

Chemical and Micromorphological Analysis of Rock Art Pigments from the Western Great Basin

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That the prehistoric rock art of North America has been largely ignored by archaeologists is no secret (see Meighan 1981). This neglect is due to the difficulty in placing rock art within chronological frameworks, and because many archaeologists find the nature of rock art data to be far removed from the material culture items usually the subject of archaeological analysis. Koski et al. (1973) have argued that the technique of rock art production, and particularly the chemical composition of pictographs, is an analytical dimension worthy of careful study. They have suggested that analysis along such lines can lead to useful inferences concerning prehistoric interaction networks and temporal and cultural classification, thereby providing a needed avenue for incorporating rock art into larger cultural-historical and explanatory frameworks. We have analyzed pigment samples from three sites in the western Great Basin of eastern California (fig. 1), and mineral soils from a nearby hot spring, to start a data base for this region from which more intensive studies of pictograph technique can be initiated.

The archaeological sites from which pigment samples were obtained are: CA-Ker-735 and CA-Ker-736, both in the Indian Wells Canyon, Kern County, California, and CA-Iny-439, in Wilson Canyon, Inyo County, California. The first two sites lie within 2.5 kilometers of each other, and can be classified as examples of the Coso Painted Style (Garfinkel 1978; T. C. Whitley 1981a, 1981b). As such, they are characterized by the frequent association of bighorn sheep and horse and rider elements (D. S. Whitley 1982). These last motifs indicate a temporal placement in the Historic period (post-A.D.

1772) for this style. CA-Iny-439 can be classified as an example of the Great Basin Painted Style and is therefore hypothesized to have been painted sometime after A.D. 1000 and probably before the Historic period (Heizer and Baumhoff 1962). It should be noted that while this site contains simple monochrome drawings of circle and "rake" elements characteristic of Great Basin Painted Style sites, it also contains simple paintings of bighorn sheep, reminiscent of both the sheep petroglyphs common to this region (Grant 1968) and the limnings of the more elaborate Coso Painted Style sites.

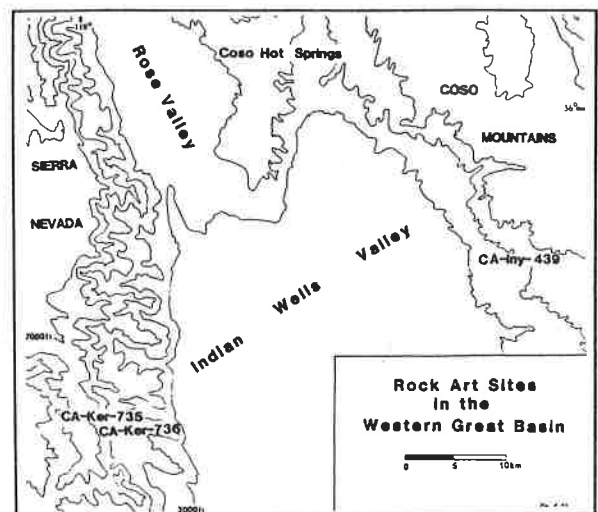


Figure 1. Location of rock art sites mentioned in the text and Coso Hot Springs. Contour intervals are 1,000 feet (304.8 meters).

Pigment Sampling and Analysis

One sample of rock art pigment was obtained from each of the three rock art sites. A steel blade was used to remove very small samples from pictograph motifs in the field; contaminants from underlying rock were removed in the laboratory under 45X magnification. Pigment samples can be described as follows:

1) CA-Iny-439: red pigment sample from a small, hollow circular element.

2) CA-Ker-735: red pigment sample from a large polychrome geometric figure consisting of a series of concentric circles (T. C. Whitley 1982a: fig. 1).

3) CA-Ker-736: white pigment sample from a large, thick patch of pigment, probably thrown on the pictograph panel or resulting from brush cleaning on the panel.

Surficial material was obtained from red and white deposits at Coso Hot Springs (fig. 1) to determine if any similarities between pictograph pigments and the mineral soils at this locale could be established. Such a possible connection was hypothesized based on the arguments of Koski et al. (1973) who suggested that hot springs may have been a primary source of pigments for Great Basin rock art. The Coso Hot Springs, in particular, consist of 40 steam wells, numerous mud pots, fumaroles, and small ephemeral hot pools, with the variously colored mud pots used to this day for medicinal purposes by Coso Shoshone and Owens Valley Paiute groups. Additionally, Coso Hot Springs is mentioned in the mythology of a number of Great Basin groups, so it can be considered a point of modern and historical (if not prehistorical) religious significance to Native Americans (Iroquois Research Institute 1979). The five samples were analyzed by X-ray fluorescence (XRF) analysis by the Air Quality Group, University of California, Davis. In addition, some of these samples were examined by scanning electron microscopy (SEM) to characterize their micromorphological structures.

