



NSW DEPARTMENT OF  
**PRIMARY INDUSTRIES**

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Photograph 7. Garnet used as skid-resistant aggregate in bus lane surface, Sydney Harbour Bridge. (Photographer H. Ray)

## Potential and Outlook

Although New South Wales is currently only a minor producer of garnet there is good potential for the discovery and development of further resources. These could supply the eastern Australian abrasives market, which currently relies mainly on copper slag.

The Willyama Supergroup (within the Broken Hill and Eurioiwie Blocks) (Figure 11) contains extensive areas of garnet-bearing metamorphic rocks. These areas appear to be the most prospective parts of the state for garnet deposits, particularly almandine, which is the most commercially important garnet mineral.

Detailed 1:25 000 scale geological mapping of the Broken Hill region has been undertaken by the Geological Survey of New South Wales. This mapping provides data on the distribution of garnet-rich rocks (Figure 11) within the Willyama Supergroup and can be used as a valuable exploration tool.

There may also be potential for the recovery of garnet as a by-product of future mining of placer mineral sands deposits in the Murray Basin (Figure 1), particularly in areas near the Broken Hill Block. There has been no assessment of the potential for such deposits.

Potential also exists for the development of resources of andradite and grossular garnet within skarn deposits in the Bathurst–Orange district (Figure 9), particularly at Mount Tennyson (near Yetholme) and Gumble. There is also potential for the identification of further garnet-bearing skarn resources in the Lachlan and New England orogens (Malloch 2004).

The tailings dumps at the major silver–lead–zinc mines at Broken Hill contain large quantities of garnet. The garnet would be a by-product of any future extraction of the large quantities of fluorite present within the dumps (see chapter on fluorite).

