Geophysical Research Abstracts
Vol. 20, EGU2018-18279, 2018
EGU General Assembly 2018

Mineral identification using a new hyperspectral library and sparse unmixing techniques

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On-line-real-time combined mineralogical and chemical analyses on drill cores are highly demanded by mining and metallurgical companies to speed up exploration and mining, as they provide more precise geomodels, and optimal definition of metallurgical parameters. The EU-H2020 SOLSA project (www.solsa-mining.eu), targets to construct an expert system coupling sonic drilling with an on-line-real-time analytical system combining systematic mineralogical and chemical analyses on drill cores. The analytical system comprises a profilometer, a high resolution RGB camera, VNIR (Visible Near Infrared)/SWIR (Shortwave Infrared) (Specim Ltd., Finland) hyperspectral cameras, and a XRF spectrometer. The objective is to reach real-time decision making through scanning of about 60 m drill cores per day. The system will be validated for nickel laterites, which represent 70 % of the Ni resources worldwide.

SOLSA will provide open databases for combined analyses. Therefore, a hyperspectral open data base is built for nickel-laterite specific rocks and pure mineral samples. All these samples are also analyzed by conventional laboratory methods (XRD, Raman spectroscopy, SEM, EPMA and QEMSCAN®). Currently, 27 spectra representing 14 minerals (i.e. asbolane, chromite, diaspore, olivine (forsterite), clay minerals (kaolinite, saponite, pimelite), magnesite, pyroxene (enstatite), serpentine (lizardite, nepouite, antigorite), talc, calcite) have been collected for our hyperspectral library. We plan to open it to public at https://solsa.crystallography.net/sod/.

As the spectra of drill cores often contain a mixture of minerals, spectral unmixing techniques have been investigated and implemented. We employed sparse unmixing techniques, which have connections with the statistical and geometrical frameworks and have recently been demonstrated a great success in unmixing hyperspectral data for remote sensing applications. Sparse unmixing techniques aim at finding the optimal subset of signatures in a spectral library that can best model each mixed pixel. The methods exploit the fact that a spectrum always contains a mixture of a small numbers of endmembers, which is the case in our data acquired from the nickel-laterite samples. Among investigated unmixing methods, the collaborative sparse unmixing by variable splitting and augmented Lagrangian (CLSUnSAL) method provided the most accurate unmixing results on simulated data that were generated from our hyperspectral library. Hyperspectral data acquired from a serpentinized harzburgite sample (SOLSA label of ER-MB00-0012) on a polished surface, were processed by the CLSUnSAL method using our hyperspectral library. The same sample was analyzed by QEMSCAN®. A good correlation was found for the mineralogy and mineral distribution (olivine, pyroxene, serpentine, chromite) between the results of the CLSUnSAL and QEMSCAN® methods. These analyses will be cross-evaluated by the Raman spectroscopy mapping.