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Mining History of the East Riverina Region, New South Wales

K.G. McQueen

Introduction

The main commodities mined in the East Riverina region of southern New South Wales have been gold and tin, with minor production of tungsten, molybdenum, lead-silver and fluorite (Fig. 1). As mineral discoveries were made across the region it was realised that the gold deposits were developed along a NNW trending belt. This was later recognised by geologists as a major crustal fault zone, the Gilmore Fault Zone, a focus of shearing and introduction of mineralising fluids. Tin mineralisation in the western part of the region was found to be related to a suite of tin-bearing granites.

The greater Riverina area has large tracts of low-relief terrain marked by extensive plains and shallow stream channels, and the pattern of mineral discovery was strongly influenced by this landscape topography. Unlike in the rugged and more incised areas of eastern Australia, mineral discoveries in the Riverina were mostly made on the small, exposed hills of bedrock, rather than in the shallow and ephemeral stream channels or the surrounding regolith covered plains. Availability of water was a significant factor in mineral production, with output curtailed during periods of severe drought.

Gold

Discovery of gold in the East Riverina was relatively late in the history of the NSW gold rushes. On the western plains the first gold discoveries were of reef or bedrock deposits, followed by discovery of any alluvial gold in the surrounding deep cover. This was quite different to the pattern in other regions, where generally alluvial gold was first detected by panning up the drainage networks, followed by discovery of the source, bedrock deposits.

Major gold deposits occur along the eastern margin of the East Riverina area at Adelong and Tumbarumba; further to the northwest important historic deposits are at Junee Reefs, Sebastopol, Temora, Reefton, Barmedman and West Wyalong. More recently, significant gold has been mined at Gidginbung. Total gold production from these deposits is greater than 77.3 t (2.485 M oz).

Adelong

Rich alluvial gold was found along Adelong Creek in mid-January 1853 by a party of seven prospectors on their way to the Ovens goldfield in Victoria. Prior to this in 1852, Edward Hargraves had passed through this area advising the local residents 'that there is too much grass here for a good gold field, that there certainly was gold but it would cost £50 an ounce to collect it'.¹ The subsequent rich discovery created a sensation in nearby Gundagai and by the end of January 1853 there were 200 diggers washing the 'drift'.² One sluicing party was able to recover up to 9 oz of gold per day. Heavy rains in April reduced mining activity and the number of miners, but attention turned to the higher banks, gullies and slopes. Many of the early miners were reported to be from California. During this period additional finds were made along Adelong Creek up to 10 km downstream from the initial discovery. In one Sunday afternoon at a locality 13 km below where anyone was digging, the little daughter of miner Martin Curran recovered nearly half an ounce of gold from rocks in the creek using a penknife.³ On 15 February 1855 the alluvial workings were officially proclaimed a goldfield and a small settlement developed on the creek, eventually growing into the town of Adelong.⁴

In May 1857, William Williams discovered a quartz reef with bonanza grade gold on Charcoal Hill while working eluvial gold in the surrounding soil.⁵ This discovery on the north side of Adelong Creek, later became known as the Old Hill Reef. Initially, rubbly soil from the cap of the reef was collected and washed in cradles before primitive hand operated dollies were used to crush the quartz and extract the gold.⁶ The first quartz crushing plants arrived on the field in mid-1858.⁷ Numerous

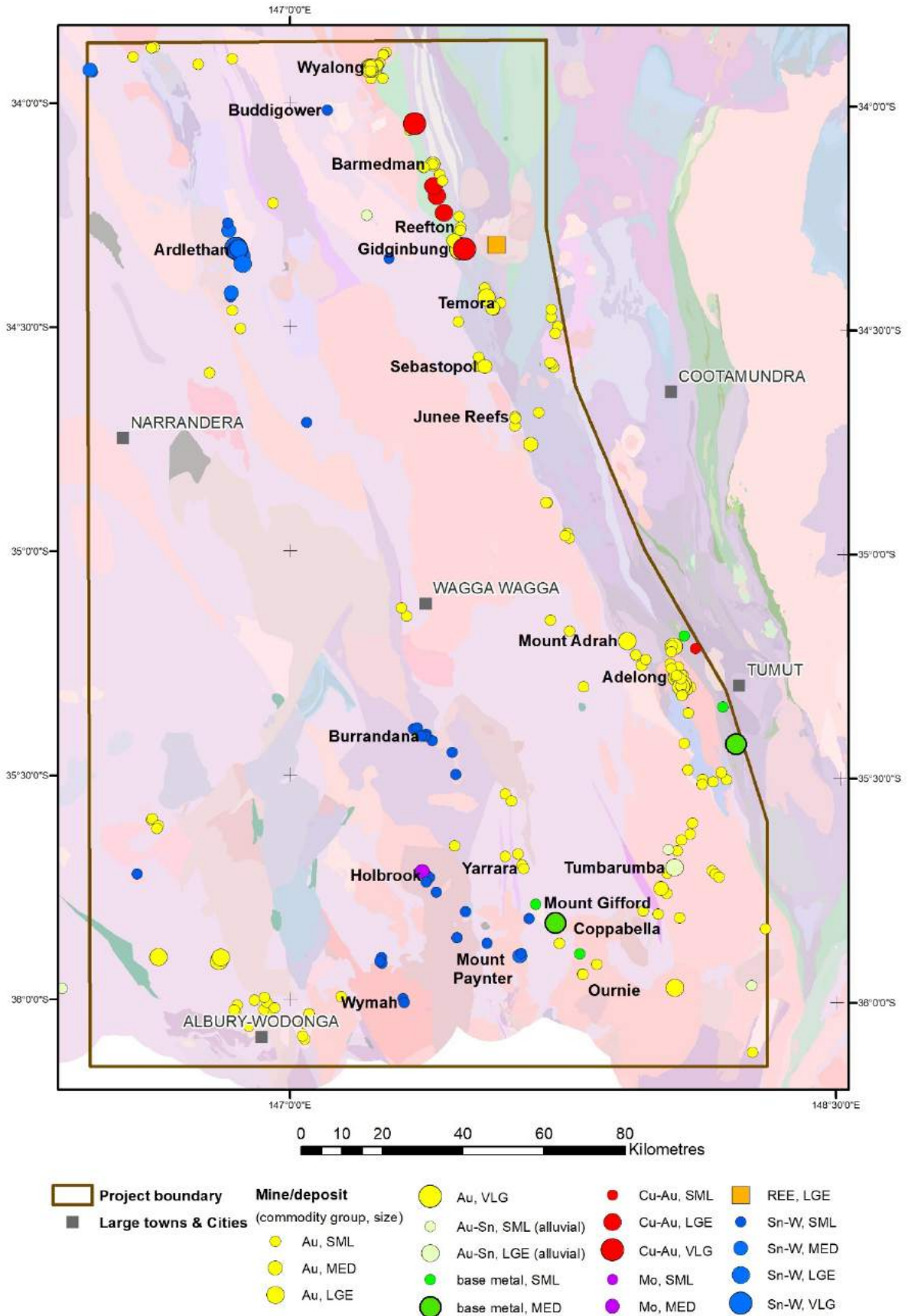


Figure 1. Map showing the mineral deposits and mining sites of the East Riverina area, NSW. Mine/deposit data from MetIndex, background is NSW Seamless geology.

miners were attracted to the reefs, although alluvial mining continued and several older deep leads were discovered.⁸ The rush to the Kiandra goldfield in 1860 caused a decline in alluvial mining at Adelong, but despite this setback, by 1861 Adelong was an established town with a settled population of 200 and a further 1500 in the surrounding area.⁹ Over the next decade substantial timber and brick buildings were erected including three churches, two schools, four stores, a police station and a courthouse. There were four hotels, the Adelong, Commercial, Star and Pride of Galway, a brewery and a branch of the Bank of New South Wales,¹⁰

Reef mining at Adelong led to an upswing in gold production. Further prospecting revealed at least 12 lines of mineralisation developed within a 4 km long area of the Wondalga Granodiorite (Fig. 2). The mineralised zones contained discontinuous, auriferous quartz reefs that trended either north or northeast and ranged from 3 cm to 6 m wide (generally about 1 m). The reefs consisted of quartz impregnated with gold, pyrite and other sulfides (arsenopyrite, chalcopyrite, galena) enclosed by sheared and brecciated quartz and country rock, which also carried gold. Some reefs assayed up to 14 oz of gold/tonne. Numerous claims were taken out along the eight main reefs, including the Old Hill, Caledonian, Fletchers, Donkey Hill, Victoria, Gibraltar and Currajong reefs. In 1876 there were 32 mining companies working these reefs.¹¹

