DIGITAL MAPPING TECHNIQUES 2025

The following was presented at DMT'25
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The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2025)
http://ngmdb.usgs.gov/info/dmt/

Elevating Energy Research: Geologic Applications of Drone and Hyperspectral Technologies

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Prepared for the
Digital Mapping Techniques
Workshop 2025

UNIVERSITY OF WYOMING
3DVIZ CENTER

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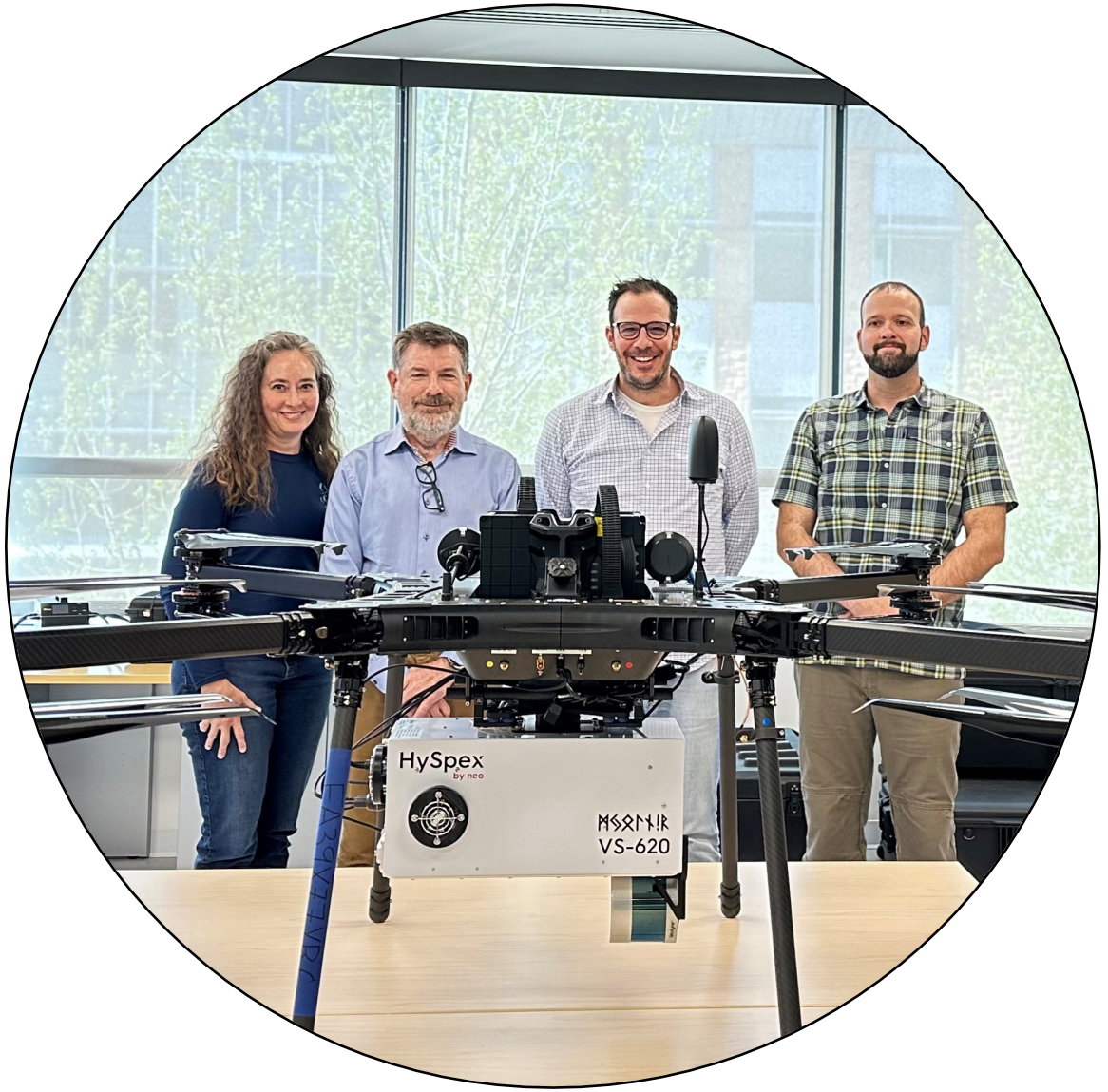
THE WORLD NEEDS MORE COWBOYS.

