Photograph 15. Tallawang magnetite mine, Gulgong. The Tallawang mine is the sole producer of magnetite in the state. The magnetite is used almost entirely by the New South Wales coal mining industry during coal beneficiation. When finely milled, magnetite remains suspended in water, producing a dense medium suitable for separating impurities from coal. The magnetite is easily recovered by applying a magnetic field. (Photographer I. Paterson)

Potential and Outlook

There is good potential for commercial magnetite deposits in New South Wales, principally in skarns within aureoles of high-temperature granites. There are many known occurrences in the Lachlan and New England orogens (Figure 16). Newly available high-resolution aeromagnetic data over most of the prospective areas should allow opportunities for such deposits to be readily assessed.

In the Lachlan Orogen, numerous, scattered skarn-related magnetite occurrences are associated with Ordovician and Silurian–Devonian mafic plutons intruding dolomite and limestone sequences. In the New England Orogen, prospective areas include the Fine Flower (Figure 16), Lionsville and Mount Gilmore areas (Clarence River Supersuite) and Moonbi Supersuite granites.

Magnetite-bearing andesitic volcanic rocks near Tamworth, quartz–magnetite and magnetite–pyrite rocks in the Broken Hill region, and Carboniferous placer deposits in the Tamworth Belt, may also have some potential for magnetite deposits. There may also be some potential for extracting small amounts of magnetite from maghemite, an iron-rich duricrust extensively developed in western New South Wales.

