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Hyperspectral Imaging and Analysis of Hydrothermal Alteration Mineralogy in Cuprite, Nevada

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ABSTRACT

Lab- and drone-based hyperspectral imaging scans of different clays, micas, sulfates, and other alteration products were classified to show the distribution of spectrally active minerals in the exposed upper zone of the Cuprite epithermal system.

BACKGROUND

Procedure

Low altitude (40-80m AGL) UAV Flights were conducted over the Cuprite Hills region of Nevada, USA, with a sensor payload including LiDAR, Short Wave Infrared (SWIR, ranging from 900-2500 nm) and Visible Near Infrared (VNIR, ranging from 400-1000 nm) Hyperspectral sensors. The LiDAR data were used to build 3D and Digital Elevation Models (DEMs) of the surveyed terrain, which were in turn used to orthorectify the data from the line scan imagers.

Samples were collected from the survey areas and analyzed in the laboratory to generate spectral libraries for classification of the spectral images.

Classification of drone-based hyperspectral scans shows the distribution of spectrally active minerals in the exposed upper zone of the Cuprite epithermal system in southern Nevada. The exposures of different types of clays, micas, sulfates, and other alteration products can help to map the nature, intensity, and geochemical conditions of the epithermal processes active at Cuprite, indicating a low-pH fluid system with variable sulfidation.

The classified mineral maps were then fused with the LiDAR point clouds to generate 3-dimensional images of the mineralogy of the areas surveyed.

DATA/OBSERVATIONS

Ground-Truth Spectra

All of the reference spectra used to create the classification model of the hyperspectral images were collected during the mission. During each day of UAV flights, personnel collected samples, logging locations for each. Spectra from these samples were taken with a single point lab spectrometer. The reference spectra used for classification are shown in the Ground Truth Spectra section on the right side of this poster.

CONCLUSIONS

High-resolution Scan Interpretation

The Siebert tuff and unnamed ashflow tuff display similar spectral alteration mineralogy related to their shared rhyolitic origin and argillic alteration. A change in the alteration in the middle of the scan area may indicate a small normal fault.

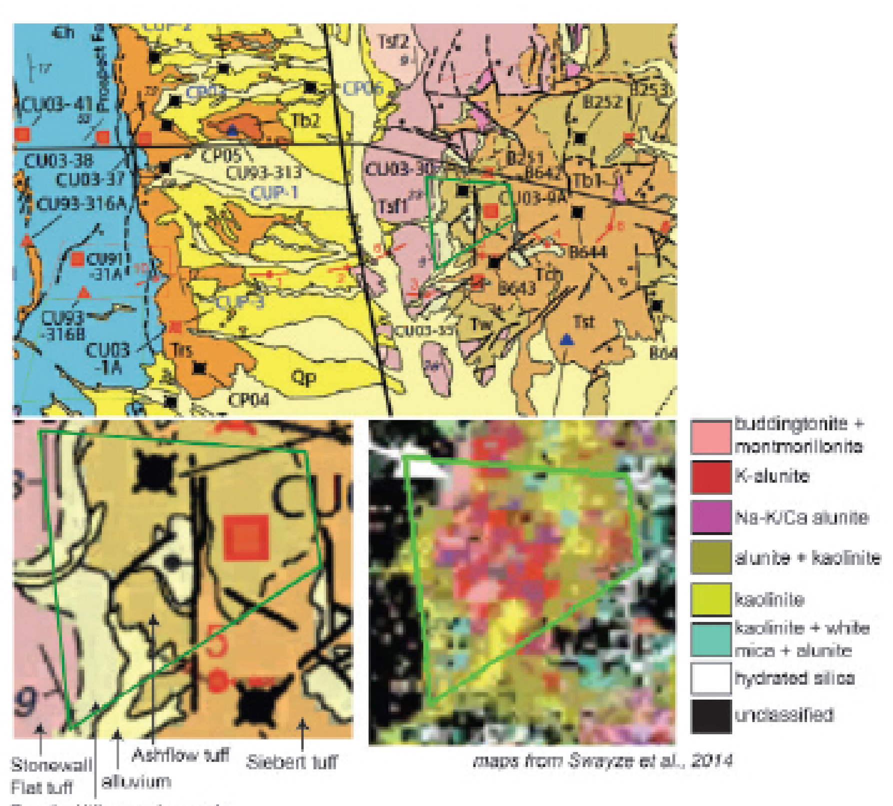
Tentative Geochemical Interpretations

Significant spatial and/or temporal variation found in the Cuprite system's alteration history. Southeastern scan area suggests an oxidized, near-neutral alteration system, possibly in a hot-spring or steam-heated environment (Consistent with the interpretation of Swayze et a.). While southeastern scan area exhibits low sulfidation, the formation of native sulfur in parts of the Cuprite Hills suggests a high sulfidation state elsewhere. The temperature range during the alteration was probably between 150-300 °C (from the phase diagrams).

