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# Evaluating the information content of National ASTER Geoscience Maps in the Wagga Wagga and Cobar regions of New South Wales

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This article summarises the results of a study, commissioned by the Geological Survey of New South Wales (GSNSW), that evaluated the use of the National ASTER Geoscience Maps of Australia (Version 1, released 2012. DOI: 10.4225/08/51400D6F7B335) for regolith and geological mapping in the Wagga Wagga 1:100 000 and the Cobar 1:250 000 map sheet areas (Figure 1). The study is described in full in the GSNSW Quarterly Note 140 (Hewson and Robson, 2014).

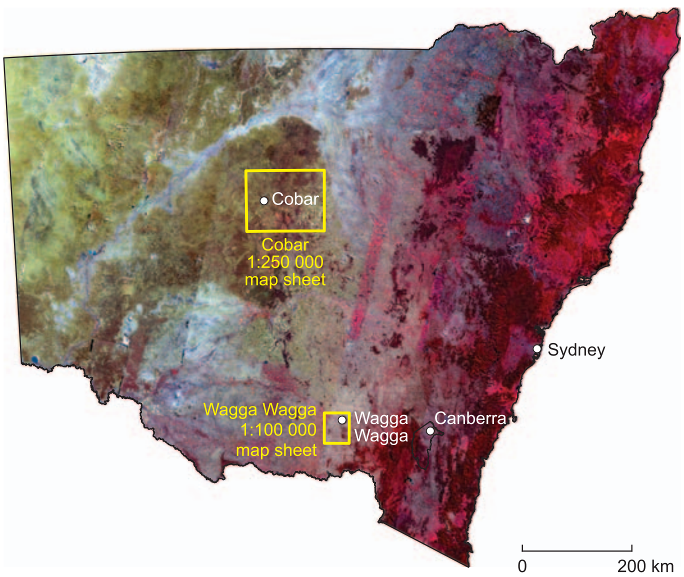


**Fig. 1.** *ASTER False colour for NSW. The Cobar and Wagga Wagga study areas are outlined.*

The National ASTER Geoscience Maps, freely available from CSIRO/GA (https://data.csiro.au/dap/landingpage?pid=csiro%3A6182 and for viewing: http://www.ga.gov.au/aster-viewer), were found to be useful for identifying and discriminating between variations in the composition of surface materials. These products have the potential to aid mineral exploration in NSW within semi-arid environments such as Cobar and, to a lesser extent, within open woodland and cultivated environments such as Wagga Wagga.

## Data processing, interpretation and results

Although several National ASTER Geoscience Map products provided useful information as individual entities, it was found that their information content could be enhanced by integrating these products with geophysical, topographical and fractional land cover data.

In the **Wagga Wagga** area, slope information derived from the Shuttle Radar Topography Mission (SRTM) 80 m Digital Elevation Model (DEM) and vegetation fractional data were used to mask and refine ASTER map products. Wagga Wagga is located on the temperate and vegetated Riverine Plains and the analysis was carried out in order to identify terrain with greatest geological exposure and to exclude areas of vegetation, active cultivation and transported cover. The analysis included illuminating the DEM to simulate similar conditions when the relevant ASTER imagery was acquired. This was followed by field validation and a portable field spectrometer was used to measure spectral signatures of outcrop and soils. The fieldwork demonstrated the importance of validating spectral signatures as the original ASTER satellite imagery can sometimes exhibit miscalibration in areas of deep shadow and dark ground surfaces.

The Wagga Wagga area is highly cultivated so the areas of particular interest to mineral explorers are areas of relatively high relief where bedrock might outcrop or where it might be accessible in hill slope or talus deposits. The DEM data was processed for slope percent information and the major ranges and topographic relief were highlighted (Figure 2a). A mask based on slopes greater than 10% was generated. In Figure 2b this mask has been used to screen the ASTER's green vegetation product. When this derived product is combined with sun-shaded imagery it can be observed that much of the higher relief areas in the region are moderately to highly vegetated (Figure 2b).

