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Hyperspectral Imaging for Mapping Outcropping Li-bearing Pegmatites

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The transition towards a net-zero economy has led to an increased need for several critical raw materials required for green technologies. Lithium (Li) is one of these materials, which is experiencing a sharp increase in demand that recycling alone is not capable of meeting. Significant mineral exploration using sustainable, efficient and innovative methods is required to not only improve mineral detection and mapping, but also foster social acceptability for the mining and exploration industry. Hyperspectral imaging (HSI) is a rapidly developing technology that allows for fast and systematic identification of key minerals and provides information about mineral abundances and associations. In this contribution, we propose an innovative approach for exploration by using hyperspectral data from multiple sensors at various scales to non-invasively map ore and pathfinder minerals. We showcase this approach at the Uis pegmatite complex located in Namibia. Hand-samples taken at the Uis pit were used to identify the relevant minerals as well as for training/validation purposes, and we acquired HSI data of the pit using a short-wave infrared (SWIR) camera mounted on a tripod. Using machine learning and computer vision techniques, we upscaled this information to the outcrop scale and created a three-dimensional (3D) point cloud of the pit with HSI attributes to map relevant Li-bearing minerals, such as cookeite and montebrasite. Results were validated using drill-core data, LIBS measurements and XRF analyses. We recently acquired uncrewed-aerial vehicle (UAV)-based SWIR data, to allow flexible data acquisition and mitigate access limitations. With in-house tools, the data is being processed (e.g., geometric and radiometric corrections) and we expect to map Li-bearing minerals in a similar manner. This approach enables rapid and efficient mapping of complex terrains in a sustainable exploration scheme, and can be used for monitoring and optimisation of ore extraction.