The Mount Boppy Gold Mine, NSW: A Leader in its Day and More to Come

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The Mount Boppy gold mine at Canbelego in north western New South Wales was one of the most successful gold mining ventures in Australia during the early part of the twentieth century. From 1901 to 1922 the operation produced 13.5 tonnes (0.433 million ozs)[1] of gold from about 1 million tonnes of mined ore. Four years after start up the mine was considered the leading gold mine in New South Wales and until 1937, when it was eclipsed by the New Occidental mine at Cobar, it held the record as the state's largest gold producer. By the end of 1911, shareholders had received a 350 per cent return on their investment and over the 21 year life of the first phase of mining the operation returned five times the original capital cost.[2] This success was due in large part to good management, use of state of the art and innovative technology, the application of scientific exploration and development methods combined with the high quality of the ore deposit. At the end of the first major mining phase in 1922, approximately 0.5 million tonnes of tailings containing around 3 g/t of gold were left at surface. In more recent years these have been re-treated for additional gold following advances in gold extraction metallurgy. In 1974 the first carbon in pulp (CIP)[3] plant in Australia was constructed at the Mount Boppy mine by Leighton Mining NL to process historic tailings. The Mount Boppy mine is now undergoing a further renaissance with open pit extraction and reprocessing of mine backfill sands from the old underground workings and mining of remnant ore. Exploration around the mine has detected further ore resources that may in future be mined by modern open pit and underground methods.

Discovery

Gold was first discovered in the Canbelego area in 1889, though not in payable quantities.[4] This occurred during a period (1887-1889) of increased gold prospecting in the Cobar region, sparked by the discovery of gold at Fort Bourke Hill, just a short distance south of the Great Cobar copper mine. Interest in gold exploration was also

encouraged during this time by a general decline in the copper mining industry. In 1887 the local mines inspector noted in his annual report:

> The [Cobar copper mining] industry being in a languishing condition for the last two to three years, it affords me very great pleasure to be able to report that during the last six months a decided improvement has taken place, in consequence of gold being discovered within three miles of town.[5]

The Great Cobar mine closed down on the 3rd of August 1889, to reopen in 1893, after the railway reached Cobar. Many of the workers thrown out of work were glad to find employment in the emerging gold mines.

In 1896 Michael Delaney O'Grady in partnership with prospecting mate Thomas Reid, discovered the rich Mount Boppy gold lode 3.8km southeast of the prominent conglomerate hill known as Buppe Mountain (now generally called Mount Boppy). The discovery is well described by Geological Surveyor E.C. Andrews who visited and reported for the New South Wales Geological Survey on the Cobar and Canbelego mineral fields in 1910 and 1912. Andrews was able to construct an accurate account of the discovery from several contemporary sources. These included: evidence given to the Warden's Court in connection with a reward application for discovery of payable gold at Mount Boppy; information in various official reports compiled by the Department of Mines (including their annual reports); and a personal interview with Thomas Reid, one of the prospectors involved in the discovery.[6] The description is sufficiently detailed to allow all the stages and sites in the discovery to be revisited today, a reflection of the level of accuracy and historical detail following the establishment of the Geological Survey of New South Wales in 1875. Andrews' account (summarised below) also provides a valuable insight into the approach and methods used by the local gold prospectors at the time.

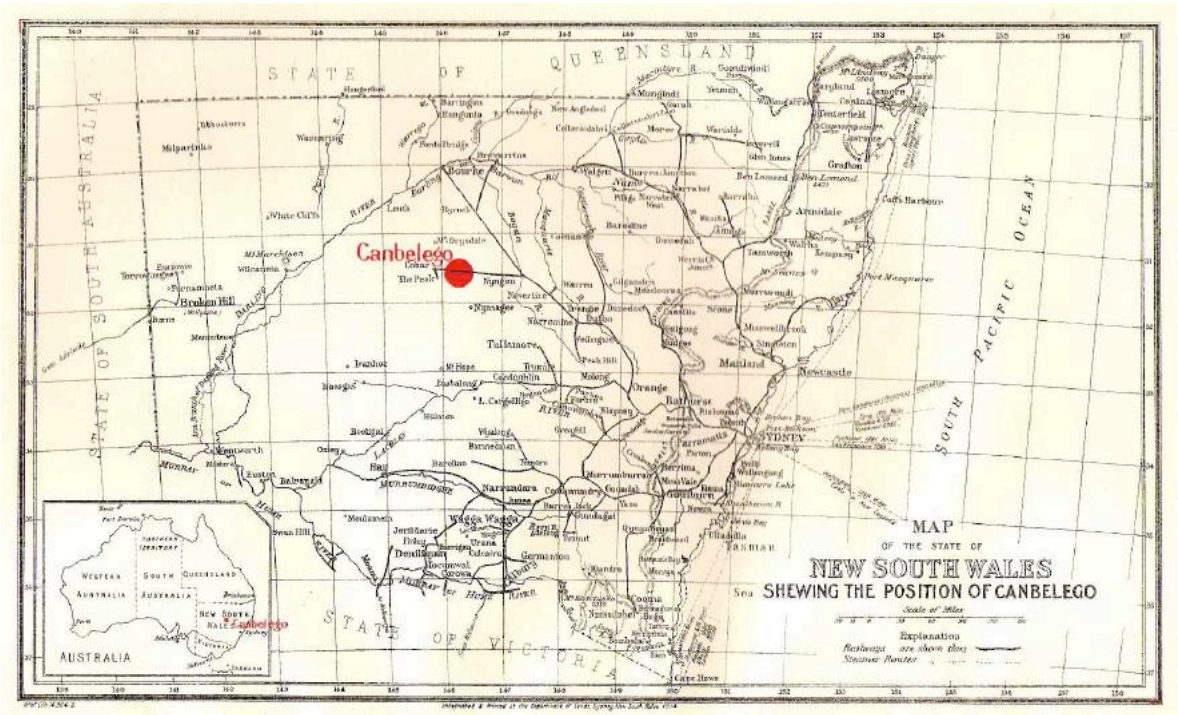
In about 1886 blocks or 'boulders' of a peculiar grey chalcedonic quartz were found along the Nyngan to Cobar road 4.5km east of the prominent hill known as Mount Boppy by an unknown man who detected no visible gold in this material. Ten years later Thomas Reid (a local prospector) dollied (hand crushed) the stone, panned it and found good gold prospects. Reid commenced tracing these loose blocks upstream in the broad south-trending belt of alluvium to locate their source. About a kilometre and a half upstream he located quartz and ironstone outcrops on the side of the channel, but these were of a different nature to the blocks. Nevertheless he decided to prospect this

