



## Iron Ore - Terminology Ready Reference

**Acid Pellet:** Iron ore pellets with a low basicity (that is, low ratio of calcium to silicon oxides) are known as acid pellets. These may often be produced using only ore and binder without addition of other material such as limestone.

**Agglomeration:** Process which increases the particle size of material. In iron ore, these processes are usually used to convert fine ore or concentrates into larger pieces for charging to the blast furnace. The most common agglomeration processes are sintering and pelletising, which use a combination of mechanical and thermal processes with addition of other materials to adjust mechanical or chemical properties.

**Alumina:** Aluminium oxide (specifically aluminium (III) oxide or  $Al_2O_3$ ). The second most commonly occurring oxide (behind silica), accounting for about 16% of the earth's crust and hence a common impurity (also known as gangue component) in iron ores.

**Banded Iron Formation:** Distinctive type of sedimentary rock that is comprised of alternating bands of iron oxide layers and iron-poor rock such as shale or chert. Typically, these rocks are distributed across wide areas and can be several hundred metres thick. Deposition of these iron formation was most prevalent between 2.7 and 1.8 billion years ago and associated with the evolution of atmospheric oxygen (the exact mechanism is still debated). These formations are the source of a significant proportion of global iron ore production, especially Australia's Brockman and Marra Mamba mines and Brazil's Carajas operations.

**Basic Oxygen Furnace (BOF):** A steel making furnace in which molten pig iron (usually with some steel scrap) is converted into steel by blowing oxygen into the furnace beneath a basic slag. The BOF process is the major steel production method (the other major process is Electric Arc Furnaces or EAFs) and the predominant route for primary steelmaking (where iron ores are reduced to pig iron in the blast furnaces and the BOF converts pig iron to steel).

**Benchmark Pricing:** A price which is taken to be representative of a commodity when the commodity exists in many forms which can be clearly distinguished by different properties or quality. In iron ore, this refers to the pricing approach where iron ore prices were negotiated annually between a major steelmaker (such as the Japanese Steelmakers, or JSM or more recently CISA) and usually a major producer (BHP, Rio Tinto or Vale). This system broke down in 2009-2010 and iron ore prices are now commonly set using daily spot indices for 62% or 65% Fe fines set by a price reporting agency such as Platts or Fastmarkets MB.

**Beneficiation:** The process by which the grade of mined ore is increased by removing high impurity and gangue fractions. The most common processes use differences in particle size (classification), mass (gravity), magnetic properties (wet or dry magnetic separation) or surface properties (flotation). Processing facilities generally use a combination of processes and are



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described by a range of terms such as concentrators, ore processing facilities (OPFs) or beneficiation plants.

**Blast Furnace:** This type of furnace is a counter-current chemical reactor where a solid burden comprising iron ores (usually in the form of sinter, pellets or lump), coke (produced from coking coal), limestone and other additives is reduced by a hot air blast (often enriched with oxygen) injected into the base of the furnace. The coke acts as both a fuel and chemical reductant. Molten iron (“pig iron”) and slag are periodically removed (“tapped”) from the base of the furnace. The coke-fired blast furnace has been the dominant method to produce primary steel for over 150 years. In a blast furnace, hematite ( $\text{Fe}_2\text{O}_3$ ) reduces to magnetite ( $\text{Fe}_3\text{O}_4$ ), then wustite ( $\text{FeO}$ ), then forming impure iron ( $\text{Fe}$ ) which then melts to form pig iron. The iron oxides are reduced by carbon monoxide in the indirect reduction zone of the blast furnace or by carbon directly in the direct reduction zone.

**Braemar:** The Braemar Iron Formation is an emerging iron ore region in northeast South Australia and far western New South Wales. It consists of a series of alternating bedded, tillitic, and interbedded magnetite units that represent cycles of glacial advances and retreats. Unlike typical Banded Iron Formations, the Braemar Iron Formation is a meta-sedimentary siltstone formed during the Neoproterozoic (~750 million years ago). The extensive Braemar iron ores are on average softer than banded iron formations and can be processed to produce high quality iron ore concentrates with low deleterious elements. The Braemar Iron Formation has major potential as an undeveloped, globally significant iron ore province, as it has large defined resources and even larger exploration targets.

**Burden:** The combination of solid material charged into a blast furnace, usually comprising processed iron ores, coke and slag modification additives such as limestone.