Further analysis of the ASTER map products in the Wagga Wagga area focused on the terrain with the greatest geological exposure (Figure 3). In these terrains anomalous AlOH- and silica-rich areas were discriminated in the vicinity of the Bulloc Bulloc Range, especially at The Rock Hill, and found to be associated with radiometric anomalies and structures mapped using high frequency filtered total magnetic intensity (TMI).

The ASTER Ferric Iron Content product in areas of geologically exposed terrain also appeared to show northwest lineament trends similar to those highlighted by filtered TMI products (Figure 4). These lineaments might be related to regolith or geological units.

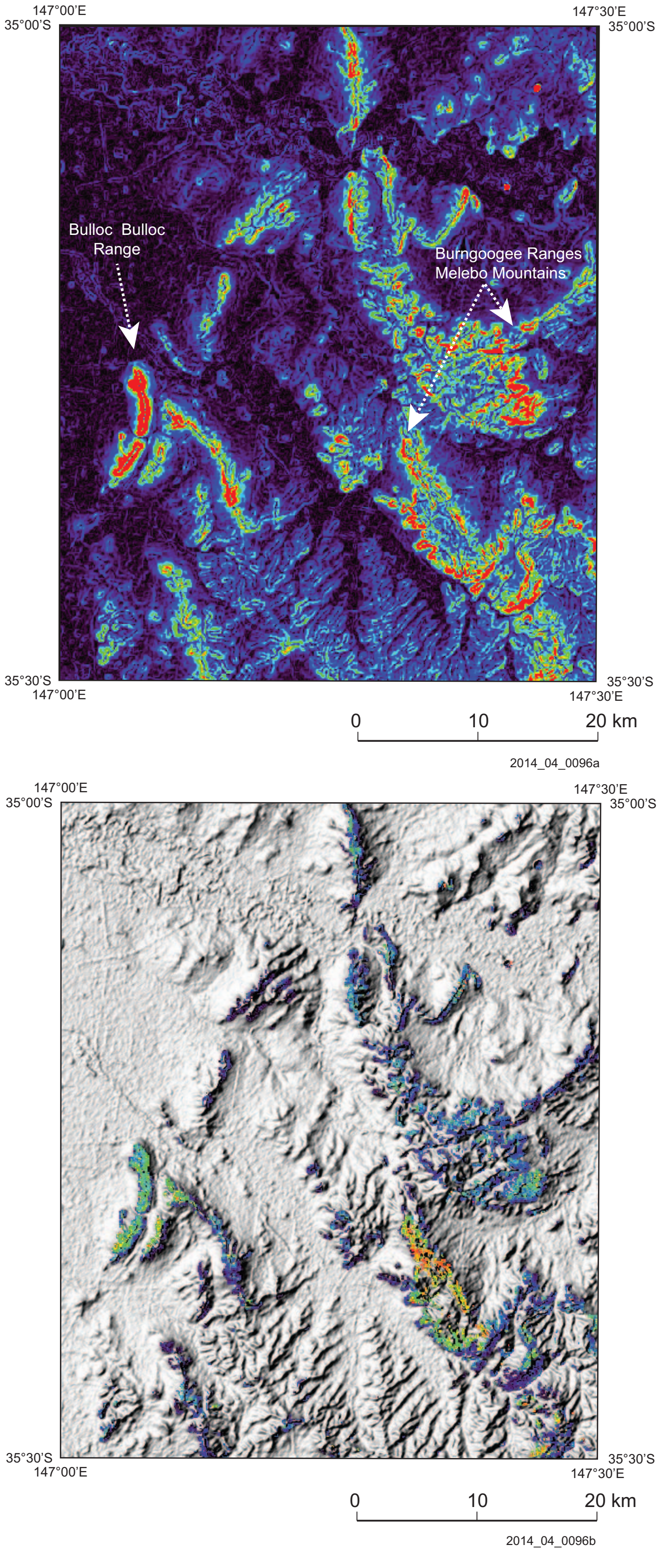


**Fig. 2.** *(a) Wagga Wagga 1:100 000 sheet SRTM 80 m slope percent (blue, low; red, high). (b) SRTM 80 m sun-shaded imagery draped with ASTER Green vegetation (a) masked for slope >10%.*

