MAGNETITE MINES
High Grade Iron Ore Concentrate

White Paper

Where will future iron ore supply come from?

Mark Eames
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So, can the existing producers shift direction to supply the large volumes of higher-grade ore that appear to be required for lower-emissions steelmaking?

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Following COP26 and the Glasgow Climate Pact's commitment to rapid deep and sustained reductions in global greenhouse gas emissions - which includes the 'phasedown of unabated coal power'- there is a renewed focus on emissions from the iron and steelmaking sector, which accounts for 7% of global emissions.

There is a growing consensus that low-emissions steel will require large volumes of high-grade iron ore. For example, the International Energy Agency scenarios for emissions reduction include substantial increases in Direct Reduced Iron (DRI), which requires high-grade, low-impurity iron ore feedstock. A wide range of industry participants have flagged the need for higher-grade iron ore inputs to assist with the transition to low-emissions steelmaking.

So, the question is, where will all this high-grade iron ore come from? And is it available? The challenge is that over the last 20 years or so, traded iron ore grades have gone down, not up. Iron ore grades from Australia now average around 60%, well below the industry 62% benchmark. Vale has indicated that the world's remaining ore bodies face depletion and beneficiation challenges, thus making it difficult to increase supply of high-grade ores.

Until recently, mining companies, customers and investors favoured direct shipping ore (DSO) supplied to coke-based blast furnace steelmakers. About 50 years ago, the opening-up of Australia's Pilbara and Brazil's Carajas region enabled large quantities of mid and high-grade ore to be supplied direct to customers with limited processing, mostly simply crushing and screening. Customers liked the low cost. Mining companies operated integrated supply chains and incrementally expanded. Investors enjoyed the benefits.

However, this traditional model of iron ore supply has challenges around quality, sustainability and competition. The quality of DSO is directly related to the quality of iron ore in the ground and over time, a number of orebodies have become exhausted and quality has declined. Steelmaking based on coking coal faces obvious environmental challenges. A supply model dominated by a small number of suppliers has raised concerns with some customer groups.

Compounding the issue is that many efforts to date to produce higher-grade ores have not been fully effective. Some ore processing (or beneficiation) has been introduced in DSO operations, but this has partially offset declining grades rather than improving quality. Miners have invested in higher-grade processed ore operations (such as Rio Tinto in Canada, Anglo in Brazil and more recently FMG in Australia) but have not always faced a smooth development path. Efforts to develop other iron and steelmaking approaches have not captured a lot of market share to date and past investments by Rio in HIsmelt and BHP in HBI have not proved successful.

While Fortescue and Roy Hill have proved successful new entrants in the iron ore market, both produce fines below the market reference grade and many other new iron ore investments have not worked out as well.

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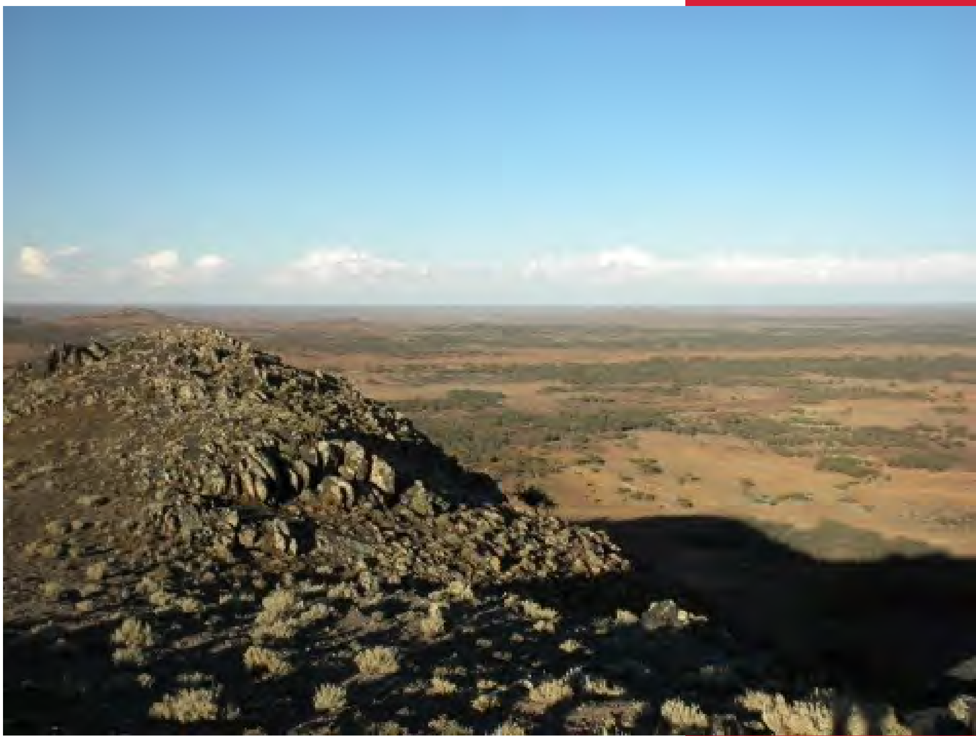

