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Drone-borne spectral monitoring of post-mining areas

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Mining always played a decisive role in achieving modern technology standards, influencing raw material driven aspects of today's societies. During the last decade, more focus is put towards environmental protection in developed countries. This progression is not yet implemented in many mining sites all over the world. In those cases, mining and post-mining management represents a negative intervention in ecosystems. We take the example of acid mine drainage (AMD) accompanied by high concentrations of dissolved metal ions, which influence characteristics of soils and water bodies. This poses a hazardous situation not only to nature, but also to agriculture and food production. Monitoring of post mining-related contamination hot-spots is one step to detect problems and take fast responsive actions. Environmental screening basically depends on geochemical analyses, gathered from sampling points, distributed over the investigated area. Even though this kind of investigation provides very detailed information about concentrations of various elements and compounds, that information is only available for sampled spots. Furthermore, some areas are inaccessible due to various reasons (risks of rockfall, cliffs, inaccessible terrain). We present two case studies with test-areas from the coal-mining districts of Sokolov in the Czech Republic and from eastern Saxony in Germany. The acquisitions in the German test sites are part of the EU-founded project "VitaMin".
The use of unmanned aerial systems (UAS) provides the possibility of detailed surface mapping, using sensors that are light enough to be mounted on a UAS. We carried out several studies in post mining areas, including drone [U+2011] borne multi- and hyperspectral acquisitions, along with ground-based validation data. This approach allows the generation of high resolution surface maps, containing information about the distribution of certain elements, mineral proxies and chemical compounds. The sensor wavelength-ranges and spectral resolution determine the substances that can be detected. Among the spectral detectable substances, iron is of key importance. By analyzing the spectra in the visible to near infrared region of the electromagnetic spectrum, we distinguish between Fe(II)- and Fe(III)-compounds. Furthermore, iron bearing minerals are a suitable indicator for the distribution and severity of acid mine drainage. A rough estimation about the predominant pH-value can be made. Hyperspectral imagery is one solution to enhance the quality of classical geochemical analyses and increase the overall amount of information during efficient environmental monitoring. We highlight the potential of UAS hyperspectral mapping to provide a highly efficient way of precisely mapping superficial indicative compounds. We explore the potential in combining drone-borne hyperspectral imaging with geochemical analyses.