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Iron

Iron is the commonest element and mostly occurs in the inner and outer core of our planet. It forms about 5% of the Earth's crust where it is the 4th most frequently occurring element. Because of its ability to rust (rapidly oxidize) it rarely occurs in the natural state. It frequently forms with silicates, sulphides and as rusty oxides, the latter account for the red colour of so many of our soils, sands and rocks. The common sulphide variety (iron pyrite) is also known as *Fools Gold*.

Iron is naturally soft and requires the addition of carbon and other minerals such as chromium and vanadium to produce different types of steel with wide ranging strength and durability performance characteristics. In ancient times, iron was used to make weapons since it was much harder and more durable than bronze. Eventually, with the advance of iron-working techniques, it largely replaced bronze (around 1300—1000 BC) resulting in what is known as the Iron Age. .

Nowadays, iron is the most widely used metal due to its low cost, high strength and adaptable design. It is mainly used to manufacture various types of steel for machinery, automobiles and to reinforce construction.

Practically all iron produced commercially is consumed by the steel industry and made using a blast furnace. In essence, iron oxide, Fe_2O_3, is reduced with carbon (as coke) which reacts with oxygen in the air blast to produce carbon monoxide:

$$2\,C + O_2 \rightarrow 2\,CO$$

The carbon monoxide reduces the iron ore to molten iron, becoming carbon dioxide in the process:

$$Fe_2O_3 + 3\,CO \rightarrow 2\,Fe + 3\,CO_2$$

This process is one of the most significant industrial processes in history.

Geological deposition

Although iron is common on the Earth's surface, it mainly occurs in the combined form of iron silicate minerals: considerable energy would be required to extract iron from silicates. Hence, only certain iron minerals, mostly iron oxides, such as magnetite and hematite, where extraction is relatively easy, are economically viable.

Iron Ore

" Iron Ore" refers to rocks or minerals containing iron that can be readily extracted and three major sources exist:

Banded Iron Formation (BIF):

BIF's are believed to have originated under water. Alternate layers of iron and silica (i.e. quartz) minerals, which were deposited as sediments and were compressed and heated by geological processes, give the characteristic banding. This type of deposit

鐵

鐵是最常見的一種元素，主要藏在地球的內核與外核。地殼的 5%是由鐵組成，是第四常見的元素。由於鐵容易因急速氧化而生鏽，因此人很少機會可以一睹它最原始的形態。鐵的形成一般都會帶有矽酸鹽及硫化物，因硫化物是生鏽的氧化物的緣故，所以會令泥土及石頭變紅。其中一種常見的硫化物 — 二硫化鐵 — 又稱*愚人金*。

Fools gold *愚人金*

鐵的自然特質是柔軟。要煉製成硬度、耐久度不一的各種鋼材，鐵還需要加入碳及其他礦物，例如鉻和釩。古時，因為鐵比銅更加堅固和耐用，所以成為製造武器的材料。後來，隨著製鐵技術愈趨成熟，鐵在大約公元前 1300 至 1000 年已大致取代銅，人類正式進入鐵器時代。

今天，鐵的低成本、高強度及高可塑性令它成為世上最廣為使用的金屬，其主要用途是製成各種鋼材，再用於機械、汽車及建築加固工程之上。

基本上所有用於商業用途的鐵都是用鼓風爐製造，然後供給鋼業的。事實上，碳 (焦炭)與氧氣在鼓風中產生作用後，形成一氧化碳，會令鐵氧化物 (Fe_2O_3) 分解:

$$2\,C + O_2 \rightarrow 2\,CO$$

一氧化碳再把鐵礦分解成溶鐵，並在過程中變成二氧化碳:

$$Fe_2O_3 + 3\,CO \rightarrow 2\,Fe + 3\,CO_2$$

這是歷史上其中一個最重要的工業過程。

地質沈積

雖然鐵常見於地球表面，但它主要以含鐵矽酸鹽礦物的合成形態出現。從矽酸鹽中提取鐵需耗很大能量，因此只有一些較能容易從中提取鐵的鐵礦物 (其中大部份又是鐵氧化物) 例如磁鐵礦和赤鐵礦，在經濟效益上才比較可行。

