# A geophysical profile across Australia at 29°S

*J. C. Dooley*

**Long wave-length components of the gravity and magnetic fields, topography, and heat-flow data, are examined along a trans-continent profile close to 29°S. The profile crosses from the west Australian Archaean shield in the west to the New England Permian geosyncline in the east. The depth to the Moho, the mean crustal density, and temperatures at 40 km depth and at the base of the crust are derived from the profiles. Depths obtained from seismic refraction and reflection surveys near the profile are shown for comparison. The gravity anomalies show that departures from isostasy along the profile must be small, although in the eastern part of the Precambrian shield compensation must be either regional or deeper than the base of the crust. The Moho is probably at about 35-40 km depth over most of the profile. Average crustal density estimates range from 2.82 to 2.96 t/m$^3$. Temperatures at a given depth increase from west to east; the depth to the Curie temperature may be below the base of the crust under the west Australian craton, but within the crust in the eastern part of the profile.**

**The magnetic profile shows long wave-length features of some hundreds of nanoteslas amplitude; some of these correlate with gravity anomalies, others show a reverse correlation. Anomalies are generally larger in the western part of the traverse. Some anomalies appear to be caused by permanently magnetised rocks. The crust beneath the Permian New England Geosyncline is similar to that beneath the Archaean shield in Western Australia in average crustal density, elevation, and crustal thickness.**

## Introduction

Over a number of years various types of geophysical data have been or are being mapped more or less systematically over Australia.

In this paper, published and unpublished data from the various geophysical fields have been assembled along a profile (Fig. 1) crossing the Australian continent from west to east at latitude approximately 29°S. The objective is to examine in a preliminary way the long wave-length components of the data for significant features and correlations. The shorter wave-lengths have been removed by taking averages over ½° latitude-longitude 'squares', over 50 km length of profiles, or by scaling from small-scale contoured maps.

The data plotted in Figure 2 include the gravity and magnetic fields, topography, and heat flow. Deep seismic soundings at a few points close to the profile have been shown for comparison. The main geological features crossed by the profile are also shown.

Features derived from the data include the depth to the Mohorovicic discontinuity, mean crustal density, temperature at 40 km depth, and temperature at the base of the crust. Values for these parameters depend on the assumptions made and models used in deriving them, and should be regarded as tentative hypotheses at present, to be tested as further data or more rigorous analyses become available.

The profile follows a series of magnetic profiles flown in 1975/76, crossing the continent from Geraldton-Laverton-Emu-Oodnadatta-Tibooburra - Bourke - Moree-Grafton. Because of logistic and navigational problems, the line contains bends (Fig. 1). However, because long wave-length magnetic data would have been difficult to extract from any other source, it was decided to adopt these flight paths as constituting the profile for study, and to plot the other more readily available data along that profile. For plotting purposes, the profile has been projected onto latitude 29°S.

The averaging process is not necessarily the best for extracting long wave-length data, and the gravity, magnetic and topographic data will be subjected to Fourier analysis in due course. The present study is intended as a preliminary examination of the data to assess what correlations seem likely to lead to useful conclusions.

Many very interesting anomalies at shorter wave-lengths have been eliminated by the averaging process. The relation of some of these to geological features has already been studied, and there are still many fruitful studies of this nature to be made. Occasionally it may be advisable to look at the more detailed data in order to understand the longer wave-length components. However, detailed comparisons have been avoided in this study.

For further appreciation of the nature of some of the anomalies shown on the profiles, reference should be made to maps which show the extent and trend of the anomalies; by studying the maps, it can be seen where the profile crosses features obliquely, where it crosses a major feature near its end and does not illustrate its full amplitude, and similar instances (BMR, 1976c, 1976d; Anfiloff & others, 1976; Wellman, 1976, figs. 2, 7 & 8; Wellman, 1979, fig. 5; Cull & Denham, 1979, fig. 1).

## Data

### *Magnetics*

During the course of a first-order magnetic survey (i.e., reoccupation of about 60 stations over Australia for mapping the main field and its secular variation) BMR's Aerocommander aircraft was used for transport between stations. The opportunity was taken to record the total magnetic field on flights between stations at an altitude of 3 km, with overflying of end points to ensure continuity.

The records were digitised approximately every 5 km (McMullan, pers. comm.). For this paper, successive groups of ten values have been averaged; thus the means are obtained of about 50 km of traverse, corresponding approximately to the 0.5° x 0.5° block averages of gravity and topography. A component representing the Earth's main field has been subtracted, and the residual total intensity anomalies have been plotted in Figure 2 (a).