So, can the existing producers shift direction to supply the large volumes of higher-grade ore that appear to be required for lower-emissions steelmaking? The difficulty is that the Pilbara DSO orebodies are not well suited to beneficiation and upgrading to produce higher-grade products. The only plant built to produce near-DR grade products was BHP's Boodarie beneficiation plant built to feed its HBI operation in 1999. This was designed to produce a high-grade (67.5% Fe) product from readily saleable iron ore fines (with a plant head grade of 62.5% Fe), but the plant was low efficiency with reported plant tailings at over 50% Fe content, and as a consequence, recovered only around 75% of the iron in feed. Ultimately BHP wrote off $2.6B on the HBI venture.

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Since then, the development of new orebodies in the Pilbara has been accompanied by challenges of complex textural mineralogy, challenging material handling, increasingly goethite rich ores, higher clay content and variable porosity, all of which make beneficiation even more difficult than in 1999.

The effect of these more difficult feedstocks has been partially mitigated by the introduction of limited processing. Much of the Pilbara iron ore output is already the result of some processing to reduce clays and alumina, but even with this additional processing, the trend has been for overall product grades from Australia to decline as volumes have increased. This combination of mineralogy, history and results suggests that it is unlikely that the conventional Pilbara orebodies (Brockman, Marra Mamba and channel iron deposits) can be economically upgraded to high-grade iron products in significant volumes.

So the global steel industry faces a massive challenge – well over half of current global iron ore comes from the Pilbara, so if the traditional Pilbara operations are not able to supply the large volumes of higher-grade ores required, how will steel industry emissions be reduced? There is no ready substitute for steel (for example, total aluminium consumption by weight is less than 5% of steel production and that industry faces its own emissions challenges). Vale has some high-grade orebodies, but has been slow to expand – and in any case, traditional iron ores from the Pilbara run at double the rate of Vale today.

The likely answer to this conundrum is perhaps slightly counterintuitive. The best grades of iron ore are actually sourced from lower-grade in situ ore bodies.

In other words, sometimes the purest iron ore can be made from relatively low-grade ore bodies that then use processing to separate the higher-grade iron ore and generate higher-grade products. About a third of the world's steel is made from these processed iron orebodies, where lower-grade orebodies - often based on magnetite or mixed magnetite-hematite - are processed to higher-grade ores, instead of the more conventional hematite form of iron ore or ore bodies. This approach is well known and already widely used in places such as China, US and Canada.

There is a precedent for a transition from low-grade minimally processed ores to higher-grade products. In 1950, the US was the world's largest steel producer and around 80% of its iron ore needs were sourced from domestic high-grade, direct shipping orebodies, which were facing depletion. The US steel and mining industry successfully invested in processed taconite operations. Within 10 years, more than 50% of US primary steel was made from processed ores and today, about 95% is sourced from processed ores.

But in Australia, and Western Australia in particular, magnetite operations face some prejudice. For example, Colin Barnett, then WA Premier, in 2013 introduced a royalty rebate as 'bringing magnetite ore to grades suitable for export is capital and energy intensive, so this royalty rebate will assist in recovering the massive investment required to achieve production'. The challenges faced by WA's major new magnetite operations, Sino Pacific and Karara, led the government to extend the rebate scheme over fears of job losses.

