

History of the C.S.A. Mine

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The C.S.A. mine contains the largest known copper resource in the Cobar region. Up until 2005 it produced a total of 596,250 tonnes of copper metal and is estimated to still hold at least another million tonnes. In addition, significant amounts of lead, zinc, silver and some gold have also been produced. However, it took more than thirty years from the initial discovery until the first commercial ore was located and almost another sixty years before the true potential of the mine was recognised.

Discovery of copper at Cobar

In the spring of 1870 copper was discovered at “Kubbur”, an aboriginal water hole on the semi-arid plains between the Darling and Lachlan Rivers. Three contract tank sinkers, Charles Campbell (true name Ferdinand Emilius Kempf), Thomas Alfred Hartman (true name Jens Arnholdt Gottfred Albrecht Hartmann) and George Samson Gibb, had been led to the water at this site by their aboriginal guides Frank and Boney, while travelling from Louth on the Darling River to Priory and Gilgunia. The party camped overnight at the water hole and noticed bright green and blue staining on the walls of the rock hole. In the early 1860s the three contractors had tried their luck on the Victorian goldfields and were sufficiently curious to collect samples of the brightly coloured mineralization. The next day as they continued south they met Henry and Sidwell Kruge and showed them the specimens. Mrs Kruge (nee Woolcock) had worked as a “bal girl” in the Cornish copper mines. She immediately identified the samples as copper ore. Campbell, Hartman and Gibb returned to Bourke, and on the 6th of October 1870 in partnership with local postmaster and businessman Joseph Becker, they took up a mineral conditional purchase of 40 acres. They then returned to the Kubbur water hole to evaluate their find. A three ton sample was sent to Louth by bullock dray and then to Adelaide by river boat for testing. Joseph Becker also sent samples to Sydney for analysis. Assays received from Adelaide in February 1871 showed 33% fine copper. The Cobar Mining Company was formed in late 1871 with 200 shares issued at a price of £10 per share. The original owners were the three tank sinkers and four leading men of Bourke, Joseph Becker, William Bradley, Russell Barton and James Smith. Becker’s accountant, Alexander Ogilvie was appointed company secretary. This company would become the Great Cobar Copper Mining Company (Limited) following merger with the adjacent South Cobar mine in 1876. Captain Thomas Lean, an experienced mine manager, was appointed to supervise mining and arrived at Cobar from South Australia with six Cornish miners on the 4th November 1871

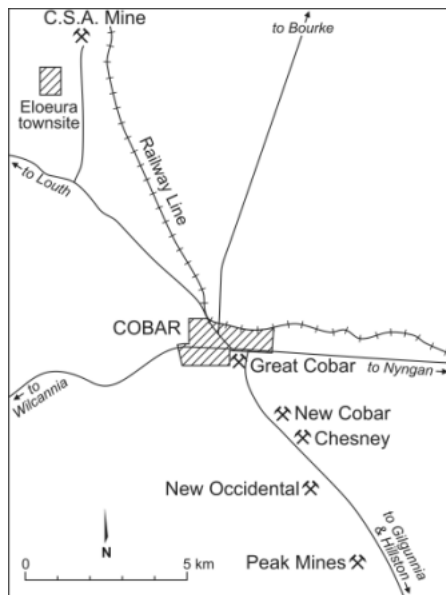
Discovery of the C.S.A. deposit

The discovery of rich copper ore at Cobar led to the search for similar deposits in the district. Joseph Becker with others took out claims around the initial discovery in 1871. In late 1871 or early 1872 Tom O’Brien discovered a large outcrop of brick-red iron oxides on a low rise (later called Elouera Hill) 11 km north of Cobar. After some searching he picked up a small piece of copper carbonate. O’Brien appears to have approached or been a member of a prospecting party set up and funded by George Gibb in late 1871. George Gibb and his partner John Connelly examined the find and decided it was worth claiming. It was said that they departed for Bourke very quietly in the hope of securing the ground without opposition, even muffling the hoofs of their horses with bags so that their movements might not be heard in the clear night air. They did not have sufficient cash to pay the required £20 deposit for a 40 acre lease, but two Bourke businessmen, Henry William Nancarrow and his younger brother Richard, were able to help them out in return for an interest. The claim was lodged on the 1st of February 1872. On the 27th of February a well-equipped party including Henry Nancarrow and John Connelly revisited the discovery to further evaluate the find. They returned to Bourke around the 21st of April with fine specimens of grey and ruby oxide of copper. The four lease holders decided to put the venture into 1000 shares and call the mine the Cornish, Scottish and Australian after their respective nationalities, Nancarrow (Cornish), Gibb (Scottish) and Connelly (Australian). They issued shares and many started buying, although enthusiasm was dampened when Captain Lean, visited the site but declined to pass judgement on the discovery. The prospecting party had suffered great hardships, including shortage of water and food and decided to wait for rain before commencing operations.

An early description of the C.S.A. mine was not particularly encouraging. In June 1872 Augustus Becker (brother of Joseph Becker) inspected the site on his return to Bourke from a visit to Cobar. He reported:

“On returning, the road being heavy and wet, I visited the Cornish, Scottish and Australian copper mine, which is situated about seven miles north-west of the Cobar. There was no person on the ground. The mine is a recent discovery. A small quantity of ore, some of it of good percentage, lies on the ground. Only one blast has been put in the lode. I traced the ‘back’ of it for some distance. The country has some resemblance to Cobar. Those who have knowledge of copper mining speak favourably of it, but I don’t profess to speak authoritatively

myself on such matters and regretted that no one was on the ground to guide me as to its probable extent. Two practical men have been sent out to open the mine. All desirous of correct information concerning either this mine or the Cobar will obtain it from the recognised agent, Mr W. Webb, Bourke”.



Location of the C.S.A., other mines and some key sites in the history of Cobar.

Early optimism, speculation and disappointment

In 1872 the price of copper was at a dramatic high and the discoveries around Cobar sparked a local land-pegging boom from June to August. On the 6th of July the Bourke correspondent for the Town and Country Journal noted:

“The copper mania is fast upon us but nothing positively can be said of any of the mines save Cobar”.

The following week he may have succumbed to the mania himself, reporting:

“The specimens brought in from the C.S.A. mine, or where the mine is to be, are rich and great are the expectations there”.

In late July the Cornish, Scottish and Australian Copper Mining Company Limited was formed with a nominal capital of £40,000 in £1 shares. Two hundred and sixty acres of land were taken up and two men were engaged to develop the prospect. In August the number of miners was increased to six and a few shares in the new company sold at auction in Bourke for £18 5s. A group holding the northern half of the hill at C.S.A. formed the North Cornish, Scottish and Australian Copper Mining Company. On the 7th of August the Bourke correspondent for the Town and Country Journal reported on the copper mining activities in the Cobar area as follows:

“There are some fine specimens of copper ore on view from the C.S.A. Company and there is no doubt if the directors do their duty to the shareholders in an intelligent, energetic manner, there will be nothing to complain of. It is regarded by the majority of scrip holders that a mistake was made in the issue of 40,000 shares instead of 20,000. 640 acres taken up last Thursday, and tomorrow there will be another rush. The cartage of copper ore will commence directly from Cobar, many teams being put on at the C.S.A. There are six miners at work, while four times that number is needed. The lack of miners is a great drawback to the various enterprises. The work goes on too slow”.

