Notes on the Moonta-Wallaroo Mining District

Compiled by G.J. Drew

2014

Cornish miners at Elders Shaft, Wallaroo Mine, c.1900.
INTRODUCTION

A hundred years ago the Moonta-Wallaroo district was one of the world's great base metal mining centres, famous for the value of its mineral production, as a centre of technological innovation, and for the spirit of its Cornish community. While the district's mining heyday is long past, it has left us a fascinating industrial landscape.

The Moonta - Wallaroo Mining District covers an area of about 130 square kilometres on the northern Yorke Peninsula. The area is flat-lying with a thin veneer of calcrete and soil overlying older crystalline basement rocks containing copper vein mineralisation. There was no surface expression of these veins. In 1859 and 1861, shepherds discovered brightly coloured copper ore which had been brought to the surface by the burrowing of native animals. W.W. Hughes, the owner of the pastoral leases covering the discoveries secured mining leases and formed two separate companies to work them – the Wallaroo Mining Company and the Moonta Mining Company.

These discoveries which subsequently became the Wallaroo and Moonta mines, were made at a time when the earlier rich copper carbonate ores at Kapunda and Burra were declining and ensured the continuity of production and employment in the South Australian mining industry. They caused a rush for leases in the vicinity of the two mines and numerous companies were formed to work extensions of the Moonta and Wallaroo lodes or prospect new ground. However none of the mines was as rich or successful and many were later incorporated into the Moonta and Wallaroo operations.

The Moonta and Wallaroo mines remained in almost continuous production for more than 60 years during which time their combined production was about 335,000 t of copper metal from 7 mt of ore. They were worked as private ventures until 1889 when they amalgamated to form the Wallaroo and Moonta Mining and Smelting Co. Up to that time Moonta outshone the Wallaroo Mine in terms of production and richness of ore and in 1876 the Moonta Mining Co. became the first mining company in Australia to pay £1 million in dividends. However the years after the amalgamation saw widespread modernisation at Wallaroo which was accelerated by a disastrous fire at Taylors Shaft in 1904. This included electrification of the works and the addition of new headframes and power plants, and the flotation process to ore treatment.

Large smelting works which were erected at Wallaroo on the coast, treated ore from the mines from 1861 until 1923. The Welsh smelting process using small reverberatory furnaces remained virtually unchanged during the first 30 years of operation when it was for a time the largest smelting works in the world outside Swansea in Wales. The amalgamation of the two companies resulted in the application of new technology and diversification including the Bessemer smelting process, copper sulphate plant and sulphuric acid works.

The mining and smelting of copper had a great influence on economic activity in the district. At the peak of mining activity in the mid 1870s, the mines employed more than 3000 and the district had a population of about 20,000 predominantly Cornish immigrants and their descendants. In particular, it resulted in the establishment of three significant towns - Kadina, Moonta and Wallaroo.

View of Elders Lode from Richmans Tailings Dump, Moonta Mine, c.1900
GEOLOGY OF THE MOONTA-WALLAROO MINING DISTRICT

GEOLOGICAL SETTING

The Moonta-Wallaroo Mining District is located in the eastern part of the Archaean-Proterozoic Gawler Craton. The Moonta and Wallaroo ore deposits are hosted by the Proterozoic Moonta Porphyry and Doora Schist, respectively, both of which are concealed beneath a thin cover of younger Proterozoic, Cambrian and Cainozoic sediments. The Moonta Porphyry is a fine-grained, metamorphosed volcanic rock which has been dated at 1740 million years old (porphyritic rhyolite-rhyodacite interpreted to be either a series of ignimbrites or subaerial flows with adjacent epiclastic sediments and/or waterlain tuffs or, at least in part, subaerial lava flows). The Doora Schist is in contact with the Moonta Porphyry in the Wallaroo field and consists of metamorphosed sedimentary rocks.

The Arthurton and Tickera Granites were emplaced following the 1850 to 1700 Ma Kimban Orogeny. These granites are equivalents of the Hiltaba Suite granites that are widespread in the Gawler Craton, and have ages in the range 1600-1585 million years old. Feldspar-quartz pegmatites are common throughout the Moonta-Wallaroo district, including within the ore zones. They represent late stage fractionation of both the Tickera and Arthurton Granites. Granite emplacement was followed by deposition of Proterozoic and Cambrian sediments.

