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GUIDE TO USING THE AUSTRALIAN CRUSTAL ELEMENTS MAP

BY

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AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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Australian Crustal Elements map

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AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

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Abstract

The map of Australian crustal elements, released at 1:5 million scale, delineates upper-crustal elements, primarily based on composite geophysical domains, each of which shows a distinctive pattern of magnetic and gravity anomalies. These elements generally relate to the basement, rather than the sedimentary basins, which tend to mask or distort — rather than define — the magnetic and gravity characteristics. Boundaries between these elements are interpreted to mark crustal-scale changes in composition or structural pattern, or both. Where feasible, these boundaries are chosen to emphasise their correlation with the outcropping boundaries of geological provinces. The elements are categorised according to their magnetic character, in a way which places them in a tectonic context. A tentative relative timescale emphasises the range of time over which the geophysical features, normally the magnetic patterns, are thought to have been developed.

Introduction

Objectives

Existing tectonic maps of Australia have the limitation that they do not tell us what basement units underlie the sedimentary basins; nor do they give us much information about the third dimension (depth). We have compiled an innovative type of map, inspired by the virtual completion of gravity and magnetic maps for the continent (Morse et al. 1992a; Tarlowski et al. 1995). This dual coverage allows for a more integrated interpretation of basement crustal elements than was previously possible. Our map builds on an earlier analysis of crustal-scale gravity anomalies (e.g., Wellman 1978), and on other regional studies of gravity and magnetic anomalies. It places a geophysical perspective on earlier evolutionary models based on geological data (e.g., Plumb 1979). The map uses the magnetic signature of composite magnetic and gravity domains to provide links to the outcropping geology. It goes farther by using structural relationships deduced from the geophysical trends, and links to the geology, to reveal the relative time implied by the combined geological and geophysical data sets.

The objective of this map is to present a new model — based on geophysical interpretation — of the tectonic framework of the Australian continent. In doing so, we hope to provide a starting position for the examination or re-examination of evolutionary tectonic models. The map presents the 'big picture'; it encourages the user to consider how the continent might have evolved into its present configuration, and to make predictions about the distribution, relative ages, and nature of its constituent crustal blocks. This kind of predictive ability should be helpful in targeting new areas for frontier petroleum and mineral exploration, or revealing problem areas for future research.

The chief interpreters were R.D. Shaw (NT, northwest WA, gravity SA), P. Wellman (northern Qld, NSW, VIC), P. Gunn (magnetics SA), and A. Whitaker (WA). M. Morse and others of the national gravity database group organised various sets of gravity data. Input in the form of magnetic images was provided by C. Tarlowski and others from the national airborne magnetic mapping team.

Previous geophysical interpretations

Early studies were focussed on the available gravity data. The significance of broad gravity domains was examined by Wellman (1976a), who assessed the implications of boundaries showing discordant trends. Wellman (1978) drew attention to how major gravity dipole anomalies can be used to recognise crustal changes across crustal block boundaries. Wellman (1988) applied these concepts to an interpretation of the development of the Australia Proterozoic provinces.

An earlier subdivision of the continents into Bouguer gravity domains (Fraser et al. 1977) made limited correlation with geological features and had little impact on our understanding of how the continent evolved. Mathur and Shaw (1982) attempted to relate the patterns of gravity highs and lows to the evolution of orogenic belts, in the process hinting at their possible plate-tectonic implications.

By adopting the concept of geophysical domains, developed in the 1970s (e.g., Provodnikov 1975), and combining it with other concepts, such as the presence of major dipole gravity anomalies and abrupt discordance in trend, it became possible to recognise geophysical features that showed reasonable correlation with geologically-defined tectonic features of crustal dimension such as plate boundaries (e.g., Thomas et al. 1988). With increasing computerisation, it became easier to produce and interpret various sets of derived gravity data, such as filters to extract short-wavelength residual anomalies (e.g., Kane & Godson 1985, Murray et al. 1989). Wellman, in a series of papers (Wellman 1988, 1992a, 1992b, 1995a, By about 1976, images of derived gravity and magnetic data sets were becoming available for much of the continent. The more recent versions of these maps, the gravity map of Morse et al. (1992a, 1992b) and the magnetic map of Tarlowski et al. (1993, 1995) have been particularly inspiring. These maps and a growing understanding of how to interpret them, provided the impetus for the current study.

Other data sets, such as those derived from deep seismic reflection profiling, are providing a more comprehensive three-dimensional picture of crustal structure in some regions (e.g., Goleby et al. 1989). In addition, a growing number of regional interpretations of potential-field data have been carried out throughout the continent and allow for an increasingly more reliable understanding of the continent's tectonic framework. Particular regional geophysical studies that bear on the geophysical interpretation of those individual crustal elements, recognised in the current study, are referenced in Appendix B.

Geological Setting

Evolutionary studies of the continents geology are hindered because over one-half of the continent is covered by post-tectonic sedimentary rocks of Proterozoic to Phanerozoic age (Fig. 1). As a result, surface geological information does not provide a lot of insight into how the different crustal blocks that make up the continent relate to each other. Gravity and magnetic anomalies can be used to tackle this problem by allowing us to look below the sedimentary cover and map the upper crustal anomalies sourced within the buried basement.

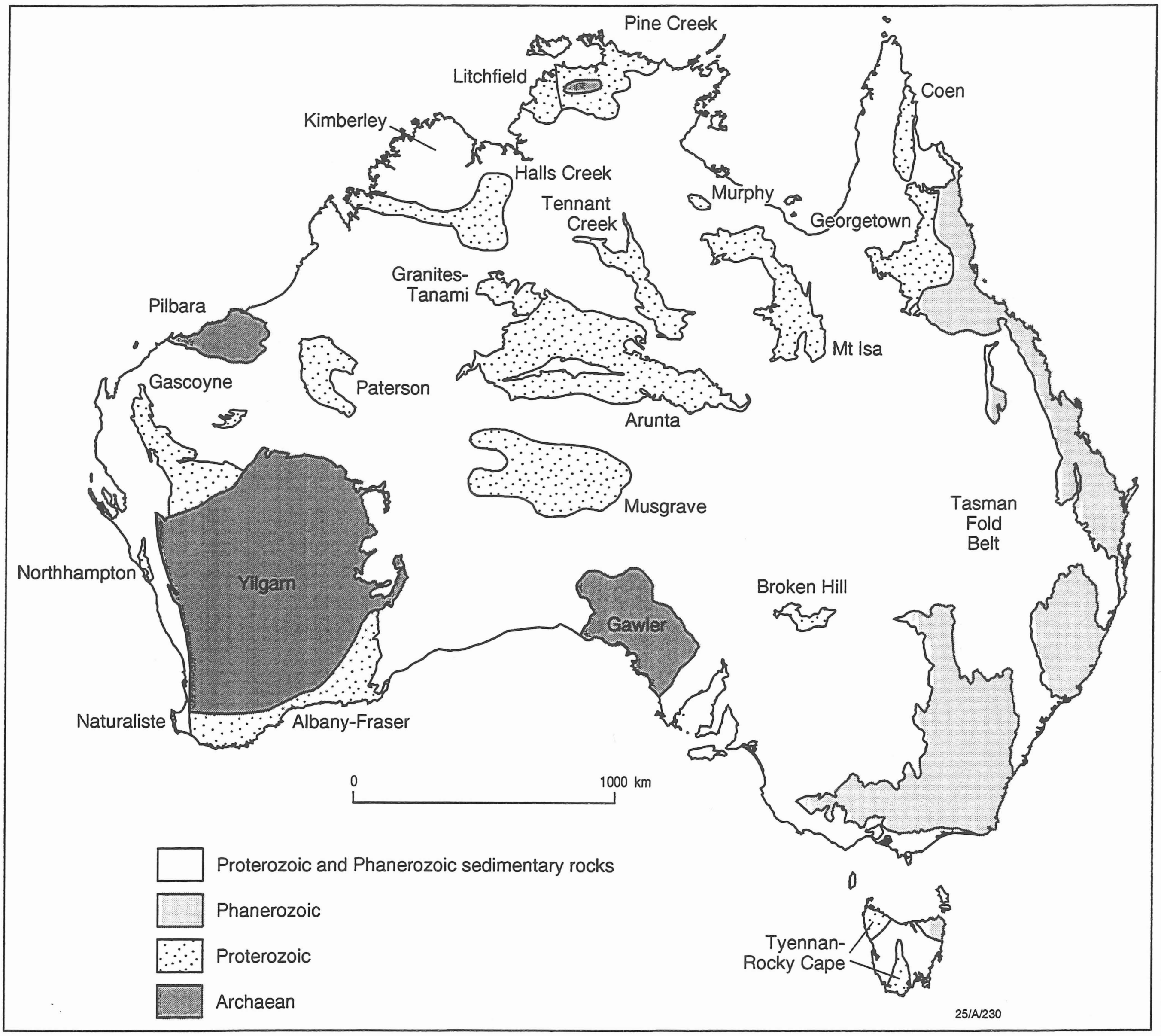

Figure 1. The main basement provinces and sedimentary basins of Australia.

Data Sources

Our task of making the crustal elements map began with assembling various data sets.

Gravity Data

The gravity data used in this study includes: (1) that recently integrated into an 2.5-km (91.5 minute) gridded format; (2) contoured Bouguer anomaly contour maps (BMR 1976, Morse et al. 1991), plotted at 1:2 500 000-scale; and (3) enhanced images of the Bouguer anomalies at 1:5 000 000-scale (Morse et al. 1992, Milligan et al. 1992), a recent image of which is shown in Figure 2.

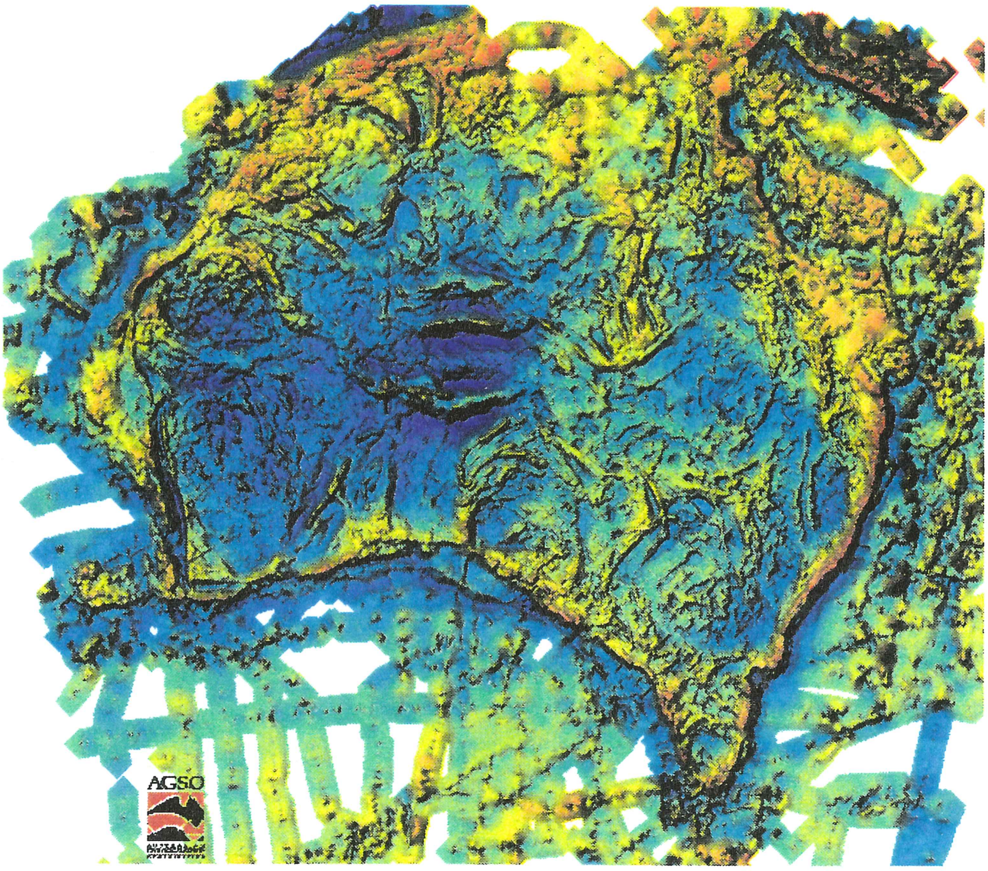

Figure 2. Image, with gradient enhancement, showing simplified Bouguer gravity anomalies of Australia, derived from the Australia National Gravity Database.

Magnetic Data

Magnetic data, generally collected along 1.5-km lines spacing and 150-m terrain clearance, has been studied in the form of 1:1 000 000 and 1:2 500 000 contour maps (BMR, 1976b) as well as computer generated images at various scales. A valuable overview of available data is provided by the magnetic anomaly 1:5 000 000-scale map of Australia, showing gradient enhanced residuals of total intensity (Tarlowski et al. 1996), a recent derivative of which is shown in Figure 3.

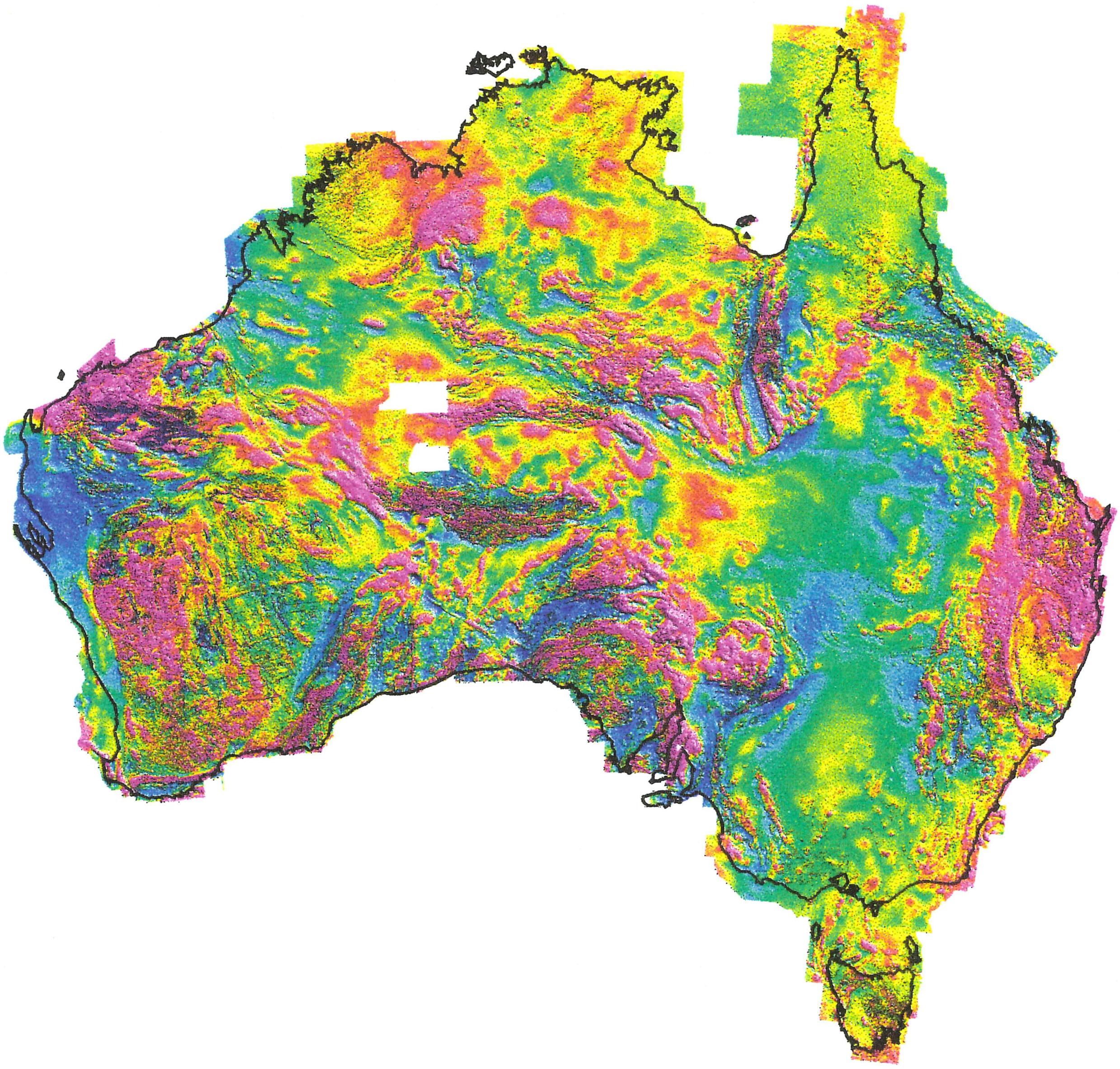

Figure 3. Image, with gradient enhancement, showing a simplified sample set of the magnetic anomalies of Australia, derived from the Australia National Magnetic Database.

An idea of the variation in flight-line spacing, for various surveys carried out throughout the country, can be gained from Figure 4. It can be seen that coverage is sparse (about 3-4 km line-spacing) for much of the central Australian region around 24 °S. In this region, the magnetic signal from basement rocks is both masked by the effects of a thick sedimentary overburden and by the loss of detail in the high frequency content as a result of the sparseness of the data coverage. These factors make interpretation in this region difficult.

AEROMAGNETIC DATA LINE SPACING

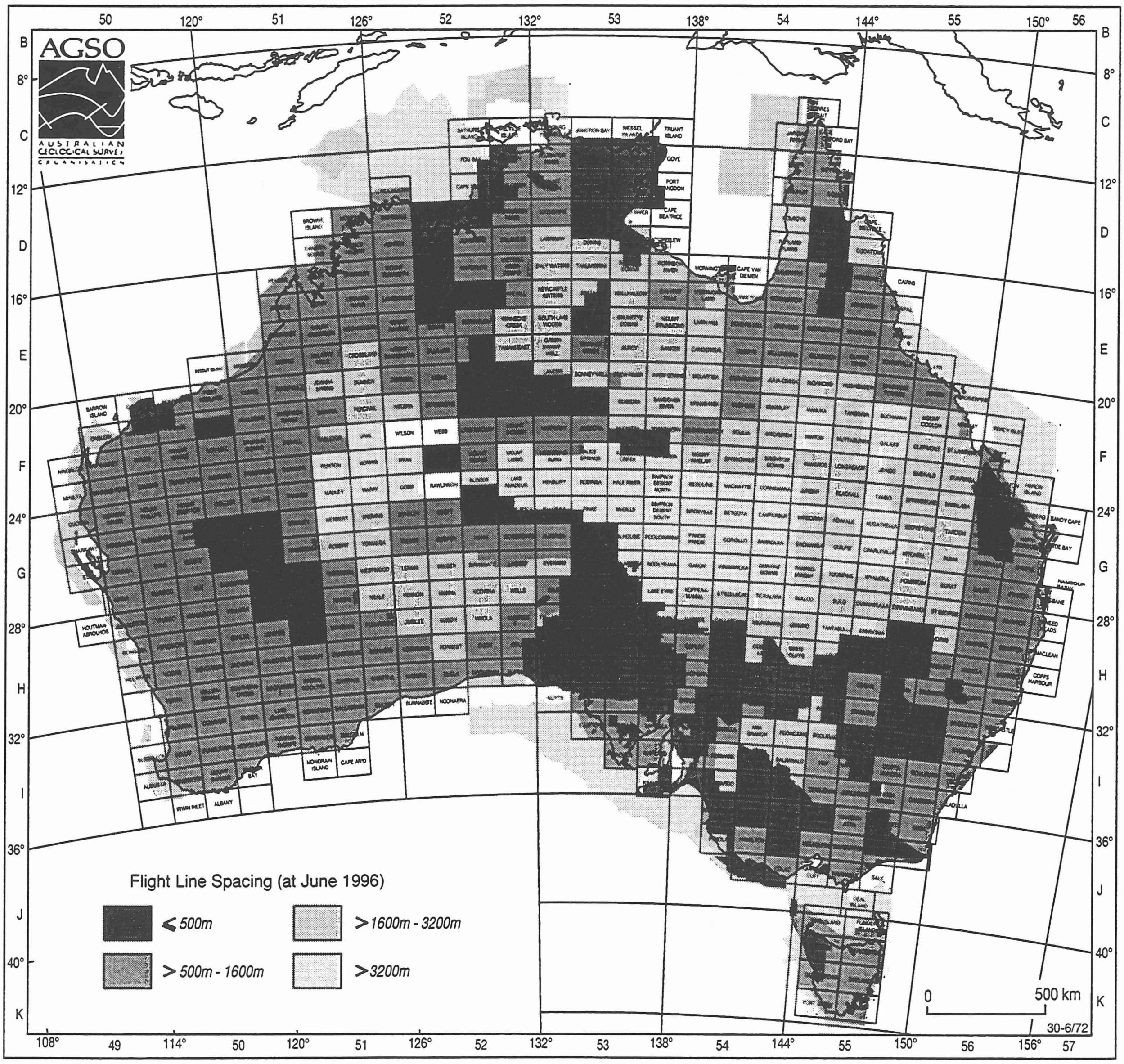

Figure 4. National aeromagnetic data flight-line spacing at May 1996.

