



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

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Potential and Outlook

Iron oxide pigments were extracted on a minor scale in New South Wales until the 1960s from deposits consisting of coloured clays and lateritic ironstones/gossans. In general, the deposits were small and of variable quality. Little work has been done on the geology of the pigment deposits in New South Wales since a report by Raggatt (1925) was compiled at a time when it appeared that the industry was at its peak.

Ironstones and gossans occur throughout much of the state. There is moderate potential for small to moderate-sized deposits that may be suitable for use as pigments. There may be some potential for extracting iron oxide from maghemite, an iron-rich duricrust extensively developed in western New South Wales.

Nature and Occurrence

Natural iron oxides occur widely and are obtained from a variety of deposit types. Sedimentary iron ore deposits are the main source of hematite, although it is also obtained from hydrothermal, metamorphic and volcanic deposits. Magnetite is associated with mafic and ultramafic rocks or skarn-type metamorphic deposits. Limonite, ochre, sienna, umber and goethite occur in gossans and are essentially weathering and/or alteration products of iron ores, sulphide minerals or other iron-rich rocks (Harben & Kužvar 1996).

Weathered iron ore deposits are the main source of ochre in India, which is the largest producer of natural iron oxides. Umber is produced in Cyprus from deposits that are believed to have formed by precipitation from seawater on the ocean floor. Cyprus also produces considerable amounts of ochre from oxidised massive sulphide ore bodies (Harben & Kužvar 1996).

Magnetite deposits are a common source of black pigments—as well as red and yellow ochres which can form as weathering products of the original magnetite.

Umber and ochre are mined in Georgia, USA, from deposits formed by deep leaching of carbonate rocks by meteoric water (Harben & Kužvar 1996). Specularite, a micaceous iron oxide, is sought for its anticorrosive properties and is mined from high-grade metamorphic terranes in Austria.

World production of natural iron oxide pigments in 2004 was more than 460 600 tonnes, of which India accounted for over 70% (Table 15) (Potter 2004).

Besides the major producing countries, small amounts are produced in a number of other countries including Azerbaijan, China, Kazakhstan, Russia and Ukraine.

Table 15. World natural iron oxide pigment production 2004

Country	Production (tonnes)
India (ochre)	360 000
Spain (ochre)	75 000
Cyprus (umber)	12 000
Pakistan (ochre)	4 500
Austria (specularite)	4 000
Iran	2 500
Brazil	2 000
Germany	430
USA	n/a
Other	170
Total	>460 600

Source: Potter (2004)

Main Australian Deposits

Currently the only iron ore pigment production in Australia is from Western Australia. Red iron oxide is obtained from a deposit at Little Wilgie Mia in the Weld Range Greenstone Belt in Western Australia. Micaceous iron oxide was mined from the Mount Gould deposit, northeast of Geraldton, in Western Australia between 1996 and 2001. The mine is currently on care and maintenance (Fetherston 2002).

Potential resources of yellow and brown ochres have been identified at Savage River, Tasmania (Davies 1999).

New South Wales Occurrences

There are currently three operations supplying iron oxide to cement manufacturers in New South Wales — two near Rylstone and one at Breadalbane. Cement manufacture is a small and limited market for iron oxides. Iron oxide is used as an additive during cement manufacture to promote formation of calcium silicates in flux. Generally, any type of iron oxide can be used provided it has a sufficient Fe₂O₃ content and can be obtained cheaply. There are 28 recorded occurrences of iron oxide pigments in New South Wales (Ray et al. 2003). Small to moderate quantities of pigments were produced in New South Wales from the late 1800s to early 1960s. Production peaked during the 1940s and 1950s at 500–1000 tpa. Much of this came from two areas: Home Rule north of Mudgee, where 'red oxide' was produced; and at Whylandra and Eumungerie near Dubbo. Other localities where pigments have been produced include Michelago, Marulan, Wingello and Glen Innes (Raggatt 1925).

The deposits from which pigments have been produced in New South Wales can broadly be classified as coloured clays, or laterite/ironstone/gossans. The following descriptions are based substantially on Raggatt (1925).

The deposits at Home Rule and near Dubbo represent coloured clay types. Yellow and red ochres were mined from kaolin horizons coloured by iron oxides produced by weathering and groundwater movement. At Home Rule, the coloured clays occur in extensive kaolin deposits that developed from deep weathering of the Gulgong Granite. Near Dubbo, these horizons represent weathered siltstone units in the Pilliga Sandstone. Other examples of this type of deposit are the coloured clay lenses in the Wianamatta Group in and around Sydney from which minor quantities were extracted in the early 1900s, and clays derived from the weathering of the Milton Monzonite near Ulladulla where red ochre was extracted in the 1930s.

