Hyperspectral Surveying for Mineral Resources in Alaska

**Background**

Alaska is a major producer of base and precious metals and has a high potential for additional undiscovered mineral resources. However, discovery is hindered by Alaska’s vast size, remoteness, and rugged terrain. New methods are needed to overcome these obstacles in order to fully evaluate Alaska’s geology and mineral resource potential. Hyperspectral surveying is one method that can be used to rapidly acquire data about the distributions of surficial materials, including different types of bedrock and ground cover. In 2014, the U.S. Geological Survey (USGS) began the Alaska Hyperspectral Project to assess the applicability of this method in Alaska. The primary study area is a remote part of the eastern Alaska Range where porphyry deposits are exposed. In collaboration with the Alaska Division of Geological and Geophysical Surveys, the University of Alaska Fairbanks, and the National Park Service, the USGS is collecting and analyzing hyperspectral data with the goals of enhancing geologic mapping and developing methods to identify and characterize mineral deposits elsewhere in Alaska.

**Kilometer to Micrometer Scales**

This project applies an integrated approach that combines spectroscopic measurements with field and laboratory-based geologic investigations. Hyperspectral data (also known as imaging spectrometer data) have been collected at the following scales: (1) regional, (2) outcrop, and (3) hand specimen. The regional airborne survey, conducted over two days, used the HyMap™ sensor and provides spectral characterization of surficial materials across an extensive area (1,900 square kilometers [km²]) at 6-meter (m) resolution (fig. 1). A ground-based outcrop-scale survey done with the HySpex™ sensor provides higher spatial resolution mineral mapping over a kilometer-scale hillside at 30-centimeter (cm) resolution (fig. 2). The most detailed data were collected at 500-micrometer (µm) spatial scale on individual rock samples in the laboratory using Corescan’s Hyperspectral Core Imager Mark III™ imaging spectrometer. Analyses of these measurements reveal complex spatial relations of minerals (fig. 3). Scanning electron microprobe and X-ray diffraction analyses of rock and soil samples are used to validate mineralogical and spectral interpretations of hand specimens. The hand specimen and outcrop results are used to improve interpretations of the regional hyperspectral dataset.

**What is hyperspectral analysis?**

When light hits a material, some of the light is reflected back from the material. Scientists measure the intensity of reflected light with a spectrometer. Measuring over a range of wavelengths generates a spectrum. The shape of the spectrum is like a fingerprint that provides information, including presence and qualitative abundance of certain minerals and the mineral chemistry. Some common minerals, such as quartz and feldspars, do not have distinctive sharp absorption features in the wavelength region of sunlight and must be detected with a thermal spectrometer.

**Figure 1.** Regional mineral classification map overlaying a digital elevation model of the Orange Hill area, Wrangell–St. Elias National Park and Preserve, Alaska. Colors represent the spectrally dominant minerals. Data collected at 6-meter spatial resolution.
Dominant Minerals and So Much More

The hyperspectral surveys provide key pieces of information. Mineral classification maps (figs. 1–3) are based on a match to USGS spectral library standards (Clark and others, 2007) and show the predominant mineral(s) for each spectrum. The USGS is taking steps to extract even more information from the spectral data by developing methods to determine qualitative abundances of the predominant mineral(s) across the survey area. Subtle changes in the shapes of spectral features are also being examined to map differences in the chemical composition of select minerals. Generally, relative abundances of predominant mineral(s) and observed compositional differences of some minerals may reflect variations in rock type. In this study area, muscovite spectral features are empirically observed to change with proximity to porphyry copper deposits (fig. 4), as has been shown by studies in other areas (for example, Harraden and others, 2013; and Laakso and others, 2015).

Preliminary Observations

- Regional-scale mineral classification maps generally show lithologic changes consistent with previous geologic mapping.
- Mineralogical groupings are consistent at the regional (6 m) to outcrop scales (30 cm), with greater detail at the hand-specimen scale (500 µm).
- Differences in wavelength positions for muscovite (different chemistry) can correspond to certain geologic units and general proximity to known porphyry occurrences.
- Preliminary observations in this study support past studies which indicated that hyperspectral data can be used as a tool to identify surface signatures of undiscovered mineral resources.

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References Cited