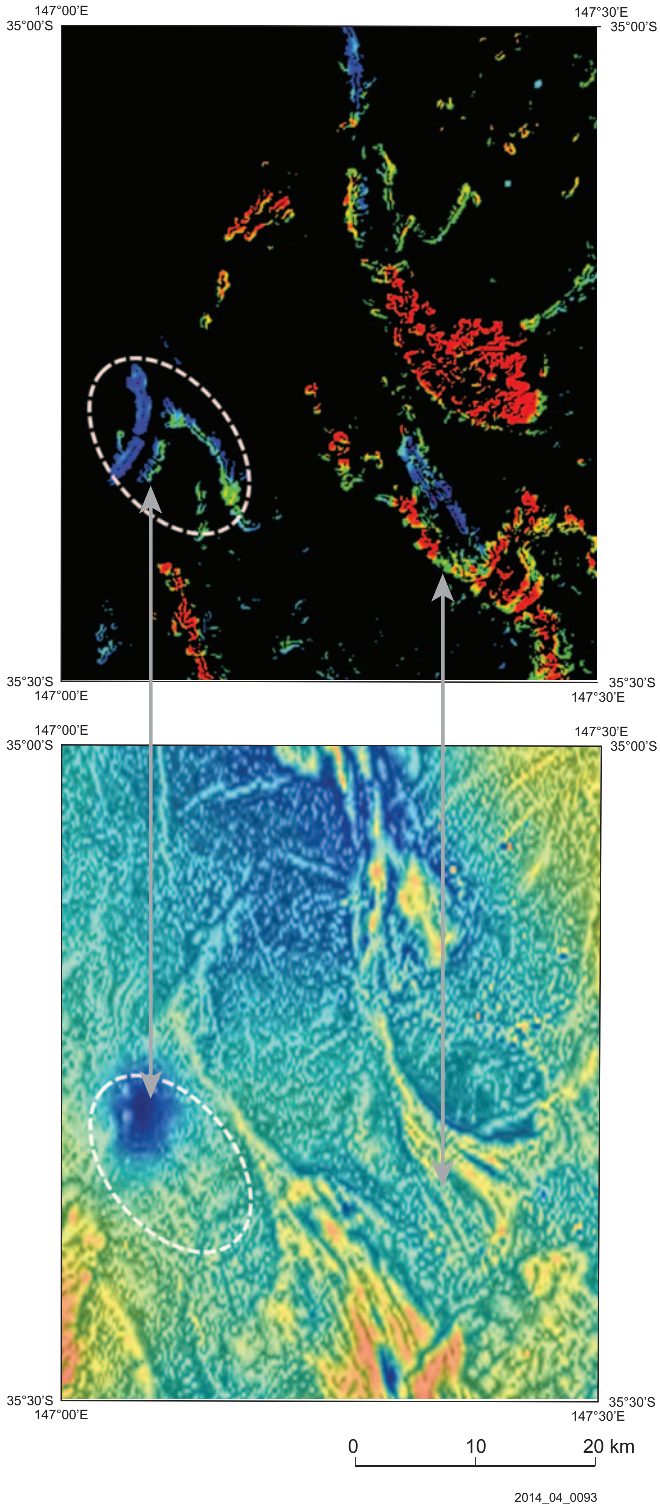


**Fig. 3.** *(a) Wagga Wagga 1:100 000 sheet radiometric K, masked for slopes >10% (blue, low; red, high). (b) Reduced to the Pole total magnetic intensity (TMI) over Tilt filtered TMI. Bulloc Bulloc Range shown in white dashed lines.*

Vegetation cover is less of an issue in the **Cobar** region, which is semi-arid and sparsely vegetated.

