Potential and Outlook

Global resources of chromite are measured in billions of tonnes. Despite the abundance of chromite, commercial deposits are rare. Depending on their physical and chemical properties even small depostits can be commercially viable.

Stratiform deposits in ultramafic rocks are the dominant commercial source of chromite, with nearly all world production coming from such deposits. Podiform and vein deposits tend to be smaller than the cumulate type, and are less important commercially. South Africa accounts for 46% of world production.

Only minor production of chromite, from small podiform deposits, has occurred in Australia. All known deposits in New South Wales are relatively small podiform deposits associated with serpentinites or other ultramafic rocks (Photograph 3) (Figure 6). These deposits are believed to represent cumulate segregations that were caught up in ultramafic bodies as solid inclusions and disrupted into isolated, small pods during emplacement. The largest deposit of this type in the state is near Bingara, associated with a large serpentinite body. There, several separate chromite pods and chromite float occur over a considerable area.

A large, low-grade lateritic deposit of chromium, nickel and platinum has been defined at shallow depths in the Flemington intrusion, part of the Tout Intrusive Complex near Fifield (Figure 6). This intrusion contains a core of ultramafic rocks, principally dunite, with an outer shell of gabbro and hornblende-rich rocks. Chromite grains are present in local 1–2 cm thick bands that contain more than 30% chromite. Some platinum enrichment is also present. There is the possibility of larger cumulate-style chromite deposit being present. Using a cut-off grade of 2.5% chromite, an indicated lateritic resource of almost 6.9 Mt at 4.31% chromite has been defined, although the feasibility of extracting chromite ore and other metals is unknown (Noble Resources NL 1994).

Mapping by the Geological Survey of New South Wales in the Cowra Trough has identified chromite concentrations in the Late Ordovician Kabadah Formation (Barron & Warren 1998; L.M. Barron pers. comm. 2001) (see later discussion).

Photograph 3. Part of Quilters East chromite workings, Cootamundra. The deposit is highly variable, intensely fractured podiform chromite within poorly to unfoliated dunite of the Coolac Serpentine Belt. Chromite is the sole commercial source of chromium, which is mostly converted to one of several alloys for use in specialty steels. (Photographer P. Downes)

Nature and Occurrence

Chromite is the general name given to the chromium-bearing spinels, which have the general formula $Mg,Fe^{2+})(Cr,Al,Fe^{3+})_2O_4$. The end members of this group are magnesiochromite ($MgCr_2O_4$) and ferrochromite ($FeCr_2O_4$). Chromite, the only commercial ore mineral of chromium, is only found in primary form in ultramafic rocks such as peridotite, dunite, pyroxenite, and in altered derivatives such as serpentinite.

