ASTER IN MINERAL EXPLORATION: REVIEWS AND PROSPECTS

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Orbital remote sensing technologies have been employed for mineral exploration as both a geological mapping tool and a means to ore deposits within hydrothermal alteration haloes. Until 1999, Landsat TM and ETM+ images were the only globally available data used for geological and hydrothermal alteration mapping. Due to their limited spectral coverage such data could only detect two assemblages of alteration materials – iron minerals and clay/carbonate mineral which were manifest in the visible near infrared and shortwave infrared wavelengths respectively. This limitation was removed with the launch, of the Advanced Spaceborne Emission and Reflection Radiometer (ASTER), on board the Terra spacecraft - the first Earth Observing System (EOS) satellite. ASTER data contribute to a wide array of applications, especially those involving geology and mineral exploration. The ASTER instrument acquires images covering a wide spectral region with 14 bands from the visible to the thermal infrared with high spatial, spectral and radiometric resolution. The spatial resolution varies with wavelength: 15 m in VIS-NIR, 30 m in the SWIR, and 90 m in the TIR.

Three features make ASTER an ideal satellite sensor for mineral exploration. First, the 6 ASTER -SWIR bands enable the recognition of alteration patterns and in some cases the identification of individual species of minerals, which provide a means to map hydrothermal zoning and identify host rocks. Spectral simulation between mineral signatures extracted from spectral libraries and their response in relation to ASTER SWIR bands show that the following assemblages can be mapped, even if when present as mixtures within a scene: (i) alunite, pyrophyllite based on their strong 2,167µm absorption feature; (ii) muscovite, illite/smectite, sericite based on their 2,2µm absorption feature; (iii) kaolinite group minerals based on their concurrent features at 2,167 and 2,2 µm; (iv) dolomite based on its 2.26 feature; (vi) calcite, chlorite and epidote based on their 2,33 features. Second, the ASTER instrument includes the first orbital multispectral, high spatial resolution TIR remote sensing system which allows silicate minerals to be mapped and, in particular, silicic alteration. Silification (quartz) is a key indicator of hydrothermal alteration, which has not been identified with the visible and reflected infrared wavelengths recorded by ASTER, but shows prominent spectral features in TIR region due to fundamental asymmetric Si–O–Si stretching vibrations. Quartz displays absorption features at 8,29µm and 9,07 µm that are sensed by the ASTER TIR bands. Third, ASTER has a backward looking telescope with one detector array in the same spectral band as the near infrared of the vertical array. These infrared arrays (bands 3N and 3B) generate an along-track stereo image pair with a base-to-height ratio of 0.6 and an intersection angle of 27.7 degrees and can be used to produce 15m-resolution digital elevation models.

These three features empower the exploration geologist using ASTER data with several alternatives for both reconnaissance and detailed mineral exploration worldwide.

This work provides (i) a review of the current characteristics the ASTER sensors; (ii) information on the spectral response of alteration minerals and their likely detection with ASTER spectral resolution; (ii) an appraisal of key ASTER products and their derivation; (iv) a review of the data reduction techniques and strategies/solutions for processing ASTER data; (v) a discussion of methods and strategies to create compositional maps from ASTER data (including the use of hyperspectral algorithms adapted to ASTER data processing) and; (vi) successful case histories using sites in both arid and tropical terrains worldwide.