In this region the National ASTER Geoscience Maps Regolith product was found to be useful for mapping the extensive ephemeral drainage network (Figure 5b). As described by Cudahy (2012), the Regolith product, which is based on the Landsat TM Regolith ratios, helps to separate regolith and rock units, while vegetated areas are highlighted by white/bright areas and clouds are highlighted in blue (Figure 5b). ASTER's Green vegetation product confirmed the limited nature of the green vegetation cover, which is mostly restricted to drainage lines outside of the cultivated areas (Figure 5c).

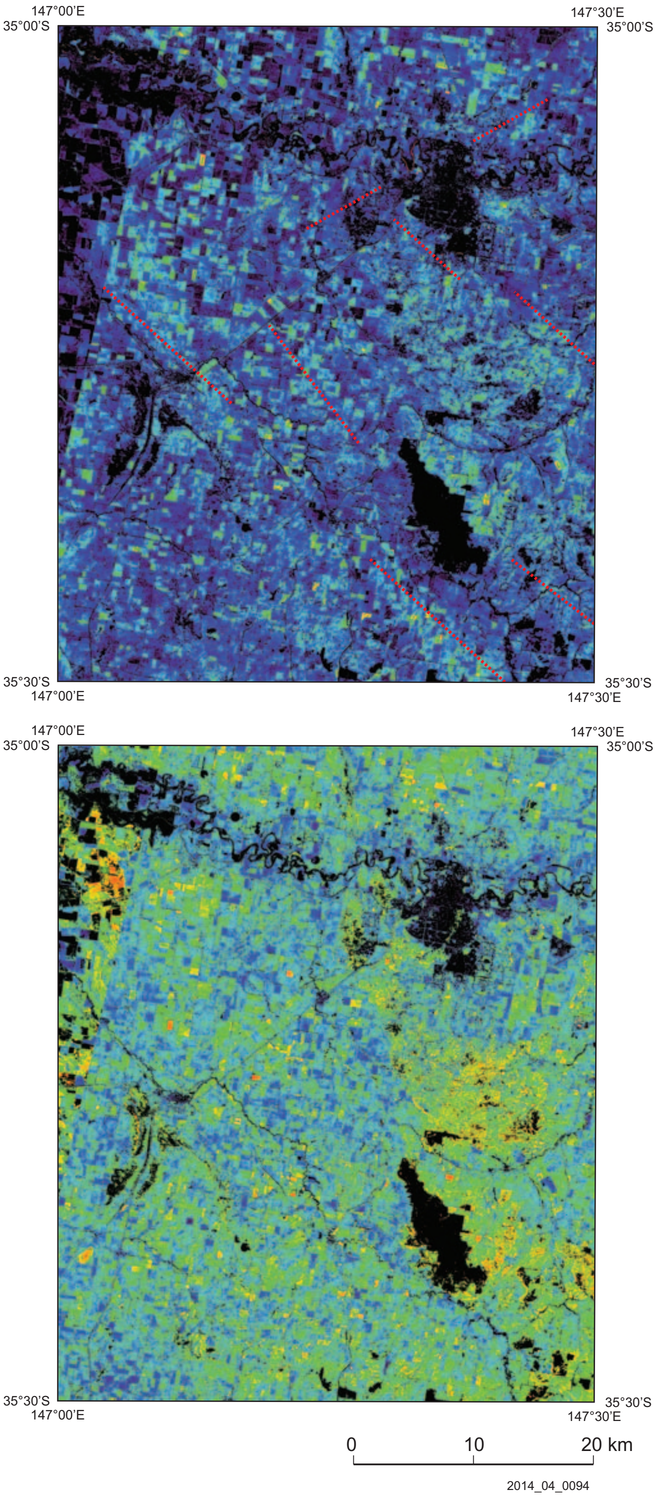


**Fig. 4.** *(a) Wagga Wagga 1:100 000 sheet ASTER Ferric oxide content (blue, low; red, high), and (b) Ferric composition map products (blue–cyan, goethite-rich; red–yellow, hematite-rich). Apparent trends in the ferric oxide content are shown in red dashed lines.*

