lloyd 1989). One must be careful, however, lest one be tempted "to assign meaning to every squiggle" (Gould 1990:238). But suppose that some of the non-representational petroglyph designs examined here are "maps" reflecting routes, features, or places on the landscape, then it is stimulating to speculate why this kind of information is placed in the situations we observe them.

A sketch-map-like representation does not, by itself serve as a representation for a cognitive map. Spatial relationships between certain places are stored in a manner that tolerates ignorance of the relationships between other places. Locations are stored in

multiple frames of reference, allowing for a place to be represented in more than one "map," facilitating the solving of spatial problems. Grouping places into regions enables one to "search" for places within large areas (Kuipers 1983). As noted earlier, route-finding is simplified by representing the environment as a network of places.

Suppose that the placement of map-like petroglyph images on the landscape served as mnemonic keys to relatively small areas in the total range of a group that required "connection" by those group members having experienced repeatedly the routes connecting landmarks and important resource locations (see Baird and Wagner 1983). Rock art produced to enhance a landmark and, more importantly, to serve to mnemonically orient the relationship between places would then allow for large ranges to be divided up into regions for which more detailed "layers" of the cognitive map could be stored. Cueing memory with places, especially those accentuated with rock art, would serve to reduce the risk of decision-making in arid environments like that of southeastern Utah.

The information measure of these sites also requires further discussion, insomuch as each of the three assigned topographical situations varies with respect to this measure (see Table 2). Those sites positioned along known trails exhibit the highest mean measure of information (.6221), while rock art observed on boulders prominently situated (.4885) and associated with the confluence of drainages (.5203) is much lower. I would argue that the rock art

on these boulders along trails reflects an accretion of elements carved during activities at these sites over long periods of time. Again, an analogy with those activities reported at the Willowsprings site is tempting. We must be cautious, however, in extrapolating these sociocultural meanings to fit the seventeen "trail" sites examined here. In seeking explanations for differences and similarities of behavioral phenomena we observe in the archeological record, like that of the rock art on detached boulders, etic descriptions increase in importance with the time span of activities we are confronted with (Harris 1990). The high information measure of these "trail" sites may well be a reflection of the kinds of activities that went on there. However, we can only make observations that can later be compared with others, and as in this case, we use ethnographic analogy to present an argument for a kind of mechanism of behavior that we cannot capture directly in the ambiguous archeological record.

Discussion

Knowledge of the physical geography of the region encompassing the Colorado River drainage was required to successfully access those resources available. Ethnohistoric documents demonstrate that the range used by aboriginal groups in the early historic period of the desert west was extensive, at least as regards that total area used throughout the lifetime of the individuals. Memorization of localities was probably essential for navigation, and various kinds of mnemonic cues were likely necessary to maintain a body of

geographic information that encompassed thousands of square miles (e.g., Strehlow 1971; Lewis 1976; Minc 1986; Gould 1990). I have argued here that rock art on detached boulders functioned as one medium of information available for coping with the mobility demands of this physical environment.

The various morphological shapes of petroglyphs are laden with past sociocultural meaning that we can only enjoy speculating about. But the frequency of these different kinds of images observed on boulders leads us to recognize their significance in these cultural systems. Gould (1990:227) has suggested recently that the repetition of elements should be considered an "essential attribute of artistic behavior in societies that live under conditions of extreme unpredictability with respect to key resources." He considers such repetition an "archaeological signature of a cultural system's adaptation to conditions imposed by stress of this kind." I would argue further that this kind of expressive behavior helped reduce the number of wrong decisions about biogeographical factors as well as about inter-group interactions in southeastern Utah. As I've argued elsewhere (Hartley 1989, 1992) it was probably a challenge to these groups to acquire, update, and transmit enough information about the resource base to make the search and procurement of these items least expensive in terms of time and energy.

Transmission of information obviously implies "communication." The communicative behavior embedded in rock art is, I believe, susceptible to the same explanations as any other medium of human

communication. Some modern evolutionary theorists view any kind of "signalling" as fundamentally an extension of an organism's attempts to manipulate the sociophysical environment (Dawkins and Krebs 1978; cf. Kaplan 1987). It functions, as Ley and Cybriwsky (1974) view inner city gang graffiti, as a means by which to influence the direction of behavior of others in a competitive environment.