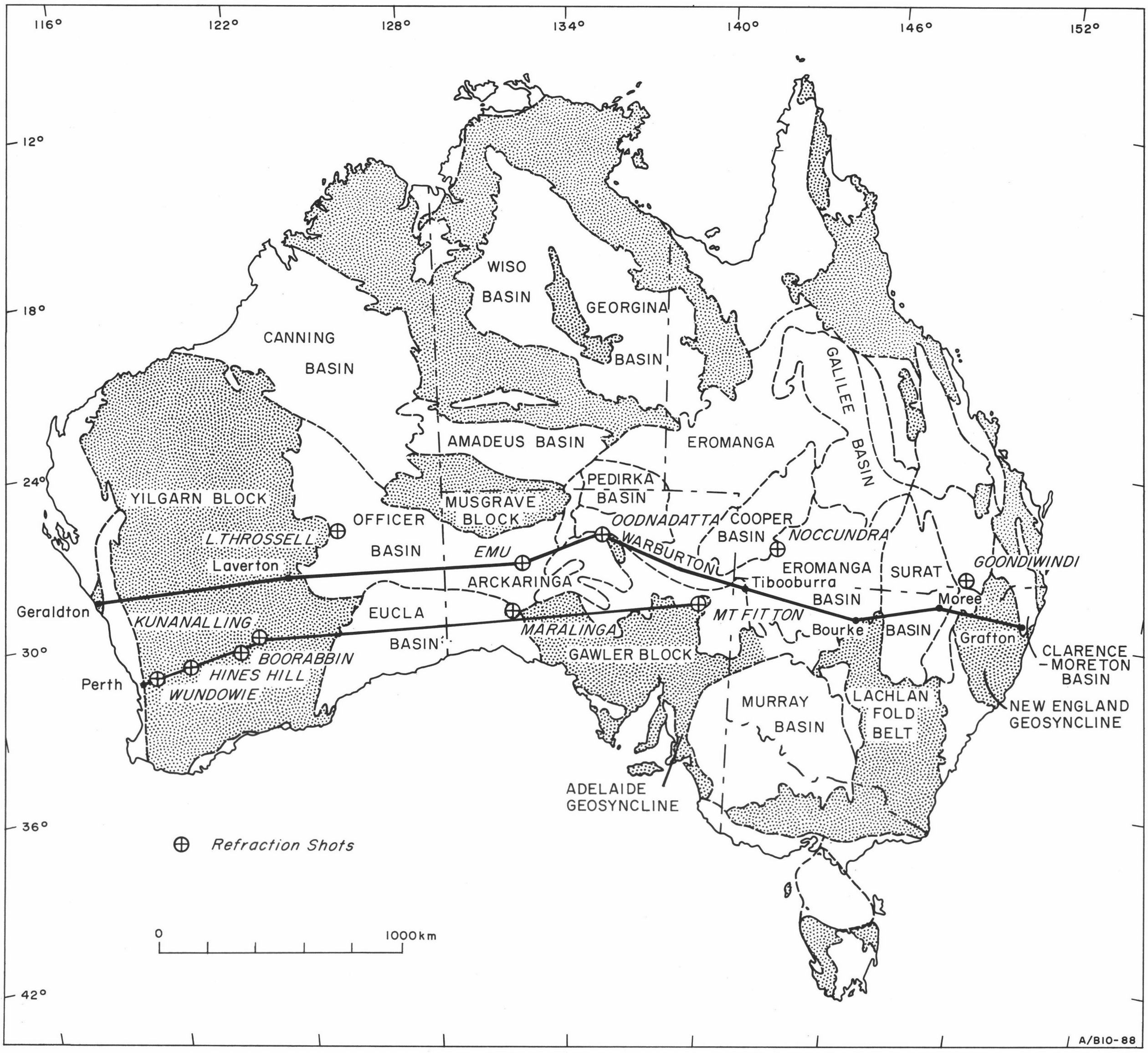


**Figure 1. Locality map showing profiles, reflection and refraction probe sites, and major geological provinces.**
The legend on the figure should read reflection and refraction shots.

A third-order regional magnetic survey has been conducted to fill the gaps between first-order stations; the vector field components of total intensity, horizontal intensity, and declination were measured at intervals of about 20-100 km along roads or tracks, or by helicopter in remote areas.