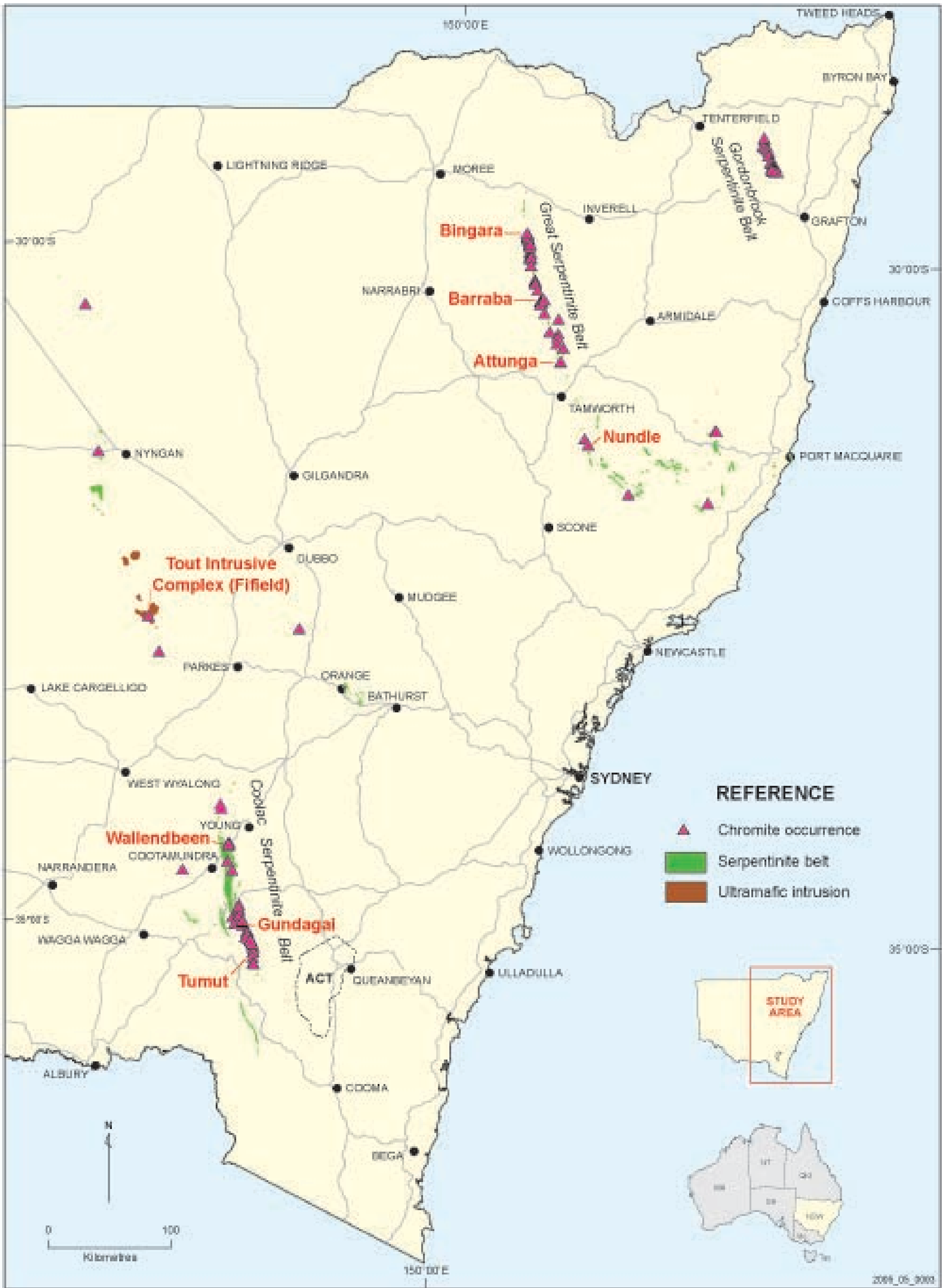

Figure 6. Chromite occurrences and prospective rocks in New South Wales

There are two main types of chromite deposits (Harben & Kužvart 1996):

- Stratiform, or layered, deposits. These result from fractional crystallisation of chromite within mafic and ultramafic layered igneous intrusions. Chromite spinel is one of the first minerals to crystallise and, being denser than the host magma, sinks and settles within the magma chamber. Homogeneous layers of chromite-rich horizons form, generally with well-defined boundaries. Although the compositions of separate chromite seams may differ, individual layers have been found to be extremely homogeneous. Even though thickness may vary significantly, many seams can be traced over great distances.
- Podiform, or Alpine-type, chromite deposits. These occur as pods, lenses and many other types of irregular shapes near the margins of serpentinites. They are thought to have formed in the upper mantle in peridotites which crystallised in oceanic lithosphere and were emplaced as ophiolite sequences. They may be tabular or occur in layers, but are differentiated from the stratiform deposits by their irregular development and, in many places, the lack of a systematic distribution pattern within the host rock.

World resources of chromite are estimated to exceed 12 billion tonnes (Papp 2005). World reserves are 810 Mt, and global production in 2004 was 17 Mt.

Four countries (South Africa, India, Kazakhstan and Turkey) account for about 80% of world production. South Africa is responsible for more than 46% of global production and has been a major supplier of chromite ore and ferrochromium to Western industrialised countries. Other countries with significant production include Brazil, Iran and Madagascar.

Main Australian Deposits

There has been comparatively little production of chromite in Australia, which was mainly from New South Wales up to the mid-1900s. More recently, significant deposits have been found at Coobina, in northern Western Australia, where numerous massive lenses of chromite are associated with ultramafic rocks within Archaean granites (Consolidated Minerals Ltd 2001). The Coobina chromite deposit contains a chromite resource of 1.96 Mt (to a depth of 30 m). Extensive alluvial resources of chromite have also been identified nearby. The Coobina Chromite Project production capacity (2007) is 250 000 tpa of chromite ore. It is considered highly suitable for the stainless steel industry (Consolidated Minerals Ltd 2007).

New South Wales Occurrences

There are 169 recorded occurrences of chromite in New South Wales (Ray et al. 2003). These occurrences are mainly in the New England region and in southern New South Wales (Figure 6).

Nearly all known occurrences of chromite in New South Wales are associated with serpentinites or other ultramafic rocks (Figure 6). They occur as:

- small pods up to 30 m long by 10 m across;
- narrow veins with connected trains of pods; and
- lenticular masses that have been deformed to form wide bands parallel to foliation in sheared serpentinite.

