

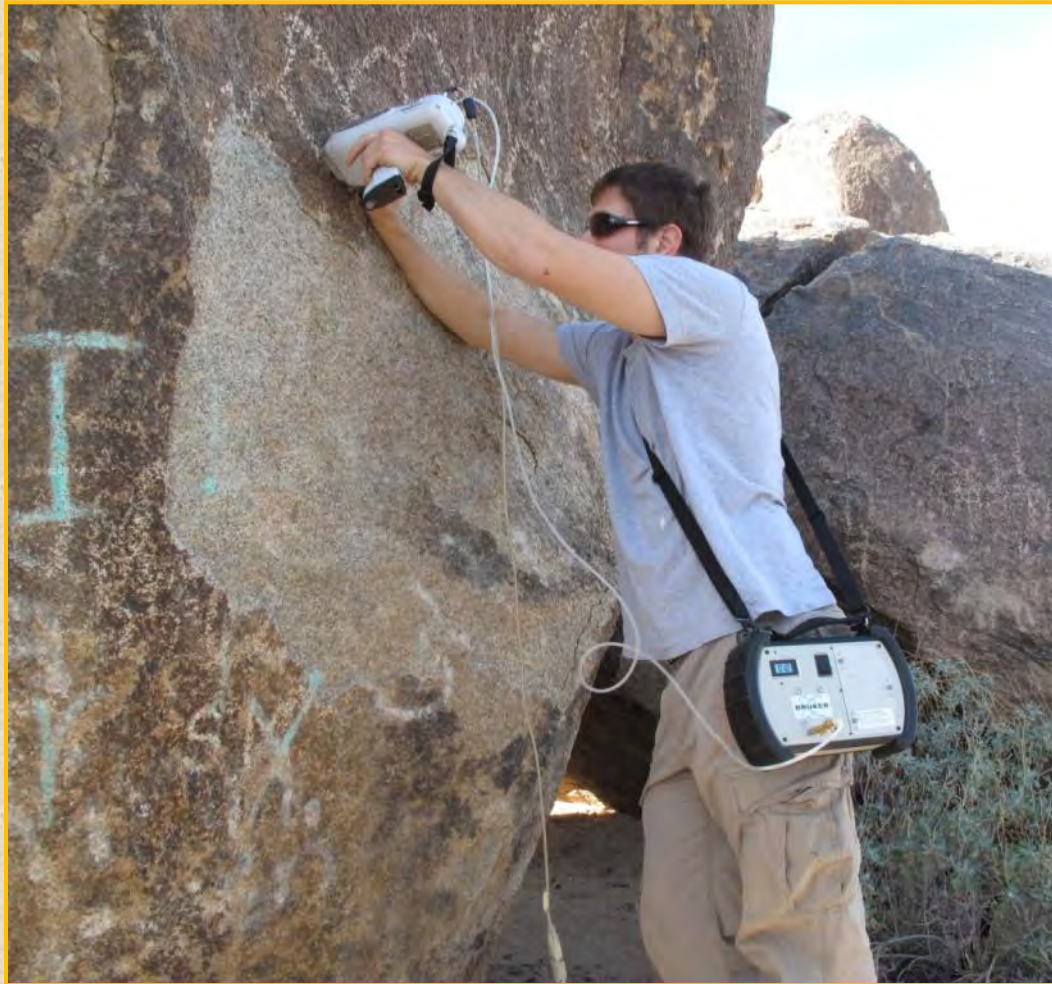
Analyzing Red Pictographs with X-Ray Fluorescence



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Bruker Tracer III- V Energy Dispersive X-Ray Florescence (EDXRF) Rock Art Analysis



- EDXRF data can be used to determine pictograph pigment composition for documentation and conservation purposes.



EDXRF Rock Art Analysis

Advantages

- Fully portable device allows *in situ* study of rock art.
- Non-destructive analysis.
- Can detect atoms as light as Mg using a vacuum.
- Possible to adjust the sensitivity to elements of different atomic weights.
- Real time data collection provides immediate compositional feedback.

EDXRF Rock Art Analysis

Limitations

- Can not detect many common paint constituents including organic compounds consisting of hydrogen, oxygen, and carbon.
- It is difficult or impossible to quantify the concentrations of elements present in paint.
- As a result, inter-observer comparisons are complicated.
- Elements up to 4mm deep within the substrate are also detected in addition to paint.