Differences from Swayze et al.

More correspondence found between lithological and spectral boundaries, and less crosscutting of alteration zones across rock units. No direct detection of buddingtonite, but a significant ammonium signature in alunite samples could indicate buddingtonite mixed with ammonium-alunite.

CUPRITE SE MARKUP

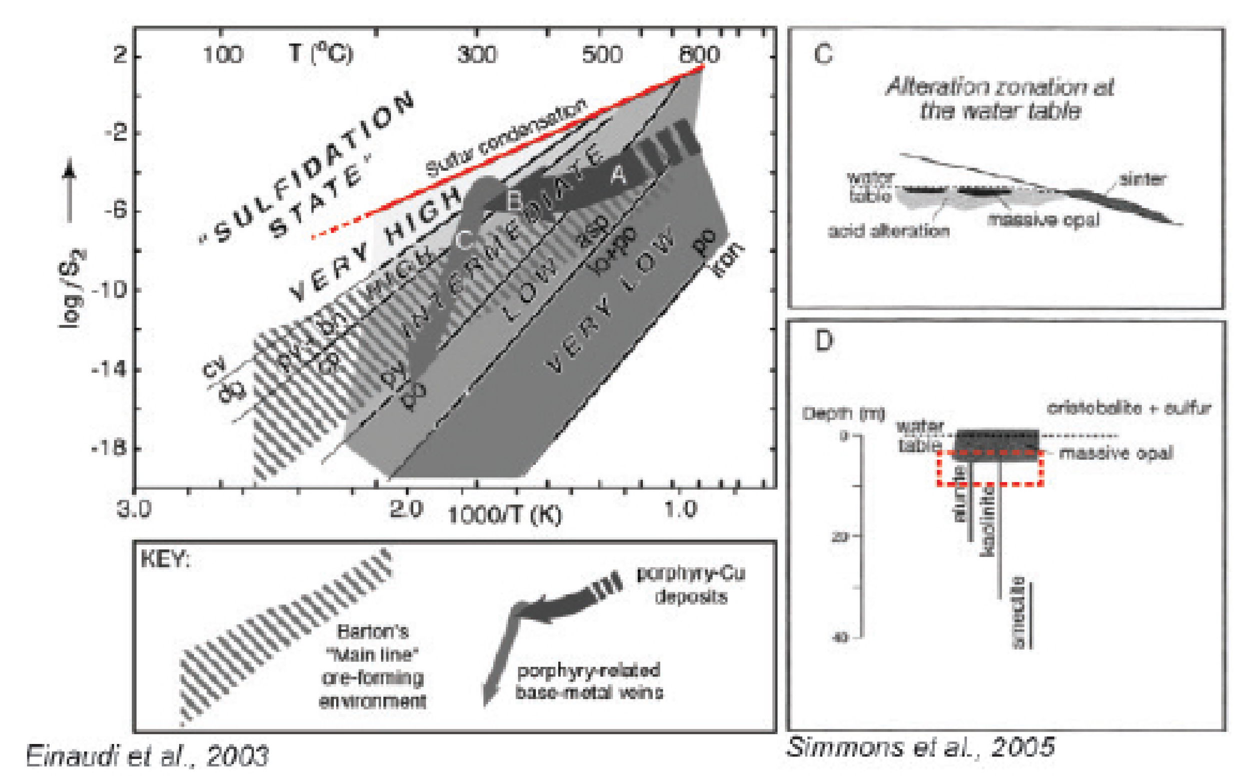


maps from Swayze et al., 2014

TERRAIN

VNIR/SWIR HYPERSPECTRAL & LIDAR

EPITHERMAL PHASE DIAGRAMS



Einaudi et al., 2003 Simmons et al., 2005

REFERENCES

Swayze, G., et al., 2014. Mapping advanced argillic alteration at Cuprite, Nevada, using imaging spectroscopy. Economic Geology 109: 1179-1221.

