EMIT Bare Earth: Regional to Global Mineral Mapping from Hyperspectral Satellite Data

EMIT is a satellite-based hyperspectral sensor that measures wavelengths spanning the visible and near-infrared (VNIR) to the shortwave infrared (SWIR), capturing the diagnostic absorption features of specific minerals. Multispectral imagery typically comprises 6–12 spectral bands enabling the identification of specific mineral groups, whereas hyperspectral sensors record more than 200 bands, making them well suited to identifying individual mineral species. Building on this capability, the EMIT Bare Earth product supports regional to global mineral mapping and surface analysis by maximising the value of these data. The approach processes the full stack of EMIT imagery over an area of interest, significantly reducing the spectral and analytical interference introduced by cloud cover, terrain shadow (hill shade), and vegetation.

The barest available pixels for each location are selected and the resulting mosaics provide an enhanced representation of the barest Earth surface at high spectral resolution, enabling the detection and potential discrimination of individual mineral species rather than broad mineral assemblages. Critically, the workflow scales to very large regions, and has been applied across extensive terranes such as the Arabian Shield, the Andes, and the Anti-Atlas.

The advantages of hyperspectral data come with considerable technical demands. Processing at this scale requires handling, cleaning, and analysing terabytes of geospatial and spectral information, alongside careful georeferencing, mosaicking, and quality control. We address these requirements using high-performance computing (HPC) workflows, which allow the Bare Earth approach to extend beyond individual scenes to seamless mosaics covering entire regions without compromising spectral quality.

Once the mosaic has been generated, two complementary methods can be applied, depending on whether the objective is localised prospecting or regional screening. Linear Spectral Unmixing (LSU) is a data-driven workflow that identifies the most mineralogically pure pixels in the image and compares them against established mineral spectral libraries. Each pixel is then decomposed into proportional mineral abundances, and minerals of interest can be highlighted in the outputs. This enables a targeted search for specific minerals and mineral assemblages informed by prior knowledge of the area, and is especially useful where specific commodities, alteration assemblages, or geological models are of interest.

In contrast, Minimum Wavelength Mapping (MWM) is a knowledge-driven method that does not require predefined targets. It visualises spectral anomalies and outliers within key absorption windows across the spectrum, highlighting both abrupt changes and gradual transitions in mineral chemistry across a region. In doing so, it can flag previously unrecognised materials or assemblages for geological interpretation at a regional scale, making it particularly valuable for early-stage exploration, regional screening, and frontier settings where prior geological understanding may be limited. This extends interpretation capability beyond traditional band-ratio techniques.

Together, these workflows provide a flexible toolkit spanning hypothesis-driven investigations and more open-ended, exploratory analyses. By combining high spectral resolution with the ability to process very large areas, the approach makes it practical to apply consistent, detailed mineral mapping across whole belts and shields.