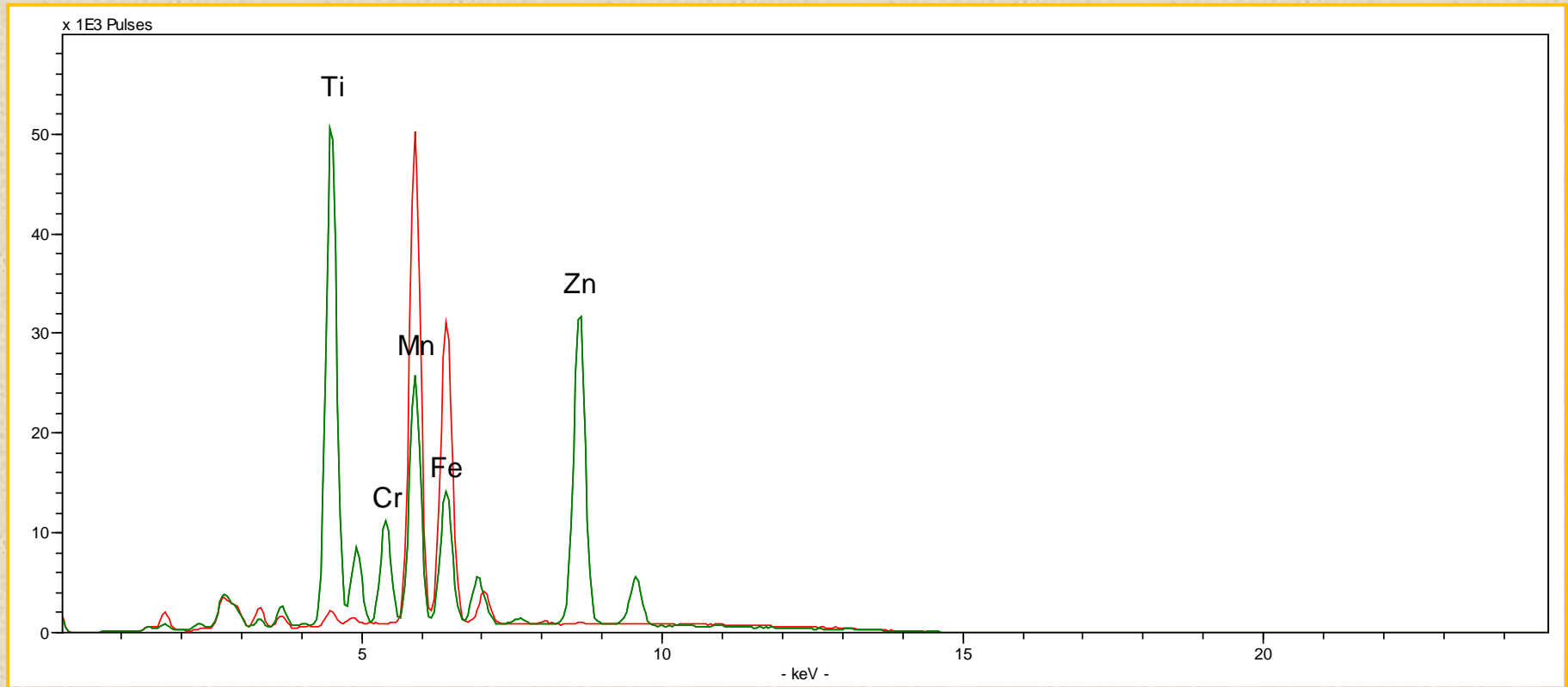
Methodological Approaches that Mitigate EDXRF Limitations



- First, it is necessary to collect multiple EDXRF readings from painted areas and adjacent unmodified portions of pictograph panels.

Comparing the Rock Background to Painted Areas Allows Determination of Elements Present in the Paint

- In this instance, the paint contains titanium, zinc, and chromium.