The use of toas, usually consisting of a wooden stick painted, carved, and sometimes decorated with clay, in Central Australia is an example of this kind of potential behavior in group interaction as described by Stirling and Waite (1919) and Morphy (1977). The "message" encoded in the morphology of the toa is intended to direct the behavior of those encountering it. Attributes of the toa can lead to the identification of those who produced it, the locality or direction in which the group is moving, and/or the purpose of the move.

Unlike toas, petroglyphs carved on boulders are not portable and cannot easily be obliterated. However, the information content of the assemblage of rock art can, I believe, be changed with an accretion of images. The relatively high information content of the rock art assemblage on boulders, as measured here, is probably indicative of a non-competitive social environment. That is, there likely did not exist any advantage in producing rock art that would "communicate" information intended to deceive those encountering a boulder. The environment in which the enhancement of a boulder with rock art did not promote the threat of competition among

groups known to be using the area, probably changed dramatically by the eleventh century in many areas. As the population density increased and the range size decreased in this region it's easy to envision the rock art on these boulders serving to "legitimize" magico-religious sites (cf. Memmott 1983; Young 1985:33; Deacon 1988). Behavioral responses to the rock art became context dependent. That is, rituals associated with a place communicated a message to participants and observers that promoted cooperative behavior in a social environment characterized by inter-group competition.

This paper is, admittedly, speculative in its melding of environmental psychology, ethnographic analogy, and the archeological record. But whether one finds support for my approach to the role of rock art on boulders in this environment is probably not as important as the need to assess the validity of the assumptions upon which it is built. Not all behavior need necessarily be viewed as adaptive; yet if we acknowledge the communicative dimension of rock art, then is it not, like mediums of "socializing," of fitness relevance? Some prominent researchers of this behavior might argue otherwise (e.g., Conkey 1984; Halverson 1987; Schaafsma 1989). Nevertheless, rock art will continue to be viewed as a medium of "signalling" that communicates various kinds of information. "Messages" assumed to be encoded in an assemblage of rock art will likely also continue to solicit speculation. Fortunately, the means by which prehistoric groups in southeastern Utah used this landscape is subject to understanding

and will, as a result, be the subject of investigations indefinetly. The enigma that rock art has posed in this area can be ameliorated by incorporating empirical observations into analyses of the conditions that fostered land-use practices. The assemblage content of the rock art and its geographical variability are two variables to which we have access and that can, I believe, contribute to our quest for understanding the reasons for the activities that we witness in the archeological record.

Notes

[1] Rock art on the detached boulders examined for this study was assigned a quantitative index using the Shannon formula (Shannon and Weaver 1949) to calculate the initial measure of information for each rock art assemblage:

$$H_n = \sum_{i}^{n} p_i \log_2 (1/p_i)$$

This measure, H_n, lies on a scale that ranges from 0 to $\log_n$. Zero, the minimum value, occurs where only one kind of the glyph element is observed. Maximum dispersion of a set of proportions occurs when each of the twenty-eight glyph element categories contain the same number of figures (Thomas 1981). This degree of dispersion can be standardized on a scale of 0 to 1 by further calculation:

$$\text{Rel.}H_n = \frac{\sum_{i}^{n} p_i \log_2 (1/p_i)}{\log_2 n}$$

These standardized or relative measures of information (Rel.H_n) no longer express the magnitude of diversity or variety, but may be interpreted as an index of uniformity (Krippendorf 1986).

One of the most useful advantages of Rel.H_n over other indices of dispersion is that its value is invariant with the value of n, permitting comparison between rock art assemblages that differ widely in the number of glyph elements present.

[2] The communication potential of rock art is, at a fundamental

level, very simplistic. Human encounters with petroglyphs and pictographs permit the reception of information that can be assigned meaning. A "message" is not necessarily encoded by the producer(s) of the rock art. However, the assignment of meaning to the raw information (i.e., rock art) allows for the construction of knowledge that can be shared or manipulated. Material art in almost all forms has the potential to serve as a medium of communication about conditions in the social and physical environment (see Berlyne 1971; Smith 1977; Halliday 1983; Slater 1983).

