

A brief history of BHP Billiton¹

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BHP Billiton is the most diverse and largest minerals company in the history of the world. It has three main ancestors, each of which was created in the 19th century. The ancestors came together only in the last two decades. Billiton is the oldest; BHP is the largest; and a South African ancestor briefly served as the vital link between the two - it is not part of the organization and indeed no longer exists. The three ancestors or strands are very different. Billiton began with tin in the Dutch East Indies, BHP began with silver and lead in Australia, and the South African ancestor began with gold. The head office of the merged company is in Melbourne, and the Australian strand in this combined history is the most significant.

The Tin Island of Billiton

John Crawfurd, a historian and geographer and administrator of Scottish birth, was an expert on the Malay peninsula and the Indonesian archipelago in the first half of the 19th century. He served in India and South East Asia for much of his professional career. Indeed he worked in early Penang when it was one of the crossroads and sea junctions of South Asia, and he served in what was called the Dutch East Indies when it was briefly a British possession at the end of the Napoleonic Wars, and in 1823 was appointed to administer the infant trading post of Singapore where he succeeded Sir Stamford Raffles.¹

In 1815, when in his early thirties, Crawfurd witnessed the effects of an astonishing event in the island of Flores - a huge eruption of the volcano called Tambora. Said to be the largest eruption in the recorded history of the world, it makes the Krakatoa eruption of 1883 seem small. John Crawfurd was at Surabaya in Java when the volcano exploded. The sounds travelling from some 250 or 300 miles away were enormous, and Surabaya officials in some alarm despatched a gunboat to see if an enemy was just around the headland. They found no sign of a ship. Crawfurd later learned what had happened at Jogjakarta in central Java. There the sounds coming from

¹ This is a revised and enlarged version of a speech prepared for the senior leadership conference of the company, held near Melbourne on 3 March 2010.

the distant volcano nearly 500 miles away were so loud that the British, who were temporarily governing Jojogjakarta, sent soldiers in the direction of the explosions, but they found no enemy. Crawford did not record what the inhabitants of the island of Billiton thought of the explosion – Billiton then was not worth noticing.²

In later years Crawford learned more about Billiton or Belitung as it was named on the Dutch charts. It lay in the wide strait separating Sumatra and Borneo, not far from the rich tin-producing island of Banka. He understood that Billiton was inhabited only by Malay fishermen - the so-called Men of the Sea - until the arrival of a few Dutchmen.³

Billiton lay at one end of what was then the largest known tin-bearing zone in the world. Stretching from the most tropical regions of Siam and the northern part of the Malay peninsula, the tin zone ran like a corridor all the way down to the island of Billiton, which was three degrees south of the equator. That corridor - passing through 17 degrees of latitude – had already surpassed Cornwall to become the largest producer of tin in the world; and so Billiton was a strategic point on the minerals map.⁴

Dutchmen are said to have discovered Billiton's alluvial or stream tin in June 1851, but the existence of the surface tin must have long been known. The Dutch syndicate was granted an official monopoly of the tin, and at The Hague in 1860 it registered a company called Billiton Maatschappij but known in England as the Billiton Tin Company.⁵ The Chinese did the mining. They came in large numbers, and probably Billiton held as high a proportion of Chinese in its population as any other island in the Indonesian archipelago in the first decade of the 20th century. In about 1910, Billiton held 42,000 people, of whom 12,000 were Chinese.⁶

The tin mined by the Chinese was bought by the Billiton company and smelted on the island. In later decades it was smelted at new works in Singapore, and, from 1928, at Arnhem in Holland. The mine was very profitable. In a typical year the Dutch East Indies did not produce as much tin as the Straits Settlements - as the Malay peninsula was then called - but Billiton was to flourish for many decades.

Just before World War One, the Billiton tinfield was prospering, and some 80 mines employed about 7,500 men. In 1924 the Dutch government increased to five-eighths its holding in the Billiton company. The company continued to pay annual dividends in the depression of the early 1930s, at which time it was mining lode tin and also using suction and bucket dredges to mine the alluvial tin.⁷ When the Japanese armed forces came south with devastating speed in the summer of 1941-1942, they

captured Billiton and worked the tin for the remainder of World War Two. The new republic of Indonesia took over the mine in 1958, by which time its richest era had long since receded. Already the Billiton directors had moved their company into other minerals. In 1935 they began to mine bauxite on Bintan Island in the Indonesian archipelago. They also went to Dutch Guiana or Suriname, where they took up bauxite deposits lying near the important mine being opened on a large scale by Alcoa, the American aluminium giant based in Pittsburgh. Billiton began to mine bauxite on a considerable scale during World War Two, and by the mid 1960s Suriname was one of the world's three major producers of the mineral.