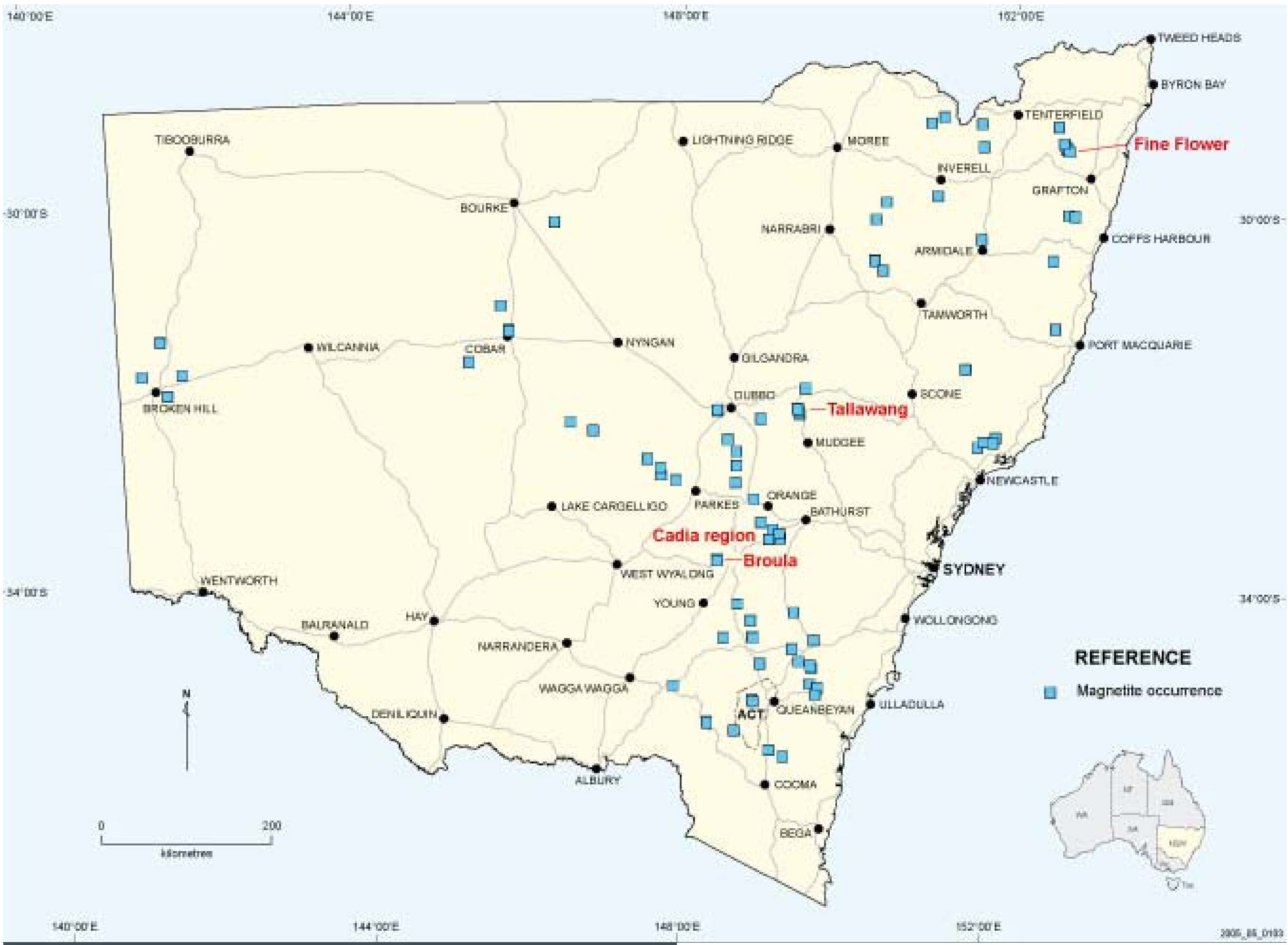

Figure 16. Magnetite occurrences in New South Wales

Nature and Occurrence

Magnetite (Fe_3O_4) is a common, highly magnetic, black opaque mineral with a metallic lustre and a high specific gravity (4.9–5.2).

Magnetite occurs as an accessory, or in segregations, in igneous rocks, in skarns, and in association with sulphide mineralisation. It also occurs in sedimentary iron deposits (banded iron formations) and as detrital grains in placer deposits. In addition, magnetite can be a product of metasomatic alteration of impure limestone. Commercially significant deposits include magmatic segregations, skarns and placer deposits.

Although magnetite usually occurs as a minor mineral in most igneous rocks, it can be concentrated owing to accumulation in magmatic segregations that develop in response to fractional crystallisatisation.

The largest commercial deposits of magnetite in the world are in the Kiruna area in Sweden and are estimated to exceed 2000 Mt (Nystrom & Henriquez 1994). The deposits consist of concordant to subconcordant, steeply dipping tabular and pipe-like magnetite–apatite bodies and dykes in Palaeoproterozoic trachyandesite lavas, felsic and intermediate–mafic volcanic rocks. The tabular shape, association with subaerial volcanic rocks, presence of ore breccia and other features indicate that Kiruna-type magnetite deposits were derived from iron-rich magmas through fractional crystallisation.

Magnetite occurs as cumulate deposits within layered ultramafic–mafic intrusions, such as the Bushveld Complex in South Africa, which are important sources of chromium, vanadium and platinum group metals.

The Bushveld Complex contains more than twenty titaniferous magnetite layers of considerable lateral extent (Cawthorn & Molyneaux 1986). Magnetite concentrate from the Bushveld deposit is processed to recover vanadium, which occurs in solid solution.

Magnetite is commonly found in skarns and is the dominant mineral in some occurrences. These skarns are associated with the intrusion of iron-rich gabbro or diorite into volcaniclastic limestone-rich sequences or the intrusion of granodioritic to granitic plutons into dolomite (Meinert 1992; Ray 1995).

Fluvial and marine (beach) placer deposits may contain significant concentrations of magnetite, in addition to various other heavy minerals (Force 1991). Fluvial placers are highly variable, typically thin, lens-shaped deposits (Levson 1995; Levson & Giles 1995). Beach placers, in contrast, tend to contain much larger resources of heavy minerals, primarily because of their development over long distances, greater thicknesses and generally higher grades (Whitehouse et al. 1999).

Magnetite is a major component of the heavy minerals assemblage in beach placer deposits of Holocene age in coastal India (Nagamalleswara 2003). Australian beach placers, which are typically dominated by rutile, zircon, ilmenite and altered ilmenite, do not contain economic concentrations of magnetite (Whitehouse et al. 1999).

