Developments in Instrumental Multi-ELEMENTAL Analysis for Ochre Geochemistry

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Abstract

Iron oxides, ochre and associated minerals were widely used during ancient times. Determining elemental composition and understanding the processes involved in ochre formation is vital for archaeological studies. Instrumental multi-elemental analysis (IMAA) techniques including wavelength dispersive X-ray fluorescence spectroscopy (WDXRF) and neutron activation analysis (NAA) that allow for the determination of elements present in ochre at trace levels. This paper presents a comparison of IMAA techniques that allow for the characterization and understanding of the elemental composition of ochres formed in different environments.

Analytical Methods

The ochre samples from Arizona, Georgia, and Wyoming were analyzed for their elemental composition using a WDXRF instrument at the University of Missouri Research Reactor (UMRR). The results are expressed in parts per million (ppm) using the equation: ppm = (X/E) * 10^6, where X is the value obtained from the WDXRF instrument and E is the element's atomic number.

Statistical Treatment of the Data

The concentration of each element was calculated as a percentage of the total iron content. The results were then subjected to a one-factor ANOVA test to determine if there were significant differences among the samples. The results revealed that there were significant differences among the samples, with Fe being the most abundant element followed by Al, Ca, and Mg.

Conclusion

The results of this study provide valuable information for the characterization and understanding of ochre composition. The comparison of the results from different environments shows that the elemental composition of ochre varies greatly. This information can be used to better understand the processes involved in ochre formation and to improve the interpretation of archaeological remains.

References


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Project Goals

The goals of this project are to:

- Determine the elements present in various samples of ochre
- Investigate the relationship between the elements present in ochre and their potential application in archaeological studies
- Develop a database of ochre samples from different environments

Ochre Mineralogy

Ochre is a mineral composed of hydrated iron oxide that is often found in archeological sites. The composition of ochre varies widely, and the most common form is hematite (Fe2O3). Hematite is a reddish-brown mineral with a Mohs hardness of 6.5-7 and a specific gravity of 5.0-5.2. Ochre is often used as a pigment in ancient art and for its medicinal properties.

Rare Earth Elements

Rare earth elements (REE) are a group of 17 elements that are commonly found in ochre samples. REE are often used as tracers in archaeological studies to determine the origin of ochre samples.

Figure 1: Rare earth elements in ochre samples from different environments.