area and followed a gently sloping ridge of schist to an area of gossanous mineralisation that later became the Birthday Mine. Not finding the stone he was after he descended another spur of the ridge and found good signs of gold-bearing quartz mineralisation in an area that is now in the centre of the town of Canbelego (on Wilga Street). This became the Hidden Treasure gold mine. Had he continued further west he would probably have encountered the Mount Boppy lode outcropping in the bed of the shallow creek, the source of the peculiar quartz. Reid informed Michael O'Grady of his find and the two agreed to share any prospecting results. According to Reid, he and O'Grady worked at the Hidden Treasure for a few days. O'Grady was living about 5km to the northwest, near the Boppy Mount railway station and while returning from his prospecting operations one evening in September 1896 he observed the outcrop of the Mount Boppy lode. He collected a sample, dollied and panned it at home that night and informed Reid the next day that he had found good gold. Both prospectors examined the site and pegged out a gold lease of 13 acres and a prospecting area of 7 acres. O'Grady proceeded to Cobar to take up the area in both names on the 18th of September 1896. They commenced work on the prospecting area and to help with the work and on the existing Hidden Treasure mine, took in two partners, M.J. Brown (former manager of the nearby Sussex station) and William Budd (road works contractor and owner of the nearby 'Gap Inn' on the Nyngan-Cobar road near the Florida turnoff). The prospectors put in a costean and sank a shaft to 61 feet before successfully applying for assistance from the Prospecting Vote[7] to deepen the shaft to 150 feet.[8] The prospecting area and an adjacent 10-acre area held by Budd were put up for sale at £800 and £200 respectively. In May 1887 a Captain Dunstan inspected the mine for Messrs Hardy Bros but did not purchase. In November 1897 the leases were inspected and purchased for the amounts sought by the Anglo-Australian Exploration Company for the amounts sought. This company immediately set about proving the property and employed sixteen men to sink two shafts and to undertake other prospecting works.[9] In 1898 Inspector of Mines David Milne reported that:

> It was originally worked by O'Grady and Reid …. After some 12 months of prospecting they sold to the above company, who have still further proved the lode by sinking at intervals, and have now proved it for over 1,000 feet in length and 130 feet deep: … The reef averages about 8 feet and a bulk sample of ore treated at Dapto gave a return of 16 dwt per ton.[10]

At the time the prospectors did not place great store on the value of the deposit and were happy to sell rather than take out an interest. This was apparently common practise by prospectors in the area at the time, their aim being to locate prospects and then test them to a level sufficient to attract a larger buyer. Given the capital required to mine and process many of the sulphide-rich bedrock ores in the region this was probably a sensible strategy. After Mount Boppy had proven to be a rich lode, William Budd did make a determined effort to find southern extensions to the lode. Together with partners he found some low-grade reefs in the area that later became the Boppy South property.[11] The discovery of the Mount Boppy lode encouraged much prospecting in the surrounding region resulting in discovery of smaller deposits, such as Reid and Rankin's and the Restdown gold mines.[12]

Figure 1: *Location Map Mount Boppy Gold Mine, Canbelego.*



Source: E.C. Andrews, *The Canbelego, Budgery and Budgerygar Mines. Part II of the Cobar copper and gold field*, New South Wales Department of Mines, Geological Survey, Mineral Resources, no. 18, Government Printer, Sydney, 1915.

The Anglo-Australian Exploration Company under the management of F.H. Granstedt spent about £7,000 over a two-year period during severe drought conditions to further prove the deposit.[13] A 200-ton sample of ore was forwarded to Dapto for testing in 1898 and a further 1,000 tons tested in 1899. In 1900 the company floated the Mount Boppy Gold-Mining Company in England to work the mine. The company was

floated with 110,000 shares of £1 each and 168 acres of gold leases were secured around the discovery site. Mr Frank Taylor of Messrs John Taylor and Sons, a well-known firm of mining engineers in London, was engaged to oversee the setting up and managing of the operation.[14] This company had connections with Cornish hard rock miners and experience with mining operations in Cornwall, Mexico and the Kolar gold fields of India. They continued as consulting engineers and managers to the new company and also retained members on the board of directors.[15] During 1900 a small settlement had started adjacent to the mining leases held by the Mount Boppy Gold-mining Company and in July 1901 this was surveyed as the new township of Canbelego.[16]

The first mining phase

Major production did not commence at the new Mount Boppy mine until May 1901 owing to a scarcity of water (1897 to 1902 was a period of major drought throughout the region and Australia in general – the Federation Drought). Testing of the deposit and construction of mining equipment and a treatment plant had continued through 1900. Four prospecting shafts were completed and connected by drives at the 100 foot level. Systematic assaying was conducted along the drives to establish the continuity of the ore and a stamp battery and winding machinery were erected at the site. This equipment was purchased from the recently closed Gallymont mine at Galley or Gully Swamp, 22km southwest of Blayney in central NSW.[17]

The mining plant consisted of forty head of stampers, poppet heads, winding plant, air compressor, cyanide plant, sawmill and other equipment to the value of £40,000. A dam with a capacity of about 12 million gallons was excavated to provide a source of fresh water. Sam Vale, from Cobar, was appointed mine manager. Over a seven-month period in 1901, 12,400 tons of ore were crushed and 7,695 tons of tailings were treated for a return of 6,092 oz of fine gold. Development had proved the deposit to a depth of 300 feet.[18]

In 1902 a water condensing plant was built. This consisted of two components, an exhaust steam condensing unit collecting steam from the various steam engines and a salt water condensing unit to process brackish mine water. This innovation drastically reduced the amount of fresh water needed each day from 25 thousand gallons to eight thousand gallons, a major benefit in such a dry climate. The condenser plant could also

provide a ready supply of hot water for the boilers and some processing requirements, reducing the total amount of fuel required. This was the first use of a condensing plant in the Cobar district and demonstrated the practical benefits for water conservation. In a special report on the plant Inspector of Mines Robert Schloesser noted:

> The plant has certainly had sufficient success to warrant better and larger ones being erected in the Cobar District; so much so, that a mine neglecting to do so after the object lesson of the Mount Boppy Gold mine, may be fairly accused of wilful waste of water.[19]

By the close of 1902 the mine had been developed to a depth of 310 feet. The mill operated over a six- month period treating 10,697 tons of quartz and producing 5,700 ozs of gold. Tom White had taken over as manager in September 1902, following the sudden death of Sam Vale.[20]

During the period 1903-1905, mine superintendent George Davey, a graduate of the Redruth School of Mines in Cornwall, made major improvements. In 1903 the main shaft (Taylor Shaft) was sunk to a depth of 400 feet[21] and during 1904 there was a significant upgrade to the mill and processing plant costing £13,137.[22] A new Gates crusher with the necessary ore bins and associated infrastructure was installed. Twenty additional stampers were added to the battery to increase crushing capacity to 4,000 tons per month. Five Wilfley tables and an elevator (tailings or Raff wheel) to raise the tailings from the mill to the treatment plant were also added, as well as additional leaching vats and other equipment for the cyanide plant. There was considerable underground exploration and development and large bodies of ore were opened up down to the 400-foot level.[23] At the end of 1904, known ore reserves were 170,000 tons; an increase over the year of 127 per cent. Additional gold leases were also taken up, increasing the holding to 293 acres. Mr William Frecheville, a mining and geological consultant, inspected the mine in September 1904 and recommended that a new shaft be sunk to the south of the main shaft to access the deeper levels of the southerly plunging orebody. He also recommended that a crosscut be made to the west on the No. 3 Level to test the possibility that faulting had displaced the lower part of the lode in that direction. In June 1904, Chief Inspector of Mines, J.B. Jaquet, inspected the workings and recognised that the Mount Boppy lode had the geometry of an inverted 'saddle reef'. This gave a new direction to prospecting activities.[24]

