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South Australia

EarthResources

Information Sheet

Iron ore deposits in South Australia

Iron (Fe) is a metallic element which constitutes about 5% of the Earth's crust and is the fourth most abundant element in the crust. Iron ores are rocks from whcih metallic iron can be economically extracted. the principal iron ores are hematite (Fe_2O_3) and magnetite (Fe_3O_4).

Hematite ores dominate the world production of iron ores and are sourced mainly in australia and Brazil. However, magnetite is continuing to increase its presence in world production.

During 2011, China was the world's largest producer of iron ore with 43%, or 1200 million tonnes (Mt) followed by Australia with 17% or 488 Mt and Brazil with around 14% or 390 Mt of world production (Geoscience Australia (GA), 2013).

Almost all iron ore mined (~98%) is used in the production of steel. Steel is regarded as the economic mainstay of industrialised nations. Steel's versatility is unsurpassed; it is the cheapest metal to produce and has a ready supply of raw materials.

South Australia is arguably the birthplace of the Australian iron ore and steel industry, and continues to play an important role as an iron ore and steel producer. The state is emerging as Australia's second largest producer of iron ore, accounting for more than 5% of the nation's total Economically Demonstrated Resources (EDR), (GA, 2013)

Currently the state has two iron ore producers — Arrium Ltd, producing hematite and magnetite ore from several iron ore deposits in the Middleback Ranges and northern Gawler Craton; and IMX

Figure 1 *Operating iron ore mines, development projects and occurrences in South Australia*

Government of South Australia
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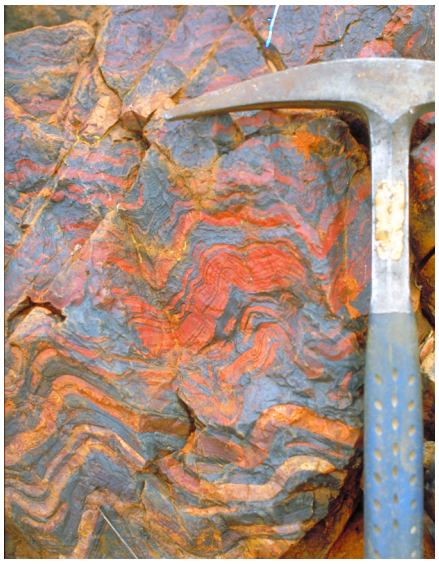

Folding in banded iron formation, Wilgena Hill. (Photo 039861)

Resources producing copper-gold bearing magnetite ore from the Cairn Hill deposit. Two more iron ore mines are approved — Wilgerup and Wilcherry Hill.

The state also hosts significant iron ore developing projects and prospects

Iron ore in South Australia

The Middleback Ranges deposits were the main source of ore for Australia's iron and steel industry from 1915 to the early 1960s, until the Federal Government lifted the export embargo on iron ore which subsequently led to production from the Pilbara, commencing 1966, and iron ore exploration in South Australia declining. It was not until ~1985 that the search for iron ore in this state recommenced. During 1995–96, PIRSA and BHP outlined large low-grade and limited high-grade iron resources. The success of this exploration highlighted the potential for further major discoveries in very extensive banded iron formation (BIF) horizons throughout the Gawler Craton.

This potential was realised during the global mineral resources boom of 2004–08 with record levels of exploration activity leading to the discovery and development of a number of new iron ore deposits and a resultant resurgence of South Australia's iron ore industry.

Geological environment

South Australia's iron-rich rocks are classified into six deposit types — residual, chemical sedimentary iron formations, Fe-skarn and, of lesser significance, hydrothermal, clastic and magmatic.

Production has been overwhelmingly from the high-grade residual deposits in the Middleback Ranges of northern Eyre Peninsula.

Gawler Craton

This stable region of Archaean to Mesoproterozoic crystalline basement extends over almost half the State. The Craton hosts two very extensive BIF sequences, which are sparsely exposed and generally overlain by thin soil and flat-lying younger sediments. The older BIF sequence occurs in the southern, central and western parts of the Craton. These Archaean rocks contain BIF generally <50 m thick with discontinuous strike lengths of up to 500 m.