Banded iron formation in Australia
於澳洲的條狀鐵層

鐵礦

「鐵礦」指含有可以被隨時提取的鐵的石頭或礦物，已知有三個主要來源:

條狀鐵層:

條狀鐵層相信形成於海底。相間交替的鐵層和矽土 (即石英) 礦物層原是沉積物，在地質過程中受到擠壓和受熱，才造成這獨特的條狀特徵。此類沈澱物一般體積龐大，是一些國家的重要經濟支柱。角岩 — 條狀鐵層

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is often enormous and forms a substantial part of some countries economies. Taconite, a variation of BIF, is mined in the United States and Brazil. BIF's exist through the world.

Black magnetite sands in New Zealand
於紐西蘭的黑磁鐵礦砂

Magmatic Magnetite:

This type of deposit is associated with volcanic eruption and contains significant amounts of the mineral magnetite. Some of these rocks were weathered, then transported by river and finally concentrated and deposited by waves as beach deposits. These iron sands are called black sands and examples exist in the west coast of New Zealand and in the Philippines.

Sometimes, these magmatic magnetite rocks will be deposited along with titanium and, maybe, vanadium. This special deposit is called titanomagnetite, and specialized smelters can recover these supplementary minerals as well as the iron ore.

Hematite:

Most of the hematite originates from BIF's where hot underground fluids react with the BIF altering the iron minerals into hematite.

Mining and Processing

Unlike precious metals or base metals, iron has much lower value. Moreover, the capital investment in infrastructure for transportation and beneficiation is huge. Thus, iron ore mining is a low margin business and it can only be economical if mined in large scale.

Iron ore mining is mostly done on the surface because of the cost issue. Since most of the raw mined iron ores have low iron content, they will be concentrated on site or near the mine site, in order to reduce transportation cost. For example the industrial cut-off grade in China is typically an iron content of 25% which, after concentration and beneficiation, can be substantially increased. The mined ore will be crushed and ground into fine grains to separate the iron minerals. If the iron minerals are magnetic, they can be extracted by magnetic separation. Otherwise, gravitational process or flotation process might be used depending on the characteristics of the original ore. The concentrated ore typically has a grade of at least 50% iron by weight.

The quality of iron ore depends on the three main factors:

1. Chemical composition: the higher the iron content with lesser impurities the better the ore;
2. Physical characteristics: the particle size, lumpy ore needs to be crushed and very fine ore needs to be pelletized for further processing;
3. Metallurgical performance: any factors that might affect the steel making productivity.

Smelting

Blast Furnace:

Iron concentrates are mixed with coking coal and fed into a reducing environment (lacking oxygen) in the blast furnace. The carbon from the coking coal will react with the iron oxides in the iron concentrates.The end product of this process is pig iron or cast iron. Meanwhile, the flux, which is usually limestone, added to remove the impurities, namely silicates, from iron concentrates will also form a slag by-product which can be used as a supplementary cementitious material (GGBFS: Ground Granulated Blast Furnace Slag) and for road construction.

的一種 — 在美國和巴西都有開採，而條狀鐵層則遍佈世界各地。

岩漿磁鐵礦

此類礦床由火山爆發形成，內含大量磁鐵礦礦物。這種石頭有些在風化之後，會被河流帶走，最後被海浪沖積而成為潮灘沉積。這些鐵沙又叫黑沙，在包括紐西蘭西岸和菲律賓等地都可看到。

有時，岩漿磁鐵礦石會與鈦甚或釩一同沈積，而這種特別的沈積物稱為鈦磁鐵礦。利用專門的溶爐可把這種附帶的礦物和鐵礦提取出來。

赤鐵礦

大部分赤鐵礦都是從條狀鐵層而來的。條狀鐵層在與地下溶漿產生作用後令鐵礦物轉化成赤鐵礦。

Kidney stone (a form of hematite ore)
腎石 (赤鐵礦的其中一種形態)