By early September 1872 a shaft had been sunk 27 feet and it was reported that black “sulphate” of copper had been intersected. C.S.A. shares were quoted at £13 10s. Later in the month the leading miner reported that the shaft was down 38 feet in rich lode material and a specimen sent to a Mr Twemlow of Sydney assayed 11% copper. However, the water supply was beginning to fail. By this time a number of parties had pegged ground around the C.S.A. mine and it was proposed to amalgamate these properties with the existing company. This appears to have been misrepresented to shareholders in Sydney as a forced amalgamation, necessitating a public meeting in Bourke on the 18th of September to resolve the issue. A number of shareholders were unhappy with the management and development of the property, with local complaints that there was not enough ‘brain and muscle on the ground’. In October the company was handed over to the Sydney shareholders, with George Gibb, Henry Collis and W.W. Davis chosen to represent the Bourke interests. In early 1873 a new mine captain was appointed to properly develop the mine although a subsequent report in the press gives a hint of the speculative approach of management at the time:

“The Captain of the C.S.A. has arrived at the mine but has not had sufficient time for more than a cursory inspection. From this however he has formed a most favourable opinion of the Company’s property. The

manager and some of the local directors propose visiting the mines after the races in order to confer with the Captain as to carrying on the work”.

In June it was reported that Captain Tonkin with a few miners was sinking at the C.S.A. and doing other necessary work, such as making a ground tank for water and constructing a few huts. Progress appears to have been slow and no significant lode was discovered. In March 1874 the shaft was down to 150 feet and the captain was ‘positive that the mine will be profitable’. After this time little is reported from the mine and it appears to have been abandoned by 1876 when the lease lapsed. During this initial period of exploration many shallow diggings were put into the outcropping gossan, but unlike the Cobar mine, no significant body of rich copper ore was found in the near surface oxide zone. Many of the shareholders and Bourke entrepreneurs were also clearly more interested in making money from speculation than from mining.

Further attempts to develop the C.S.A.

In 1882 a new group under Isadore Cohn started prospecting at the C.S.A. and attempted to develop it as the Scottish and Australian mine. Lack of water in 1883 forced the company to suspend operations for that year and continuing dry conditions and low copper prices during 1884 and 1885 meant that copper mining in the whole Cobar district was in a very depressed state. Eventually in 1886 the C.S.A. lease was again forfeited. The Great Cobar Copper Mining Company then took up the property and under the management of Captain R.N. Williams began further shaft sinking and prospecting. Encouraging prospects were obtained from the gossan in 1887. By 1888, two new shafts had been sunk on narrow veins of copper ore to depths of 100 and 120, and drives had been put in from the old shaft, but with limited results. Work was again hampered by a lack of water, there being only 6 inches of rain in 1888. On the 3rd of August 1889 the Great Cobar mine was closed following a drop in the copper price due to the failure of the Société de Metaux to corner the copper market. Prospecting operations at the C.S.A were also suspended.

From 1895 to 1899 the C.S.A. lease was held by Henry Cornish and party. Henry was a well known Cobar identity who had held shares in the original company as well as a number of other Cobar mining ventures. He had lost his investment in the C.S.A. but obviously not his faith. By this stage the main shaft into the large gossan had been sunk to 250 feet. The weathered lode at this level was very wide and carried a little gold all through, with occasional veins of lead carbonate. Henry’s group received Government aid to deepen the main shaft a further 100 feet. After carrying the shaft down to 332 feet and completing some driving, operations were abandoned, no payable ore being discovered in the still persistent porous gossan.

Discovery of rich secondary ore

In early 1905 George Blakemore set up the C.S.A. Development Syndicate in yet another attempt to prospect the C.S.A. property. This syndicate was probably modelled on the Great Cobar Mining Syndicate, which very successfully redeveloped the Great Cobar mine from 1893 to 1906. Blakemore’s group was able to raise £2,000, in 40 £50 shares, although at the time many understandably considered the venture a gamble. From his experience as mine manager and general manager of the Great Cobar, Blakemore recognised the importance of testing deposits in the region to below the extensively leached and depleted zone above the water table. In a letter to the Department of Mines in 1905 and as part of an application for prospecting aid he noted:

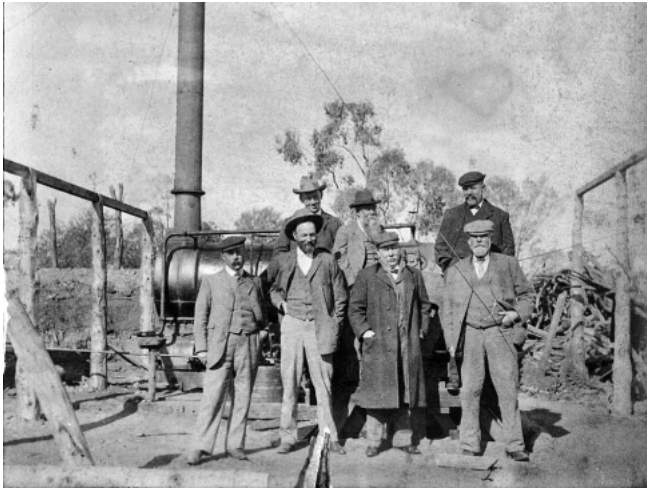
“No persistence was shown by the original prospectors, and they seem to have wasted their money in sinking a number of shafts and cutting costeans all over the hill, instead of starting in one shaft and sinking below the oxidised zone. The depth that oxidation has reached is notable”.

The C.S.A. Development Syndicate commenced work in March 1905 by cleaning out and re-timbering the old main shaft. An engine and boiler were borrowed from the Great Cobar Syndicate and a poppet head erected over the shaft. Prospecting aid was granted to deepen the shaft to 482 feet, to get below the water table, and to explore by cross-cutting 75 feet east and 50 feet west. By September, after sinking 125 feet, water was encountered in the shaft. A cross-cut was then started east, and after a few feet this intersected rich lead carbonate ore. This cross-cut was continued for 168 feet in ore. A bulk sample of ore over an eleven foot section assayed 52.5% lead 11 dwt of silver and 1 dwt of gold. The C.S.A. Syndicate shares rose to £500 each. Further development revealed a large body of secondary lead and silver-bearing ore with minor copper, the redeposited accumulation from 450 feet of leaching from the overlying oxidised zone.