In post-war Holland Billiton also ran their tin smelter and other industrial plants. By 1970, for reasons which are still debated, the directors decided to accept a takeover offer from another Dutch firm. At that time the Billiton company was smaller and less diverse than BHP but global in its scope.

The Royal Dutch/Shell, the new owner, had personal and geographical links with the Billiton company. The two had long been neighbours, both in Holland and in the same region of the Dutch East Indies, for Royal Dutch had found oil in Sumatra in 1885 - its first such discovery - followed by the opening of a coastal refinery there in 1892 and the selling of its first product known as Crown Kerosene. At that time the company was simply called Royal Dutch and, like Billiton, had financial links to members of the Dutch royal family.⁸

The combination of oil and tin, so close together in this corner of South East Asia, had already shaped world history, for the attractions of those minerals, and rubber too, did more than anything to persuade Japan - so deficient in these commodities - to make its onslaught in the Pacific in December 1941.

When Royal Dutch/Shell resolved to diversify in 1970, it bought out Billiton for \$US123 million. Under the new name of Billiton International this wholly-owned subsidiary expanded into scattered parts of the globe. Aluminium was its main investment. A smelter was opened in Brazil and an interest was bought in the huge belt of bauxite - one of the most remarkable in the world - discovered by Western Mining Corporation's geologists in the Darling Range near Perth in 1957.⁹ In the 1980s, at the southern end of this bauxite belt, Worsley Alumina and Boddington Gold - their big mines were adjacent - were both developed by joint ventures in which Billington was primarily a major player in bauxite, alumina and aluminium in various parts of the world. So far Billiton had few connections with BHP - except that they did cross paths.

From 1975 to 1983, in one of its minor ventures, BHP actually worked the old tin deposits on Billiton Island.¹⁰

The Ascent of Broken Hill

BHP - the middle strand in this story - already had a dynamic history. Initially it possessed one huge advantage, to which it added others. It was the largest occupier of one of the greatest base-metal deposits so far found in the world. Broken Hill, lying in the far western region of New South Wales, had been found in 1883 by a German, Charles Rasp. We now know that he was an officer in the one of the armies which successfully invaded France in the Franco-Prussian war of 1870-71. He decided to desert from the army before the war was over, and he emigrated to Australia, having changed his name - he had no wish to be recognized as a deserter.¹¹ He was working as a boundary rider on a huge sheep station called Mount Gipps, and his job was to ensure that the sheep were safe. He was well educated and had mineral knowledge, and he was pleased to find on the surface of the dry ground a piece of mineralised rock that was heavier than it should be. He thought that perhaps it was tin but it proved to be silver-lead.

Soon a syndicate was formed to search for a lode of payable silver-lead. Consisting of Rasp the discoverer, and other men who managed or worked for some of the large sheep properties of the district, Rasp selected two miles of mining lease covering the line of lode and duly paid the annual rent of five shillings an acre to the New South Wales Government. My own research suggests that this was the biggest single mining lease hitherto taken out on a major and payable orebody in Australia. Between 1850 and 1880, Australian metal-mining leases were small. Therefore one vital ingredient of the early success of Rasp's company was that it owned a huge area of ground, much of which proved to be rich.

The company issued new shares on various Australian stock exchanges in 1885 in the name of the Broken Hill Proprietary Company Limited. BHP, its nickname or abbreviated name, ultimately became its real name. The seven directors were wool men, and with one exception their expertise was not in the mining industry. Fortunately they made one of the wisest decisions in Australia's industrial history. They decided that they would search overseas for the best engineers whom money could buy. In Colorado they hired their chief metallurgist Herman Schlapp in Virginia City (Nevada) their general manager and chief mining engineer W.H. Patton. The two highly-paid recruits

were slightly shocked after they reached Broken Hill to experience the long hot periods without rain, and the lack of civic amenities in that rough but booming mining-camp.

