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## From Hyperspectral Pixels to Lithogeochemical Vectors: Mapping Porphyry Lithocaps from Space

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Remote sensing has long been used in mineral exploration to identify alteration associated with porphyry copper deposits, but most applications have relied on multispectral datasets that primarily detect broad mineral groups. The emergence of satellite hyperspectral sensors such as PRISMA and EnMAP represents a significant shift: for the first time, diagnostic hydrothermal minerals, including alunite, dickite, kaolinite, muscovite, and chlorite, can be mapped directly from space at regional scales.

Despite this capability, hyperspectral satellite data are rarely integrated with detailed lithogeochemical interpretation. As a result, mineral maps derived from satellite imagery are often used in isolation, without the geological context required to understand hydrothermal processes, alteration zoning, or mineralization vectors.

This study explores how satellite hyperspectral mineral mapping can be combined with lithogeochemical datasets to improve interpretation of alteration systems associated with porphyry copper deposits. Hyperspectral imagery is used to delineate advanced argillic lithocaps and surrounding alteration assemblages, while geochemical datasets provide constraints on alteration intensity, fluid pathways, and metal distribution. In particular, variations in white mica spectral features are evaluated alongside lithogeochemical indicators to better understand transitions from lithocap environments toward deeper porphyry-style alteration.

Preliminary work from porphyry copper districts in Arizona suggests that integrating hyperspectral mineral mapping with lithogeochemistry provides a more robust framework for interpreting lithocap systems and identifying prospective portions of large hydrothermal footprints. By linking satellite-derived mineralogy with geochemical vectors, this approach helps bridge the gap between regional-scale remote sensing observations and deposit-scale exploration models.

These results highlight the growing potential for hyperspectral satellite datasets to move beyond reconnaissance mapping and become an integrated component of geochemical exploration workflows.