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Airborne and Satellite Measurements

The new airborne-magnetic map of Australia: applications, expectations and problems

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Airborne magnetic surveying has been in progress in Australia since 1951, and a first pass cover may be completed by about 1990. Approximately 50% of the surveys will provide digital data and the others will have provided analogue recorded profiles and hand reduced contours. It is intended that standard scale pixel maps will be published and will provide a digital database for general use from all suitable data.

Three types of maps will be produced:

(1) Total Magnetic Field Pixel Map (greyscaled);

(2) Total Magnetic Field Pixel Map (colour scaled);

(3) Total Magnetic Field Pixel Shadow Map (greyscaled).

Scales of the maps will be 1:1 000 000 and 1:2 500 000. The 1:1 000 000 series maps will cover the same areas as the standard 1:1 000 000 topographic series, and the 1:2 500 000 series will consist of six maps covering Australia.

Prototype pixel maps of three areas have been produced by image processing techniques, and various problems associated with these have been identified: integrating data from surveys flown at different times with different specifications; preserving the integrity of the original data; tying into the Australian Geomagnetic Reference Field (AGRF), and ascertaining the correctness of very long wavelength anomalies; interpretation of the diverse information available in pixel maps.

On a regional scale, inaccuracies may result from generation and propagation of errors during matching of data from different surveys, the previous introduction of distortions by removal of various, sometimes not well described, regional gradients and reference fields, and the changing of the geomagnetic field with time. Long airborne calibration and check traverses will be flown, and appropriate tying in with the AGRF is highly desirable. Completion of these tasks will itself involve solution of numerous difficult problems.

The new maps can provide an objective base for developing and testing ideas on the geological framework of Australia, and will give an opportunity for new and comprehensive interpretation of Australia-wide and relatively local areas. They permit the assembling and presentation of very large scale data sets with minimal loss of detail, and enable easy recognition of the form and texture of the magnetic field. The maps reveal both large and small scale features which are difficult to recognize in contour and profile presentations.

Long wavelengths are relevant to deep structures and large crustal blocks, and short wavelength anomalies (width of 500 m) allow analysis of near-surface patterns. While most short-wavelength anomalies have been attenuated, some can still be seen with amplitude as low as 1–2 nT.

So far interpretation of the new maps has been directed towards relatively local areas. Various applications in interpretation are becoming evident and already the new maps have provided a major improvement in the amount and quality of information obtained from interpretation.

Compared with the existing contour maps, the pixel maps show a dramatic improvement in resolution and in definition of sources at the scale used. This improvement is partly because they represent more effectively the dynamic range of the data, but more because they take advantage of the ability of the human eye to distinguish subtle changes of intensity, colour, and hue. An example of the improvement is provided in the Albany 1:1 000 000 greyscale pixel map, which provides considerable information on dykes and lithostratigraphy (Fig. 1).

One prominent feature disclosed by the Albany magnetic data is the abundance of long linear magnetic anomalies indicating a pervasive system of magnetic sources crossing the sheet area, much of which has little outcrop. The linear anomalies are interpreted as magnetic basic dykes, and 5 times as many of these can be interpreted from the pixel map as from contour maps and profiles. The dykes, some of which extend for more than 500 km across the Yilgarn Shield, have probably at some time exercised a strong control on paleodrainage. As such they could present a target for deposits of alluvial heavy minerals.

A second prominent feature evident on the Albany magnetic map is a broad belt of anomalies about 20 km wide across the bottom of the area. Close inspection of this belt shows that it consists of quite remarkably subparallel narrow curvilinear magnetic anomalies. The belt is wrapped around a relatively quiet zone with a few lozenge-shaped narrow anomalies scattered about.