The land cover is more explicitly highlighted in the Landsat-derived fractional cover image, which shows that close to the time of ASTER acquisition (September 2003) the most exposed bare ground was within the Cobar 1:100 000 map sheet area, and to a lesser extent Canbelego 1:100 000 map sheet area (reddish areas, Figure 5d). Non photosynthetic vegetation ('dry vegetation') appears to be pervasive in the non-cultivated areas (blue areas, Figure 5d), which might be an issue for some ASTER map products.

The National ASTER Geoscience Maps Ferric oxide content product highlights coherent and continuous distribution of ferric oxides across the Cobar 1:250 000 sheet area, with increased abundance within the Cobar 1:100 000 sheet area (Figure 6a). An improved insight into the ferric iron oxide was provided by the ASTER's Ferric oxide composition using histogram equalisation (Figure 6b), rather than a Gaussian stretch, within the same threshold stretch limits advised by Cudahy (2012). The histogram equalised version of the ASTER Ferric oxide composition product highlights an apparent increase in hematitic composition within the western Cobar 1:250 000 map sheet area, including the Cobar 1:100 000 sheet area (Figure 6b). The presence of hematite versus goethite may be important for understanding the developmental history of the regolith.

Regolith landform mapping in the Cobar 1:100 000 sheet area has indicated that most of the surface materials are highly weathered rocks (Gibson, 1999). The ASTER AlOH group composition product (histogram equalised, Figure 7a) highlights extensive areas of low values (blue) in the western Cobar 1:250 000 sheet area, including within the Cobar 1:100 000 sheet. Cudahy (2012) interpreted such low ASTER AlOH composition product values as mapping well-ordered kaolinite or Al-rich white mica such as illite. These areas also appear to coincide with the interpreted hematite-rich areas shown in Figure 6b (red areas). Further work needs to be done on the regolith mineralogy to explain this association in the Cobar area. The ASTER Kaolin group index product for Cobar 1:250 000 sheet area does not indicate significant anomalies, using linear or histogram equalised versions.

The National ASTER Geoscience Maps Silica index product indicates high silica content along the western boundary of the Cobar 1:100 000 sheet area. This area coincides with elevated areas mapped by Gibson (1999) as being capped by silicified sedimentary units (histogram equalised, Figure 7b). Geophysical radiometric products K and Th also highlight distinctive units with the Cobar and Canbelego 1:100 000 map sheet areas (Figure 7c,d). An RGB composite image of ASTER's AlOH group content, ferric oxide content and silica index products appeared to discriminate generally elevated combined clay- and quartz-rich units (e.g. red and blue areas shown as purple) from ferric iron oxide minerals (green) within some drainage areas. A RGB composite image of the radioelement K, ASTER Ferric oxide content and ASTER AlOH group content products generated significant and complex spatially coherent patterns, particularly within the Cobar and Canbelego 1:100 000 sheet areas.

## Conclusions

This project demonstrated, within the study areas of Wagga Wagga and Cobar, the usefulness of the National ASTER Geoscience Map products for identifying variations in the composition of surface materials.

Although several ASTER map products provide useful information as individual entities, their information content is enhanced when they are integrated with geophysical, topographical and fractional land cover data. In particular, DEM-derived slope information and vegetation fractional data were useful for identifying geological exposed areas – where