The younger (~1900 million years old) Palaeoproterozoic BIF units are most extensive in the eastern and northern parts of the Craton. These are up to 700 m thick, persist along strike for up to 25 km, and include Peculiar Knob, Hawks Nest, Giffen Well, Wilgena Hill and the Middleback Ranges.

Middleback Ranges

The residual deposits in the Middleback Ranges are of Palaeoproterozoic age, with the larger deposits at Iron Monarch, Iron Baron and Iron Duke having collectively yielded more than 200 million tonnes (Mt) in almost 100 years of mining. They occur in a discontinuous series of north–south-orientated hills and ridges on northeastern Eyre Peninsula, 40 km west of Whyalla. These extend for 40 km from Iron Knob in the north to Iron Duke in the south, and rise to a maximum height of 250 m above the surrounding plains.

Most of the high-grade deposits are contained in shallowly north and south-plunging synclinal keels.

High-grade iron ore has been mined from three areas:

- Northern Iron Knob area that includes the Iron Knob, Iron Monarch and Iron Princess deposits.
- Central Iron Baron area comprising the Iron Baron, Iron Prince, Iron Queen and Iron Cavalier deposits.
- South Middleback Ranges which includes the Iron Duke, Iron Duchess, Iron Knight and Iron Chieftain deposits.

Curnamona Province

The best expression of Neoproterozoic iron-rich rocks in the Curnamona Province is in the Braemar ironstone facies of the Nackara Arc. These BIF horizons show great lateral persistence locally, varying in thickness from a single bed to massive iron formation up to 20 m thick. The Razorback Ridge prospect is the best known with an accumulated thickness of 610 m and average grade of 25% Fe. Principal iron minerals are magnetite, hematite and martite. Other prospects include Eldorado and the recently discovered Lilydale. Preliminary chemical analysis of Lilydale samples indicates a Fe grade of 58.6%.

Adelaide Geosyncline

The Western spur deposit lies between Jurassic and Cambrian lithologies with an 8 km strike of Fe grades up to 58.9%. Drilling results show hematite and siderite ($FeCO_3$) intercepts of up to 60 m thick. This type of mineralisation is different in formation and age from other iron ore projects in South Australia, and has the potential to lead to the development of a new type economic iron deposits for the region.

Operating/approved mines

Middleback Ranges
magnetite and hematite

Arrium Ltd

www.arrium.com

Arrium Ltd operates open-cut mines in the Middleback Ranges producing both magnetite and hematite ore for steel production and export respectively. Iron ore is also shipped to Port Kembla and Newcastle New South Wales, in the form of blended fines and pellets.

In 2005 the company embarked on a major expansion initiative, Project Magnet, designed to extend the Whyalla operations a further seven years to beyond 2027 by processing magnetite to steel in the integrated Whyalla Steelworks and high grade hematite ore sold to global markets.

A second major expansion project (Hematite Extension Project, HEP) is underway to double iron ore sales to 12 Mtpa by mid 2013.

This includes hematite ore from new mine Peculiar Knob as part of the Southern Iron project.

To accomodate the additional iron ore exports the Whyalla Port is undergoing significant expansion and on completion in mid 2013 will have have a 13Mtpa throughput capacity.

- Total resource: Hematite 153.2 Mt at 58.0% Fe, magnetite 228.2 Mt at 38.8% Fe.
- Reserve: Hematite 44.4 Mt at 59.5% Fe, 0.09% P, magnetite 70.5 Mt at 41.8% DTR.

Peculiar Knob(Southern Iron)
hematite

Arrium Ltd
www.arrium.com

- Open-pit mine, high-grade DSO hematite, first ore shipped through the Port of Whyalla in December 2012.
- Total resource 19.2 Mt at 64.0% Fe, 7.16% SiO_2, 0.25% Al_2O_3, 0.01% P and 0.4 LOI.

Iron Chieftain
hematite

Arrium Ltd
www.arrium.com

- Resource 18.2 Mt at 58% Fe. JORC Reserve 7.7 Mt at 60.5% Fe.
- Mineral lease for the Iron Chieftain Mine was granted in October 2010 and mining has commenced.
- Open cut hematite iron ore mining operation consisting of a primary and secondary pit.
- Ore will be blended to meet export grade targets.
- Actual mine life will depend on the detailed sequencing of production and beneficiation across all of Arrium Ltd's South Middleback Ranges mines.