Another land-pegging boom ensued and during October 1905 a total of 1,700 acres was claimed around the C.S.A. Two mining experts, John Howell and A.T. Brown, visited the mine in November and reputedly agreed that “it promises to be the biggest lead discovery since Broken Hill”. A number of groups keen to float companies took advantage of the excitement. In early October, the “C.S.A. North” with 32 £10 shares was floated at a meeting at Newberry’s Hotel in Cobar and the “South C.S.A. Development Syndicate” was also set up.

Following the discovery of rich lead mineralisation, the C.S.A. Syndicate decided to float a company to further develop the mine. On the 5th December 1905 C.S.A. Mines Limited was formed with a nominal capital of 44,000 £1 shares. Directors of the Company were J.O. Armstrong, G.H. Blakemore, A.T. Brown, John T.

Lemperiere, Dr R. Read and Peter Snelson, all of whom were members of the original syndicate. By early 1906 the company held 210 acres of leases with 17 men working underground and 20 on the surface. Equipment



The C.S.A. Mine in early 1905 showing the newly installed steam engine. The mine captain, Mathew Bryant is at the front right and Peter Snelson, local Director is front, second from left.

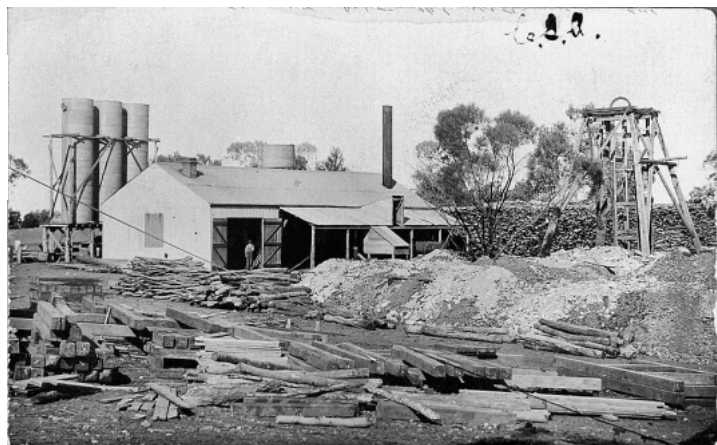
included two boilers, a winding engine and air compressor. Captain Mathew Bryant was the mine manager and F.N. Yarwood the company secretary. During 1906 a new three compartment main shaft was started 240 feet northwest of the old main shaft. This new shaft was designed to test the sulphide zone well below the water table and to connect with the workings from the old shaft, improving access and ventilation. At the end of 1906 it was down to 250 feet. A new steam winding engine was installed at the new shaft. This was manufactured by Jas Martin and Co. of Gawler and featured 8 inch cylinders with a 16 inch stroke. Exhaust steam was condensed in 20 foot high air condensers constructed from concentric double cylinders of galvanised iron. A large amount of driving was done from the old shaft and the system of square set timbering, using imported Oregon pine, was introduced for stope support. This was necessary because of the considerable

width of the stopes and the very friable nature of the secondary ore being mined. The ore produced and sold during 1906 amounted to 1,923 tons and realised £17,238. Production and smelting costs for this period averaged £3 2s 11d per ton.

In 1907 L.J. Winton, an engineering graduate of the University of Sydney, took over management of the C.S.A. mine. The adjoining C.S.A. Block 10 Mining Company was absorbed and the nominal capital of the company was increased to 60,000 £1 shares by the addition of a further 16,000 contributing shares. Machinery to the value of £3,100 was added to the plant and the number of men employed was around 50, with 31 working underground and 19 above ground. At this stage there were 2 boilers, 2 winding engines, a three drill air compressor, oil engine and pump and other machinery in the course of erection. The main shaft was extended to 595 feet and connected with the drive from the old shaft at the 450 feet level. Another level was developed at a depth of 560 feet. During the year, 1,367 tons of ore were raised, of which 1,024 tons were sold for a return of 355 tons of lead, 1,223 oz of silver and 87 oz of gold valued at £6,500.

Further development during 1908 proved large bodies of low-grade mixed sulphides, but there was no recorded production. Up to this time C.S.A. Mines Limited had treated a total of 5,294 tons of ore for a yield of 1,350 tons of lead, 5,600 ozs of silver and 325 ozs of gold, worth £24,676. The company had expended £59,867 without a return to shareholders.

Discovery shaft and plant at the C.S.A. mine circa 1908. Note steam condensers at rear of engine house and Oregon timber for underground workings.



The promise of copper

In April 1909 the C.S.A. mine was closed following exhaustion of the known secondary lead ore. It was reopened in August 1910 and a search was made to the east of the main underground workings to test for possible copper bodies beneath gossans east of the main gossan. After driving a few feet from the No 1 east cross-cut from the old shaft on the 450 foot level, a body of copper ore 8 to 10 feet wide was encountered. This was the first positive sign of the possible copper potential of the mine and it provided the impetus for further copper exploration. Between 1910 and 1911 the mine manager, Charles Mackenzie, focussed exploration in the area east of this discovery. As a result of this work a large body of siliceous copper ore was outlined.

During 1905 a separate group had been prospecting to the south of the C.S.A. workings in an area known as Gardner's Block. An underlay shaft was put down 200 feet on a gossan about 700 feet south of the main C.S.A. shaft. In 1906 this shaft was continued a further 100 feet, and below this a winze was extended an additional 118 feet making a total of 418 feet from the surface. A cross-cut 52 feet to the west intersected carbonate ore, similar to that found in the C.S.A. mine, and containing an average of 15 % lead and 1.5 ozs of silver per ton. In 1907 another shaft was sunk east of this discovery and by 1908 had reached a depth of 450 feet. At this depth, a cross-cut driven 25 feet to the west intersected a lode carrying rich oxides and black sulphides of copper. In March 1909 the property was floated into a company called the Cobar Tinto Copper Company NL and during the year a large body of copper oxides and sulphides were mined near the water table. In 1910 the main shaft was deepened a further 85 feet and intersected the east dipping lode, exposing primary sulphides. Driving commenced north and south at this level. During this development a mass of silicified slate with poor copper grades impeded progress and the mine was closed down. To this time a total of 5,129 tons of ore had been raised at the Cobar Tinto yielding 45 tons of lead, 582 ozs of silver, 112 ozs of gold and 244.5 tons of copper valued at £15,667.



New three compartment main shaft at the C.S.A. circa 1908 from the west.

