# How NASA Reads Minerals from Light

This activity was developed on behalf of NASA for Earth Science Week 2026.

## Introduction

What if you could identify a mineral just by looking at the color of light it reflects? That's the idea behind imaging spectroscopy, a technology NASA originally developed to study the surfaces of other planets period now, through a mission called the Geological Earth Mapping Experiment (GEMx), NASA and the U.S. Geological Survey are turning those same instruments toward the American West to locate critical minerals. In this activity, you will explore how light-based remote sensing works, examine real GEMx data, and consider the larger economic and environmental questions surrounding critical mineral discovery.

## Materials

- Computer with internet access:
    a. NASA Flights Map Critical Minerals from Skies Above Western U.S.
    b. EARTHDATA Search Interactive Data Map
    c. EMIT mission page
- Colored pencils or markers (optional)

## Steps

1. The science of spectroscopy:
    a. Every molecule reflects light in a unique pattern across different wavelengths. Scientists call this a spectral “fingerprint.” Think about what you already know about light:
        - What is the visible spectrum? What lies beyond the visible spectrum?
        - Why might different minerals reflect specific wavelengths of light in different ways?

    b. Read the article, NASA Flights Map Critical Minerals From Skies Above Western U.S., written by the Jet Propulsion Laboratory (JPL).
        - In your own words, explain how an imaging spectrometer is different from a standard camera.
        - The article describes the landscape looking “barren and brown" to the human eye but “gleaming and hundreds of colors” To the sensors. What

does this tell you about the limits of human vision for this type of scientific work?
- The article mentions two instruments: AVRIS and EMIT. What is the key difference in how and where each operates? What are the tradeoffs between collecting data from an aircraft versus the International Space Station?

2. Exploring GEMx data:
    a. Access the EARTHDATA Search Interactive Data Map filtered to search for GEMx data. Take a few minutes to explore the interactive map.
    b. Select a flight path or survey area and zoom in to examine the mineral map data shown.
        - What region are you looking at? Describe its general geography.
        - What colors do you observe in the data layer, and what minerals do those colors represent according to the map key?
        - Are the minerals distributed evenly, or do certain minerals cluster in specific locations? What might explain the patterns you see?
    c. Find a standard satellite or topographic map of the same location and compare it to the GEMx data map.
        - Do mineral concentrations appear to follow any geographic features, such as mountain ridges, dry lake beds, or river valleys?
        - What geological processes might explain why minerals are concentrated where they are?

3. From space to the field:
    a. Once mineral maps are released, ground truthing—physically visiting locations to verify what remote sensors detected—is a critical step. The article mentions that geologists are revisiting old, abandoned mines as part of this work. Why might a mine that was abandoned decades ago suddenly be worth a second look?
    b. The article notes that mine waste sites that were once considered pollution sources "could now be a resource." What are the potential benefits and risks of extracting minerals from old mine tailings? Consider:
        - environmental impacts
        - community health
        - economic opportunity

## Analysis

1. How does imaging spectroscopy offer a fundamentally different kind of information in the geophysical surveys that geologists have traditionally used, such as measuring gravity, magnetism, or radioactivity? Why do scientists typically use more than one approach?
2. GEMx covers more than 190,000 square miles, roughly the size of Spain. What are the advantages of surveying such a large area from the air rather than on the ground? What information might still need to be collected from ground-based field work?
3. Who benefits from the data GEMx collects, and who makes decisions about what happens next? Consider the rules of federal agencies, private mining companies, local communities, and foreign governments in this process.
4. GEMx data is described as having value beyond mineral identification, including for studying and base of species, mind contamination, and natural hazards. Pick one of these non-mineral applications that explain how an imaging spectrometer could help scientists study it.

## Extension

Visit the EMIT Mission page. EMIT was originally designed to study mineral dust and its effects on climate, but its data also contributes to mineral mapping.

- How does a single instrument end up being useful for two very different scientific questions?
- Compare the spatial resolution of EMIT (which operates from the ISS) to AVRIS (which operates from a low flying aircraft). When would you want coarser resolution data, and when would finer resolution matter more?