Broken Hill's was a difficult orebody to mine, and a difficult ore to treat in the concentrating mills, but almost from the start BHP possessed first-rate technical knowledge. For thirty years it continued to import much of its top managerial talent from Europe and the United States. It then experienced an era of 80 or so years in which its main executives were homegrown - a long succession of its senior executive officers spent their whole working life or a large part of it with BHP. An unorthodox formula for success - by present criteria and fashions - it proved to be highly effective for a long period.

The lode at Broken Hill - a huge deposit of silver, lead and zinc – was like a boomerang or a coat hanger, with the bend or apex at the top. Many mining companies took up leases along the line of lode but BHP had the richest ore because it occupied the top of the coathanger. In short, it owned the oxidized zone. Other companies to the right and left of BHP had the deeper but poorer ore: they were the kings of the deeper or sulphide zone. They realised that they owned ore in immense quantities as their exploratory shafts went deeper.

BHP, like many companies that became notable, made the most of adversity. It faced an acute problem in treating the ore after the zinc became the predominant mineral. The specific gravity of the zinc was very close to that of the rhodonite and other unpayable minerals present in the ore, and so the traditional gravity process did not work. BHP tried other treatment methods but they could not separate effectively the grains of zinc from the barren material, nor extract the great majority of the lead and silver in the ore. Soon the various Broken Hill mines were surrounded by small mountains of tailings containing about 20 percent zinc. Here were potential riches. How to extract them was the puzzle.

It proved to be a crisis for Broken Hill as a mining field and for BHP as the leading company on the field. By dint of numerous experiments - 11 local companies were experimenting, and at least 40 people were contributing valuable ideas - Broken Hill's staff and employees found a new process. They did more than engineers on any other mining field in the world to develop what is called the flotation process. This remarkable innovation, improved again and again by metallurgists working in many lands, is now used in every continent to extract a variety of minerals.¹²

In everyday speech, the process can be likened to filling a large tank with liquid, finely crushing a sample of the ore and placing the resultant sand in the tank, adding chemical agents and air or gas, and inducing a myriad of bubbles to rise; and so the bubbles carry the grains of mineral to the top, where they are skimmed. The barren matter remains in the vat, unable to rise on the bubbles.

The first publicised process was eventually called the Potter-Delprat process after much litigation. Potter was a Melbourne brewer and Delprat was the general manager or chief executive of BHP. Other flotation processes were devised. New companies saw their potential value. The Zinc Corporation - which in the 1960s, through a merger, became half of the present Rio Tinto - had been formed in 1905 simply to work the untreatable zinc tailings at Broken Hill with the aid of the novel flotation processes.¹³ It was to make one of the crucial innovations, known as selective flotation.

Almost from its inception BHP worked its mine on a very large scale as an open cut and then in heavily-timbered underground workings. By the standards of the time it paid huge dividends, in the financial year 1890 and again in 1891 paying more than one million pounds. Hitherto, to the best of my knowledge, only one Australian company - the Mt Morgan Gold Mining Company, which operated in central Queensland - had come close to paying out such a sum in a financial year, though it did not quite attain the million mark.¹⁴ Its peak dividend was £867,000 in the year ending May 1890. In the following four years 1892-95 inclusive, the dividends from BHP, while declining, remained well above £500,000. They continued to fall. Between 1897 and 1913 the dividends exceeded £300,000 in only three years: the peak dividend in that period was £528,000 during the base-metal boom of 1907.¹⁵

BHP was the first big mine on the Broken Hill field to exhaust the largest part of its mineral deposit. By the 1920s it was suspending mining activities in months when the price of minerals was very low. It finally closed the mine in February 1939.¹⁶

Whenever the prices of zinc and lead and silver were low, the directors of BHP watched their profits slump. Perhaps there was more profit to be made from other activities. In June 1911 they thought that they might manufacture iron and steel, of which Australia - still in its busy phase of building railways - was a large consumer. BHP happened to own, near Whyalla, a large body of high-grade iron ore, the largest such deposit known in the continent at that time, and it was conveniently close to BHP's silver-lead smelting works at Port Pirie in South Australia. The iron ore, mined on a small scale, was used as flux in the silver-lead furnaces but could also be the raw

material for a smallish steelworks. From the USA the company engaged a consultant named David Baker and he designed the project. BHP would quarry ore in South Australia, ship it about 1,000 miles along the coast to Newcastle, not far from Sydney, and there use the local black coal to make coke for the planned steelworks.¹⁷