UNIVERSITY OF WYOMING

School of Energy Resources

The School of Energy Resources (SER) collaborates with stakeholders at the state, national, and international levels to develop energy technologies and policies to grow and support Wyoming's robust energy sector. SER's mission is to advance energy-driven economic development for the state, and it leads the University of Wyoming's talent and resources for interdisciplinary research and outreach, fulfilling Wyoming's promise to be a global leader in a thriving and sustainable energy future.

- Certification
- Compliance
- Platform
- Payloads
- Hyperspectral
- Recommendations



FAA Part 107

The FAA Part 107 certification is a set of regulations governing the use of small unmanned aircraft systems (sUAS) for commercial purposes in the United States.

To obtain this certification, individuals must pass the Unmanned Aircraft General – Small (UAG) knowledge exam.

- In 2020, the Department of Defense was restricted from purchasing DJI drones as well as other platforms from China, Russia, Iran, and North Korea via the National Defense Authorization Act (NDAA).

- Many states have followed suit and have banned DJI drones from both state and local government.

- Currently there is a bill moving through Congress referred to as the *Countering CCP Drones Act* which is gaining traction and raising the possibility of a nationwide DJI ban. The bill passed the House, September 10, 2024.

Unpacking NDAA and Blue UAS

NDAA-Compliant Drones

NDAA compliance refers to Section 848 of the Fiscal Year 2020 National Defense Authorization Act (NDAA), which restricts the Department of Defense (DoD) from purchasing drones manufactured in certain foreign countries (China, Russia, Iran, North Korea) or by companies based in these countries. The focus is on key components such as **flight controllers**, **radios**, **data transmission devices**, **cameras**, **gimbals**, **ground control systems**, operating software, and data storage. NDAA compliance ensures supply chain security.

Blue UAS

Initiated by the DoD's Defense Innovation Unit (DIU), the Blue UAS program vets and scales commercial UAS for DoD use. Blue UAS drones are NDAA-compliant, but they also undergo rigorous cybersecurity assessments to protect sensitive military information. These drones are often offline to prevent potential cybersecurity threats.

Green UAS

An initiative from the Association for Unmanned Vehicle Systems International (AUVSI), Green UAS verifies commercial drones against high-level cybersecurity and NDAA supply chain requirements. The Green UAS program provides a more affordable and accessible alternative to the Blue sUAS certification, especially for non-DoD customers. The focus is on maintaining the same level of security without the steep cost and time associated with Blue UAS certification. The key difference is that Green UAS does not meet DOD requirments, but may still meet requirements for local departments and agencies to purchase with grant.

https://advexure.com/pages/ndaa-compliant-blue-uas

Harris Aerial: Carrier HX8:

NDAA Compliant

- Number of Motors = 8
- Empty Weight = 21.5 lb (9.8 kg)
- Max Payload = 17.6 lb (8 kg)
- Flight Time = 48 min (no payload)
- Max Speed = 33.6 mph (15 m/s)
- Max Wind Speed = 25 mph (11 m/s)
- GPS = Dual RTK GNSS
- Flight Controller = Cube Orange
- Firmware = ArduPilot
- Material = Carbon Fiber
- Power = 16,000-10,000 mAh
  Smart Batteries