Principles of the map

General Approach

The map is pre-eminently a geophysical domain map, NOT a map of tectonic provinces, nor an interpretative tectonic map. In its present form, potential correlations with established geological basement provinces are provided by colouring the map using deduced age-ranges, which are commonly poorly constrained (see below).

In attempting to build our model for the tectonic framework of the continent, we began by looking for coherence between gravity and magnetic domains so that we could delineate composite geophysical domains. After analysing several portrayals of amalgamated magnetic and gravity data sets (e.g., Figs 2 & 3), we erected compositional and structural province-scale boundaries that correlate, where possible, with geological features.

Such boundaries can then be extrapolated under the sedimentary basins.

To give the map an added tectonic flavour, we characterised the domains according to their magnetic and gravity character, in a way that reflects the tectonic significance of their magnetic responses.

Mapping Composite Geophysical Domains

We have mapped gravity and magnetic domains by recognising regions showing unifying characterisics of styles of magnetic and gravity anomalies, such as trend, magnitude and frequency content. Such features can imply a common geological history and similar ranges in bulk physical properties. Composite geophysical domains can be delineated where there is a consistency between the mapped gravity and magnetic domains.

Close attention was given to spatial relationships of geophysical features at the boundaries between geophysical domains, because these relationships can provide information on the relative age of crustal features. For example, a younger relative age for one domain relative to another is probable if it shows parallel trends at its margin that align with and/or truncate trends in the bordering domain. Major changes in the magnitude of anomalies suggest differences in physical properties at domain boundaries for the upper crust, and in places for the entire crust.

Mapping the Crustal Elements

Crustal elements are the interpreted pieces of upper crust that:

- correspond, more or less, to composite geophysical domains,
- show as close a correlation as is possible with geological provinces, and
- are deduced to have formed over a similar time-range.

The map is pre-eminently a geophysical domain map.

We emphasise that the magnetic and gravity boundaries shown on the 1:5 million map are not always exactly coincident with those of the crustal elements. Where there is some mismatch, or choice, the crustal boundary favoured is that which most closely corresponds to an established geological boundary. On the current version of the map, unlike typical maps of geophysical domains, the crustal elements have relative age-range as an attribute, as explained below.

Labelling the Crustal Elements

Although the use of mnemonic codes may lead to some confusion through unintended broadening of the meaning of these entities, they are needed so that the reader can readily find them on the map..

We choose to refer to the various elements by map symbol [groups of letters], rather than by giving them names. We do this because the history of naming such shows that names tend to be short-lived and to require constant refinement with incoming of new data and fresh interpretations. Our symbols [code is MAP_SYMBOL] can be used in the construction of databases. (see Glossary: Map-symbol).

Are most element boundaries defined with magnetic data?

In choosing crustal element boundaries, we have favoured magnetic boundaries as these can be more directly tied to exposed or near-surface geological boundaries. In general, gravity boundaries are favoured only where the magnetic signature is weak, either because of a thick sedimentary overburden, or poor coverage, or some other complication such as lack of continuity.

The relative contribution made by magnetic and gravity data to the definition of the crustal elements varies widely, depending on the situation. Magnetic domain boundaries are favoured as element boundaries in regions of exposed or near-surface basement rocks, where correlation with geological features is more direct. Gravity boundaries give a better indication of the geometry and position of deeper, crustal-scale features, which correspond to gravity anomalies of large magnitude and wavelength.

In principal, because gravity and magnetic potential fields have effects that vary inversely as the distance squared, the near-surface anomalies should be better resolved than more deeply sourced anomalies. However, gravity data is not readily automated, so coverage of large areas at a close spacing is not feasible at present. Consequently, current gravity coverage has, in general, only a 10-km station spacing, so does not map short-wavelength density variation. It, therefore, tends to monitor either more regional features or anomalies sourced much deeper in the crust, than magnetic anomalies (**for a more detailed explanation see** The nature of the magnetic and gravity anomalies). Most short-wavelength variation in the intensity of magnetisation can be related, in an approximate way, to the distribution, in three-dimensions, of igneous, volcanic and metamorphic rock bodies.

The nature of the magnetic and gravity anomalies

The geomagnetic field is a vector quantity that varies systematically in position and amplitude throughout the globe, and also shows diurnal and secular variations. How rocks interact with the earths' geomagnetic field depends partly on their mineral content and partly on their history of formation, so that both *induced* and *remanent* components of magnetisation need to be assessed to fully describe the magnetic character of rocks. The *induced* magnetisation of a rock can be specified in terms of its magnetic susceptibility, but this parameter is not always isotropic and depends on the fabric of the rock. Most short-wavelength variation in magnetic signature within a particular region (with a similar geomagnetic field) reflects variation in the ferromagnetic minerals within the rock, mainly variations in 'magnetite' content (more specifically in the Ti-Fe-oxides). The dominant magnetic sources are igneous, volcanic and metamorphic rocks bodies which generally possess both *induced* and *remanent* magnetisation. However — as is also the case with gravity anomalies — you can only approximately determine the character, shape and position of these magnetic bodies, as all the parameters are seldom uniquely constrained and, as a result, the calculations involve too many 'trade-offs' between parameters.

Bouguer gravity anomalies are calculated to minimise the effects of topography. They show the sum of the affects of density variations in the upper crust, and the attraction of the thickening of the crust that represents isostatic compensation to variations in Earth surface altitude.

Deducing the relative age of elements

We enhanced the tectonic significance of the map by deducing relative ages, mainly according to geophysical evidence derived from two sources: we deduced the relative ages of the domains from the structural relationships between adjoining elements; and then we assigned an age-range for the sources of the dominant magnetic and gravity signals. The two methods of interpretation were used to deduce plausible age-limits for each element. This approach has enabled us to express the evolution of the continent as a sequence of relative age slices on the map sheet. A simplified version of the map, using generalised age-boxes, is shown in Plate 1.

In the 1:5 000 000-scale map, each crustal element is coloured according to its relative age, which is taken to be the time when the main geophysical features, normally the magnetic patterns, were imposed. Possible limits for each age range are listed in *Table 1*, together with one or more key examples that were used in formulating the age-limits. In many, but not all cases, the minimum age-limit corresponds to the relative age of the last major cratonisation or orogenesis. The maximum age-limit, listed in *Table 1*, reflects that age indicated or hinted at in the local geological record. A curved line, marking the maximum limit, as shown in the 1:5 000 000-scale map, signifies that there is poor control on that limit.

Table 1. Inferred age limits for magnetising events and/ or source rocks

Age ID	Era	Age Limits	Remarks: Examples of Magnetising Events and/ or Source Rocks
1	Archaean	3600-2700	Magmatic event producing granite-greenstone association, Pilbara Province
2	Archaean	4000-2600	Magmatic event producing granite-greenstone association, Yilgarn Superprovince
3	Archaean	3400-2500	Basement to The Granites-Tanami Complex
4	Archaean	2500-2350	Diagenesis of banded iron formation in Hamersley Basin
5	Archaean	2800-2500	Events in Sleaford and Mulgathing Complexes, Gawler Craton
6	Palaeoproterozoic	2500-1900	Unit AP, NW Gawler 'craton'
7	Palaeoproterozoic	1950-1800	Capricorn Orogeny; basement to Eastern Succession, Mount Isa Province; basement to Redan Zone, Broken Hill Province
8	Palaeoproterozoic	1920-1850	Hooper Orogeny in King Leopold Province; Barramundi Orogeny and precursor events in northern Australia
9	Palaeoproterozoic	1840-1780	Leichhardt Extension and precursor events throughout northern Australia; eg., Flynn and Ooradingee Subgroups of Hatches Creek Group, Davenport Province; Halls Creek Orogeny in east Kimberleys, and following Kimberley Subsidence in Kimberley Basin
10	Palaeoproterozoic	1780-1730	Strangways Orogeny in Arunta Province
11	Palaeoproterozoic	NA	(Reserved for later use)
12	Palaeoproterozoic	1840-1700	Magmatic pulses on northern Australia, including (I) volcanism in Leichhardt Trough, Mount Isa, and (II) Tawallah volcanism
13	Palaeoproterozoic	1850-1750	Early phases of Kimban Orogeny, Gawler Craton
14	Palaeoproterozoic	1740-1700	Late phases of Tawallah volcanism
15	Palaeoproterozoic	1800-1300	Granites, gneisses and granulites in Albany-Fraser Province
16	Palaeoproterozoic	2000-1600	Argilke event, Arunta province; precursor rocks

NOTE: Age-limits are commonly poorly-defined

Table 1. Relative deduced age-limits (Continued)

Age ID	Era	Age Limits	Remarks: Examples of Magnetising Events and/ or Source Rocks
17	Mesoproterozoic	1700-1600	Events traditionally assigned to the end phases of Kimban 'orogeny', Gawler Craton; Olarian Orogeny
18	Mesoproterozoic	1600-1500	Gawler Range Volcanics and correlated magmatic and metamorphic events, concentrated at about 1590 Ma
19	Mesoproterozoic	1800-1500	From early volcanism in Leichhardt Trough to about end of Isan Orogeny
20	Mesoproterozoic	1530-1400	Events in: Anmatjira uplift, Arunta Province; early uplift of Redbank thrust zone
21	Mesoproterozoic	1800-1190	Deformation and granite intrusion in Albany-Fraser Province; includes granite plutonism at c.1300 Ma and thrusting at 1100 Ma, which mark end of tectonism in Rudall Complex, Paterson Province
22	Mesoproterozoic	1150-1050	Pinjarra Orogeny
23	Mesoproterozoic	1300-1000	Musgravian Orogeny, followed by Giles magmatism; Yampi Event in King Leopold Province
24	Neoproterozoic	1000-?600	Covered units bordering Paterson Province
25	Neoproterozoic	750-600	Orogenesis in the Leeuwin Province, WA
26	Palaeozoic	560-525	Petermann Ranges Orogeny; precursor events
27	Palaeozoic	545-470	Delamerian Orogeny
28	Palaeozoic	545-405	Includes: Early to mid-Cambrian felsic and mafic volcanics in Warburton Basin, Delamerian Orogeny, Benambran Orogeny to end magmatism in Thompson Province; unnamed events affecting the Thompson Province and the Bourke zone
29	Palaeozoic	460-405	Start magmatism in Lolworth-Ravenswood belt to Coen Orogeny
30	Palaeozoic	435-370	Benambran, Bindian, Bowning and Tabberabberan orogenies
31	Palaeozoic	420-300	Alice Springs Orogeny; late-stage tectonism in element BK (Bourke Zone); includes late magmatism & thrusting in elements BUR (Burdekin River) & CHT (Charters Towers); plutonism in element CE (Coen and Yambo inliers)
32	Palaeozoic	410-270	Events in New England Province
33	Palaeozoic	300-250	Magmatism in Townsville-Mornington Island igneous belt

NOTE: Age-limits are commonly poorly-defined

It is important to emphasise that the age limits apply to the sources for the dominant geophysical signals within each element. Where a separate, older signal (pattern/ trend) is apparent in a geophysical data set for the upper crust (not necessarily in gravity or magnetic data), a relict class of element (see Glossary and below) is recognised and an additional older relative age is shown (designated by a white-cross-pattern in the hardcopy 1:5 000 000 map).

The suggested age for imposition of the magnetic pattern is particularly poorly constrained when the elements cannot be related to exposed and well-dated basement provinces. Other complications arise where a region has been subjected to several orogenic events or periods of multiple fault reactivation. Multiple sources of unknown origin and age can also be stacked within the upper crust. It is for these reasons that the map emphasises the relative age of the elements, rather than the absolute age of orogenic events.

Grouping and Classifying the Elements

The Rank of Crustal Elements

Ranking the elements helps the process of establishing links with geological features, such as basement provinces and overlying sedimentary basins

Rank refers to the hierarchical ordering (or subdivision) of elements — by their size and significance — into enclosed polygon regions. The main ranks are mega-elements, elements and sub-elements (for fuller explanation, see Glossary: Rank of Crustal Elements).

The Mega-elements

The general picture that has emerged from the new map is that of a continent made up of eight coherent mega-elements. These represent groups of crustal elements having similar geological and geophysical characteristics, and lying within a common set of boundaries (Fig. 5). They tend to reflect the configuration of crustal regions following their final cratonisation and may be compared with earlier geologically based tectonic subdivisions, such as that of Plumb (1979, fig. 7).

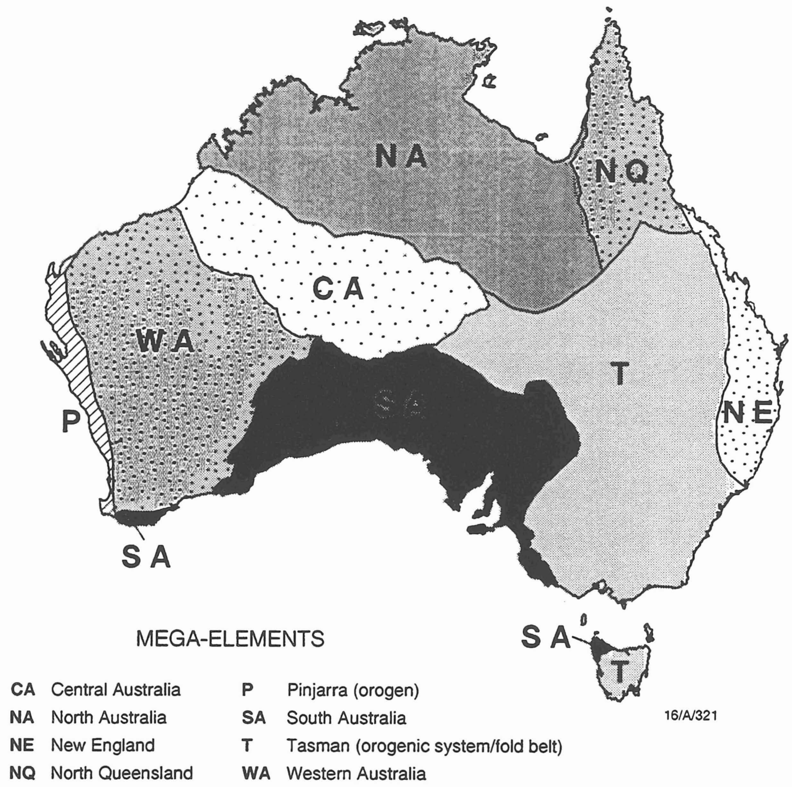

Figure 5. Australian mega-elements, representing continent-scale groups of crustal elements. The mega-elements are: NA, north Australia; NQ, north Queensland; CA, central Australia; P, Pinjarra (orogen); WA, Western Australia; SA, South Australia; T, Tasman (orogenic system/ fold belt); and NE, New England.

Boundaries between mega-elements

The boundaries between mega-elements and between many of the crustal elements are commonly associated with two broad classes of geophysical anomaly. One is a major change in mean density or mean apparent susceptibility of the crust, which gives rise to paired high and low gravity or magnetic anomalies along the boundary — ie., dipole anomalies. The other is that generated as a result of interactive processes at the boundary; anomalies within this class include three main types:

- zones of geophysical overprinting, which commonly correlate with zones of shearing, where trends of one element replace those of another;
- zones of overprinting characterised by extensive magnetic lows generated as a result of processes such as demagnetisation associated with metamorphism of the older element (e.g., when a younger, and potentially hotter, element was emplaced over or against it); and
- zones characterised by major gravity and magnetic highs, formed along the margin of the younger element; these are thought to be the result of either major intrusions along the boundary, or uplift of the middle and, in places the lower crust, by overthrusting along the boundary.

Classes of Crustal Element

Six classes of crustal elements are recognised, the principal three of which are identified in Plate 1:

The crustal elements are classified primarily on the basis of their geophysical character and, secondarily, on the basis of their spatial relationships to each other. The deduced, relative age of their source rocks is a third, much less-well-constrained attribute.

1. Standard — not modified by any geophysical overprinting, so that similar geophysical patterns and trends are distributed throughout the element;
2. Highly Magnetic — dominated by magnetic and gravity highs, implying gross modification of the crust;
3. Geophysically Overprinted — explained further below;
4. Covered — where the magnetic signal is subdued due to thick sedimentary cover;
5. Relict — where an even older geophysical pattern or feature is detectable locally within the element; and
6. An internal sub-element showing a muted geophysical signal, possibly due to thick and localised sedimentary fill.

Standard crustal element (class S)

These are pieces of crust that correspond, more or less, to composite geophysical domains that most closely correlate with geological provinces, and that are considered to have not been extensively modified since their initial cratonisation. Their geophysical features show a similar pattern, or sets of trends, throughout. The deduced age-range for their source rocks is also thought to fit within the same approximate range, although this is not a pre-eminent criteria.

Highly magnetic elements (class M)

These zones commonly correspond to uplift regions of mid- to lower crust, where there has been either regional-scale addition of material (e.g., magmas), or pervasive deformation and high-grade metamorphism, or both. Unlike the geophysically overprinted zone, this type of element does show a transition structural boundary at the margin of its parent element. Some of these highly magnetic zones could represent zones of 'advanced' overprinting where the original magnetic fabric of the parent element has been obliterated and the region has subsequently been uplifted or its boundary with the parent element destroyed by fault reactivation.

The highly magnetic category is assigned to elongate domains or subdomains that are characterised by intense magnetisation, commonly reflecting high-grade metamorphism or abundant magmatism (shown as white overprint pattern of diamond-shapes on the paper copy of the 1:5 000 000-scale map). Such highly magnetised zones can mark orogenic zones, as is the case for the King Leopold and Halls Creek Orogens produced during phases of the Barramundi Orogeny at about 1850-1870 Ma or earlier {e.g., Elements KL (King Leopold); subelement *HCC* (central zone, Halls Creek)}. Other specific examples include: Element AF (Albany Fraser); parts of the central Arunta Block affected by the Strangways Orogeny at about 1730-1780 Ma (subelements *ANR* and *ASR*); and the Musgrave Block affected by the Musgravian Orogeny at about 1070-1225 Ma (element M, Musgrave).

Zones of geophysical overprinting (class O)

***Geophysically overprinted zones** are **subelements** that correspondto zones where the geophysical signatures reflect younger tectonic events, overprinted on older geophysical features:*

***Highly magnetic zone** are **elements** that commonly correspond to either uplift blocks of mid- to lower crust or belts of pronounced magmatic activity, or both.*

Geophysically overprinted zones are elongate domains in which one set of geophysical features is progressively replaced by another. For example, older structures can become less well-defined or offset, and the geophysical anomalies can progressively change in magnitude and frequency, or just in magnitude. Many are also characterised by demagnetisation. Many of these zones correspond to zones of structural reworking and crustal modification, as a result of metamorphism, deformation and intrusion, during orogenesis preceding cratonisation of the younger crust.

The nature of overprinting zones is well illustrated by that at the boundary between mega-elements **WA** (Western Australia) and **SA** (South Australia; Fig. 3), which separates the element labelled Y (Yilgarn) from element AF (Albany–Fraser); see Significance of the Mapped Features; Relationship of mega-element boundaries to overprinting zones.

Covered and locally covered elements (classes L and LC)

We categorised elements as 'Covered' where the magnetic signal is subdued as a result of a thick sedimentary overburden.

The category LC (Locally Covered) is applied to localised regions within crustal elements where the magnetic signal is subdued. This class is applied to subdomains where either the magnetic signal is largely wiped out due to thick sedimentary cover (e.g., thick Roper Group deposits in the McArthur Basin region; map-symbols *MAB* (Beetaloo Sub-basin; and possibly *WEL*, northwestern Wiso Basin), or the sedimentary cover only slightly masks the magnetic signal as it is relatively thin (e.g., Nabberu Basin; map-symbol NBB). Where the sedimentary cover is thick, a gravity low may be developed, as is the case for subelements *MAG* and *WEL*. A gravity low may also reflect a granite batholith, as may be the case with subelements *MAN* and *SNCM* in northern Australia (not shown on all versions of the map).

Elements showing older relict geophysical patterns (class R)

Another type of geophysical feature, shown as white overprint pattern of diagonal crosses on the 1:5 000 000 - scale map, is used where a relict magnetic signal can be recognised, either in the form of a ghost signal (subelement *MFR* in the southern part of element M) or as patches showing an older pattern within a more widespread and dominant magnetic pattern, such as subelement *GCT* (Coulta) bordering element G (Gawler). Such features may reflect an underlying older tectonic feature such as a cratonised subcrust. The negative nature of the corresponding gravity domain can also imply the existence of an older subcrust if its expression relates to a deeper source than that producing the domains' magnetic signal (e.g., element K). Supporting evidence can be found in other data, such as deep seismic reflection data (e.g., for element K: see Symonds et al. 1994).