開採與處理

與貴金屬及基本金屬不同，鐵的價值相對來說低很多。再者，花在運輸基建與選礦程序的資金投入龐大，因此開採鐵礦是一項低收益的投資，只能靠大規模開採才能合符經濟效益。

限於成本，開採鐵礦大多數都在表面進行。由於大部分剛開採的原鐵礦鐵含量不高，它們都會在採礦場附近或當場被濃縮，以節省運輸成本。舉例說，中國的工業邊界品位一般定在鐵含量25%，然而經過濃縮和選礦程序之後，鐵含量會大幅增加。開採得來的鐵礦會被壓碎和磨成幼細粒狀，以分隔出鐵礦物。如鐵礦物屬磁性，則可用磁力選礦法提取鐵礦物。至於其它鐵礦物，則可根據礦石原本的特性，考慮利用重力分離法或浮選法提取鐵礦物。經濃縮的礦石通常都達到 50%鐵重量的邊界品位。

礦石的質素主要取決於三大因素:

1. 化學成份: 礦石的鐵含量愈高，雜質愈少，代表礦石的質量愈好；
2. 物理特性: 粒子的大小；凹凸不平的礦石需要被壓碎，而細小的礦石則會被製成小球狀，再作進一步處理；
3. 冶金性能: 任何可能影響製鋼生產力的因素。

熔煉礦石

A modern steel work blast furnace
現代煉鋼鼓風機

鼓風爐:

鐵精礦會與焦煤混合，然後置於鼓風爐的缺氧還原環境之中。焦煤中的碳會與鐵精礦中的鐵氧化物產生作用，最後製造出生鐵或鑄鐵。同一時間，常被用作為助熔劑，而加入鐵精礦中來除去當中的雜質(即矽酸鹽) 的石灰石，亦會結成爐渣，可以當作輔助膠性凝材料(爐石粉)用於路面工程。

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Direct Reduction:

Iron concentrate can also be processed by direct reduction: natural gas is used to react with iron ore in a furnace to produce sponge iron. Both pig iron and sponge iron can be used to make cast iron, wrought, and steel.

Market

Currently, China is the world's largest iron ore consumer and the world's largest steel producer. Despite the fact that China is the largest iron ore producer in the world, China is also a major importer of iron ore (China imported almost two-thirds of the world's total iron ore exports. The world's largest iron ore producer is a Brazilian mining company Vale, which produced 308 million tonnes of iron ore in 2010, followed by Rio Tinto and BHP Billiton which produced 184 and 128 million tonnes of iron ore in 2010 respectively. It is thought that in total China produced almost 900 million tonnes of crude ore in 2010 while the second and third largest producers, Australia and Brazil, produced almost 400 million tonnes and 300 million tonnes of usable ore respectively. India was the 4th largest producer in 2010, at almost 250 million tonnes.

While some of the high-end products use aluminum alloy or titanium alloy to replace the use of steel in order to reduce the weight while achieving similar strength, there is no substitute for iron at this moment. Other than mining, iron can also be obtained from recycling.

Iron, like coal, remains one of mankind's most important commodities and consumption is a direct marker of economical growth and development.

Country	Mine production 2009	Mine production 2010 estimated	Reserves Crude ore	Reserves Iron content
Australia	394	420	24,000	15,000
Brazil	300	370	29,000	16,000
*China	880	900	23,000	7,200
India	245	260	7,000	4,500
Kazakhstan	22	22	8,300	3,300
Russia	92	100	25,000	14,000
Ukraine	66	72	30,000	9,000
World total	2,240	2,400	180,000	87,000

Data are in million metric tonnes of usable ore, except China.

* The mine production estimate for China is based on crude ore, rather than usable ore.

