Field-Based and Airborne Hyperspectral Imaging for Mineral Exploration in Alaska

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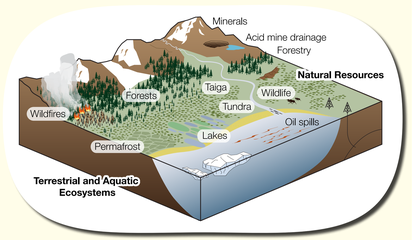
What is the HyLab?

- An NSF funded research facility at the Geophysical Institute (GI), University of Alaska Fairbanks (UAF).
- Provides low-cost, in-state field-based and airborne hyperspectral data acquisition capabilities.
- Supports data acquisition, processing, and analysis for resource exploration and ecological research (see lower box for an overview of our expertises).
- Coordinates education, training and public outreach activities related to techniques and applications of imaging spectroscopy.

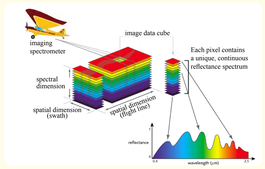


Would you like to know more?

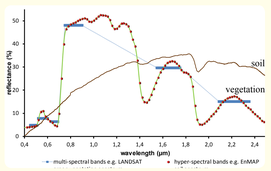
www.hyperspectral.alaska.edu

What is hyperspectral imaging?

- Also known as Imaging Spectroscopy, it is a remote sensing technique where images are acquired in many contiguous and narrow spectral regions, so that each pixel contains a reflectance spectrum.



- Reflectance spectra provide the basis for the discrimination and characterization of different target materials.
- Hyperspectral imaging provides a means for detailed mapping of materials and the derivation of physical, chemical, and biological variables with unprecedented accuracy.



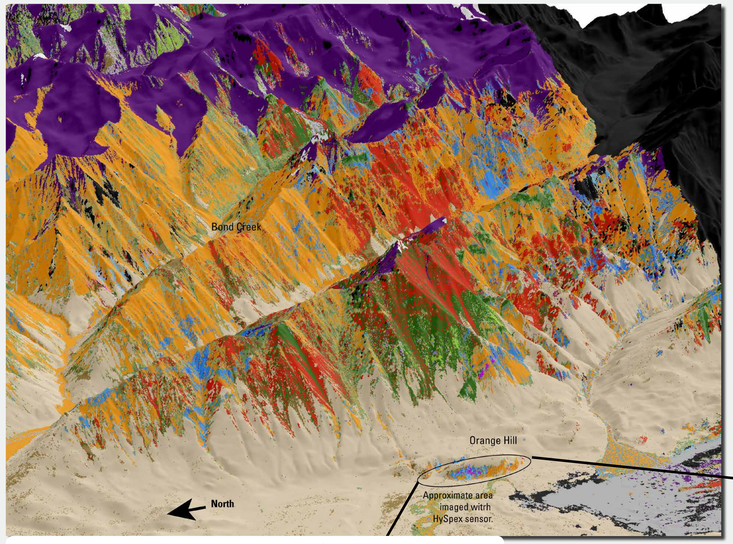
Despite huge potential for mineral development, Alaska remains largely under-explored. Hyperspectral imaging has the capability to identify ore-deposit related mineral assemblages. However its application in Alaska has lagged because of the remoteness and the unique challenges posed by Alaska's high-latitude setting. The Hyperspectral Imaging Laboratory (HyLab) at the University of Alaska Fairbanks (UAF) was established in 2014 to help meet the exploration and mapping needs of the state of Alaska.

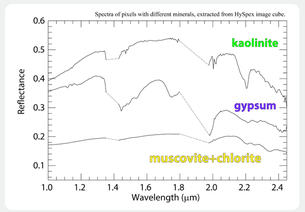
HyLab houses the Hyspex camera system that can be mounted on a rotational stage for field-based, outcrop-scale scanning, or in the belly of an aircraft for airborne image acquisitions; and the PSR+ 3500, a pointing field-portable spectro-radiometer that also operates in the full 350nm to 2,500nm range. Additionally, an optical and a thermal camera can be mounted for DEM and surface temperature retrieval. HyLab personnel also maintain other accessories for instrument calibration.

This poster shows an example of airborne, field-based, and laboratory spectroscopy for identification of large-tonnage, base metal-rich deposits in the Nabesna area, Wrangell-St.Elias NP, Alaska. Airborne VNIR-SWIR images with a spatial resolution of 0.25 m to 6.0 m were used to distinguish the various micas. In field-mode, vertical scans of exposures were made with resolutions of 0.08 m to 0.30 m. Processed imagery helped to map carbonates, clays, sulfates, and alteration-related minerals.

The **image below** was processed at USGS and shows the results of hyperspectral image analysis for carbonate, clays, sulfates and alteration-related minerals, draped over 3-D topography of the Nabesna area.

The hyperspectral imagery spanning the 0.4 to 2.5 micrometer wavelength region of the electromagnetic spectrum were collected over the Nabesna areas in 2014. The data were collected at a nominal 6 m ground-instantaneous field of view (GIFOV). Simultaneously with the airborne survey, representative samples of geologic units were collected for ground verification of remote sensing data.