How crustal elements differ from geological provinces

We emphasise that the crustal elements are not geologically defined features, because they have been defined primarily from magnetic and gravity data sets, which largely monitor the overall properties of the upper crust. The crustal elements represent upper-crustal segments showing some overall commonality of geophysical properties. In contrast, basement provinces are defined on the basis of geological criteria derived from outcrop mapping, event stratigraphy, and the isotopic dating of events. Such geologically defined provinces are three-dimensional bodies that have a definite thickness and represent time–rock units whose maximum and minimum ages are generally, but not always, well established. Some of the crustal elements could represent a set of overlying or overlapping basement provinces resting on and including pre-existing crust.

How crustal elements differ from normal geophysical domains

The crustal elements are based on a higher degree of interpretation than normal geophysical domains. They have the additional attributes of relative-deduced age, rank (grouping), and potential-field character, as well as being closely linked to geological provinces. They are considered to represent pieces of upper crust which have similar overall physical properties. As such, their validity can be tested and their geometry and physical characteristics can be refined using a greater variety of geophysical and geological data sets (e.g., seismic, EM, heat flow etc) other than magnetic and gravity data. So, with time and continuing research, the three-dimensional outline of the crustal elements will become better defined by criteria other than potential field data. Hopefully, through such processes, their near-surface outline can be married, in many but not all cases, to that of geologically-defined basement provinces, as part of the production of various solid geology maps.

Significance of the mapped features

Relationship of mega-element boundaries to overprinting zones

Both the nature of several of the mega-element boundaries and the significance of the overprinting zones are well illustrated by features at the boundary between mega-elements **WA** (western Australia) and **SA** (south Australia; Fig. 5). This boundary separates the element labelled Y (Yilgarn) from element AF (Albany–Fraser; Fig. 4: see discussion by Wellman 1988). This zone (subelement *YMR* in Fig. 4) is characterised by a drop in magnetic intensity (demagnetisation) and the progressive disruption of the magnetic pattern of element Y (NE-SW zone in Fig. 6).

The demagnetisation results from Mesoproterozoic deformation and metamorphism of Archaean granite and gneisses, as well as greenstones within packages of volcanic and sedimentary rocks (Yilgarn) during convergence of the crustal blocks (Fig. 7; Beeston et al. 1988). This overprinted zone, *YMR*, is adjoined immediately to the west by a highly magnetic zone, the 40–200-km wide element AF (Albany–Fraser; southeastern corner of Fig. 6). The more magnetic features in this zone show as bright white in Figure 6. Element AF correlates with a substantially covered, complex orogenic belt, consisting of migmatite complex (orthogneiss and paragneiss) and metamorphosed mafic rocks (dolerite and gabbro), that was extensively intruded by granite at about 1150 Ma (Fig. 7; see also Myers 1990; Nelson et al. 1995).

An analogous situation has been described by Whitaker (1994) for the same boundary along strike to the southwest, where the southern boundary of the Yilgarn Craton has been demagnetised up to 20 km north of the boundary and other discordant magnetic lineaments parallel this feature a further 30 km inboard of the boundary. He attributed these features to deformation associated with thrusting of the Albany Province over the Yilgarn Craton.

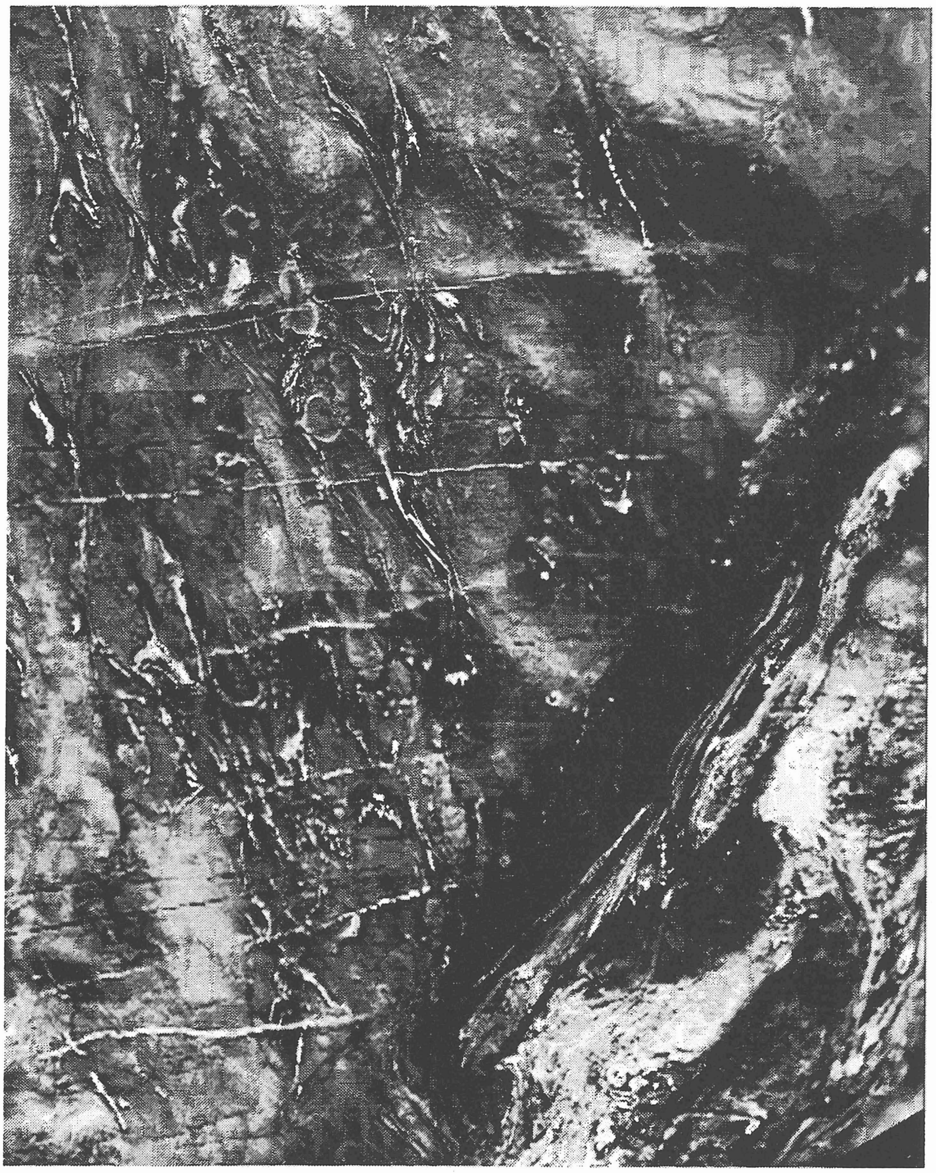

Figure 6. Image of Total Magnetic Intensity in the region of the Y-AF element boundary. The northeast-trending zone of textural overprinting and demagnetisation *YMR* (Mulga Rock) shows as dark tones at the margin of element Y (Yilgarn), characterised by northwest-trends (UTM projection).

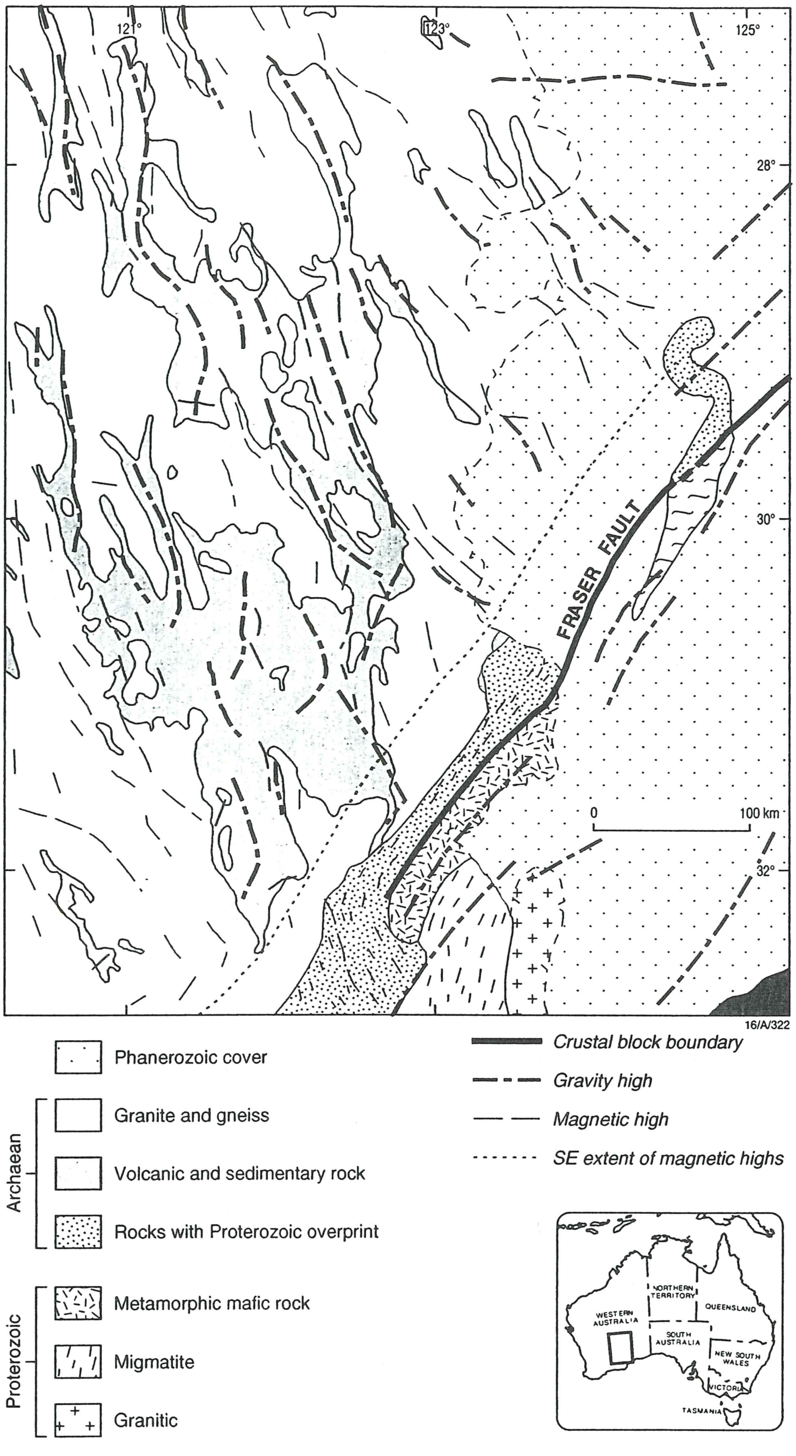

Figure 7. Geological features, including the Fraser Fault, corresponding to the zone of overprinting YMR (Mulga Rock), marked by the 'SE extent of magnetic highs' at the margin of element Y (Yilgarn) The figure is a modification of that shown by Wellman (1988), based on Gee (1979), and BMR/ AGSO mapping (1972-1995) (see also Nelson et al. 1995).

The western margin of the magnetic zone AF corresponds to major collinear gravity highs in the southeast and its boundary with zone YMR corresponds to a matching gravity low to the west. Together these features constitute a gravity dipole (Fig. 8). Farther to the northwest, the gravity anomalies are of shorter wavelength and show a northwest-trend. To the southeast of the gravity highs, the gravity anomalies show elevated values. Modelling of the anomalies across this boundary (Anfiloff & Shaw 1973; Mathur 1974; Mathur & Shaw 1982), suggests that the Fraser Fault, the master fault in a imbricate fault-wedge, continues to mantle depths. It seems probable that development of the thrust wedge resulted in crustal thickening, as well as structural reworking and metamorphism in rocks of the adjoining Yilgarn craton. It is conceivable that foreland-like basins developed in front of the thrust wedge and that these sedimentary rocks have since been largely removed by erosion.

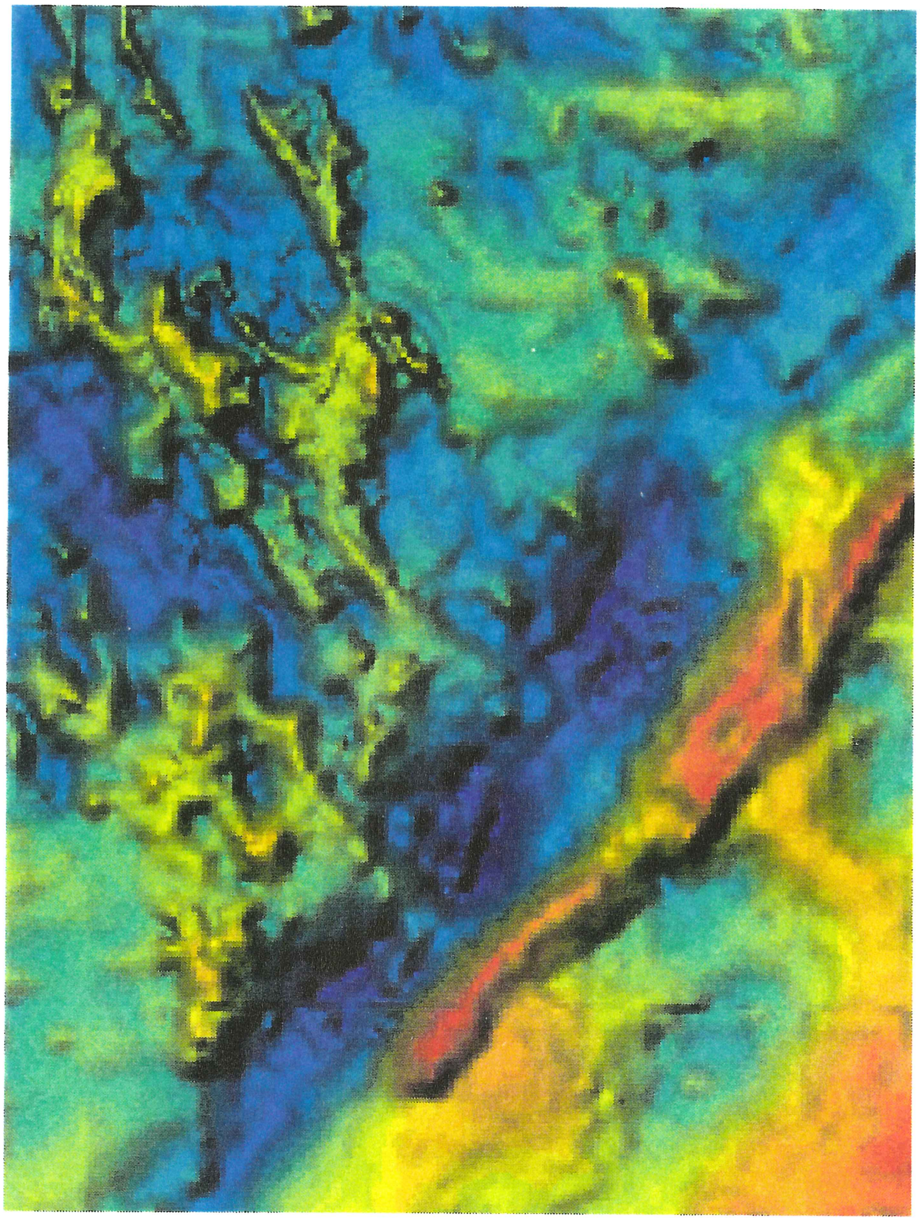

Figure 8. Image, with gradient enhancement, showing Bouguer gravity anomalies across the zone of overprinting YMR (Mulga Rock) at the margin of element Y (Yilgarn) (see text for further explanation).

At this complex boundary (corresponding to the WA–SA mega-element boundary), the gravity dipole anomaly reflects a major change in crustal density between the dense margin of the SA mega-element and mega-element WA. The magnetic anomaly reflects the geological processes acting at the crustal-element boundary.

Significance of the Crustal Elements

Wellman (e.g., Wellman, 1995b) argues that the gravity and magnetic trends that characterise each element were formed at the time of cratonisation of each element (composite geophysical domain), in the period following orogenesis after which the crust was relatively stable.

An Overview of the Mega-elements

For each mega-element we can estimate an age of final cratonisation by establishing the time-range of the last main stage of magmatic, metamorphic and structural events that can be related to the imprinting of the youngest, widespread magnetic pattern. We contend that the mega-elements, as mapped, reflect the configuration of large cratonic regions before their final incorporation into the Australian continent.

Once the mega-elements are defined, using essentially geophysical criteria, one can re-evaluate what they and their boundaries represent in geological and tectonic terms. As each element, or piece of crust, records something of its past evolution, each mega-element can contain smaller fragments, themselves possibly representing older cratons (or lithospheric plates) that have been subsequently amalgamated to form a larger feature.

Mega-element CA (central Australia)

Mega-element **CA** (central Australia; Fig. 5) is characterised by a series of east-west, long-wavelength, elongate, gravity highs and lows. It is a complex zone separating simpler and more coherent mega-elements. It comprises an assembly of long narrow crustal elements, large, more-equidimensional elements, and relatively small elements. These include several highly magnetic zones and overprinted zones, similar to those described above. The geophysical evidence indicates that mega-element **CA** corresponds to a wide region of long-lived interaction between, on the one hand, the cratonic mega-element **NA** (north Australia) and, on the other, **WA** and **SA**, which are even more cratonic in character. Geological evidence suggests that mega-element **CA** evolved between 1900 Ma and 1100 Ma (Collins & Shaw 1995; Clarke et al. 1995).

Major discordant boundaries within mega-element **CA** (Fig. 5) imply crustal-scale strike-slip displacements. These include the discordant boundary where a belt of subelements *ANR, ASR* and *CYN* (labelled ASR in Fig. 4; a composite, highly magnetic zone that borders the Redbank Thrust Zone, in the central Arunta Block) truncate element M (Musgrave). Two other discordant boundaries are: (i) where the southern margin of element BR truncates the boundary between elements LA (Lagrange) and R (Roeves), and (ii) where these are cut by Zones PA (Paterson) and RU (Rudall).

Element M (Musgrave) exhibits some continuity with mega-element **SA** (South Australia), hinted at by the continuity of magnetic trends (between elements FR-WG and sub-element *MFR*). So, the main crustal boundary marking the limit of mega-element SA may be either within element M (Musgave) or separate elements M (Musgave) and PR (Petermann Ranges). Nevertheless, in terms of its geophysical character, element M (Musgrave) fits more readily in mega-element **CA.**

An important boundary, corresponding to the overlap between the Amadeus and Canning basins, divides the western and eastern parts of the mega-element. Alongside and slightly west of this boundary, a north-trending mega-shear zone, the Lassiter Shear Zone of Braun et al. (1991), has been proposed as a way of accommodating the situation in the Devonian-Carboniferous, where there was 60 km or more of extension in the Canning Basin while there was 100 km or more of shortening in the Amadeus Basin (Shaw et al. 1991a). Our map does not support such a simple partitioning of the accommodating strain. Rather, it would be more consistent with a wide zone of more distributed interaction, perhaps involving many en-echelon strike-slip faults. Given the complex features seen in this north-south zone, it seems probable that a variety of movements have occurred during several periods (see Forman & Shaw 1973).

Mega-element NA (north Australia)

Mega-element **NA** (north Australia; Fig. 5) is characterised by a large northern region with subdued magnetic response, and bordering regions with closely spaced, linear, short-wavelength anomalies, which show broad swings in trend. Its gravity expression is also subdued, apart from its marginal regions, which reflect particular periods of crustal growth. It consists of a complex amalgamation of elements that correspond to the North Australian Craton (North Australian Orogenic Province of Plumb (1979a, b)). Geological evidence suggests that evolution of the mega-element started sometime before about 1900 Ma and that by 1700 Ma it was essentially cratonised (Plumb 1979, Myers et al. 1996). The most important tectonic event to shape the region was the poorly-defined Barramundi Orogeny (Etheridge et al. 1987), which started at about 1890–1870 Ma in Mount Isa and in the Pine Creek regions, and continued in other regions (e.g., East Kimberleys) as a late, largely magmatic stage, until about 1865–1850 Ma (see Shaw, 1994; Myers et al. 1996 for discussion).

The southern margin of the North Australian Craton has been multiply deformed and dismembered, so much so that its corresponding geophysical member-elements are included in mega-element **CA** (central Australia), itself characterised by an assembly of long, narrow crustal elements expressed as a series of east-west, long-wavelength, elongate gravity highs and lows. The southern margin of mega-element **NA** is placed at the zone of overprinting BD (Bright Downs). This zone, corresponding to a zone of strike-slip faulting, truncates element MI (Mount Isa), and swings from southwest to northwest to merge with the boundary between mega-elements **CA** and **NA** (TN and MD overprinted zones; Fig. 4).

