

A Multi-method Spectral Workflow for Hydrothermal Alteration Mapping and Exploration Targeting in a Complex Metallogenic District, Central Peru

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Remote sensing and field spectroscopy are critical tools for mineral exploration in geologically complex and inaccessible terrains. In the eastern Cerro de Pasco region of central Peru, a polymetallic district hosting porphyry, skarn, and high-sulfidation systems, an integrated spectral workflow was applied to delineate hydrothermal alteration zones and identify new exploration targets.

This study combines ASTER satellite imagery with field spectral data acquired using ASD TerraSpec. A multi-method approach was implemented, including RGB composites for iron oxides and clay mapping, band ratios for alteration discrimination, SWIR spectral indices, and Spectral Angle Mapper (SAM) classification integrating satellite and field-derived spectral signatures. Cross-validation between methods allowed refinement of alteration halos and increased interpretive confidence.

Results show consistent mineralogical zoning across all techniques, defining hydrothermal alteration assemblages associated with different deposit types. Eleven exploration targets were identified and classified according to their alteration styles and metallogenic context. These include high-sulfidation systems characterized by advanced and intermediate argillic alteration, porphyry-related systems with phyllic, argillic, and propylitic assemblages, and stratabound polymetallic targets associated with carbonate-rich alteration.

The integration of spectral techniques with geological and structural controls demonstrates a robust and scalable workflow for hydrothermal alteration mapping. This approach improves early-stage targeting and highlights the value of combining satellite and field spectroscopy in mature metallogenic belts.