ORE DEPOSITS

Moonta District

Ore bodies or lodes in the Moonta district typically have the form of tabular veins within fractures and shear zones in the Moonta Porphyry. Veins up to 10 m wide and up to 1500 m long were mined to depths of almost 700 m. The majority of the veins are located in a series of concentric arcs trending from NNE to ENE. The largest veins (e.g. Taylor or Elder) are hosted by structures known as Main Lode Shears that dip 40º to 65º NW. West Lode Shears dip approximately 60º NW, but diverge in strike by about 15º from Main Lode shears, and do not host major ore bodies, although high-grade ore shoots are located at the intersections with Main Lode Shears.

The dominant primary minerals of the Moonta ores are chalcopyrite, bornite, pyrite, hematite, magnetite, quartz, tourmaline and chlorite.
Wallaroo District
The Wallaroo ore bodies were fewer in number compared to the Moonta district and occur within the Doora Schist. Most ore bodies are located in Main Lode shears which run approximately E-W and contain large and continuous ore bodies. The largest of these, the Wallaroo Main Lode, dipped steeply, varied in width from less than one metre to more than 20 m and was mined over a distance of about 1000 m and to a depth of 850 m. It contained two productive shoots - Taylors and Youngs. Two major NE-SW shears have disrupted the Main Lode shears - the Western and Eastern shear zones.

The main minerals in the Wallaroo ores were chalcopyrite, pyrite, pyrrhotite, magnetite and minor galena and sphalerite in a matrix of quartz and carbonate minerals (calcite, dolomite, siderite and rhodocrocite; bornite and hematite were much less abundant than in the Moonta ores.

PRODUCTION
The total production for the Moonta-Wallaroo Mining District is estimated at 383,000 t of copper of which about 87% (335,000 t) was the combined production from the Moonta and Wallaroo mines. Of the remainder approximately 10,000 t were produced from the Hamley Mine and a combined 8,700 t from the Paramatta and Yelta mines. A total of 19,055 t were produced from the modern Wheal Hughes and Poona mines.
WEATHERING OF THE LODES

Below the surface layers of calcrete and clay in the Moonta-Wallaroo districts, weathering of the underlying primary ore formed an oxidised and enriched zone which extended to depths of 30-50 m. In the upper portions of this zone green copper carbonates, mainly atacamite with minor malachite, extended to a depth of about 20 m. Below this, an enriched zone containing mainly cuprite and chalcocite overlay the primary sulphide ore.

The common occurrence of atacamite was very efficient used in prospecting for concealed copper lodes. Auger holes were bored to 10 m in the clay layer to detect atacamite and the existence of the lodes from which they were derived.
MINING METHODS

Shafts were sunk on the incline following the lodes, the deepest being Taylors Shaft, Wallaroo Mine at more than 900 m. The Cornish system was used to drive horizontal tunnels or levels at regular intervals connecting shafts. These levels were initially at intervals of 10 fathoms (1 fathom = 1.83 metres) but were increased by Captain Hancock to 15 fathoms after 1870 and later to intervals of 20 fathoms (36.6 m). Hence the lodes were explored and ore reserves proven by development of levels and connecting shafts or winzes.

In removing ore, miners worked upward from the upper part or back of one level towards the bottom of another. The resulting excavation or stope was therefore arranged so that broken ore fell to the level below and was trammed to a hauling shaft. This method of mining was known as overhand stoping. As stoping progressed, timbers were hitched into the sides of the stope, forming a platform or stull which gave a protective cover to the level and a platform for landing ore, which was passed through chutes to the level below. Basic hand-picking of ore was carried out in the stopes.

A stope was worked by taking about one metre off the roof of the stope at one end, continuing to work towards the opposite end. Where the lode was wide and the ground weak, timber pillars known as styes, were erected to support the roof. As the roof was removed, the styes were increased in height and filled with crushed rock or attle which was conveyed by attle passes to the worked-out sections of the mine.

Gunpowder was used to break the rock and was placed in shot-holes drilled by hand, using a technique known as hammer and tap in which one man held a steel borer while two others alternatively hit it with sledge hammers. After 1880, gunpowder was replaced by dynamite and, later, small rock drills worked by compressed air supplied from a central power plant were introduced. When the Wallaroo mine closed, the underground workings extended for more than 70 km.

Method of working a wide stope
THE

Cornish Pumping Engine,

AS USED FOR DRAINING MINES.

This illustration shows the usual method adopted for the unwatering of deep mines. The pumps are arranged in lifts placed one above the other at distances varying from 80 to 50 fathoms or more. At the bottom is placed the drawing lift, by which the water is lifted a height of about 10 fathoms to the first plunger lift, from which point it is forced by a plunger up the rising main to the second lift, and so on, until it reaches the surface.