Cairn Hill
magnetite-copper-gold

IMX Resources NL
www.imxresources.com.au

- IMX Resources commenced production of 1.8 Mtpa high grade magnetite-copper-gold ore in mid 2010.
- Produces a 68.8%-69.9% Fe magnetite product. Premium quality ultra-coarse grained magnetite concentrate with contained Cu-Au accounting for one third of the production value.
- Mining Phase 1 completion expected in 2015-16.
- Work continues on Cairn Hill Phase 2 development option - potential to extend mine life.
- Resource 14.3 Mt at 50.6% Fe, 0.29% Cu, 0.09 g/t Au.
- Reserve 6.9 Mt at 51.2% Fe, 0.43% Cu, 0.13 g/tAu.

Wilgerup
hematite

Centrex Metals Ltd
www.centrexmetals.com.au

- Proposed 10 Mt hematite over 6 years (1.66 Mtpa).
- All mining approvals received and offtake agreement in place.
- To be developed in line with Port Spencer.
- Indicated Resource 13.2 Mt at 57.7% Fe, 4.9% SiO_2, 2.8% Al_2O_3, 5.1% LOI, 0.5% P.

Wilcherry Hill
magnetite

IronClad Mining Ltd
www.ironcladmining.com

- Total resource (ind. & inf.) 69.3 Mt at 25.9% Fe 32.0% SiO_2, 7.9% Al_2O_3, 0.06% P.
- High quality crystalline magnetite, low contaminants, suitable for low cost beneficiation with concentrate grades likely to exceed 67% Fe.
- High grade (55–65% Fe) surface samples recently discovered.
- Focus on early production of near surface DSO.

Developing projects

Bungalow
magnetite

Centrex Metals Ltd
www.centrexmetals.com.au

- Current Inferred Resource 338 Mt at 29.6% Fe (34.3% DTR conc. at 69.7%).
- Joint Venture with Baotou Iron and Steel (Group) Co.

Exploration, base line environmental studies and feasibility study running in parallel.

Giffen Well
hematite and magnetite

WPG Resources Ltd
www.westernplainsresources.com.au

- Resource 689.1 Mt at 31.4% Fe, 38.7% SiO_2, 1.9% Al_2O_3 and 0.07% P.
- Prefeasibility study complete.

Gum Flat
hematite and magnetite

Lincoln Minerals
www.lincolnminerals.com.au

- Total magnetite Inferred Resource 104.7 Mt at 24.0% Fe.
- Hematite-goethite Inferred Resource 2.7 Mt at 46.2% Fe.
- Hematite-goethite Indicated Resource 0.9 Mt at 54.2% Fe or 57.9% calcined Fe.

Steel slabs being produced at the continous caster, Whyalla. (Photo 042007)

- Proposed two stage development option:
  - Stage 1 - mine and export DSO of 0.5 Mtpa to 1 Mtpa over 3-5 year mine life.
  - Stage 2 - potential to mine up to 10 Mtpa magnetite, beneficiate on site to produce 2.5 Mtpa concentrate over a 20 year mine life.

Hawks Nest
hematite and magnetite

Arrium Ltd
www.arrium.com

- Hematite resource 102.5 Mt at 37.4% Fe (Indicated and Inferred).
- Magnetite resource 569 Mt at 35% Fe Total Measured, Indicated and Inferred.
- Scoping study completed at Hawks Nest and Kestrel.
- Plans to mine deposit after Peculiar Knob.
- Joint Venture with Wuhan Iron and Steel Group company (WISCO).

Hematite Extension Project – HEP
hematite and magnetite

Arrium Ltd
www.arrium.com

- refer to Middleback Ranges

Maldorky
magnetite

Havilah Resources NL
www.havilah-resources.com.au

- JORC Indicated Resource147 Mt at 30.1% Fe.
- Over 50 m of shallow dipping magnetite-rich siltstone.

DTR results indicate a premium magnetite product can be beneficiated from the primary iron ore.

Mutooroo
magnetite

Minotaur Exploration Ltd
www.minotaurexploration.com.au

Resource 1.5 Bt magnetite at 15.2% Fe DTR.