**Calcined grade:** Upon heating iron ore until its mass ceases to change, the mass of a given sample reduces due to the loss of volatile compounds and/or increases due to oxidation of any magnetite to hematite. This type of process is sometimes referred to as calcining and the proportion of ore components such as iron, silica or alumina can be expressed on a ‘calcined’ basis. Typically, for a hematite ore, calcined grades, such as iron, increase, but for a magnetite ore calcined grades tend to be lower.

**Capesize:** A class of large ships used to transport bulk or dry cargo (for example iron ore, coal, phosphate, alumina or grain). These vessels are the largest dry cargo ships and are too large to transit the Suez Canal or Panama Canal and so have to pass either the Cape of Good Hope or Cape Horn to traverse between oceans. Ships in this class usually transport coal, ore and other commodity raw materials. The average size of a capesize bulker is around 156,000 DWT (carrying capacity not including empty weight of the ship), although larger ships (normally dedicated to ore transportation) have been built, up to 400,000 DWT. The large dimensions and deep drafts of such vessels mean that only the largest deep-water terminals can accommodate them.



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**CFR:** A term defining the location of sale of goods where the seller of goods pays for ocean freight (hence “Cost and Freight”). Most iron ore sales contracts reference the International Chamber of Commerce INCOTERMS CFR definition. In a CFR sale, seller arranges and pays for ocean freight to a named destination port. However, the risk of loss of or damage to the goods passes when the products are on board the vessel (not when unloaded) and in general the buyer covers the risk and any insurance cost for the ocean transport leg. The buyer bears all costs from the destination port onwards. Most iron ore sales are now CFR (delivered to destination country), not FOB.

**Channel Iron Deposit:** Iron rich sedimentary stream deposits in paleochannels. Of much more recent geological origin than BIF’s, these deposit types are significant commercial iron ore sources in Australia, with notable examples being BHP and Rio’s Yandicoogina deposits and Rio’s Robe operations.

**Coke:** A relatively hard, porous and large-sized coal product produced by heating coking coals in an airless high temperature oven. These ovens are most commonly located within steel plants in batteries of slot ovens. During the coking process, volatile material in the coking coal is driven off (“volatile matter”) in gaseous form, creating the fuel for both the coke ovens themselves and other heating processes in the plant (hence the term “Integrated Steel Mill”). Coke is fed into blast furnaces where it has a number of functions, including physically supporting the burden, being sufficiently porous to allow free flow of gases up the blast furnace, providing fuel for the furnace and generating the reducing gas to convert iron oxides to iron.

**Coking Coal:** There are few coals that are suitable for making the high quality coke required in steelmaking. These coals are typically low in sulphur and ash compared to thermal coal, but the critical property is that these coals melt when heated before resolidifying into coke. About 15% of global coal production is used for coke production. The major sources are China and Australia (NSW and Queensland), with smaller volumes mined in Russia, Canada, US and Mongolia.

**Comminution:** The process by which materials are reduced in size either by grinding, crushing or other processes. Mined ores are crushed to meet typical product sizing (e.g. 90% under 10mm for fines, maximum 15% under 6.3mm and maximum 15% over 31.5mm for lump) or as a precursor to beneficiation.

**Crude Steel:** Unrefined or unprocessed steel, defined as the first solid steel product made from liquid steel, typically in the form of ingots or semis from output of BOF or EAF steel plants.

**Davis Tube Recovery (DTR):** A Davis Tube is a laboratory instrument designed to separate small samples of strongly magnetic ores into strongly magnetic and weakly magnetic fractions. It has become a standard laboratory equipment used for the assessment of the separability of magnetic ores by low-intensity magnetic separators. The separator consists of an inclined tube



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25mm in diameter, placed between pole-tips of an electromagnet. Material to be separated is passed through the tube; the strongly magnetic fraction is held by the magnetic field while the weakly magnetic material is washed down the tube. The test is a two stage process, a pulverising step and the Davis Tube wash resulting in an estimated mass and grade of concentrate at a given grind size. The DTR test is in effect a pilot run on each part of the deposit. Unlike many other test procedures, DTR test procedures are specific to individual magnetite deposits, so consistency of approach is critical. Commercial magnetite orebodies typically exhibit a range in magnetite recoveries from 15% to 45%.

**Deleterious impurities:** impurities present which degrade the quality of the desired mineral. These may also be referred to as elements or gangue constituents (material which reports to slag in ironmaking). Common impurities include silica, alumina, phosphorus or sulphur (for example, the Platts 62% IODEX fines assessment is based on 4% silica, 2.25% alumina, 0.09% phosphorus and 0.02% sulphur).