Element MI (Mount Isa) lies towards, but not at, the eastern margin of the mega-element. Its prominent northerly-trending, linear, alternating positive and negative gravity and magnetic anomalies are interpreted to be the result of complex crustal extension, expressed in three periods of east-west rifting (Wellman, 1992a).

The zone of geophysical overprinting YR (segments *YRN*, *YRS*) at the western edge of element MI (Mount Isa) is marked by a sharp swing in the trend of gravity and magnetic anomalies from east-west to southeasterly, indicating a wide zone of distributed dextral shearing, resulting in a southerly translation of the Mount Isa region with respect to elements to the west. The timing of this shearing is unknown. As the shearing presumably predate movements recorded in overprinting zone MD (Mount Ida) at the southern margin of mega-element **NA**, we consider that it occurred well before 400-300 Ma, and possibly before 1500 Ma. The translations recorded by zone YR may well antedate the extension that formed the Leichhardt Trough (element MI), itself starting at about 1820 Ma. There is also evidence in the geological record of some late-stage mid-Palaeozoic(?) reactivation (e.g., along May River Fault).

In the far west, element K (Kimberley) is separated from the main body of mega-element NA by the zone of overprinting HC (Halls Creek: segments *HLC, HCF, HCA, HCB* and *HCC*), a feature that is particularly prominent in the gravity data. This zone corresponds to the Halls Creek province (orogen), which is noted for its record of repeated episodes of strike-slip, commonly sinistral faulting, from the Mesoproterozoic to the Palaeozoic (Plumb et al. 1985). More recent data suggests that the zone follows a terrane boundary dating from the late stages of the so-called Barramundi orogeny at 1865–1850 Ma (Tyler et al. 1995; Myers et al. 1996). On its western margin, it exhibits a discordant boundary against overprinting zone KL (King Leopold) and element O (Oscar) (see Shaw et al. 1994a). Element NK (Nookanbah) may represent a continuation of zone HC to the southwest, its signature being subdued by the thick (15 km) sedimentary cover of the Fitzroy Trough.

Mega-element NE (New England)

Mega-element **NE** (New England; Fig. 5) comprises two north-trending zones, bordering mega-element T (Tasman) to the west. It is made up of a series of long, narrow crustal elements, with magnetic and gravity features outlining a complex Z-bend (sharp oroclinal (?) bend). In the current map, the mega-element corresponds to the New England Fold Belt. It has not been subdivided, although the corresponding geological feature is traditionally broken up into several tectonic blocks or tectonostratigraphic terranes. Geological evidence suggests that the province corresponding to mega-element **NE** has had a long history, dating back to the Ordovician, but that most tectonic activity was between 410 Ma and 270 Ma, and followed the Early to mid-Palaeozoic (460-370 Ma) tectonism evident within mega-element **T** (Tasman)

(Fukui et al. 1995). Based on a broadly discordant boundary relationship, major southward (?) translation of mega-element **NE** (New England) relative to mega-element **T** (Tasman) is inferred to have taken place within overprinted zone *MN* between the Devonian and the Late Permian.

Mega-element NQ (north Queensland)

Mega-element **NQ** (north Queensland; Fig. 5) is a small and relatively narrow, north-trending geophysical zone, composed of several substantially overprinted subelements. The provinces corresponding to these features initially evolved from about 1680 Ma to 1550–1500 Ma. Magmatism occurred in the eastern parts at about 1100 Ma. The region was subsequently reactivated in two or more stages in the Palaeozoic, between about 460 and 400 Ma. This Palaeozoic tectonism has markedly influenced the magnetic pattern.

NQ adjoins mega-element **NA** (north Australia) to the west, along a boundary that may not penetrate the whole crust as it is not marked by a major gravity-dipole anomaly. Element KW (Keer Weer) may be a continuation of element MI (Mount Isa); so the latest versions of the Australian Crustal Elements Map (1996, Arc/Info) place element KW in mega-element **NA** (north Australia). Element KW's poorly defined, and somewhat gradational, boundary with element *NWP* (Weipa; Normanton - Kowanyama province) also implies that the boundary between mega-elements **NA** and **NQ** is not major. Indeed, the next version of our map (1996, Arc/Info) may include the element N (Normanton; subelements *NPW*, and *NCR*) in mega-element **NA** (north Australia).

The marginal region of the mega-element to the south and southeast — adjoining mega-element **T** (Tasman) — is also complex, reflecting crustal extension, back-arc extension and arc-related plutonism beginning at about 460 Ma. (This is the reason why the boundary was shifted southwards to include elements HO (Hodgkinson), BR (Broken River) and LR (Lolworth-Ravenswood) between hardcopy versions 1 and 2 of the map).

A zone of overprinting, TMI (Townsvillle-Mornington Island), which cuts right across mega-element **NQ**, corresponds to a concentration of Carboniferous-Permian igneous activity (Wellman et al. 1994b).

Mega-element P (Pinjarra, westernmost Australia)

Mega-element **P** (Pinjarra; Fig. 5) is a poorly understood zone at the western margin of mega-element WA (Western Australia). Basement in this zone is largely covered by Palaeozoic and Mesozoic sedimentary rocks. Geological evidence suggests that mega-element **P** evolved in the Mesoproterozoic, with final tectonism at about 1100 Ma, involving deformation and metamorphism under granulite-facies conditions (Bruguier et al. 1994). The Leeuwin Complex, corresponding to element LU, may have undergone sinistral transcurrent to transpresssional shearing during the late Neoproterozoic (~550 Ma? see Beeston et al. (1995)). This movement may have resulted in a 90-degree rotation of the east-west trends of the Albany province (Element AF).

Mega-element SA (South Australia)

Mega-element **SA** (South Australia; Fig. 5) is a complex region, made up of linear arcuate elements that are aligned in a circular manner around a core region marked by the element G (Gawler). Some arcuate gravity highs and aligned linear magnetic highs could correspond to ancient rift zones, as postulated by Gunn (1984).

Geological evidence suggests that mega-element **SA** evolved between the Late Archaean and the end of the Palaeoproterozoic (1600 Ma) (Daly & Fanning 1993; Flint 1993). Overprinted zone KR (Karani) corresponds to a major fault zone, marking a proposed new northern limit for the Gawler Craton. Subelement *GFW* (Gawler: Fowler in 1:5 000 000-scale map) is a wedge of anastomosing blocks in northeastern element G, outlined by a series of prominent northerly-trending magnetic and gravity highs, corresponding to meta-igneous calcalkaline cumulus gabbro-diorite and tonalite, as well as banded iron formation (bif), pelitic schists and ultramafic rocks (Daly et al. 1995). These authors refer to this zone as the Fowler Suture Zone and propose that it represents an oblique Palaeoproterozoic (1730–1540 Ma) collision zone at the northern margin of a continent (Mawson), comprising the Gawler Craton and parts of the East Antarctic shield.

The magnetic interpretation for the western margin of the element AD, corresponding to the Adelaide "Geosyncline", reflects the postulate of Gunn (1994) that the gravity and magnetic features, corresponding to the Torrens Hinge Zone, could represent an ancient rift system.

Subelement *GRV* (Gawler Range) within element G (Gawler) corresponds to intracratonic volcanic rocks (rhyolite, dacite, andesite and basalt) and associated granites (Hiltaba Suite), emplaced at about 1595-1585 Ma (Flint 1993). It has been suggested that these magmas were derived from a mantle plume (Campbell & Hill 1991). Subelement *GRV* includes a highly magnetic micro-element, *GRV3,* that could represent the expression of the feeder to such a mantle plume. A similar scenario could apply to element CN (Curnamona) as it has a similar magnetic expression and correlates with volcanic rocks showing similar chemistry to those of the Gawler Range Volcanics (Giles & Teale 1979).

The zone overprinting the eastern margin of mega-element **SA**, element KA (Kanmantoo), corresponds to zone bordering the eastern margin of the Nackara Arc, itself representing Adelaidian rocks deformed and metamorphosed during the Delamerian Orogeny (505–470 Ma). The pre-existing crust in the region of element KA may be similar to the Precambrian rocks of the Redan Zone at the eastern margin of the Broken Hill basement province. The western limit of element KA is taken to be the discontinuous series of magnetic highs that correlate with I-type granites emplaced during the Delamerian Orogeny (505–470 Ma).

Mega-element T (Tasman)

The mega-element **T** (Tasman; Fig. 5) contains abrupt internal changes in magnetic and gravity field marking two major zones that define the boundaries between wide orogenic belts. These features, described in detail by Wellman (1995b), could be suture zones that are remnants of complex mid-to Late Palaeozoic episodes of collision between crustal blocks. Apart from a segment in north Queensland, mega-element **T** corresponds to the Tasman Orogenic System of Wellman (1995a). The preferred tectonic model involves accretion of element LE (Lachlan East) to element LW (Lachlan West), resulting in reworking of LE (Lachlan East) to give zone WO (Wagga-Omeo). Similarly, element AK (Anakie) may have accreted onto element TH (Thomson), resulting in reworking of zone HG (Hughenden). A complex zone of interference, zone BK (Bourke), separate elements TH (Thomson) and LW (Lachlan West), and may have formed during accretion of these two major elements, to the north and south — although it could represent a zone of crustal extension, which underwent later convergence.

In Tasmania, element *TYR* (Reed; Tyennan) is a zone of overprinting, interpreted to record complex collision during the Cambrian between an older Proterozoic block, represented by element RC (Rocky Cape) and a younger block, corresponding to element TY (Tyennan). This younger block is, in turn, bordered and overlain by another unit of turbidites and Siluro-Devonian granites, represented by element MT (Mathinna).

At first sight, zone GLN (Glenelg/Stavely), also at the margin between elements **SA** and **T**, has the appearance of a zone of overprinting. However, the eastern boundary is not well-defined (in either the magnetic or gravity data). Rather, overprinting having the same deduced relative age, is mapped to the west in the region of element AD (Adelaide).

Mega-element WA (Western Australia)

Mega-element **WA** (Western Australia; Fig. 5) comprises elements P (Pilbara) and Y (Yilgarn) joined by element CP (Capricorn: *CGP, CPB & CPE*) and corresponds to the West Australian Craton, which formed a separate entity from about 1800–1600 Ma (Tyler & Thorne 1990). Element CP (Capricorn) contains a major dipole gravity anomaly, which appears linked to a well-defined boundary at the northeastern margin of element Y (Yilgarn), so elements P and Y may have been separate plates in the Mesoproterozoic. However they are kept, for the moment, within the one mega-element, as their magnetic and gravity patterns are similar, being mainly sourced from similar variably magnetic, low density granites and markedly magnetic, high-density greenstones. Geological evidence suggests that mega-element **WA** formed between 1900 Ma and 1100 Ma (Myers 1990).

The boundaries against mega-elements **P** and **SA** are both marked by zones of overprinting and gravity dipole anomalies (zone NH - Northampton in west and zone YMR - Mulga Rock; Yilgarn in east), and so these may well have been plate boundaries at some time in their history.

Tectonic significance of regionally discordant boundaries

Zones of overprinting at or parallel to the NA-CA mega-element boundary

A discordant boundary, outlined by the zone of overprinting BD (Bright Downs), marks the southern margin of mega-element NA. This zone truncates element MI (Mount Isa), and swings from southwest to northwest to merge with the boundary between mega-elements **CA** and **NA** (TN and MD overprinted zones; Fig. 4). Geologically, zone MD (Mount Ida) corresponds to a wide zone of en-echelon quartz-filled faults within a region of distributed transpressional and transtensional shear, which was active more than once, but is considered to be essentially of Silurian-Devonian age (Shaw 1994). Similarly, within zone BD (Brighton Downs), displaced magnetic and gravity trends of element MI (Mount Isa) suggests a zone of dextral shearing (Wellman 1992), possibly of a similar age.

Another subparallel boundary to the south — marked by zone BR and the composite, highly magnetic zones bordering the Redbank Thrust Zone (elements *ANR*, *ASR* and *CYN* (labelled ASR in Fig. 4) — wraps around older elements *AYW and AYE* (Arunta: Yuendumu North & South). These older elements were deformed at 1880-1860 Ma (Yuendumu Event in Collins & Shaw 1995), and so is more akin, in their geological history, to rocks of the North Australia Craton (mega-element NA). Several lines of evidence, listed below, suggests that this boundary was a plate boundary early in its history and became an intraplate boundary from the Neoproterozoic:

1. Major dipole gravity anomalies mark its southern margin;
2. It marks the southern limit of subduction-related magmatism of Palaeoproterozoic age (Zhao & McCulloch 1995; Sun et al 1995; Sivelle & McCulloch, 1996);
3. It truncates element M (Musgrave) at its eastern end, as well as elements in the far west (LA & R in 1:5 000 000-scale map); and
4. While it may have existed as a plate boundary before 1780-1750 Ma, it was reactivated at about 1400 Ma, in an unknown tectonic setting, and at 400-300 Ma as an intraplate boundary (Shaw & Black 1991; Shaw et al. 1992; Foden et al. 1995).

Zone of overprinting at the WA-SA mega-element boundary

A major crustal boundary, marked by overprinted zone YMR (Mulga Rock), is recognised between elements Y (Yilgarn) and AF (Albany-Fraser), based on the presence of major dipole gravity anomalies and distinctly different geological histories on either side of the boundary (e.g., granulite metamorphism at about 1300 Ma is restricted to the east of the boundary; Mathur & Shaw 1992; Beeston et al. 1988; Wellman 1988; Nelson et al.1995). If element M (Musgrave) represented a continuation of element AF (Albany-Fraser), at about 1300-1100 Ma, then it has been subsequently displaced westwards during a younger tectonic event.

Zones of overprinting at the CA-SA mega-element boundary

The northern limit of overprinted zone PR (Petermann Ranges) at the northern margin of element M (Musgrave) has long been identified as a major crustal boundary (Forman & Shaw 1973; Mathur & Shaw 1982; Lambeck & Burgess (1992). Clarke et al. (1995) speculate that it may have acted as a plate boundary during the Petermann Ranges Orogeny at 550–530 Ma, and been linked to the edge of element AF (Albany-Fraser), the combined feature marking the convergence of part of Antartica with the Musgrave Block and the Yilgarn Craton. But if a superbasin blanketed the central Australian region (including the boundary marked by zone PR) from about 1830 Ma or earlier, as argued by Shaw et al. (1991b) and Walter et al. (1996), then any plate boundary was older than that and probable older than the intracratonic Giles magmatism at 1080 Ma (Sun et al. 1996). A more probably age for plate convergence is during granulite metamorphism at about 1200 Ma (age of Grey 1978). Our mapping suggests that the overprinting zone (*PRW* in 1:5 000 000-scale map) does not continue westwards to join elements RU (Rudall) and PA (Paterson), but swings sharply northwards near the western end of element M (Musgrave).

The WA-CA mega-element boundary

A major crustal boundary, which may well have been a plate boundary in the Mesoproterozoic (Myers et al. 1996), marks the boundary between western parts of mega-elements CA with mega-element WA. It corresponds to two major aligned gravity dipole anomalies, which link to the southern margin of element M (Musgrave). At what stage in the Mesoproterozoic these mega-elements first impinged on each other is problematic. It may have been either sometime in the time-span ?1750–1500 Ma (Hickman & Bagas, 1995) or immediately preceding granite intrusion at about 1300 Ma (Smithies & Bagas 1996).

Benefits and uses of the map

Benefits of Map

For evolutionary tectonic models

Our new map of Australian crustal elements delineates and classifies the geophysical domains in a way that sheds new light on the tectonic development of the continent. The map recognises many abrupt or discordant boundaries in the upper crust, some of which may be plate or subplate boundaries that have been active at various stages in the continent's history. The map aims to provide a starting position for the examination or re-examination of evolutionary tectonic models. By presenting, the 'big picture', it encourages the user to consider how the continent might have evolved into its present configuration, and to make predictions about the distribution, relative ages, and nature of the crustal blocks.

For petroleum and mineral exploration

Our map represents a model of the structural framework of the continent, which is a starting point for new and integrated tectonic models. The map provides the first step in the process of evaluating those structures and events that control the localisation of mineral and petroleum resources. The structure and composition of the crust are key elements in the understanding of sedimentary basins and mineral provinces, features that underpin databases for resource evaluation. As such, the map should generate new exploration concepts and may open new areas for frontier petroleum and mineral exploration, or reveal questions for future investigation.

Uses of the Map

The map is designed to be used in conjunction with other types of geological and geophysical maps. It can be used:

- to provide an initial model of the framework for the Australian crust;
- to interpret the distribution of basement geological provinces underneath sedimentary cover;
- to provide regional settings for more detailed geophysical interpretations;
- to provide a framework for many types of geological interpretations, such as solid geology maps, structural syntheses, diagrams of basin development, and reconstructions of plate-tectonic settings and palaeogeographic evolutions;
- to enhance resource evaluation by allowing databases of sedimentary basins with petroleum potential and mineral provinces to be linked to crustal structure
- as a framework for studying crustal processes such as cratonisation, earthquake distribution, geodynamics, crustal heat flow, the formation of metal deposits, and the generation and entrapment of petroleum.

Limitations of Map

In its current form, the map has several limitations:

- The map is only a two-dimensional interpretation of magnetic, gravity and crustal element boundaries;
- Whereas the boundaries are intended to approximate their mean position in the upper crust, the accuracy of their position is considerably reduced in regions of thick sedimentary cover and sparse data;
- Time spans, expressed as the possible limits of deduced relative ages for source rocks, are one the most poorly constrained attributes used in construction of the map. They are used to allow a visualisation of geological correlations, thereby providing a pseudo-tectonic map. In many, but not all cases, the maximum age is largely unconstrained. Hence, a 'curly' reference box is used in the map legend (Intergraph versions) for this lower limit;
- Lineaments and faults, even those with lengths of 10s or 100s of kilometres, are not shown unless they form element boundaries;
- The distinction between geophysically overprinted zones (O) and highly magnetic zones (M) is not so clear cut in mega-elements NE and T;
- At this stage, map coverage is limited to onshore regions.

Digital and hard copy versions of the map

Hard Copy Versions

In Microstation™ Hard Copy versions, map units of possible Archaean age are portrayed in red, those of possible Proterozoic age in shades of purple, yellow, brown and those of possible Palaeozoic age in shades of blue. The overprinted zones are generally shown in paler complementary colours such as pale green or yellow. The coloured pattern on some overprinting zones is that of the parent unit.

A 1: 5 000 000-scale, coloured, hard copy of the Australian Crustal Elements map was first released on 17 November 1995, coinciding with the project-presentation seminar of AGSO's Division of Regional Geology & Minerals. As the map is released on demand, new versions reflect our current understanding of the crustal elements. The version status is indicated by date of publication and version number. The difference between versions 1.0 and 2.0 mainly concerns a revision to the boundary between mega-elements **NQ** and **T**, whereas the changes between versions 2.0 and 2.2 mainly concern the labelling of some elements to make them more consistent with GIS versions.

Please refer to the map as:

Shaw, R.D., Wellman, P., Gunn, P., Whitaker, A.J., Tarlowski, C. & Morse, M., 1996a, Australian Crustal Elements (1:5 000 000 scale map), based on distribution of geophysical domains. Australian Geological Survey Organisation, Canberra.

and the Notes as:

Shaw, R.D., Wellman, P., Gunn, P., Whitaker, A.J., Tarlowski, C. & Morse, M., 1996b, Users Guide to the Australian Crustal Elements map. Australian Geological Survey Organisation, Record, 1996/xx, **$$**

Digital Versions

A microstation .dgn file of the map is available and comes with a Microsoft Excel™ file, which lists the attributes of each element (listed by mega-element).

In the ArcInfo™ version of the map, 3 geodata sets are available: 1. polygon coverage of map elements (tectpg_1), 2. line coverage of gravity features (grav_1), & 3. line coverage of magnetic features (mags_1).

A translation into ArcInfo™ is complete. The data sets include a table listing key attributes for each element polygon-area, labelled by Map-Symbol. A version of this attribute list is supplied in Appendix A.

Future ArcInfo™ versions of the map will incorporate new data and concepts as various projects are completed and new data and concepts are evaluated.

MapInfo™ translation is also planned.

Concluding Discussion

Tectonic significant of features

Several features recognised in the new map point to an evolution of the Australian continent through the dismembering and collision of crustal blocks, involving translations between blocks of many, probably hundreds, of kilometres.