[3] It is recognized that this class of images is a result of my inability to assign this rock art to something (i.e., some representation) that is reflective of my sociocultural experience or knowledge and that some of these prehistoric images were possibly depictions of "things" in past cultural systems.

REFERENCES CITED

Allen, G.L.

1987 Cognitive Influences on the Acquisition of Route Knowledge in Children and Adults. In *Cognitive Processes and Spatial Orientation in Animal and Man*, edited by P. Ellen and C. Thinus-Blanc, pp. 271-283. Martinus Nijhoff Pub., Dordrecht

Baird, J.C. and M. Wagner

1983 Modelling the Creation of Cognitive Maps. In *Spatial Orientation: Theory, Research, and Application*, edited by H.L. Pick, Jr. and L.A. Acredolo, pp. 321-344.

Berlyne, D.E.

1971 *Aesthetics and Psychobiology*. Meredith Corp., New York.

Berndt, R.M.

1972 The Walmadjeri and Gugadja. In *Hunters and Gatherers Today*, edited by M.G. Bicchieri, pp. 177-216. Holt, Rhinehart, and Winston, New York.

Blakemore, M.B.

1981 From Way-Finding to Map-Making: The spatial information fields of aboriginal peoples. *Progress in Human Geography* 5:1-24.

Blundell, V. J.

1974 The Wandjina Cave Paintings of Northwest Australia. *Artic Anthropology*, 11(Supplement):213-223.

1982 Symbolic systems and cultural continuity in Northwest Australia: a consideration of aboriginal cave art. *Culture* 2:3-20.

Britt, C. Jr.

1973 An Old Navajo Trail with Associated Petroglyph Trail Markers, Canyon de Chelly, Arizona. *Plateau* 46(1):6-11.

Cole, S. J.

1989 Katsina Iconography in Homol'ovi Rock Art. *The Kiva* 54:313-329.

1990 *Legacy on Stone: Rock Art of the Colorado Plateau and Four Corners Region.* Johnson Books, Boulder.

Colton, M.F. and H.S. Colton

1931 Petroglyphs, the Record of a Great Adventure. *American Anthropologist* 33:32-37.

Conkey, M.W.

1984 To Find Ourselves: Art and Social Geography of Prehistoric Hunter-Gathers. In *Past and Present in Hunter Gatherer Studies*, edited by C. Shirire, pp. 253-276. Academic Press, Orlando.

Conway, T. and J. Conway

1989 An Ethno-Archaeological Study of Algonkian Rock Art in Northern Ontario, Canada. *Ontario Archaeology* 49:34-59.

Dawkins, R. and J.R. Krebs

1978 Animal Signals: Information or Manipulation? In *Behavioural Ecology: An Evolutionary Approach*, edited by J.R. Krebs and N.B. Davies, pp. 282-312. Blackwell Scientific Pubs., Oxford.

Deacon, J.

1988 The Power of Place in Understanding Southern San Rock Engravings. *World Archaeology* 20:129-140.

Dean, J.S., R.C. Euler, G.J. Gumerman, F. Plog, R.H. Hevly, T.N.V. Karlstrom

1985 Human Behavior, Demography, and Paleoenvironment on the Colorado Plateaus. *American Antiquity* 50:537-554.

Downs, R.M. and L.S. Liben

1987 Childrens Understanding of Maps. In *Cognitive Processes and Spatial Orientation in Animal and Man,* edited by P. Ellen and C. Thinus-Blanc, pp. 202-219. Martinus Nijhoff Pub., Dordrecht.

Euler, R.C.

1988 Demography and cultural dynamics on the Colorado Plateau. In *The Anasazi in a Changing Environment*, edited by G.J. Gumerman, pp.192-229. Cambridge University Press, Cambridge.

Ferg, A.

1979 The Petroglyphs of Tumamoc Hill. *The Kiva* 45:95-118.

Geib, P.R. and P. W. Bungart

1988 San Juan Archaeological Survey: Glen Canyon Year 3 Report, 1987-1988. *Northern Arizona*

University Archaeological Report No.1010.