Spectrograph for paint (green line) and unpainted adjacent rock locations (red line)

Identify Paint Types by Comparing EDXRF Data from Rock Art Sites to Known Paint Samples



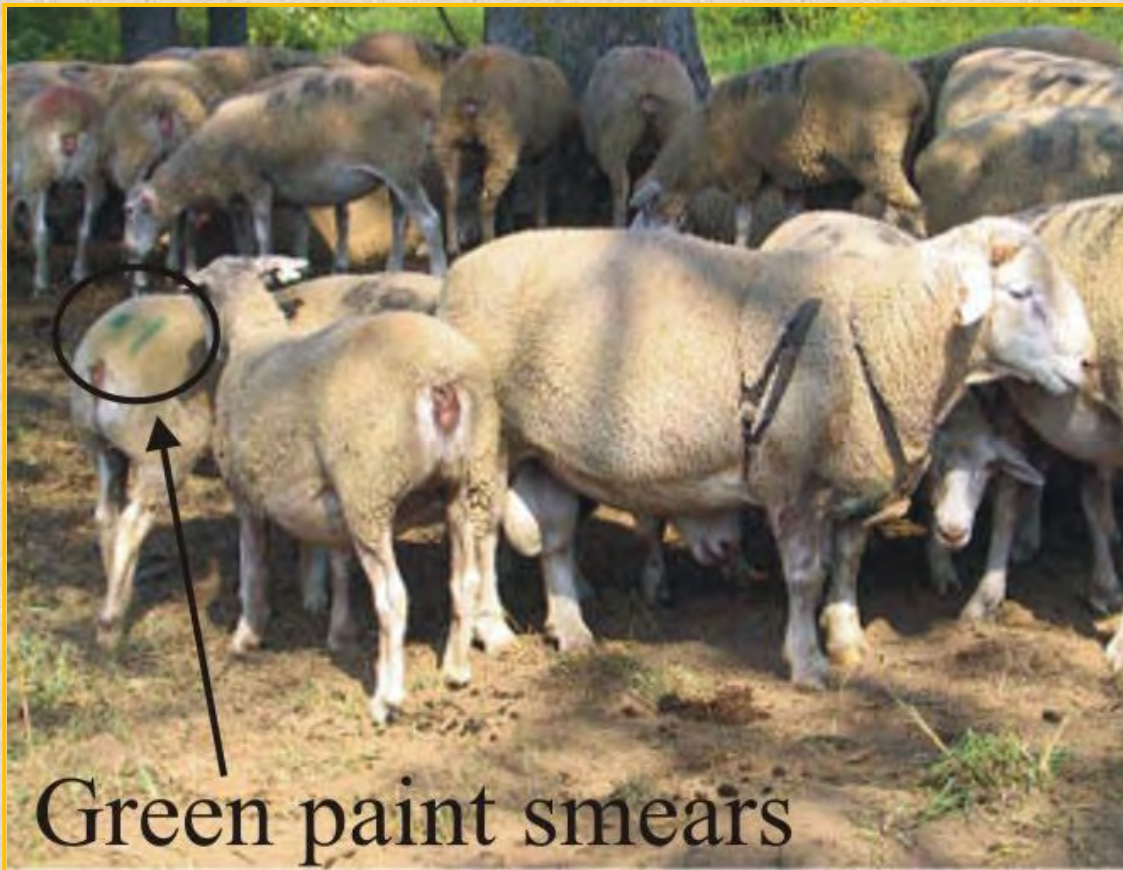
Notches Dome, Wyoming



Dry Creek, Colorado



EDXRF Data from Known Sheep Branding Paint Samples Were Compared to the Rock Art



- The composition of the branding paint samples is similar to some of the paint at Notches Dome and Dry Creek.

Semi-Quantitative Analysis

- X-ray counts are the only data produced by EDXRF, and conversion to concentrations using calibration software is likely to introduce error.
- However, this step is not necessary for analyses that only compare EDXRF data (e.g., raw material sourcing studies) and X-Ray count data can be analyzed without conversion to concentrations.



EDXRF Analysis

Fort Bliss, Texas



- Semi-Quantitative Analysis of Pictographs at Picture Cave

Picture Cave Bruker Tracer III-V Pictograph Pigment Composition Analysis



- Located in the Hueco Mountains north of El Paso, Texas.
- The site was initially recorded by Frank Roberts in 1921.
- The pictographs are thought to date to the El Paso phase (AD 1300-1450).

Seventeen Rock Art Panels were Recorded



- The panels occur in a series of chambers that penetrate the cliff face to different depths across an area of approximately 45 meters long and 75 meters above the floor of a short canyon.

EDXRF Data Collection Focused on Panel 1



- Largest and most complex group of figures at the site.
- At least 36 individual elements are present on the panel.
- All figures are monochrome red paintings.