Thomas Pascoe, a mining engineer with wide experience in Australia, took charge of the operations on the 1st January 1905.[25] The capital of the company was increased

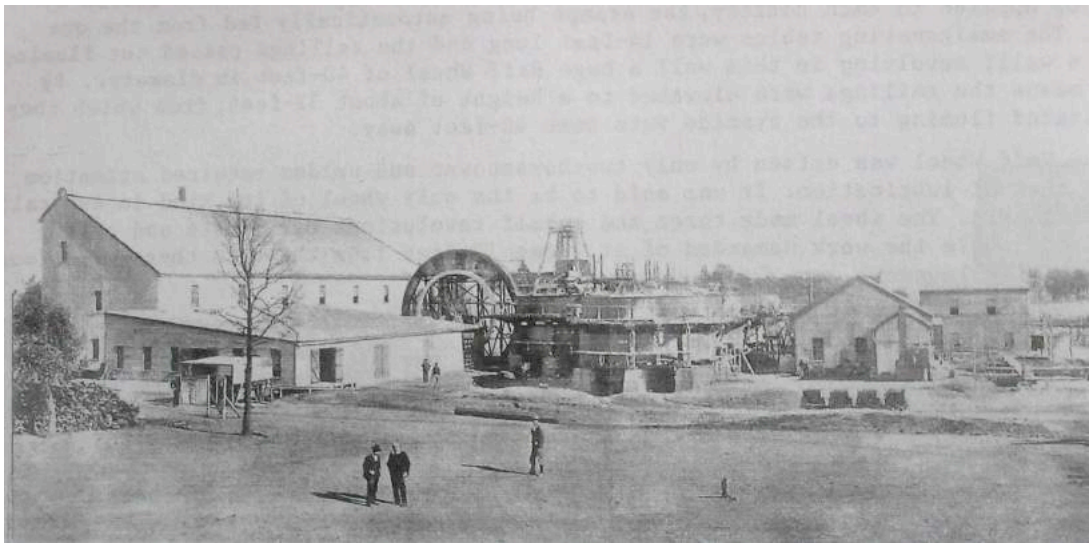
by a 1 for 10 issue of an additional 11,000 £1shares at a premium of £2. It was planned to use the additional £33,000 of working capital to sink the recommended new shaft (Henry Shaft), construct a new water tank, make other improvement to the plant and extend prospecting work on the southern leases. The new shaft did not commence until 1909 and the plant was significantly upgraded. During the year, four patent grinding and amalgamating pans, a Dehne filter press and two more cyanide vats were added[26] and a new steam driven dynamo was installed to provide electric lighting throughout the plant. A slimes dam capable of holding 10,000 tons was formed. There was vigorous prospecting near the mine for extensions to the main Mount Boppy lode and for additional saddle reefs in adjoining leases. Mr A. Hoffnung, Chairman of the London directors of the company visited the site in mid 1905. A major newspaper report on the Mount Boppy operations with accompanying photographs and produced by the *Sydney Mail* in July 1905, coincided with this visit.[27]

By the end of 1905 Mount Boppy was regarded as the leading gold mine in New South Wales. The mine employed 300 men and largely supported the township of Canbelego with a population of 1,500, and it was estimated that the mine contributed £50,000 per annum to the state economy.[28] The ore crushing and processing plant was 'state of the art' (Figures 2 and 3) and customised to treat the mixture of mainly oxidised and partially oxidised and primary ore.

Ore direct from the mine was passed through grizzlies and a rock breaker for the oversize and then transferred to the battery house by an inclined tramway with trucks on an endless wire cable. Here it was put through the 60-head stamp battery and over amalgam plates to take out the free gold. The sands were then passed through a concentration plant of Wilfley tables to extract the sulphide component. The concentrate was bagged and shipped for custom smelting. The tailings from the concentration plant were then allowed to settle and the sands leached in cyanide vats. The slimes (fine suspended material) were also settled and then sent to filter presses to produce a fine-caked material suitable for cyanide treatment. Gold was recovered from the cyanide solution in zinc boxes. This treatment was modelled on the MacArthur-Forrest cyanide process invented in Glasgow in 1887. The battery was capable of treating 1,100 tons per week. The average yield per ton was 12 dwt, with 30 per cent of the gold recovered by amalgamation, 35 per cent from cyanidation of the sand, 25 per cent from cyanidation of the slimes and 10 per cent from processing concentrates.[29] The insignificant copper

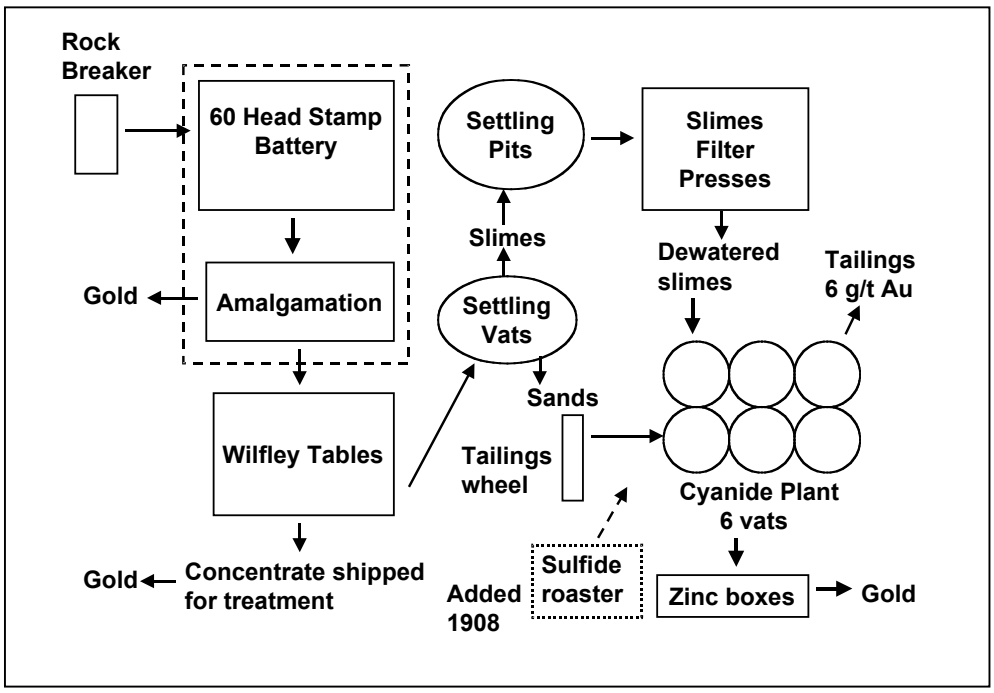
content of the Mount Boppy ore, as compared to some other gold ores in the Cobar district, was a major advantage allowing for more efficient cyanide treatment.[30]

Figure 2: *General view to the west of the Mount Boppy mine site and plant in 1905. Battery and Wilfley concentrators at left, tailings wheel and cyanide vats centre, slime treatment and gold recovery section at right. The headframe of Taylor shaft is in the background.*



Source: *Sydney Mail*, 12 July 1905.