Elements showing different crustal properties and histories

Although the map is pre-eminently a geophysical domain map, which emphasises links to tectonic provinces, and NOT a tectonic map as such, it has major implications for the tectonic development of the continent. It provides the reader with a starting point to pursue a wide range of tectonic issues.

A set of crustal elements are recognised that show differing crustal properties, such as bulk density and degree of magnetisation, and features implying different evolutionary histories, such as differing geophysical trends and anomaly patterns.

Such features are reminiscent of those ascribed to tectonostratigraphic terranes, that is, 'fault-bounded packages of rock of regional extent characterised by a geological history which differs from that of its neighbours' (Howell et al. 1985). The concept of terranes has been developed for the Mesozoic crustal fragments that have accreted, in a transpressional environment, onto the west coast of North America where their boundaries are commonly, but not necessarily, marked by melange, blueschist and/ or ophiolite (possibly altered to serpentinite).

The crustal elements, as mapped, are NOT synonymous with tectonostratigraphic terranes.

However, the mapped crustal elements may help to differentiate tectonostratigraphic terranes and, ultimately, the types of crust that constitute and underlie them.

Because terrane analysis presumes a plate tectonic model, a hypothesis fraught with some difficulties when applied to the Precambrian, it would be unwise to assume that tectonic terranes and crustal elements are necessarily synonymous — both being established using different sets of criteria. A tectonostratigraphic terrane is defined as fault-bounded package of strata that is allothonous to, and has a geological history distinct from, the adjoining geological unit (Howell, 1995), whereas crustal elements are primarily defined using potential field data.

The danger of directly linking the two types of feature is well illustrated by noting the mismatch between the tectonostratigraphic terranes erected by Scheibner (1985) for the Tasman fold belt with the crustal elements interpreted by Peter Wellman (1995; this volume). For example, the crustal element map implies that the two terranes (Stanwell-Bendigo and Tabberabberan), mapped by Scheibner (1985), lying between the element K (Kanmantoo) and element WO (Wagga-Omeo) are one coherent unit (element LW), not two tectonostratigraphic terranes. This reassessment is consistent with the findings of Gray et al. (1996) and Grey (1997) that much of the region is dominated by thin-skinned thrust slices, which were initiated during the Benambran Orogeny (425-435 Ma).

Zones of Crustal Modification

Zones of crustal modification, 40-200 km wide and commonly 700-1000 km long, can be mapped across the continent using magnetic and gravity images. Two types of modification are apparent:

1. Zones of geophysical overprinting where the degree of magnetism is either lower or higher than in the adjoining region. These zones commonly correspond to zones of structural reworking and either retrograde (lower magnetisation) or prograde metamorphism (higher magnetisation).
2. Highly magnetic zones that correspond to either zones of uplifted lower crust or zones characterised by abundant magnetic igneous rocks, some of which have been subsequently deformed and metamorphosed. Other possible origins for these and similar zones include crustal-scale extension and cordilleran-style arcs.

Discordant Boundaries

The tectonic significance of major discordant boundaries between elements can be assessed by their degree of discordance and whether they mark abrupt changes in crustal composition. Studies in Canada (Gibbs et al. 1983), west Africa, and Brazil (Lesguer et al. 1984) suggest that many discordant boundaries showing abrupt changes in mean crustal composition can represent geosutures between previously separated lithospheric plates.

Future Research

The map and legend could be redesigned so that the mapped emphasis some general physical property of each crustal elements and excluded any age connotations.

The 1995 map represents a tectonic model for the continent, which requires ongoing testing as further information on crustal structure, derived from other data sets, become available. In this way, one could explore the degree of consistency between different data types.

Further information on the deeper crustal structure that can be used to test and refine the crustal model can be gleaned from a variety of sources including:

- crustal heat flow (Somerville et al. 1994);
- upper mantle Pn seismic velocity (Collins 1991);
- refraction seismic data obtained from the current SKIPPY survey (van der Hilst et al. 1996);
- distribution of earthquakes reflecting underlying crustal structure (like the faults marking the rifted (passive) margin of Iapetan craton in North America (Wheeler, 1995);
- 'hot' and 'cold ' upper mantle regions inferred from the distribution of kimberlite, lamprophyres and other related alkaline-magmatic rocks;
- granite basement provinces pointing to compositional differences in the lower crust (Chappell, 1988);
- mapped domains showing common ranges in crustal residence ages, derived from Sm-Nd T_{DM} model ages and U–Pb zircon ages for older zircon grains in magmatic rocks, that reflect differing histories for older rocks in the lower crust.

Ideally, we need to build a three-dimensional model of the various crustal pieces in which we can have an increasingly higher degree of confidence. This will not only require better data, testing and analysis, but more precise and meaningful integration with the geology.

The next step will be to construct a solid geology map, emphasising the tectonic features of the continent's basement. This new map will be a different map, based on different criteria. As such, it will need to take greater account of mapped geology, particularly that derived from new NGMA outcrop mapping, as well as improved geochronological and geophysical data.

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including those in Appendices A & B, and the Glossary of Terms

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Glossary of Terms

Age-limits

The estimated limits in relative deduced age for source rocks within each crustal element. The legend portrays possible maximum and minimum limits for groups of rocks presumed to have generated the magnetic and gravity anomaly patterns mapped as geophysical domains.

Covered Crustal Element

A crustal element for which the magnetic signal is subdued as a result of a thick sedimentary overburden.

Cratonisation

The tectonic state that typically follows orogenesis, after which the crust is relative stable (see 'craton' in Bates & Jackson (1980); West (1980)). This phenomena may result from several processes that thicken the crust (eg., magmatic or tectonic underplating) or by the progressive strengthening of the lithosphere following a mantle induced thermal event (cf. Bird 1979). Normally, cratonisation follows tectonic activity marked by magmatism, metamorphism and pervasive deformation.

Crustal Element

Upper-crustal pieces showing some overall commonality of geophysical properties.

Dipole gravity anomalies

Paired, major, elongate subparallel, positive and negative gravity anomalies. Such anomalies commonly have amplitudes of 200 μms^{-2} (20 mGal) and are generated at major changes in upper crustal density, and isostatic compensation at or below the crust-mantle boundary (Wellman 1978; Lambeck et al. 1988). The gradient between the anomaly-pair commonly marks a site where younger, denser crust is thrust over older lithosphere, as at a plate boundary (for discussion, see Wellman 1978; Gibbs et al. 1983).

Geophysical Domain

A region within which there is a single geophysical pattern or character (Provodnikiv, 1975; Wellman, 1976a; Thomas et al. 1988). Commonly, the magnetic and gravity trend lines within the domain are subparallel, though not necessarily straight.

Highly Magnetic Crustal Element

A crustal element dominated by magnetic high of such magnitude that gross modification of the crust is suggested. These elements form zones that represent either upthrust blocks of lower crust or zones that have been significantly modified by the addition of new crustal material, such as magmas, during orogenesis.

Map-symbol

The symbol (map_symbol) used to label the smallest mappable unit in any region. The symbol is derived from an informal, and, potentially temporary, reference name ('unitname'), and uniquely identifies any element, which can be of any rank (see also Rank of Crustal Elements).

Mega-element

These represent groups of crustal elements having similar geological and geophysical characteristics, and lying within a common set of crustal boundaries.

Overprinting Zone (Geophysical)

An elongate domain where one set of geophysical features are progressively replaced by another. For example, older structures can become well-defined or offset, and the geophysical anomalies can progressively change in magnitude, frequency and/or magnitude.

Rank of Crustal Elements

Elements are ranked in hierarchical order, by their size and significance, into enclosed polygon regions, namely mega-elements, elements, sub-elements and micro-elements. This ranking is designed to aid correlation with other geological and tectonic features. How these individual ranks may be related to other geological terms is summarised in Table G1.

Where possible, an attempt is made to reserve the rank of 'element' for features that approximate geological provinces. So, the element G (Gawler) consists of several subelements, for example *GCH* (Christie structural subdomain — symbolised in italics in the 1:5 000 000 map), as does the element A (Arunta).

Recently, it has become necessary to coin the term, 'micro-element' for the smallest mapped unit. This term is applied when division of sub-elements is needed to: 1) accommodate internal changes in physical properties, such as splitting subelement GRV (Gawler Range C Volcanics) into standard, highly magnetic, covered classes; and 2) identify complex segments within the boundary zone between elements or mega-elements.

Examples of similar, hierarchical ordering are those of (i) countries into states, regions, and districts; and (ii) rock units into groups, formations and members.

Table G1. The 'Rank' of crustal elements and their potential relationship to other geological terms in common use.

STATUS	FEATURE	Discipline	Type	Group, G	S Standard	Elongate, E	Minor, M	Localised, L
NOTES		*Data sources*	*Dimens-ions*	*Highest Rank*	*Most common*	*Special category*	*Subordinate, applies to some only*	*Small Domain/ region*
Geological Province	SEDIMENTARY BASIN [unmetamorphosed province; not cratonised]	Geological	3D, t	Superbasin, eg., Centralian	Basin	Compressional Terrane	Subbasin	Structural domain (element)
Geological Province	BASEMENT PROVINCE	Geological	3D, t	Superprovince eg., Yilgarn	Province: tectono-stratigraphic	Compressional Terrane	Subprovince	Structural domain
Composite Feature	CRUSTAL ELEMENT (piece of crust, mapped on multiple data sets and not necessarily well-defined)	Hybrid	2.5D+, +/- t	Mega-element	Element	Overprinted Zone (a sub-province)	Subelement	Micro-element
Geophysical Feature	GEOPHYSICAL DOMAIN (Magnetic and/or gravity)	Potential Field data	2D	Group of Domains	Domain	Elongate, marginal sub-domain	Subdomain	Anomaly or small domain

Relict geophysical pattern

This classification is applied where an older geophysical pattern is detectable locally within the element or is recognised in some other geophysical data set (e.g., deep seismic data).

Reworking (structural)

Structural reworking is overprinting of deformation fabrics within linear zones. It is commonly accompanied by pervasive recrystallisation of metamorphic assemblages. This phenomenon, discussed by Goscombe (1992), is more typical of Proterozoic orogenic zones.

Standard Crustal Element

A piece of the upper crust, corresponding to a recognisable geophysical domain, that has not been modified by any geophysical overprinting.

Subelement

These features, also referred to as zones, show second-order differences in geophysical character within geophysical domains, such as differences in the amplitude of anomalies.

Tectonostratigraphic Terrane

A fault-bounded package of strata that is allchothonous to, and has a geological history distinct from, that of the adjoining geological unit (Glossary in Howell 1995).

Plates

Plate 1. Simplified crustal elements map of Australia, 1995 (See text and Appendix A for an explanation of letter symbols).

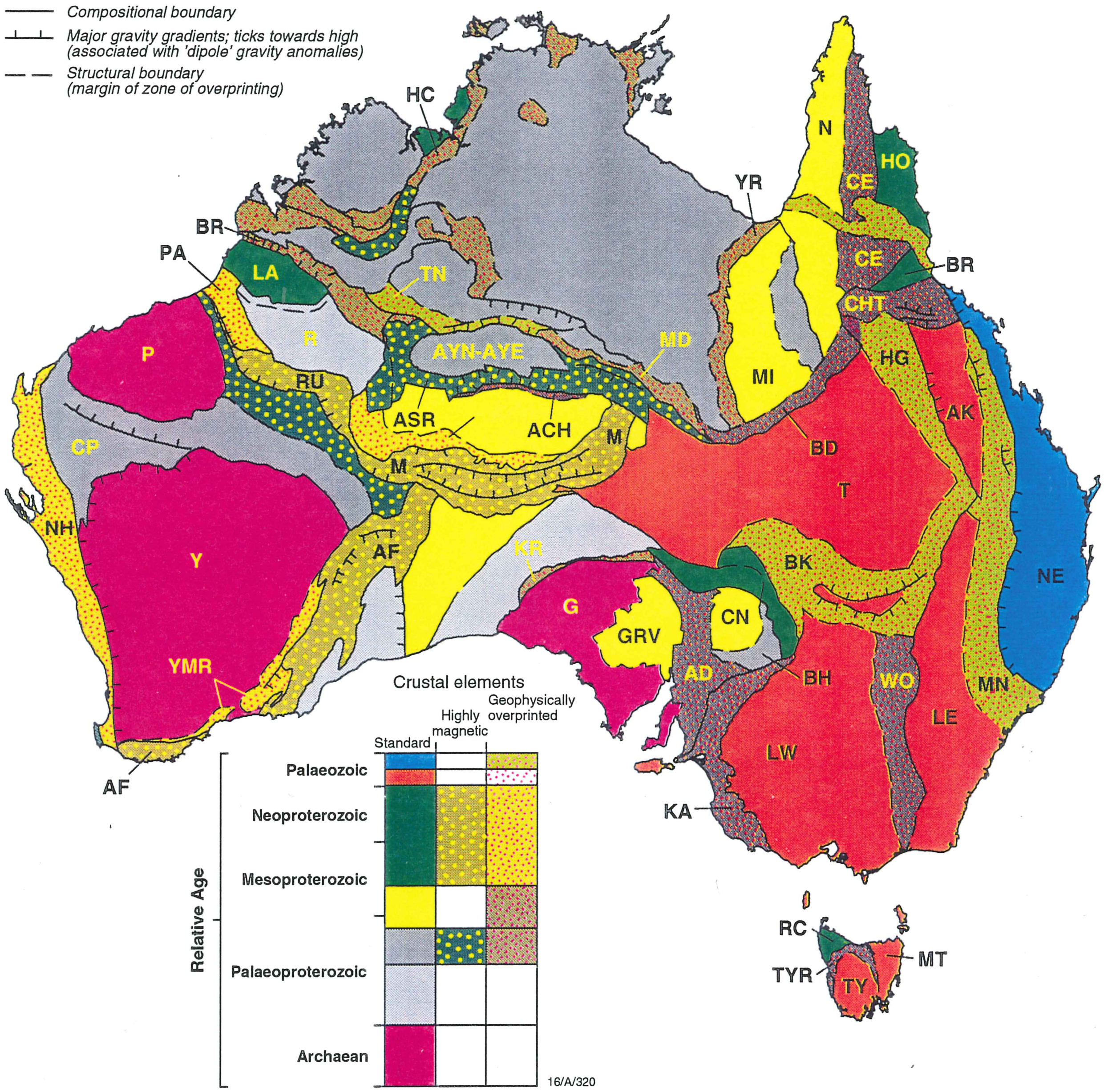
Compositional boundary
Major gravity gradients; ticks towards high (associated with 'dipole' gravity anomalies)
Structural boundary (margin of zone of overprinting)
HC
BR
PA
LA
TN
R
P
RU
AYN-AYE
MD
ASR
ACH
M
CP
M
NH
Y
AF
KR
G
GRV
CN
YMR
AF
N
HO
YR
CE
CE
BR
CHT
HG
MI
AK
BD
T
BK
NE
AD
BH
WO
MN
LE
LW
KA
RC
MT
TYR
TY
Crustal elements
Standard
Highly magnetic
Geophysically overprinted
Relative Age
Palaeozoic
Neoproterozoic
Mesoproterozoic
Palaeoproterozoic
Archaean
16/A/320

Plate 2. Australian Crustal Elements,1:5 000 000 scale map, based on distribution of geophysical domains.

Australian Geological Survey Organisation, Canberra

by Shaw, R.D., Wellman, P., Gunn, P., Whitaker, A.J., Tarlowski, C. & Morse, M., 1996a,

1:5 000 000- scale map supplied separately

- See text and Appendix A for an explanation of letter symbols

- See Appendix B for bibliographic data about each element

Appendices to:

Guide to Crustal Elements

Australian Geological Survey Organisation

AGSO

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

Contents

Appendix A: Primary attributes

Outline of the primary attribute data set for each element

The following the tables provides details of the attributes of each element used in map construction. These tables are a modified version of those that originally accompanied the digital data release of the Australian Crustal Elements Map in *.dgn format [Microstation] ***(see also Appendix B: Bibliographic data for each element).***

Each table lists the symbols (MAP_SYMBOL) assigned to each crustal element (polygon), as well as its key set of attributes (data fields) used in the construction of the map. The main data fields are:

(i) the name from which the labels were derived,
(ii) the relative deduced age, and
(iii) the class or category of each element.

Other, descriptive data fields are:

(i) correlations with provinces,
(ii) overlying basins

The attributes listed are, more or less, those used in compiling the Australian Crustal Elements Map, version 2.1. A few changes, indicated by the symbol '< ', have been made between versions 1 and 2.1 to improve the overall consistency of the map. With new data and interpretations, there is an ongoing need to update, relabel and change the attributes of elements. The latest changes, under consideration for the ARC/ INFO version of the map, are indicated by the symbol ' >>'.

The following is a set of notes on each of these attributes (data fields):

A. Map-symbols (Codes) for: Elements/ Subelements/ Micro-elements
We choose to refer to the various elements by symbol [groups of letters], rather than by giving them names. We do this because the history of naming such shows that names tend to be short-lived and to require constant refinement with incoming of new data and fresh interpretations. Our symbols [codes] can be used in the construction of databases, after some editing to suit your system/ platform.

B. Name: used for crustal element map-symbol/ code
ie., Derivation of name from which the element symbol was derived.

C. Current Rank Status [indicated by symbol]
ie., Mega-element, element, subelement and micro-element
Codes (*, $, # ^), provided with the release of a few - but not all - data sets, indicate when various changes in 'rank' took place. These are:

*SE subelement not on version 1 of map
$SE subelement not on version 2 of map, but used on version 1 of map
#EL element not on version 1 of map
^SE subelement not used in current map series

D. Correlation with Provinces/ Corresponding Feature: geological, geophysical, topographic reference-area
The numbers refer to the primary key [reference number] used for *basement provinces* in Australian provinces database. These refer to those listed in the GEOPROVS table (Oracle Software Platform) as used by the database OZROX (see Ryburn et al., 1995).

E. Overlying Basins
Numbers refer to primary key [reference number] for *sedimentary basins* in Australian provinces database. These refer to the GEOPROVS table (Oracle Software Platform) as used by the database (see Ryburn et al., 1995).

F. Relative Deduced Age
Gives relative deduced age (PA) of elements and, if appropriate, the age of overprinting (OA) and, in some cases, the age of their protoliths (RA: Relict Age). These relative ages are substantially biased towards geophysical, rather than geological, criteria.

