Mapping of Gold Mineralization Alteration Zones in Central Eastern Desert Egypt using Spectral Angular Mapper and Aeromagnetic Data

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Introduction
Central Eastern Desert (CED), Egypt has long history of gold exploration and exploitation (Figure 1). In this study, we integrated Spectral Angular Mapper (SAM) technique and aeromagnetic data to map the gold mineralization associated within alteration zones in CED. The spectral reflectance curves of five main alteration minerals (Hematite, Illite, Kaolinite, Chalcopyrite, and Quartz) were utilized as end members in the SAM supervised classification of ETM+ data. Each alteration mineral type was represented as a binary image that overlaid together to obtain single primary alteration map in CED. The possible pathways for the alteration migration was defined based on the subsurface and surface lineation features. For the subsurface lineation, Euler deconvolution filter was applied on the aeromagnetic data to locate the deep-seated faults. The surface lineation and shear zones were extracted from ETM+ data and used together with the subsurface lineation map to obtain a structural map. Layer intersection and fuzzy membership operation were applied for the entire datasets to identify the possible sites of alteration zones. Several GPS readings were taken from the field areas around the gold mine sites, and used as validation points for our methodology.

Gold History and Background

Alteration Zones
Alteration zones are defined as changes in the mineralogy, chemistry and texture of rocks, it formed along faults, shear zones, dykes and unconformities due to some tectonic activities. Alteration zones are the most favorable locations that host some precious metals like gold; it can be exposed or embedded within the rocks formation (Figure 2). Alterations that can host gold in ED such as: sericitization, beresitization, alunization, silification, ferrugination.

Figure 2. Two different kind of wall-rock alteration. a) is embedded in within the rock. b) exposed alteration zone, photos taken at CED, Egypt.

Methodology
SAM: technique is a supervised classification developed by (Kruse et al., 1993). It determines the angle between the two spectra and treating them as a vector in the space with n-dimensionality equals to the numbers of the bands. The smaller the angle the closer matches as one class.

Figure 3. Spectral reflectance curves of the main five Alteration Minerals

SAM Technique

Results
The resulted binary images of SAM classification based on Landsat7 ETM+ bands and the spectral reflectance curves of mineral forming the alteration zone provide the primary source of data about the alteration existence (see Figures 5 and 6).

Figure 5. Alteration zones structural controls factors: a) deep seated fault from Euler filter of the magnetic data, b) surface lineation features from ETM+.

Figure 6. Primary exploration map. a) Alteration zones indicated as black dots, b) validation of the results with GPS reading (in red) from alteration sites around mining area in CED.

Conclusion
Alterations zones considered the most promising areas for new mineral deposits exploration. The ancient miners of gold mineral in Egypt (Figure 7) only targeting the smoky quartz veins that contains plenty amount of gold that can be noticed by the naked eye. SAM is a powerful supervised classification that take the information from the reflectance curves of alteration minerals. Geophysical techniques can provide low cost effective tools that gives valuable information about the new sites of mineralization.

Figure 7. Ancient gold mine area in CED, Egypt.

References