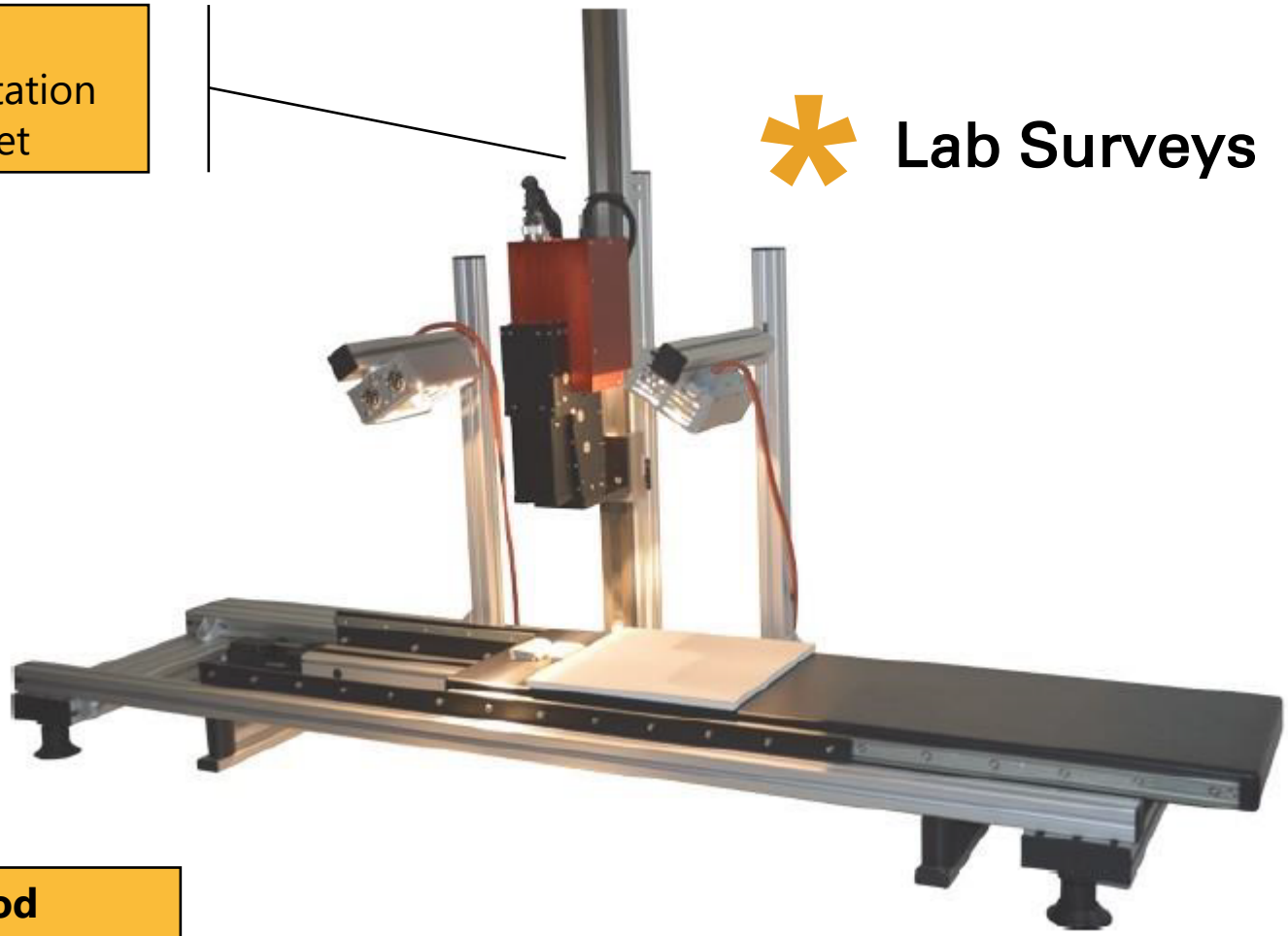
High Resolution RGB Camera

Sony ILX-LR1
61MP DSLR; 24mm F2.8
G Full-frame Wide-angle lens

Hyperspectral VNIR-SWIR (400-2500 nm) Imaging Spectrometer w/ LiDAR

HySpex Mjolnir VS-620
VNIR = 200 Spectral Bands @ 3.0nm
SWIR = 300 Spectral Bands @ 5.1nm