G. Element Class/ Category:

S Standard: not modified by any geophysical overprinting
M Highly Magnetic (zone): dominated by magnetic and gravity highs, implying gross modification of upper crust
O Overprinted (zone): geophysically overprinted
C Covered: with reduced/suppressed (quiet/ muted) magnetic signal

LOCAL VARIATIONS
R Relict geophysical pattern within element
LC Covered subelement; locally suppressed pattern within element

H. Mega-elements

CA Central Australia:
NA North Australia
NQ North Queensland
NQ? North Queensland in version 1; moved to Tasman (**T?**), in version 2
P Pinjarra (orogen)
SA South Australia
SA? Those Tasmanian elements tentatively placed in South Australia (**SA**), possibly a separate mega-element
T Tasman (orogenic system/ fold belt)

T? Moved to Tasman (**T?**), in version 2; assigned to North Queensland in version 1
WA Western Australia

List (A-Z) of primary Attributes for each mapunit (MAP_SYMBOL) — with notes on previous usage

Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
A	Arunta	EL	009 Arunta Province (Block)	004 Adadeus Basin; 061 Ngalia Basin	10	0	M highly magnetic	CA	No		8
AAR	Arltunga: Arunta	SE	Arltunga Nappe Complex, 009 Arunta Province		8	10	O overprinted	CA	Yes	CYN, AS; (10, 12)	
ACH	Chewings; Arunta	SE	128 Southern Arunta Subprovince (Chewings region);		16	31	O overprinted	CA	Yes		
AD	Adelaide	EL	002 Adelaide Province (Fold Belt)		17	27	O overprinted	SA	Yes		
AF	Albany-Fraser West	EL	003 Albany-Fraser Province	015 Bremer Basin [Esperance Shelf]	15	0	M highly magnetic	SA	No		
AF1	Albany-Fraser West	MI	003 Albany-Fraser Province, Fraser segment	015 Bremer Basin [Esperance Shelf]	15	0	M highly magnetic	SA	Yes		
AF2	Albany-Fraser East	MI	003 Albany-Fraser Province, Albany segment		15	0	M highly magnetic	SA	Yes		
AG	Angus	EL	Angus region; basement province	012 Birrindudu Basin [western]	8	10	O overprinted	CA	Yes		
AHR	Harts Range; Arunta	SE	Region of Harts Range Group, 009 Arunta Province		8	10	O overprinted	CA	Yes	Unlab elled	
AK	Anakie	EL	Anakie Inlier; 220 Thompson Province (Fold Belt), eastern	028 Drummond Basin	28	0	S standard	T	Yes		
AKN	Kanandra; Arunta	SE	Region of Kanandara Granulite; 009 Arunta Province		10	0	M highly magnetic	CA	Yes		

Note: If you cannot find the map-symbol in the main list, try the Old (Disused) Field (OID)

Abbreviations for Fields:

PA — Deduced, relative *Primary Age*
OA — Deduced, relative *Overprint Age*
OID — 'Old' (Disused) Map-Symbols
RA — *Relict* features; inferred *Age*

Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
AL	Aljawarra	EL	Aljawarra [geophysical] region, basement province/ ?craton	038 Georgina Basin	12		C covered	NA	Yes		8
AM	Amadeus	EL	Basement to 004 Amadeus Basin	004 Amadeus Basin	16	0	C covered	CA	No	AM (EL)	
AM1	Amadeus, South	MI	Basement to southern 004 Amadeus Basin	004 Amadeus Basin	16	0	C covered	CA	Yes	AM (EL)	
AM2	Amadeus, Northeast	MI	Basement to northeast 004 Amadeus Basin	004 Amadeus Basin	16	0	C covered	CA	Yes	AM (EL)	
AM3	Amadeus North	MI	Basement to northernt 004 Amadeus Basin	004 Amadeus Basin	16	0	C covered	CA	Yes	AM (SE)	
AMS	Mount Sir Charles; Arunta	SE	Mount Sir Charles region, Wigley Block; 009 Arunta Province	004 Amadeus Basin, NE part of	12	10	O overprinted	CA	Yes	unlabelled; (10, 12)	6
AN >>MY	Myaoola Bay (was Arnhem)	EL	Outlier of 052 McArthur Basin. Arnhem region	052 McArthur Basin	14	0	C covered	NA	Yes	S standard	8
ANH	Newhaven; Arunta	SE	Newhaven [100k map] region; 127 Central Sub-province of 009	061 Ngalia Basin	12	0	C covered	CA	Yes		
ANR	Narweitooma; Arunta	SE	Narweitooma [100k map] region; western 127 Central		10	0	M highly magnetic	CA	Yes		
AR >> MAJ	Junction Bay; McArthur (was Arafura)	SE	052 McArthur Basin	052 McArthur Basin; 005 Arafura Basin to north	14	0	C covered	NA	Yes	S standard; EL 28	8
ASR1	Strangways Range, West; Arunta	MI	Strangways Range region; western 127 Central Subprovince of 009		10	0	M highly magnetic	CA	Yes	ASR (SE)	
ASR2	Strangways Range, East; Arunta	MI	Strangways Range region; eastern 127 Central Subprovince of 009		10	0	M highly magnetic	CA	Yes	ASR (SE)	

Abbreviations for Fields:

PA — Deduced, relative *Primary Age*
OA — Deduced, relative *Overprint Age*
OID — 'Old' (Disused) Map-Symbols
RA — *Relict* features; inferred *Age*

Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
AYE	Yuendumu East; Arunta	SE	Eastern Yuendumu [100k map] region, 009 Arunta Province (Block)	061 Ngalia Basin	8	0	C covered	CA	Yes	AY (SE)	
AYW	Yuendumu West; Arunta	SE	Western Yuendumu [100k map] region, 009 Arunta Province	061 Ngalia Basin, 012 Birrindudu Basin	8	0	C covered	CA	Yes	AY (SE)	
BC	Bancannia	EI	Basement to 010 Bancannia Basin	010 Bancannia Basin	28	0	S standard	SA	Yes		
BD	Brighton Downs	EL	Brighton Downs Zone at northern margin of 220 Thomson Fold Belt	031 Eromanga Basin, 034 Galilee Basin	19	28	O overprinted	NA	No		
BD1	Brighton Downs, Main	MI	Brighton Downs Zone at northern margin of 220 Thomson Fold Belt	031 Eromanga Basin, 034 Galilee Basin	19	28	O overprinted	NA	Yes	BD	
BD2	Brighton Downs, Northeastern	MI	Easternmost segment of Brighton Downs Zone	031 Eromanga Basin, 034 Galilee Basin	18	28	O overprinted	NQ	Yes	BD	
BH	Broken Hill ; Broken Hill	EL	016 Broken Hill Province (Block), udivided (BHR, BHW, BHC)		17	0	S standard	SA	No		
BHC	Covered [Willyama]; Broken Hill	SE	Covered Willyama Province; 016 Broken Hill Block	002 Adelaide Basin ['Geosyncline']	17	0	C covered	SA	Yes	Unlab elled	
BHR	Redan; Broken Hill	SE	Redan [geophysical overprinting] Zone; southern margin of		7	17	O overprinted	SA	Yes	Unlab elled	
BHW	Willyama; Broken Hill	SE	108 Willyama subprovince (Block) and Olary subprovince	Locally by 002 Adelaide Basin ['Geosyncline']	17	0	S standard	SA	Yes	BH	
BK	Bourke	EL	Bourke [geophysical] region/ belt [e.g., Bourke 250 map]	031 Eromanga Basin	28	31	O overprinted	T	Yes	BKN, BKS	
BKC	Bourke Central; Bourke	SE	Central part of Bourke [geophysically overprinted] zone	031 Eromanga Basin	28	0	O overprinted	T	Yes		
BKE	Bourke East; Bourke	*SE	Eastern part of Bourke [geophysically overprinted] zone	031 Eromanga Basin	30	31	S standard	T	Yes		29

Abbreviations for Fields:

PA — Deduced, relative *Primary Age*
OA — Deduced, relative *Overprint Age*
OID — 'Old' (Disused) Map-Symbols
RA — *Relict* features; inferred *Age*

Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
BN	Bonaparte	EL	Base of 013 Bonaparte Basin; basement province	013 Bonaparte Basin - southern	27	0	S standard	NA	Yes		
BR	Broken River	EL	192 Broken River Subprovince; 037 Georgetown Province		29	0	S standard	NQ	Yes	categ C < O	
BRN	Baron	EL	Baron Inlier, representing 004 Amadeus Basin and underlying	017 Canning Basin, Ryan Shelf	16	0	C covered	CA	Yes		
BRW	Barbwire	EL	Basement to Barbwire Terrace of 017 Canning Basin	017 Canning Basin; Barbwire, Jurrarra & Dampier Terraces	8	10	O overprinted	CA	Yes	BR	
BS >> ANB	Bradshaw; Arnhem	EL	Region of Bradshaw Complex; 007 Arnhem Province		8	9	S standard	NA	Yes		
BU	Buchan	EL	Buchan region [Limbunya 250k map], basement province	065 Ord Basin; eastern margin to 088 Victoria River Basin	12	0	C covered	NA	Yes		
BUR	Burdekin River	EL	Burdekin River Fault Zone; 037 Georgetown Block; possibly a		31	32	O overprinted	NQ	Yes	GNT	
BWC	Barrow Creek	EL	Barrow Creek [250k map] region; 009 Arunta Province (Block)	038 Georgina Basin	10	0	S standard	NA	Yes	AM, MS	
CE	Coen; Georgetown	SE	022 Coen Province		18	33	O overprinted	NQ	No		
CE1	Coen, Main	MI	022 Coen Province, Main part; 191 Cape York Province		18	33	O overprinted	NQ	Yes	CE (SE)	
CE2	Coen, Laura	MI	092 Yambo Province (Block) Inlier	048 Laura Basin	18	31	O overprinted	NQ	Yes	CE (SE)	
CHT	Charters Towers	EL	Charters Towers [geophysically overprinted] Zone [100k map]		29	32	O overprinted	NQ	Yes	LR, unlab elled	
CK	Cook	EL	Cook [geophysically overprinted] zone [e.g., Cook 100k]	033 Eucla Basin	23	0	O overprinted	SA	Yes	WT	

Abbreviations for Fields:

PA — Deduced, relative *Primary Age*
OA — Deduced, relative *Overprint Age*
OID — 'Old' (Disused) Map-Symbols
RA — *Relict* features; inferred *Age*

Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
CL	Clutterback	EL	Clutterback Inlier, ?004 Amadeus Basin	017 Canning Basin, Ryan Shelf	16	0	C covered	CA	Yes		
CLF >> PP	Point Parker (was Cliffdale)	EL	Point Parker [100k map] region, basement province	020 Carpentaria Basin	14	0	C covered	NA	Yes	8	
CLR	Clarke River	EL	Clarke River Fault Zone; superseded part of 037 Georgetown		29	31	O overprinted	NQ	Yes		
CN	Curnamona	EI	Curnamona craton [nucleus], basement province	008 Arrowie Basin	18	0	C covered	SA	Yes		
CNP	Mount Painter; Curnamona	SE	055 Mount Painter Province (Block), adjoining northern Curnamona		18	0	M highly magnetic	SA	Yes		
CO	Coompana	EI	Coompana Province (Block); basement province	033 Eucla Basin	6	0	C covered	SA	Yes		
CP	Capricorn	SE	Capricorn Orogen: 035 Gascoyne Province and adjoining regions	011 Bangemall Basin	7	0	S standard	WA	No	CA	
CPB	Bangemall; Capricorn	SE	Basement to 011 Bangemall Basin; Capricorn Orogen	011 Bangemall Basin	7	23	LC locally covered	WA	Yes	CA	
CPC	Collier; Capricorn	SE	Collier [250k map] region of Capricorn Orogen; southern 035	011 Bangemall Basin, Glengarry Basin	7	0	S standard	WA	Yes	CA	
CPE	East; Capricorn	SE	Capricorn East [geophysical] region of Capricorn Orogen	064 Officer Basin, Gunbarrell Basin [Palaeozoic part]; Savoy Basin,	7	0	C covered	WA	Yes	CE	
CPG	Gascoyne; Capricorn	SE	035 Gascoyne Province (Block) of Capricorn Orogen	019 Canarvon Basin - Southern	7	0	S standard	WA	Yes	CG	
CPY	Coober Pedy	EL	Coober Pedy region, margin of 036 Gawler Craton	031 Eromanga Basin	13	0	M highly magnetic	SA	Yes		
CU	Cullen	EL	241 Cullen igneous province; overprints 071 Pine Creek Province		9	0	S Standard, ?O overprinted	NA	Yes		

Abbreviations for Fields:

PA — Deduced, relative *Primary Age*
OA — Deduced, relative *Overprint Age*
OID — 'Old' (Disused) Map-Symbols
RA — *Relict* features; inferred *Age*

Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
CY	Casey	EL	Casey Bore Inlier; ?009 Arunta Province	004 Amadeus Basin, NE part of	12	10	C covered	CA	No	(10, 12)	6
CYN	Casey North; Casey	SE	Casey Bore Inlier; ?009 Arunta Province	004 Amadeus Basin, NE part of	12	10	O overprinted	CA	Yes	unlab elled; (10, 12)	6
CYS	Casey South; Casey	SE	Casey Bore Inlier, basement province	068 Pedirka Basin	12	0	C covered	CA	Yes		
D	Davenport	EL	26 Davenport Province	038 Georgina Basin	9	0	S standard	NA	Yes		
DEN	Denison	EI	Region of Cadlareena Volcanics [Warrina 100k map] western	Boorthanna Trough; 006 Arckaringa Basin	24	0	C covered	SA	Yes	unlab elled	
DUT	Dutton	EL	Dutton River [250k map] region; a possible extension of 204	031 Eromanga Basin	29	32	O overprinted	NQ	Yes	LR (EL)	23
FR1	Forrest, North	MI	Forrest [250k map] region, basement province	064 Officer Basin	18	0	C covered	SA	Yes	FR (E)	
FR2	Forrest South	MI	Forrest [250k map] region, basement province	033 Eucla Basin	18	0	C covered	SA	Yes	FR (E)	
G	Gawler	EL	036 Gawler Craton	033 Eucla Basin	5	0	S standard	SA	No		
GCH	Christie; Gawler	SE	Christie structural subdomain [Barton 250k map]; 036 Gawler Craton	033 Eucla Basin	5	0	S standard	SA	Yes		
GCL	Challenger; Gawler	SE	Challenger [Mine] region [Coober Pedy 250k map]; 036 Gawler Craton	006 Arckaringa Basin	5	0	S standard	SA	Yes		
GCT	Coulta; Gawler	SE	Coulta structural subdomain [e.g., Kimba 100k map]; 036 Gawler Craton		7	0	S standard, R relict	SA	Yes		2
GFW	Fowler; Gawler	SE	Fowler zone [Colona & Coorambie Fault zones], eastern	033 Eucla Basin	17	0	M highly magnetic	SA	Yes		5
GLN	Glenelg	EL	Glenelg and Stavely Zones; western margin of 047 Lachlan	057 Murray Basin	27	0	S standard	T	Yes	E-most KA (E)	

Abbreviations for Fields:
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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
GMN1	Moonta West; Gawler	MI	Western Moonta structural subdomain [Whyalla 250k]	078 St Vincent Basin	13	0	M highly magnetic	SA	Yes	GMN (SE), unlabelled	
GMN2	Moonta East; Gawler	MI	Eastern Moonta structural subdomain [Whyalla 250k]		13	0	M highly magnetic	SA	Yes	GMN (SE), unlabelled	
GRV	Gawler Range;Gawler	SE	Gawler Range Volcanic Subprovince; 036 Gawler Craton		18	0	S standard	SA	No		
GRV1	Gawler Range, Standard; Gawler	MI	Gawler Range Volcanic Subprovince; 036 Gawler Craton		18	0	S standard	SA	Yes	GRV (SE)	
GRV2	Gawler Range, Covered; Gawler	MI	Gawler Range Volcanic Subprovince; 036 Gawler Craton		18	0	C covered	SA	Yes	GRV (SE)	
GRV3	Gawler Range, Magnetic; Gawler	MI	Gawler Range Volcanic Subprovince; 036 Gawler Craton		18	0	M highly magnetic	SA	Yes	GRV (SE)	

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
GSB	Streaky Bay; Gawler	SE	Streaky Bay [geophysical] region [Streaky Bay 250k map]; in 036		17	0	S standard	SA	Yes		5
GT	Granites-Tanami	EL	085 Granites-Tanami Province (Block)		8	0	S standard	NA	Yes	C cover ed	3
GTN	Georgetown	EL	037 Georgetown Province (Block); possibly a subelement		18	31	O overprinted	NQ	Yes		
GWG	Wilgena; Gawler	SE	Wilgena and Nuyts structural subdomains; 036 Gawler Craton		5	0	S standard	SA	Yes		
HC	Halls Creek	EL	040 Halls Creek Province (Orogen)		8	8	O overprinted	NA	No		
HCA	Argyle segment; Halls Creek	SE	Argyle segment of 040 Halls Creek Province (Orogen)		8	9	O overprinted	NA	Yes	20	6
HCB	Biscay; Halls Creek	SE	Biscay zone; Eastern Zone of 040 Halls Creek Province (Orogen)		8	9	O overprinted	NA	Yes		6
HCC	Central; Halls Creek	SE	Central segment; Western and Central Zones of 040 Halls Creek		8	9	O overprinted	NA	Yes	10, M highly magn etic	6
HCF	Fitzmaurice; Halls Creek	SE	Fitzmaurice segment; 040 Halls Creek Province (Orogen)	088 Victoria River Basin	8	9	O overprinted	NA	Yes	8	6
HCL1	Litchfield, West; Halls Creek	MI	051 Litchfield Province (segment); 040 Halls Creek	013 Bonaparte Basin - Northern	8	9	O overprinted	NA	Yes		6
HCL2	Litchfield, East; Halls Creek	MI	051 Litchfield Province (segment); 040 Halls Creek	013 Bonaparte Basin - Northern	8	9	O overprinted	NA	Yes		6
HG	Hughenden; Thomson	EL	Hughenden [250k map] region; eastern [geophysically	028 Drummond Basin	31	0	O overprinted	T	Yes		
HM	Hermit Creek	EL	Region of Hermit Creek Metamorphics; 071 Pine Creek	088 Victoria River Basin	12		C covered	NA	Yes		8

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
HO	Hodgkinson	EL	043 Hodgkinson Province (Fold Belt)		18	29	O overprinted	NQ	Yes	< C cover ed	
IT	Itiledoo	EL	Itiledoo Basin; older successor basin	072 Ploda Basin	20	0	LC locally covered	SA	Yes	CYO	
JC	Julia Creek	EL	Julia Creek [250k] region; basement province bordering 054	031 Eromanga Basin, 045 Karumba Basin	7	0	S standard	NA	Yes		
K	046 Kimberley	EL	Base of 046 Kimberley Basin	046 Kimberley Basin	9	0	S standard	NA	Yes		6
KA	Kanmantoo	EL	044 Kanmantoo Province (Fold Belt)	057 Murray Basin, 066 Otway Basin	27	0	[S standard]	SA	No		
KA1	Kanmantoo, main	MI	044 Kanmantoo Province (Fold Belt)	057 Murray Basin, 066 Otway Basin	7	27	O overprinted	SA	Yes	KA [S stand ard]	
KA2	Kanmantoo, Kangaroo	MI	Kangaroo Island segment: Kanmantoo Trough		7	27	O overprinted	SA	Yes	KA [S stand ard]	
KA3	Kanmantoo, Pendola	MI	Pendola segment; Southeastern Padthaway Ridge	Robe and Pendola depressions, 066 Otway Basin	7	27	O overprinted	SA	Yes	KA [S stand ard]	
KBE	Kimberley East; Kimberey	SE	Kimberley East [geophysically overprinted] Zone; base of 046	046 Kimberley Basin	8	9	O overprinted	NA	Yes	20/9	6
KI	King Island	EL	073 Rocky Cape Province (Block), NW Tasmania		25	0	?O overprinted	SA	Yes		
KL	King Leopold	EL	King Leopold Subprovince [Orogen]; 040 Hall Creek Province		8	23	O overprinted	NA	Yes	8/6	6
KR	Karari	EL	Karari Fault Zone; N-margin to 036 Gawler Craton [redefined craton]	Tallaringa Trough; 006 Arckaringa Basin	7	17	O overprinted	SA	Yes		
KW	Keer-Weer	EL	Cape Keerweer [100k] region, basement province	020 Carpentarian Basin	19	0	S standard	NQ	Yes		

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
LA	Lagrange	EL	Lagrange [250k map] region, basement province	017 Canning Basin, Broome Platform	24	0	C covered	CA	Yes		
LC	Lake Caroline	EL	Lake Caroline region [marked gravity ridge];	038 Georgina Basin, 031 Eromanga Basin	8	10	O overprinted	CA	Yes	LCN + LCS	
LD	Lake Dissapointment	EL	LD Lake Dissapointment region [Gunanya 1:250k map]; 067	064 Officer Basin, Karara Basin; Yenenna Basin; Savoy Basin,	8	0	C covered	WA	Yes	YP	
LE	Lachlan East	EL	Eastern part of 047 Lachlan Province (Fold Belt), includes eastern	080 Surat Basin; southwest 081 Sydney Basin	30	0	S standard	T	Yes		
LR	Lolworth-Ravenswood	EL	204 Lolworth-Ravenswood Province (Igneous Province);		29	0	S standard	NQ	Yes		
LU	Leeuwin	EL	049 Leeuwin Province (Block)		25	0	O overprinted	P	Yes	LW	
LW	Lachlan West	EL	Western part of 047 Lachlan Province (Fold Belt)	057 Murrray Basin, 025 Darling Basin, 063 Oaklands Basin, Barka Basin	28	0	S standard	T	Yes		
MA	McArthur	EL	Basal volcanic units in 052 McArthur Basin [e.g. Tawallah		14	0	S standard	NA	Yes		
MAB	Beetaloo; McArthur	SE	Beetaloo Trough; top of 052 McArthur Basin	Part of 052 McArthur Basin, overlain by 038 Georgina Basin	20	0	LC locally covered	NA	Yes		14
MAD	Madura	EL	Madura [250k map] region (or Naretha region); basement	033 Eucla Basin	6	0	C covered	SA	Yes		
MAN	Nymbilli; McArthur	SE	Nymbilli [100k map] region; 052 McArthur Basin	Part of 052 McArthur Basin	20	0	LC locally covered	NA	Yes		14
MAR	Marathon	EL	Marathon [250k map] region; a possible extension of the Brighton	034 Galilee Basin	28	31	O overprinted	NQ	Yes		