By the end of 1911 the C.S.A. mine had been developed on 4 levels between 330 and 660 feet below surface. Although significant bodies of copper-bearing ore had been found, the two largest veins were highly pyritic admixtures of lead, zinc and copper with a copper content too low to allow them to be worked as stand alone copper ores. However they had potential as a basic flux in copper smelting. During 1912 further deposits of lead carbonate, some with high values of native silver, were discovered. A total of 2,519 tons of lead ore was raised and sent to Cockle Creek for treatment to produce 806 tons of lead and 10,078 ozs of silver, returning £14,185. The company also completed 574 feet of horizontal diamond drilling from underground, and one hole on the 660 foot level intersected three distinct copper ore bodies, 100, 15 and 10 feet wide respectively. These averaged 2-3% copper and gave great encouragement for the C.S.A. to be worked as a copper mine. Limited mining at the Tinto mine produced 60 tons of ore grading about 8% copper. It had previously been recognised that if the copper contents of the C.S.A. together with the Tinto deposits could be brought up to about 2.5% it would be possible to smelt them profitably on a large scale. However it was also realised that an extension of the railway from Cobar would be required to encourage sufficient investment to construct a proper plant. At this stage C.S.A. Mines Limited employed twenty three men and the total value of machinery was estimated at £6,889. In 1913 4,002 tons of lead ore were sold to the smelters for a return of £11,345. The separate Cobar Tinto mine employed eight men and in 1913 mined 505 tons of ore averaging 7.1% copper. This was sold to the Great Cobar mine for £1,202. In August 1913 C.S.A. Mines Limited acquired the Cobar Tinto mine when it absorbed the Tinto Company.

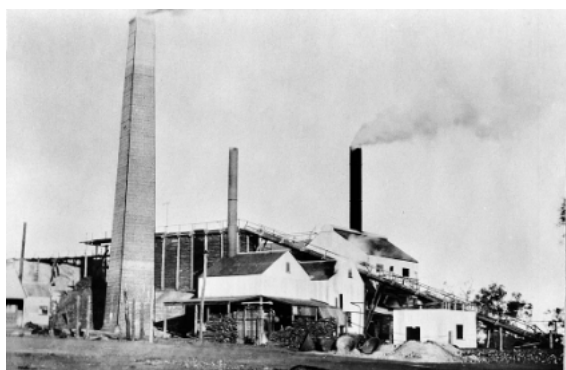
Extraction of the higher-grade lead ore was completed in 1914 and attention then turned to the copper ores. The outbreak of war in the latter part of the year meant that many of the Cobar mines were unable to sell their ore due to an export embargo and market uncertainty. Copper prices had also dropped in early 1914 due to the impending hostilities and the Great Cobar mine and associated smelters had closed in April, throwing many men out of work. At the C.S.A. mine, operations continued throughout the year with the exception of two or three months pending an application for suspension of labour conditions. A total of 1,499 tons of ore was treated to produce 490 tons of lead and 101 tons of copper.

The Great Cobar finally went into liquidation in 1915 and remained idle throughout the year while arrangements were made between the receivers, unions and NSW Government to finance and reorganise mining and smelting operations. The increased demand for copper due to the war pushed the price to £86 per ton and mining at the C.S.A. was focussed on the copper ores. Total production for the year was 455 tons of copper from 4,350 tons of ore. There was a firm proposed to extend the railway line from Cobar to the C.S.A. mine, but first it was necessary to establish that sufficient copper ore was available to justify this investment by the state Government. An investigation conducted in 1916 by Inspector of Mines J.R. Godfrey, calculated the available copper resource as more than 200,000 tons at 5.5% Cu, giving a minimum mine life of 4 to 6 years. Construction on the railway extension started in late 1916.

An important aspect of the copper smelting activities at Cobar was the blending of different ore types. Ores with a high silica content were referred to as acid or siliceous ore, and ores with high iron content as basic ores. During smelting it was important to have the right mix of silica and iron to produce a good slag to remove the various non-copper components of the ore. Basic ores were particularly abundant at the Great Cobar mine and thus required the addition of siliceous ores from various local sources. Up until this time all of the C.S.A. ores had been sent away for processing and the company had concentrated on the high grade supergene lead ore and the basic copper ores that were most in demand and most profitable. Large-scale mining and smelting on site would allow the mining of the abundant siliceous ores that surrounded the basic ore lenses and which carried surprisingly high values of copper. It was also recognised that some sort of mineral separation, such as flotation or gravity separation could greatly benefit the processing of those C.S.A. ores that contained mixed metals. This would remove deleterious zinc and lead from the copper and also take advantage of the high zinc prices by producing a zinc concentrate. However such a process was not introduced, probably because of the complex nature of the ores (containing at least four different ore minerals) and the state of flotation technology at the time.

The price of copper was abnormally high during 1916, ranging from £100 to £150 per ton, well above pre-war levels. However, in the Cobar district this very favourable price did not result in an increase in prospecting activity or the opening of new copper mines. This was apparently due to the inability of smaller mines to get their ores treated locally and the relatively high prices charged by custom smelters outside the district. Copper smelting had recommenced at the Great Cobar in January 1916 but industrial unrest and a lack of skilled labour hampered production. Operations on the mines were also considerably interrupted by an engine drivers strike, a coal strike and demands by local miners for increased wages and a 44 hour system similar to that granted to the Broken Hill miners. At the C.S.A. mine a modern smelting plant capable of treating 100-150 tons per day was completed in August but was not started until early 1917.

In 1905 the C.S.A. Development Syndicate had applied to the NSW Forestry Department to reserve a belt of vegetation a mile wide around the mine site so that if a township developed it would not have the barren aspect typical of most mining settlements in western NSW. This far-sighted request was approved and an additional belt requested. A small settlement known as Eleoura had gradually developed southwest of the C.S.A. mine where the company initially erected three houses for its staff and a large boarding house to accommodate fifty men. In 1917 it constructed eleven workmen's cottages and Eleoura had grown to small town with its own hotel and public school.



Main shaft headframe and engine house C.S.A. mine and the smelting works circa 1918.

The railway connection from Cobar to the C.S.A. mine was completed at the end of 1917 and officially opened in January 1918. This considerably improved the economics of the C.S.A. operations. Until the railway was opened the low-grade matte produced by the blast furnace was concentrated to a shipping grade of 45-50% copper and sold in that form. After the railway was opened, contracts were made with the Electrolytic Refining and Smelting (E.R. & S) Company at Port Kembla for the sale of the matte for direct processing and refining. This contract would not have been profitable without the cheaper transport provided by the railway link. A second larger smelter commenced operations in January 1918. From June 1917 to July 1918 the furnace plant smelted 26,118 tons of copper ore and 6,979 tons of basic pyritic ore to produce 1,343 tons of copper in the form of shipping matte. However, the Directors of the Company, particularly the Chairman George Blakemore, were not happy with the high processing and refining charges being levied by the refinery. Since the start of the war the Federal Government had prohibited the export of copper ore, copper matte or unrefined copper. This effectively gave the E.R. & S. Company a monopoly on treatment in New South Wales as they possessed the only electrolytic refinery. Blakemore devised a bold plan for the C.S.A. to build its own refinery and cut refining costs by 70%, saving the company an estimated £20,000 per year. He also reasoned that this plant could service