Figure 3: *Simplified material flow diagram showing the major components of the Mount Boppy treatment plant in 1905. Cyanide treatment was based on the MacArthur-Forrest process invented in 1887.*



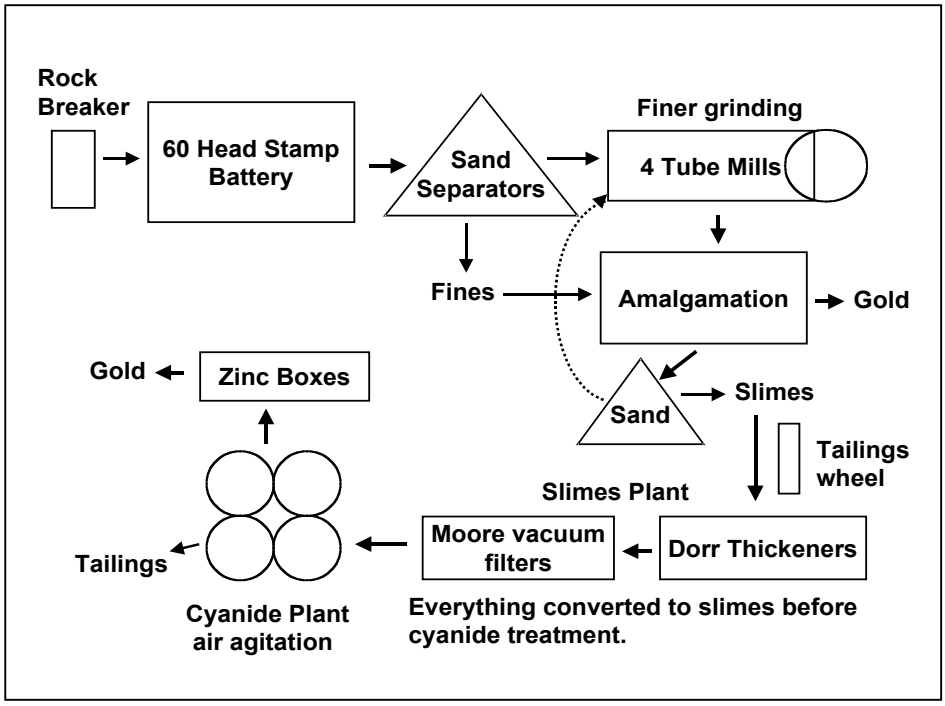
In 1905, the Mount Boppy Company mined and treated 51,878 tons of ore and produced 27,881 ozs of gold. By 1907 annual production had increased to more than 76,000 tons of ore and 31,598 ozs of gold.[31] The company continued to make improvements to the plant, including installation of an Edwards duplex roasting furnace to breakdown the sulphide component of the primary ore and release the gold for cyanide extraction. The roaster was commissioned in 1908 but was not a complete success until a drying plant was added to improve efficiency. Annual gold production continued to increase until 1908, when it peaked at just over 34,000 oz,[32] retaining its position as the largest gold producer in NSW. The mine employed an average of 380 men and the value of machinery was £100,000.[33] Development and exploration continued apace and in 1909 the ore reserves were 220,000 tons. A number of companies, including the South Mount Boppy Mining Company Ltd explored for other possible reefs in the area. This company had been formed in November 1906 with capital of £150,000 in 150,000 £1 shares to explore for possible southern extensions to the main Mount Boppy lode.[34] Leases held by the Mount Boppy Gold Mining Company were transferred to the new company in return for an interest of 55,000 shares. Another company called the North Mount Boppy Limited, also with a capital interest from the Mount Boppy Gold Mining Company, was floated about 1908 to explore the area north of the Mount Boppy lode.[35]

In January 1909, the long proposed new shaft to the south was started. This shaft (Henry shaft) was needed to more efficiently access the deeper parts of the southerly plunging orebody. A new poppet head, direct winding engine, boilers, air compressor and machine drills were installed at the new shaft.[36] By the close of 1910 the shaft was down to 600 feet and connections were made with the Taylor shaft at the 500 and 600-foot levels. The number of men employed was 375. Ore reserves had increased to 230,000 tons. The total dividend paid to shareholders by this date exceeded 320 per cent of their investment.[37] In 1911 Henry shaft reached 797 feet and by the end of the year had been extended to 816 feet to open up the 800-foot level.[38] Production for the year was 39,072.81 ozs of bullion containing 26,404.96 ozs of fine gold, down by 7,310 ozs on the previous year. This less favourable result was attributed to three factors: a decrease in grade of the chief oxide stoping areas; a strike among the miners for higher pay; and the resultant effect of an increased wages bill.[39] A two-year wages agreement between the mine owners and the employees had expired in June 1911. Being prompted by significant pay increases in other mining centres in the State, when negotiations for

higher wages broke down, the miners went on a strike that lasted 17 days. The issue was finally resolved by appointment of a Wages Board by Government Mining Officials. As a result a new scale of pay for three years was prepared and gazetted.[40]

During 1912 the Company pursued the usual development policy but was hampered by drought conditions.[41] Crushing ceased in April 1912 due to lack of water in the mine tank. Opportunity was taken to upgrade the surface plant, add a new boiler and enlarge the holding capacity of the main water storage dam by about 10,000 cubic yards. This dam was full by the end of 1912.

Figure 4: *Simplified material flow diagram showing the major components of the Mount Boppy treatment plant at the end of 1912. Fine grinding and cyanide treatment of resulting slimes was based on the Diehl process developed in 1899.*