But where would BHP find the capital to finance the steelworks? In Australia in the late 19th century the practice - I do not think that chief financial officers would now approve of it - was for a locally owned mining company, as soon as it earned profits, to pay them out in dividends. At Ballarat and Bendigo, which were then the largest goldfields, some companies initially paid fortnightly dividends, while even at Broken Hill in the 1890s a few companies paid out six or eight dividends in the course of an exceptionally prosperous year. Likewise BHP preferred to pay out rather than hoard its profits, and by 1911 it had paid out nearly all its profits in dividends. As it held very small reserve funds, it had to issue new shares and debentures in order to raise most of the money needed for the new project.¹⁸

In April 1915 at the port of Newcastle, BHP opened its steelworks, a momentous day in the history of Australia. Before long, the company became primarily a steelmaker on the Pacific coast rather than a base-metal miner at Broken Hill. To support its main activity it was soon the nation's largest ship owner and the largest miner of black coal, its early collieries being in the vicinity of Newcastle. In this period it exported neither iron ore nor coal, except to meet occasional, small orders. The home market was everything, for Australia was in the process of industrialising, and the local demand for iron and steel products grew strongly - except during the world depression.

To become the largest player in a major field, a company usually has to enter into major mergers or takeovers. BHP for long did not take over other companies. At last in 1935 it acquired its rival, Australian Iron and Steel, which had recently built steelworks at Port Kembla, New South Wales.¹⁹ Interestingly the early boards of BHP had been more inclined to sell some of its company's own assets rather than buy out other firms. It was almost as if they did not wish to be too big. Thus in 1887-8, BHP floated sections of its ore-bearing ground at Broken Hill into independent companies - the BHP Block 10 Co. and the BHP Block 14 Co. whose head offices were established in Melbourne, and the British BHP whose head office was established in London.²⁰ In those three Broken Hill companies, all of which paid dividends, BHP itself retained no shares.

BHP was the largest industrial company in Australia by the 1930s but had no research laboratory and no close links with any overseas steel company. Essington

Lewis, its Australian-born chief executive used to travel around the world in mail steamers every few years to examine steelworks and allied plants, coke ovens and coal mines, just to find out the latest information and new techniques. He would come home after his tour of Europe and North America, his notebooks full of information. As BHP was not an international competitor, no overseas company seemed to resent it pirating or borrowing new techniques. Moreover, Lewis freely divulged information about BHP's practices and also the prospects of Australia's steel markets.

Lewis visited Japan in 1934, in the course of a long overseas tour, and found much secrecy. He was not allowed to enter some industrial plants which he had expected to visit. Nonetheless, being inquisitive and observant, he learned of Japan's unexpected capacity to build fighting aircraft: 'in emergency they could build 100 per day', he reported privately.²¹ He returned to Melbourne, sure that Japan was preparing skilfully for war, and that Australia would ultimately be involved in that war.²² He resolved that BHP, with outside help, should manufacture military aircraft and sell them to the federal government.

Lewis set up a syndicate, consisting ultimately of BHP, the Orient Steam Navigation Company, General Motors-Holden's, Electrolytic Zinc whose mining and treatment operations were in Tasmania, Broken Hill Associated Smelters which was based in Port Pirie in South Australia, and the Imperial Chemical Industries of Australia and New Zealand (ICANZ). Together they set up the Commonwealth Aircraft Corporation, a private company. From a celebrated aircraft company,²³ North American Aviation, they bought the design of a training aircraft capable of being armed in the event of war.

In discussions of Australian history in the period 1850-1940, it is commonplace to assume that Australia always depended heavily on Britain and was emotionally and culturally tied to Britain. In the mining and manufacturing industries, however, the dependence was less often to be seen. In the three major but separate decisions made by the board of BHP in the period 1885 to 1945 - namely the recruiting of the first managers, the building of the steelworks, and the making of military aircraft - United States' skills and technology rather than Britain's were preferred.

In March 1939 at Port Melbourne the first Australian-made aircraft was flown. It was called the Wirraway.²⁴ In 1941, when Japan entered World War Two, most of the frontline Australian fighters were Wirraways. Inadequate and slow, most were shot down in combat. Australia had been a year or so too late in launching the industry. By

1942, however, it was building military aircraft that could match the Japanese fighters. During the war, 3,500 aircraft were built in Australia. This nation of only 7 million people therefore mass-produced its own military aircraft before it mass-produced its all-Australian car. It was a sign of how willing were the directors of BHP to risk their hand in novel and diverse ventures. Indeed much of the Australian war effort in munitions and defence equipment relied on BHP, and it was Lewis himself who was placed in charge of the task with the titles of federal director not only of munitions but of aircraft production.