other copper produces in NSW and break the monopoly held by E.R. & S. Blakemore's grand vision was not shared by all the Directors and shareholders, who felt that the required funds might be better directed towards dividends. After some persuasion the decision was made to go ahead with the refinery and a suitable site was selected at Kandos on the railway near Mudgee. This was next to the New South Wales Cement, Lime and Coal Co., Ltd works and a contract was arranged with this company to lease suitable land and provide water, coal, limestone for flux and electricity at a cheap rate. Deposition tanks for the electrolytic plant were procured from the closed Great Cobar copper refinery at Lithgow. In May 1918, C.S.A. Mines Ltd commenced construction of a furnace plant and electrolytic refinery at Kandos capable of producing up to 50 tons of refined copper per week. The plant cost about £32,000 and this capital expenditure also allowed the company to avoid paying War Profits Tax of 75% on additional dividends above the 10% profits allowed under the Federal Government's War Profits Bill. In October 1918 a blowing plant was also under construction at the C.S.A. mine site. This was designed to make full use of the fluxing qualities of the immense basic ore supplies available at the C.S.A. mine in smelting other siliceous ores of the Cobar district. By the end of 1918 the C.S.A. plant had treated 55,028 tons of ore and produced 2,232 tons of copper, 60,294 ozs of silver and 558 ozs of gold, the largest annual production to that point. However, these positive developments all started to come unstuck with the end of World War I and the dramatically reduced market for copper.

In 1919 the price of copper plummeted. The Great Cobar mine closed in March and shortly after the C.S.A. ceased mining and remained idle throughout the winter except for exploration work. Operations commenced again in September when an assured market was found for the company's copper. The new plant at Kandos had commenced smelting operations and some furnace refining, but the electrolytic refinery, although complete, was not used. Total production for 1919 was 396 tons of copper, 8,791 ozs of silver and 43 ozs of gold from 15,626 tons of ore.

Problems resulting from the low copper price were soon eclipsed by a much greater disaster. On Saturday 20th March 1920 at about 6 pm after the end of shift, dense smoke was seen pouring from the Tinto shaft at the C.S.A. mine. Investigation revealed that a fierce fire was raging in the Oregon timbers of the old worked-out stopes on the 450 level. As there were no means of isolating the fire and there was great risk of it invading the timber in the underlying producing stopes, it was decided to seal the mine in the hope of smothering the fire. This was feasible given there were only five easily sealed connections to the surface. After this was done a steel smoke stack was erected over the Tinto shaft so that when the mine was reopened the hot smoke and gas would be drawn to this outlet, setting up a current of air in one direction. This would minimise the risk to anyone going below to investigate and fight the fire. Preparations were made for reopening the mine and a number of "Proto" breathing apparatus were imported from Broken Hill. The shaft was reopened on the 3rd May and the workings investigated by a small team using the "Proto" equipment. The fire appeared to be out but the mine was allowed to stand and ventilate for two days. On the second day the fire broke out again, but as the stack over the Tinto shaft was drawing well it was decided to leave the mine open and allow the fire to burn itself out in the old workings. Unfortunately a collapse in the stopes blocked the outlet to the Tinto shaft stopping the air current and causing the whole mine to fill with thick smoke. There was no option but to reseal the mine. At the time and over the years, a number of conspiracy theories have been proposed, suggesting sabotage as the cause of the C.S.A. fire. A more likely explanation relates to the oxidising characteristics of some of the C.S.A. ores. Self-combustion or heating of remnant sulphides or backfill in the old stopes could have ignited the dry Oregon timbers. In late 1917 when the smelter was idle, a large stockpile of ore on the surface had caught fire spontaneously and burned for some months. Also in the 1960s when the mine was redeveloped, there were a number local explosions and fires caused by ore dust igniting after blasting. These later incidents prompted detailed studies of the combustibility of the C.S.A. ores that resulted in special precautions being recommended to prevent further ignitions.



*Fire investigation team C.S.A. mine 1920.
L to R: Fred Rue (miner) A.J. Julius Mine
Manager, Gwyder Whanen (surveyor) Bob
Pivetta (underground foreman).*

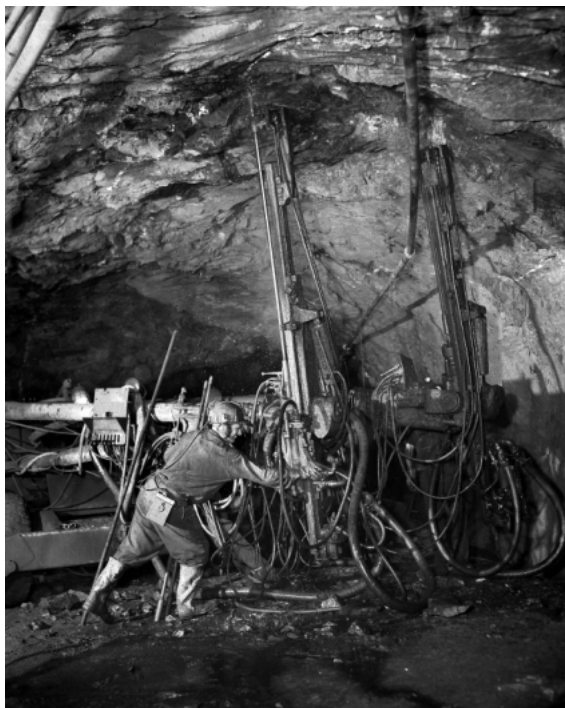
The underground fire in 1920 put an end to mining and smelting operations at the C.S.A. and also resulted in the closure of some smaller mines that relied on the C.S.A. plant to process their ores. The fire burned until about 1936 and the mine remained closed apart for some very small-scale mining until 1962. From 1905 until 1920 a total of 113,559 tons of ore had been treated to produce 4,182.5 tons of copper, 3,978 tons of lead, 94,955

ozs of silver and 1,335 ozs of gold. Most of this production occurred during a few short periods and the early history of the C.S.A. mine was greatly affected by fluctuations in the copper price, droughts and world events.

Drilling and deeper exploration reveal full potential

Copper mining across the whole Cobar field remained largely dormant from 1920 until World War II. Following the war the Federal Government was keen to rehabilitate the mining industry and set up a Mining Industry Advisory Panel to examine proposals to redevelop mines. The Bureau of Mineral Resources, Geology and Geophysics (BMR), and the New South Wales Geological Survey, were asked to prepare reports on these proposals. This led to a co-operative joint project between the BMR and NSW Geological Survey to reassess the Cobar mineral field. The Commonwealth Government was also persuaded to free up the official price of copper, which rose from £95 to £130 per ton by May 1947 and to £160 by mid 1948. The Broken Hill mining companies became interested in the potential of the Cobar area. Enterprise Exploration Company Pty Ltd, a subsidiary of The Zinc Corporation (later Consolidated Zinc Pty Ltd. and then Conzinc Riotinto of Australia Ltd.), started exploring the Cobar district in 1947. In 1951 this company acquired the leases over the derelict C.S.A. mine. The workings were de-watered, the main headframe re-erected and the shaft re-timbered. Underground drilling was commenced and some copper precipitate produced from the mine waters. Exploration around the old workings established that there was at least 17 million tonnes of ore containing 1.3% Cu, 1.3% lead and 3.2% zinc between a depth of 492 and 1,600 feet and another 3.6 million tonnes of 3% copper, 1% lead and 3% zinc in a separate lens. However a feasibility study indicated that this mineralisation could not be extracted economically and in 1958 the C.S.A. mine was placed on care and maintenance.