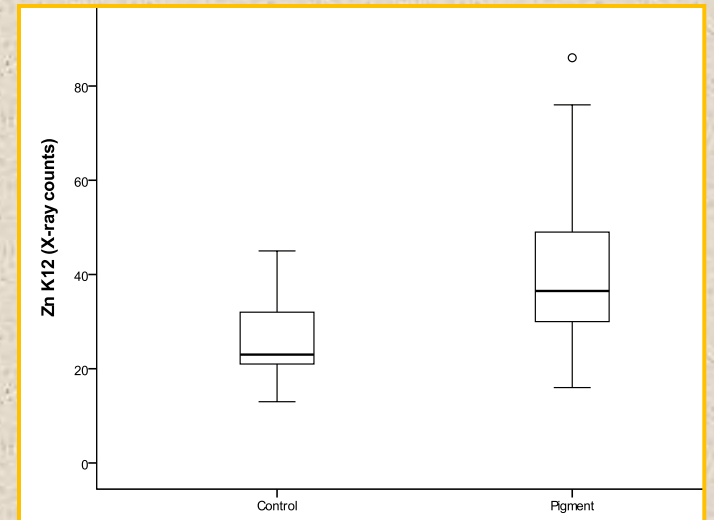
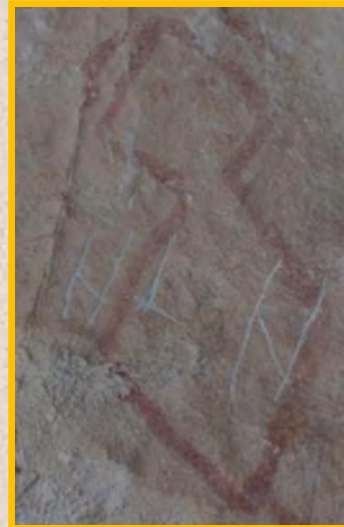
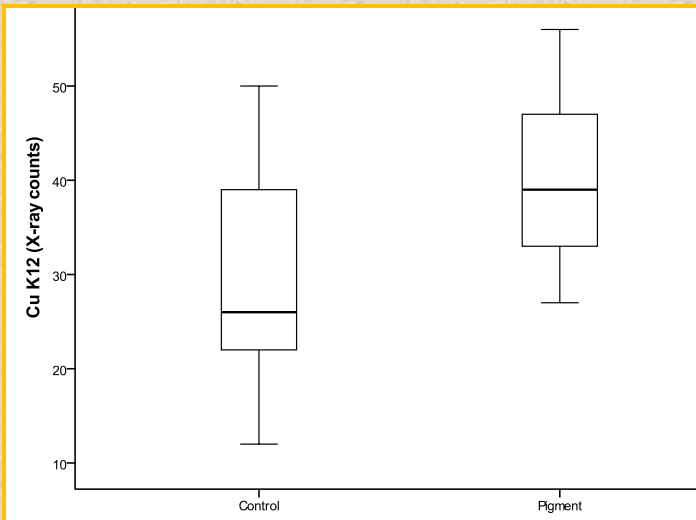
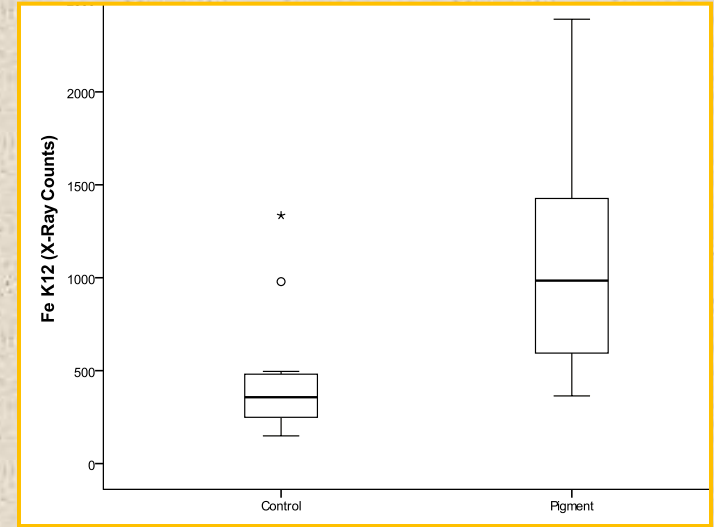
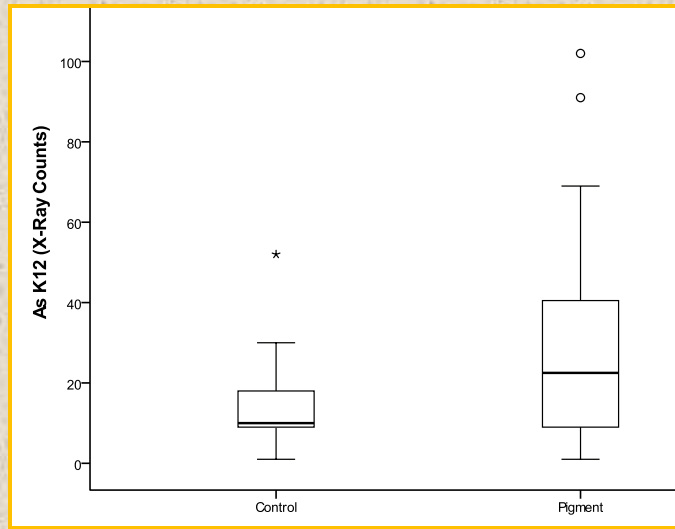
EDXRF Data were Collected from both the Painted Figures and Nearby Natural Rock Surfaces



