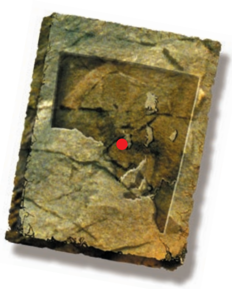

Mineral mapping in the Gawler Craton

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Introduction

Hyperspectral imagery (also known as imaging spectrometry) is a non-invasive remote sensing method used in many scientific disciplines. In the current study it has been used as a means of identifying and mapping rock, regolith and alteration mineralogy based on the characteristic absorption features occuring in spectra of reflected solar radiation in the visible and near infra-red (VNIR) to shortwave infra-red (SWIR) part of the electomagnetic (EM) spectrum.

The HyMap™ system used in this survey is an airborne hyperspectral imaging scanner which acquires data over 128 channels in a continuous spectrum across the VNIR and SWIR region. Mineral species detected in these wavelengths include Fe oxides and rare earths in the VNIR, and phyllosilicates, hydroxylated silicates, sulphates, carbonates and ammonium minerals in the SWIR.

Applications of hyperspectral data used to map the extent of alteration halos associated with mineralised zones include studies of the VHMS deposit in Death Valley, Arizona USA, and Panorama-style mineralisation studies in the Pilbara, WA.

Analysis of HyMap data over the Gawler Craton in the present study has identified:

- alteration halos possibly associated with hydrothermal mineralisation
- distribution and abundance of rock units such as the Ealbara Rhyolite and conglomerate facies of the Mentor Formation.

Project outline

In May 1998, Integrated Spectronics, manufacturers of the HyMap scanner, flew a series of test runs over the Lake Barry region of the Gawler Craton. The current study was based on one of these runs, with the aim being to evaluate hyperspectral data as a tool to map the surface mineralogy of an area of geological significance. Landsat 5 TM imagery was used to compare and contrast the usefulness of this data as a geological mapping tool.

Regional geology

Outcropping units in the area include the Ealbara Rhyolite of the Mesoproterozoic Gawler Range Volcanics and conglomerate facies of the Mentor Formation, formerly known as the Peela Conglomerate Member of the Tarcoola Formation. These are overlain by Quaternary clay and sand units.

The Ealbara Rhyolite is a densely welded ignimbrite with a well-defined eutaxitic texture and abundant lithic fragments. K-feldspar and quartz dominate the rhyolite, which has a background gold content of 0.02 ppm (Blissett *et al.*, 1993).

The Mentor Formation comprises chloritic and sericitic mudstone containing small, angular, lithic fragments of K-feldspar, acid volcanics, chert and BIF, and larger fragments of vesicular basalt and tuffaceous and porphyritic rhyolite–rhyodacite. These have been intersected in drillhole Bulgunnia 1 adjacent to the Bulgunnia Shear Zone, which is the most likely focus for volcanism and has considerable potential for Olympic Dam style mineralisation (Daly *et al.*, 1998).

Data comparison

The analysis of multispectral data from sensors such as Landsat TM bears little resemblance to the techniques used to analyse hyperspectral data from sensors such as AVIRIS and HyMap. Differences exist in the processing techniques, data volumes, data resolution and spectral continuity (Table 1).

***Table 1** Comparison of some features from HyMap and Landsat 5 TM.*

Feature	Landsat 5 TM	HyMap
Software	ERMapper	ENVI
Bands	7	128
Band width	70–270 nm	<20 nm
Pixel size	30 m	5 m
Scan width	185 km	2.5 km

Low resolution scanners such as Landsat cannot identify particular minerals on the basis of their absorption features. These sensors undersample the spectral response of materials, and do not show any wavelength shifts and spacing variations of absorption features (Fig. 1).

Hyperspectral data analysis

Processing hyperspectral data can be broadly divided into three steps.

1. reducing the observed radiance data to apparent surface reflectance
2. spectral compression to reduce the large volume of spectral data
3. mineral identification and mapping.

In order to achieve surface reflectance, which is directly related to the surface composition, an atmospheric correction is applied to the data. In this study, the HYCORR atmospheric correction package written by CSIRO was used.

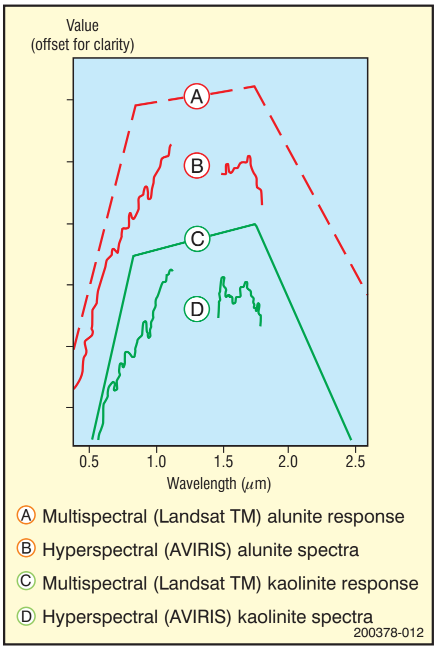

***Fig. 1** Alunite and kaolinite responses from multispectral scanners (Landsat TM) compared to spectra of the same minerals as seen using hyperspectral scanners (AVIRIS) (after Kruse, 1998).*

Spectral compression was achieved by a spectral–spatial ordering transform called 'Minimum Noise Transform'. This isolates the geologically relevant signal from the noise (Cudahy *et al.*, 1999). 'Spectrally pure' pixels are calculated from the compressed data. These are identified and their distribution plotted using mapping techniques supplied in the ENVI software.