Mineralisation similar in size and type to Carpenteria Exploration's Hawson's project in NSW 25 km east.

Magnetite concentrates producing 69.8% Fe. The deposit strike persists laterally for almost 40 km.

Project Fusion
magnetite

Eyre Iron Pty Ltd
www.eyreiron.com.au

- Fusion is an amalgamation of five projects located in close geographical proximity, incorporating the magnetite deposits of Koppio, Brennand, Kapperna, Iron Mount and Oolanta.
- Combined Resources 680 Mt at 25.1% Fe (22.7% DTR at 66.8% Fe, 5.2% SiO_2), 47.7% SiO_2.
- Joint Venture (EPJV) between partners Centrex Metals Limited and Wugang Australian Resources Investment Pty Ltd.
- Exploration, base line environmental studies and feasibility study running in parallel.

Razorback Ridge
magnetite

Royal Resources Ltd
www.royalresources.com.au

- Resource 1.816 Mt at 21.0% Fe, 44.6% SiO_2, 7.4% Al_2O_3, 0.18% P.
- Progressing feasibility studies
  - Proposed conventional open-pit mining targeting 8 Mtpa
  - high grade magnetite concentrate
  - third party infrastructure and transport solutions being progressed.

Snaefell / Mount Woods
magnetite

IMX Resources NL
www.imxresources.com.au

- Magnetite-quartz hosted iron deposit (coarse grained magnetite).
- Resource 569 Mt at 27.1% Fe (using 18% Fe cut-off).
- Metallurgical results and studies continue.

Warramboo
magnetite

IronRoad Ltd
www.ironroadlimited.com.au

- Indicated and Inferred 2,597 Mt at 16.0% Fe, 52.9% SiO_2, 12.7% Al_2O_3, 0.08% P and 1.0% LOI.
- Pre--feasibility studies have demonstrated viability of an open pit mining operation producing 12.4 Mtpa iron concentrate.
- Ore beneficiated to produce a high grade 67% iron concentrate.

Prospects

Bald Hill
magnetite

Centrex Metals Ltd
www.centrexmetals.com.au

- Current Inferred Resource 6.7 Mt at 37.2% DTS (63.5% Fe)

Bramfield
magnetite

Lymex Ltd

- Best intersections
  - BLDD20 36.2 m at 42.4% Fe from 75.0–111.2 m
  - BLDD21 53.50 m at 39.8% Fe from 82.0–135 m

Carrow
magnetite and hematite

Centrex Metals Ltd
www.centrexmetals.com.au

- Current combined Indicated and Inferred Resource 159.2 Mt at 27.2% magnetite.

Lilydale
magnetite

Havilah Resources NL
www.havilah-resources.com.au

- Consistent grades of 29–33% Fe in magnetite bearing ironstone reported.

Mount Christie

Limited drilling has identified an Inferred Resource of 5–20 Mt at 40% Fe.

Other prospects include Acropolis, Oak Dam and Emmie Bluff.

Olympic Dam

BHP Billiton Ltd
www.bhpbilliton.com

The Olympic Dam Cu-U-Au-Ag ore deposit, hosted by Mesoproterozoic granite, represents a total resource of 2200 Mt. It is a major iron ore occurrence with affinities to the Swedish Kiruna deposit.

Sequoia
magnetite

Southern Exploration Ltd

The deposit contains an Inferred Resource of 20 Mt to 100 m below the level of oxidation at an average 28% Fe.

Wilgena Hill

Wilgena Hill, the most prominent of a group of poorly delineated outcrops in the Tarcoola region has visually been estimated to contain 60 Mt at 40% Fe above plain level. Other smaller outcrops include Coolybring, Big Tank and Hicks Hill.

References

Geoscience Australia 2013. *Australia's identified mineral resources 2012.* Geoscience Australia, Canberra.

Davies M 2000. *Iron ore in South Australia.* South Australia Department of Primary Industries and Resources. Commodity Review 8.

Shortened forms

DSO	direct shipping ore
DTR	Davis Tube Recovery
DTS	Davis Tube magnetic separation
JORC	Joint Ore Reserves Committee
LOI	loss on ignition
MOU	memorandum of understanding

Further information

For further information, visit the Department of State Development website www.minerals.statedevelopment.sa.gov.au

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