PROGRESS WITH HYPERSPECTRAL ANALYSIS OF GEOLOGICAL TERRAINS

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Four instruments of hyperspectral analysis deployed by the participants in the Mineral Mapping SA Project of CRCLEME Program 2 have been found to demonstrate unique individual characteristics in addition to mutually corroborative relationships. Hyperion, HyMap, HyLogger and PIMA all bring different specifications to the study of mineralogy related to mineral exploration through cover. The challenge has been how to integrate the information derived from each instrument in a meaningful and scientific manner.

Hyperion is a space-borne instrument with over 100 channels sampling the 400 to 2500 nm wavelength range of the EM Spectrum. With 30 m pixels, narrow swath width, low signal to noise ratio (SNR) and the high risk of data acquisition failure being borne by the customer, the instrument has not enjoyed a prolonged deployment. In spite of its failings it has proved possible to map regolith units based on the spectral response of surface materials recorded by Hyperion.

In contrast HyMap, an airborne instrument with 128 channels over the same wavelength range, boasts a very high SNR and can image at 3 m resolution. Careful mission planning to optimise flight line orientation and solar position considerations is critical for quality control. Time of year, time of day, proximity to periods of wet weather and synchronisation with vegetation growth cycles all contribute to the final quality of the product. Atmospheric correction and orthorectification are necessary in order to maximise the return on geological information derived from the recorded reflected solar radiation. Vegetation, atmosphere and the physical movement of surface material, conspire to conceal the surface expression of bedrock mineralogy.

HyLogging core is in its infancy but already it is demonstrating the benefit of not having to accommodate atmosphere and vegetation in the spectral analysis of mineralogy. Touted as objective core logging the core scanning version of HyLogger has 189 channels from 412 to 2512 nm and scans diamond core trays at 1 cm spatial resolution for the spectra while acquiring an RGB image at 0.1 mm image resolution at the rate of 60 m per hour or 90,000 readings per day. Automated techniques are capable of digitally masking out rubbish in the core trays and software provides automated mineral interpretation of the spectra. Beyond the library incorporated in the software, the spectra offer the opportunity to subdivide the core by their spectral response, objectively identifying clear boundaries between distinct units and potentially allowing for more accurate correlations between holes.

The Portable Infrared Mineral Analyser (PIMA) with its 601 channels between 1300 and 2500 nm provides higher definition and superior discrimination of mineral species that provide characteristic interactions in the shortwave infrared (SWIR). The outcome is that more SWIR responsive minerals are identifiable but there is no measurement of the 400-1300 nm responsive minerals covered by the other three instruments. The nature of PIMA limits the number of readings to a couple of hundred per day. This sets a limitation on mapping mineralogical trends over a project area but provides excellent calibration for less sensitive but higher volume instruments.

Integration of spectral logging of angled diamond holes with HyMap data where the stratigraphy could be projected to the surface has demonstrated some of the challenges facing this technology. Blue Mine in the Mount Painter Inlier, South Australia, offered one such opportunity. The objectively identified units with discrete spectral signatures from HyLogger offered the opportunity to process the HyMap data in such a way as to enhance the differences. It proved difficult to enhance the imagery to replicate those units at the surface. Field checking identified that scree movement down slope had obscured and smeared the anticipated responses (Steve Hore, *pers comm*., 2005). The mere scale difference from 1 cm resolution in the core to 5 m resolution in HyMap data would also contribute to the issue of mixing of spectral responses. In spite of that the chosen method of discrimination identified in HyLogger data proved useful in discriminating geological units in other parts of the HyMap imagery.

Over Tarcoola all four datasets have been collected. In addition detailed mineralogical work has been undertaken to ground truth HyMap discrimination supported by PIMA analyses of surface samples. In spite of anthropogenic disturbance from mining activity, clear spectral zonation related to surface mineralogy can

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be mapped using HyMap data. PIMA identified that the relative dominance of kaolin and white mica contributed to this discrimination. In addition the chemistry of illite appears to account for a previously unmapped mineralogical boundary evident in the imagery.

Scale of observation and dilution of signal appear to be major issues confronting the practitioners of hyperspectral analysis when it comes to mineralogical mapping of surface geology. Often the success arrives from identifying previously unrecognised significant subcrop. Sometimes the apparent area of subcrop has been enlarged by surface processes, for example with the down slope spreading of scree material. At other times the same process will conceal an interesting target. Like many analytical techniques sometimes the signal reveals and at other times it conceals. The question one has to ask is “will I potentially miss something by not using this technology?”