In October 1955, Broken Hill South Ltd, through its subsidiary Mines Exploration Pty Ltd, took an option over the leases held by New Occidental Gold Mines Ltd. and the following year set up two companies, Cobar Mines Pty Ltd and Cobar South Pty Ltd, to develop the base metal and gold properties respectively. This group began exploring the southern part of the Cobar field, pioneering the introduction of deep diamond drilling from surface, including at the Great Cobar and Chesney mines. In May 1960 Broken Hill South and Consolidated Zinc decided to merge their Cobar interests to better explore and develop the field. Agreement was reached whereby Broken Hill South Ltd retained a 76⅔% interest and Consolidated Zinc Pty Ltd acquired a 23⅓% interest in a joint Cobar project conducted through Cobar Mines Pty Ltd and Cobar South Pty Ltd. Cobar Mines commenced a major exploration program across the Cobar area, which included additional surface drilling at the C.S.A. mine. This drilling confirmed the ore continued to a depth of 3,100 feet and also identified a significant new zone of copper mineralisation (the Eastern Lode) to the east of the previously known lodes (Western Lodes). A magnetic survey and follow up diamond



Miner and 2 Boom Jumbo underground in the new C.S.A. mine 1965.

drilling confirmed its existence with four further ore intersections between depths of 1,700 and 2,500 feet. As a result of these very encouraging discoveries it was decided in October 1961 to further investigate the ore bodies by shaft sinking and pattern drilling, prior to possible mining and production of 650,000 tons of copper concentrate per year. Shaft-sinking commenced on the 13th February 1962 with collaring of the exploratory (later ventilation) shaft south of the old historic workings. Underground drilling showed the Eastern Lode to have a length of 550 feet and average width of 33 feet and the Western Lodes to be 1,120 feet long with an average width of 26 feet. Both these lodes were open at depth and reported to total 5,100 tons of ore per vertical foot, containing 1.3% copper, 6.3% zinc and a minor amount of lead. The first shaft was continued to a depth of 1,303 feet and a second production shaft sunk to 2,027 feet.

Modern Mining Commences

Production at the re-established C.S.A. mine began in 1964, with ore coming from both the Western and Eastern Lodes. The modern processing plant commenced operations in May 1965 and the first shipment of copper concentrate was railed to the Electrolytic Refining and Smelting Company in Port

Kembla in the same year. Zinc and lead concentrates were also produced and these were stockpiled on site until 1967 when the zinc concentrates were sent to Port Kembla for sale overseas. In 1968 the lead concentrates were dispatched to Sulphide Corporation Pty Ltd at Cockle Creek.

The new C.S.A. mine was officially opened on the 8th October 1966 by T.L. Lewis, the NSW State Minister for Lands and Mines. At the time it was the most modern underground mine in Australia, introducing such technological innovations as mechanised trackless cut and fill mining methods, incline access to working levels, concrete-lined shafts with a friction hoisting system using rope guides, autogenous grinding, automatic controls and closed circuit television monitoring of the process plant.

Large-scale development of the C.S.A. mine brought major benefits to Cobar, which grew dramatically in population from 2,200 to 4,000. As well as employment for 376 people, the project provided the catalyst to connect Cobar to the NSW State power grid and to construct a water pipeline from the Bogan River at Nyngan, 135 km to the east. The 12 inch pipeline was completed in July 1965 and for the first time in its history Cobar was virtually immune from severe water shortages due to drought. The capital cost of establishing the C.S.A. operation to mid October 1966 was \$15 million, with a further \$2 million spent on purchasing mining leaseholds and housing for employees. The parent Broken Hill companies had spent approximately \$2 million up to February 1962 on exploration at Cobar. Cobar Mines also undertook long term financial obligations of approximately \$4.2 million to the NSW government and local government authorities for repayment of the capital cost of providing power, water and rail services.



Aerial view of the new C.S.A. mine and plant in 1966.

Recent Developments

Since modern mining commenced, ownership of the C.S.A. has changed several times. In 1980 Conzinc Riotinto Australia Pty Ltd (CRA) acquired the assets of Broken Hill South Ltd, including Cobar Mines Pty Ltd, operator of the C.S.A. mine. CRA continued the mining operation and conducted an intensive exploration program in and around the mine, but in December 1992 decided to sell it. During this period, technical problems, low metal prices and periods of industrial unrest had affected profitability. The economics improved in 1991 when it was decided to switch to production of copper only. In March 1993 Golden Shamrock Mines Ltd (GSM) purchased the mine and surrounding tenements for \$19.1 million. Ashanti Goldfields Company Ltd (Ashanti) then acquired the interests of this company in 1997. They were interested in the gold assets of GSM in Ghana and immediately tried to sell the C.S.A. assets. This attempt failed and the mine was closed by Ashanti, who were then unwilling to pay the debts owed to workers and unsecured (mainly local) creditors. Eventually in October 1998, the present owner Glencore International AG acquired the mine. Operating through Cobar Management Pty Ltd, they reopened the mine and established it as a profitable concern.

During this period ongoing near-mine exploration has identified further hidden mineralisation. A new zone of copper-zinc ore (the CZ system) was discovered between the Western and Eastern Lodes in the late 1960s. In 1976 a weak gravity geophysical anomaly east of the main orebodies was targeted by underground drilling, which intersected another zone of mineralisation called the QTS system (from Queenslander, Tasmanian and South Australian after the discoverers). This system was found to have two components, the QTS North to the east of the known lodes and the QTS South, 500 m to the south. Both are covered by more than 600 m of barren rock. Recently a further extension has been found below and to the south of the QTS South workings (QR1 lens). Ore has now been proven down to 1.8 km and is still open at depth. All the lodes plunge steeply and have large down-plunge dimensions. The copper-rich QTS system is currently being mined 1.42 km below surface, making the C.S.A. workings the second deepest in Australia after Mt Isa.