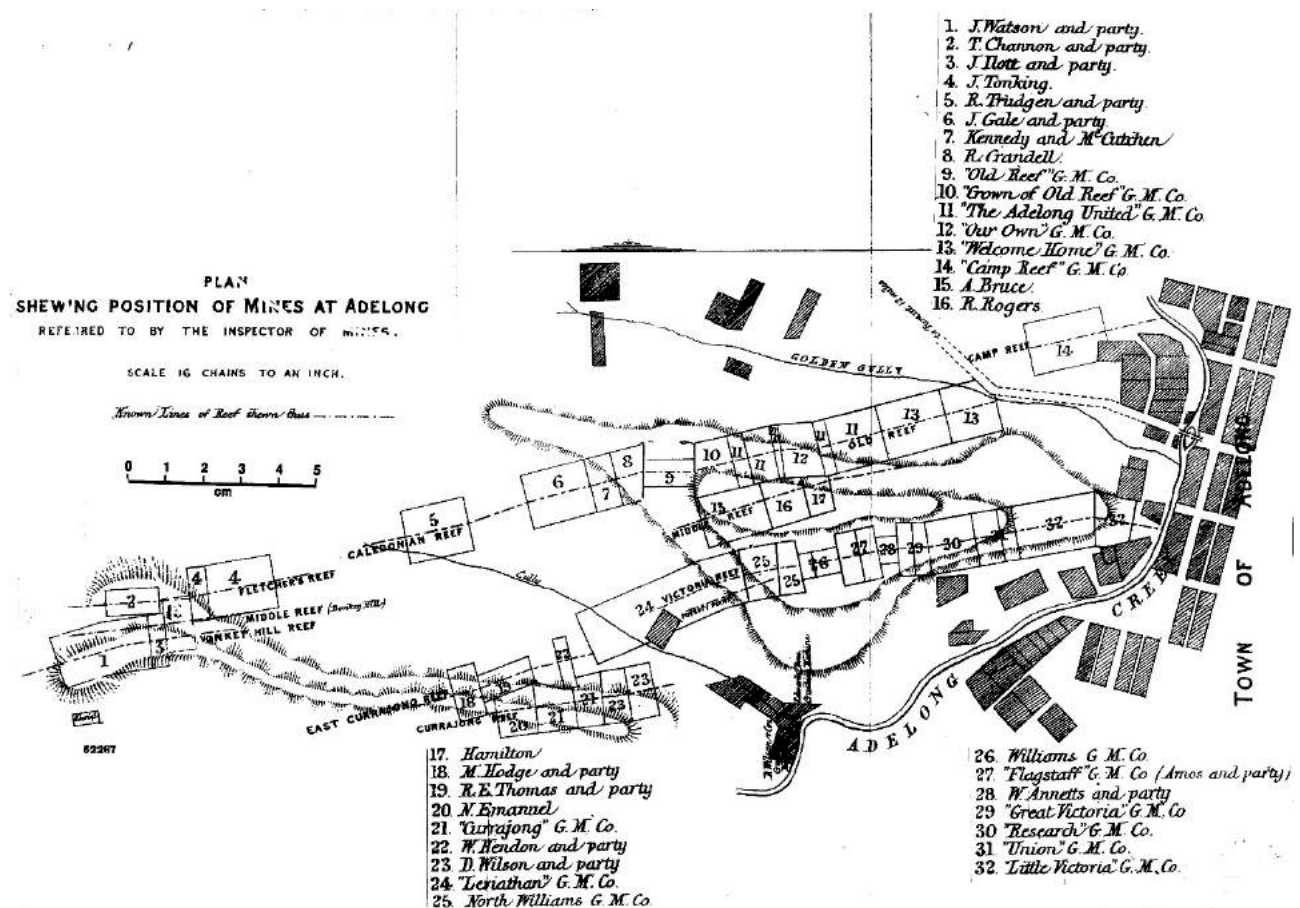


Figure 2. Plan of the Adelong Goldfield showing the main lines of gold reefs and mine properties. Source: Harper, L.F. 1916. The Adelong Goldfield. Mineral Resources No 21, NSW Department of Mines.

A major mine on the Victoria Reef was developed by the Great Victoria Gold Mining Company. In 1877, this was the first reef mine in Australia to reach a vertical depth greater than 800 feet (244 m) in payable ore. For this achievement the company won the reward of £1 000 offered by the NSW Government as an incentive to deep prospecting and demonstration that reef-gold extended to significant depth.¹² Most of the mines on the Victoria Reef had reached more than 500 feet (152 m), but surprisingly still used horse whims to work their shafts. The first successful quartz crushing

plant, the *Pioneer*, was built by Samuel Emanuel in 1858. A number of water powered batteries were built to utilise the ready water supply and steep terrain. These included Wilson and Ritchie's plant at the Adelong Falls, which used early developed methods to extract the significant amount of refractory gold locked in pyrite (Fig. 3). This plant operated until 1914.¹³

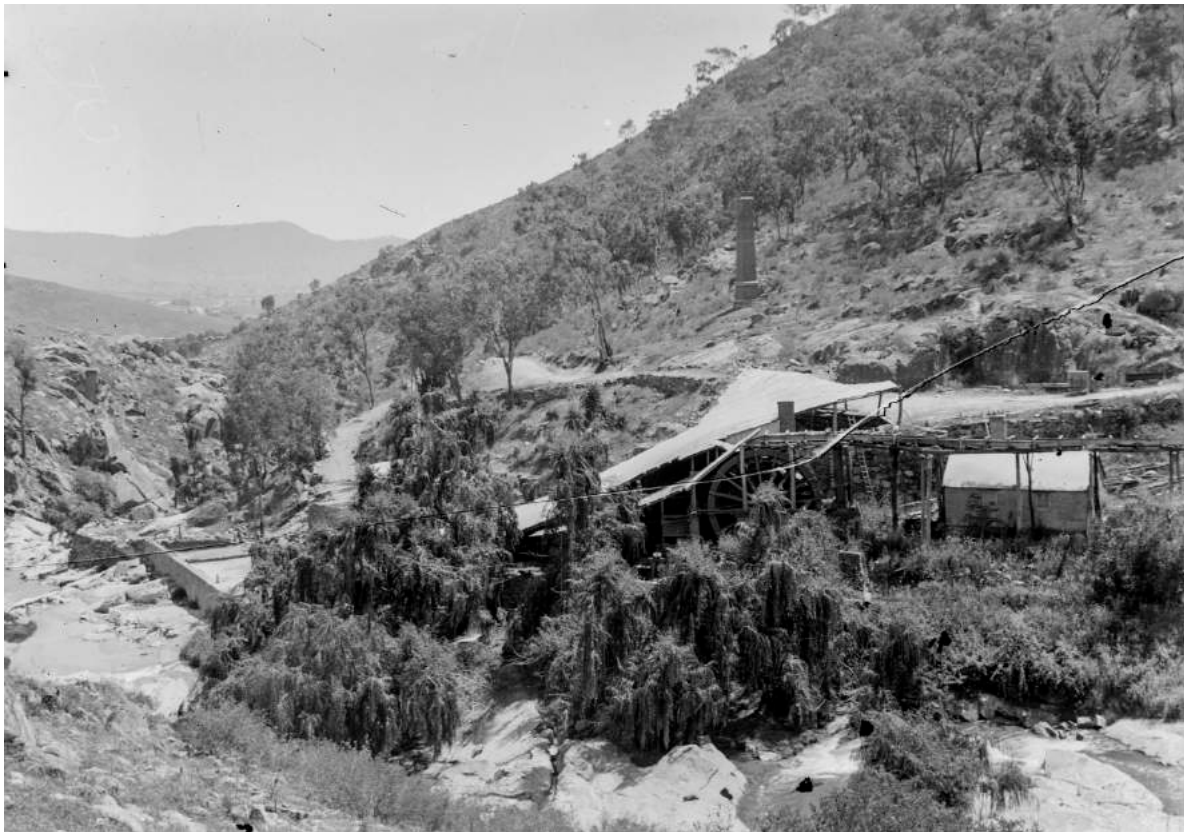


Figure 3. Wilson and Ritchie's water powered battery at Adelong Falls (also known as the *Reefer* Battery) ca. 1915. Source: Geological Survey of NSW Photo Collection (HG1667).

Reef mining continued successfully up to 1885, after which gold production declined. In 1895 the Gibraltar Gold Mine on the Gibraltar Reef was taken over by the Gibraltar Consolidated Gold Mine Ltd., an English company with nominal capital of £300 000.¹⁴ This company commenced vigorous development and introduced modern equipment, including chlorination and cyanide gold extraction works. As a result, annual gold production in the first year increased from 96 kg to 280 kg (3 090 to 9 000 oz) and during 1897-1899 a total of 1344.8 kg (43 237 oz) were produced from 47 588 tonnes of ore.¹⁵ In 1900 the Gibraltar Company was reconstructed with additional investment and the Challenger, Caledonian and Caledonian Extended mines on the Old Hill line of reef acquired. From this point production decreased and the massive capital expenditure on equipment and the necessary underground prospecting eventually rendered the operation unprofitable. Up to 1915 the two companies produced more than £450 000 worth of gold but paid only one dividend.¹⁶ Significant reef mining at Adelong ceased by 1916, although there was limited, sporadic reef mining during 1928-42.¹⁷

From 1901, Adelong Creek was extensively worked by dredging, particularly in the downstream areas near Grahamstown and Shepherdstown.¹⁸ It is estimated that 7.381 tonnes of gold were produced from alluvium with an average grade of 0.22-0.4 g per m³. In 1916 there were seven dredges operating at Adelong. The main production was from four companies. Davies and Kershaw Gold Estates Pty Ltd (earlier Grahamstown Gold Estates) operated from 1901-1914, producing just over 1.904 t (61 215 oz) of gold. Adelong Gold Estates N.L. began operations in 1913 with two bucket dredges and up to 1928 produced 2.129 t (68 449 oz). Between 1911-1928, Adelong Creek Dredging Co. N.L. worked the area between Mt Horeb and Adelong Crossing for 2.13 t (68 481 oz). During a

late revival in dredging from 1932 to 1942 the Golden Valley Mining Co. N.L. produced 0.244 t (7 845 oz) of gold from the western side of Adelong Creek, near Mt Horeb, and from leases just below Grahamstown.

From the 1960s numerous companies explored and assessed the Adelong goldfield including Planet Gold Ltd, Central Pacific Minerals N.L. and Carpentaria Exploration Co. Pty Ltd. In the 1980s Pan Australian Mining Pty Ltd accessed the upper part of the Challenger Reef on the Old Hill by a decline and conducted mapping and sampling (Fig. 4). From 1996 to 2000 Adelong Consolidated Gold Mines conducted extensive exploration drilling and soil geochemical surveys to define a target for possible open pit mining. The gold deposits at Adelong continue to attract exploration interest.



Figure 4. A shear-hosted quartz vein array exposed by recent underground exploration in the Challenger deposit, Adelong. Individual mineralised zones/veins are outlined in red. Photo: P. Downes, 2003.

