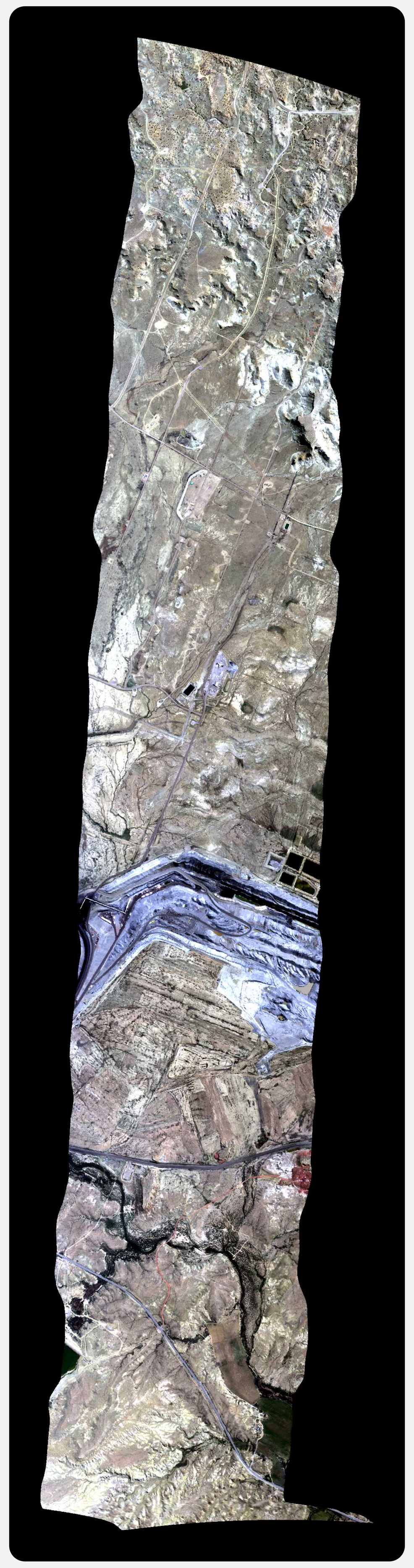
COAL AND OPEN-PIT SURFACE MINING IMPACTS ON AMERICAN LANDS (COAL)

COAL is a Python library for processing hyperspectral imagery from the Airborne Visible/InfraRed Imaging Spectrometer (AVIRIS-C & AVIRIS-NG)