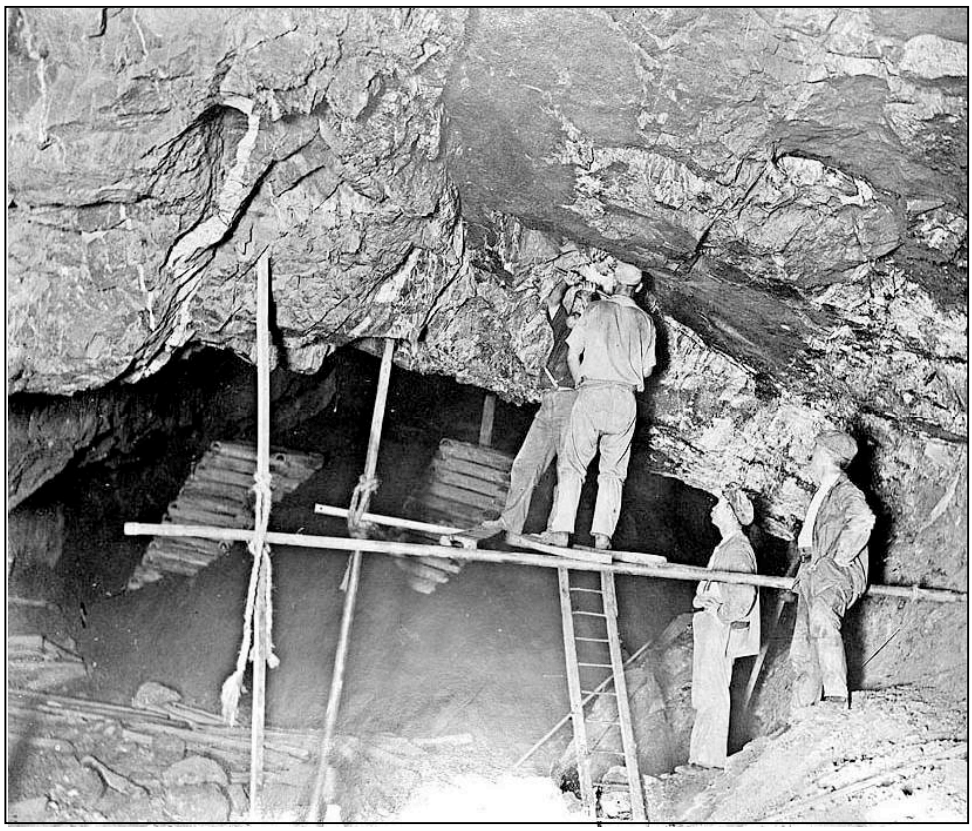
By this stage the mine workings had reached greater depth and the proportion of more refractory sulphide-bearing ore had significantly increased. This necessitated changes to the plant to improve recovery. Numerous experiments on the ores from the sulphide zone indicated the advisability of finer grinding and the economic advantages of simplifying the overall treatment process and reducing the number of labour-intensive stages in the plant. Under the direction of Superintendent James Negus and metallurgist W.D. Williamson, a new slimes plant was erected in 1912 at cost of £17,000. This plant was expected to save approximately 40 percent per ton of ore

treated through improved extraction and reduction in processing costs, but actually exceeded this target by 85.2 per cent.[42] The new treatment was adapted from the Diehl process developed by Dr Ludwig Diehl to treat refractory gold ores at the Brown Hill mine in Kalgoorlie in 1899.[43] It introduced fine grinding by tube (or pebble) mills to convert all the ore to slimes prior to cyanide treatment. The crushings from the stamp battery were sent direct to four tube mills, which used lumps of ore for the grinding pebbles. The finely ground ore was passed over amalgam plates to extract the free gold and then separated from suspension using Dorr settlers and Moore vacuum filters before cyanide leaching and extraction of gold from solution using zinc shavings (Figure 4). The company metallurgists also conducted experiments on air agitation of the cyanide solution and were able to demonstrate that this achieved better recovery of gold than traditional mechanical agitation.[44] The dewatered slimes were air agitated for a minimum of 12 hours in a 0.12 per cent potassium cyanide solution. The whole of the filtration plant was electrically driven, power being provided by a 90kw Bellis and Morcom steam engine. By 1912 the company had switched to using coal for fuel due to the increased difficulty of obtaining sufficient firewood for the boilers.[45]

Ore reserves at the end of 1913 were 200,000 tons. The mining methods used to this time included open stoping, with some support by timber 'pigsties' (stacked timbers), and backfilling (Figure 5). Tailings sands and limited amounts of underground mullock were used to backfill the stopes around box timber man ways and ore passes after mining. This early type of 'cut and fill' method saved on timber. The miners appear to have used a combination of hand and mechanical rock drills with the latter employed in the harder ground. In February 1910 there had been a major rock fall in the northern part of the 2 Level stopes that had sterilised approximately 12,000 tons of ore.[46] There had been sufficient warning to evacuate the site so there were no casualties or injuries, although a previous small fall on 5th January had killed a miner (J.D. Price).[47] It was initially proposed to rework this area with an open pit, but this proved impractical. Instead the 'square set' method of timber support was introduced to allow successful resumption of mining in this area. This method was first developed in 1860 at the Comstock Lode in Nevada by mining engineer Phillip Deidesheimer and applied widely at Broken Hill from 1888. It used a modular approach that assembled prefabricated timbers into cubes (typically 1.8-3.2 m tall and 1.2-1.8 m wide) that could be stacked to support large openings.

Between 1913 and 1915 a vigorous and extensive development program was carried out with resulting discoveries of lode extensions, particularly along the western leg of the deposit on the 2, 3 and 5 Levels.[48] The remaining ore reserves were increased to a quarter of a million tons by the end of 1913 and the mine was capable of producing more ore than in the previous three years of operations.

Figure 5: *Stope on No. 3 Level Mt Boppy Gold Mine. Note 'pigsty' timber support and backfill.*



Source: Courtesy NSW Department of Primary Industries, Minerals Photo Collection.

The new plant was performing well and two new high efficiency Babcock and Wilcox water tube boilers, two five foot grinding pans and a high speed vertical compressor were added to the plant. A diamond drill was installed underground in 1914 to assist in further exploration.[49] A shortage of water over February 1914 caused a temporary cessation of operations. Development during 1915 included 2,497 feet of driving and sinking and 465 feet of diamond drilling. Ongoing experiments had found that coarse sulphides encountered in the deeper workings contained gold values that hitherto had not been extracted by cyaniding. A new concentration unit was installed to separate these sulphides and 265 tons of concentrate was produced in 1915. As a result

of the changes to the plant in 1912 and these further improvements, total gold recovery was increased by 15.5 to 86.5 per cent.[50] This encouraged a plan to rework the 300,000 tons of slimes and sands in the residue dumps, although this did not eventuate. Approximately 80,000 tons of ore were treated in 1915, the largest production to date, and 28,453 ozs of gold produced.[51]