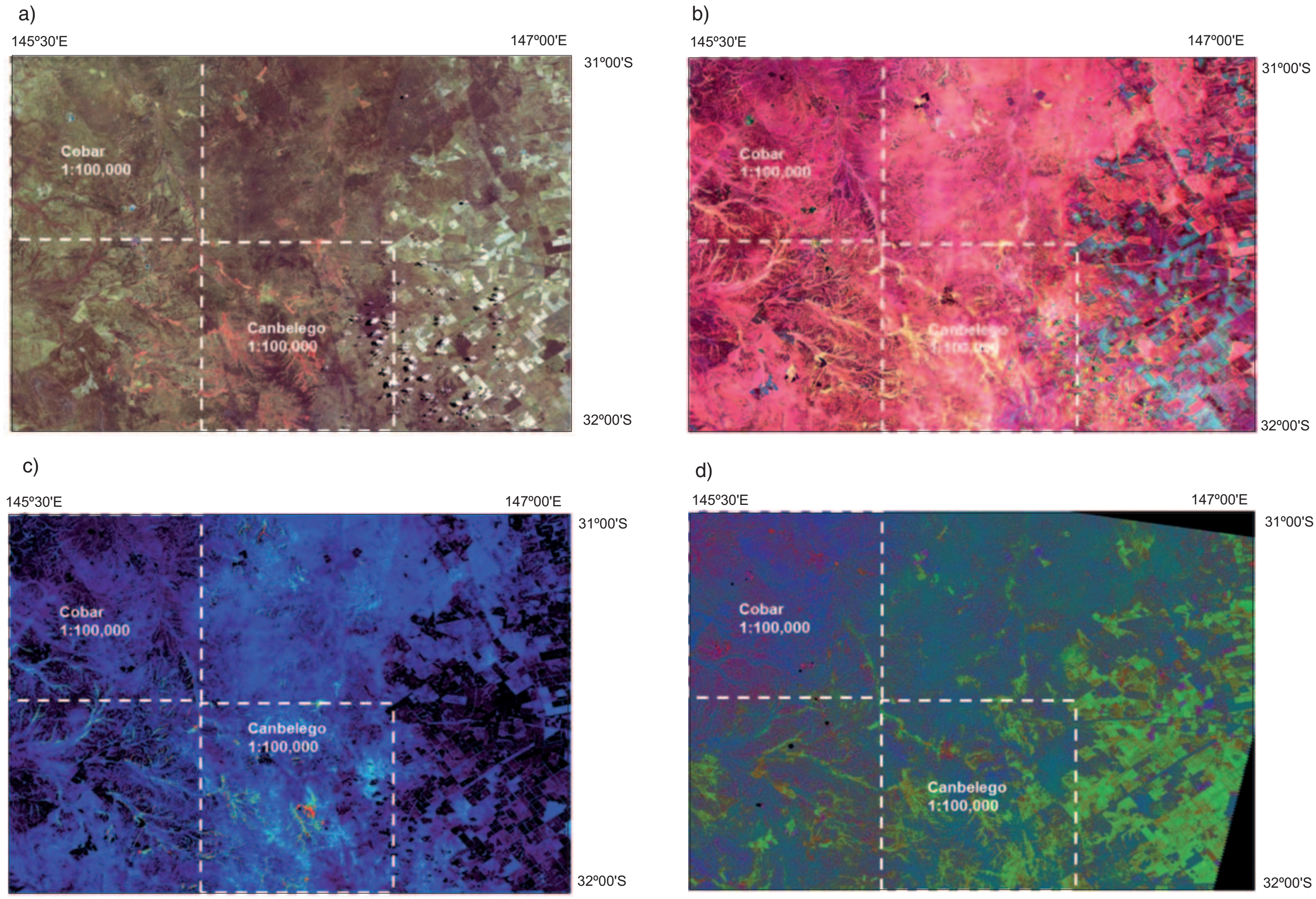


**Fig. 5.** *Cobar 1:250 000 sheet. (a) ASTER False colour. Note clouds and shadows in lower right. (b) ASTER Regolith (Cudahy 2012). (c) ASTER Green vegetation (blue, low; red, high). (d) Landsat fractional cover RGB. Red, bare ground; green, photosynthetic vegetation; blue, non-photosynthetic vegetation. (Linear stretch, 0–100%.)*