The total gold production from the Adelong goldfield up to 1941 is estimated at 22.9 tonnes, including at least 13.14 t (454 612 oz) from alluvial mining and 11.76 t (378 093 oz) from reef mining.¹⁹

Tumbarumba

Alluvial gold was discovered in the Tumbarumba area in January 1855 with intermittent production until 1954. The initial discovery was at Tumbarumba Creek by a party of three prospectors. Early mining was hampered by the difficulty of getting supplies to the remote area, but by July 1856 about 150 miners, many from Omeo in Victoria, were on the field and earning an average £6 per week (a little under 2 oz of gold). One old Victorian digger described the site as the best poor man's diggings he had ever been on.²⁰ The first miners worked the recent alluvium in the creek banks and terraces, either by sinking shallow (<3 m) shafts and washing the pay dirt in long tom sluices or by ground sluicing (Fig. 5). Eventually, extensive areas were worked along Tumbarumba and Burra creeks with lesser production from Manus Creek, Paddys River, Tarcutta Creek and Pound Creek. The gold along these creeks tended to be patchy. The early settlement of Tumbarumba was a 'moving feast' following

the miners down Tumbarumba Creek as they worked out the alluvial gold. The town appears to have stopped where the gold did, as very little gold was found below the present town site.²¹



GOLD MINING AT TUMBARUMBA CREEK, N.S.W.
(View showing Sluice-boxes, and Pelton Wheel operating Pump.)

Figure 5. Alluvial gold miners using long tom sluice boxes on Tumbarumba Creek ca. 1899.
Source: Annual Report New South Wales Department of Mines for 1899.

Quartz reefs, the primary source of the gold, were discovered from the early 1860s. These occurred in granite and surrounding Ordovician metasedimentary rocks and were generally small. The main reef mining areas around Tumbarumba were at Quartzville, Yarrara, Ournie, and Little Billabong (see below). Numerous small syndicates and mining companies were set up to prospect and mine the reefs, but these were either unsuccessful or had small production and were soon abandoned. One of the more successful mines south of Tumbarumba was the Isabella Reef at Ournie 26 km southwest of Tumbarumba, worked to a depth of 45 m, with recorded production during 1875-1901 of 121.4 kg (3 902.6 oz) of gold.²²

In 1868 the Laurel Hill – Tumbarumba deep lead was discovered by two miners, Porter and Crawford, while ground sluicing at Surface Hill, where bedrock cropped out beneath basalt.²³ This is an old, broad river channel infilled by gravels, clay and lignite and overlain by a Tertiary basalt lava flow, now partly eroded. The lead runs roughly parallel to the present Tumbarumba Creek for 31 km from Laurel Hill in the north to Burra Creek in the south. Although gold occurred throughout the wash, payable quantities were found in irregular patches only. The lead was worked by sluicing under the basalt until it became too thick to handle then the miners resorted to tunnelling and sinking shafts through the basalt. At the main site of Laurel Hill more than 200 shafts and tunnels were put into the lead and mining continued up to 1918, with a further period of production from 1933 to 1938. Gold shed from this elevated deep lead by weathering and erosion contributed much of the alluvial gold found in the recent creek valleys. The deep lead and some of the recent drainage also contained alluvial tin, as well as sapphire and ruby gemstones.

From 1900 to 1918 there was extensive dredging along Tumbarumba, Burra, Tarcutta and Pound creeks using pump dredges (Fig. 6) and a bucket dredge. The main dredging companies were the Union Jack Gold Mining Co., Burra Sluicing Co., Tumbarumba Gold Dredging Co. and Heinecke and Juster. Gold production from dredging amounted to 362 kg (11 630 oz).

Total recorded gold production from the Tumbarumba field from 1859 to 1954 was 3.71 t (119 279 oz), mostly from the alluvial deposits.²⁴



GOLD MINING AT TUMBARUMBA CREEK, N.S.W.
(Centrifugal Elevating Pump and Suction-pipe.)

Figure 6. Alluvial gold miners working with a centrifugal elevating pump dredge at Tumbarumba ca. 1899. Source: Annual Report New South Wales Department of Mines for 1899.

Mount Adrah - Bangadang

Eighteen years after discovery of gold at Adelong, gold was found in the Mount Adrah area 18 km to the northwest. In February 1871, C. Day, H. McNair and C. Bliss discovered a gold-bearing reef near Nacki Nacki Creek and prospected the adjacent area for alluvial gold.²⁵ About this time Percy Stephen and party found a rich patch of shotty alluvial gold in shallow alluvium near the junction of Nacki Nacki and Yaven Yaven creeks. This party was able to make £16 per man while the patch lasted. Subsequently, Engelen and party traced the alluvial gold into a large flat and recovered about 15 oz before a group of Victorian miners took up a large claim in early 1872. The Victorians cut an expensive water race from Nacki Nacki Creek to work the deposit but with disappointing results.²⁶ Several additional small quartz reefs were discovered in the Mount Adrah area about this time, but mining appears to have been limited at this stage.

From the 1880s there was renewed interest in the area.²⁷ In 1883 George Cole, discovered a significant auriferous reef at Bangadang, 7 km south of Mt Adrah. By 1885 the reef was being worked by Cole and partners Ryan and Pastrelli at a depth of 50 m, with parcels of ore sent to Adelong for crushing.²⁸ This reef became known as the Ironbark (Fig. 7) and by July 1892 it had produced 34.78 kg (1118 oz) of gold.²⁹ Numerous other quartz reefs, some with rich gold, were discovered scattered around Mount Adrah in the Ordovician metasedimentary rocks, but there is little recorded information on production.

In March 1884 there was a new discovery of alluvial gold on Nacki Nacki Creek, which led to a small rush. Alluvial deposits were worked along Hillas Creek, but operations were hampered by ground water inflow. In 1899 dredging leases were applied for to work Hillas and Nacki Nacki creeks, although it is not clear if dredging ever took place. Mining in the area largely ceased by WWI.

The Bangadang area also continued to receive intermittent attention. In July 1894 the Bangadang Gold Mining and Water Power Company Ltd erected a water powered 10-head stamp battery with water race to process ore from eight reefs in the Bangadang field. (Fig. 8).³⁰ However,

the disappointing results, mainly related to a problem with the battery, forced the company into voluntary liquidation five months later.³¹ After this setback there was a significant revival in reef mining at Bangadang during 1910 as a result of new discoveries. In August of that year, brothers William and Michael O'Dwyer found a reef on Bangadang Hill running 3 oz per ton in surface stone.³² The reef, just under 1 m wide, was within altered diorite and being in previously unexplored country soon attracted much prospecting interest. By October, the O'Dwyers had a shaft down 5 m and were transporting ore to the nearby battery at Dog Trap Gully.³³ At depth, the ore became increasingly refractory with significant gold hosted in arsenopyrite, requiring custom treatment at Cackle Creek where returns up to 7 oz/ton were achieved. Other surrounding deposits were discovered over an area of 2.6 km².³⁴

After initial success, mining at Bangadang Hill waned due to the cost of transporting the ore to Cackle Creek. In May 1914 the O'Dwyer's gold mine was sold to a Melbourne syndicate for £5 000 and formed into the Bangadang Gold Mines Company.³⁵ The following year this company was reorganised into a new company capitalised to £100 000 and with a plan to acquire surrounding properties and process a large tonnage of lower grade ore by a combination of amalgamation, roasting and cyanide treatment.³⁶ During 1914-15 there was considerable prospecting and underground development, including construction of an adit.³⁷ Former mine owner, William O'Dwyer, was appointed as manager in 1916 to apply his experience of the area and in early 1917 he installed a 10-head stamp battery and plant valued at £3 000.³⁸ In 1918 a cyanide plant was added and 54.5 oz of gold produced.³⁹ Mining appears to have ceased in 1919.⁴⁰



Figure 7. Deep shaft at the Lucky Horseshoe (aka Ironbark) mine, Bangadang. Photo: R. Robertson, 1995.



Figure 8. Shallow adit at old reef workings, Bangadang area. Photo: R. Robertson, 1995.

With its numerous signs of gold mineralisation, interest in the Mount Adrah – Bangadang area, returned during the 1980s gold exploration boom. In 1980-84 Getty Oil Development Company Inc. discovered Hobbs Pipe, an altered and mineralised felsic intrusive, south of Mount Adrah. The deposit was initially detected during geochemical exploration and followed up by geophysical surveys and drilling. Subsequent exploration by several companies, including Range Resources, Cyprus, Michelago Resources N.L. and Sovereign Gold, identified a large, low-grade gold deposit containing a 20.5 Mt resource grading 1.1 g/t gold.⁴¹ Exploration of the area is ongoing.

Junee Reefs

In March 1868, a fourteen-year old shepherd discovered a gold-bearing reef 19 km north of Junee. His father, George Wallett, together with George Peterson, Maxwell Stewart and others, took out a prospecting claim on the new discovery. Within months other reefs were discovered, including the Eaglehawk, Doctor's, and the Hope.⁴² The discovery of gold in this area was important as it showed that the gold-bearing country of NSW extended further west than previously known.

Parcels of quartz from the reefs were sent to Grenfell, Coolac and Adelong for test crushing, with stone from Walle's claim returning 3.5 oz per ton gold. A parcel of 7.5 tonnes from the Hope Reef yielded just over 25 oz of gold.⁴³ In April 1869 a 12-head stamp battery was erected by Thomas Kirkpatrick from Grenfell, next to a newly excavated dam on Houlaghans Creek to provide a local crushing facility.⁴⁴ A settlement quickly formed and by March 1869 had a population of 100. There were several stores and butcher shops, a bakery, comfortable hotel, and a school with 20 students.⁴⁵ The settlement became known as Junee Reefs. Walle and company obtained good results from their mine and in September 1871 purchased and refurbished Kirkpatrick's crushing plant. However, drought conditions and severe bushfires during the early part of 1872 led to a hiatus in production and in October the mine was sold to the Junee Gold Mining Company.⁴⁶

The various reefs occurred in gneissic granite as northeast and northwest trending quartz veins, with free gold, gold-bearing pyrite and other sulfides. The main mines were Walle's (or the Prospectors), Eaglehawk, Hope, Doctors-Rockdale and the Dust Hole.⁴⁷ The latter was a very promising claim with rich quartz, but under various owners the mine never seemed to flourish, possibly because of its close proximity to the hotel. Numerous other claims that were pegged eventually proved unprofitable. A search for payable alluvial gold around the reefs also proved unsuccessful. The heyday of Junee Reefs was around 1870-72, after which mining declined as miners were drawn away to the new alluvial diggings at Gulgong and later Temora.