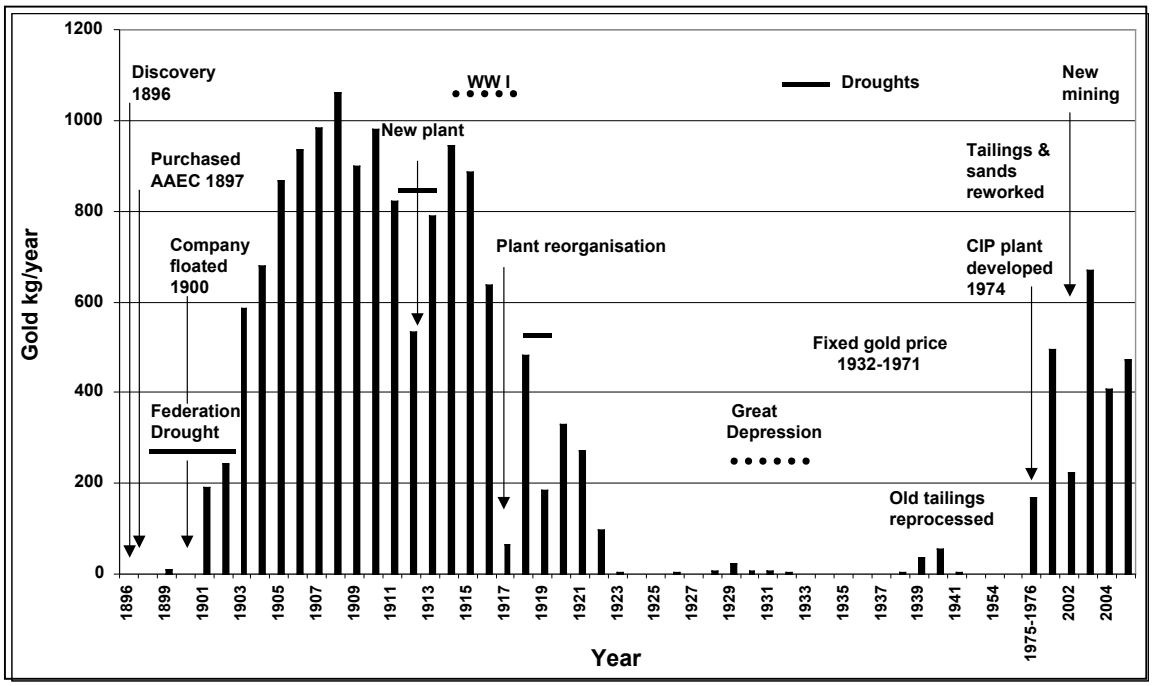
During 1916, operations were severely affected by manpower shortages and generally high materials costs related to World War 1. These costs had risen 20 per cent compared to pre-war. Underground development was restricted and exploration abandoned. Consequently additions to the ore reserve were limited. The company announced in their annual report for 1916 that:

> The sinking of a new central shaft and the erection of an experimental plant to treat the residue dump have not been undertaken as foreshadowed in the last Annual Report. The men were not available for that purpose and at the same time to carry on the operations of the mine, even to last years limited extent. … in the coming year it will be necessary to temporarily close down and sink a new shaft or re-timber 200 feet of Taylor's Shaft. The advantage of a new shaft would be: (1) it would be sunk in country to the east of the footwall of the lode (2) the upkeep would be light and many thousands of tons of oxide ore surrounding the present shaft would be available for extraction (3) the ore should be worked from a huge open cut, stoping costs would be light.[52]

In May 1917, the sinking of a new three-compartment shaft was started east of the main Taylor Shaft making a large tonnage of ore in the previous shaft pillar available for mining. The new shaft was completed to a depth of 400 feet in eight months and some items of the surface plant were moved closer to this shaft, to improve their efficiency.[53] The old main shaft was dismantled and used as an ore pass for the open cut. The cessation of operations necessitated by the new shaft development and accompanying reorganisation of the plant resulted in a significant reduction in gold production for the year (Figure 6).

From November 1918 to September 1919 operations again ceased at the Mount Boppy mine due to severe drought conditions and a shortage of water for the plant.[54] By 1921 gold production was down to 8,685 ounces and most of the ore was coming from the open pit.[55] In 1922 the Mount Boppy mine was let on tribute and a party of 20 men earned wages during the year, producing a total of 5,762 tons of ore. The Mount Boppy mine closed in 1923 and this marked the end of the first very successful phase of mining.

Figure 6: *Gold production from the Mount Boppy mine and timing of some events affecting production rates*



Source: Data from the Annual Reports of the NSW Department of Mines; C.L. Stegman and T.M. Stegman, 'History of Mining in the Cobar Field', in: W.G. Cook, A.J.H. Ford, J.J. McDermott, P.N. Standish, C.L. Stegman and T.M. Stegman (eds), *The Cobar Mineral Field – A 1996 Perspective,* Australian Institute Mining and Metallurgy, Melbourne, 1996, p. 33.
Polymetals Mining Services Pty Ltd., personal communication 2005.

Variations in gold output over this period (Figure 6) reflect the interplay of negative factors such as major drought periods, increasing costs and labour shortages during the later stages of World War I and various improvements in the mining and processing operations that reduced costs and improved gold recovery. Prior to closure, the eastern leg of the Mount Boppy lode had been developed for a length of 1,840 feet and worked to a depth of 900 feet from 9 levels, of which the uppermost or 100 feet level was the longest. The greatest length of workings on the western limb did not exceed 600 feet.

Some time after the mine closed (probably in 1928), George William Budd, son of the member of the original prospecting syndicate that had opened up the Mount Boppy lode in 1896, purchased the lease. Between 1928 and 1941 he mined small parcels of ore from the old workings, mainly the open pits. These were mostly despatched to Port Kembla for treatment, although Budd constructed small treatment plants at the mine in 1930 and 1932. Total recorded gold production by Budd over this period was 1,840 ozs.[56]

Mine tailings re-treatment phase

The first phase of mining at the Mount Boppy gold mine had produced in excess of 500,000 tonnes of tailings (slimes and sands) that still contained about 2 dwt per ton (3 grams per tonne) gold. The first recorded attempt to treat these tailings was in 1930 by the Mount Boppy Treatment Company set up by E.B. South and party. This venture failed as the plant used was not suitable.[57] In April 1938, Mount Boppy Gold Mines Pty Ltd was formed in another attempt to re-treat the tailings. This company had a capital of £50,000 and Lindesay Clark of Western Mining fame was one of the directors. Previously, in 1932, Gold Mines of Australia, the precursor and sister company to Western Mining Corporation Limited had carried out some drilling on extensions of the syncline hosting the Mount Boppy deposit but with no significant results.[58] Treatment by the new company commenced in 1939 using a Hardinge ball mill, associated Dorr bowl classifier, Dorr thickener and agitators and Oliver filters. Gold cyanide extraction and precipitation was by the Merrill-Crowe process. The treatment plant had a capacity of just over 400 tonnes per day and was electrically driven from a steam power plant.[59] This venture appears to have been only a partial success with 2,862 ozs of gold produced between 1939 and 1940 before the operation was suspended. A power house breakdown and difficulty in supplying sufficient material to keep the plant operating at full capacity were some of the problems. There may also have been difficulties in extracting sufficient gold from the tailings, as in 1947 new experiments were conducted by Mount Boppy Gold Mines Pty Ltd on a 132 tonne sample (this recovered 3 ozs of gold).[60] In 1950 New Occidental Gold Mines NL from Cobar acquired the plant and machinery and a start was made on reconditioning the plant and installing a power line from Cobar. However, after a small section of the power line was completed the project was abandoned due to rising costs and other factors.[61]

Little activity occurred at the site from 1951 until the early 1970's, partly reflecting the low fixed price of gold over this period. Mr A.K.W. Budd erected a cyaniding plant to treat residue sands in 1952, and in 1954 produced 6.9 ozs of gold.[62] In 1957 he constructed an inclined tramway to access the old open pit and mined about 10 tonnes of ore as well as cyaniding a small quantity of sands from the old battery to produce 36 ozs of gold.[63] In 1963 a sample of low-grade tailings from the Mount Boppy mine was submitted by Vam Ltd to AMDEL in Adelaide for laboratory testing and cyanide leaching. These tests revealed that about 50 per cent of the gold could be extracted using solutions containing 0.3 per cent sodium cyanide.[64]