Source: U.S. Geological Survey, Mineral Commodity Summaries, January 2011

References: Rio Tinto (www.riotinto.com); BHP Billiton (www.bhpbilliton.com) ; Vale (www.vale.com)

直接還原:

鐵精礦亦可用直接還原方法處理:天然氣可以與鐵礦物在熔爐裡產生作用，造出海綿鐵。生鐵和海綿鐵均可製成鑄鐵、熟鐵和鋼。

市場

目前，中國是全球最大鐵礦消費國，以及全球最大的鋼材生產國。雖然中國是全球最大的鐵礦生產國，但同時亦是鐵礦的主要進口國 (中國進口的鐵礦佔全球出口量的大約三分之二。全球最大的鐵礦生產商是巴西採礦公司 Vale，其 2010 年所產鐵礦量達 3 億 8 百萬噸，緊隨其後的是 Rio Tinto 及 BHP Billiton，2010 年分別生產鐵礦 1 億 8 千 4 百萬噸及 1 億 2 千 8 百萬噸。) 中國據稱於 2010 年總共生產原礦 9 億噸，而第二和第三大生產國澳洲及巴西則分別生產 4 億噸和 3 億噸的可用礦物。印度在 2010 年是第四大生產國，產量達 2 億 5 千萬噸。

Elements 成份	Content 含量
Iron	Fe > 60%
Sulfur	S < 0.1%
Phosphorus	P < 0.1%
Arsenic	As < 0.1%
Silica	SiO_2 < 10%
Copper	Cu < 0.2%
Aluminum	Al_2O_3 < 6%
Lead	Pb < 0.1%
Zinc	Zn < 0.1%
Titanium	TiO_2 < 10%

General criteria for commonly traded iron ore
鐵礦石貿易的普遍規格

縱使已有一些高端產品以鋁合金或鈦合金這些較輕而耐久度又不輸鋼的金屬來取代鋼，但迄今仍然未有任何物料可以替代鐵。除了開採一途，鐵亦可從回收得來。

與煤一樣，鐵是其中一個對人類十分重要的商品，而它的消耗又直接反映經濟增長和發展的情況。

Rio Tinto's Pilbara Operation (Source: AFP)
力拓公司於西澳的鐵礦 (資料來源: AFP)

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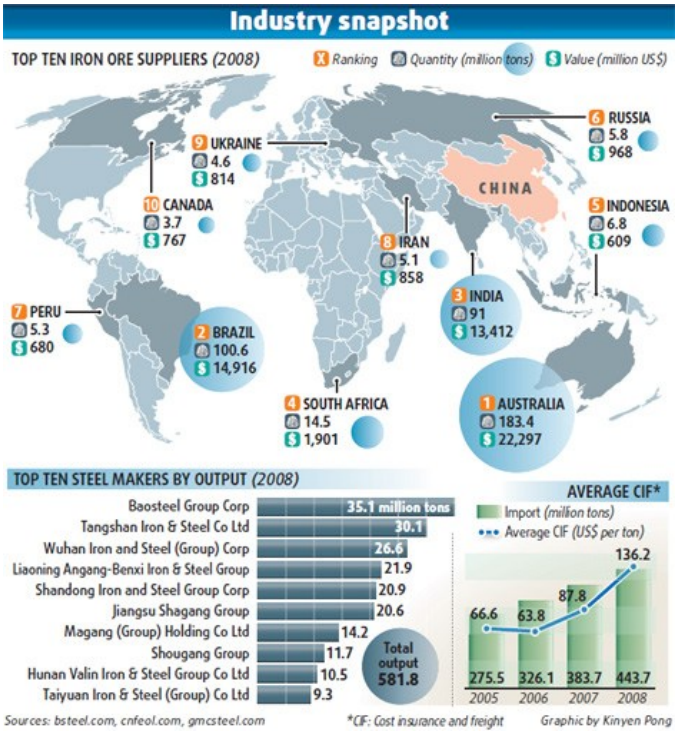