There was a revival of the field in 1883-85 with redevelopment of several of the mines, particularly the Dust Hole, and discovery of a new reef called Pike's. There was also interest in treating the accumulated tailings. An innovative crushing plant was built, designed for finer grinding and incorporating blanket strakes, as well as Halley's percussion tables and a Moore's patent hydraulic gold extractor.⁴⁸ It was also intended to add a component to treat the pyritic residue and tailings from previous mining. This addition was made in late 1884 using equipment from a similar plant at Sebastopol, but it was not a success.⁴⁹ Further interest was sparked in 1896 with renewed working and major investment, including by John Howell of the Howell Exploration Syndicate (later Howell Consolidated Co.). A cyanide plant was built to reprocess old tailings (Fig. 9). After six years this renewed mining activity was abandoned as financially unviable, partly due to the refractory nature of the ore at depth.⁵⁰

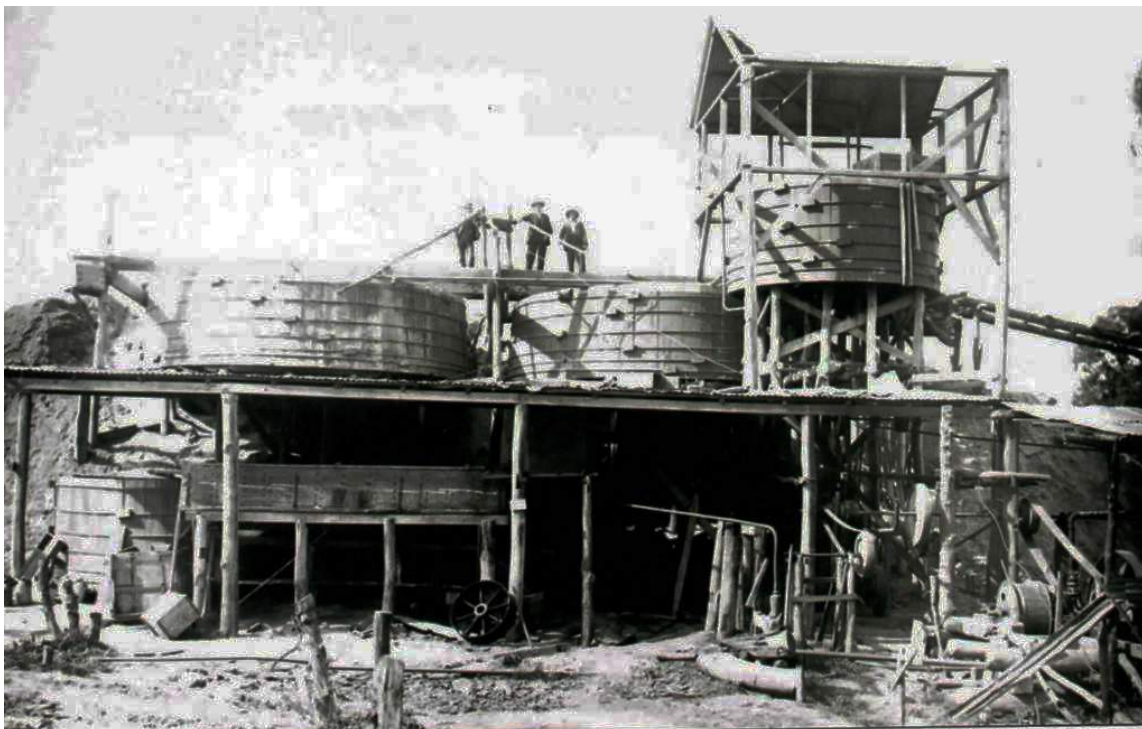


Figure 9. Cyanide plant at Junee Reefs used for reprocessing tailings ca. 1900. Source: Junee Broadway Museum.

Official gold production from Junee Reefs is 131.7kg (4 233 oz), however early production prior to 1884 was not recorded.⁵¹ Press reports indicate that Wallett's claim alone produced 116.6 kg (3 750 oz) up to September 1871.⁵²

Sebastopol

Soon after discovery of the Junee Reefs, gold was found 16 km to the north at Sebastopol Hill. It is not clear who made the discovery, but John Ryan and Patrick Heffernan (a prominent local pastoralist) were early prospectors who claimed the first reef. In December 1868 they sold shares in the reef to a group of investors from Grenfell and this became the Morning Star mine, the most important at Sebastopol with recorded production of 0.93 tonnes of gold.⁵³ By August 1869, a shaft was down 10 m on a 1.5 m wide quartz reef with an estimated gold grade of 1 oz per ton (27.9 g/t). Other reefs were discovered, and a small town was established with two hotels, the 'Reefers' and the 'Exchange', as well as a post office and four stores. By 1870 the population of Sebastopol had grown to 250 and a public school was opened the following year.⁵⁴

In March 1871, the Morning Star Company was registered with nominal capital of £2 000 in ten shares.⁵⁵ Other mines that were developed in the area included the Homeward Bound, Evening Star, Hibernian and Maid of Judah.⁵⁶ As at Junee Reefs, mining declined after 1872 and in 1880 the Morning Star mine was abandoned. In 1882, the claim was jumped and redeveloped by Davidson and company.⁵⁷ Production from the Homeward Bound and Evening Star mines peaked in the period 1884-1885 during the local revival of gold mining. However, most of the profits from these mines were expended on litigation, particularly at the Homeward Bound. Mining on the field continued until 1896, after which it faded to small-scale and intermittent activity, apart from some work at the Morning Star in 1904 and 1910. During 1929-1935 there was some final interest in redeveloping the Morning Star mine (Fig. 10).⁵⁸

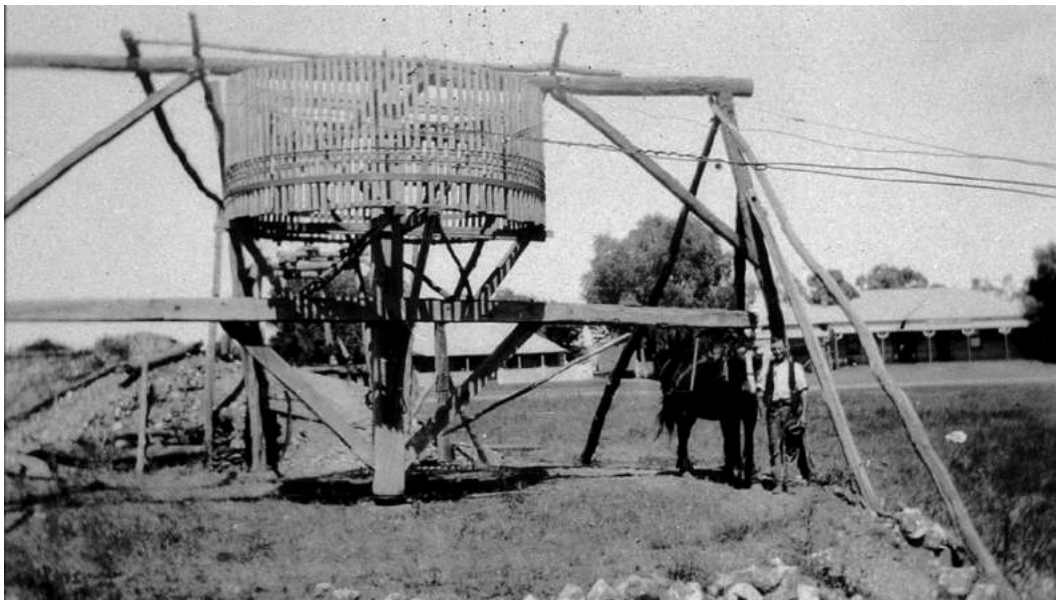


Figure 10. Horse whim at the Morning Star mine, Sebastopol, ca. 1920. Source: State Library of NSW.

The reefs at Sebastopol consisted of auriferous quartz veins in Ordovician age metasedimentary rocks, to the west of the major Gilmore Fault. The dominant northwest trending set of veins were bedding-parallel and considered fissure fillings, but with some accompanying replacement of the host rocks. The Morning Star reef extended for a length 335 m and was mined to a depth of 109 m. The vein mineralogy was similar to that at Junee Reefs with significant gold hosted by accompanying sulfide minerals.⁵⁹ Unsuccessful attempts to recover gold lost in tailings were made in 1884 by a Melbourne syndicate headed by William Marshall, using a novel treatment process designed by W.R. Fitzgerald Moore. This process, trialled for the first time at Sebastopol,

incorporated finer grinding, followed by multiple electro-amalgamation and roasting stages.⁶⁰ From 1895 to 1898 a New Zealand company successfully treated the extensive tailings at both Sebastopol and Junee Reefs using the cyanide process, recovering 0.5 oz per ton (14 g/t).⁶¹

Total production from Sebastopol is not clearly known as some gold returns were referenced to other fields. A minimum estimate from official reports is approximately 1 tonne (32 151 oz) of gold.⁶²

Temora

Gold was accidentally discovered on Temora Station in early 1869 by a party of 'bushmen' erecting a fence. They observed a quartz reef with visible gold on a low hill, later named Flagstaff Hill. The property lessee, John Macpherson, began working the large outcrop, which became known as Macpherson's Reef.⁶³ Prospectors, including Goldspink and party, Kingland, Harris and Schaffer, were quickly attracted to the area and several other lines of reef were discovered and worked.⁶⁴ However, lack of capital and the difficulty of getting the quartz crushed impeded development by the early miners. Several parcels of ore were sent 30 km to the batteries at Junee Reefs for testing, but except for one parcel from the Hidden Star Reef, which yielded 3.5 oz per ton, the results were not sufficiently encouraging, and reef mining was largely abandoned. Between 1870 and 1879, Henry Waite a miner who was convinced there would be alluvial gold on the flat below the reefs, returned four times to the area but each time was unsuccessful in his prospecting. However, his conviction encouraged Harry Parker (Parknitz), a Hungarian exile, to try the flat. With three companions, Parker had some success and on 17th November 1879 took out an alluvial claim. Other prospectors were attracted, including George Bloomfield who found the first patch of payable alluvial gold in shallow ground in January 1880.⁶⁵ Soon after, Parker's group also found good payable gold at the rate of 2-4 gr (0.13-0.26 g) per dish and when a telegram from mining warden Charles De Boos was mistakenly reported in the press as 2-4 oz per dish, a minor gold rush ensued.⁶⁶

