The Australian continent is well endowed with many different classes of resources. The main concentrations of minerals occur in the cratons and the eastern Paleozoic fold belts (Figure 13.1). Whereas mineral sand deposits are to be found along current or former coastlines, such as in the Murray Basin.

In Figure 13.1 we superimpose the geological province boundaries on the resource locations. However, in many instances there is a more direct relation with the major crustal boundaries of Korsch and Doublier (2016). We therefore display more specific groups of resources in Figure 13.2 with these boundaries superimposed. In Figure 13.2 we also include the areas of hydrocarbon production, major black and brown coal deposits as well as oil shales. Most onshore hydrocarbon production is gas, with only a small amount of oil. Substantial quantities of oil have been produced from Bass Strait. On the North West Shelf, gas discoveries are now more significant than petroleum. Significant coal seam gas production is being made in the coalfields of eastern Australia. There is considerable further potential for the development of such unconventional energy sources in this area and across the vast Proterozoic basins of Australia.

**Key to commodities:**
- Al2O3—Alumina
- Brt—Barites
- Fl—Fluorite
- MgO—Magnesia
- Phos—Phosphates
- REE—Rare Earth Elements
- IIm—Ilmenite
- Rt—Rutile
- Zrn—Zirconia
- Dmd—Diamond
- Graph—Graphite

**Figure 13.1:** Distribution of major minerals and commodities across the Australian continent. Ores are indicated with the element symbol for the major economic constituent.
We have seen in Chapter 3 that uranium is widely distributed about the continent, but only moderate number of places reach viable concentrations for exploitation. Approximately one-third of the known world uranium reserves are in Australia, but only a limited number of mines are operational.

Gold deposits are widespread across the continent, with a number of major current and historical gold provinces. The prosperity of the state of Victoria was established with the 1851 gold rush in the Ballarat area. The largest current mine is the 'Super pit' in Kalgoorlie, Western Australia, which has been producing gold for more than a century.

There are extensive iron ore deposits in Australia, particularly in the Hamersley Basin of the Pilbara Craton. Iron ore is a major export commodity for the Australian economy with Port Hedland as the main port.

Much of the nickel deposits lie in the greenstone belts of the eastern Yilgarn Craton, which also hosts considerable gold. These belts have a clear expression in the gravity field, notably in the half-derivative (Figures 12.5–12.6).

Major base metal ore concentrations have been found in the Mt. Isa Province, in the Curnamona Province at Broken Hill and in western Tasmania.

Diamond pipes are concentrated around and within the Kimberley Block, with a very large-scale exploitation at the Argyle field. Minor finds of diamonds have also been made in the Capricorn Orogen, the New England Orogen and the Gawler Craton.

Figure 13.2: Different aspects of resources with the Korsch and Doublier (2016) major crustal boundaries.
Many of these diamond pipe locations occur close to strong gradients in seismic wavespeeds in the mantle, linking to structural edges or suture zones (Figure 13.3).

Graphite is produced mainly in the Eyre Peninsula, where its presence undoubtedly contributes to the significant electrical conductivity anomaly in this region (Figure 10.1). Graphite is also present in the Halls Creek Belt, which also shows a strong conductivity anomaly (Figure 10.2).

In Figures 13.3–13.7 we present different aspects of the geophysical fields with superimposed locations of major mineral resources. In each case we display the major crustal boundaries from Korsch and Doublier (2016) as a reference.

We start with the seismic wavespeed in the crust and mantle. In Figure 13.3, we display in the upper row the P wavespeed in the crust at 15 km depth, and in the lower row the S wavespeed in the mantle at 125 km. Both distributions are taken from the AuSREM model and use the primary wavespeed for each component of the lithosphere.

Many crustal materials have similar seismic wavespeeds. In the middle crust the seismic contrasts are moderate, and there is little direct correspondence with surface geological provinces. No consistent pattern emerges with resource location, though there is a tendency for known deposits to lie over areas with lower mid-crustal wavespeeds.