The total intensity profile was derived from the continuous flying rather than the third-order survey, as the former gives a more even representation of the field. It is of interest to determine whether the long wave-length anomalies result from induced or permanent magnetisation. The horizontal component of the magnetic field $H = F \cos I$, where F is total intensity and I is inclination. I is about 60° along the profile, so H should be about half F. If the anomalies reflect induced magnetisation over broad zones, approximately the same ratio should be maintained for the anomalous part of the field. A major deviation from this ratio would indicate remanent magnetism in a different direction from the present field. Remanent magnetism could exist in the same direction as the present field, which could not then be distinguished from induced magnetisation.

In order to examine this, average horizontal components were determined over half-degree longtitude segments of the profile from the third-order regional magnetic observations; observations within about half a degree of latitude from the profile were used. These were corrected for the main field and secular variation of Finlayson (1973), modified by later measurements (van der Linden, unpublished data) which showed that Finlayson's maps give values about 190 nT too low near Geraldton.

The average horizontal intensity values have been plotted with the total intensity values in Figure 2(a). In comparing the two profiles, it should be remembered that they are based on different data sets, one at ground level and the other at 3 km elevation. The different sampling procedures—averaging point observations at irregular spacings in one case, and averaging segments of a profile in the other case—could lead to apparent local differences, particularly in disturbed areas. An example is the sharp negative H anomaly at 117°E, which mainly results from one point with an anomaly of −5000 nT. Near 136°E and 137°E is another disturbed area, where the observations near the profile range through several hundreds of nanoteslas.

The separation of the regional field from the residual or anomalous part is to some extent arbitrary, and removal of very long wave-lengths (10° or more) in the regional fields for F and H may not be consistent. Between the two extremes, we can expect that major variations of direction of magnetisation should be apparent for anomalies of horizontal extent of the order of 2° to 10° along the profile. The attenuation of such anomalies because of upward continuation from ground level to 3 km is less than 10%; this is not significant for the present study.

*Geology*

The geological features in Figure 1 and Figure 2(c) have been extracted from the Geological Map of Australia at 1:12 M (BMR, 1971), Geology of Australia at 1:10 M (BMR, 1976a), and the Tectonic Map of Australia and New Guinea at 1:5 M (GSA, 1971).

*Gravity*

The topographic and gravity anomaly profiles have been prepared from the 0.5° x 0.5° area averages used by Wellman (1979). Free-air anomalies, Bouguer anomalies using a density of 2.67 t/m$^3$, and isostatic anomalies for the Airy hypothesis with standard depth 30 km, have been plotted in Figure 2(b). Where necessary, profile values have been interpolated between means of adjacent areas. The topographic profile has a vertical exaggeration of 500:1.

Also shown in Figure 2(b) is a very long wave-length gravity field derived by Anderson & others (1973), using spherical harmonics to order 16, based on satellite data. This is probably related to density variations at some depth in the mantle, and should be regarded as a base-line for studying the crust.

The depth to the base of the crust and the mean density of the crust plotted along the profile are based on investigations by Wellman (1976), and have been plotted in Figures 2(c) and 2(d). Depths are shown with a vertical exaggeration of 10:1.

The absolute levels of these curves cannot be derived from gravity data alone. The depths shown were derived by Wellman as consistent broadly with seismological data. Wellman's density variations were added to an assumed standard crustal density of 2.9 t/m$^3$ to give an estimation of actual densities.

*Heat flow*

The heat flow profile (Fig. 2(e)) was constructed from a contour map of heat flow values (Cull & Denham, 1979, fig. 1), based on a 1° x 1° grid derived by interpolation from observations distributed somewhat unevenly over the Australian continent.

The reliability of the contours depends of course on the distance from observations. There are several observation sites both north and south of the profile from the western end to about 123°E; after that there is a gap, then some observations to the south of the profile from about 131°E to 142°E; another at about 145°E, and several near the eastern coast but not near the latitude of the profile. Thus the accuracy of representation of heat-flow data is variable.

Sass & others (1976), and Lilley & others (1978) summarised and reviewed Australian heat flow data comprehensively up till that date. Sass & others divided Australia into three—western and central shields, and eastern province—in each of which the heat production characteristics have uniform properties. They constructed steady-state temperature profiles for the three provinces for various values of observed surface heat-flow (their fig. 7). Using these curves, the temperatures at 40 km depth (which Sass & others took as the base of the crust) have been calculated using heat flow values of Cull & Denham (1979) along the profile, and have been plotted on Figure 2(f).