**Deposit:** A mineral deposit is a natural concentration of minerals in the earth's crust and an ore deposit is a mineral deposit containing potentially economic concentrations.

**Direct Shipping Ore (DSO):** Mined products that may be sold for ironmaking without beneficiation. In general, these are mined from ore deposits with relatively high insitu grade (although DSO product grades may be at the lower end of commercial grades). Mined ore is crushed and screened to product lump and fines products without upgrading. There are few deposits worldwide capable of producing DSO products and even fewer commercial operations producing a natural, DSO product. Major examples are the Vale Carajas operations, much of the Australian channel iron deposit output and the majority of BHP's Australian iron ore production.

**Direct Reduction:** The process of reducing a solid oxide to a solid metallic state through the use of reduction gas (usually a mixture of hydrogen and carbon monoxide) or, less frequently, coal without melting. High grade iron ore concentrates are pelletised and then reduced to Direct Reduced Iron (DRI) products or, less frequently, compacted to form Hot Briquetted Iron (HBI). Neither are completely metallised and still contain all the gangue impurities as there is no slag separation, but can still be charged to EAFs to make steel. Current production of iron products by this method is about 100Mt each year resulting in about 5% of global steel production. The process avoids the need for coke and coking coal, but requires high grade feedstock (usually DR grade pellets) and low cost gas, a combination which is available in relatively few places. Pellet-based DRI technology has been established for over 50 years. Attempts to develop a commercial fines-based DRI process (an example is BHP's ill-fated investment in HBI in the late 1990s) have so far proven largely unsuccessful.

**Electric Arc Furnace:** A furnace which heats charged material by means of an electric arc. EAFs are frequently used to make steel from scrap metal, although impurities from scrap sources



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often limit production to lower grade long products such as reinforcing bar. Nucor in the US pioneered the production of higher quality flat products from EAFs using premium scrap and DRI feedstock, but flat steel products are mainly produced via the blast furnace/BOF route.

**Fines:** Iron ore fines products are nominally sized between 0 and 6.3mm as well as meeting the other suitability requirements for ironmaking. Mined ores are crushed and screened to meet these product sizing requirements – as an example, the Platts 62% IODEX is based on sizing of 90% under 10mm for fines.

**Fluxed Pellet:** Fluxed or basic pellets have materials added to increase the ratio of calcium to silicon oxides. The pellets are made from a mixture of iron ore and binder together with limestone, dolerite or calcite in the amount of typically between 1 – 10% limestone depending on the desired product specifications and the requirements of the blast furnace.

**FOB:** A term defining the location of sale of goods where the buyer pays for ocean freight (“Free On Board”). Most iron ore sales contracts reference the International Chamber of Commerce INCOTERMS definitions for either CFR or FOB. In the case of FOB sales, the seller delivers the goods on board the vessel nominated by the buyer at the named port of shipment. The risk of loss of or damage to the goods passes when the products are on board the vessel. The buyer bears all costs from that moment onwards. Most iron ore sales are now CFR (delivered to destination country), not FOB.

**Gangue:** See Deleterious impurities.

**Goethite:** An iron bearing oxide-hydroxide (FeOOH) mineral often associated with weathering and hydration of iron oxides (ochre is an example). Over time, the Pilbara region has moved from predominantly hematite-rich Brockman ores to Marra Mamba ores and Channel Iron Deposits which contain higher proportions of goethite. The different mineral compositions of these ores result in different physical, chemical and metallurgical properties. While these ores are competitive, they are usually less competent (with limited additional revenue from lump products) and lower grade (in part resulting from higher loss on ignition or LOI).

**Grade (% Fe):** The percentage of iron content by weight in given ore sample, measured on a dry basis. Grade of a quantity of iron ore, such as a shipment, is determined by taking a series of representative samples, usually on loading or discharge, carefully drying and subdividing the sample before laboratory analysis. Most iron ore sales contracts reference ISO standards and sampling and grade determination is performed by independent superintending organisations on loading and discharge of a shipment.

**Grade Premium:** See Iron Ore Pricing.



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**Gravity Separation:** A process by which differences in the densities of minerals are used to separate them from one another. Gravity concentration is generally effective for larger particle sizes (typically over 50 microns). Common process are heavy (or dense) medium plants which use water and finely ground ferrosilicon as a medium, spirals which use water flowing through a spiral shaped channel and jigs which use pulses of water to stratify beds of mineral into different densities.