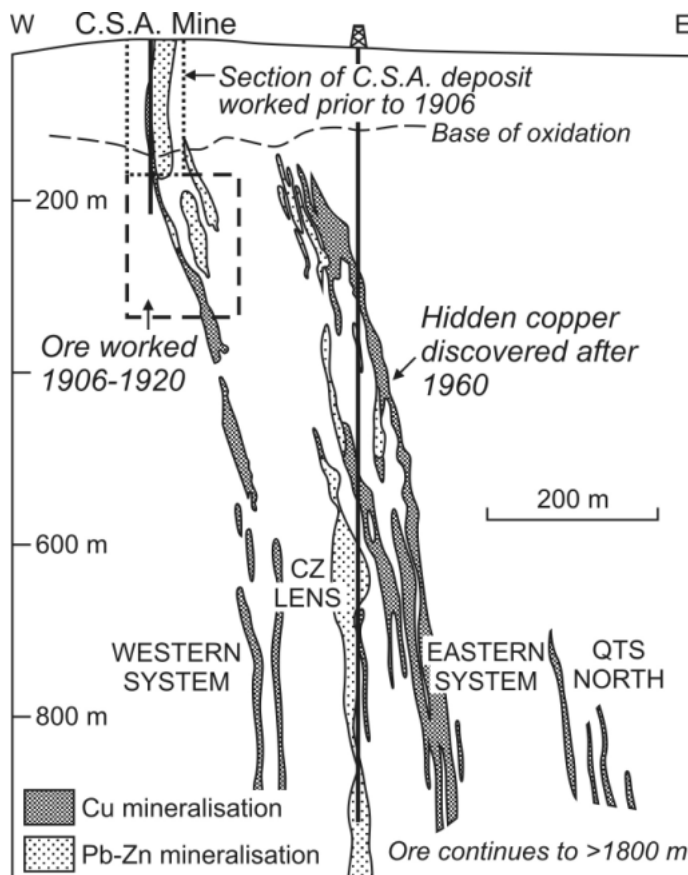
Conclusions

Like many of the ore deposits in the Cobar mineral field the C.S.A. ore system gave little surface indication of the great wealth that lay below. This was due to a combination of factors including the geometry and composition of the ore lenses (the exposed lode was a lead-zinc-copper body) and the intense, prolonged weathering that had leached most of the metals from the upper part of the deposit. Most deposits at Cobar are pipe-shaped and have a very small surface area but great depth extension. The outcropping C.S.A. gossan covered an area of 400 by 10 m, quite large by Cobar standards. However, the early prospectors found only small showings of copper and lead minerals. They were effectively beaten by the extent of the leaching. Thin veins of copper oxides and carbonates were found below 3 m but it was not until the workings reached the water table and the zone of supergene enrichment that the true potential was indicated. George Blakemore deserves the credit for recognising the importance of sinking below the strongly leached oxidised zone. Mining of the rich secondary ores provided the capital and incentive to further explore the deeper parts of the deposit leading to the discovery of new blind ore lenses, particularly of copper. The history of the C.S.A. mine provides a lesson to modern explorers in the Cobar area, highlighting the need for very careful surface and near surface search and persistence in exploration at depth.

Much of the early exploration in the Cobar area was focussed on the search for solid iron-rich gossans, with little attention paid to the siliceous “blows” occurring on the low residual hills, some of which later proved to be mineralised. The potential of these siliceous outcrops for gold was overlooked until well into the 1880s, also partly because of the belief that Cobar was “copper country” and the two metals didn’t mix. The attention to gossans reflected the Cornish proverb:

‘There’s never a mine so rich and fat as that which wears the iron hat.’

The C.S.A. deposit certainly had a recognisable “iron hat” but it took a long time and much persistence to find “the fat”.



Cross section of the upper part of the C.S.A. ore deposit showing location of early workings and the large copper resources hidden to the early miners. Most of the metal had been leached from the upper zone of the Western System above the water table.

Geology, Mining and Processing at the C.S.A.

Formation of the C.S.A. deposit

The C.S.A. deposit like most of the ore deposits around Cobar was formed by metals and sulphur precipitating as combined metal sulphides from hydrothermal fluids (hot water) circulating through cooler rocks. This all happened about 350 million years ago, when the rocks near the surface today were buried much deeper. Metals including copper, zinc, lead, gold and silver were dissolved as complex metal compounds leached from deep, heated rocks, possibly including granites, and transported in the fluids as these were pushed by pressure to higher levels. Zones of weakness and fracturing in the rocks focussed the fluids into a particular pathway, which is where the ore deposits were able to form by fluid mixing, cooling and reaction with the surrounding rocks. Geologists can determine the nature and temperature of these ore fluids by examining small inclusions of fluid trapped and still preserved in some of the minerals that were deposited. The surrounding rocks had been deposited about 30 million years earlier as mud, silt and sand in a deep sea basin. The shallow margins of this basin had volcanoes and shelly reefs and as these and the deeper sediments were compacted by burial they transformed to rocks such as slates, siltstones, sandstones, volcanic rocks and limestone. Movement of the Earth's crustal plates gradually squeezed the basin, compressing the rocks so that the different layers were folded and fractured by faults. What was originally a pile of soft sediments beneath the sea became a new uplifted part of the Earth's crust. It was during or soon after this compressive deformation that large amounts of fluid were able to circulate through the rocks to form ore deposits.

The C.S.A. ores

The C.S.A. ores occur as elongate lenses (6-20 m thick) developed in near-vertical pipe-like clusters. These are zones where fluid pressure and lower stress on the rocks has allowed dilation of the rock and deposition of copper, lead and zinc sulphides, together with quartz and calcite and other non-ore minerals. The main ore minerals are chalcopyrite (copper-iron sulphide), cubanite (another copper-iron sulphide with slightly less copper), sphalerite (zinc sulphide) and galena (lead sulphide). These are accompanied by large amounts of pyrite and pyrrhotite (iron sulphides) and trace amounts of many other minerals that contain silver, bismuth, antimony and tin. Different parts of the C.S.A. deposit have different combinations of ore minerals and metals so that some sections contain predominantly copper and others have significant zinc and lead. The deposit appears to be more copper-rich in the deeper parts. At present the mine is mainly exploiting the copper-rich ores, which average about 5.5% copper. These also produce significant amounts of silver and some other trace elements.

Mining

Before mining can commence the economically mineable ore must be located. This is done by diamond drilling or in some cases underground development. Exploration and mapping of the deposit is the job of the mine geologists. The mining engineers can then design the workings and openings to access and mine the ore safely. There are a number of different underground mining methods. At the C.S.A. the main method used is called long hole open stope (LHOS). This involves establishing levels in the ore at 30 m vertical intervals. Rows of fan pattern holes up to 30 m long are drilled vertically into the ore and loaded with explosives. The charged holes are then blasted in sequence. Initially a "slot" is created to start the stope (which is the working space in a block of ore). Then subsequent rows of holes are blasted, with the ore falling into the expanding opening. The broken ore is removed from draw points at the bottom of the stope. When all the ore is mined out, the open stope is backfilled with cemented sand fill and/or mullock. Up to four of these stopes can be in production in different parts of the mine at any one time. Walls and openings are re-enforced by rock bolts or cable bolts. Surface support is provided by steel mesh or a coating of fibrecrete. The cable bolts are inserted and grouted into 6 m holes drilled into the rock. All the drilling, blasting, ore removal and rock support is carried out by the mining crews. Mined ore is transported by haul trucks to 9 Level and fed to an underground primary crusher. Once it is crushed, it is brought to the surface via the hoisting shaft.