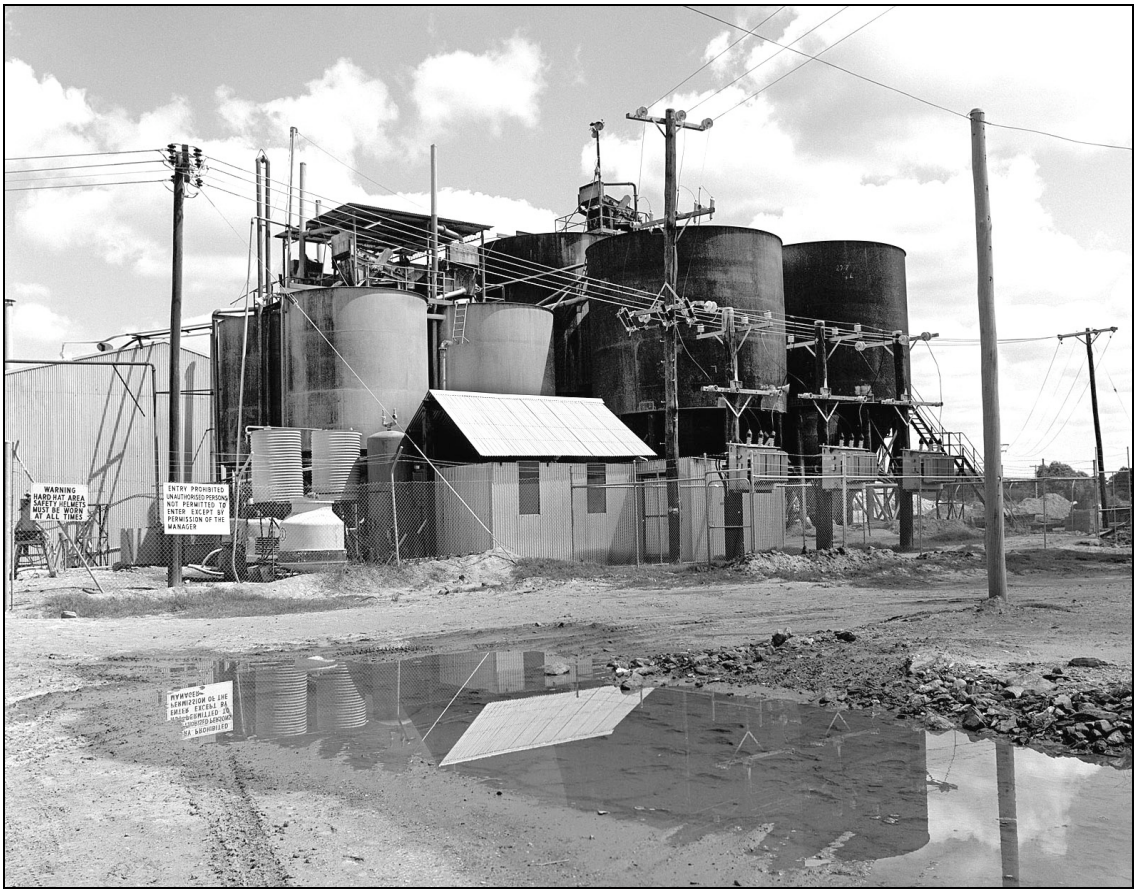
Between 1960 and 1970 a number of companies explored unsuccessfully for additional mineralisation around the Mount Boppy mine and in the surrounding region. The lack of new surface and near surface discoveries attested to the thoroughness of the early prospectors. In 1966 Ausminda Pty Ltd carried out a limited percussion-drilling program, also with little success.[65]

In 1972 Lennard Oil was sponsored by Westralian Sands Ltd to assess the gold mining tailings under their control and the tailings at the Mount Boppy mine were selected for reprocessing. Through 1973 the company investigated the latest technologies in gold extraction and were in contact with the Homestake Mining Company at Lead in South Dakota.[66] Homestake, one of the largest gold producers in the world had been developing the carbon in pulp (CIP) cyanide extraction technology, first foreseen by J. Gross and J. Walter Scott in1927 and advanced by Zadra at the United States Bureau of Mines in 1952.[67] Test work carried out under the direction of consultant metallurgist Arthur Keats indicated that the tailings were amenable to this new treatment and the decision was made to build a treatment plant at Canbelego employing the revolutionary new carbon technology. Sydney based Leighton Mining NL, who had a 33.75 per cent joint venture interest in the project, took over management. In 1974, Leighton Mining constructed the first CIP plant in Australia at the Mount Boppy mine (Figure 7). The plant was commissioned in March 1975.[68] The Homestake group, developers of the CIP technology took a small indirect interest in the Canbelego project through a 10.25 per cent holding in Lennard Oil and provided important technical advice to the project.

The CIP plant operated from mid 1975 to September 1976 and treated 200,000 tonnes of tailings to produce 5,393.68 oz of gold and 4,461.161 oz of silver. However the venture was not a financial success. Being the first plant of its type in Australia it suitable skilled plant personnel were difficult to find and experimental adjustments had to be made to adapt the process to local conditions. There were numerous problems with the materials handling aspect of the project and the operating companies had other financial difficulties.[69] In September 1976, Canbelego Management Services Pty Ltd, as manager of the joint venture, ceased ore treatment citing rising costs, low gold prices and poor recoveries.[70] The plant was placed on care and maintenance with a skeleton crew of five. The following year the plant was auctioned and partly dismantled. Although this experimental plant did not prove profitable it did pioneer the introduction of CIP technology in Australia, which ultimately revolutionised gold processing in the

1980's. In turn, this helped lead to a major renaissance in the Australian gold mining industry, adding billions of dollars to the economy.

Figure 7: *Plant built by Leighton Mining NL in 1974 to retreat the tailings at the Mount Boppy mine. This was the first carbon in pulp (CIP) plant built in Australia. This technology would revolutionise treatment of gold ores in the 1980's and help revitalise the gold mining industry in Australia.*



Courtesy NSW Department of Primary Industries, Minerals Photo Collection Photograph taken by G. Hicks in March 1977

In 1981 the Mount Boppy tailings were further tested and two alternate strategies for processing were investigated by Murdoch Geoscience on behalf of Epoch Minerals Exploration NL. These involved agglomeration and heap leaching with zinc precipitation of the gold, versus grinding, agitation and CIP recovery.[71] Epoch decided to take the second option, refurbished the Canbelego plant and in 1985 began treating the remaining tailings, together with fresh ore sourced from an open cut, which took out the upper crown pillar of the old underground workings. Six men were employed at the plant, half the population of Canbelego at the time. Their activities continued until 1991.[72]

In July 1993, the privately owned, non-listed company Polymetals Australia Pty Ltd purchased the leases and derelict plant at the Mount Boppy mine and modified the plant to treat flotation tailings from supergene ore trucked in from the Elura silver-lead-zinc mine north of Cobar. From 80,000 tonnes of these externally sourced tailings they recovered 32 tonnes of silver and 5,000 ozs of gold.[73] The treatment process incorporated a number of novel metallurgical adaptations and at the time this was the only cyanide plant in Australia producing silver as its main revenue source.[74] In 1995 Polymetals turned their attention to processing tailings that had been used as backfill sands in the upper underground workings at the Mount Boppy mine itself. Initially these were accessed from a small open pit into an old stope.

