AHS mapping for hydrothermal alterations detection and mineral deposits exploration

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Abstract. The Active Hyperspectral Sensing (AHS) application for a mineral mapping have been tested on outcrops with porphyry-copper style of mineralization in the Vlaykov Vruh and Tsar Assen deposits. As a new tool used in mineral exploration AHS reveals the advantages for mineral detection and targeting as an express new innovative technology and efficient tool for mineral prospecting.

Keywords: active hyperspectral sensor (AHS), Cu-porphyry deposits, mineral alterations.

Introduction

A new technology of Active Hyperspectral Sensing (AHS) field tests for hydrothermal mineral alterations has been presented on the example of the Cu-porphyry deposits in the Panagyurishte ore district, Bulgaria. This advanced mineral detection approach demonstrates an innovative technology and efficient tool for mineral mapping and ore deposit exploration. The AHS is a new tool recently used in mineral exploration. However, the screening of large surface areas irrespective of any light conditions is now available. Thus, a high-quality geological mapping of outcrops and mine benches become possible in addition to underground mine sections. We have tested this recently developed technology (Kääriäinen et al., 2019) that could be efficient in any ambient light conditions and enables a distant mineral alteration detection and mapping of Cu-porphyry and Au-epithermal systems.

In this work, we present the operating principle of the active hyperspectral sensor (AHS) and field measurement results from two Cu-porphyry outcrop locations in Bulgaria.

Methods

Hyperspectral sensing is widely used for mineral recognition and geological surveys. The use of this technique requires well illuminated conditions. Therefore, a successful passive hyperspectral imaging requires a sunny day and a clear sky. The use of active systems, on the other hand, is cumbersome, as to this day the only light sources have been thermal sources which require large amounts of power and can only be used at very small distance to the target. Recently, the use of supercontinuum-based illumination has been demonstrated to overcome these limitations for hyperspectral sensing (Jaansson, 2018; Kääriäinen, 2019, 2021). In the EU Goldeneye project, this technique is further applied for mineral detection.

The working principle of the AHS used in this work is illustrated on Fig. 1A. The system consists
of a unique broadband laser source developed at VTT. This source provides very controlled illumination, such as from a visible laser pointer. Small spot size can be illuminated from a significant distance. In addition, the illumination contains a broad band of wavelengths in the short-wave-infrared (SWIR) region, covering the range 1300–2500 nm. The laser source makes the system operable in complete darkness, such as underground mines. Since the light is emitted in short pulses, it is also simple to separate the reflected signal from the ambient illumination. To record spectral information, the broadband laser source is filtered with a proprietary microelectromechanical tunable filter (Antila, 2010; Akujärvi, 2016; Rissanen, 2017). The filter transmittance, shown on Fig. 1A, is swept across 2 µm to 2.5 m, as this region is suitable for mineral detector. The receiving optics of the AHS collect the small amount of light scattered from the target minerals. The system sensor can record 50 spectra every second from 5 m. Figure 1C shows the AHS mounted on a pan-tilt unit and a tripod. By moving the AHS, we can record a hyperspectral image of the target. The power consumption of the AHS unit is low enough to be used by battery powered systems and, in the future, even drone-based operation could be feasible.

### Field tests results

Mineral alteration mapping AHS study of selected field sections of alteration minerals assemblages covering area of ca. 2×1 m have been performed in Cu and Au deposits in the Panagyurishte ore district to display surface mineral distribution. Outcrops, consisting of phyllic, argillie, propylitic and K-silicate alteration zones associated with and porphyry-copper style of mineralization in the Vlaykov Vrhu and Tsar Assen deposits, in addition to agglomerate lava-breccia from the Pesovets volcano and propylitic alterations in the Radka Cu-Au epithermal deposits (Kouzmanov et al., 2009; Popov et al., 2012) were tested. Surface spectral properties of phyllosilicate minerals such as muscovite, kaolinite, montmorillonite, illite, clinochlore, celadonite were detected by means of AHS imaging for mineral prospecting purposes. Muscovite, illite, albite, K-feldspar, epidote, clinochlore, pyrite, chalcopyrite, magnetite, hematite, calcite, dolomite, anhydrite, and jarosite have also been confirmed by reference of the USGS spectral library and XRD study. For the surface distribution maps of quartz, kaolinite and muscovite (Fig. 1D) and for muscovite (Fig. 1E) for the Tsar Assen Cu-porphry outcrop obtained by means of active hyperspectral sensing the pixel resolution is 1 cm.

### Conclusions

Our preliminary results of a reflectance spectra recorded with the supercontinuum-based illumination for mineral detection study of the ore associated phyllic, argillie and propylitic alteration assemblages from epithermal gold and porphyry-copper style deposits reveal the advantages of AHS sensing for mineral detection and targeting as express new innovative technology and efficient tool for mineral prospecting. Ongoing work aims at extending the spectral coverage to enable the identification of a wider range of important features for mineral identification.

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### References