Measuring mining impacts on water resources



An AVIRIS flightline over the San Juan Coal Mine in Waterflow, New Mexico

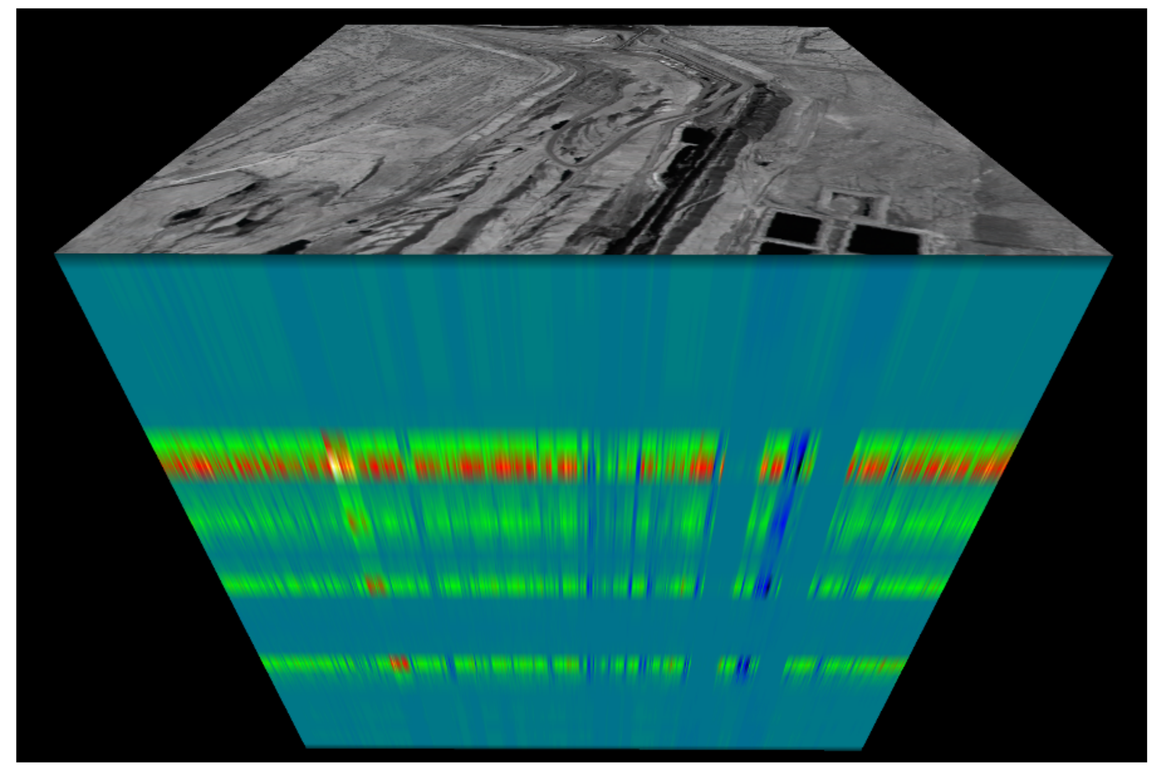
Problem

- Mining is known to affect the environment, but few software tools exist to quantify its impacts
- A large volume of **AVIRIS imagery** is available
- **Spectral libraries** contain samples of thousands of minerals and other materials
- **Environmental data** is collected by local, state, and national governments as well as non-governmental organizations
- Our goal is to contribute tools to **combine this data** in a coherent way

Solution

- Python library implementing a **suite of algorithms**
- **Classify minerals** and other land surface types
- **Identify mines** and other geographic features
- **Correlate environmental impacts** with mining operations
- Release as **Free and Open Source Software**

The San Juan Coal Mine and Generating Station. Courtesy San Juan Citizens Alliance/EcoFlight.



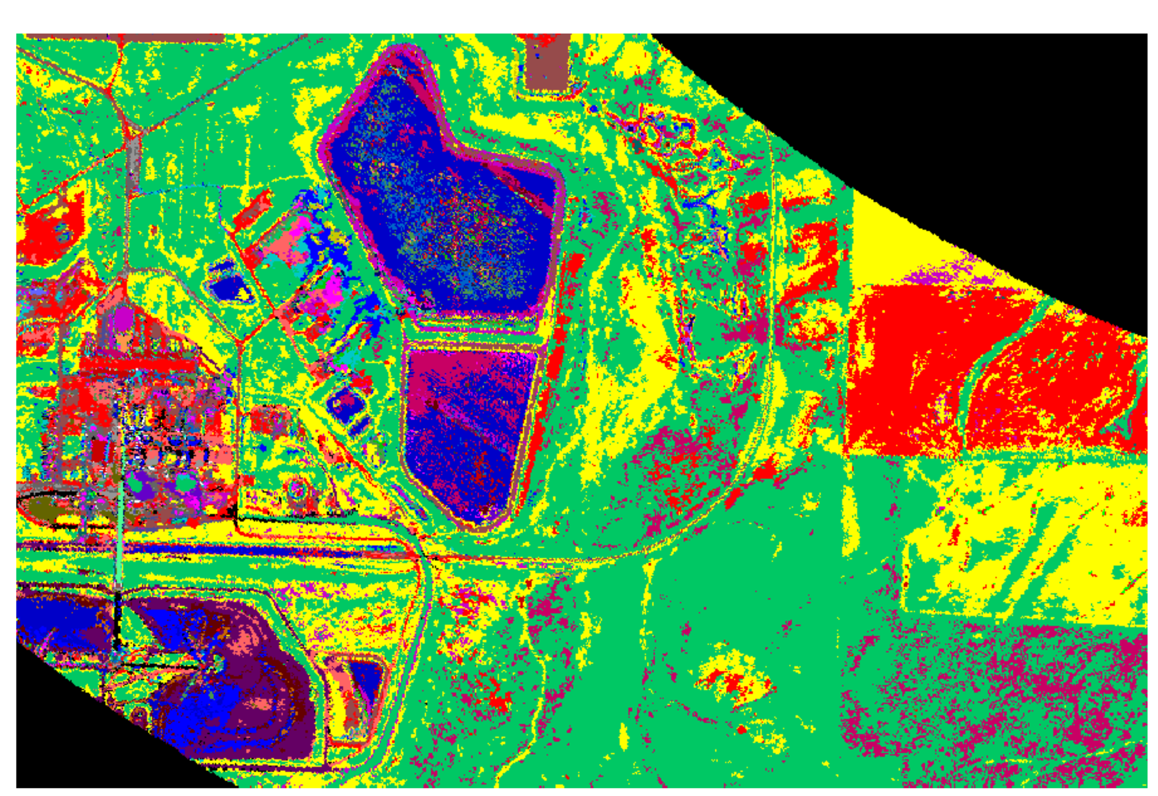
Three-dimensional visualization of hyperspectral imagery displaying spectral bands

