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## **GeoMAP-outcrop – 3D hyperspectral outcrop mineral and REE mapping**

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Imaging spectroscopy is gaining importance in earth and environmental sciences. Noninvasive, fast and extensive surface scans from various distances and platforms and the retrieval of surface mineralogy linked with element abundances estimations complement classic prospection and exploration approaches. A first prototype for hyperspectral outcrop mineral and REE 3D surface mapping has been recently developed and tested in the framework of the EnMAP satellite project and the Rare Earth Element MAPPING project (REEMAP). This approach is part of the GeoMAP (Geosphere MAPPING) framework that combines multiple remote sensing sensors, analysis modules (Minerals and Rare Earth Elements) and applications (EnGeoMAP – EnMAP GeoMAP). It is primarily designed for geological exploration, but might be utilized for other applications such as mining monitoring. GeoMAP-outcrop combines photogrammetry using a Nikon digital camera and a Cubert UHD-185 full frame spectrometer with rotational HySPEX VNIR/SWIR outcrop line scanning. The prototype processing chain consists of three specific modules: sensor, core and map. In the sensor module geometrically and atmospherically corrected at-surface reflectance is retrieved for all imaging spectrometers. It utilizes a modified SIFT and affine FFT sub pixel precise co- and intra-sensor-registration, spatial polynomial irradiance estimation, shadow impact reduction and 3D digital surface modelling. The core module consists of two existing analysis approaches – GeoMAP-base and GeoMAP-REE - for automatic and knowledge based surface minerals and REE retrievals using geochemically and mineralogically validated reference spectral libraries. In the map results are projected onto the 3D surface and may serve as basis for thematic geological applications such as exploration. First tests proved the high potential of GeoMAP-outcrop and may serve as motivation for further research and testing of different applications in the earth science domain.

