

## What is Iron Ore?

Iron ore is a rock from which metallic iron can be economically extracted. Iron is the most used metal accounting for about ninety five per cent of the total metal produced worldwide. It can be alloyed with many elements to produce stronger and harder products which are used in millions of items we use every day.

Iron ore resources occur in all the Australian States and Territories, with almost 97% of the 2009-10 total production occurring in Western Australia<sup>1</sup>. (ABARES)

The Pilbara region is particularly significant with 79.5% of Australia's total identified resources and 92.4% of the production.

In 2009 Australia's economic demonstrated resources (i.e. those that have been sufficiently tested by drilling and that could be economically extracted at current prices with existing technology) totalled 28 billion tonnes and ranked Australia second (with 17%) behind the Ukraine (18%)<sup>2</sup>.

## How was iron ore formed?

Nearly all of Earth's major iron ore deposits are in rocks that formed over 1.8 billion years ago. At that time Earth's oceans contained abundant dissolved iron and almost no dissolved oxygen. The iron ore deposits began forming when the first organisms capable of photosynthesis began releasing oxygen into the waters. This oxygen immediately combined with the abundant dissolved iron to produce hematite or magnetite. These minerals deposited on the sea floor in great abundance, forming what are now known as the "banded iron formations." The rocks are "banded" because the iron minerals deposited in alternating bands with silica and sometimes shale. The banding might have resulted from seasonal changes in organism activity<sup>3</sup>.

In Western Australia, most iron ore deposits are mainly hosted in the banded iron formation rocks. These black, red and grey banded sedimentary rocks were laid down approximately 2,500 million years ago. The iron-rich layers are composed of black magnetite ( $Fe_3O_4$ ) and dark grey/red haematite ( $Fe_2O_3$ ), whereas the silica-rich layers comprise fine grained quartz or chert consist of alternating iron-rich and silica-rich layers.

## How is iron ore mined in WA?

The iron ore mining operations in Western Australia are highly mechanised using sophisticated technology. In traditional operations, the ore is mined from large open pits by progressive extraction along steps or benches 12 to 15

metres high. After the soil and overlying rock are cleared, the ore is drilled and blasted. The fractured ore is loaded by huge mechanical shovels, hydraulic excavators or front end loaders onto some of the world's biggest dump trucks and hauled to the crushing plant. Crushing and sieving reduces the ore to less than 32 mm in size. The crushed ore is then separated according to size into 'lump' or 'fines' (up to 10mm).

The ore is then transported hundreds of kilometres by rail to a variety of ports including Cape Lambert, Dampier and Nelson Point and Finucane Island at Port Hedland. These rail lines are the most extensive privately operated rail systems in Australia and can be up to eight kilometres in length.

Before being shipped overseas or interstate, haematite ores are blended to meet customer specifications.

**Extensive remote controlled mining operations are now part of the mining landscape in Western Australia with the Rio Tinto high tech operations centre operating from Perth. The centre remotely controls the company's network of mines, rail systems, infrastructure facilities and port operations in the Pilbara. Using the skills of 200 controllers and schedulers and more than 230 technical planning and support staff, cutting edge technologies are employed to control operations 1,500 kilometres away from Perth.**



Control room, located in Perth, for remote mining operations 1500 kilometres away. Image courtesy of Rio Tinto.

## What happens after mining?

Ongoing environmental management and rehabilitation projects aim to produce stable landforms and self-sustaining revegetation so that, on completion of mining, the flora and fauna of the area is not significantly different from the surrounds.

## How is iron ore processed?

At the steelworks, blended 'lump' ore is fed directly into the blast furnace with coke (upgraded coal) and limestone. Iron ore 'fines' need to be fused into bigger pieces. They are mixed with powdered coke and limestone, then pass through a furnace to ignite the coke, fusing the iron ore into a clinker-like mass which can then be fed into the blast furnace.

### Iron Ore Fast Facts

- The chemical symbol for iron is Fe from the Latin name ferrum.
- Iron (Fe) is the fourth most abundant element in the earth's crust ranked fourth in abundance in the earth's crust and is the major constituent of the Earth's core. It rarely occurs in nature as the native metal.
- The pure metal is silvery white, very ductile, strongly magnetic and melts at 1528° C.
- The ferrous form of iron, Fe<sup>2+</sup>, dissolves in water but the ferric form, Fe<sup>3+</sup>, does not and precipitates as Fe<sub>2</sub>O<sub>3</sub> (OH) - rust.
- The most useful metal known -we use 20 times more iron, in the form of steel, than all other metals put together.
- Pure Iron is quite soft hence small amounts of other elements such as manganese, nickel, molybdenum, aluminium, chromium, copper and titanium are added to improve its strength, hardness and elasticity.
- Cast iron is partly refined iron and contains up to 5% carbon making it very hard, but brittle. The tensile strength can be increased by including other alloying elements such as 1-3% silicon. Cast iron is used in such things as vehicle cylinder blocks.
- Wrought iron is nearly pure iron mixed with a glasslike material. Unlike cast iron, it resists corrosion and is more malleable, making it better for use in outdoor furniture, porch railings and other decorative items.
- Steel, the most commonly used form of iron, contains about 1% carbon as the principal hardening element. By far the greatest use of iron in the world is as various forms of steel.
- Stainless steel contains chromium as the main alloying element. It resists corrosion and hence is used in the production of motor vehicle parts, hospital equipment and razor blades.
- Tool steel is extremely hard steel used in metalworking tools. It is produced by tempering certain alloy steels by heating then cooling quickly.



Image courtesy of Rio Tinto.

The raw materials are fed in alternate layers through the top of the blast furnace and a continuous flow of superheated air (1,200°C) causes the ingredients to react and melt, reducing the iron oxide to molten iron ( $\text{FeO} + \text{CO} = \text{Fe} + \text{CO}_2$ ). The resulting 'pig iron' is drawn off at the bottom of the furnace - at this point it has few uses and is usually refined to steel.

To make steel, molten pig iron, scrap steel and limestone are fed into large vessels where 99% pure oxygen is blown onto the materials. Heat generated by the oxygen increases the temperature to 1,700°C, which melts the scrap steel and the unwanted impurities are oxidised. Molten steel is then tapped off and alloying elements are added for strengthening.

The cooled steel is rolled into bars, sheets or plates in readiness for further processing into the many products we use daily.

## What are the uses of iron ore?

Almost all iron ore is used in blast furnaces to make pig iron which is the main material in steelmaking. Small amounts of iron ore are used for example in coal washeries and in cement manufacturing. Iron can be alloyed with a variety of elements to produce stronger and harder products which are useful in the construction industry and in the manufacture of millions of products including motor vehicles, ships, trucks, pipelines, trains and railway tracks.

The **Chamber of Mines and Energy Western Australia** is acknowledged as the provider of this resource with significant contributions from Rio Tinto.

<sup>1</sup> ABARES (2011)

<sup>2</sup> [www.australianminesatlas.gov.au/education/fact\\_sheets/iron.jsp](http://www.australianminesatlas.gov.au/education/fact_sheets/iron.jsp)

<sup>3</sup> <http://geology.com/rocks/iron-ore.shtml>

Last updated August 2011.