HySpex Lab Rack
Transition stage; lamps rotation stage; reflectance target



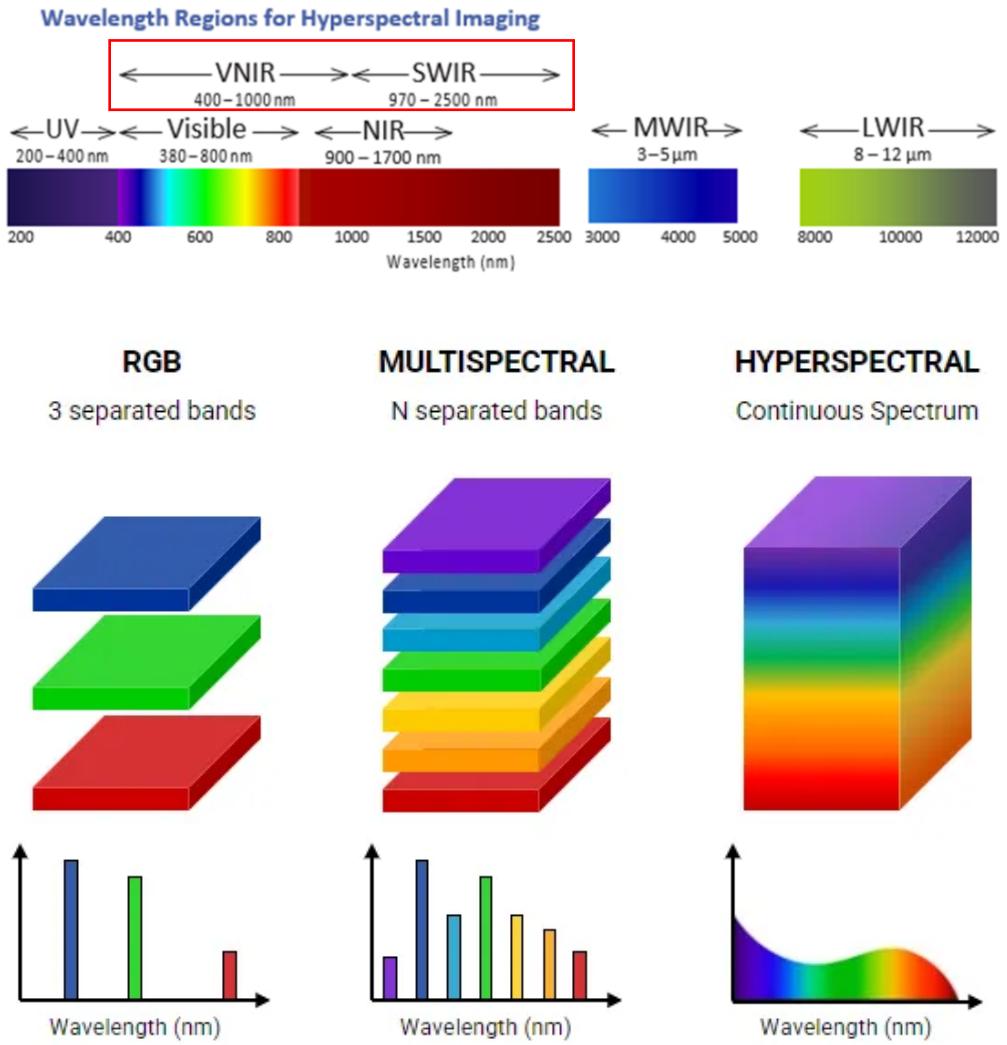
* **Lab Surveys**

* **Field Surveys**

HySpex Field Tripod
Battery and charger; rotation stage; reflectance target

Hyperspectral imaging is a technology that acquires and analyzes reflected light in the Visual Near Infrared and Infrared wavelength regions of the electromagnetic spectrum.

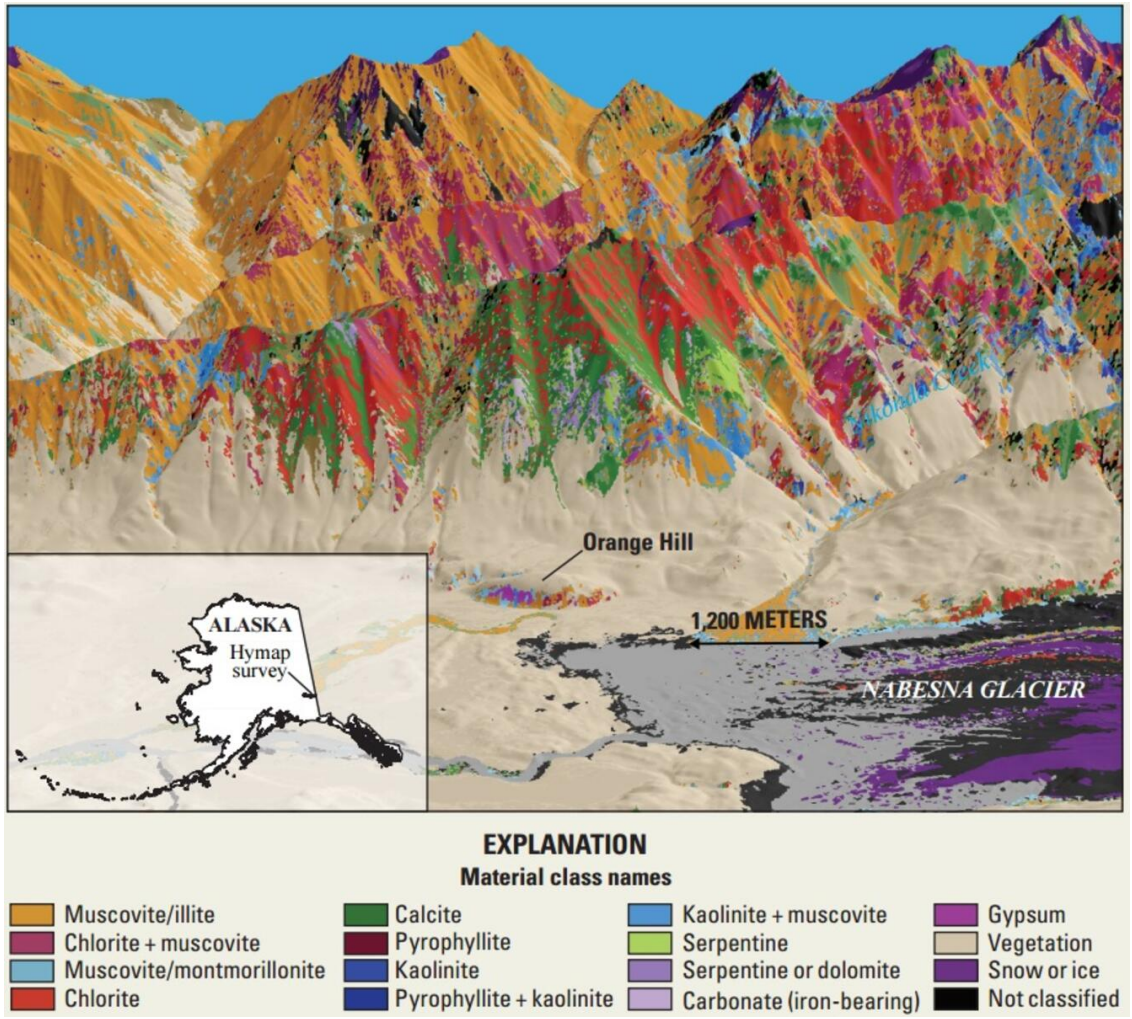
Utilizing hundreds of continuous spectral bands, HSI provides a wealth of spectral information compared to the tens of discrete spectral bands used in multispectral imaging.