Figure 1: *Awaiting flight of the first fighter-bomber built in Australia, Port Melbourne, 3 October 1941. Essington Lewis, (on right); designer Sir Lawrence Wackett (centre)*



Source: Geoffrey Blainey, *The Steel Master: A Life of Essington Lewis*, MacMillan, South Melbourne, 1971, between pp.154-55. By permission of the author.

In the 1950s, BHP occasionally pondered opportunities outside the iron and steel industry, and all those manifold post-war industries that were gathered around its twin steelworks at Newcastle and Port Kembla. It became somewhat interested in the search for oil, at a time when Australia possessed no payable oil field. In the mid 1950s several of its senior staff, including Sir Ian McLennan, became worried lest another company should find oil and natural gas beneath their coal-mining leases in the Sydney Basin: ‘how embarrassing it would be’.²⁵ One exploratory well was actually sunk, with no success. An outstanding American petroleum geologist, Dr Lewis G. Weeks, was

invited in 1960 to visit Australia to report on the chance of finding oil beneath BHP's coal leases south and north of Sydney. After dismissing the idea, he suggested to McLennan that he knew a site where oil might well be found. He suggested Bass Strait, the narrow sea between Victoria and Tasmania: we have recently learned that an outstanding Tasmanian geologist, Professor Sam Carey, had already pointed to Bass Strait and had probably interested Weeks in the concept. Meanwhile the technology of drilling for oil beneath the ocean bed was improving. So in 1964 the BHP in partnership with Esso of the United States began to drill for oil in Bass Strait. They found natural gas in the summer of 1964-65, and then they found oil - the first major oil discovery in Australia.²⁶

This find was a profound event in the nation's history. When in 1973 a huge leap in oil prices occurred, followed by another leap in 1979, Australia avoided the economic dislocation because it was virtually self-sufficient in oil. Meanwhile in 1976, BHP bought out Burmah Oil's interests in oil and natural gas in Australia's north west shelf and so became an equal partner with Shell.²⁷ BHP's valuable interests in oil in the Gulf of Mexico came later.

It was in the 1960s that BHP developed huge deposits of iron ore in the Pilbara in Western Australia. It also began to investigate minerals at Groote Eylandt in the Northern Territory; and a valuable manganese mine was opened there. BHP's directors also became interested in Queensland coal. They had previously been mining coal on a large scale near their own steelworks in New South Wales but now came an opportunity to export coal from the Bowen Basin. Thus in 1984 they bought vital assets from General Electric of the United States, including Utah International, which was exporting metallurgical coal from central Queensland to East Asia.²⁸ General Electric also owned 57.5 percent of the shares in the recently found Escondida copper deposits in Chile, and BHP helped to open up that huge mine in the Atacama Desert. But BHP's expensive adventure in Magma Copper Mines in Arizona in 1995 was not a winner, and the Ok Tedi copper mine in Papua New Guinea aroused environmental anger. At home BHP was thinning and rationalising its old steel empire that had underpinned so much of the industrialisation of Australia. In 1999 it ceased to make steel at Newcastle, the home of its original steelworks and for decades the core of the company's operations. Soon iron and steel interests - still wide - became two separate companies, One Steel and BlueScope Steel.²⁹ And so the company, which twenty years previously was virtually an

all-Australian company in its ownership and its activities, became more and more a global company.

The South African ancestors

This brief history moves to The Rand in South Africa, which by 1900 was the largest goldfield the world had seen. There two of the strongest companies were General Mining & Finance Corporation, which was founded in 1895, and the Union Corporation, which began life in 1897 as AD Goertz & Co. Both companies were founded largely by German mining and financial men. After developing their deep gold mines near Johannesburg, they were important in opening the vast gold deposits of the Orange Free State. They were to form, much later, a vital third strand in the history of the present BHP Billiton.

I should add that in European history, the Union Corporation holds a special place. When Germany was re-arming in the mid-1930s, Winston Churchill, then a backbencher, was one of the few influential members of the House of Commons to insist that Germany was highly dangerous. He particularly wished to ascertain how heavily Germany was re-arming, and how many vital raw materials it was quietly importing. Germany of course did not disclose such vital statistics. Fortunately Churchill had a new-found friend, Sir Henry Strakosch, who was the chairman of the Union Corporation, which was then directed from London, and he sought his help. Union Corporation's office in London had its own small intelligence department, which did the vital research on the German economy.