Results and Interpretations

Results of the XRF analysis are presented in table 1. The values in this table are normalized to 100 percent. The limited amount of data currently available is not sufficient to warrant statistical analysis; however, some patterns are evident that suggest provisional interpretations. As regards the red pigment and mineral soil, first, it is evident that substantial (and probably statistically significant)

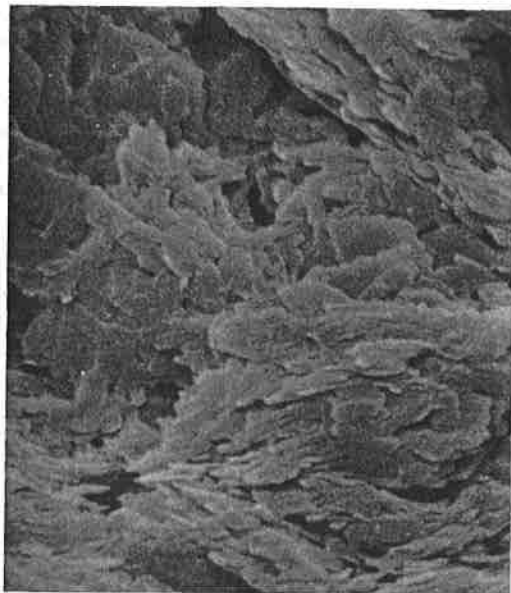
differences in the quantities of trace elements such as Mn, Zn, As, Rb, Sr, Zr, Co, Ga, Cu, and Y exist between the samples from sites CA-Iny-439 and CA-Ker-735. This suggests that the source of the red pigment for these two sites differed. In comparing the XRF results from CA-Ker-735 with the red mineral soil from Coso Hot Springs, the opposite is suggested: elemental values are more similar, particularly for Rb, Fe, K, Sr, As, Mn, Co, and Cu. The limited available data do not allow us to establish whether these trace elements provide diagnostic signatures for the pigments.

The results of SEM observations also support a Coso Hot Springs source for the red pigment from CA-Ker-735, as the two samples are structurally very similar (fig. 2a, 2b). This similarity is emphasized when these figures are compared with the micromorphology of other rock art pigment, e.g., red pigment from site CA-Ker-421 (fig. 2c), and green pigment from CA-Ker-736 (fig. 2d).

TABLE 1
XRF Results for Rock Art Pigment
(in percent)

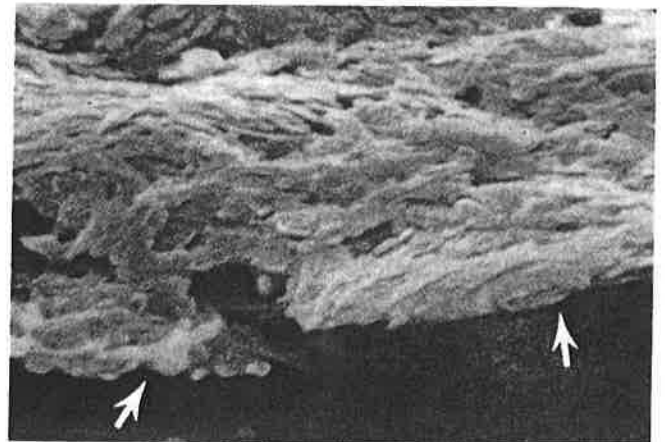
Element	Iny-439 (red pigment)	Ker-735 (red pigment)	Coso H.S. (red earth)	Ker-736 (white pigment)	Coso H.S. (white earth)
S	12.30	3.50	1.90	3.30	43.60
Cl	0.00	0.00	0.00	0.00	27.30
K	0.00	3.90	3.70	42.70	8.40
Ca	58.10	5.1	1.30	22.80	5.40
Ti	0.01	0.05	0.07	0.03	0.92
V	0.00	0.00	0.30	0.65	0.00
Cr	0.00	0.00	0.90	0.00	0.00
Mn	0.33	0.50	0.70	0.70	0.70
Fe	24.90	85.20	90.00	26.60	10.20
Ni	0.04	0.00	0.00	0.02	0.09
Cu	0.00	0.01	0.01	0.00	0.00
Zn	0.04	0.02	0.08	0.13	0.18
As	0.00	0.02	0.03	0.06	0.00
Pb	2.30	0.00	0.00	0.00	0.00
Br	0.00	0.00	0.00	0.00	0.50
Rb	0.00	0.06	0.07	0.80	0.00
Sr	0.80	0.40	0.30	1.13	0.50
Zr	0.00	0.08	0.30	0.30	1.30
Mo	0.00	0.00	0.00	0.20	0.00
I	0.80	0.07	0.00	0.30	0.00
Co	0.30	1.10	1.20	0.30	0.10
Ga	0.002	0.00	0.001	0.01	0.90
Y	0.00	0.01	0.00	0.01	0.00
Hg	0.00	0.00	0.03	0.00	0.00

The white pigment and white earth samples show no similarities in either major or trace elements, suggesting that the white earth at Coso Hot Springs was not the source of the white pigment at CA-Ker-736. Garfinkel (1978) chemically analyzed the white pigment from the nearby CA-Ker-735. Because his results were not computed in the same manner as ours, they are not completely com-