The refined spectral resolution of HSI can provide direct identification and analysis of surface materials.

Many subtle objects and material substances can be detected, discriminated, classified, identified, and quantified.

Over the past couple of decades, HSI has become increasingly popular in economic and environmental geology.



https://eros.usgs.gov/doi-remote-sensing-activities/2016/usgs/hyperspectral-remote-sensing-characterize-mineral-resources-alaska

Infrared Mineral Identification Table

	Silicate Structure	Mineral Group	Example	VNIR	SWIR	MWIR	LWIR
Silicates	Inosilicates	Amphibole	Actinolite	Possible	Good	None	Good
		Pyroxene	Diopside	Moderate	Moderate	Uncertain	Good
	Cyclosilicates	Tourmaline	Elbaite	None	Good	Good	Moderate
	Nesosilicates	Garnet	Grossular	Possible	Possible	None	Good
		Olivine	Forsterite	Possible	Possible	Uncertain	Good
	Sorosilicates	Epidote	Epidote	None	Good	Uncertain	Moderate
	Phyllosilicates	Mica	Muscovite	None	Clear	Uncertain	Moderate
		Chlorite	Clinochlore	None	Good	Uncertain	Moderate
		Clay Minerals	Illite	None	Good	Uncertain	Moderate
			Kaolinite	None	Good	Uncertain	Moderate
	Tectosilicates	Feldspar	Orthoclase	None	None	Possible	Good
			Albite	None	None	Possible	Good
		Silica	Quartz	None	Possible	Moderate	Clear
Non-Silicates	Carbonates	Calcite	Calcite	None	Moderate	Clear	Good
		Dolomite	Dolomite	None	Moderate	Clear	Good
	Hydroxides		Gibbsite	None	Good	Uncertain	Moderate
	Sulphates	Alunite	Alunite	Possible	Good	Moderate	Moderate
			Gypsum	None	Good	Moderate	Good
	Borates		Borax	None	Moderate	Uncertain	Uncertain
	Halides	Chlorides	Halite	Uncertain	Uncertain	Uncertain	Uncertain
	Phosphates	Apatite	Apatite	Possible	Possible	Uncertain	Good
	Hydrocarbons		Bitumen	Possible	Moderate	Good	None
	Oxides	Hematite	Hematite	Good	None	Possible	Possible
		Spinel	Chromite	None	None	Uncertain	None
	Sulphides		Pyrite	Possible	None	Possible	Possible