**Grinding:** See Comminution.

**Hematite (haematite):** A common mineral form of iron oxide, technically iron (III) oxide or  $Fe_2O_3$ . Pure hematite has an iron content of 69.9%.

**Hot Metal:** Metal produced in a liquid state. Pig iron is tapped from the blast furnace as hot metal.

**Iron Ore:** Iron ore is any rock or mineral from which metallic iron may be potentially economically extracted.

**Iron Ore Pricing:** Iron ore prices are now commonly set using daily spot indices for 62% or 65% Fe fines set by a price reporting agency such as Platts or Fastmarkets MB. Iron ore sales contracts reference these prices and provide contract specific adjustments for location, quality and commercial terms. In particular, sales contracts provide for bilaterally negotiated premiums and discounts against the benchmark price to reflect the value of a particular ore. The factors are significant, potentially increasing (or decreasing) the realised price by up to 50%.

**Iron Quadrangle (Quadrilátero Ferrífero):** A region in southern Brazil near the city of Belo Horizonte with substantial iron ore mining operations. The Iron Quadrangle and the Carajas region are the principal regions for iron ore mining in Brazil.

**Labrador Trough:** A large north – south band running through Northern Quebec and Labrador with significant iron ore mining operations.

**Limonite:** An iron bearing material consisting of a mixture of various hydrated iron oxide-hydroxides with varying composition. It is often formed from the hydration of iron oxides and is a significant component of lateritic soils. Limonites can be yellow or brown in colour and, unlike for example goethite, are not a single mineral.

**Loss on Ignition (LOI):** In general, LOI is determined by strongly heating ("igniting") a sample of material at a specified temperature, allowing volatile substances to escape, until its mass ceases to change. For iron ore, the International Standard specifies a gravimetric method for the determination of the loss in mass of fully-oxidized iron ores, when ignited at 1000 °C.



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It is often thought of as the loss of ‘chemically bound’ moisture from a dry iron ore sample, but this concept is misleading. More specifically, it is the sum of contributions from the mass loss of volatile compounds (such as water vapour, carbon dioxide and sulphides (due to the decomposition of goethite and carbonaceous materials) and the mass gain due to oxidation of any magnetite to hematite. Highly goethitic ores may have a LOI up to 10% while magnetite ores actually show a ‘gain on ignition’ of around 3%. This type of process is sometimes referred to as calcining and the proportion of ore components such as iron, silica or alumina can be expressed on a ‘calcined’ basis.

**Lump:** Large sized iron ore which can be screened from mined ore and is suitable for charging direct into the blast furnaces. Pellets and lump are sometimes referred to as “direct charge” materials for this property. Lump sizing is nominally between 6.3 and 31.5mm (maximum 15% under 6.3mm and maximum 15% over 31.5mm for lump). Sizing alone is not enough: lump ore must be sufficiently competent at high temperatures to support the burden. Suitable lump ores earn a variable lump premium which is added to the fines price to calculate the total price for a lump shipment. Most of the global lump supply comes from Australia, which generates about 200Mt each year or about a quarter of output. Not all lump earns the full premium: significant volumes of lower grade and/or less competent material are sold as lump ore, but do not generate the full lump premium.

**Magnetic Separation:** The process of separating minerals with a magnetic signature from waste rock. Magnetic separation is applied to both hematite and magnetite ores, but it is often the main method used to concentrate magnetite ores. The process is usually used wet, although dry magnetic separation is used, for example in Iran and Mauritania. With the intensity of the magnetic field used for separation, magnetic separation may be classified into categories such as LIMS (low intensity magnetic separation or WHIMS (wet high intensity magnetic separation).

**Magnetite:** A common mineral form of iron oxide, technically iron (II,III) oxide or  $Fe_3O_4$ . Pure magnetite has an iron content of 72.4%. Magnetite is the most magnetic of mineral in the earth’s crust. While magnetite is stable at room temperature, when heated in air at high temperatures (around 800 degrees C) or over geological time, it can oxidise to form hematite in an exothermic reaction, gaining oxygen and reducing grade (a “gain on ignition” of about 3%). While magnetite ores are produced, sold and transported as magnetite, when pelletised or sintered before charging to the blast furnace, the ores convert to hematite (so it can be argued that magnetite is not actually used as an ironmaking feedstock!)