There is some uncertainty about heat production in the eastern province because of the absence of measurements of near-surface radioactivity; the temperature cannot be estimated reliably, and a range of possible temperatures is shown. Temperatures at the base of the crust have been calculated using Wellman's Moho depths, and are also plotted on Figure 2(f). These temperature estimates depend on the models adopted, both for heat production parameters and crustal thickness, and neither of these models can be considered definitive at this stage.

*Deep seismic sounding*

Refraction seismic traverses giving information on crustal thickness and structure have been recorded along lines somewhat to the south of the profile (Fig. 1).

The westernmost of these is the 'Geotraverse' from Perth to Coolgardie (approx. 32°S, 116°E, to 31°S, 121°E). Mathur & others (1977) derived a three-layer crust thinning from about 42 km to 36 km from west to east.

As part of the Trans-Australia Seismic Survey between Kunanulling (30.7°S, 121.1°E) and Mount Fitton (30.0°S, 139.6°E), Finlayson & others (1974) deduced a crustal thickness of about 36 km near Coolgardie, deepening to about 48 km at Mount Fitton, with some relief on the boundary surface.

The crustal models and Pn velocities deduced by these authors have been plotted on the cross-section (Figure 2(c)); they are displaced by between 1° and 3° of latitude to the south of the profile.

Some late events (from 5 to 13 s) have been recorded at various sites around Australia in the course of seismic reflection surveys; these may represent reflections from deep crustal boundaries and the base of the crust (Moss & Dooley, 1973). Some of these sites are close to the profile (Fig. 1). Dooley & Moss (unpublished data) have interpreted these in terms of a simple two-layer crust consistent with the gravity field. The method was outlined briefly by Dooley (1979).

The relevant sites, their locations, and depths to Conrad (K) and Mohorovicic (M) boundaries are given in Table 1. The interpretations should be regarded as tentative because the nature of the reflections has not been fully investigated. Once again, it should be borne in mind that some of the reflection sites are offset from the profile by 1° or 2° latitude. They have been plotted along the cross-section of Figure 2(c) for comparison with the other data. Other reflection events not identified as major crustal boundaries have also been shown.

The reflections plotted include an event recorded from the Emu atomic explosion of 1953 (Doyle & Everingham, 1964), which was interpreted as an oblique reflection; the depth calculated (23 km) suggests an intermediate crustal boundary as the reflector.

Attempts were made to record reflections along the Geotraverse (Mathur & others, 1977) at several sites. Several events or bands of energy were reported. However there appeared to be no simple correlation with the refracting boundaries in general, and no clear events which could be correlated with the base of the crust. They have not been plotted on Figure 2(c).

| *Site* | *Latitude* | *Longitude* | *K* | *M* |
|---|---|---|---|---|
| *Lake Throssel* | 27.1°S | 124.7°E | 27.5 km | 40.5 km |
| *Emu* | 28.6°S | 132.2°E | 22.7 | — |
| *Oodnadatta* | 27.4°S | 135.3°E | 18.8 | 37.5 |
| *Noccundra* | 27.8°S | 142.6°E | 21.4 | 35.4 |
| *Goondiwindi* | 28.5°S | 149.4°E | 15.8 | 37.6 |

**Table 1. Deep reflection sites and interpreted depths to Conrad (K) and Mohorovicic (M) boundaries.**

## Discussion

Geraldton, at the western end of the profile, is on the coast near the northern end of the Perth Basin. The coastal strip contains outcropping Jurassic sediments, with a narrow strip of Permian between the Urella and Darling Faults. The Darling Fault extends for about 1000 km to the south, and forms the western boundary of the Archaean shield. The maximum depth of the Perth Basin probably exceeds 10 km; however the profile crosses it very close to the northern boundary where it abuts against Proterozoic metamorphics.

The profile passes over the northern edge of the major gravity anomalies associated with the Perth Basin and the Darling scarp; with the averaging, these anomalies practically vanish.