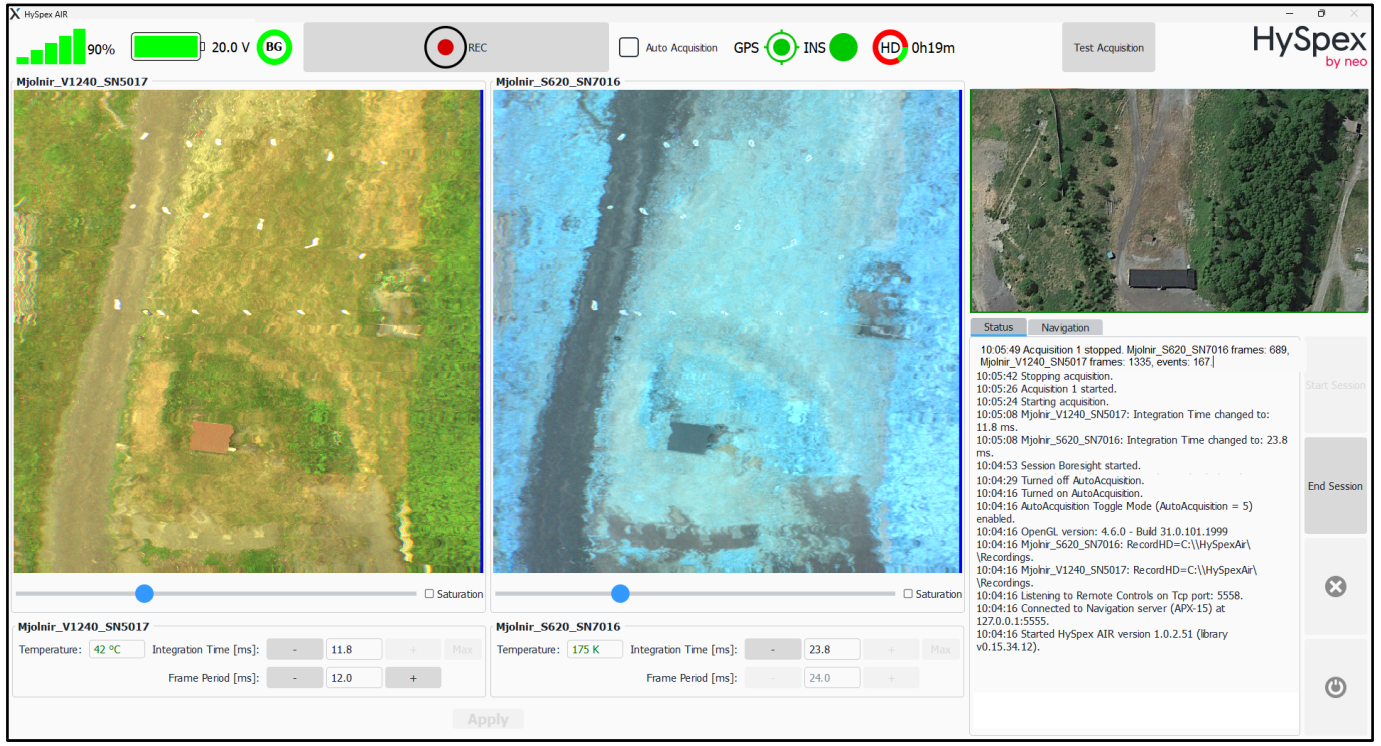
Clear – Most suitable region for mineral identification
Good – Good response but mixtures can influence mineral characterization
Moderate – Moderate but better mineral responses in other regions
Possible – Selective response possible but mineral identification difficult
None – Non-Diagnostic responses or no responsiveness of mineral in region
Uncertain – Available spectral data insufficient to assess identification potential

Source: TerraCore

Minerals exhibit distinct absorption and reflectance features at specific wavelengths of the electromagnetic spectrum due to their unique chemical compositions and crystal structures.

In HSI, these spectral signatures enable precise identification and mapping of minerals, particularly in the visible, near-infrared (VNIR), and shortwave infrared (SWIR) regions.