World's top ten iron ore supplying countries and China's top ten steel makers in 2008
2008年世界十大鐵礦供應國及中國十大煉鋼廠

罕王控股 (3788) 成功於香港上市

China Hanking Holdings Ltd. (3788) Successfully Listed in HK

罕王控股於2011年9月30日成功於香港集資上市。

澳洲將徵收資源稅

Australia Going to Charge Resource Tax

澳洲政府於早前公佈了礦產資源稅立法草案，預料年底會獲議會通過。此法案將影響於澳洲投資煤礦及鐵礦業務的中資企業，包括打算於明年投產的中信泰富 (267)。

Iron Resource in China

Iron, chromium and manganese are the fundamental to steel manufacture. Steel is frequently used in the construction of infrastructure. Thus, iron ore price usually fluctuates with economic cycles. The recent high iron ore price is mainly sustained by the economic growth of China.

China has a poor iron reserve compared to its population and its demand for iron. Although there are some large iron mines in China, the ore grade is relatively low. According to US Geological Survey's *2011 Mineral Commodity Summaries*, China has crude iron ore which yields a grade of about 31.30%, compared to the world's reserve which generally yields a grade of 48.33%. In order to utilize its iron reserve, China has spent many years in developing technologies to separate titanium and iron from titanomagnetite deposits. Although expensive to develop and operate, such technologies allow utilization of certain large titanomagnetite deposits in the area of Panzihua, Sichuan.

中國鐵鈦(0893) *30/9/2011 <交銀國際>*

2010年以來國內鈦精礦價格出現大幅上漲，中國鐵鈦(0893)銷售的高品位鈦精礦2011上半年平均銷售價格至1,138元/噸，較去年同期增長100%以上。鈦精礦在公司總收入中的比重已由去年同期的2.6%上升至8.8%。而公司目前高品位鈦精礦的成本僅為400元/噸左右，其毛利率已高達60%以上，為公司盈利能力最高的產品。公司2011年高品位鈦精礦產量可達11萬噸，預計2012年將增長至15萬噸以上。而國內鈦精礦目前受制於供應緊張，其價格將維持持續高位運行的態勢。鈦精礦將成為公司未來新的盈利增長點。

供應短缺 鈦精礦價大漲。此輪鈦精礦價格的大幅上漲主要受供應短缺所致。中國現年鐵精粉消費量約350萬噸，其中進口各種品位鈦精礦約200萬噸。越南對華出口鈦精礦佔國內年鈦精礦消費量的30%左右。而越南政府已於2011年6月宣布將在2011年底結束對中國的鈦精礦出口。這意味著未來中國國內將有巨大的鈦精礦市場缺口。短期來看，目前國內鈦精礦產能沒有顯著增長的可能，全球其他市場向中國大幅增加出口鈦精礦的可能性也較低。因此我們認為在未來2-3年內國內鈦精礦供應將持續偏緊，鈦精礦價格走強將有支撐。

公司所處鐵礦石市場相對封閉，鐵礦價格穩定性較高。公司現主營產品鐵精粉及球團礦主要供應四川等西南地區鋼鐵企業，其所處市場相對封閉，價格主要受區域內市場供需關係影響。2011年底攀鋼於西昌的第二鋼鐵基地將投產運營，該項目設計年鋼鐵產能400萬噸，預計將需要新增鐵精粉600萬噸左右，攀鋼集團內部僅能供應300萬噸，其餘300萬噸將依賴當地市場或進口解決。因此我們認為2011年底後整個西南地區鐵礦石供應將趨緊，公司鐵礦石銷售價格將有較高穩定性。

公司名稱	代碼	市值 (百萬港幣)	P/B 2011F
中國鐵鈦	893	2,801	0.70
新礦資源	1231	3,840	0.00
鐵江現貨	1029	3,396	0.82

資料來源: 交銀國際 (數據截至 30/9/2011)