There has been no production of chromite in Australia for over thirty years. New South Wales produced a total of about 48 000 tonnes of chromite between 1882 and 1958 (Flack & Suppel 1969). The most significant areas of production were associated with: the Coolac Serpentinite Belt (Tumut, Gundagai and Wallendbeen areas); the Great Serpentinite Belt (Nundle, Attunga, Barraba, and Bingara areas); and the Gordonbrook Serpentinite Belt near Fine Flower (Flack & Suppel 1969). The main features of each province (Figure 6) are summarised below:

- The Coolac Serpentinite formed as oceanic crust and was deformed and disrupted during the Late Silurian to early Middle Devonian. Pods of chromite, although distributed throughout the Coolac Serpentinite, are more common in the northern part. In a typical pod, closely packed massive chromite ore merges peripherally into open-textured disseminated mineralisation. The chromite pods can be categorised into two groups: olivine-bearing chromitites containing Cr-rich chromite ores; and clinopyroxene-bearing chromitites contain Al-rich chromites. The composition ranges are similar to those of Alpine-type (podiform) deposits.
- The Great Serpentinite Belt is developed along the Peel Thrust and extends southeasterly from near Bingara, through Barraba to Bowling Alley Point, near Nundle. Chromite occurrences are widespread but small, the three largest deposits each having produced only about 2000 tonnes. The majority produced less than several hundred tonnes each (Brown et al. 1992; Brown & Stroud 1997). All deposits occur in schistose serpentinite as single or multiple lenses, which are in linear trains or stacks, and dip subvertically. Some of the trains are connected by thin, vein-like aggregates of chromite.
- The Gordonbrook Serpentinite extends for about 30 km from Fine Flower to Ewingar near Baryulgil

in northeastern New South Wales. The main chromite deposits are concentrated in the southern parts of the Gordonbrook Serpentinite, although minor occurrences are noted elsewhere (Henley et al. 2001).

Several near-circular Alaskan-type mafic to ultramafic intrusions of Devonian age, the Tout Intrusive Complex, intrude the Cambrian–Ordovician Girilambone Group near Fifield (Figure 6). Two zones of mineralisation are recognised: a primary zone of platinum, chromium, nickel and cobalt in the main dunite core zone; and a secondary zone of thick ferruginous laterite of probable Tertiary age containing a potential resource of platinum, chromium, nickel and cobalt that overlies the dunite (Noble Resources NL 1994).

Chromite concentrations of up to 1% chromite have been identified by the Geological Survey of New South Wales in basal units of the Late Ordovician Kabadah Formation of the Cowra Trough (Barron & Warren 1998; Meakin & Morgan 1999; L.M. Barron pers. comm., 2001). The chromite grains are in ultramafic detritus in sandstone in the Kabadah Formation and are thought to have been derived either from weathering of obducted ophiolite basement or an oceanic island serpentinite diapir (Barron & Warren 1998). Analysis shows that these chromites are exceptionally pure, with up to 60% Cr_2O_3. Such levels are rare and are comparable with chromites from ultramafic intrusions in Kamchatka, Russia. The locality at which the samples with the highest purity occur coincides with aeromagnetic anomalies in an area of poor outcrop north of Cumnock, and may be worthy of further investigation.

Applications

The main uses of chromite are in the production of stainless steel, chemicals, pigments, refractories and foundry sands (Maliotis 1996). Although the ferrochrome market drives chromite supply, so-called 'special grades' of chromite find important application in refractories, chemicals and foundry markets. High-alumina chromite, largely from podiform ores, is used in refractory applications whereas iron- and chromium-rich ores, largely from stratiform deposits, are used in metallurgical and chemical applications.

The production of ferrochrome, the main component of stainless steel, accounts for approximately 75% of the world's chromite usage. The other 25% is used in the manufacture of chemicals, pigments (colour and corrosion inhibition) and refractories. Chromite ore cannot be substituted in the production of ferrochromium, chromium chemicals, or chromite refractories. However, chromite refractories have been in a decreasing demand cycle as industrialised nations alter their ferrochrome and stainless steel production methods to those that no longer require the use of chromite refractories.

Economic Factors

Production of chromite ore on a world scale is essentially driven by demand in the ferrochrome industry, and is a major factor influencing demand in the chemical, refractory, and pigment markets. Strong demand for ferrochrome for use in stainless steel manufacture is currently putting pressure on the supply of chromite for non-metallurgical uses.

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