Gould, R. A.

1969 Subsistence Behaviour among the Western Desert Aborigines of Australia. *Oceania* 3:161-185.

1990 *Recovering the Past.* University of New Mexico Press, Albuquerque.

Gortner, W. A.

1988 Evidence for a Prehistoric Petroglyph Trail Map in the Sierra Nevada. *North American Archaeologist* 9:147-154.

1989 Evidence for a Prehistoric Petroglyph Trail Map in the Sierra Nevada II. Two Additional "Glyph Maps". *North American Archaeologist* 10:231-236.

Gramly, R.

1975 Meat-feasting sites and cattle-brands: patterns of rock-shelter utilization in East Africa. *Azania* 10:107-121.

Halliday, T.

1983 Information and Communication. In *Communication*, edited by T.R. Halliday and J.B.

Slater, pp. 43-81. W.H. Freeman and Co., New York.

Halverson, J.

1987 Art for Art's Sake in the Paleolithic. *Current Anthropology* 28:63-71.

Hamann, N.R. and K. Hedges

1986 Topographical Distribution of Hohokam Petroglyph Sites. Rock Art Papers 4:77-86. *San Diego Museum Papers No.* 21.

Harpending, H, and H. Davis

1977 Some Implications for Hunter-Gatherer Ecology Derived from the Spatial Structure of Resources. *World Archaeology* 8:275-286.

Harris, M.

1990 Emics and Etics Revisited. In *Emics and Etics - the Insider/Outsider Debate*, edited by T. N. Headland, K. L. Pike, and M. Harris, pp. 48-61. Sage Publications, Newbury Park.

Hartley, R. J.

1989 Variability in Content and Context of Aboriginal Rock Art on the Northern Colorado

Plateau. Ph.D. dissertation, Department of Geography, University of Nebraska, Lincoln.

1991 Rockshelters and Rock Art: An Assessment of Site Use. *Proceedings of the Anasazi Symposium 1991*. Mesa Verde Museum Association, Mesa Verde National Park, Colorado. (in press)

1992 *Rock Art on the Northern Colorado Plateau*. World Wide Archaeology Series, Avebury, Aldershot.

Hayden, J.D.

1972 Hohokam Petroglyphs of the Sierra Pinacate, Sonora, and the Hohokam Shell Expeditions. *The Kiva* 37:74-83.

Heizer, R. G., and M. A. Baumhoff

1959 Great Basin petroglyphs and prehistoric game trails. *Science* 129:904-905.

Hunt, C. B.

1974 *Natural Regions of the United States and Canada*. W.H.Freeman, San Francisco.

Ives, G.A.

1986 Rock Art of the Dolores River Valley. In *Dolores Archaeological Program: Research Designs and Initial Survey Results*, comp. A.E. Kane et al., pp.235-252. U.S. Department of Interior, Bureau of Reclamation, Denver, Co.

Kaplan, H.

1987 Human Communication and Contemporary Evolutionary Theory. *Research on Language and Social Interaction* 20:79-139.

Kaplan, R.

1976 Way-finding in the Natural Environment. In *Environmental Knowing* edited by G.T. Moore and R.G. Golledge, pp. 46-57. Dowden, Hutchinson, and Ross, Stroudsburg, Pa.

Kaplan, S. and R. Kaplan

1982 *Cognition and Environment.* Praeger Pub., New York.

Krippendorff, K.

1986 *Information Theory - Structural Models for Qualitative Data.* Sage University Paper series on Quantitative applications in the Social Sciences, 07,062. Sage Publications, Beverly Hills.

Kuipers, B.

1982 The "Map in the Head" Metaphor. *Environment and Behavior* 14:202-220.

1983 The Cognitive Map: Could It Have Been Any Other Way? In *Spatial Orientation:Theory, Research, and Application,* edited by H.L. Pick and L.P. Acredolo, pp. 345-359. Plenum Press, New York.

Lee, R.B.

1976 Kung Spatial Organization: An Ecological and Historical Perspective. In *Kalahari Hunter-Gatherers,* edited by R.B. Lee and I. DeVore, pp. 73-97. Harvard University Press, Cambridge.