So, if you wanted to invest in a successful high-grade iron ore business that will assist in meeting the global steelmaking environmental challenge, where should you look?

There are two key factors to consider - geology (the ease of upgrading iron ore from the host rocks) and infrastructure (the availability of competitive power, transport and water services).

Geology that is suitable for high-grade products is not actually about grade (as it is for direct shipping ores) but is about the ease of upgrading. When you think about separating different minerals, what is important are really two factors. One is how closely the minerals are mixed together and, secondly, whether the particles can easily be separated. For a clean separation of a high-grade product, what you're looking for is separate particles of iron ore that can be easily separated from the host rocks, which don't have iron in them.

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You can think of this analogy as iron filings in a medium-like sand, where you can easily use a magnet to separate out iron particles because they're magnetic and easily separated from the silica sand. Magnetite orebodies are generally well suited to this kind of upgrading approach for two reasons. One is that magnetite particles often have simple cleavage planes and readily separate into discrete particles when the ore is crushed. And the second property which is important is of course magnetite is magnetic and therefore can be readily separated with simple techniques using magnets.

But upgrading potential is not of itself sufficient for a commercially-successful operation, the infrastructure setting is also important – especially power, water and transport. Low-cost electricity is a pre-requisite for success as upgrading ores depends on fine grinding. Practically all upgrading techniques rely on water as a medium (there is some dry processing of magnetite to finished products, especially in Mauritania and Iran, but it depends on a specific and rare combination of properties). Low-cost transport infrastructure is also required.

The Pilbara is not particularly favourably endowed for production of high-grade iron ore products. WA is not connected to the main SE Australian electricity grid and the Pilbara region is not connected to the main WA South West system. Most electricity is derived from gas, which can be expensive. Rail and port infrastructure for iron ore is mostly owned by the iron ore companies without open access. So that means that Pilbara processed ore operations have had to develop facilities themselves

As an example, Sino Pacific had to build a 480MW gas-fired power station, a huge 51 gigalitre/year desalination plant and its own transhipment port. It is perhaps no surprise that efforts to produce high-grade products in the Pilbara to date have faced challenges. Locations that have proved successful for processed ores include North America, South America, Europe, China India and, within Australia, Tasmania and South Australia, all locations that offer some or all of these factor advantages. In Australia, there is a long and successful history of magnetite operations, particularly Grange's Savage River operation in Tasmania, which has been operating for over 50 years, and SIMEC's South Australian magnetite operation, which has been providing the feedstock for steel operation at Whyalla.

The transition to zero emissions steel is feasible, but it is no surprise that it will require significant investment and changes in the quality and location of iron ore supply. BloombergNEF recently estimated that $278B would be required by 2050 and require a shift to higher-grades of iron ore, highlighting the supply potential from Russia, Brazil, South Africa and India. However, it is not just about the availability of funding - there are plenty of examples of processed iron ore businesses in these regions that have not done well for investors, either because the projects themselves did not have the geology and infrastructure tied down or because the project potential was unable to be delivered. Australia faces a particular challenge.

BloombergNEF also commented that: "Australia, however, currently produces lower grade ores, and could lose its number one place in the supply chain, if it does not invest in equipment to upgrade its product".

But there are large iron ore resources in Australia with the right combination of geology and infrastructure. Investors will find opportunities in a new generation of more sustainable, high grade iron ore operations that can assist Australia's iron ore industry with the transition.

For investors, we are at the beginning of a substantial shift in the iron ore industry and there will be undoubtedly winners and losers over time as commodity and asset markets evolve. In the iron ore market, this transition would likely be accompanied by shifts in the iron ore market to much higher premiums for higher-grade iron ore products (and potentially greater discounts for lower-grade ores).

Existing iron ore businesses will be affected by shifting demand trends. And early investors in competitive resources that can deliver higher grade, sustainable iron ore products stand to benefit from the rewards.

References

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