Ironstones of various origins have been worked at a number of localities, including Glen Innes (New England area) and Wingello (Southern Highlands). At Glen Innes, the ironstone formed in response to laterisation of volcaniclastic units whereas ironstones at Wingello developed by laterisation of basalt. Gossans resulting from the weathering of sulphides were mined at Marulan, Illalong Creek north of Yass and at Cobar. In the case of Illalong Creek, micaceous hematite was reported. At Michelago, ironstone formed as a result of iron- and manganese-rich groundwater infiltrating and replacing pre-existing sandstone and phyllite. The ironstone deposits were small and presumably of variable quality as the total production from individual operations were modest — in the order of several thousand tonnes.

The potential for extracting limited quantities of iron oxides that may be suitable as pigments from maghemite is unknown but may warrant investigation. Maghemite is an iron-rich duricrust, commonly pisolithic, that is extensively developed in western New South Wales, either in soil profiles or in Tertiary palaeochannels.

Applications

Iron oxides used for pigments consist of a combination of one or more ferrous or ferric oxides and impurities, such as manganese oxide, clay, silica, alumina and clays (Table 16). A major use of natural iron oxides is for pigments.

Iron oxides are the second most important natural pigment after titanium dioxide (TiO₂). Iron oxide pigments are non-toxic, relatively inert, weather-resistant and mainly opaque. They are used in paints, stains, inks, plastics, pharmaceutical products and cosmetics. Micaceous iron oxide also acts as an anti-corrosion agent. Iron oxides produced synthetically are

Table 16. Common iron oxide pigments

Material	Composition	Colour(s)
Goethite	$\alpha\text{FeO.OH}$	Yellow, brown
Hematite	Fe ₂ O ₃	Red (as pigment)
Lepidocrocite	$\gamma\text{FeO.OH}$	Yellow
Magnetite	Fe ₃ O ₄	Black
Siderite	FeCO ₃	Red*, brown*
Pyrite	FeS ₂	Red*
Limonite	Mixture of hematite, goethite, lepidocrocite, often with adsorbed water	Yellow, brown*
Ochre	Limonitic and/or hematitic iron oxide	Yellow, red, brown
Sienna	Yellow brown limonitic material	Yellow, brown
Umber	'Brown earth', mixture of hydrated iron oxides, manganese oxides, silica, alumina and lime	Brown
Specularite	Micaceous iron oxide, a micaceous variety of hematite	

*when calcined

Source: Harben (1999)

superior to natural iron oxides because of their greater uniformity, consistency and purity of colour and greater tinting strength.

The composition of iron oxides used for pigments varies widely, and their physical properties are usually more important than their composition. Characteristics such as bulk density, oil absorption, grainsize and grindability, opacity, uniformity of colour and tinting strength determine the suitability of material for a given application. For pharmaceutical and cosmetic applications chemical purity is also important.

Iron oxides used for pigments should be uniform in colour, have good opacity and of such hardness that they can be ground to an ultrafine grainsize. Deposits of natural pigments with these characteristics are rare and thus synthetic pigments, which can be easily produced from iron compounds, are preferred by most manufacturers.

Iron oxides come in various colours and the range can be extended through blending. Table 16 summarises the composition and colour range of the common iron oxide pigment materials. Pyrite and siderite are also included, as they form natural iron oxide when calcined (Harben 1999).

In addition to naturally occurring iron oxides, a substantial amount of iron oxide is manufactured. Such processes as thermal decomposition of iron salt or iron compounds; precipitation of iron salts accompanied by oxidation; and reduction of organic compounds by iron are widely used to produce pigments commercially. The advantages of synthetic pigment manufacture are that they can be produced close to where they are used and more closely to required specifications. The amount of manufactured pigment produced annually is five to six times the production of natural pigments.

Besides pigments, non-metallurgical applications of iron oxides include dense medium separation and cement manufacture. Magnetite is used in dense

medium separation due to its high specific gravity and magnetic properties which allow the magnetite to be recovered and reused. Magnetite (see separate chapter) is mainly used in coal washing but has also been used in high-density separation of such other minerals as fluorspar and gypsum.

Economic Factors

The demand for iron oxide pigments is driven mainly by the construction and automotive industries.

Automotive industries use pigments for primers and paints. Pigments in the construction industry are used in ready-mixed concrete, concrete products, roofing tiles, pavers and paint.

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