The early alluvial miners were disappointed with results until on 30th June 1880, James Maloney struck rich gold on what proved to be the main lead (Selector's Lead). A day later Patrick Murray also found good gold on a nearby claim. This confirmation of payable gold sparked a major rush and within 5 weeks an estimated 20,000 people were on the field.⁶⁷ Maloney and his party



Figure 11. Gold workings on one of the alluvial leads at Temora, 1881. Source: Geological Survey of NSW Photo Collection (HG0376).

received a reward of £400 from the government for their persistence in locating a major alluvial lead. The main lead extended 5.6 km in a northerly direction from Flagstaff Hill within a buried Tertiary channel with numerous tributaries. Depth to bedrock at the head of the lead was 21 m, deepening north to more than 60 m, with gold occurring at various levels in gravelly wash interbedded with sand and clay (Fig. 11). The gold occurred in irregular patches, commonly across the lead rather than along its length, and included coarse gold and angular nuggets (up to 99 oz), as well as gold in quartz fragments.⁶⁸ A second lead

(Frontage or Deep Lead) was discovered parallel to the main lead 3.2 km further east in September 1880. Shafts in this lead also struck water, which was in great demand for puddling.⁶⁹

By mid-1880 Temora consisted of a straggling settlement of three town centres developed around the different workings. These were Upper Temora (southeast), Lower Temora (northwest) and the Government town in between, named Watsonford. The architectural theme was bark for walls, galvanised iron for roofs and calico windows.⁷⁰ Many of the early ‘rushers’ were idlers and ‘shepherders’ of claims. In late August 1880 the population had settled to about 9 000, but only 500 were actively engaged in mining.⁷¹ Drought conditions during 1880-81 meant that much alluvial wash could not be processed by puddling machines and had to be stockpiled to await rain.⁷² In 1882 there were 20 alluvial claims with 10 being worked, however heavy rain in the latter half of the year allowed stockpiled wash dirt to be processed, resulting in an output of 1.005 t (32 298 oz) of gold.⁷³ Alluvial gold production declined from 1883 and the field was considered almost worked out by 1885.

The initial alluvial rush encouraged renewed interest in reef mining and in early 1881 there were more than 26 reefing claims.⁷⁴ The reefs consisted of steeply dipping, commonly easterly trending, quartz veins 8 cm-4 m wide in diorite. Many of the reefs featured patches of coarse nuggety gold. The main concentration of reefs was around Flagstaff Hill, near Upper Temora in the southeast. Major reefs included: the Agnes, worked for a length of 190 m on various claims; Amelia, worked over 300 m; Bourkes; Hidden Star, Mother Shipton; McPhersons, Eureka; Shamrock; and Currys Hill, near Lower Temora. Most of the reef mining was to shallow depth, typically less than 100 m, and most production occurred prior to 1900.⁷⁵

Probably the most famous reef was the Mother Shipton, discovered in September 1881 during excavation of a drain on the side of Flagstaff Hill (Fig. 12).⁷⁶ In October 1885, a large mass of gold



Figure 12. Surface remains of the Mother Shipton mine ca. 1920. Source: State Library of NSW.

was found in this reef and became known as the Mother Shipton ‘nugget’. This spectacular specimen of 9.67 kg (311 oz) of gold in quartz, broke into three pieces as it was dug from the reef on the 80 foot level.⁷⁷ The pieces were purchased by the NSW Government for £1,233 8s to display at the upcoming Colonial and Indian Exhibition in London in 1886, with the smallest piece being subsequently presented to Queen Victoria as a gift.⁷⁸ The main specimen, which contained 258.33 oz of gold and featured attractive gold threads in quartz and unusual crystalline gold,

became a drawcard at numerous national and international exhibitions. These exhibitions were important events, promoting the economic potential of New South Wales and stimulating immigration. In August 1906, while on display in the window of the Orient Steamship Company in London the Mother Shipton ‘nugget’ was stolen in a ‘smash and grab’ burglary. In the hope of saving it from the melting pot, the insurance company offered a reward of £100, but the ‘nugget’ was never recovered.⁷⁹

Total recorded gold production from Temora is 4.614 tonnes, (148 353 oz) about three quarters being from alluvial mining.⁸⁰

Barmedman

Following the gold discoveries around Junee and at Temora, discoveries were made further to the north. In September 1873, Frances Treasure, the wife of Alfred Treasure a sawyer on Barmedman Station, discovered gold in quartz on a low hill, 36 km north of Temora.⁸¹ Alfred, with four partners, registered a prospecting claim on the 3rd October 1873. The reef, named the Ada, was tested for five

months, abandoned, and then taken up by the Quail brothers, later joined by a Mrs Maher and Mr H. Minter from Young.⁸² Meanwhile, other reefs were discovered and worked, but little could be done with the mounting piles of quartz, due to the lack of a crushing plant and drought conditions. Soil near the reefs was found to contain fine gold, so the miners then prospected for buried reefs by panning the soils or 'loaming'. Reefs on the field were small but rich, consisting of gold-bearing quartz veins 8 cm to 1.5 m thick hosted in slates and to a lesser extent conglomerate and diorite. There were several lines of reef including the Hard to Find and Phoenix reefs about 3 km south of Barmedman. Eventually reefs were discovered over a strike length of 9 km.

A small crushing plant was erected by James Bacon in late 1877, however the dam for the engine provided insufficient water for continuous operation. About a year later the plant was purchased by Minter, refurbished and the dam enlarged to provide efficient crushing on the field for the various claims.⁸³ Barmedman was declared a goldfield in 1879 and by 1882 there were 150 miners on the field.⁸⁴ Attempts were made to find alluvial gold around the reefs and although some traces were found in alluvium on bedrock, no significant alluvial gold was discovered. Companies were formed to take over existing claims, the main ones being the Barmedman United Gold Mining Company Ltd, formed in March 1882 on four claims, and the Jackson's Reef Gold Mining Company N.L. formed in May the same year.⁸⁵ A surveyed township was established, with half a mile of main street, substantial buildings and a population of 300-400 (Fig. 13).⁸⁶ The town would become an important centre for further gold discoveries and mining in the area, particularly at Wyalong and Reefton.



Figure 13. Main street of Barmedman, 1910. Source: State Library of NSW.

During the early years of mining there were numerous changes of ownership of the various claims at Barmedman, reflected in a plethora of interesting names including: the original Ada (prospectors claim); Fanny Park; Hard to Find; Hunted to Death; Black Angel; Italians; Never Sweat; Phoenix; Moonlight; White Cross; and Fiery Cross.⁸⁷ Mining activity declined from around 1890, as the main workings reached the water table. The Fiery Cross mine was taken over by a new group in 1895, resulting in some sporadic development and production. Another company erected a cyanide plant to retreat the 40 000 tonnes of tailings from the early reef mining as well as new crushings.⁸⁸ Mining ceased in 1903 when the Fiery Cross mine finally closed.⁸⁹ The largest producing mines were those of the Barmedman United Gold Mining Co, the Fiery Cross, and Jackson's Reef. Total recorded gold production from Barmedman is 0.859 t (27 618 oz).⁹⁰

Water was always a major issue for the Barmedman mines, initially a lack of sufficient surface water for ore treatment and later as the mines deepened, problems with pumping out abundant saline

groundwater. In 1953, well after mining had ceased, mineralised water from the White Cross mine was used to set up a 'mineral pool' baths, which are still an attraction for the town.⁹¹ Interestingly, the name Barmedman is an indigenous Wiradjuri word meaning 'long water'.

Wyalong (Main Camp)

Gold was discovered near Wyalong Station in September 1893 by Joseph Neeld, a member of the Neeld family who had settled on a land selection. After arriving on the property, Joseph began prospecting and discovered a loose piece of gold-bearing quartz. There being virtually no outcrops, an intensive search was made for the reef by following a trail of gold in surficial rubble through dollying and washing the contained quartz and ironstone. Eventually the reef was located and became the Pioneer claim. Members of the family continued prospecting for several months in adjacent areas of thick mallee scrub and discovered two other reefs using the same technique. These became the Dead Rabbit (later Easter Gift) and Harry's claims.⁹² The fine-grained nature of the gold in the quartz, the widespread cover of red soil and the thick vegetation meant that these reefs had not previously been detected.

