HYPERSPECTRAL ANALYSIS AS APPLIED TO REGOLITH STUDIES IN SOUTH AUSTRALIA

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The “Mineral Mapping SA” project of CRC LEME Research Program 2 "Regolith Geoscience" has covered a number of key sites and technologies in South Australia. The underpinning commonality has been the investigation of hyperspectral spectrometry as a means to record mineralogy and subsequently relate the recorded mineralogy to regolith mapping and regolith processes. The technologies embraced during the project included: satellite based Hyperion; airborne HyMap™; handheld PIMA II™ and ASD Field Spec; robotic core tray scanner HyLogger™. The various sites selected endeavoured to demonstrate the complimentary and corroborative nature of the data provided by each technology. The inventory of sites studied includes: Screechowl Creek, Willouran Ranges; Beltana, near Leigh Creek; Mount Painter, northern Flinders Ranges; Pine Creek, Burra; White Dam, Curnamona; Tarcoola, Gawler Craton; Barns, Eyre Peninsula; and Tunkillia, Yarlbrinda Shear Zone, central Gawler Craton.

At the beginning of the project it was recognised that HyMap offers a key to surface mapping of the regolith however ground truthing represented a challenge because PIMA II does not cover the same wavelength range and ASD Field Spec was only occasionally available to the project. Throughout the project several technological advances have improved our ability to understand the processed data provided by HyMap. First the adoption of ACORN™ software to perform atmospheric corrections provided improved calibration of spectra from HyMap. Second the use of XQInertia™ in conjunction with Shuttle Radar DTM improved the geometric adjustment for the HyMap data especially where aircraft navigation data was available. Thirdly the invention of the HyLogger by CSIRO, covering the same spectral range as HyMap, provided hand specimen and diamond drill hole spectroscopy for verification and calibration of HyMap interpretation. Along with the development of the HyLogger, the analytical software package “The Spectral Geologist - Core” has undergone significant improvement and HyMap spectra can be imported for direct comparison with PIMA II, ASD Field Spec and HyLogger spectra.

Two study sites that demonstrate the integration of the various technologies are Blue Mine in the Mount Painter district and Tarcoola in the Gawler Craton. Blue Mine has the advantage of two angle diamond holes drilled under outcropping stratigraphy. Due to the slope of the terrain much of the outcrop is scree covered. The investigation involved sampling the surface projected positions of the drill holes every five metres. These samples were measured with the PIMA II and compared to both the co-registered 5mx5m HyMap pixels and the 1cmx1cm resolution of HyLogger spectra, effectively establishing three scales of hyperspectral observation.

Results from Blue Mine demonstrate that for the particular units under consideration scree mineralogy tends to dominate the HyMap signal. Compared to the projected geology from the drill hole, the spectral response at the surface is smeared downslope of its projected outcrop. For drill hole BM5 the PIMA II results from surface sampling provided new information, permitting refinement of the HyLogger interpretation. In this instance hornblende was removed from the list of possible minerals available in the spectral library thus allowing tremolite and actinolite to be recognised minerals in the drill hole. The distribution of tremolite and/or actinolite, recognised from PIMA analysis of surface samples and recorded by HyLogger, can be mapped on the HyMap imagery and represents a significant component of the surface mineralogy of the Skillogalee Dolomite unit.

At Tarcoola, abandoned workings and unmined prospects along the Tarcoola Ridge provided drill hole material for HyLogger. PIMA II and ASD Field Spec where used to collect spectra from surface samples. HyMap and Hyperion instruments also provided remotely sensed hyperspectral data for the region and specifically the Tarcoola Ridge. In order to understand the coherent patterns observed in the processed HyMap data detailed thin section and microprobe work was undertaken. Four scales of hyperspectral observation were thus established.

The significant result from Tarcoola was the recognition of the role of the 1900nm water feature in mapping systematic variations in surface illite chemistry. The illite with the lower water content is considered to be the more crystalline or least weathered and in other places in the central Gawler gold province has been found associated with mineralisation. At Tarcoola the trace of the Perseverance fault containing the identified "bonanza" gold zone bounds one edge of an area of "low water" illite. This zone of illite cuts across the stratigraphy and incorporates an outcrop of "Lady Jane" diorite intrusive, considered a potential heat source for the mineralising fluids. It is hypothesised that illite, when it is formed as a weathering product of other high temperature minerals, is likely to carry less water in its structure.

The integration of various scales of hyperspectral observation assists in informing the analysis of each dataset in turn. HyMap analysis offers a variety of images which reflect key elements of the visible to shortwave infrared spectrum. Understanding the spectra of the materials examined allows independence of preset and often limited spectral libraries. Understanding regolith processes enables the interpreter to identify physical displacement and concealment of materials with key spectral signatures.