Application of airborne hyperspectral data in the mapping of alteration zones associated with gold mineralisation on the island of Milos, Greece

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Background: Epithermal gold deposits are currently of particular interest as gold exploration targets because of their low cost of exploitation and their quick return of profit. A sequence of alteration zones each defined by a particular assemblage of minerals is commonly formed around these deposits. Each of these zones has one or more diagnostic clay minerals which can readily be identified using their spectral variations, especially in the SWIR. Variations in ferrous mineralogy and in emissivity can provide additional mineralogical information.

Site: The island of Milos is situated in the south-western part of the Cyclades and is mainly made up of volcanic rocks which range from andesites, dacites to rhylolites and are made of pyroclastic deposits, lava flows and domes. A large amount of recent hydrothermal activity has affected the island and transformed the volcanic deposits into a range of clays minerals kaolinite, bentonite and also formed a number of mineral deposits, from sulphur, manganese, silver and gold.

Objectives: There are six major objectives for this project. (I) an assessment of the ability of DAIS data to differentiate the diagnostic clay minerals; (ii) develop and validate algorithms for the correction of atmospheric effects; (iii) evaluation of the effects of environmental reflectance; (iv) develop and validate algorithms for the derivation of emissivity spectra; (v) determination of the distribution of the alteration minerals in three dimensions using spectral measurements taken along drill cores; (vi) simulation of the data sets that will be available from satellites in the near future, such as ARIES and ASTER.

Dataset: The remote sensing data set consists of 2 sets of DAIS data (each of 4 flightlines) obtained at local noon on the 25th of august and at pre-dawn on the 26th. Weather conditions for both overflights were excellent, 100% cloud free, very high visibility and very low humidity. During the day flight ground spectral measurements were obtained from 12 large, homogeneous ground targets of variable albedo. During both flights ground surface temperatures were measured at the 12 sites using thermocouples. Spectral measurements from over 30 cores from geological boreholes ranging from 50 to 250m in depth have been acquired. Statistical techniques have been applied to the spectral data to produce a three dimensional distribution of alteration mineralogy.

Methodology: an empirical line correction was applied to the DAIS data using the ground spectral data obtained coincident with the aircraft overflight. Meteorological data was retrieved for the time of the aircraft overflight and used to validate the results of an atmospheric correction technique using a radiative transfer approach. The reflectance-corrected DAIS data was analysed and distributions of alteration minerals retrieved. A

second field campaign was carried out in august 1999 to follow up the preliminary results of the DAIS data analysis. Laboratory analysis to measure clay mineral species and emissivity values have been carried out. The mineral spectral libraries have been resampled to DAIS wavebands to indicate the sensitivity of DAIS data in identifying the diagnostic minerals. It is apparent that the DAIS data has sufficient sensitivity to carry out this task. The results of the empirical line correction were validated using ground spectra from very pure hematite and kaolinite targets. The distribution of a number of key minerals has been mapped out.

Preliminary Results: *Kaolinite* (with very variable amounts of alunite and bentonite) has been shown to be widely dispersed over Western Milos. The kaolinite is much less intense and widespread on the Profitas Elias gold prospect and appears to form a continuous zone around the prospect. Hematite distribution has been successfully mapped out. There is a strong correlation with Kaolinite distribution. However some small occurrences of hematite are located on the Profitas Elias gold prospect with no associated kaolinite. On Profitas Elias gold prospect some patches of illite-jarosite have been identified. These are often linear in outcrop and are not associated with kaolinite but occasionally have associated hematite. Preliminary results of thermal data analysis have identified the locations of altered rocks both in the kaolinite region and on the Profitas Elias prospect.