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
MAW	Walker; McArthur	SE	Deep crustal feature under Walker Trough;	052 McArthur Basin, Walker Trough	14	0	S standard	NA	Yes		
MB	Mount Bannerman	EL	Mount Bannerman [250k] region; basement province	017 Canning Basin; E Fitzroy Trough, W Gregory Subbasin,	12	0	C covered	CA	Yes		
MBCE	Mabel Creek - East; Mabel Creek	SE	Eastern part of Mabel Creek [100k map] region [geophysical		13	0	S standard	SA	Yes	MBC	
MBC W	Mabel Creek - West; Mabel Creek	SE	Western magnetic part of Mabel Creek [100k map] region		13	0	M highly magnetic	SA	Yes	MBC (SE)	
MD	Mount Ida	EL	Mount Ida [faulted/ geophysically overprinted] Zone	038 Georgina Basin, 031 Eroganga Basin	12	20	O overprinted	NA	Yes		
MFR	Fregon; Musgrave	SE	Part of Fregon structural subdomain [geophysical]; 058	Levenger Graben	23	0	S standard	CA	Yes	M	18
MG	Musgrave	EL	058 Musgrave Province (Block)		23	0	M highly magnetic	CA	No	M	
MGC	Musgrave Central; Musgrave	SE	058 Musgrave Province (Block), central part		23	0	M highly magnetic	CA	Yes	M, MC	
MGE	Musgrave East; Musgrave	SE	058 Musgrave Province (Block), eastern part	031 Eromanga Basin	23	0	S standard	CA	Yes	M, ME	
MGN	Musgrave North; Musgrave	SE	058 Musgrave Province (Block), northern part		23	0-	M highly magnetic	CA	Yes	unlab elled, PR	
MGW	Musgrave West; Musgrave	SE	058 Musgrave Province (Block), western part	017 Canning Basin	23	0	S standard	CA	Yes	M (SE, E)	
MI	Mount Isa	EL	054 Mount Isa Province (Inlier)		19	0	S standard	NA	Yes		
MK	Marqua; Teikin	SE	Marqua fault zone [100k map region], basement to 038 Georgina Basin	038 Georgina Basin, S of Toko Trough/ Syncline	12	31	O overprinted	NA	Yes		
ML	Muloorina	EL	Muloorina [100k map] region (Ridge); basement province	031 Eromanga Basin	24	0	C covered	SA	Yes		

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
MN	Meandarra; Lachlan East	SE	Meandarra [geophysical] zone; subcropping eastern margin of	041 Bowen Basin, northeast part 081 Sydney Basin	32	0	O overprinted	T	Yes		
MR	Murphy	EL	056 Murphy Province	020 Carpentaria Basin	8	0	S standard	NA	Yes		
MV	Mount Vernon	EL	Mount Vernon [100k map] region; 112 Asburton Basin; nxt Capricorn Ogn	112 Ashburton Basin	6	0	C covered	WA	Yes	CP, CPA	
MWN	Mount Winnecke	EL	Mount Winnecke Subprovince [new name]; 085 Granites-Tanami		9	0	S Standard	NA	Yes	GT	
MWO	Mount Wood	EL	Mount Wood Inlier; in old 036 [superseded] Gawler Craton		18	0	M highly magnetic	SA	Yes		
N	Normanton	EI	Normanton region; Kowanyama basement province	020 Carpentarian Basin, 045 Kasrumba Basin	18	0	C covered	NQ	No		
NBB	Nabberu Basin	MI	Overlies NE Yilgarn	059 Nabberu Basin	16	0	LC locally covered	WA	Yes		
NCL	Claraville; Normanton	SE	Basement province in Claraville region	031 Eromanga Basin	18	0	C covered	NQ	Yes	N	
NCR	Croydon; Normanton	SE	Croydon district, Normanton region; basement province	020 Carpentarian Basin, 045 Kasrumba Basin	18	0	C covered	NQ	Yes	N	
NE	New England	ME	195 Drummond Carboniferous-Permian Igneous Sub-Province 060	021 Clarence-Morton Basin; 042 Hillsborough Basin (also Biloela, Sytx	32	0	S standard	NE	Yes		
NF	North Flinders	EL	North Flinders (arm) of 002 Adelaide Geosyncline		17	0	C covered	SA	Yes		
NH	Northhampton	EL	062 Northhampton Province [Block, inlier]		22	0	O overprinted	P	Yes		

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
NK	Nookanbah	EL	Nookanbah [250k] region, basement province	017 Canning Basin; central Fitzroy Trough	12	0	C covered	CA	Yes		
NMW	Max Walton; Normanton	SE	Max Walton district [100k map], southern basement	031 Eromanga Basin	18	0	C covered	NQ	Yes	N	
NW	Nawa	EL	Nawa structural subdomain, basement province [includes	064 Officer Basin	6	0	C covered	SA	Yes		
NWP	Weipa; Normanton	SE	Weipa [250k map] district, Normanton region; basement province [	020 Carpentarian Basin	18	0	C covered	NQ	Yes	N	
O	Oscar	EL	Oscar Range region, basement province	017 Canning Basin, Lennard Shelf; relict basin of Oscar Range	8	0	C covered	CA	Yes		
PA	Paterson	EL	067 Paterson Province	017 Canning Basin, southern shelves	6	26	O overprinted	CA	Yes		
PC	Pine Creek	EI	071 Pine Creek Province ['Geosyncline']		8	0	S standard	NA	No		3
PCM	Main (or central); Pine Creek	SE	Main or central region; 071 Pine Creek Province ['Geosyncline']		8	0	S standard	NA	Yes		3
PCN	Nimbuwah; Pine Creek	SE	Nimbuwah region; 071 Pine Creek Province		8	9	O overprinted	NA	Yes		
PCR	Rum Jungle; Pine Creek	SE	074 Rum Jungle Province (Block/ Inlier); within Pine Creek Province		3	8	S standard, R relict	NA	Yes		
PHA	Hamersley: Pilbara	SE	041 Hamersley Basin; overlies 070 Pilbara Craton	041 Hamersley Basin	4		S standard, R relict	WA	Yes	H	1
PK	Peake	EL	Spring Hill region [Umbum 100k map]; eastern 027 Peake and		7	0	S standard	SA	Yes		

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
PR	Petermann Ranges	EL	Petermann Ranges [100 k map] region, north of Woodroffe Thrust		23	26	O overprinted	CA	Yes	not PA =23 [M]	
PRC	Petermann Central; Petermann Ranges	SE	Petermann Ranges Central region [Mulga Park Sdmn] of 058 Musgrave	004 Amadeus Basin	23	26	O overprinted	CA	Yes		
PRE	Petermann East; Petermann Ranges	SE	Petermann Ranges - East region; 058 Musgrave Province	004 Amadeus Basin	26	0	C covered	CA	Yes		
PRW	Petermann West; Petermann Ranges	SE	Petermann Ranges - West region; 058 Musgrave Province	017 Canning Basin; 004 Amadeus Basin	26	0	S standard	CA	Yes		
R	Roeves	EL	Roeves [gravity feature, Reeves Knoll] region; basement	017 Canning Basin; Willara & Kidson Sub-basins	6	0	C covered	CA	Yes		
RC	Rocky Cape	EL	073 Rocky Cape Province (Block), NW Tasmania		25	0	O overprinted	SA	Yes		
RKP	Koop; Roeves	*SE	Koop [100k] map region [geophysically overprinted zone];	017 Canning Basin; Munro Terrace	6	8	O overprinted	CA	Yes		
RO	Rosewood	EL	Rosewood region [Lissadell 100k map]; basement province	065 Ord Basin	9	0	S standard	NA	Yes		
RU	Rudall	EL	Rudall Inlier within 067 Paterson Province	017 Canning Basin: parts of SE Table Top Shelf, NW Ryans Shelf;	21	0	M highly magnetic	CA	Yes		
SN	South Nicholson	EL	Basement to 075 South Nicholson Basin	075 South Nicholson Basin	8	0	C covered	NA	No	SM	
SN1	South Nicholson, North	MI	Basement to 075 South Nicholson Basin (gravity low)	075 South Nicholson Basin	8	0	C covered	NA	Yes	SN	
SN2	South Nicholson, South	MI	Basement to 075 South Nicholson Basin	038 Georgina Basin	8	0	C covered	NA	Yes	SN	
SNCM	Camooweal; South Nicholson	SE	Camooweal [100k map] region; underlying 090 (NE) Wiso Basin	038 Georgina Basin	26	0	C covered	NA	No		

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
ST	;Sturt	EI	Sturt Block; western margin of 085 Granites-Tanami Province	065 Ord Basin, 012 Birrindudu Basin	12	0	C covered	NA	No		
STN	Sturt North; Sturt	SE	Northern part of Sturt Block; western margin of 085 Granites-Tanami	065 Ord Basin, 012 Birrindudu Basin	12	0	C covered	NA	Yes	ST (EL)	
STS	Sturt South; Sturt	SE	Southern part of Sturt Block south; western margin of 085	065 Ord Basin, 012 Birrindudu Basin	12	0	C covered	NA	Yes	ST (EL)	
TC	Tennant Creek	EL	084 Tennant Creek Province (Block) Inlier	090 Wiso Basin, 038 Georgina Basin	8	0	S standard	NA	Yes		
TEK	Teikin	EL	Mount Teikin region [Marqua 100k map]; basement	038 Georgina Basin, S of Toko Syncline	12	0	C covered	NA	Yes		8
TH	Thomson	EL	220 Thomson Province (Fold Belt), volcanics in 089 Warburton	031 Eromanga Basin, 034 Galilee Basin	28	0	S standard	T	Yes		
THM	Mitchell; Thomson	SE	[Mitchell [250k map] geophysically overprinted] zone	080 Surat Basin	31	0	S standard	T	Yes		

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Sym	Unitname	Rk	Correlation	Basins	PA	OA	Class	ME	C	OID	RA
TMI1	Townsville-Mornington, Main	MI	Townsville-Mornington Island (igneous province) region, main part		18	33	O overprinted	NQ	Yes		
TMI2	Townsville-Mornington, West	MI	Western, end of Townsville-Mornington Island (igneous province)		18	33	O overprinted	NQ	Yes		
TN	Tanami	EL	Tanami Zone; S-margin to 085 Granites-Tanami Province; N 009		12	31	O overprinted	NA	Yes		
TNE	Tanami East	SE	Tanami East Zone; 009 Arunta Province (Block)		12	31	O overprinted	NA	Yes	TN	
TNW	Tanami West	SE	Tanami West Zone; 085 Granites-Tanami Province, Sth-most	012 Birrindudu Basin, 017 Canning Basin, NW-most part;	12	31	O overprinted	NA	Yes	TN	
TY	Tyennan	EL	087 Tyenna Province (Block)	083 Tasmania Basin	27	0	S standard	T	Yes		
TYR	Reed; Tyennan	SE	Region of Mount Read Volcanic belt; 087 Tyenna Province (Block)	030 Dundas Basin (Trough)	27	0	O overprinted	T	Yes		
V	Victoria River	EI	Basement to 088 Victoria River Basin	088 Victoria River Basin	12	0	C covered	NA	Yes		
VL	Vanderlin	EI	Vanderlin [100k map] region; margin of 052 McArthur Basin		8	0	C covered	NA	Yes		
W	Wiso	EL	Basement to 090 Wiso Basin		12	0	C covered	NA	No		
W1	Wiso, Daly	MI	Basement to 090 Wiso Basin	024 Daly River Basin	12	0	C covered	NA	Yes	W	
W2	Wiso, Central	MI	Basement to 090 Wiso Basin		12	0	C covered	NA	Yes	W	
W3	Wiso, Lander	MI	Basement to 090 Wiso Basin	Northern Lander Trough, part of 090 Wiso Basin	12	0	C covered	NA	Yes	W	
WEL	Esley; Wiso	SE	Esley [100k map] region, underlying 090 (NW) Wiso Basin	090 Wiso Basin, 025 Daly Basin	23	0	LC locally covered	NA	Yes	unlabelled	

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WG	Waigen	EL	Waigen [250k map] region; basement province	064 Officer Basin	18	0	C covered	SA	No		
WG1	Waigen North; Waigen	SE	Waigen [250k map] region; basement province; N of CK	064 Officer Basin	18	0	C covered	SA	Yes	WG (E)	
WG2	Waigen South; Waigen	SE	Waigen [250k map] region; basement province; S of CK	033 Eucla Basin	18	0	C covered	SA	Yes	WG (E)	
WL	Willowra	EL	Willowra [100k map] region, 009 Arunta Province (Block)	Traditionally part of 009 Arunta Province (Inlier), northern margin of	8		S standard	NA	Yes	[8 C cover ed]	3
WLA	Wiso-Lander; Wiso	EL	Lander [100k map] region; basement province, southern marginof 090 Wiso	Southern Lander Trough, 090 Wiso Basin	12	31	C covered	NA	Yes		
WN	Wonominta	EL	091 Wonominta Province (Block)		24	0	C covered	SA	Yes		
WO	Wagga-Omeo; Lachlan West	SE	Wagga-Omeo belt; subdivides 047 Lachlan Province (Fold Belt)		30	0	O overprinted	T	Yes		
WRC	Warriner Creek	EL	Warriner Creek region [Irrapatana 100k]; prevoiusly part of NE 036		7	0	S standard	SA	Yes		
Y	Yilgarn	EL	093 Yilgarn Craton (Superprovince/ (Block)		2	0	S standard	WA	Yes		
YMR1	Mulga Rock, West; Yilgarn	MI	Mulga Rock [overprinted geophysical] zone; southwset margin		2	21	O overprinted	WA	Yes		
YMR2	Mulga Rock,. East; Yilgarn	MI	Mulga Rock [overprinted geophysical] zone;eastern	015 Bremer Basin [Esperance Shelf, Scaddan Embayment]	2	21	O overprinted	WA	Yes		
YRN	Yaringa North; South Nicholson	SE	Northern extension of Yaringa [geophysically overprinted] zone	075 South Nicholson Basin, 038 Georgina Basin	19	0	O overprinted	NA	Yes		
YRS	Yaringa South; Aljawarra	SE	Region of Yaringa Metamorphics; central 145 Lawn Hill Platform	038 Georgina Basin	19	0	O overprinted	NA	Yes		

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Appendix B: Bibliographic data

Outline of the bibliographic data sets — for each mega-element

The following the tables provides details of the previous regional geophysical investigations that included each of the elements. Separate tables are provided for each mega-element. For each element, a reference to a key investigations is listed, as well as a secondary reference. In a few cases, additional references are also included. Cross-references to the numbered gravity domains and subdomains of Fraser et al. (1977) are also listed ***(see also Appendix A: primary attributes for each element).***

Mega-element CA

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al	Sub-domains
A	Arunta	Mathur & Shaw (1982)	Mutton et al (1983)	Mutton & Shaw (1979)	48, 49, 50, 51	
AAR	Arlunga; Arunta	Stewart et al. (1991)	Shaw & Freeman (1995)	Forman & Shaw (1973)	52	d
ACH	Chewings; Arunta	Goleby et al. (1989)	Shaw et al. (1991a)	Forman & Shaw (1973); Warren & Shaw (1995)	52	b
AG	Angus	Shaw et al. (1994)	Mathur & Shaw (1982)	Fraser et al. (1977)	10	
AHR	Harts Range; Arunta	Fraser et al. (1977)	Mathur & Shaw (1982)	Shaw & Freeman (1985)	51	c
AKN	Kanandra; Arunta	Wyatt (1974)	Mathur & Shaw (1982)	Fraser et al. (1977)	51	b
AM	Amadeus	Wellman (1991)	Forman & Shaw (1973)	Shaw et al. (1991a); Wyatt (1983)	52, 53	
AMS	Mount Sir Charles; Arunta	Black & Shaw (1991)	Forman & Shaw (1973)	Fraser et al. (1977)	52	NE d
ANH	Newhaven; Arunta	Young et al. (1996)	Mathur & Shaw (1982)	Fraser et al. (1977)	50	
ANR	Narweitooma; Arunta	Goleby et al. (1989)	Shaw et al. (1991a)	Mutton et al. (1983); Warren & Shaw (1995)	50	
ASR	Strangways Range; Arunta	Mathur & Shaw (1982)	Wellman (1978)	Fraser et al. (1977)	50	b
AYE	Yuendumu East; Arunta	Young et al. (1996)	Mathur & Shaw (1982)	Mathur & Shaw (1982)	49	b
AYW	Yuendumu West; Arunta	Young et al. (1996)	Gunn et al (1995a)	Mathur & Shaw (1982)	49	a
BR	Barbwire	Shaw et al. (1994)	Fraser et al. (1977)		23	d
BRN	Baron	Shaw et al. (1994)	Fraser et al. (1977)		22	W-part

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al	Sub-domains
CL	Clutterback	Shaw et al. (1994)	Fraser et al. (1977)		54	a NW
CY	Casey	Shaw & Freeman (1985)	Stewart et al. 1991)	Fraser et al. (1977)	51	c
CYN	Casey North; Casey	Shaw & Freeman (1985)	Stewart et al. 1991	Fraser et al. (1977)	51	c
CYS	Casey South; Casey	Fraser et al. (1977)			51	c
LA	Lagrange	Shaw et al. (1994)	Fraser et al. (1977)		20	a, b
LC	Lake Caroline	Shaw & Freeman (1985)	Mathur & Shaw (1982)	Fraser et al. (1977)	51	
LCN	Lake Caroline - North; Lake Caroline	Mathur & Shaw (1982)	Fraser et al. (1977)		51	b
LCS	Lake Caroline - South; Lake Caroline	Mathur & Shaw (1982)	Fraser et al. (1977)		51	a
MB	Mount Bannerman	Shaw et al. (1994)	Fraser et al. (1977)		23	c
MFR	Fregon; Musgrave	Flint in Drexel et al. (1993)	Mathur & Shaw (1982)	Leven & Lindsay (1995)	55, 56	c Wst; a, b
MG	Musgrave	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	55, (17)	a, b, c; b Wst
MGC	Musgrave Central; Musgrave	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	55	a (Sth), b (Sth)
MGE	Musgrave East; Musgrave	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	55	c
MGN	Musgrave North; Musgrave	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	55	a Nth
MGW	Musgrave West; Musgrave	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	17	b Wst
NK	Nookanbah	Shaw et al. (1994)	)Fraser et al. (1977)		23	c Nth
O	Oscar	Shaw et al. (1994)	Fraser et al. (1977)		23	b, part of c

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al	Sub-domains
PA	Paterson	Shaw et al. (1994)	Mathur & Shaw (1982)		17	a
PR	Petermann Ranges	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	54	a, b
PRC	Petermann Central; Petermann Ranges	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	54	b Wst
PRE	Petermann East; Petermann Ranges	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	54	b Est
PRW	Petermann West; Petermann Ranges	Lambeck & Burgess (1992)	Forman & Shaw (1973)	Mathur & Shaw (1982)	54	a
R	Roeves	Shaw et al. (1994)	Fraser et al. (1977)		21	a, b; 20c
RU	Rudall	Mathur & Shaw (1982)	Mathur & Shaw (1982)		17	b
RPK	Koop; Roeves	Shaw et al. (1994)	Fraser et al. (1977)		21	a NW edge

Mega-element NA

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. sub-domains
AL	Aljawarra	Tucker et al. (1979)	Fraser et al. (1977)		44	h
AN >>MY	Myaoola Bay (was Arnhem)	Plumb & Wellman (1987)	Fraser et al. (1977)		36	
AR >> MAJ	Junction Bay; McArthur (was Arafura)	Plumb & Wellman (1987)	Fraser et al. (1977)		36	
BD	Brighton Downs	Wellman (1991)	Wellman (1988)	Murray et al. (1989)	88 (S margin)	j, h
BN	Bonaparte	Gunn (1995c)	Gunn (1988)		28, 33	
BS >> ANB	Bradshaw; Arnhem	Plumb & Wellman (1987)	Fraser et al. (1977)		36	
BU	Buchan	Fraser et al. (1977)			40	w margin of
BWC	Barrow Creek	Wyatt (1974)	Fraser et al. (1977)		41	f
CLF >> PP	Point Parker (was Cliffdale)	Fraser et al. (1977)			42	d
CU	Cullen	Wellman (1991)	Fraser et al. (1977)		35	sw part
D	Davenport	Hone in Blake et al. (1987)	Fraser et al. (1977)		44	b
GT	Granites-Tanami	Gunn et al. (1995a)	Fraser et al. (1977)		46, 47	; a

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. sub-domains
GT	Granites-Tanami	Gunn et al (1995a)	Fraser et al. (1977)		46	
HC	Hall Creek	Fraser et al. (1977)	Shaw (1992)	Mathur & Shaw (1982)	23, 25	; b, e
HCA	Argyle segment; Halls Creek	Fraser et al. (1977)			24	a
HCB	Biscay; Halls Creek	Shaw (1992)	Mathur & Shaw (1982)	Fraser et al. (1977)	23	b, e
HCC	Central; Halls Creek	Shaw (1992)	Wellman (1978)	Mathur & Shaw (1982)	25, 23	b
HCF	Fitzmaurice; Halls Creek	Mathur & Shaw (1982)	Fraser et al. (1977)		33	
HCL1	Litchfield; Halls Creek	Tucker et al. (1980)	Fraser et al. (1977)		33	Nth
HCL2	Litchfield; Halls Creek	Tucker et al. (1980)	Fraser et al. (1977)		33, 38	Sth
HM	Hermit Creek	Fraser et al. (1977)			38;	
JC	Julia Creek	Wellman (1992b)	Fraser et al. (1977)		88	h
K	046 Kimberley	Symonds et al. (1994)	Mathur & Shaw (1982)	Fraser et al. (1977)	26	
KBE	Kimberley East	Symonds et al. (1994)			26	E margin of **a**
KL	King Leopold	Mathur & Shaw (1982)	Fraser et al. (1977)		23	a