**Manganese:** A metallic element with the symbol Mn. It does not occur naturally as a usable metal and is often found in combination with iron. Manganese is an essential component of steel as it prevents brittleness caused by oxygen and sulphur in steel. Most manganese ore produced is consumed by the steel industry.



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**Mesh:** Screening is a common process in iron ore production and used to separate size fractions. Ores are typically fed onto a vibrating screen with mesh panels, so the small particles fall through and the larger particles remain. Mesh size may also refer to the number of screen openings per linear inch (so for example 3 mesh would be equivalent to 6.7mm).

**Metallurgical Coal:** Refers to coals that are used in for smelting purposes. In practice, this is used to refer to coal used for steelmaking. Metallurgical coal includes not only coking coals, but also other coals used in the blast furnace such as Pulverized Coal Injection (PCI coal) which is injected through the tuyeres at the base of a blast furnace to add fuel and reductant (technically, PCI coal is a metallurgical coal but not a coking coal).

**Metric Tonne:** A unit of measurement equivalent to 1000 Kg or 2204.6 Lbs.

**Open Pit Mine:** Also known as open cut mining, this is a method of mining where minerals are exposed and mined from the surface (in contrast to underground mining, which relies on a series of underground entries to access the orebody). The orebody is exposed by removing any overburden or waste material (this material is usually stored in an out of pit dump or sometimes used to backfill previous mining activity). The mine progresses usually in a series of benches using large shovels and haul trucks to dig and transport ore and waste out of pit. While underground iron ore operations do exist (the largest example is the long running LKAB block caving operation in Sweden), almost all commercial iron ore mining is from open cut operations.

**Ore Sorting:** Also known as pre-concentration, ore sorting uses a sensor to measure a property of an ore flow that is different in the retained and rejected components and using that result to separate the material. When applied early in the comminution and beneficiation process, it can result in significant processing efficiencies. Application of Xray Fluorescence to diamond ore sorting in the Rio Tinto Argyle Diamonds operation in the 1980s was a successful application.

**Overburden (also know as waste or spoil):** Material on top of an economic resource. As part of the mining operation, overburden is moved to overburden or waste dumps to expose the orebody. These dumps may be outside the pit area (out of pit dumps) or material may be moved to previously mined pit areas (in pit dumping). The most common mining method is truck and shovel mining, although draglines are widespread in coal and tar sands operations.

**Panamax:** A class of medium cargo ships defined as the largest class of vessels that can still pass through the Panama canal, nominally 60,000 DWT carrying capacity. Some of these vessels are used to transport bulk or dry cargo (for example iron ore, coal, phosphate, alumina or grain), although use in iron ore tends to be less frequent than Capesize vessels.

**Pellets:** Iron ore pellets are small, round objects made from compressing and baking the powder resulting from crushing, grinding and beneficiating iron ore. Up until the last two decades, fine



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concentrates from beneficiation were not sold as merchant products, so many iron ore producers operated pellet plants. They are usually produced with a size of 9-16mm nominal. Finely ground iron ore is mixed with binder and additives and fed to balling discs or drums to produce “green” pellets before feeding to an induration stage at high temperatures, up to roughly 1200-1350 °C. Pellets are direct charge products that have been described as “artificial lump”. Blast furnaces can be operating on a wide range of sinter, lump or pellets and increasingly concentrates are widely traded, so on-site pellet plants are falling out of favour. However, most DR grade pellets are still produced from pellet plants located near mines.

**Phosphorus:** A chemical element with the symbol P. Phosphorus is an undesirable element in steel that will increase brittleness. As phosphorus is highly reactive, it is comparatively difficult to remove from iron and steel. Most steelmakers impose strict limits on phosphorus in iron ore or metallurgical coals, controlling phosphorus content through oxidation in the BOF or add an additional dephosphorisation step in steelmaking. Phosphorus is particularly significant as a factor in the Pilbara, where high iron, low phosphorus ores have been depleted and phosphorus levels in products have substantially increased.

**Pilbara:** A large mining region in the north of Western Australia. While the region is richly endowed with many mineral deposits it is most famous for its iron ore mines which are some of the largest and most productive in the world. Iron ore exports from Australia were banned from 18 April 1938 after the Government’s adviser warned that Australia only had 350Mt of iron ore resources and BHP argued that Australian export trade was unlikely. Large scale iron ore mining only developed after the embargo was limited in 1966. The major operators presently are Rio Tinto (commenced in 1966), BHP (1968), Fortescue (2009) and Roy Hill (2015). Ironically, the Pilbara alone exports and amount equivalent to Mr Woolnough’s total 1938 Australian resource estimate every four months.