Processing

Processing the C.S.A. ores into metals firstly involves converting the ore to fine particles, where each particle is ideally of a single mineral, and then separating the particles to form a concentrate largely composed of that mineral. This is done in the Concentrator under the direction of the metallurgists. In detail the process involves primary crushing of the mined ore to fragments less than 300mm and then grinding in rotating mills partially filled with steel balls. The milled product consists of particles that are mostly less than 0.1 mm. This is then pumped to the flotation plant where the different types of particles are separated. Flotation works by selectively causing particular mineral particles to become hydrophobic and they attach themselves to rising air bubbles in an agitated solution. This is done in banks of tanks called flotation cells. Different minerals can be sequentially floated off at different stages by changing the solution and surface properties of the minerals with various

additives. The surface froth on the flotation cell contains the selected particles and this is collected for further refinement (cleaning) by other flotation cells before being dried to form a shippable concentrate. The concentrate is then sent off for further processing, including smelting and electrolytic refining to produce pure copper metal and by-products such as silver.

Concluding Statement from CSA Management

The success of the CSA mine owes much to the persistence and belief of all those that have explored, developed and processed its rich ore since discovery in 1871. The modern history of the CSA has seen the mine transform into one of the deepest mines in Australia, mining one of the highest grade copper sulphide ore bodies in the world. The challenges of the operation as it deepens will require the same persistence and belief as the pioneers who developed the CSA in the early days.

Glossary of some terms

Cross-cut – a horizontal underground excavation commonly from a shaft towards or at right angles to the length of a lode or orebody (hence cross-cutting).

Drive – horizontal underground excavation parallel to or within a lode or orebody (hence driving).

Gossan – weathered and leached outcrop of an ore deposit (from a Cornish word for hat or wig).

Incline – inclined (gently sloping) underground excavation suitable for trackless rubber tyred equipment.

Matte – impure metal sulphide alloy produced by smelting ore (requires further refining).

Secondary (supergene) ore – ore formed by re-precipitation at depth of metals leached by weathering from the upper part of an ore deposit.

Stope – underground opening where the ore is removed.

Sulphide – mineral containing metal combined with sulphur.

Winze – vertical or near vertical opening excavated downwards, usually connecting different levels in a mine.

Units

1 troy oz (the standard measure of gold/silver) = 20 dwt = 31.10348 g

1 dwt = 1.55 g

1 lb = 0.454 kg

1 (long) ton = 1.01605 tonnes

1 foot = 0.3048 m

1 mile = 1.609 km

1 acre = 0.4047 hectares

Acknowledgments and Sources

Thanks to John Collins from the Great Cobar Heritage Centre, Cobar, staff of the Department of Primary Industries, Maitland, and the National Library of Australia, Canberra for helping locate information on the C.S.A. mine. David Barnes from the NSW Department of Primary Industries is thanked for providing copies of photographs held by the Geological Survey of N.S.W. in their Minerals Photo Collection. Details on the history of the C.S.A. mine were obtained from a variety of sources including: Reports of the NSW Department of Mines and other government records; *Report on the Cobar Copper and Gold Field* Parts 1 and 2 by E.C. Andrews; *The Town and Country Journal*; *The Cobar Herald*; *Cobar Founding Fathers* by W. Clelland; *The Great Cobar* by N. Burgess; *Lodes of Gold* by C.L. Stegman and T.M. Stegman. (Full bibliographic details are available in *Hidden Copper: The early history of the Cornish, Scottish and Australian (C.S.A.) mine*, by K. McQueen, *Journal of Australasian Mining History* Volume 4, pp. 20-46).

Minerals reported from the C.S.A. mine, Cobar, NSW

Oxide Zone	Supergene Zone	Primary Zone
Major to minor minerals	Major minerals	Major minerals
Goethite FeOOH		Pyrrhotite Fe _{1-x} S
Hematite Fe ₂ O ₃	Cerussite PbCO ₃	Chalcopyrite CuFeS ₂
Coronadite Pb(Mn ⁴⁺ ,Mn ²⁺) ₈ O ₁₆	Chlorargyrite Ag(Cl,Br)	Cubanite CuFe ₂ S ₃
Pyrolusite MnO ₂	Native Silver Ag	Pyrite FeS ₂
Malachite Cu ₂ (CO ₃)(OH) ₂	Malachite Cu ₂ (CO ₃)(OH) ₂	Sphalerite (Zn,Fe)S
Azurite Cu ₃ (CO ₃) ₂ (OH) ₂	Azurite Cu ₃ (CO ₃) ₂ (OH) ₂	Galena PbS
Cerussite PbCO ₃	Cuprite Cu ₂ O	Minor or trace minerals
Jarosite KFe ₃ (SO ₄) ₂ (OH) ₆	Chalcocite Cu ₂ S	Arsenopyrite FeAsS
Minor or trace minerals	Minor Minerals	Tetrahedrite (Cu,Fe) ₁₂ Sb ₄ S ₁₃
Plumbojarosite PbFe ₆ (SO ₄) ₄ (OH) ₁₂	Covellite CuS	Freibergite (Cu,Fe,Ag) ₁₂ Sb ₄ S ₁₃
Beudantite PbFe ₃ (AsO ₄)(SO ₄)(OH) ₆	Gold Au	Bornite Cu ₅ FeS ₄
Mimetite Pb ₅ (AsO ₄) ₂ Cl		Native Bismuth Bi
Native Copper Cu		Bismuthinite Bi ₂ S ₃
Cuprite Cu ₂ O		Guanajuatite Bi ₂ Se ₃
Anglesite PbSO ₄		Galenobismutite PbBi ₂ S ₄
Smithsonite ZnCO ₃		Clausthalite PbSe
Tripuyite FeSb ₂ O ₆		Native Silver Ag
Leadhillite Pb(SO ₄)(CO ₃) ₂ (OH) ₂		Argentite Ag ₂ S
Gold Au		Acanthite Ag ₂ S
		Stromeyerite AgCuS
		Mackinawite (Fe,Cu) ₉ S ₈
		Stannite Cu ₂ FeSnS ₄
		Cassiterite SnO
		Gangue Minerals
		Quartz SiO ₂
		Chlorite (Mg,Fe,Al ₆)(Al,Si) ₄ O ₁₀ (OH) ₈
		Muscovite KAl ₂ (Si ₃ Al)O ₁₀ (OH,F) ₂
		Calcite CaCO ₃
		Siderite FeCO ₃
		Dolomite CaMg(CO ₃) ₂
		Ferroan Dolomite (Ca,Fe)Mg(CO ₃) ₂
		Talc Mg ₃ Si ₄ O ₁₀ (OH) ₂
		Feldspar (Na,Ca)Al(Al,Si)Si ₂ O ₈

Compiled from: Andrews, 1911; Rayner, 1969; McDermott et al., 1996; Gilligan and Byrnes 1994; McQueen, 2004; Leverett et al., 2005.

Note: Some of the minerals reported have not yet been confirmed by X-ray diffraction or electron microprobe analysis.