From longitude 115.5° to 123.5°E, the profile crosses the Archaean Yilgarn block—mainly granite, with volcanics and intrusives ranging from acid to ultrabasic. Along the profile, ultrabasic intrusives outcrop mainly west of 119°E, and acidic to intermediate east of this latitude; basic volcanics occur throughout. There is no obvious change in the long wave-length geophysical parameters at 119°E. The average elevation is about 400 m over the Yilgarn Block. The isostatic anomalies are in general small (i.e., close to the satellite

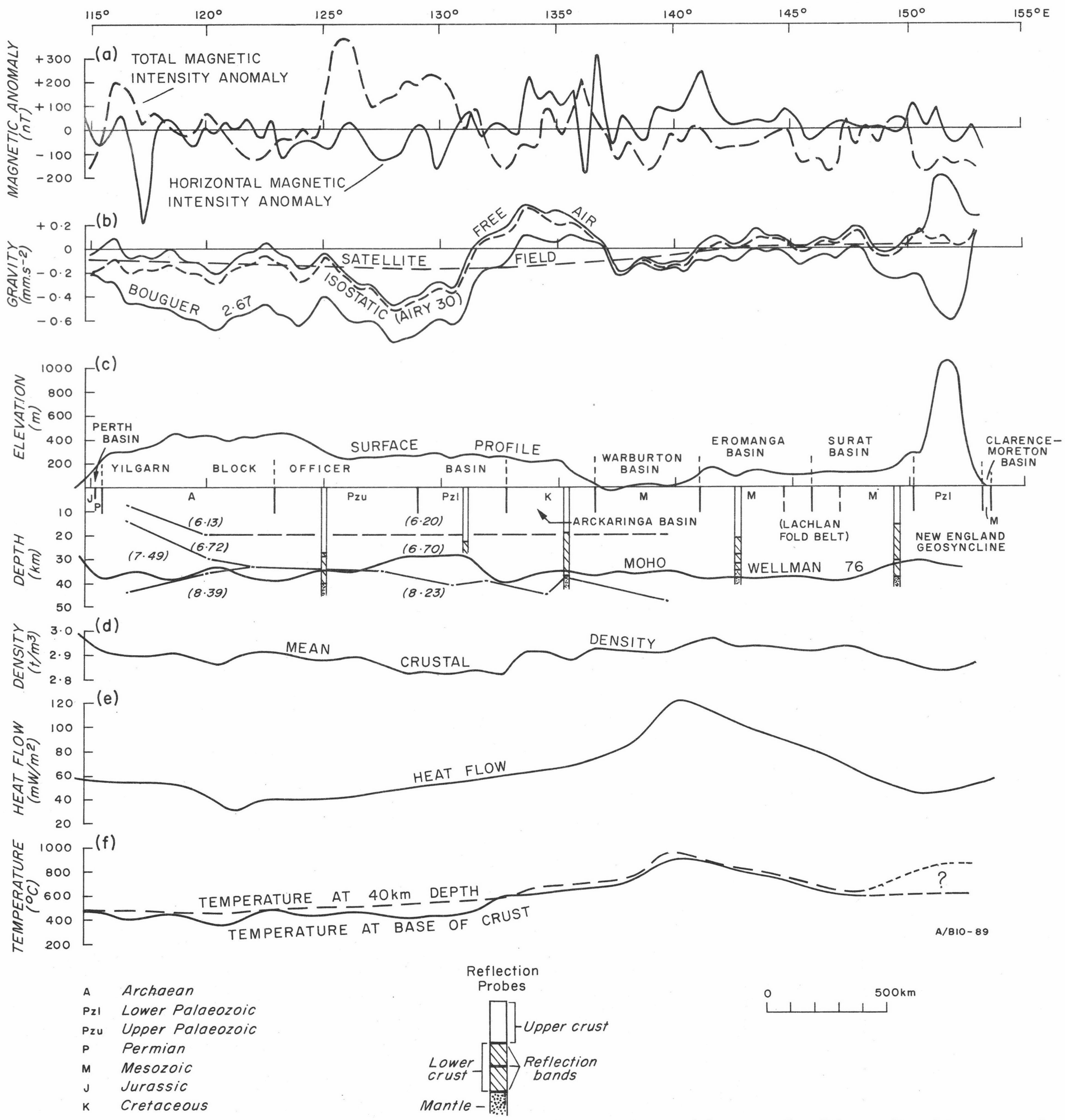


**Figure 2. Profile of geophysical parameters across the Australian continent: (a) magnetic; (b) gravity; (c) topography, geology and seismic depths; (d) mean crustal density; (e) surface heat flow; (f) temperatures at depth.**

field), which is consistent with the block being broadly in isostatic equilibirum.

The positive F anomaly at 116° to 117°E correlates with a small isostatic gravity anomaly, and is associated with the edge of the Archaean shield. In more detail the profile shows an F anomaly of 800 nT at one place.