**Pig Iron:** An intermediate product in the production of steel from iron ore, tapped from the blast furnace. Pig iron has a high carbon content and is very brittle meaning that it is not directly used except in a few limited applications. Pig iron is refined to make steel in the BOF. Pig Iron is named because in the early days of iron smelting (and to this day in smaller mills in China) the molten iron is channeled through sand and then into small pits dug by shovel. The resulting array looks like suckling piglets, hence the name pig iron.

**Reclaimer:** A large machine used to recover material from an ore stockpile.

**Reserves:** An ‘Ore Reserve’ is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined or extracted and is defined by studies at Pre-Feasibility or Feasibility level as appropriate that include application of Modifying Factors. Such studies demonstrate that, at the time of reporting, extraction could reasonably be justified (JORC 2012).



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**Resources:** A 'Mineral Resource' is a concentration or occurrence of solid material of economic interest in or on the Earth's crust in such form, grade (or quality), and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade (or quality), continuity and other geological characteristics of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge, including sampling. Mineral Resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories. (JORC 2012).

**Scrap:** Recyclable and other materials left over from industrial processes ("prompt scrap") or recovered from past consumption ("obsolete scrap"). In the context of iron ore, scrap is steel which is no longer useful for its original purpose, but which may be melted down and processed again. Scrap is the major feedstock for EAFs, but is also used in the BOF.

**Screening:** A mechanical process that accomplishes a separation of particles on the basis of size and their acceptance or rejection by a screening surface.

**Selective Mining:** refers to the separate extraction of valuable minerals from less valuable minerals and gangue. In contrast to bulk mining, selective mining ensures the most complete extraction of a useful mineral with minimal depletion. Successful application depends on efficient control of mining operations to improve overall efficiencies.

**Silica:** Silicon oxide (specifically silicon dioxide or  $\text{SiO}_2$ ). The most commonly occurring oxide in the Earth's crust at about 60% and hence a common impurity (also known as gangue component) in iron ores.

**Sinter Fines:** Fines which have suitable for sintering in preparation for use in a blast furnace. This is increasingly an obsolete classification, as iron ore products are typically now divided into lump, fines, pellets and concentrates.

**Sintering:** Sintering is a thermal agglomeration process resulting in an iron rich material that is suitable for charging to the blast furnace. It involves mixing iron ore fines with coke breeze (fine material screened out from coke before the blast furnace) and other additives such as limestone, dolomite, slag and fluxes, granulating the resulting mix and then partially melting the material at high temperatures (1300-1400 degrees C) to form sinter cake. After further crushing and screening, the final product may be feed directly to blast furnaces.

**Slag:** A by-product of the ore smelting process to separate the metal fraction from the unwanted fraction. Slag is generally a mixture of metal oxides and silicon dioxides.

**Stacker:** A large machine used to pile material onto an ore stockpile.

**Steel Scrap:** Steel which has been previously processed and used in for a given application and which may be melted down and recycled to make new steel.



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**Strip Ratio:** The strip ratio is the amount of overburden which is required to be handled to extract some volume of desired ore. In iron ore mining, the strip ratio is expressed as tonnes of waste to tonnes of ore and would typically range from 0.5 – 2:1.

**Sulphur:** A chemical element with the symbol S. It is abundantly found in nature and oxidizes with most metals. It is usually present in significant quantities in coking coal (typically 0.5%-1% by weight) and is often present in small quantities in iron ores (the Platts specification is 0.02%). While sulphur is undesirable in steel, it can be controlled through raw material selection, oxidation in the BOF and use of manganese additives.

**Tailings:** Fine rejects from beneficiation of minerals, which is usually pumped as a slurry to above ground tailings storage facilities, where water is recovered. The composition of tailings depends on the concentrator feed material and processes. Typically, iron ore tailings is a fine slurry that can readily flow if containment is not managed, as demonstrated by disasters at Samarco and Brumadinho in Brazil. In Australia, tailings dams are carefully regulated and risks of facilities are openly discussed. There are risks identified with existing facilities that are being rectified, but there have been no major recent examples in Australia of external release of tailings.