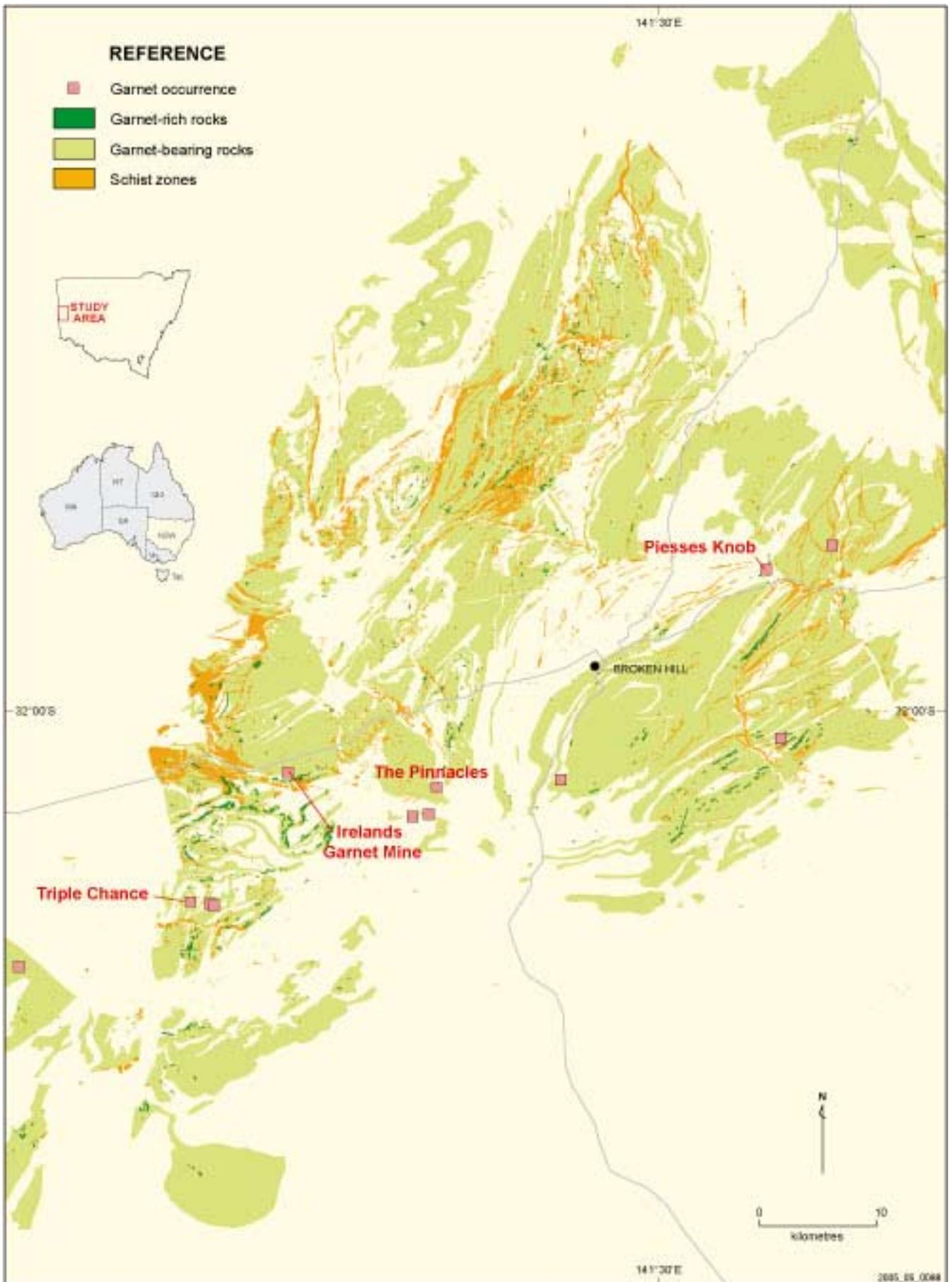


Figure 11. Garnet occurrences and garnet-bearing rocks in the Broken Hill area

## Nature and Occurrence

The name garnet is applied to a group of complex silicate minerals with broadly similar physical properties but variable colour, hardness and chemical composition. The principal members of the group are listed in Table 12.

**Table 12. Common garnet minerals**

Mineral	Formula	Hardness	SG
Almandine	$\text{Fe}_3^{2+}\text{Al}_2(\text{SiO}_4)_3$	7.0–7.5	4.1–4.3
Grossular	$\text{Ca}_3\text{Al}_2(\text{SiO}_4)_3$	7.0	3.4–3.6
Pyrope	$\text{Mg}_3\text{Al}_2(\text{SiO}_4)_3$	6.5–7.5	3.5–3.8
Spessartine	$\text{Mn}_3\text{Al}_2(\text{SiO}_4)_3$	7.0–7.5	3.8–4.3
Andradite	$\text{Ca}_3(\text{Fe}^{3+}, \text{Ti})_2(\text{SiO}_4)_3$	6.5–7.0	3.7–4.1
Uvarovite	$\text{Ca}_3\text{Cr}_2(\text{SiO}_4)_3$	6.5–7.0	3.4–3.8

Source: Harben and Kuzvart (1996)

Garnet is a common accessory mineral in a wide variety of metamorphic rocks, particularly schists, gneisses, metamorphosed carbonate rocks and in some igneous rocks, including pegmatites, kimberlites, serpentinites and eclogites. Because of its resistance to physical and chemical breakdown, garnet also occurs as a detrital mineral in sedimentary deposits.

Almandine and, to a lesser extent, andradite, are the main varieties of commercial significance. Almandine is generally preferred because of its greater hardness and durability.

Although garnet is a common mineral, large economically viable deposits of high-quality garnet are relatively rare. Commercially significant deposits of the preferred variety, almandine, generally occur in schists and gneisses formed by the regional metamorphism of pelitic rocks, or as placers derived from such rocks.

Garnet is a common constituent of skarn deposits. However, the garnet in such deposits is typically andradite or grossularite (which are regarded as inferior to almandine).

### Deposit Types

Placer deposits (alluvial and marine), principally in Australia, India and the USA, are the source of the majority of the world's garnet production. Major

deposits include the Port Gregory deposit in Western Australia; Fernwood, Idaho; and coastal deposits in Tamil Nadu and Orissa states in India, where garnet is a by-product of mineral sands mining.

Important metamorphic garnet deposits occur in New York and Maine in the USA, and include the Gore Mountain deposit (an almandine-bearing diorite of uncertain origin). This deposit is considered to be the source of the world's highest quality industrial garnet (Austin 1994). Other major deposits include Wingdale, Willsboro and Rangely.

Igneous deposits are also mined in some countries. One of the major deposits of this type is an almandine-rich eclogite intrusion mined at Dong Hai in China.

## Main Australian Deposits

World production of garnet in 2004 was 283 200 tonnes (Table 13) (Olsen 2005). Australia produces almost half of the total world garnet production, about 130 000t. India, the USA, and China account for most of the remainder.

**Table 13. World garnet production 2004**

Country	Production (tonnes)
Australia	130 000
India	64 000
USA	29 700
China	28 000
Other countries	31 500
<b>Total</b>	<b>283 200</b>

Source: Olson (2005)

The major current source of garnet in Australia, and the largest garnet producer in the world, is the Port Gregory deposit, near Geraldton in Western Australia. The garnet occurs in placer deposits within a coastal dune system of Holocene age. The mineralised zone is 12 km long and contains more than 4 Mt, with grades of about 35% almandine garnet. The source of the garnet is a nearby area of garnet-rich gneissic rocks of Archaean age (Fetherston 2002).