When Churchill personally ran into serious financial trouble in 1938, Strakosch lent him £18,161 – then a very large sum. Strakosch died five years later and bequeathed £20,000 to Churchill who by now was prime minister.³⁰ So, in a crucial phase in the defence of western civilization, when Churchill himself was a vital leader, this South African mining company played an unusual role as rescuer.

After the Second World War, those two South African companies worked often in collaboration. They moved into uranium, mineral sands, steaming coal, and platinum - eventually platinum was almost to rival gold as the dynamic South African export. In 1980 the two companies merged under the name of Gencor - an abbreviation for General Mining and Union Corporation.

Gencor, continuing to expand, was alert for takeover opportunities, and a wonderful opportunity arose in 1994. Royal Dutch/Shell decided to concentrate again

on oil and step away from general mining. Billiton had made a loss in the previous year, for the price of aluminium, its main metal, was low. Moreover its big aluminium venture in Brazil faced political as well as economic obstacles.

All those assets held by Shell in the name of Billiton International were placed on sale.³¹ Gencor was a potential buyer but it was not easy for a South African company to gain its government's permission to spend money on overseas ventures. By a remarkable piece of financial wizardry, Gencor in 1994 managed to raise enough money, mainly outside South Africa, to buy most of these mineral assets. They included ventures in gold (but not the Boddington mine in Western Australia) nickel, copper and zinc. The most valuable assets were in the bauxite and alumina industries in Suriname, Australia and Brazil.³²

In 1997 the directors of Gencor, still a South African company, resolved on a massive re-organization. They would bundle together the company's assets in aluminium, coal, copper and nickel, and float them on the London Stock Exchange. Amongst those enterprises were a few - notably the Richards Bay aluminium smelter in South Africa, which had not belonged to Billiton in its Shell era, and others which had not belonged to Billiton when, more than a quarter century previously, it was an independent Dutch company. The directors of Gencor, needing a name for the company which they were floating in London, decided on the name of Billiton. A venerable name, going back to 1860, it was respected internationally and had long been associated in the public mind with minerals. So it came to life again as Billiton plc.

In June 2001, only four years later, the jigsaw was completed. BHP and Billiton agreed to merge. Although a majority of the assets came from BHP, the name Billiton was chosen as the second part of the name for the new company. This is probably the only instance in business history of a prominent corporate name surviving various changes and takeovers, in each of which the name could easily have been extinguished.

How and why they merged is a different story, but the new BHP Billiton was successful. In the following decade China became the dominant global market for iron ore and metallurgical coal and several other minerals in which BHP Billiton specialised. More acquisitions followed, including the company W.M.C Resources (formerly Western Mining) with its massive deposit of copper, uranium and gold at Olympic Dam, South Australia - the most significant metalliferous discovery made in the continent in the last one third of a century. Today, understandably, many of the key assets of BHP Billiton lie outside Australia, and most of its shares are held overseas, but

in total far more of its mines, refineries, and smelters are in Australia than in any other single country.

BHP Billiton is now the biggest mining company in the world. That in itself does not ensure its long term success. It is easier to rise than to stay on top.

Endnotes

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³ Crawford, *A Descriptive Dictionary*, p. 53.

⁴ *Ibid.*, p. 436.

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⁶ 'Billiton', entry in *Encyclopaedia Britannica*, Cambridge, 1910, 11th edn, vol. 3, p. 940.

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¹⁶ Blainey, *The Rush That Never Ended*, pp. 274-5.

¹⁷ For further details see, Roy Bridges *From Silver to Steel: the romance of the Broken Hill Proprietary, Robertson, Melbourne, 1921*; Geoffrey Blainey, *The steel master: a life of Essington Lewis*, MacMillan, South Melbourne, 1971.

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²⁰ Unpublished, typewritten report of overseas tour by E. Lewis, 1934: inspected by the author at BHP head office, Melbourne, in 1963.

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²⁴ *Ibid.*

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³⁰ J.D.F. Jones, *Through Fortress and Rock: the story of Gencor 1895-1995*, Jonathan Ball, Johannesburg, 1995, pp. 102-3, 106-7.

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³² Jones, *Through Fortress and Rock*, p. 238.