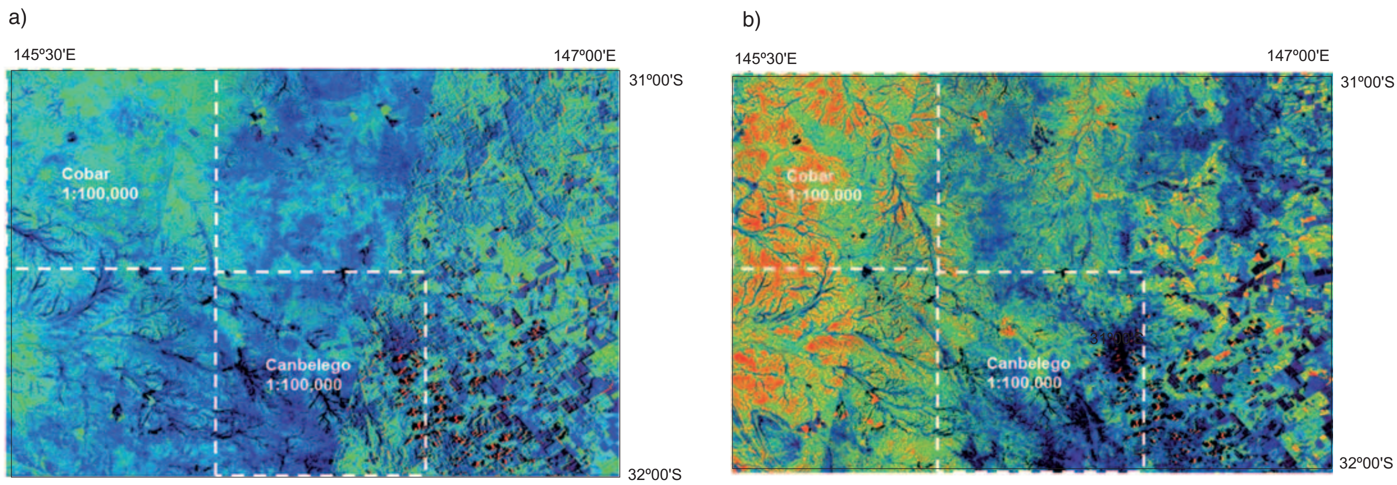


**Fig. 6.** *Cobar 1:250 000 sheet. (a) ASTER Ferric oxide content (blue, low; red, high). (b) ASTER Ferric oxide composition (histogram equalised) (blue, goethitic; red, hematitic).*

the ASTER data is likely to be most informative to mineral explorers – in the highly cultivated Wagga Wagga region. There are also areas of relatively high relief in the Wagga Wagga region and the DEM was useful for identifying areas of deep shadow where the ASTER data may be poorly calibrated.

The Cobar region is semi-arid and the ASTER map products identified a number of spatially coherent anomalous features. The application of different histogram stretches, such as histogram equalisation, was found to further enhance the display of anomalous features – although care should be applied regarding data thresholds. It is speculated that these features