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. sub-domains
MA	McArthur	Plumb & Wellman (1987)	Fraser et al. (1977)		35, 36, 42	
MAB	Beetaloo; McArthur	Plumb & Wellman (1987)	Fraser et al. (1977)		41	b
MAN	Nymbilli; McArthur	Plumb & Wellman (1987)	Fraser et al. (1977)		36	small part of
MAW	Walker; McArthur	Plumb & Wellman (1987)	Fraser et al. (1977)		37	
MD	Mount Ida	Wyatt (1974)	Whiting (1988)	Fraser et al. (1977)	51	a [S margin]
MI	Mount Isa	Wellman (1992a)	Murray et al. (1989)		88, (42)	d-h, e
MK	Marqua; Teikin	Harrison (1980)	Fraser et al. (1977)		44	i
MR	Murphy	Fraser et al. (1977)			42	c

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. sub-domains
MWN	Mount Winnecke	Fraser et al. (1977)			40, 45	a, b; NW
PC	Pine Creek	Tucker et al. (1980)	Fraser et al. (1977)		34, (33)	
PCM	Main (or central); Pine Creek	Tucker et al. (1980)	Fraser et al. (1977)		34	a, b
PCN	Nimbuwah; Pine Creek	Tucker et al. (1980)	Fraser et al. (1977)		35	part of
PCR	Rum Jungle; Pine Creek	Tucker et al. (1980)	Fraser et al. (1977)		34	a, part of
RO	Rosewood	Wellman (1995a)	Fraser et al. (1977)	Shaw (1992)	24	a
SN	South Nicholson	Plumb & Wellman (1987)	Fraser et al. (1977)		44	c, d, e, g
SN1	South Nicholson, North	Plumb & Wellman (1987)	Fraser et al. (1977)		44	c, d, e, g
SN2	South Nicholson, South	Tucker et al. (1979)	Fraser et al. (1977)		44	g (part of)
SNCM	Camooweal; South Nicholson	Tucker et al. (1979)	Fraser et al. (1977)		ww	g (part)

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. sub-domains
ST	Sturt	Fraser et al. (1977)			24	b, c
TC	Tennant Creek	Tucker et al. (1979)	Fraser et al. (1977)		44	b, c
TEK	Teikin	Harrison (1980)	Fraser et al. (1977)		88, 44	h, i
TN	Tanami	Mathur & Shaw (1982)	Fraser et al. (1977)		47, 48	
TNE	Tanami East	Gunn et al. (1995a)	Mathur & Shaw (1982)		48	S margin of
TNW	Tanami West	Shaw et al. (1994)	Fraser et al. (1977)		46, 47	
V	Victoria River	Fraser et al. (1977)			39, (24a, 40)	
VL	Vanderlin	Fraser et al. (1977)			43	
W	Wiso	Fraser et al. (1977)			38, 40, 45	
W1	Wiso North; Wiso	Fraser et al. (1977)			38	
W2	Wiso Central; Wiso	Fraser et al. (1977)			45	
W3	Wiso South: Wiso	Fraser et al. (1977)			45, 40	
WEL	Esley; Wiso	Plumb & Wellman (1987)	Fraser et al. (1977)		41	a
WL	Willowra	Gunn et al (1995a)	Mathur & Shaw (1982)		48	
WLA	Lander; Wiso	Fraser et al. (1977)			45	S margin

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. sub-domains
YR	Yaringa	Wellman (1991)	Fraser et al. (1977)		88	a, d
YRN	Yaringa North; South Nicholson	Wellman (1991)	Fraser et al. (1977)		88	a
YRS	Yaringa South; Aljawarra	Wellman (1991)	Fraser et al. (1977)		88	d

Mega-element NE

Note: Currently, mega-element NE is not subdivided

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. sub-domain	Wellman feature	Murray et al. feature
NE	New England	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	83		S2	XX (2, 3)
NE	New England	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	81	a-i	U2	XXV
NE	New England	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	81	f	V3	XXV
NE	New England	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	81	?	V3	XXV (2)
NE	New England	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	81	?	V3	XXV (5)
NE	New England	Murray et al. (1989)	Fraser et al. (1977)	Fraser et al. (1977)	81	i		XXV (4)
NE	New England	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	80, 81		U2, V3	XXV, XXVI, XXVII
NE	New England	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	80		V3	XXVI
NE	New England	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	81	e, g	V3	XXVII

Mega-element NQ

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Sub-domains	Wellman feature
BD	Brighton Downs	Wellman (1991)	Wellman (1988)	Murray et al. (1989)	88 (S margin)	j, h	I1
BD	Brighton Downs	Wellman (1991)	Wellman (1988)	Murray et al. (1989)	88 (S margin)	j, h	I1
BR	Broken River	Wellman (1992b)	Wellman (1995b)	Fraser et al. (1977)	91	a	V
BUR	Burdekin River	Wellman (1991)	Fraser et al. (1977)		91, 92	boundary region	R8
CE	Coen	Wellman (1991)	Fraser et al. (1977)		94	f	G1
CE1	Coen, Main	Wellman (1991)	Fraser et al. (1977)		94, 96	f: c, d	R1, R3-5
CE2	Coen, Laura	Wellman (1991)	Fraser et al. (1977)		96	d	R1, R3-5

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Sub-domains	Wellman feature
CHT	Charters Towers	Wellman (1992b)	Wellman (1995b)	Fraser et al. (1977)	91	b	W2, W3
CLR	Clarke River	Wellman (1992b)	Wellman (1995b)	Fraser et al. (1977)	91	a	W1
CY	Cape York-Oriomo	Fraser et al. (1977)			96	a	
DUT	Dutton	Wellman (1992b)	Murray et al. (1989)	Wellman (1988)	88 S margin	j, h	I1
GTN	Georgetown	Wellman (1992b)	Murray et al. (1989)	Fraser et al. (1977)	90, 91, 93	region of junction	R
HO	Hodgkinson	Wellman (1992b)	Wellman (1995b)	Murray et al. (1989)	92, 96	d	
HO	Hodgkinson	Wellman (1992b)	Wellman (1995b)	Murray et al. (1989)	92, 96	; d	S
KW	Keer-Weer	Wellman (1992b)	Fraser et al. (1977)		94	a	K
KW1	Keer-Weer, North	Wellman (1992b)	Fraser et al. (1977)		94	a	K
KW2	Keer-Weer, South	Wellman (1992b)	Fraser et al. (1977)		94	a	K
LR	Lolworth-Ravenswood	Wellman (1992b)	Wellman (1995b)	Murray et al. (1989)	91	a, b	W1
MAR	Marathon	Wellman (1992b)	Murray et al. (1989)	Wellman (1988)	88 S margin	j, h	I1
MAR	Marathon	Wellman (1992b)	Murray et al. (1989)	Wellman (1988)	88 (S margin)	j, h	I1

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Sub-domains	Wellman feature
N	Normanton	Wellman (1992b)	Fraser et al. (1977)		94	b, d, e, f	P, N4-5, Q, N
NCL	Claraville; Normanton	Wellman (1992b)	Fraser et al. (1977)		94	b, d, e, f	P
NCR	Croydon; Normanton	Wellman (1992b)	Fraser et al. (1977)		93	b, d, e, f	N4, N5
NMW	Max Walton; Normanton	Wellman (1992b)	Fraser et al. (1977)		90	a, part of b	Q
NWP	Weipa; Normanton	Wellman (1992b)	Fraser et al. (1977)		94, 95	b, d, e, f	N
TMI	Townsville-Mornington	Wellman et al. (1994)	Fraser et al. (1977)				
TMI1	Townsville-Mornington	Wellman et al. (1994)	Fraser et al. (1977)			weak	H
TMI2	Townsville-Mornington West	Wellman et al. (1994)	Fraser et al. (1977)			weak	H

Mega-element P

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Fraser et al gravity domains	Fraser et al. sub-domains
LU < LW	Leeuwin	Whitaker (1994)	Tucker & D'Addario (1986)	1	
NH	Northhampton	Fraser et al. (1977)		3, 2	b, c, d, e
NH	Northhampton	Wellman (1978)	Fraser et al. (1977)	3, 2	
NH	Northhampton	Wellman (1978)	Fraser et al. (1977)	2	c, e, f

Mega-element SA

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity	Fraser et al. sub - domains
AD	Adelaide	Gunn (1984)	Wellman (1988)		65	
AF	Albany-Fraser	Mathur & Shaw (1982)	Wellman (1978)	Wellman (1988)	10, 12, 13, 55, 56	
AF1	Whitaker (1994)	Tucker & D'Addario (1986)	Wellman (1978)	Wellman (1988)	10	
AF2	Albany-Fraser	Mathur & Shaw (1982)	Wellman (1978)	Wellman (1988)	12, 13 56, 57	-; a, b; 56 Wst; 57 wst
BC	Bancannia	Fraser et al. (1977)			66	c
BH	Broken Hill; Broken Hill	Tucker (1983)	Fraser et al. (1977)		65, 66	a
BHC	Covered [Willyama]; Broken Hill	Tucker (1983)	Fraser et al. (1977)		66	b
BHR	Redan; Broken Hill	Tucker (1983)	Fraser et al. (1977)		66	b
BHW	Willyama; Broken Hill	Tucker (1983)	Fraser et al. (1977)		65, 66	b
CK < WT	Cook	Fraser et al. (1977)			58	d

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity	Fraser et al. sub - domains
CN	Curnamona	Flint in Drexel et al. (1993)	Fraser et al. (1977)		65	c
CNP	Mount Painter; Curnamona	Flint in Drexel et al. (1993)	Fraser et al. (1977)		64	east
CO	Coompana	Flint in Drexel et al. (1993)	Fraser et al. (1977)		58	e, f
CPY << CPB	Coober Pedy	Fraser et al. (1977)			59	c
DEN	Denison	Fraser et al. (1977)			59	d (part of)
FR	Forrest	Fraser et al. (1977)			57, 58	
FR	Forrest	Fraser et al. (1977)				
G	Gawler	Parker in Drexel et al. (1993)	Fraser et al. (1977)	Daly et al. (1995	59, 60	
GCH	Christie; Gawler	Fairclough & Daly (1995)	Daly & Fanning in Drexel et al. (1993)	Daly et al. (1995)	59	a
GCL	Challenger; Gawler	Fairclough & Daly (1995)	Daly & Fanning in Drexel et al. (1993)	Daly et al. (1995)	59	b, a
GCL	Challenger; Gawler	Fairclough & Daly (1995)	Daly & Fanning in Drexel et al. (1993)	Daly et al. (1995)		
GCT	Coulta; Gawler	Fairclough & Daly (1995)	Daly & Fanning in Drexel et al. (1993)	Daly et al. (1995)	61	a, b
GFW	Fowler; Gawler	Fairclough & Daly (1995)	Daly & Fanning in Drexel et al. (1993)	Daly et al. (1995)	59	a
GMN1	Moonta; Gawler	Fairclough & Daly (1995)	Fraser et al. (1977)		61, 62	a, b
GMN2	Moonta; Gawler	Parker in Drexel et al. (1993)	Fraser et al. (1977)		63	c

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity	Fraser et al. sub - domains
GRV	Gawler Range; Gawler	Flint in Drexel et al. (1993)	Fraser et al. (1977)		62, 63	b
GRV3	Gawler Range; Gawler	Flint in Drexel et al. (1993)	Fraser et al. (1977)		63	b
GRV2	Gawler Range; Gawler	Flint in Drexel et al. (1993)	Fraser et al. (1977)		63	b
GRV1	Gawler Range; Gawler	Flint in Drexel et al. (1993)	Fraser et al. (1977)		62	
GSB	Streaky Bay; Gawler	Parker in Drexel et al. (1993)	Fraser et al. (1977)		61	a (part)
GWG	Wilgena; Gawler	Daly & Fanning in Drexel et al. (1993)	Fraser et al. (1977)		59	a
IT	Itiledoo	Parker in Drexel et al. (1993)	Fraser et al. (1977)		61	part of
KA	Kanmantoo	Wellman (1995b)	Brown et al. (1988)	Wang & Chamalaun (1995)	66, (68)	S, (W)
KA1	Kanmantoo, Main	Murray et al. (1989)	Wellman (1995b)	Brown et al. (1988)	66, (68)	S, (W)
KA2	Kanmantoo, Kangaroo Island	Gunn (1988)	Wellman (1995b)	Wang & Chamalaun (1995)	65	S
KA3	Kanmantoo, Robe	Gunn et al (1995b)	Wellman (1995b)	Brown et al. (1988)	68	part of
KR	Karari	Fairclough & Daly (1995)	Parker in Drexel et al. (1993)	Fraser et al. (1977)	59	c, d
MAD	Madura	Fraser et al. (1977)			13	c, d

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity	Fraser et al. sub - domains
MBC	Mabel Creek	Fairclough & Daly (1995)	Fraser et al. (1977)		59	c, d
MBCE	Mabel Creek	Fairclough & Daly (1995)	Fraser et al. (1977)		59	d
MBCW	Mabel Creek - Weat; Mabel Creek	Fairclough & Daly (1995)	Parker in Drexel et al. (1993)	Fraser et al. (1977)	59	c
ML	Muloorina	Fraser et al. (1977)			64	
MWD << MW	Mount Wood	Flint in Drexel et al. (1993)	Fraser et al. (1977)		59	c (part)
MWD << MW	Mount Wood	Flint in Drexel et al. (1993)	Fraser et al. (1977)			
NF	North Flinders	Fraser et al. (1977)			64	
NW	Nawa	Leven & Lindsay (1995)	Gunn (1984)	Daly & Fanning in Drexel et al. (1993)	59	e, f
PK	Peake	Parker in Drexel et al. (1993)	Fraser et al. (1977)		59	d (part of)
WG	Waigen	Fraser et al. (1977)			56, 58	a, b, c
WN	Wonominta	Murray et al. (1989)	Parker in Drexel et al. (1993)	Fraser et al. (1977)	66	d
WRC	Warriner Creek	Fairclough & Daly (1995)		Fraser et al. (1977)	59	d

Mega-element T

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity	Fraser et al. subdomai	Wellman feature	Murray et al. feature
AK	Anakie	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	83, (82)	a, b; a	S2	XX (2, 3), IX
BK	Bourke	Mathur & Shaw (1982)	Wyatt et al. (1980)	Wellman (1995b)	78		K1, K2, K3	XVI
BKC	Bourke Central; Bourke	Mathur & Shaw (1982)	Murray et al. (1989)	Wellman (1995b)	78		K2	XVI
BKE	Bourke East; Bourke	Mathur & Shaw (1982)	Murray et al. (1989)	Wellman (1995b)	78		K2	XVI
BKN	Bourke North; Bourke	Mathur & Shaw (1982)	Murray et al. (1989)	Wellman (1995b)	78		K1	XVI
BKS	Bourke South; Bourke	Mathur & Shaw (1982)	Murray et al. (1989)	Wellman (1995b)	78		K3	XVI
HG	Hughenden; Thomson	Fraser et al. (1977)	Wellman (1995b)		90	c (part of)	S1	
GLN	Glenelg	Wellman (1995b)	Murray et al. (1989)	Fraser et al. (1977)	67, (68)	SW, (NE)	M3	XII 1,2

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity	Fraser et al. subdomai	Wellman feature	Murray et al. feature
LE	Lachlan East	Murray et al. (1989)	Wellman (1995b)	Wyatt et al. (1980)	76, 78	a, b, c Est	R2, R3	XXI
LW	Lachlan West (Murray)	Murray et al. (1989)	Wellman (1995b)	Brown et al. (1988)	66, 69	a,b	N2, N3	XIII, XVII, XVIII
LW	Lachlan West	Wellman (1995b)	Murray et al. (1989)	Fraser et al. (1977)	76, 77, (69. 70)	a; b, (c)	N2, N3	XIII, XVII, XVIII
LW	Lachlan West (Gippsland)	Wellman (1995b)	Murray et al. (1989)	Fraser et al. (1977)	69			
MN	Meandarra; Lachlan East	Murray et al. (1989)	Wellman (1995b)		79, 82, (75, 84)	b, c; c;	U1	XXIV
MN	Meandarra; Lachlan East (Bowen)	Murray et al. (1989)	Wellman (1995b)		82		U1	XXIV
MN	Meandarra; Lachlan East (Sydney, Surat)	Murray et al. (1989)	Wellman (1995b)		79		U1	XXIV
TH	Thomson	Wellman (1995b)	Murray et al. (1989)		86,87		I2-4	IX, XIX
TH	Thomson (Warburton)	Wellman (1995b)	Murray et al. (1989)	Fraser et al. (1977)	86		I2-4	IX (16-20)
THM	Mitchell; Thomson	Mathur & Shaw (1982)	Murray et al. (1989)	Wellman (1995b)	84	Wst	K2	XVI

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity	Fraser et al. subdomai	Wellman feature	Murray et al. feature
WO	Wagga-Omeo; Lachlan West	Murray et al. (1989)	Wellman (1995b)	Fraser et al. (1977)	76	c, d	R1	XIV, XV
CHT	Charters Towers	Murray et al. (1989)	Wellman (1995b)					
CLR	Clarke River	Murray et al. (1989)	Wellman (1995b)					
HO	Hodgkinson	Murray et al. (1989)	Wellman (1995b)		92, 96	d		VII
LR	Lolworth-Ravenswood	Murray et al. (1989)	Wellman (1995b)		91	a, b	H2	VIII
MTFR	Forester: Mathinna	Murray et al. (1989)	Roach & Leaman (1996)		74 (73)	; E-margin		
MTLE	Lefroy; Mathinna	Murray et al. (1989)	Roach & Leaman (1996)		73 NE			
MT	Little Swanport; Mathinna	Murray et al. (1989)						
TY	Tyennan	Leaman et al. (1994)	Murray et al. (1989)	Fraser et al. (1977)	73 (part of), 72			XXII (part of)
TYR	Reed; Tyennan	Leaman et al. (1994)	Murray et al. (1989)	Fraser et al. (1977)	73 (part of)			

Mega-element WA

Note: Element AF (Albany-Fraser) is assigned to mega-element SA

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. subdomains
CP	Capricorn	Fraser et al. (1977)			16	
CPB	Bangemall; Capricorn	Fraser et al. (1977)			16, 9 (E)	
CPC	Collier; Capricorn	Drummond (1981)	Mathur & Shaw (1982)	Fraser et al. (1977)	16, 14	
CPE	East; Capricorn	Drummond (1981)	Mathur & Shaw (1982)	Fraser et al. (1977)	11	b
CPG	Gascoyne; Capricorn	Drummond (1981)	Mathur & Shaw (1982)	Fraser et al. (1977)	3	N parts of b, c, d, e, f
LD < YP	Lake Disappointment	Fraser et al. (1977)	Mathur & Shaw (1982)		15, 16 (NE), 11 (b-N)	
MV	Mount Vernon	Drummond (1981)	Mathur & Shaw (1982)	Fraser et al. (1977)	16, 14	
NBB	Nabberu	Drummond (1981)			8 (N)	
P	Pilbara	Fraser et al. (1977)			15	
P	Pilbara	Fraser et al. (1977)			15	
PHA < H	Hamersley: Pilbara	Fraser et al. (1977)			15	c
PS	Pilbara	Wellman (1978)	Fraser et al. (1977)		15	d

Sym	Name: used for crustal element symbol	Key Reference	Secondary Reference	Additional References	Fraser et al gravity domains	Fraser et al. subdomains
Y	Yilgarn	Whitaker (1994)	Wellman (1988)	Williams & Whitaker (1993)	4, 5, 6, 7, 8, 9, 11	
YEG	Eastern Goldfields; Yilgarn	Fraser et al. (1977)		Williams & Whitaker (1993)	58	d
YMC	Murchison; Yilgarn	Fraser et al. (1977)			5, part of 7	
YMR	Mulga Rock; Yilgarn	Whitaker (1994)	Wellman (1988)		11	a
YWG	Northam; Yilgarn	Fraser et al. (1977)			4, part of 6	
YSC	Southern Cross; Yilgarn	Fraser et al. (1977)				