HySpex Air



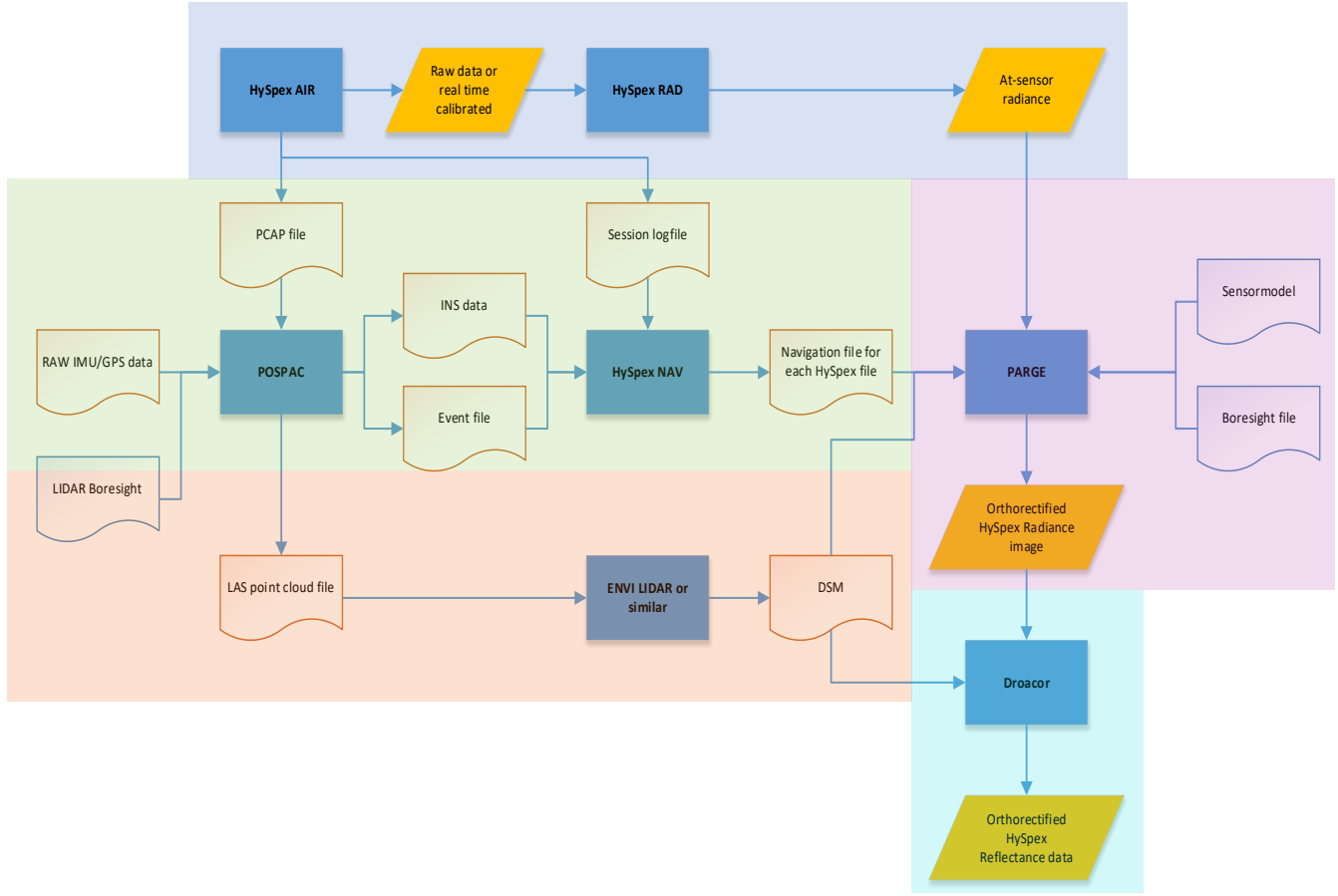
Flight times can range from 10-25 minutes depending upon the size of the drone, and the environment the survey is being conducted in. Some HSI cameras offer real-time data management.

ASD Inc.

Ground-truthing:

To assist in training, ground surveys will be conducted using a spectroradiometer to provides reliable reference data for supervised classification algorithms.

HSI requires a sophisticated sequence of data processing techniques. Different levels of post-processing are used to correct geometric and atmospheric noise generated in hyperspectral images.



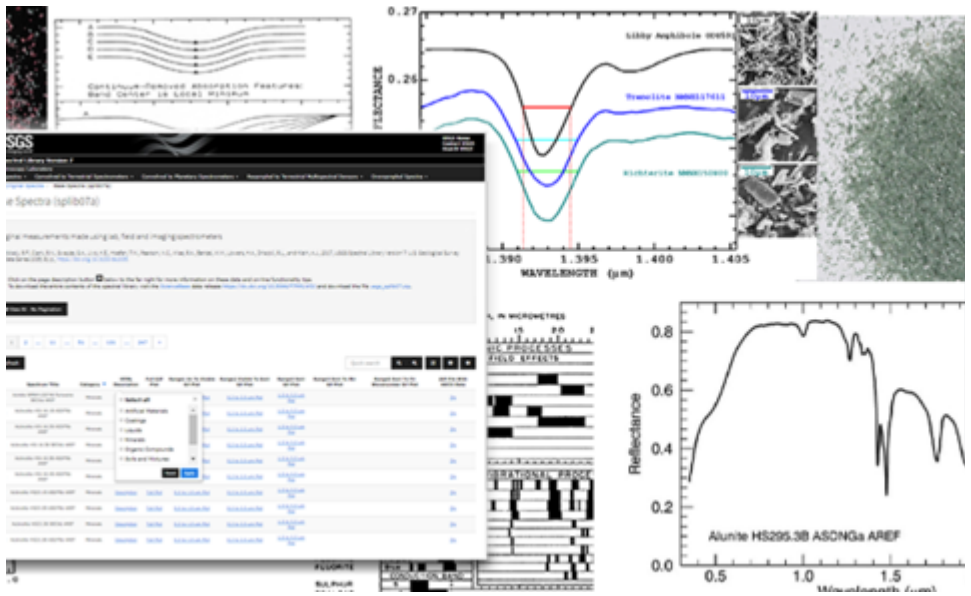
Spectral algorithms

Tetracorder; *U.S. Geological Survey*

- Designed to identify and map materials based on their spectral signatures using a library of known spectra.
- Can distinguish between very similar materials.
- Offers quantitative data on material concentrations.
- Complex to implement, computationally demanding.