In October 1893, another find was made near White Tank, on the outskirts of the original Billabong Run, and this became the Neelds' Prospecting Claim when it was pegged in December 1893. Subsequently this claim was developed as Neeld's Gold Mine (Fig. 14). Other prospectors soon arrived in the area, their number reaching 500 by January 1894. Parcels of quartz were sent to

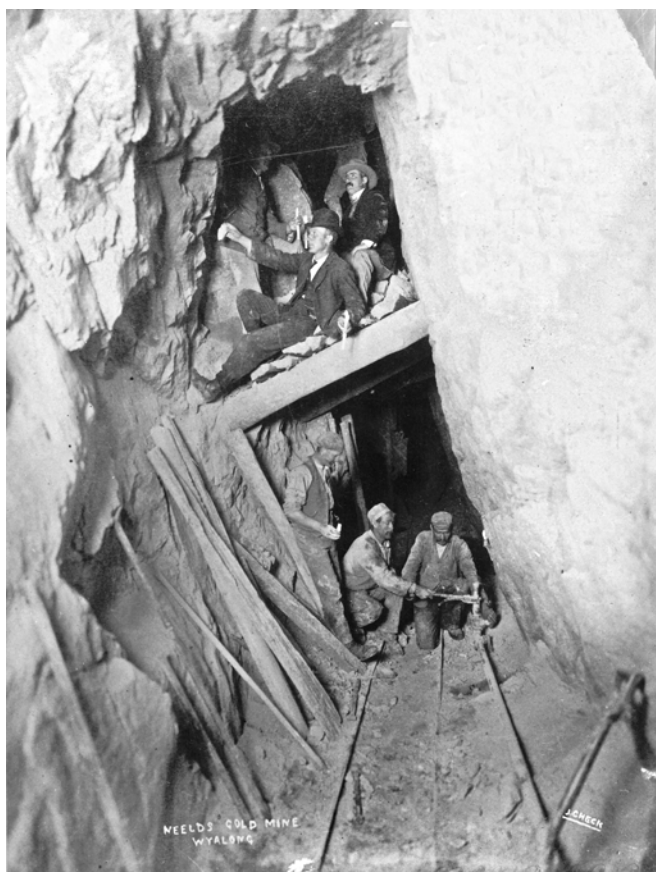


Figure 14. Miners and others in Neeld's Gold Mine, ca. 1901. Source: Geological Survey of NSW Photo Collection (MS Forbes 00214).

were held by individuals, small groups and syndicates with initial development of the field suffering from a lack of significant capital. Major mines were developed on the Mallee Bull line of lode including Neelds and the True Blue, the latter worked to a depth of 411 m, making it one of the deepest gold mines in NSW (Fig.15). Other important producers were the Golden Fleece, Homeward Bound, Kurrajong and Barrier.⁹⁶

Barmedman for crushing and when the results were revealed in March there was a major rush of possibly 10 000 people to the field. During 1894 at least 900 quartz claims were registered, although many were inactive or re-registrations and at the end of the year the number of miners had settled to just over 4 000.⁹³ Prospecting for alluvial gold had proved unsuccessful and this was put down to the nature of the topography and the fine particle size of the gold in the reefs.⁹⁴

Shortly after the main rush, a town site was chosen, well away from the mining area. It was surveyed in May 1894 and named after the Wyalong pastoral run. About 120 buildings were erected here, but the miners preferred living close to the mines and after their settlement was surveyed in 1895 it eventually became the main town of West Wyalong.

Intense prospecting at Wyalong discovered 12 significant lines of lode within an area of 4 km², with multiple claims taken up along the different lodes.⁹⁵ The main lines included the Mallee Bull, Santa Clause-Klink's, Klondyke, Currajong, and Barrier. Most of the claims

The individual gold reefs consisted of lenticular quartz-calcite veins, generally less than 1 m wide, developed along zones of intense shearing and crushing in granodiorite, diorite and to a lesser extent the surrounding slate. As well as gold, abundant pyrite and other sulfides were present in the unweathered zone and significant gold was held in the pyrite. Initially the mined quartz ore was sent 35 km to Barmedman for treatment, but from May 1894 crushing plants were erected at Wyalong.⁹⁷ After considerable quantities of ore had been processed it was recognised that treatment by stamp battery and amalgamations was inadequate, due to the refractory nature of the ores, and alternate methods were trialled. Modifications were made to the stamp batteries and a Huntington mill was erected. In 1895 a chlorination plant was constructed, leading to increased gold recovery, although this plan was not totally satisfactory due to problems with the rotating roasting furnace. Finally cyanide treatment plants were introduced resulting in effective treatment of the sulfide-rich ores and previous tailings. By 1899 there were three stamp batteries, one Huntington mill, two chlorination works and two cyanide plants in operation.⁹⁸



Figure 15. True Blue gold mine, West Wyalong, 1933. Source: State Library of Victoria.

Annual production from the Wyalong field peaked in 1899 at 1.266 tonnes (44 657 oz) of gold and then gradually declined until 1915. From 1894 to 1915 total gold production was 5.4 tonnes (190 479 oz).⁹⁹ On the 13 January 1912 the history of the Wyalong mines was marred by a serious accident, when six miners working at the Barrier Mine were asphyxiated by carbon dioxide gas.¹⁰⁰

Minimal mining continued until 1920 after which production essentially ceased. During the 1930s the old tailings were again reworked by cyanidation and in 1941 a State battery was erected to encourage some small-scale mining.¹⁰¹ Total gold production from the Wyalong field is estimated at 13.86 t (488 897 oz).¹⁰²

Renewed interest in gold during the 1980s saw modern exploration in the Wyalong area culminating some 20 years later in the discovery and development of the major Lake Cowal gold mine, 35 km to the northeast. At Wyalong itself there is now little evidence of the extensive early mining following the removal of mine dumps for road aggregate and rehabilitation of old shafts. In 2015 the main shaft of the historic True Blue mine was plugged and capped following its collapse under a motel carpark.

Reefton

The gold rush to Wyalong in early 1894 led to a burst of prospecting in the surrounding region. In April 1894, the Field brothers picked up a quartz ‘floater’ with visible gold on Trungelly Station at a location 13 km south of Barmedman and just east of the Temora-Barmedman road. Active prospecting of the area commenced immediately, and the first reef was discovered and taken out by Higgins and party. There was a rush to the area by 200 miners with hopes of another Wyalong, and three lines of reef were quickly discovered, extending in a northwest direction over 5 km in sandstone and slate.¹⁰³ Individual reefs were up to 300 m in length, but very irregular and narrow (8 cm-1 m). The quartz was typically greyish at depth, but oxidised and reddish on the surface with supergene enrichment of gold. Initially the ore was crushed at Temora and Barmedman, with the first on-site battery installed in December 1894 by Rich and Company.¹⁰⁴

A town was laid out by the miners in June 1894 to be called Gidginbung, but the name was changed to Reefton before it was proclaimed.¹⁰⁵ In July a sawmill was set up and numerous buildings erected including two general stores, several small stores, two bakers, three butchers, three boarding houses and a working man’s club.¹⁰⁶ A Public school opened in November 1894 and operated until 1971.

In 1895 a group of prospectors working around the reefs discovered alluvial gold, resulting in a short-lived rush. Slattery and Nixon had some success in a well-defined east-west channel, but most alluvial miners found little gold and abandoned their efforts by the end of the year.¹⁰⁷

In 1897 there were four reef mines working the field, the Pioneer, Enterprise, Sydney. and Prospectors, employing a total of 50 miners. Production for the year was 1 330 oz of gold from 1 453 tonnes of stone. At this stage most workings had reached the water table and production was declining due to a lack of capital for purchasing pumping equipment. A small cyanide plant was installed to treat tailings, however insufficient capital, particularly for modern pumping and winding equipment, was a continuing problem on the field.¹⁰⁸ Mining ceased in 1902 with closure of the Enterprise-Pioneer mine, which had reached a depth of 107 m. There was subsequent intermittent mining at the Enterprise and Sydney mines from 1905 to 1937, but with very small production.¹⁰⁹

Recorded gold production from Reefton is 0.193 t (6 808 oz), mostly from the Pioneer-Enterprise mine in the period 1894-1901.¹¹⁰

Gidginbung

During the renaissance in gold exploration from the late 1970s attention returned to the historic gold fields of the East Riverina. A significant new discovery was made at Gidginbung Hill, 15 km north of Temora. In 1975 geologists working for Samedan Oil Corporation of Australia noticed interesting pyritic quartz and volcanic rock being used by the local council workers to repair the main road north of Temora. On enquiry they were directed to a quarry on the side of Gidginbung Hill. An exploration licence was pegged by Samedan and a soil and RAB geochemical survey conducted, revealing anomalous levels of copper, lead, zinc and arsenic. Interest at this stage was in volcanic-hosted, massive sulfide mineralisation and the results were not sufficiently encouraging, so the prospect was relinquished in June 1979. Subsequently, Seltrust and BP Minerals Australia Pty Ltd undertook rock chip sampling followed up by testing with three drill holes in 1983.¹¹¹ The results indicated near surface gold up to 3.46 g/t over widths of 20-54 m, prompting a major drilling campaign. A company re-organisation in 1985 saw the formation of Paragon Resources N.L. and further resource definition drilling. The Gidginbung open cut mine commenced in 1987 with mining completed at the end of 1996. Total production was 21.07 t (743 222 oz) of gold with minor silver from 10.21 Mt of ore.¹¹²

The discovery of this new style of gold deposit prompted extensive exploration for epithermal gold in the region. This work led to the recognition of other epithermal gold deposits and associated porphyry copper-gold zones within Late Ordovician – early Silurian volcanic rocks in a belt just east of the Gilmore Fault Zone, extending between Temora and West Wyalong. Significant gold and copper-gold systems along this belt include Gidginbung, Yiddah, The Dam, Cullingerai, Mandamah and Estoril.¹¹³

Other smaller gold deposits

There are small historic gold mines in the Yarrara Goldfield, to the northeast of Albury. Production from this field occurred at various times between 1873 and the 1930s, mostly from four mines: the Perseverance; Rangitira; Just in Time; and Billabong.¹¹⁴ These deposits appear to be related to the Yarrara Shear Zone and comprise gold-pyrite bearing quartz veins hosted in metasedimentary rocks. Henry Palmer discovered the Perseverance Reef on the 25 March 1873 and sold his find to Messrs J. Day and K. McLennan. By 1875 this group had erected a stamp battery and produced 1,350 oz of gold.¹¹⁵ A small settlement developed at Yarrara and the population reached 200-300 before quickly dwindling when most of the surrounding reefs were abandoned on reaching the depth of the water table.¹¹⁶ North of Yarrara, the Billabong Reefs, were discovered by J.J. Riley and E Tunbridge in 1909. Various groups and companies attempted to work this area, but recorded production was a mere 131 oz. In 1932 there was an attempt to work the Billabong mine as an open cut. Total recorded gold production from the Yarrara field was about 0.73 t (26 000 oz) from depths less than 70 m.¹¹⁷

To the southeast of the Yarrara field in the Ournie area, is the Isabella Reef which produced 111.44 kg (3 583 oz) of gold from 1 717 tonnes of ore in the period 1875-1901. The nearby Peep-O-Day mine, worked between 1875 and 1906, produced 214.61 kg (6 900 oz) of gold from stockwork style quartz-pyrite-arsenopyrite mineralisation in granite.¹¹⁸ There is current interest in this style of deposit for bulk mining of low-grade gold ore.