A library of pure pixels occurring in the run was created. A portion of the run has been extracted showing the distribution of three of these end members (Fig. 2). The corresponding spectral responses of these minerals are shown on Figure 3.

Conclusions

Preliminary results of the Gawler Craton study show that HyMap has differentiated alteration minerals such as chlorite and sericite. The shift in wavelength of the spectral response of the AlOH absorption feature highlights an alteration zone of possible hydrothermal origin in the Ealbara Rhyolite unit of the Gawler Range Volcanics. These mineral combinations reveal additional geological information not acquired from traditional mapping techniques. Work in the area is ongoing and results from correlating surface sample assays with PIMA and HyMap spectral analyses are expected in the near future.

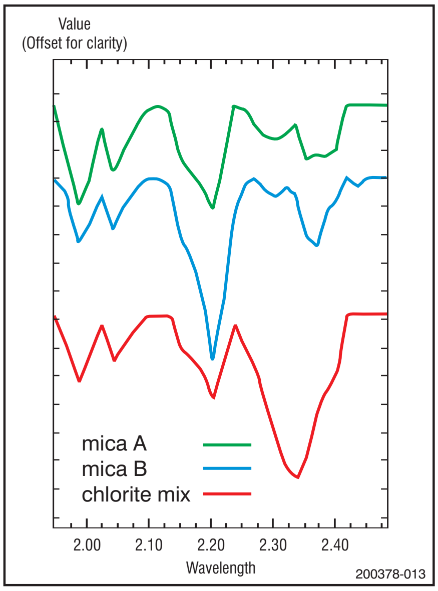

***Fig. 2** Three end members selected from the library of end members created during spectral analysis of the raw data.*

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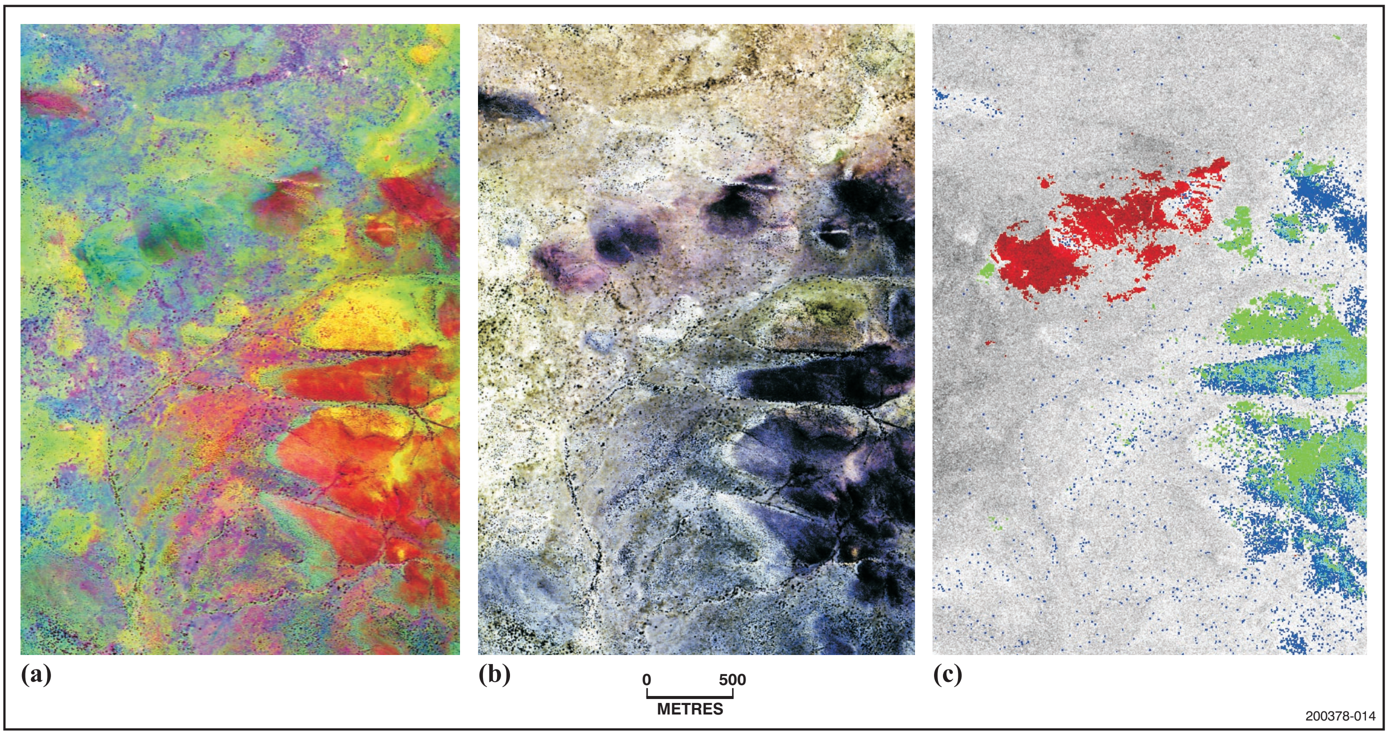

***Fig. 3** Images of a portion of the Gawler Range Volcanics. **(a)** RGB image to which a decorrelation stretch has been applied. **(b)** Atmospherically corrected HyMap survey shown as an RGB (2.4820:2.240:2.1710). **(c)** A mineral abundance map generated from the end members selected in Figure 2; red area is a chlorite-rich zone; the blue and green are micas.*