Anomalies such as the positive anomaly centred at 122.5°E, which appear in all three anomaly curves but have no topographic expression, must represent a broad excess of crustal (or possibly upper mantle) mass. The low anomalies flanking it may reflect compensating masses at greater depth, or distributed regionally. A negative F anomaly correlates with the gravity high feature; here the H anomaly is close to zero, so if base levels have been chosen correctly, this would imply that the F anomaly is caused by reversed vertical magnetisation.

The (relatively) high anomaly at 125°E is just north of the positive gravity anomaly associated with the Fraser Fault—a prominent feature on the gravity map at the southeastern boundary of the Yilgarn Block.

The high F anomaly near 126°E appears to be displaced eastwards from the gravity high; this may be partly because the traverse cuts this feature obliquely.

From 123.5° to about 133°E, the profile runs through the Palaeozoic Officer Basin, with lower Palaeozoic sediments west of 129°E, and upper Palaeozoic east of this longitude. The Officer Basin has a probable depth of 4 or 5 km in its central portion. The profile then deviates northwards towards Oodnadatta, and crosses a lobe of the Cretaceous Arckaringa Basin. The elevation drops to about 200 m over most of the Basin.

The very broad low gravity feature from 125° to 131°E, and the high feature from 131° to 137°E, are expressions of the major negative gravity anomaly associated with the Officer Basin and the positive anomaly flanking its southeastern margin. The profile cuts these features obliquely, so that the wavelengths of the anomalies on the profile are much longer than the minimum wave-lengths at right angles to the strike. Wellman (1978) has shown that it is possible to model these anomalies using a regionally compensated isostatic model; other authors have regarded them as out of isostatic balance, maintained by the strength of the crust or lithosphere.

The high feature in the Moho from about 127° to 132°E, in Wellman's interpretation, compensates the low-density crustal material above it. Because of the large north-south gravity variations in this area, it is not surprising that it is not reflected in the refraction seismic profile to the south.

Between 125° and 131°E (i.e., over the Officer Basin) F is positive. The H anomaly is mostly negative, but tends to follow the two main high features in the F profile. This could be interpreted as a broad area with reversely dipping magnetisation, and two superimposed more local features magnetised approximately in the direction of the present field.

High F anomalies correlate with low gravity anomalies over the Officer Basin, contrary to what might be expected from non-magnetic sediments. The negative gravity anomaly is larger than can be explained by the known thickness of sediments, and has been interpreted by Wellman as intra-crustal low-density material, with regional compensation at the base of the crust. A possible explanation is that the lighter rocks are granitic basement with a high magnetic content. The reverse magnetic-gravity anomaly correlation persists over the Arckaringa Basin.

The temperature profiles show that the Curie isotherm of magnetite (580°C) may well be below the base of the crust under Western Australia, and therefore magnetic anomalies could be related to the shape of the Moho or to magnetisation of deep crustal rocks. In central and eastern Australia however, the Curie isotherm is probably within the crust.

The boundary between the western and central shields of Sass & others (1976) was not defined precisely, but would be located between 125° and 129°E; a gradual transition of the temperature profile from the western to central shield profiles has been introduced here.

From Oodnadatta the profile continues east-southeasterly along the Warburton Basin, crossing Lake Eyre, which is a few metres below sea-level. This basin may be regarded as part of the Eromanga Basin and the Great Artesian Basin, in which the profile continues to about 150°E. At about 146°E it crosses the buried basement Eulo Ridge and passes into the Surat Basin. Being near the southern margin of the Eromanga Basin, the thickness of sediments is not great, probably not exceeding 1 km. From 141° to 150°E the average elevation is not much above 100 m.

Between 144.5° and 147°E, the traverse passes just to the north of the Lachlan Fold Belt; the Eulo Ridge may be in some sense an extension of this. Low gravity and magnetics from 137° to 141°E may be the effect of sediments in the Warburton Basin. The small high gravity features at 141.5° and 143.5°E correlate approximately with topography—even the isostatic anomaly; this indicates that these features are not locally compensated. Other anomalies occur between 145° and 149.5°E, where there is no topographic expression; they must represent buried crustal masses.