Minor amounts of garnet are produced as a by-product of mineral sands mining in Western Australia and

garnet has been mined on a comparatively small scale at a number of other locations throughout Australia from metamorphic deposits.

At Harts Range, near Alice Springs in the Northern Territory, alluvial deposits associated with streams draining an area of garnet-bearing gneisses and amphibolites contain up to 18% garnet. These deposits have proven and probable reserves of 2.3 Mt of almandine garnet, which is suitable for producing a wide range of abrasives (Olympia Resources pers. comm. 2005). Mining is expected to begin in late 2007 or early 2008.

## New South Wales Occurrences

There are 194 recorded occurrences of garnet in New South Wales (Ray et al. 2003). Varieties include almandine, andradite, grossularite and spessartine.

The only significant known almandine occurrences are garnet-bearing schists in the Broken Hill Block. Deposits mined in the Pinnacles area, southwest of Broken Hill, by Unimin Australia Ltd and processed at the Triple Chance Mine (Figure 11) are the only current source of garnet in the state.

Detailed geological mapping by the Geological Survey of New South Wales in the Broken Hill area has identified widespread occurrences of garnet-rich rocks, including schists, calcsilicate rocks, gneisses, amphibolites and garnet-quartz rocks and garnet-hematite/magnetite rocks associated with lead-zinc and iron-copper mineralisation (Stevens & Stroud 1983). Some of these rocks may contain up to 80% garnet. Garnet compositions vary considerably. Almandine garnet occurs in chlorite schists formed as a result of retrograde metamorphism of mafic gneiss. Spessartine and grossular garnet appear to be the most common varieties in the garnet gneisses and garnet-quartz rocks, whereas the garnet in the calcsilicate rocks has a high grossular component. They include fine-grained rocks, known locally as 'garnet sandstone', that consist predominantly of garnet with minor quartz and other minerals, and medium- to coarse-grained rocks known locally as 'garnet quartzite'. They generally occur as small lenses but larger examples are known, e.g. at Piesses Knob, which is over one kilometre long and up to several metres thick.

Garnet-bearing skarn deposits containing andradite or grossularite occur in a number of areas in eastern New South Wales, particularly in association with Carboniferous and Devonian granites in the Lachlan Orogen. Substantial resources have been identified in skarns associated with Early Devonian and Carboniferous granites in the Orange-Bathurst district (Figure 9) at Gumble and Yetholme (Mount

Tennyson) (Alexander 1997). There is potential for more occurrences in limestone-bearing sequences adjacent to oxidised, sometimes fractionated granites of the Siluro-Devonian Boggy Plains Supersuite and Bega Batholith in southeastern New South Wales, and Carboniferous granites in the Central West region (Malloch 2004). At the Whipstick molybdenite deposit northwest of Eden, spessartine garnet occurs in mineralised pipes within albitised and greisenised granite of the Bega Batholith at and near its margin (Plimer 1968).

Garnet-bearing skarns also occur in the New England Orogen, particularly in the Attunga area, where eleven occurrences are associated with granites of the Moonbi Supersuite (Malloch 2004).

There are very large deposits of garnet and fluorite in tailings dumps at the major silver-lead-zinc mines at Broken Hill which may be a potential source of garnet if recovery of the fluorite proves to be economic.

## Applications

Garnet's most commercially important properties are its hardness, inertness, and resistance to degradation. Major uses are as an abrasive and filtration medium. Specific abrasive applications include sandblasting, water-jet cutting, coated abrasives and polishing. Abrasive blasting is the main area of growth because of increasing restrictions on use of silica and slags for health and safety reasons (Harben 1999).

Minor uses include skid-resistant paints and surfaces (Photograph 7), and as filler material in high-density concrete where chemical inertness is important (e.g. marine environments).

Almandine is preferred for most applications because of its superior physical and chemical characteristics, which increase the extent to which it can be recycled. Andradite is the only other variety generally considered to be of commercial significance but is regarded as inferior in performance to almandine. Garnets from skarn deposits (commonly andradite) are reported to have a tendency to brittleness, leading to physical breakdown and dusting (Harben & Kuřvart 1996).

## Economic Factors

Demand for garnet is expected to continue to grow steadily. Most of the growth is occurring in abrasive applications because of garnet's superior performance and non-hazardous nature (Olson 2005). However, because of its higher cost, garnet still has a relatively small share of the abrasives market.

There is scope for blending industrial-grade garnet with other minerals (e.g. hornblende) to produce abrasives suitable for blast cleaning.

The market, especially for the finer grades of garnet, has been oversupplied in recent years and is highly competitive (White 1999; Olson 2005).

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