Mineral Classification

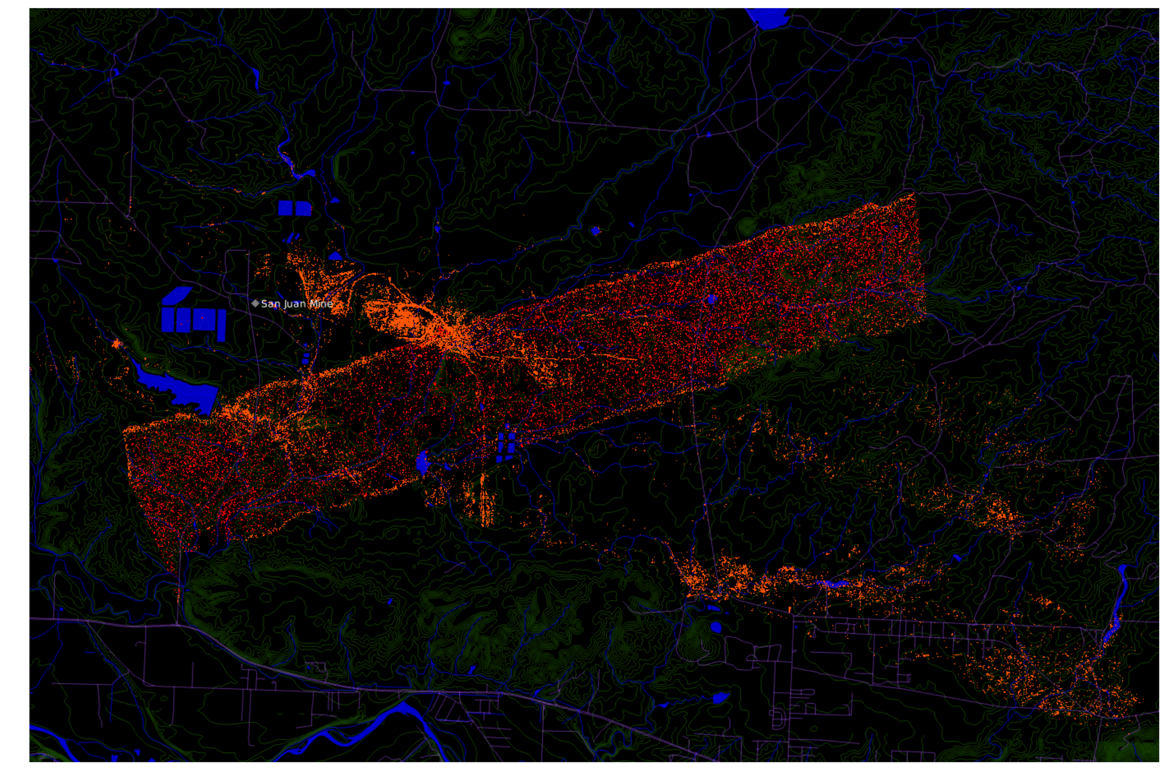
- All minerals have unique **spectral signatures**
- Samples of those spectral signatures are contained in **spectral libraries** e.g. ASTER, USGS and ENVI
- Using the raw AVIRIS images with unknown land cover and spectral signatures, **classify** each pixel with **spectral angle mapper** classification. Other classification options exist e.g. unsupervised K-Means, supervised Gaussian Maximum Likelihood, Mahalanobis Distance and Multi-Layer Perceptron
- Output is a **mineral classified file** where each pixel is assigned to a particular class in the spectral library

Mining Identification

- Use certain classes of minerals as **proxies** for presence of mining
- Output is a **mining classified file** where each pixel is identified as either corresponding to mining or not



Mineral-classified image showing land surface types surrounding a coal facility in Craig, Colorado.



Map of coal mine, waste classifications, water resources, and surrounding geography.

Environmental Correlation

- **Map identified mines** in GIS applications and correlate them with water quality measurements
- Determine whether **water pollution** is linked to mining
- Use results to enhance **environmental understanding**

Temporal Analysis

- Implement a **Science Data System** to batch process past and present imagery
- **Facilitate research** with unique data products
- Enable analysis of **changes over time**

Future Work

- Accepted as OSU Senior Capstone 2017-2018 COAL Follow-On focused on improving classification algorithms
- Leverage NSF-funded XSEDE Startup HPC Allocation to process entire AVIRIS-C/NG archive

Distribution of coal mining waste classifications along streams and water bodies.

Hyperspectral imagery of the Escondida Mine in Chile. Courtesy NASA/JPL-Caltech.

Capstone COAL

Team

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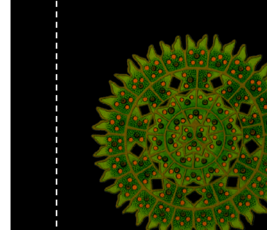

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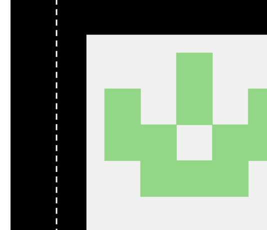

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Website

For more information, visit our website:

`https://capstone-coal.github.io`