The general level of F anomalies east of about 137°E is below zero. H is positive to about 142°E, and then near zero. This implies a permanent component of magnetisation. It may be that the level of the main field for F has not been chosen correctly in this area. However there are clear relative lows in F from 145°E to 147.5°E, just north of Lachlan Fold Belt, and under the eastern highlands. Further, Regan & others (1975), in a global magnetic anomaly map based on Pogo satellite data at 540 km mean elevation, show a positive F anomaly over western Australia with a maximum of +8 nT about 128°E, and a negative anomaly over eastern Australia with a minimum of −6 nT about 142°E. Such an anomaly would be amplified by a factor of about 4 or 5 on downward continuation to the Earth's surface; hence the very broad variations of F along the profile are consistent with the satellite data.

A lower level for F might be associated with the decrease in depth of the Curie isotherm from west to east, but such a broad change would be difficult to separate from the main field. Larger amplitude and longer wave-length anomalies occur in the western part of the traverse than in the east; this could be associated with the depth to the isotherm, with possible deeper magnetic sources and more magnetised rocks at depth in the west. The high temperature feature near 140°E, with a maximum of 800°C or 900°C, does not have any obvious effect that might be expected in the magnetic field, and is not shown in Wellman's crustal depths or density variations; this is consistent with the interpretation of Cull & Denham (1979), that the heat-flow measurements are affected by discharge of water from the Great Artesian Basin.

From 150° to about 152.5°E, the profile crosses the lower Palaeozoic New England Geosyncline, and then the coastal strip near Grafton in the Mesozoic Clarence-Moreton Basin, in which sediments may reach a thickness of about 2 km near Grafton. There is a narrow zone where average elevation reaches about 1 km over the eastern highlands. The free-air anomaly correlates positively with topography, and the Bouguer anomaly correlates negatively, as would be expected. The isostatic anomaly remains small, which shows that compensation is almost complete for 30 km standard crust.

Cull (1979) has recently estimated that a correction should be applied to heat flow data for climatic variation; this could be more than 20 percent in parts of eastern Australia affected by the glaciation of about 10 000 years B.P. Further, the measured heat flow values may be too low because of the recharge zone of the Great Artesian Basin near 150°E. Accurate correction for the discharge and recharge effects cannot be made; however allowing for their influence, together with the climatic affect, would change the temperature profiles to make a more nearly uniform rise from west to east.

The Moho depths on the profile do not obviously reflect the major topographic changes, as would be expected for isostatic compensation. Apart from the eastern highlands, the expected Moho relief would be only about 2 km, and is apparently masked by effects associated with the crustal density variations. The Moho depths agree reasonably well with the seismic reflection and refraction depths, considering their geographical displacement.

The decrease in Pn seismic velocity from the Geotraverse to the Trans-Australia profile is probably associated with increased temperature—though this is not evident in the temperature at the base of the crust until east of 132°E, because of the high feature in the Moho between 127° and 132°E.

The profile is intersected by two north-south lines of refraction recordings—one from a shot at Meekatharra (26.6°S, 118.5°E), and a very long line from explosions at Ord River Dam (16.1°S, 128.7°E). The Meekatharra shot was intended mainly for recording to the north in conjunction with a major crustal survey in the Pilbara/Hamersley area in 1976. The few recordings to the south have not yet been analysed, but Drummond (1979) considers that low intercept times indicate a much thinner crust than to the north. The Ord River line crosses the profile near Oodnadatta. The source is too distant to give details of crustal structure, but the intercept times (Denham & others, 1974) indicate a thick crust, perhaps 50 km or more, in central Australia. Neither of these rather general observations appears to be reflected in Wellman's Moho depths.

The approximate values of the main derived parameters for each of three main regions: (1) the West Australian craton (2) the central region, from 135-150°E, and (3) the eastern highlands in New England, are shown in Table 2.

The crust beneath the Permian New England Geosyncline therefore has some similarities to that beneath the Archaean Shield in Western Australia, in spite of the large difference in age of the surface rocks.

| *Region* | *Elevation (m)* | *Crustal density t/m³* | *Heat flow mW/m²* | *Temp. at base of crust °C* | *Depth to Moho km* | *Bouguer gravity* |
|---|---|---|---|---|---|---|
| 1 | 305 | 2.87 | 50 | 500 | 35 | -500 |
| 2 | 90 | 2.92 | 80 | 700 | 37 | -100 |
| 3 | 400 | 2.86 | 50 | 600? | 33 | -300 |

**Table 2.**

## Acknowledgements

The author gratefully acknowledges helpful comments by Dr P. Wellman, Mr I. B. Everingham, Dr D. Denham, Mr P. M. McGregor, and Dr J. F. Truswell. The figures were drafted by G. Clarke.