Figure 13.3: Mineral distribution relative to seismic wavespeed: upper row P wavespeed at 15 km, lower row S wavespeed at 125 km.
In the mantle, the fast S wavespeeds associated with the cratons are evident in Figure 13.3. Substructure in the mantle lithosphere tends to link to the major crustal units, particularly in the Yilgarn Craton. The locations of ore deposits seem to have their strongest association with gradients in the wavespeed structure.

In Figure 13.4 we compare the absolute gravity field and the Bouguer gravity anomaly, with the resource distributions.

As we would expect, the associations are more distinct with the Bouguer results, where fine-scale features are more readily perceived. Nevertheless, subtle variations in absolute gravity, such as the band of slightly lower values across the south of Arnhem Land, do seem to link quite well to a number of different classes of deposits.

The arcuate Bouguer gravity features around the Gawler Craton and to the north of the Murray Basin tie into a variety of styles of metallic ores. There are hints of similar gravity features under cover, particularly in the Thomson Orogen.

The greenstone belts of the eastern Yilgarn Craton, which host both major gold and nickel deposits, display significant gravity contrasts with a near north–south orientation.

Figure 13.4: Mineral distribution relative to the gravity distribution: upper row absolute gravity, lower row Bouguer gravity anomaly.
Figure 13.5 shows the resource distributions in relation to magnetic anomalies. In the upper row we use the total magnetic intensity, and in the lower row the spatial integral of the magnetic field.

Although there is the expected link between iron ores and areas of high magnetisation, many of the other commodities link well to the contrasts in the magnetic integral.

The magnetic integral senses deeper into the Earth than the magnetic field itself, and may therefore reveal magnetic relics of more deeply seated processes that control the surface location of deposits. It is also less sensitive to the details of patches of very high magnetisation.

As a result, some features become much more distinct with the magnetic integral. Thus the core of the Gawler Craton is very apparent, with deposits at or beyond its rim.

The truncation of the Mt Isa Province under cover by the Cork Fault appears to link into the eastern Arunta–Warumpi domain, again under cover. Both zones hint at potential for deposits in the continuation of outcrop structures.

Figure 13.5: Mineral distribution relative to the magnetic field: upper row total magnetic intensity, lower row spatial integral of magnetic anomaly.
In Figure 13.6, we use the ancillary fields introduced in Chapter 12 to discuss comparisons between gravity and magnetic behaviour. The upper row uses the spatial half-derivative of the gravity field, and the lower row the spatial half-integral of the magnetic field. These two fields have a more similar response to the depth of anomalies than the normal gravity and magnetic fields.

There are many similarities in the association of deposits with the two ancillary fields. But the orientation of the trends is not exactly the same and often deposits can be linked to zones where the trends cross (see Figure 12.7).

Alignments of deposit patterns with features of the gravity and magnetic fields are evident, as, for instance, in the Mt Isa Province and its extension under cover. Distinctive banding is also clear at the eastern edge of the Arunta Province with a likely undercover extension beneath the Eromanga Basin.

The abrupt truncation of magnetic trends against the Halls Creek Orogen resembles the southern edge of the Mt Isa Province, but in this case gravity signatures are muted.

*Figure 13.6: Mineral distribution relative to ancillary fields: upper row half-spatial derivative of gravity, lower row half-spatial integral of magnetic anomaly.*
In the final figure, Figure 13.7, we display the relationship of the resource distribution to the binary composite results introduced in Chapter 2. In the upper row we display the superposition of the half-derivative of gravity in red on the half-integral of the magnetic field in cyan. In the lower row we use the gravity field itself on the yellow channel, and the spatial integral of the magnetic field on a blue channel.

These displays bring to prominence textural features of the combined gravity and magnetic behaviour that are not easy to judge from individual field maps. Areas of rapid change in the orientation of the fields or where trends in the different fields cross frequently link to the location of deposits. An example is in South Australia around the location of the massive Olympic Dam copper/gold/uranium (Cu/Au/U) deposit. A similar behaviour is seen at the western edge of the Musgrave Province, where exploration has, so far, been limited.

**Figure 13.7**: Mineral distribution relative to composite fields: upper row gravity half-derivative and magnetic half-integral, lower row gravity and magnetic integral.