Rebirth of mining

In March 2002 Polymetals Mining Services Pty Ltd. commenced open cut mining on a larger scale to recover an estimated 200,000 tonnes of gold-bearing material (grading 3-5 grams per tonne) in the form of backfill sands, remnant ore pillars and other previously unmined ore. Between February 2002 and the end of 2003, approximately 350,000 tonnes of this material was mined, with processing continuing until 2004. In the latter year, a second open pit was commenced. The treatment plant, which still contains some components from the original CIP plant built by Leighton Mining was capable of processing 150,000 tonnes per year and in 2003 the estimated future production from mining and CIP treatment was approximately 90,000 oz of gold. The mining method currently involves drilling into the old stopes and blasting to loosen the fill and surrounding remnant ore (Figure 8). Samples from the blast holes are used for grade control. An excavator loads a fleet of trucks that take the fill and ore to a pad where the old mine timbers are removed. The material is crushed, then finely ground in a ball mill and put through the treatment plant. In 2005 the second open pit reached the backfilled stopes between the Nos 1 and 2 Levels of the old mine and it is hoped to continue to the No. 4-Level and possibly also develop underground mining. The mine currently has approximately 35 employees, of whom 12 are mining contractors. Exploration drilling by Polymetals in 2003 detected additional gold mineralisation at depth above the keel of the syncline in the area of the old workings and also further south in the area of the old Mount Boppy South workings.[75]

Figure 8: *Open pit exposure of old stope between the Nos 1 and 2 Levels of the Mount Boppy gold mine showing the backfill sands and buried timbers (outlined).*

Photograph taken by the author in May 2005.

Conclusions

Good management and the use of innovative technology, particularly in ore processing, marked the early history of the Mount Boppy gold mine. The managers of the operation including Frank Taylor of Messrs John Taylor and Sons, the various mine superintendents including George Davey, Thomas Pascoe and James Negus and metallurgist W.D. Williamson appear to have been highly competent and forward looking. Great effort was put into exploration and development of the deposit both before and during mining, including by geological assessment, underground driving and cross cutting, and later by diamond drilling. Over the 21-year period of the first phase of mining continual improvements were made to the plant to maximise efficient processing of the different ore types and improve gold recovery, while reducing costs. This involved considerable experimentation in the mine laboratory and plant. A significant challenge to the operation, as with a number of early mining operations in this semi-arid

region of western New South Wales, was the lack of a guaranteed water supply. Except for the worst periods of drought this was overcome by careful preparation of surface reservoirs and other water saving measures. A feature of the Company's annual reports to share holders was a regular report on the annual rainfall and the efforts to improve the water supply.

World War 1 had a serious impact on production and development of the Mount Boppy gold mine, through rising costs and labour shortages. This became apparent in 1915-1916 towards the end of its first major phase of mining. Impressive efforts were made in 1917 to overcome manpower shortages and higher costs by sinking a new shaft and open cut mining the previous shaft pillar. As a result of these initiatives and further improvement to the plant, gold production rebounded in 1918 only to be adversely effected by severe drought conditions from the end of that year until 1919. Production resumed after the drought but continued to decline over the next two years until the mine closed.

After the 1930's the tailings from the Mount Boppy mine attracted the attention of a number of groups keen to test new metallurgical techniques to extract the residue gold. This culminated in the development of the first carbon in pulp plant in Australia at the site in 1974 (Figure 7). Although experimental at this stage, this technology was soon introduced across Australia and its increased efficiency of gold extraction from low-grade material, combined with a sustained high gold price, were major factors in the revitalisation of the gold mining industry through the 1980's until the present time. This renewed interest in gold has in turn led to an upswing in exploration activity and the search for extensions to the Mount Boppy lode and other bedrock gold deposits in the region. More than one hundred years after the original discovery of gold, signs are positive that the Mount Boppy area will continue to produce more of the precious metal.

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Endnotes

[1] For conversion rates for weights and measures used in the text see figures following endnotes.
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[5] Annual Report of the NSW Department of Mines, [hereafter *ARNSWDM*] for 1887.
[6] Andrews, *The Canbelego, Budgery and Budgerygar Mines*, pp. 4-6.
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[8] *Ibid.,* p. 6.
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[10] *Ibid*., for 1898, p. 100.
[11] *Ibid.,* for 1901, p. 32.
[12] Andrews, *The Canbelego,* p .7.
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[21] *ARNSWDM* for 1904, p. 13.
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[35] The North Mount Boppy Limited, Reports and Statements of Account, April 191I, 22 pp.
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[38] *Ibid*., for 1911, p. 11.
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[41] *ARNSWDM* for 1912, p. 93.
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[51] *Ibid*. Table A p. 98.
[52] *Ibid.,* for 1916, p. 11.
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Glossary of some terms used in the text

Amalgamation – method of extracting gold by allowing it to combine with mercury (generally on copper plates) to form amalgam (mercury-gold alloy).
Chalcedonic –waxy, microcrystalline (fine-grained) quartz.
CIP – carbon in pulp, a gold extraction method that uses activated charcoal to very efficiently extract gold from a cyanide solution, the concentrated gold is then stripped from the carbon and recovered from solution by electrolytic deposition.
Costean - trench through soil or overburden to expose the underlying bedrock or lode.
Grizzley – coarse sieve to screen out large blocks of ore.
MacArthur-Forest process – a method of extracting gold from pulped ore by dissolving the gold in an aerated potassium cyanide solution and then precipitating the gold by reduction on zinc shavings.
Merrill-Crowe process – a gold extraction process similar to MacArthur-Forest but with some refinements to improve gold recovery including de-aeration of the gold cyanide solution and the use of zinc dust.

Pillar – block of ore left to support underground workings.
Raff or tailings wheel – a vertical rotating wheel with buckets to raise material to higher elevation, for example to gravity feed to part of a processing plant.
Slimes – very finely ground material.
Stope – underground opening where the ore is removed.
Sulphide – a mineral containing metal combined with sulphur, generally found in the deeper primary (unweathered) part of ore deposits, iron sulphide (pyrite) is the most common sulphide.
Tube Mill – rotating cylindrical drum used to grind material, early versions used flint pebbles to promote grinding. Forerunner of modern ball, rod, SAG and FAG mills.
Wilfley table – a sloping vibrating table with riffles used in the gravity separation of dense minerals.

Units

1 troy oz (the standard measure of gold) = 20 dwt = 31.10348 g
1 dwt = 1.555 g
1 (long) ton = 1.01605 tonnes
1 dwt/ton = 1.58 g/tonne
1 foot = 0.3048 m
1 mile = 1.609 km
1 acre = 0.4047 hectares
1 cu yard = 0.7646 cu m
1 (imperial) gallon = 4.546l litres