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Hyperspectral Mineral Mapping with UAVs: Challenges and Opportunities for Minerals Exploration

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Uncrewed aerial vehicles (UAVs) have rapidly become integrated into the mining lifecycle, with applications in exploration, production and post-mining management. Although mostly used for photogrammetric surveying, a variety of additional sensors are increasingly being deployed. Of particular relevance to mineral exploration, these include geophysical instruments (e.g., magnetometers, radiometers) and imaging spectrometers (e.g., multi- and hyperspectral cameras), that can be deployed to rapidly and accurately map structure, lithology and alteration. Hyperspectral sensors are especially sensitive to subtle mineralogical changes that can guide exploration and mining operations, albeit in well exposed areas (e.g., cliffs, open-pit workings, mountains or coastal outcrops). In this contribution, we present an overview of our current workflow for collecting and correcting UAV hyperspectral data for geological applications, and outline some of the important caveats and challenges when deriving geometrically and spectrally corrected data in topographically complex environments. We emphasise the importance of three dimensional topographic data, collected using photogrammetric techniques, and highlight the potential of combined digital outcrop and hyperspectral remote sensing workflows. An open-source implementation of this workflow (hylite) is introduced, and current challenges identified. Specifically, we highlight the need for rapid, robust and easy to use tools for processing data in the field, to facilitate QAQC and optimised survey planning and targeting. Finally, we present several case studies that apply hyperspectral UAV data to advance exploration for primary and secondary raw materials.