Lewis, D.

1976 Observation on route finding and spatial orientation among the aboriginal peoples of western desert of Central Australia. *Oceania* 46:249-282.

Lewis, R.W.

1989 Theories, Speculation, and the Structure of Knowledge. *Speculation in Science and Technology* 13:13-17.

Lewis-Williams, J.D.

1982 The Economic and Social Context of Southern San Rock Art. *Current Anthropology* 23:429-449.

Ley, D. and R. Cybriwski

1974 Urban graffiti as territorial markers. Annals of the *Association of American Geographers* 64:491-505.

Lipe, W.D.

1970 Anasazi communities in the Red Rock Plateau, Southeastern Utah. In *Reconstructing Prehistoric Pueblo Societies*, edited by W.A. Longacre, pp. 84-139. University of New Mexico Press, Albuquerque.

Lloyd, R.

1989 Cognitive Maps: Encoding and Decoding Information. *Annals of the Association of American Geographers* 79:101-124.

Matson, R.G., W.D. Lipe, and W.R. Haase

1988 Adaptational continuities and occupational discontinuities: the Cedar Mesa Anasazi. *Journal of Field Archaeology* 15:245-264.

Margalef, R.

1968 *Perspectives in Ecological Theory*. University of Chicago, Chicago.

Martynec, R.

1986 A Comparative Analysis of Rock Art at Trincheras Sites in the Tucson Basin. Rock Art Papers 3:103-116. *San Diego Museum Papers* No. 20.

Memmott, P.

1983 Social Structure and Use of Space amongst the Lardil. In *Aborigines, Land and Land Rights*, edited by N. Peterson and M. Langton, pp.33-65. Australian Institute of Aborignal Studies, Canberra.

Michaelis, H.

1981 Willowsprings: A Hopi Petroglyph Site. *Journal of New World Archaeology* 4(2):3-23.

Minc, L.D.

1986 Scarcity and Survival: The Role of Oral Tradition in Mediating Subsistence Crises. *Journal of Anthropological Archaeology* 5:39-113.

Morphy, H.

1977 Schematisation, Meaning and Communication in Toas. In *Form and Indigenous Art*, edited by P.J. Ucko, pp. 79-89. Gerald Duckworth & Co., Ltd., Canberra.

Morphy, H.

1977 Schematisation, meaning and communication in Toas. In *Form in Indigenous Art*, edited by P.J. Ucko, pp. 77-89. Gerald Duckworth & Co., Ltd., Canberra.

Olsen, N.H.

1983 Mesa Verde Anasazi Rock Art: A visual communication system? *Proceedings of the Anasazi Symposium, 1981.* edited by J. Smith, pp. 91-105. Mesa Verde Museum Association, Mesa Verde National Park, Colorado.

1985 Hovenweep Rock Art: An Anasazi Visual Communication System. *UCLA Institute of Archaeology Occasional Paper No. 14.* Los Angeles.

1989 Social roles of animal iconography: implications for archaeology from Hopi and Zuni ethnographic sources. In *Animals into Art*, edited by H. Morphy, pp.417-439. Unwin Hyman, London.

Plog, S.

1986 Patterns of demographic growth and decline. In *Spatial Organization and Exchange - Archaeological Survey on the Northern Black Mesa*, edited S. Plog, pp. 224-255. Southern Illinois University Press, Carbondale.

Rapoport, A.

1977 Australian Aboriginies and the Definition of Place. In *Shelter, Sign and Symbol*, edited by P. Oliver, pp.38-51. Overlook Press, Woodstock, N.Y.

Schaafsma, P.

1971 The Rock Art of Utah. *Papers of the Peabody Museum of Archaeology and Ethnology* Vol. 65.

1980 *Indian Rock Art of the Southwest*. University of New Mexico Press, Albuquerque.

1989 Supper or Symbol: Roadrunner Tracks in Southwest Art and Ritual. In *Animals into Art*, edited by H. Morphy, pp.253-269.

Schone, H.

1984 *Spatial Orientation: the Spatial Control of Behavior in Animals and Man*. Princeton

University Press, Princeton, N.J.