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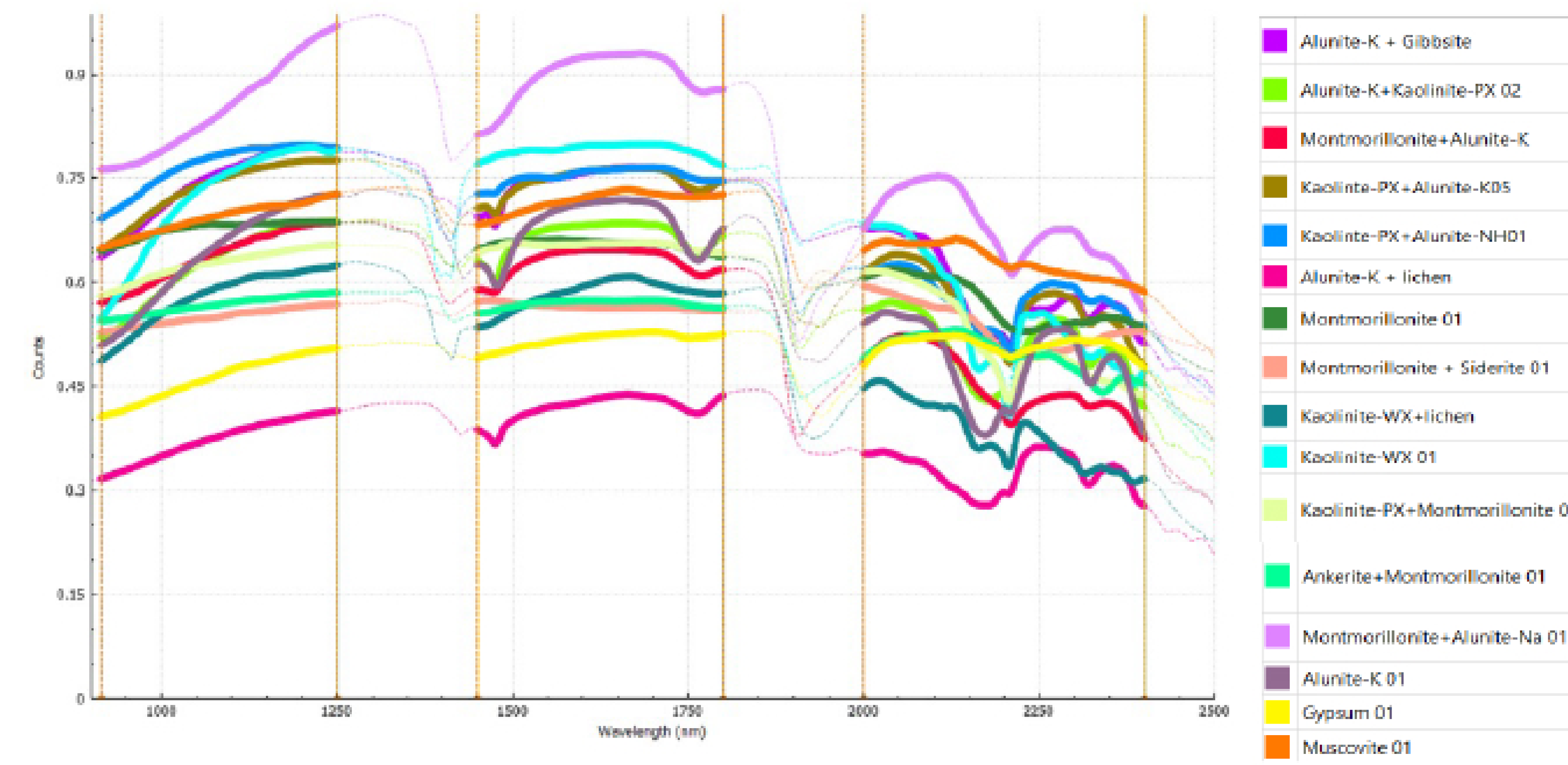
GROUND TRUTH SPECTRA



CUPRITE SOUTHEAST CLASSIFIED