Spectral Angle Mapper; *Jet Propulsion Laboratory*

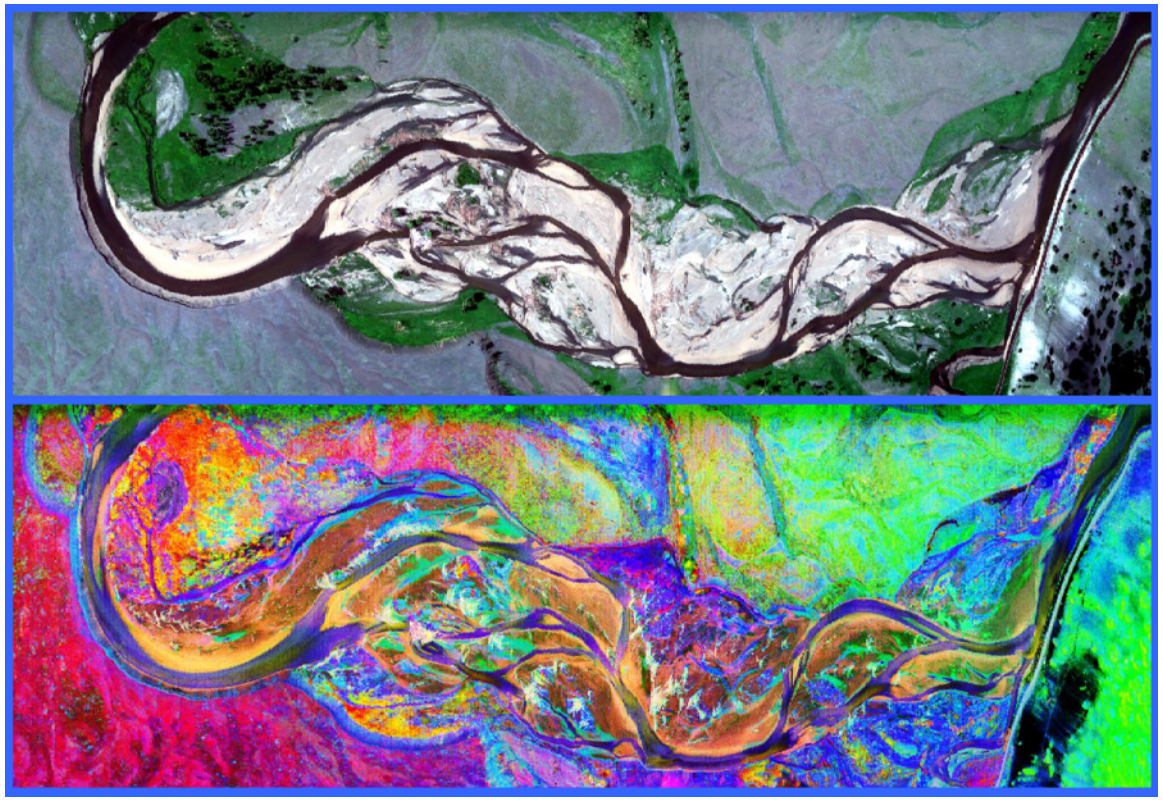
- Measures the similarity between spectra by calculating the angle between them in a multi-dimensional space.
- Less affected by variations in illumination.
- Cannot distinguish between very similar materials.
- Simple to implement, computationally less intensive.



https://www.usgs.gov/labs/spectroscopy-lab

Meet the flight crew:
James Amato FAA107
Kyle Summerfield
Rachel Toner FAA107

Photogrammetric Surveys = 2 people
Hyperspectral Surveys = 3 people



https://possibility.teledyneimaging.com/hunting-new-mining-deposits-hyperspectral-imaging/

Geologic Applications

- Mineral exploration
- Lithological mapping
- Coal quality characterization
- Indirectly monitor gas seepage

HySpex by neo

SPECIM SPECTRAL IMAGING

Headwall

RESONON

CHUBB

STARR

QUESTIONS