Main Australian Deposits

The most important Australian deposits of magnetite are Tallawang in New South Wales and Savage River in Tasmania, which are skarn deposits. Proterozeric landed iron formations in the Hammersley iron-ore province in Western Australia also contain large resources of magnetite.

The Savage River deposit has magnetite resources exceeding 100 million tonnes, and consists of massive magnetic-pyrite ores in volcanogenic rocks of Precambrian age (Evans 1993).

The Tallawang magnetite deposit currently produces about 40 000–50 000 tonnes of magnetite concentrates per annum (Unimin Australia Ltd pers. comm. 2004), almost entirely for use in coal washery dense medium separation circuits by the New South Wales coal industry. Small amounts of the magnetite are also used in applications involving the shielding of radiation X-ray equipment in hospitals.

New South Wales Occurrences

Skarns are the most important settings for commercial magnetite occurrences in New South Wales (Lishmund et al. 1999; Malloch 2004). They are most likely to occur within aureoles of high-temperature granites (L.M. Barron pers. comm. 2003). In the Lachlan Orogen, numerous, scattered deposits of skarn-related magnetite are associated with Ordovician and Silurian–Devonian felsic plutons intruding dolomite and limestone sequences.

The Tallawang magnetite deposit (Figure 16, Photograph 15) consists of two major zones of magnetite that formed in the Silurian Dungeree Volcanics, adjacent to the western boundary of the deformed Tallawang Granite, a sill-like microgranite of probable Early Permian age (Downes 1999). The Tallawang skarn deposits have a complex geological history. Recent investigations indicate the skarn is related to earlier, more mafic, intrusions (Seccombe et al. 2000).

Apart from the Tallawang deposit, which has magnetite resources of several million tonnes (Unimin Australia Ltd pers. comm. 2004), other deposits in New South Wales are small and of generally low grade (Nicholson 1967; Henley et al. 2001). The more significant occurrences are the Cadia region south of Orange, the Broula iron mine deposit near Cowra, and the Fine Flower magnetite deposits near Grafton (Figure 16). Magnetite has also been reported at a number of other localities, including lead–zinc skarns at Leadville and skarn-like assemblages in the Cuga Burga Volcanics near the Yeoval Complex (Downes 1999).

Iron ore totalling about 1.5 Mt (approximately 50% iron) was mined from low-grade copper–gold deposits in the Cadia region (Little Cadia and Big Cadia) (Pogson & Watkins 1998). These deposits consist of stratabound hematite–magnetite skarns associated with an Ordovician porphyry system. Iron ore mining ceased about 1945.

The Broula area (Figure 16) hosts several minor skarn sulphide copper–gold and iron occurrences, of which the Broula iron mine deposit is one of the more significant (Nicholson 1967). This deposit consists mainly of hematite, with magnetite and limonite, developed in hornfels and metamorphosed limestone within the Early Silurian Canowindra Volcanics (Cudal Group), which has been intruded by the Late Silurian Young Granodiorite (Pogson & Watkins 1998). The Broula iron mine deposit contains an iron ore resource of about 955 000 tonnes, of which 700 000 tonnes are considered amenable to surface mining (Earth Resources Australia Pty Ltd 1971). Recent investigations have increased the estimated size of the magnetite resource to about 1 300 000 tonnes (R.W. Corkery and Company Pty Ltd 2007).

In the New England area, a number of small deposits of magnetite occur in skarns near granitic intrusions emplaced in calcareous and basaltic rocks. In some cases, the deposits, most notably the Fine Flower deposits, near Grafton (Figure 16), have been intermittently mined to obtain magnetite for use in coal washeries and hematite for cement manufacture (Henley et al. 2001). The Fine Flower deposits occur in hornfelsed rocks of the Silverwood Group that have been intruded by the Late Permian Dumbudgery Creek Granodiorite (Clarence River Supersuite). They consist of several distinct deposits with total estimated resources of about 175 000 tonnes at an average grade of 65% iron. This area, particularly between the Fine Flower deposits and nearby Iron Mountain, remains prospective for additional magnetite occurrences, particularly for use in cement manufacture.