## References

ANDERSON, R. N., MCKENZIE, D. P., & SCLATER, G. P., 1973. Gravity, bathymetry, and convection in the Earth. *Earth and Planetary Science Letters,* **18**, 391-407.

ANFILOFF, W., BARLOW, B. C., MURRAY, A. S., DENHAM, D., & SANDFORD, R., 1976—Compilation and production of the 1976 Gravity Map of Australia. *BMR Journal of Australian Geology & Geophysics,* **1**, 173-6.

BMR, 1971—Geological Map of Australia, 1:12 000 000. *Bureau of Mineral Resources, Australia, Canberra.*

BMR, 1976a—Geology of Australia, 1:10 000 000. *Bureau of Mineral Resources, Australia, Canberra.*

BMR, 1976b—Geology of Australia, 1:2 500 000. *Bureau of Mineral Resources, Australia, Canberra.*

BMR, 1976c—Gravity map of Australia, 1:5 000 000. *Bureau of Mineral Resources, Australia, Canberra.*

BMR, 1976d—Magnetic map of Australia—Residuals of total intensity. *Bureau of Mineral Resources, Australia, Canberra.*

CULL, J. P., 1979—Climatic corrections to Australian heat flow data. *BMR Journal of Australian Geology & Geophysics,* **4**, 303-7.

CULL, J. P., & DENHAM, D., 1979—Regional variations in Australian heat flow data. *BMR Journal of Australian Geology & Geophysics,* **4**, 1-13.

DENHAM, D., SIMPSON, D. W., GREGSON, P. J., & SUTTON, D. J., 1972—Travel times and amplitudes from explosions in northern Australia. *Geophysical Journal of the Royal Astronomical Society,* **28**, 225-35.

DOOLEY, J. C., 1979—A review of crustal structure in northeast Australia. *In* STEPHENSON, P. J., & HENDERSON, R. A. (Editors), THE GEOLOGY AND GEOPHYSICS OF NORTH-EASTERN AUSTRALIA. *Geological Society of Australia, Queensland Division.*

DOYLE, H. A., & EVERINGHAM, I. B., 1964—Seismic velocities and crustal structure in southern Australia. *Journal of the Geological Society of Australia,* **11**, 141-50.

DRUMMOND, B. J., 1979—Structural relations between the Archaean Pilbara and Yilgarn cratons, Western Australia, from deep seismic sounding. M.Sc. Thesis, R.S.E.S. ANU.

FINLAYSON, D. M., 1973—Isomagnetic maps of the Australian region for the epoch 1970.0. *Bureau of Mineral Resources, Australia, Report* **159.**

FINLAYSON, D. M., CULL, J. P., & DRUMMOND, B. J., 1974—Upper mantle structure from the Trans-Australia seismic refraction data. *Journal of the Geological Society of Australia,* **21**, 447-58.

GSA, 1971—Tectonic map of Australia and New Guinea, 1:5M. *Geological Society of Australia, Sydney, N.S.W.*

LILLEY, F. E. M., SLOANE, E. M. N., SASS, J. H., 1978—A compilation of Australian heat flow measurements. *Journal of the Geological Society of Australia,* **24**, 439-45.

MATHUR, S. P., MOSS, F. J., & BRANSON, J. C., 1977—Seismic and gravity investigations along the Geotraverse, Western Australia, 1969. *Bureau of Mineral Resources, Australia, Bulletin* **191**.

MOSS, F. J., & DOOLEY, J. C., 1973—Deep crustal and upper mantle reflection studies in Australia. *Geophysics,* **38**, 1215 (abstract).

REGAN, R. D., CAIN, J. C., & DAVIS, W. M., 1975—A global magnetic anomaly map. *Journal of Geophysical Research,* **80**, 794-802.

SASS, J. H., JAEGER, J. C., & MUNROE, R. J., 1976—Heat flow and near-surface radioactivity in the Australian continental crust. *U.S. Geological Survey Open-File Report,* **76-250** (unpubl.).

WELLMAN, P., 1976—Regional variation of gravity and isostatic equilibrium of the Australian crust. *BMR Journal of Australian Geology & Geophysics,* **1**, 297-302.

WELLMAN, P., 1978—Gravity evidence for abrupt changes in mean crustal density at the junction of Australian crustal blocks. *BMR Journal of Australian Geology & Geophysics,* **3**, 153-162.

WELLMAN, P., 1979—On the isostatic compensation of Australian topography. *BMR Journal of Australian Geology & Geophysics,* **4**, 373-82.