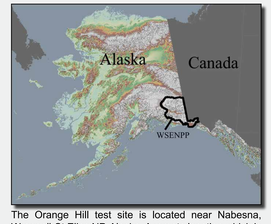




In this false-color composite, the different colors in the area of exposed rock relate to distributions of montmorillonite, gypsum, kaolinite, muscovite, and chlorite. Work is ongoing to make maps indicating the relative abundance of these minerals.


Avait Husky A-1B of the HyLab.


Preparation of the HySpex instrument for an overflight. Photo by J. Cristóbal

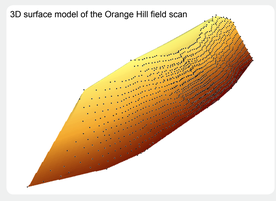


The Orange Hill test site is located near Nabesna, Wrangell-St.Elias NP, Alaska. A remote location which is only accessable via helicopter or small aircrafts.


Measuring calibration site with a field spectro-radiometer. Photo by G. Graham

During field-scans additional equipment such as DGPS, laser scanner and robotic total stations were used to gather the exact position of the instruments as well as to produce precise terrain models of the scanned surfaces.

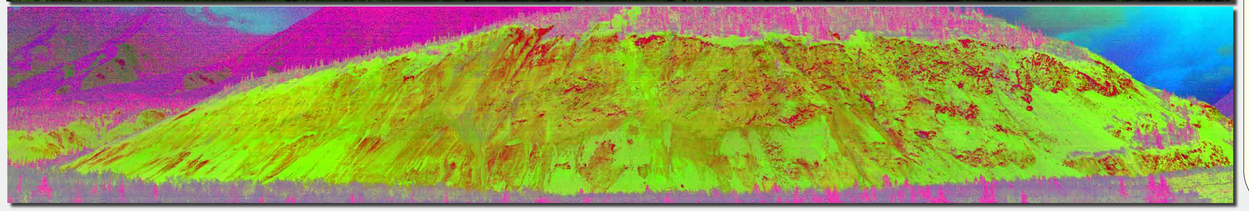

Preparing the HySpex field scan at Orange Hill. Photo by C. Phillips


3D surface model of the Orange Hill field scan


Topcon Total Station and HySpex in field configuration. Photo by M. Buchhorn

Areas of high interest, such as Orange Hill, were additionally scanned with the HySpex in field configuration. This produced full-range hyperspectral images with a GIFOV of approx. 0.08 m. Spectro-radiometer measurements helped to atmospherically correct the image cubes before they could be processed using the Material Identification and Characterization Algorithm (MICA). MICA is a module of the USGS PRISM (Processing Routines in IDL for Spectroscopic Measurements) software.

The **images below** show a true-color composite together with false-color composite image of an outcrop scan at Orange Hill, Nabesna area.



Our tools

The HySpex instrument (field-based & airborne)

- VNIR-1800 and SWIR-384 cameras (400 - 2,500 nm);
- pushbroom HS cameras with low stray light levels, low sensitivity to polarization, and low smile and keystone effects;
- across track FOV of 17° and 16° that can be increased to 34° and 32° respectively (using a FOV expander).

In airborne mode the instrument:

- is mounted with a passive vibration dampening to an Aviat Husky A-1B airplane or similar airplanes (Beaver, Bushhawk, etc.);
- is connected to an IMAR iTrace RT-F400 IMU/GPS (Inertial Measurement Unit / Global Positioning System) unit;
- is controlled by a compact, high-performance data acquisition unit (DAU), connected with a 1 terabyte solid state drive and a compact, touch screen flat-panel monitor.

In the field configuration:

- the two HS cameras are mounted on an automated rotation stage affixed to a surveyors-grade tripod;
- the horizontal swaths of HS data are possible for targets at a distance of ~3 meters to hundred's meters;
- a rugged, field portable data acquisition unit is used to control the rotation stage and cameras during in-situ imaging;
- power supply is provided by a generator.

PSR+3500 Spectro-Radiometer (field-based & lab)

- Fast, full-spectrum UV-VIS-NIR measurements (350 - 2,500 nm);
- high resolution field pPortable spectroradiometer with 512 element Si array and two 256 element extended InGaAs arrays;
- various optics ranging from 1° to 25° for reflectance, radiance and irradiance measurments.

Field-based operation:

- the PSR+ spectro-radiometer is powered by batteries and connected to a rugged PDA which provides GPS, photo tagging, and voice notes;
- our self-developed software allows in-field mineral identification and classification;
- usage of handheld contact probe allows field measurements on outcrops or mapping open pits even at cloudy conditions.

Laboratory operation:

- high signal-to-noise ratio for improved reflectance values by using full-range tungsten lamps;
- detailed analysis of field samples in order to detect pathfinder minerals for exploration of gold, silver, iron, nickel, copper, and more.

The National Science Foundation (NSF) Major Research Instrumentation (MRI) Program, funded the University of Alaska Fairbanks (UAF), to establish hyperspectral imaging capabilities in the State of Alaska **(NSF grant number 1338193)**. The MRI enables UAF to establish a new capability in airborne hyperspectral imaging that has not previously existed, and inherently opens doors to new basic and applied research, and research training. The HyLab is collaborating with the Alaska Division of Geological & Geophysical Surveys (ADGGS) and the USGS in an effort to evaluate the mineral-resource potential of lands in Alaska. See the USGS Hyperspectral Project at http://crustal.cr.usgs.gov/projects/hyperspectral-AK-mineral-deposits/