The belt of narrow curvilinear anomalies is interpreted as being caused by steeply dipping metasediments fringing a large granite pluton in the south; the lozenge-shaped anomalies appear to represent preserved roof pendants of folded metasediments. The interpretation of the granite pluton is supported by the presence of a gravity low that

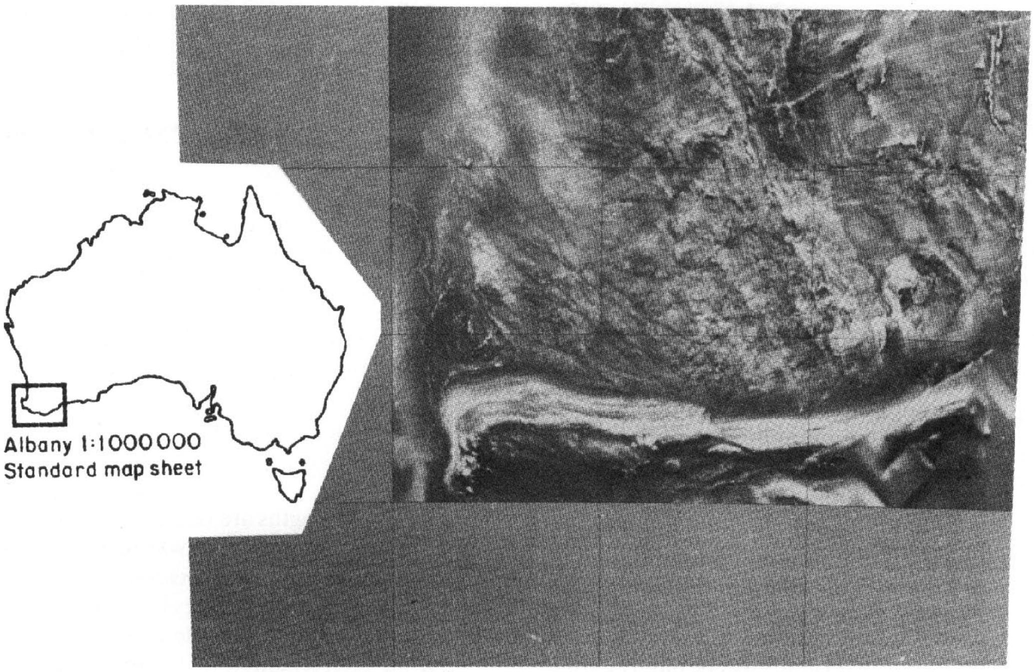

Fig 1 Albany 1 : 1 000 000 sheet area total magnetic intensity greyscale map reduced to 1 : 5 000 000 scale for presentation.

coincides with the magnetic quiet zone, and some scattered granite outcrops on geological maps. What is clear in the new pixel presentations is the prominence of the contact along the northern side and the apparent simplicity of the preserved folds of metasediments. The enveloping of the metasediments indicates that the granite was intruded upwards into a belt of sediments in the Albany Mobile Belt. A few scattered mineral occurrences in this area of extensive cover suggest that it may be of great interest for exploration.

Ground control of satellite observations of the geomagnetic field

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Measurements of the vector magnetic field were made at about 8000 stations over Australia, mainly during the period 1967–75 (Dooley & McGregor 1982); these measurements comprised the Third-order Regional Magnetic Survey. The distribution of the measurement sites is shown in Fig. 1. One of the objectives of this survey was to improve the representation of the field for the production of magnetic charts; however, it also provides an opportunity to study long wavelength anomalies associated with crustal features.

Another set of vector data over the continent is provided by the MAGSAT project. Anomalies of crustal origin have been extracted from satellite magnetic data and analysed for various parts of the world; for Australia, so far only the scalar field has been used. The limit of resolution of anomalies from satellite data appears to be at a wavelength of about 250 km. It is expected that combined use of the satellite and ground data should improve the resolution, and also enable better treatment of systematic errors present in one or other data set but not in both. The use of vector data should improve the prospects of determining the directions of magnetization of the anomalous bodies.

Two-dimensional Fourier analysis appears to be the most appropriate method for analysis of the data sets over the continental region. It has been shown that distortion due to assumption of a flat earth over a region of the sphere of radius up to about 30° is only about 2%. More serious errors are likely to arise from truncation of the third-order data at the continental boundary. Such errors may be reduced by using