Shannon, C. E. and W. Weaver

1949 *The Mathematical Theory of Communication.* University of Illinois Press, Urbana.

Silberbauer, G.B.

1981 *Hunter and Habitat in the Central Kalahari Desert.* Cambridge University Press, Cambridge.

Simmons, L. W., (ed.)

1963 *Sun Chief: The Autobiography of a Hopi Indian.* Yale University Press, New Haven.

Slater, P.J.B.

1983 The Study of Communication. In *Communication,* edited by T.R. Halliday and P.J.B. Slater, pp.9-42. W.H. Freeman and Co., New York.

Smith, C.D.

1981 The Emergence of "maps" in European Rock Art: A Prehistoric Preoccupation with Place. *Imago Mundi* 34:9-25.

1985 The Origins of Cartography: An Archaeological Problem: Maps in Prehistoric Rock Art. In

Papers in Italian Archaeology IV, edited by C. Malone and S. Stoddart, pp.205-218. *BAR International Series 244*.

1987 Cartography in the Prehistoric Period in the Old World: Europe, the Middle East, and North Africa. In *The History of Cartography, Vol. 1*, edited by J.B. Harley and D. Woodward, pp.54-101. University of Chicago Press, Chicago.

Smith, W.J.

1977 *The Behavior of Communicating: An Ethological Approach*. Harvard University Press, Cambridge.

Snyder, E.E.

1966 Petroglyphs of the South Mountains of Arizona. *American Antiquity* 31:705-709.

Spoehr, K. T. and S.W. Lehmkuhle

1982 *Visual Information Processing*. W.H.Freeman and Co., San Francisco.

Steward, J.H.

1963 *Handbook of South American Indians: 5 The Comparative Ethnology of South American Indians*. Cooper Square, New York.

Stirling, E.C. and E.R. Waite

1919 Description of Toas: or Australian Aboriginal Direction Signs. *Records of the South Australian Museum I*:105-155.

Stokals, D. and S.A. Shumaker

1981 People in Places: A Transactional View of Settings. In *Cognition, Social Behavior, and the Environment*. edited by J.H. harvey, pp. 441-488. Lawrence Erlbaum Pub., Hillsdale, N.J.

Stokes, W.L.

1977 Subdivisions of the Major Physiographic Provinces in Utah. *Utah Geology* 4:1-17.

Strelow, T.G.H.

1971 Geography and the Totemic Landscape in Central Australia. In *Australian Aboriginal Anthropology*, edited by R.M. Berndt, pp. 92-140. University of Western Australian Press, Nedlands.

Thinus-Blanc, C.

1987 The Cognitive Map Concept and its Consequences. In *Cognitive Processes and Spatial Orientation*

in Animal and Man, edited by P. Ellen and C. Thinus-Blanc, pp. 1-19. Martinus Nijhoff Pub., Dordrecht.

Thomas, R. W.

1981 *Information Statistics in Geography*. Concepts and Techniques in Geography No. 31.

Titiev, M.

1937 A Hopi Salt Expedition. *American Anthropologist* 39:244-258.

Turner, C. G.

1963 *Petroglyphs of the Glen Canyon Region*. Museum of Northern Arizona Bulletin 38.

Wallace, H.

1983 The Mortars, Petroglyphs, and Trincheras on Rillito Peak. *The Kiva* 48 (3):137-246.

Weaver, D.E., Jr. and B.H. Rosenberg

1978 Petroglyphs of the Southern Sierra Estrella: A Location Analysis. In *American Indian Rock Art*, edited by E. Snyder, A.J. Bock, and F. Bock, pp.108-123. Fourth Annual American Rock Art Research Association Symposium.

Wicker, A.W.

1979 *An Introduction to Ecological Psychology.* Wadsworth, Inc., Belmont, Ca.

Young, M. J.

1985 Images of Power and Power of Images - the Significance of Rock Art for Contemporary Zunis. *Journal of American Folklore* 98:7-48.

1988 *Signs from the Ancestors: Zuni Cultural Symbolism and Perceptions of Rock Art.* University of New Mexico, Albuquerque.