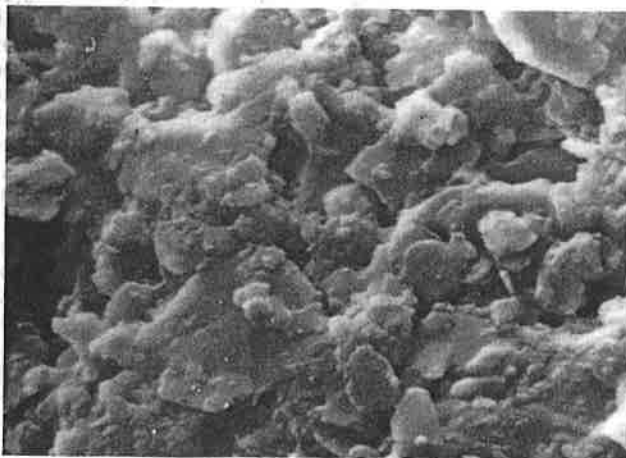
A

a. Micrograph of surficial red soil collected from the Coso Hot Springs, indicating that the crenitic deposit consists of platelets favoring a parallel orientation. Energy dispersive analysis of X-rays (EDAX) and XRF data indicate that the particles are composed of largely Si, Al and Fe, possibly clay minerals and poorly crystalline iron oxide minerals. Scale bar 2 micrometers.



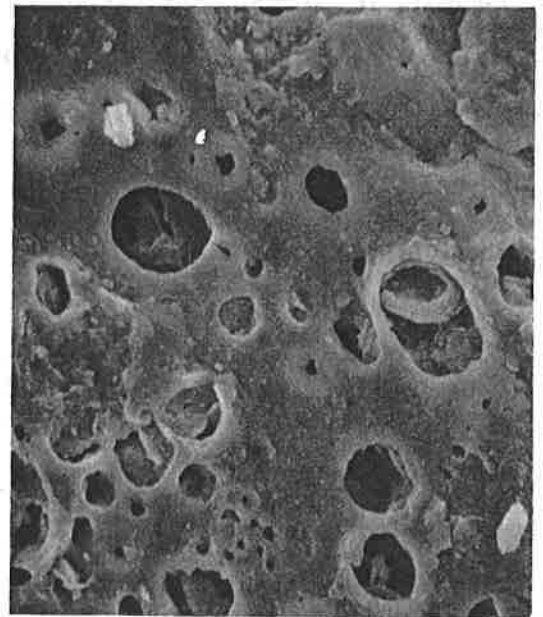
B

b. Surface of CA-Ker-735 red pigment. Like figure 2a, the structure consists of platelets that have a parallel orientation and a random stacked appearance. The arrows show the contact between the pigment and the underlying rock. Scale bar 2 micrometers.



C

c. Micromorphology of red pigment from CA-Ker-421. EDAX analysis of the pigment, normalized to 100%, reveals the following elemental content: Mg 2%, Al 9%, Si 46%, K 5%, Ca 9%, Ti 2%, Fe 24%, and Cu 3%. Note that the structure of figure 2c is dissimilar to figures 2a and b. Scale bar 20 micrometers.



D

d. Surface of green pigment from CA-Ker-735, also micromorphologically dissimilar to figure 2a - c. EDAX analysis of the pigment, normalized to 100%, indicates the following contents: Mg 8%, Al 7%, Si 34%, K 3%, Ca 6%, Ti 2%, Fe 39%, and Ni 1%. Scale bar 10 micrometers.

Figure 2. Scanning electron microscope images of the micromorphology of selected rock art pigments and the Coso Hot Springs deposit.

parable. Based solely on the relative proportions of Ti to Ca, Fe, and K, however, Garfinkel's results suggest that the CA-Ker-735, CA-Ker-736, and Coso Hot Springs samples all differ chemically.

As noted previously, diagnostic trace element signatures for pictograph pigments have not been established, and the chemical variability of the mineral soils at Coso Hot Springs has not been defined. Hence, inferences derived from comparisons of pigment among sites, and between the sites and Coso Hot Springs, can only be considered provisional. Nonetheless, a qualitative assessment of the XRF results suggests the following:

1) Red pigments from sites CA-Ker-735 and CA-Iny-439 appear to differ significantly, based on trace element constituents, and probably were not derived from the same source.

2) Red pigment from CA-Ker-735 and mineral soil from the Coso Hot Springs are chemically and micromorphologically similar, suggesting that the rock art pigment may have been derived from this source.

3) White pigment from CA-Ker-736 appears to differ chemically from white soil from Coso Hot Springs and white pigment at CA-Ker-735.

As sites CA-Ker-735 and CA-Iny-439 differ stylistically and possibly temporally, the difference in technique between them, as indicated by possible differences in red pigment, may be an indication of stylistic or chronological differences, as suggested by Koski et al. (1973). On the other hand, given that CA-Ker-735 and -736 are stylistically and chronologically equivalent, and that they evidence different sources for white pigment, such differences in technique cannot be considered diagnostic in all cases. Finally, the notion proposed by Koski et al. (ibid) that hot springs were the source of rock art pigments is supported by the data on red pigment from CA-Ker-735. Clearly, further work needs to be done to substantiate the preliminary interpretations presented here. If successful, this type of analysis may be extended into other areas of the Great Basin.

Acknowledgments

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