Late Devonian rocks in the vicinity of Keepit Dam, near Tamworth, specifically the Mostyn Vale Formation, are rich in magnetite-bearing andesitic volcanic rocks. Their potential for magnetite deposits has yet to be assessed.

Two magnetite-bearing skarns, the Bonshaw magnetite deposit and the Ashford Caves magnetite deposit, which are associated with the Bundarra Supersuite, occur near northern New South Wales (Henley et al. 2001). Their magnetite content is low (below 30%), difficult to extract and considered unsuitable for use in dense media separation owing to its generally poor quality.

Titanomagnetite-bearing placer deposits, up to several metres thick and extending over distances of up to several kilometres, occur in Carboniferous sedimentary rocks of the Caroda Formation in the Tamworth Belt (Brown et al. 1992; Brown & Stroud 1997). Examples include the Doshens and Mihi magnetite prospects. None of the occurrences have been evaluated in any detail but samples that have been tested are apparently unsuitable for use in coal washing.

Stratiform quartz–magnetite deposits, and magnetite–pyrite deposits related to intrusive granitoids, are common in the Broken Hill area (Barnes 1988). Quartz–magnetite occurrences which range from small lenses up to bodies over 5 m wide and more than 2 km in length, occur in host rocks that are most commonly well-bedded plagioclase–quartz rocks of the Thackaringa Group. Magnetite–pyrite occurrences related to granitic intrusive rocks are common in the western Broken Hill Block. Several of the larger deposits (e.g. Iron Duke) have been mined in the past as a source of ironstone flux.

Applications

Magnetite, together with other iron oxide minerals, is mainly used in the production of iron and steel. As an industrial mineral, its major use is as a dense medium in mineral processing, commonly in coal preparation. Its suitability for this application is related to its high density and recoverability by magnetic separation for recycling (Pettifer 1981).

Global consumption of magnetite in non-metallurgical uses is not precisely known because magnetite production is commonly reported with other iron oxides such as hematite.

In Australia, the major commercial application for magnetite is in the dense-medium washing process used in most coal preparation plants (Doral Resources NL 1990). This requires a suspension of finely milled magnetite in water. Magnetite is particularly well-suited to this application, because of its high density and recoverability by magnets for recycling (Evans 1993). Magnetite for coal washing must be of overall high purity and be devoid of contaminants, such as hematite, sulphides or other gangue minerals. Magnetite is reasonably durable (and therefore does not readily break down to a slime), and is chemically stable during mineral processing (Pettifer 1981). It is also non-fouling, which means that even if small amounts become incorporated with washed products, subsequent treatment stages should not be adversely affected.

Milled magnetite from Tallawang is a high-purity magnetic iron oxide containing more than 95% magnetite (Weekes & Robertson 1993). Magnetite ranging in grainsize from coarse to ultrafine is produced. Different grainsizes are produced to suit the somewhat different requirements for centrifuge-assisted dense-medium coal-preparation processes and those for bath or drum-style processes.

Other uses for magnetite include ferrite ceramic magnets, concrete aggregates, cement additives, pigments and as an agent for increasing the density of drilling fluids.

Economic Factors

In Australia, future growth in industrial magnetite usage will be mainly dependent on demand for magnetite in coal preparation operations, which currently use about 100 000 tonnes of magnetite per annum. Approximately 80 000 tonnes is consumed in coal preparation plants in New South Wales. The Tallawang mine supplies the majority of the state's requirements. About 30 000 tonnes of magnetite per year are also obtained from the Savage River deposits in Tasmania. The Tallawang mine probably has sufficient resources of magnetite to satisfy long-term coal preparation demands of the New South Wales coal mining industry (Lishmund et al. 1999). However, the rapid growth in coal production in recent years could allow the Broula deposit to become a viable magnetite producer.

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