Copper-gold

Mineral exploration from the mid-1980s discovered significant porphyry copper-gold mineralisation within Late Ordovician-early Silurian volcanic rocks in the East Riverina, particularly in the area north from Temora. These discoveries followed the recognition and interest in the associated epithermal gold mineralisation (see above under Gidgingbung).

Tin

Tin deposits in the East Riverina are associated with a NNW trending belt of granitoids that extend from Corryong in Victoria to Tallebung in northwest NSW (the Wagga Tin Belt). Alluvial tin was first observed in the area during alluvial gold mining at Adelong and Tumbarumba. Early prospecting interest was aroused during the tin boom of the 1870-1880s, sparked by major discoveries in the New England region of NSW. The Ardlethan tin field near the centre of the Wagga Tin Belt has been the largest producer of tin on mainland Australia (>32 000 tonnes).

Mount Paynter (Jingellic)

Alluvial tin was found in the Jingellic area by D.S. McKay in 1872.¹¹⁹ Other discoveries were made at the head of Swamp Creek in the Mount Paynter area, including some nearby tin lodes. The lodes occur as quartz veins in granite and contain cassiterite with minor arsenopyrite, wolframite, scheelite, pyrite and sphalerite.¹²⁰ Leases for mining the lodes were taken out from 1873. The Jingellic Tin Lodes Mining Company commenced operations in 1875 and by 1878 had opened four lodes, installed a 12-head battery and constructed a 4 km water race.¹²¹ Up to 1881 the company used a shaft and several adits to mine 690 tonnes of ore, but the only recorded production is of 0.812 tonne of cassiterite concentrate from a 10 tonne trial crushing.¹²² A new company was formed in 1882 by Hastings, Cunningham and Co. of Melbourne, but after much capital outlay work was suspended in the following year. Small amounts of ore were mined by various groups in 1905, 1914 and 1918. An attempt to explore and develop the lodes on a larger scale was made by the Mount Paynter Tin Mining Company N.L. between 1923 and 1926. Following disappointing results and difficulties in raising additional capital, the company ceased operations in 1930. The following years saw negligible mining of the lodes but there was some mining of the alluvial deposits (1.64 tonnes of cassiterite concentrate), by H. Kohn at Swamp Creek.¹²³

Buddigower

In September 1896, John McDonough, G. Cameron and H. Smith discovered gold on Buddigower Station, 24 km southwest of Wyalong.¹²⁴ McDonough also reported a small quantity of tin associated with the alluvial gold and this observation was followed up in 1901 by J. Smith, resulting in the discovery of a small tin field. Cassiterite with some arsenic and silver mineralisation was found as a 2 m wide, quartz-rich lode in granite, near the contact with surrounding slate. The area was worked until 1906 and then abandoned, although there was some prospecting in 1920, 1925 and 1954. Ardlethan Tin N.L. conducted some exploration drilling in 1967 with disappointing results.¹²⁵

Ardlethan

Ardlethan, originally known as Warri, became an established town in 1908 when the Temora to Berallan railway reached this prosperous wheat growing region. Prospectors were drawn to the area after gold was found at the Mallee Hen mine 16 km north of the town in 1910. This small, short-lived mine was discovered by Charles McLean while scrub clearing at Murrell Creek when he was distracted by a Mallee hen attempting to lead him away from her nest.¹²⁶

In April 1912, James Keogh found tin ore (cassiterite) in a prominent outcrop of quartz porphyry, on Warri Station, 6 km northwest of Ardlethan. This site would become the White Crystal tin mine. Two days later he made another discovery 0.4 km to the west, at the future site of the Carpathia mine and a few days after that, other discoveries that became the Wild Cherry, Homeward Bound and Reward tin mines.¹²⁷ It is interesting that the local farmer had previously noted very heavy stones while ploughing his wheat field adjacent to the White Crystal discovery. He referred to these oddities as 'spuds', but had not been curious as to why they were so heavy.¹²⁸

Keogh had samples tested before pegging claims over what he thought were the two most promising deposits, these being the White Crystal and Carpathia. He then formed a syndicate of six, to further prospect and mine the tin.¹²⁹ The discoveries created great excitement in Ardlethan, particularly given the very high price of tin at the time, resulting in a wild claim pegging boom. By June, 400 acres of claims were taken out.¹³⁰ On the weathered surface of the lodes, residual cassiterite was commonly encrusted with iron oxide, particularly at the Carpathia deposit where there were large boulders of this material. Initial assessment by 'experts' was not encouraging, as they pronounced



Figure 16. Big Bygoo mine northwest of Ardlethan 1919.

Source: Geological Survey of NSW Photo Collection

much of the mineralised material to be iron ore.¹³¹ Many who had rushed the area left, but Keogh, who was not a great believer in 'expert advice', persisted until further work and testing indicated the presence of economic tin lodes. Visits by former Queensland Government Geologist Robert Logan Jack and geologist W.J. Young in October 1912 confirmed the value of the Ardlethan deposits.¹³² Initial mining was of residual and loose eluvial cassiterite in soil capping the weathered lodes, with some of this material assaying 40-50% tin. Shafts were then used to explore and mine the underlying

lodes. Later there was small scale open pit mining at some deposits.¹³³

As mining progressed, the mineralisation was revealed as veins and pipes within altered granite, close to its contact with brecciated slates and sandstones. Further prospecting discovered the Big Bygoo and Little Bygoo deposits 10 km to the north (Fig. 16). Here the tin ore occurred in

irregular masses and stockworks of disseminated veinlets in the granite. Deposits were also found along the eastern margin of the granite 7 km and 15 km to the south at Talyor's Hill and Bald Hill respectively. Keogh's group sold the Carpathia mine to another syndicate for £17 000 and in November 1912 it was floated into the Carpathia Tin Mining Company N.L. with nominal capital of £50 000.¹³⁴ In December, Keogh sold an option over the White Crystal deposit to a Melbourne syndicate for £26 000, while retaining a quarter share.¹³⁵ The White Crystal Tin Mining Company was subsequently formed. Rich returns from early surface mining sparked a boom in shares and companies were formed to acquire some of the other leases, including the Wild Cherry, Southern Cross and Drumlish Hill. There were numerous other claims worked by individuals and syndicates.¹³⁶

At first, tin ore was sold direct to Sydney ore buyers or sent by rail to Wyalong for crushing and treatment.¹³⁷ Treatment plants were not constructed at Ardlethan for some time, partly due to lack of a reliable water supply. There were calls for the government to build a public battery in February 1913, but these did not receive a favourable response.¹³⁸ In May 1913, the Carpathia Company purchased a 15-head battery and mill at Barmedman, to which they railed their ore for treatment.¹³⁹ In the latter part of 1913 several companies had batteries on the field, but most of these were unable to operate due to lack of water.¹⁴⁰ During the year the Carpathia Company produced 3 632 tonnes of ore yielding tin to the value of £35 629.¹⁴¹ Dry conditions and the outbreak of WWI led to a drop in production from the field during 1914. On the positive side, the White Crystal, Wild Cherry and Southern Cross companies had their batteries and treatment plants operational.¹⁴² Alluvial tin was discovered in a buried channel west of the Carpathia mine. This discovery became known as the Yithan Lead. and was traced and worked for about 1.6 km.¹⁴³ Subsequently other smaller leads were found in the drainage from the bedrock deposits (Fig. 17).



Figure 17. View of Ardlethan tin field from the New Venture mine looking southwest across alluvial ground towards Ardlethan, 1919. Source: Geological Survey of NSW Photo Collection (HG1012). Photo by L. F. Harper.

Production from the Ardlethan mines rebounded during 1915. The Southern Cross mine, with limited ore, toll-treated material from the many small claims adding to the overall output of the field. The main shaft at the Carpathia mine reached a depth of 100 m.¹⁴⁴ Up to 1919 the Carpathia was the

major mine, producing tin to a value of £158 965, significantly greater than the capital invested. The White Crystal and Wild Cherry were also significant producers.¹⁴⁵ A sharp drop in the tin price in 1919, following the end of WWI, led to a slump in mining and many miners left the field. The price improved in 1923 and mining resumed at the Wild Cherry mine under the new ownership of the Vegetable Creek Tin Mining Co. N.L. Mining also revived at most of the other mines, including the Carpathia, White Crystal and Southern Cross, resulting in a peak in production between 1926 and 1928. A severe drought in 1929-30 led to closure of the mines due to a lack of water for mining and processing. Many of the miners thrown out of work left Ardlethan or turned to working the alluvial tin in small syndicates. The Wild Cherry mine was re-opened on a small scale and then worked by tributers. The success of this approach led to tribute mining becoming the main method of operating across the field. In 1937 the Ardlethan Tin Tailing Dumps Ltd company set up a plant to reprocess tailings from the White Crystal and Wild Cherry mines. This plant operated until the end of 1940 when tin production largely ceased at Ardlethan.¹⁴⁶

After WWII, the Australian Government encouraged a revival of the mining industry and companies turned their attention to tin mining as the tin price improved due to greater demand. Drilling of the Yelthan lead in 1949 discovered a deeper, older level in the channel containing alluvial tin and this was mined underground using the room-and-pillar and longwall techniques.¹⁴⁷ Significant tin was produced until alluvial mining ceased in 1966. Investigations by several groups between 1949 and 1952 defined two zones of disseminated mineralisation at the White Crystal and Wild Cherry sites, each with a potential of 1 Mt, but the grades were too low to be economic at the time. In 1961, Aberfoyle Tin N.L. acquired the White Crystal and Wild Cherry workings and through subsidiary Ardlethan Tin N.L. commenced large-scale mining of low-grade ore in 1964. Initial mining was at a rate of 1 000 tonnes per day, which increased to 1 500 tonnes in 1971 as discovery of new reserves extended the ore available from the Wild Cherry open pit. In 1978 underground mining commenced using the crater retreat method of mining from the bottom of the open pit. Deep underground mining ceased in 1986 following a dramatic drop in the price of tin and the mine was closed.¹⁴⁸

