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IMPROVING IN-SITU RECOGNITION OF PLANETARY MINERALS THROUGH CUSTOM DATABASE AND CLASSIFICATION SOFTWARE

Abstract

Identifying minerals in-situ is vitally important when exploring the Moon, Mars and other planetary bodies, enabling valuable geological samples to be recognised in real time and then prioritised for collection and return. The ESA-PANGAEA Mineralogical Toolkit aims to enhance the recognition of planetary minerals through creating a custom structured database containing information on all known minerals present on the Moon, Mars and meteorites. It also seeks to develop new more effective analytical methods for identifying these minerals in-situ. The Mineralogical Toolkit is composed primarily of the PANGAEA Mineralogical Database, and Machine Learning (ML) software for recognition of minerals from multispectral data. The Mineralogical database can be viewed as two distinct products, a catalogue of petrographic information, and an analytical library. The catalogue consists of petrographic information on all currently known minerals identified on Moon, Mars, and found primarily, or exclusively, within meteorites. The catalogue is envisioned to provide essential analytical in-field information for each mineral to assist in its rapid identification, interpretation, and understanding of significance during human and robotics geological exploration. The second major contribution provided by the PANGAEA Mineralogical Database, is a customised library of analytical data from all known planetary terrestrial analogue minerals. This covers four analytical methods: 1. reflective Visual-to-Near- Shortwave-Infrared (VNIR); 2. Raman scattering spectroscopy; 3. Laser-Induced-Breakdown (LIBS), and 4. X-Rays Fluorescence (XRF) spectroscopy. This library includes a set of standard spectra, which is used for evaluating the detectability of minerals with different analytical methods. The multispectral library is designed to be used for the recognition of planetary materials, and acts as a training and evaluation dataset for our mineral recognition software.

This software, based on the ML Neural Network algorithms, can classify minerals either from standalone spectroscopic methods, or using a combination of spectroscopic data. Our cross-validation tests show that multi-method spectroscopy paired with ML paves the way towards rapid and accurate characterization of rocks and minerals. The PANGAEA Mineralogical Toolkit is envisioned as a part of the PANGAEA Electronic Fieldbook system (EFB) which in combination with handheld analytical tools will enable fast reliable recognition of rocks and minerals in-situ during for example sample collection. Developed and tested together, the suite of analytical data, spectroscopic instruments, and data collection and identification software is conceived as a next generation decision support tool for future human and robotic planetary surface exploration missions.