- EDXRF readings were taken in a total of 92 different locations at Painted Cave.
- Two different instrument configurations were employed to examine light and heavier elements.



Data Analysis Results

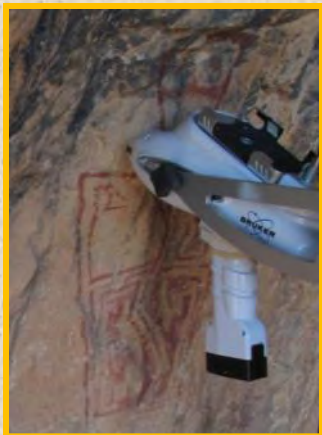


•Arsenic, Iron, Copper, and Zinc have statistically significant differences between the control and painted areas at the site.

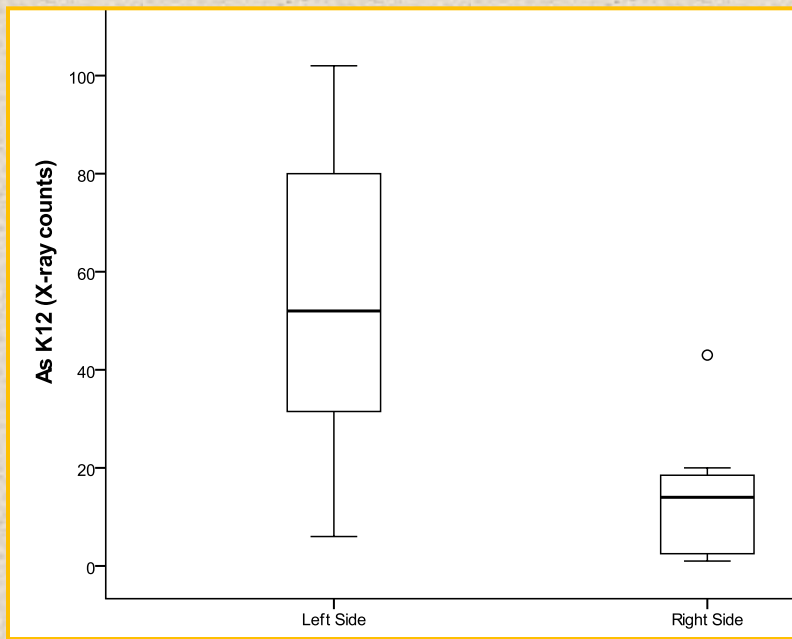
All Prehistoric Paint at the Site Consists of Red Ochre (Iron Oxide)



- However, the composition of rock art elements differs.



Rock Art Elements on the Left Side of Panel 1 have Statistically Significant Higher Readings for Arsenic than Paintings on the Right Side





- Variation in the pigment on the right and left sides of the panel suggests the figures may have been painted at different times, and/or may have been done by different artists.



Conclusions



- EDXRF is one of the few techniques that allows *in situ* and non-destructive analysis of rock art figures.
- Limitations of the method can be addressed through the collection of numerous control readings.
- Semi-quantitative analysis of X-ray counts has advantages over analyzing concentration data that are calculated based on assumptions, which are likely to be incorrect.
- Using a semi-quantitative approach it is possible to indentify paint types by compare rock art data to known pigment samples.
- Variation in the composition of pictographs can also be identified.
- EDXRF can identify and quantify variation that provides otherwise unavailable insight to the composition and nature of pictographs.

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