Marlborough Resources N.L. purchased the Ardlethan mine in 2000 and the following year began re-treating alluvial material from the Yethan Lead. This operation closed in mid-2004 when Marlborough Resources was placed in receivership due to financial difficulties resulting from lower than estimated reserves, unfortunate tin price hedging and problems with the processing plant. Most recently the mine was acquired by Australian Tin Resources Pty Ltd with the intention of trialling a processing plant to retreat the tailings as part of a rehabilitation project.¹⁴⁹

Total production from the Ardlethan field is approximately 32 000 tonnes of tin.¹⁵⁰ Minor amounts of wolframite have also been produced from the Ardlethan tin field amounting to 12.1 tonnes of concentrate.¹⁵¹

Tin-Tungsten

Burrandana-Pulletop

Tin-tungsten deposits with a history of sporadic prospecting and small-scale mining occur in the Burrandana-Pulletop area, 40-53 km south of Wagga.¹⁵² In 1872, alluvial tin was discovered at Burke's Creek (Upper Pulletop Creek) and the area was worked in 1873 by a party of four miners using sluice boxes to obtain about 60 kg of cassiterite per day.¹⁵³ Lodes were also found in granite on nearby Clifton Hill, later referred to as the Victory tin lodes.¹⁵⁴ Attempts were made to mine some of the lodes, but the tin content was too low to be worked profitably at the time and the site was abandoned. Prospecting resumed in 1880 and the following year the area was inspected by Geological Surveyor H.Y.L. Brown.¹⁵⁵ Around this time other deposits were found in the Burrandana area, 12 km to the northwest and lower down Pulletop Creek. Some mining occurred, but with limited production of tin. Lode deposits across the area were found to be similar consisting of thin quartz-rich veins with sparse amounts of wolframite and cassiterite, developed near the intrusive contact of granite with slate.

The Pulletop site was further prospected during 1894 and investigated by Geological Surveyor J.E. Carne the same year and again in 1895. Carne noted that the alluvial deposits contained a mixture of cassiterite and wolframite. It was impossible for the miners to separate these minerals, resulting in a concentrate of low value, particularly as the dominant component was wolframite for which there was little demand at the time. Enquiries were made in Europe to see if the mixed concentrate could find a market there. It was determined that the concentrate was worth about £30 per ton, less £6 for treatment and the shipping cost.¹⁵⁶ Interest in the area then waned until 1903 when prospecting resumed, but mining was hindered by a lack of water.¹⁵⁷

After 1903 and until 1956 there was desultory alluvial fossicking, plans for dredging and numerous intermittent attempts to develop and mine at least 100 reefs in the area, particularly for tungsten. Mining was inhibited by the small and scattered nature of the deposits, shortage of water and lack of capital. A 4-head stamp battery and Wilfley table were erected at the Victory tin lodes and from 1909 to 1911, J. Turner produced at least 15 tonnes of tungsten concentrates. The following year the Pulletop Tin Mining Syndicate did some exploration drilling, but the results were not promising. In 1953 the Barrandana Mines Syndicate erected a jaw crusher and modern concentration plant, however insufficient ore was mined to keep the plant operating and work was suspended the same year. All mining appears to have ceased after 1956.¹⁵⁸

Total recorded production of tin concentrate from 1874 is 6.34 tonnes, mostly from the Victory lodes after 1931. Total recorded production of tungsten concentrate is 15.43 tonnes.¹⁵⁹ It is likely that some production, particularly of alluvial tin was unrecorded.

Wymah (Wagra)

Wolframite was discovered at Wymah, 42 km northeast of Albury, in early 1911 by Colin Collingridge and his brother. Collingridge had previous experience in wolfram mining at Chillagoe in Queensland but appears to have done little with the find at Wymah.¹⁶⁰ During WWI there was increased demand for tungsten and in 1915 a syndicate of Albury businessmen investigated the Wymah deposits. Early in 1916 this group formed the Wymah Wolfram Mining Company N.L.¹⁶¹ During 1918-1919 the Company produced 3 576 tonnes of ore containing both tungsten and bismuth valued at £7 264.¹⁶² The nearby Woolindina reef was also worked during 1918 by the Lukin brothers for 50 tonnes of ore containing 1.5% W. The field was then largely abandoned until 1937 when H.D. Haffner mined 51 tonnes of ore from the Wymah mine.

The Wymah deposits were next investigated during WWII as a local source of tungsten for the war effort. There was significant exploration and development, but no record of production. In 1951 during the Korean war W.J. Beaty produced some concentrates from the surface dumps.

In the Wymah area there are several different quartz reef systems including the Wymah, Williams, Appletree, Woolinda and Monash deposits. The reefs are steeply dipping and easterly trending quartz lenses in a biotite granite, commonly with adjacent pegmatite zones. Individual reefs typically extend for 150 m and are up to 2 m wide.¹⁶³

Total recorded production from the Wymah deposits is 29.6 tonnes of tungsten concentrate and 5.6 tonnes of tungsten-bismuth concentrates.¹⁶⁴

Other metals and commodities

Molybdenum

Minor deposits of molybdenite occur in the south-eastern portion of the East Riverina associated with granite and in some cases accompanying tin, bismuth and tungsten mineralisation. Some of these deposits have been prospected, particularly during WWI, but recorded production has been small. The occurrences include a site 6.4 km southeast of Holbrook where northerly trending quartz veins exposed on a high ridge and up to 1.2 m wide contain molybdenite in flakes and bunches up to 7 cm across. Three of these veins were investigated from 1915 by the Holbrook Prospecting Syndicate.¹⁶⁵ In 1920 the Holbrook Proprietary Co. mined 30.5 tonnes of ore from this site.¹⁶⁶ About 5 km north of this area there is another occurrence developed in greisenous granite with podiform quartz veins

and aplite dykes. Here molybdenite, with lesser cassiterite, chalcopyrite and trace bismuth-tungsten minerals, occurs in the quartz veins and in the surrounding greisen.¹⁶⁷

Lead-Silver-Fluorite

Small lead-silver deposits have been mined in the East Riverina region, particularly in the Carboona area, 90 km northeast of Albury.

During the Broken Hill inspired silver boom of the 1880s, William Musgrave and party discovered silver ore exposed in a small creek bed near Coppabella Station in April 1888. The discovery was described as a lode 7.6 m wide at the surface with a 1 m thick zone of solid galena and other distributed patches.¹⁶⁸ The discovery was named 'Revealed' (later the Mt Gifford silver-lead mine) and three 40-acre claims were taken up. Over the next year the leases were tested, but no actual mining conducted. By early 1890 the surrounding ground had been pegged for 16 km and a store set up. Additional discoveries were made including by Coghlan and Miller. Mining Warden J.E. Makinson visited the field in April 1890 and expressed a high opinion of the ore in Coghlan and Miller's prospecting shaft, which was down 24 m. Assays indicated from 1.2 to 122 kg/t (40 to 400 oz/ton) silver.¹⁶⁹

The field then appears to have languished, possibly due to lack of capital and disappointing silver grades, until June 1905 when Young and Cummins opened up a very promising outcrop near a steep range 6.5 km southeast of Musgraves discovery. Their attention was drawn to this site by a sample at the Walwa Hotel, taken there two years earlier by the original discoverers, W. Woodward and A. Parsons.¹⁷⁰ This discovery sparked a revival of interest and was eventually developed into the Coppabella mine, which became the most important on the field. During July and August 1905, excitement ran high and 200 miners were attracted to the area. Authority to Enter applications were made for over 7 000 acres of land.¹⁷¹ Additional leases were taken out along the Coppabella lode, with visitors and investors appearing from Melbourne and Sydney. Business allotments were offered at £12 per year and two stores and a boarding house were quickly erected.¹⁷² With all the excited interest the field began to resemble a miniature Broken Hill, but hopes of a full replication soon faded. The Coppabella Silver Lead Mining Company commenced mining and by the end of 1905 had sent 27 tonnes of hand-picked ore to Cockle Creek for smelting. Given the quality of ore exposed during development the company decided to build a concentration plant.¹⁷³ The following year the mine was let on tribute and 28 tonnes of ore were produced.¹⁷⁴ By 1907 prospecting and development on the field had ceased and the only mining was by tributers at the main Coppabella mine for a small tonnage. The only business establishment left in the settlement was Mrs E. Goodwin's Coffee Palace.¹⁷⁵

In 1912, after being abandoned for almost three years, the Coppabella mine was taken up by a group of Melbourne investors styled as the Carboona Silver-Lead Syndicate.¹⁷⁶ Development work at the mine discovered a new lode in April 1913, however the company was unable to capitalise on this discovery.¹⁷⁷ Howard Holman acquired the property and worked it on a small scale for several years producing about 20 tonnes of ore. In 1916 J.H. Dawson, representing the Broken Hill Proprietary Co. (BHP), took an option on the mine to prospect for fluorite to use as a flux in steel making. During 1917, 723 tonnes of fluorite were produced and sold to BHP.¹⁷⁸ In 1918 the mine, now referred to as the Carboona, was taken over by Dawson and E.W. O'Brien to mine the fluorite, but also produce a lead-silver by-product.¹⁷⁹ A new concentrating plant was built to effectively separate the galena and fluorite.¹⁸⁰ BHP purchased the operation in 1920 and operated the mine until 1925 when it was finally closed.¹⁸¹ Over its life the Coppabella-Carboona mine was worked to a depth of 70 m using three adits, several shafts and an open pit. The ore consisted of quartz, fluorite and galena with minor pyrite, sphalerite and calcite, developed in shear-hosted veins within alternating granite and metasedimentary rocks. Other worked deposits in the area were of similar style.

Production from the Coppabella lode during 1905-1925 was about 5 000 tonnes of fluorite from high-grade ore that also averaged 62 g/t silver and 4% lead.¹⁸²

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