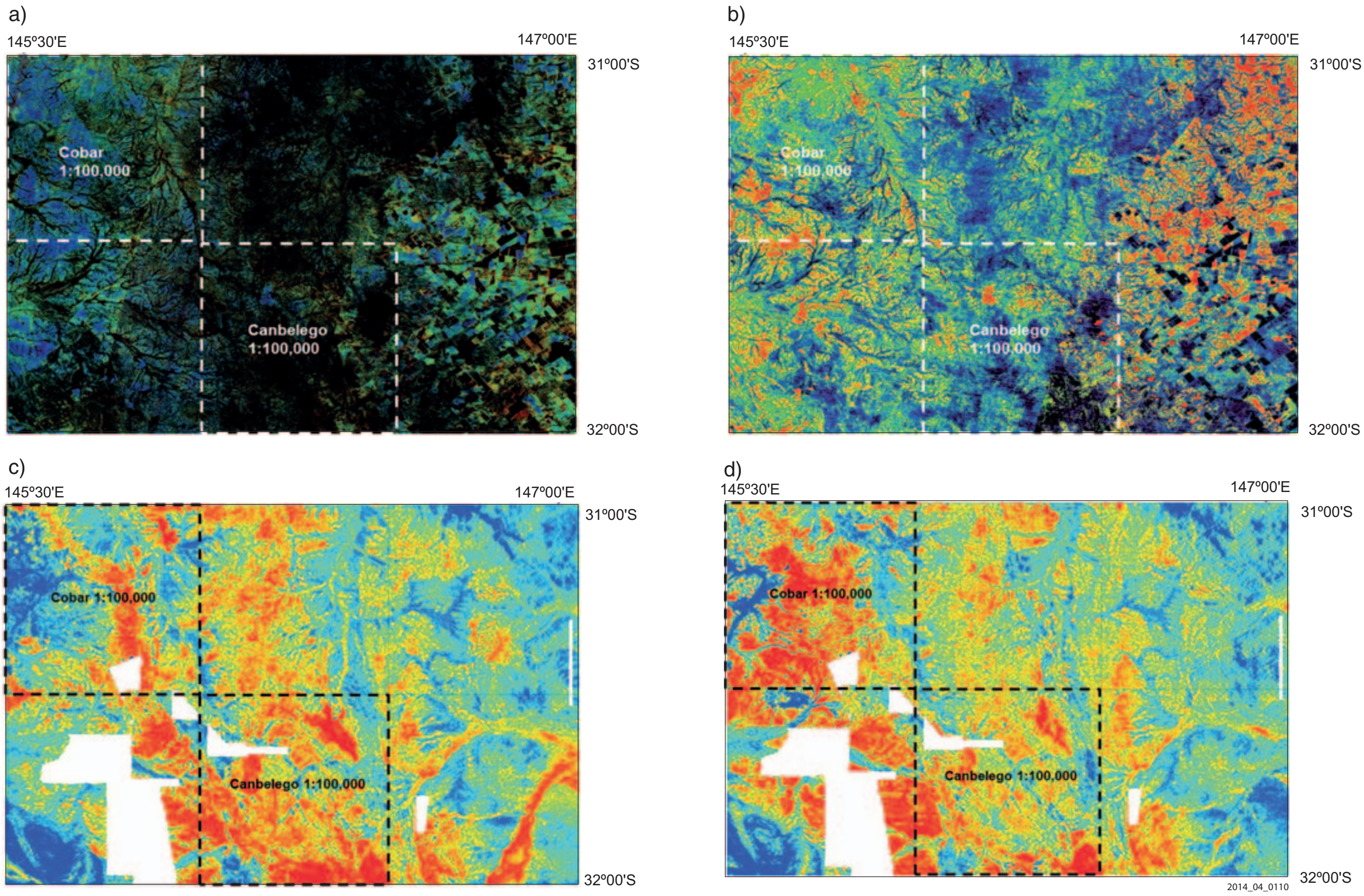


**Fig. 7.** *(a) ASTER AlOH group composition (histogram equalised) (blue, Al-rich mica/well-ordered kaolinite; red, Al-poor mica). (b) ASTER Silica index (histogram equalised) (blue, low; red, high). (c) Radiometric K (blue, low; red, high). (d) Radiometric Th (blue, low; red, high).*

relate to variations in the mineralogy of the regolith, which has ramifications for regolith mapping and for developing an understanding of the regolith history. The application of the ASTER map products individually, as RGB composites, or in combination with radiometric data, shows considerable promise as a regolith mapping tool in this region.

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## References

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Gibson D.L., 1999. Explanatory notes for the 1:500 000 Cobar regolith landform map. *CRCLEME/Geological Survey of NSW*, Open File Report 76.

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***Robert Hewson*** *obtained his PhD in remote sensing from the University of NSW. He then joined CSIRO's Division of Exploration and Mining in Perth from 1998 to 2010 where he focussed on HyMap and ASTER imagery, data integration of remote sensing and airborne geophysics, and thermal infrared mineral spectroscopy. He currently consults and undertakes studies as a Principal Research Fellow at RMIT University.*

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