The accompanying Illustrations show some of the principal parts of the pump work, &c.

H Piece and Door Piece.

Wrought Iron Main Caps, with Saddle, Brass, and Bolts.

V Bobs for Flat Rods and Underlay Shafts.

These V Bobs are used in places where it is necessary to change the direction or underlie of the Main Rod or Flat Rods. In sinking on metalliferous lodes, the underlie frequently changes; under such circumstances feed off, or holdback Bobs, are required to enable a new direction to be given to the Main Rod.

Outer connection from pump end of the Engine Beam to the top of the Main Connecting Rod.

From the 1884 Catalogue of Harvey and Co.
WALLAROO MINE WALK

This walk commences from the car park near Harveys Enginehouse at the western end of the mine and follows the main lode to Taylors Shaft. Alternatively it can start at the cairn near Home Shaft.
1. Harvey Enginehouse
Harveys 60-inch Cornish beam engine was erected at North Hughes Shaft on Milnes Lode in 1876, replacing Hughes engine at the western end of the mine. It raised about 0.5 million gallons per day with three 10-inch plunger pumps. It ceased pumping in 1906 when the mine was electrified but remained intact until 1924 when broken up for scrap.

![Harvey Enginehouse at North Hughes Shaft, c.1915](image)

2. Hughes Shaft
Hughes shaft was the principal shaft for some years and, in 1867, a second hand 48-inch Cornish Bull engine was erected to dewater the western and of the mine. The engine pumped until 1876 when replaced by Harveys Engine to the north. Hughes engine operated as a man engine until 1880 when wire rope and man skips were introduced. In 1912, it was converted to an updraught ventilation shaft with an exhaust fan erected in a concrete housing.

Near Hughes Shaft the Wallaroo main lode has been offset into four lodes by a NE-SW shear zone - the Western Shear Zone. These lodes are from north to south, North Mairs, Milnes, North Youngs and Main Lode.

![Wallaroo Mine showing Main Lode split into four lodes at western end of mine](image)
3. Attle Crushing Plant
Erected in 1901 to crush waste rock (attle) from Office Sorting Plant which was then re-trucked to large bins at various parts of the mine to fill stope out areas. A steam engine (replaced by an electric motor in 1906) powered an underground shaft which drove the crusher in an adjacent building.

4. Youngs Shaft
A major hauling shaft which reached a depth of 814 m. Youngs 30-inch Cornish winding engine was erected in 1876 and was the main winding engine until 1905 when replaced by a modern horizontal steam winder. In 1910, the engine was turned by 90° around the shaft. Youngs shaft was a downcast shaft in the mine ventilation system.

5. Manager Residence and Office
Housed the underground mine survey plans.

6. Office Shaft
This was one of the principal hauling shafts reaching a depth of 631 m. It was converted to an updraught ventilation shaft in 1915 with the erection of a large capacity fan housed in a concrete structure.

7. Office Sorting Plant
Up to 1900, ore was broken by hand and sorted on ore floors at the major shaft. In 1902, a central sorting plant was erected at the centre of the mine. Large ore bins were erected at the three main shafts and ore conveyed by belt to the plant where it was crushed and sorted by hand. High-grade ore was railed to the smelter, second grade transferred to the Devon concentration plant and mullock to Harveys attle crusher.

8. Powerhouse
Erected in 1904 to supply electricity and compressed air to the mine. The power plant contained turbines, generators and compressors which were mounted on large concrete blocks. The adjacent boilerhouse contained ten Babcock and Wilcox boilers connected to two large steel chimneys. An inclined conveyer belt took coal from an underground bin to an overhead crusher.

9. Taylors Shaft
This was the principal shaft on the mine and was 908 m deep. Taylors 60-inch Cornish pumping engine operated from 1863 until the fire of 1904 which destroyed the upper part of the shaft. A new shaft collar was sunk to the south to intersect the shaft at 245 m. The new collar was equipped with a modern headframe and winding engine, and electric pumps replaced the Cornish engine. Taylors Shaft was a downcast shaft in the mine ventilation system. Near by is Taylors pool which held water pumped to the surface by Taylors Engine.
10. Company Housing
Three large houses built for the company’s doctor, surface manager and last general manager.

11. Wallaroo Mines Settlement
Stirling Terrace was the hub of civic and leisure activities for the mines settlement. It was located at the main entrance to the mine and contained the Post Office, doctor’s rooms and residence, Police Station and Mines Institute all erected about 1900. Other houses were occupied by mine staff.
MOONTA MINE WALKS

ELDERS LINE OF LODE

Elders Lode was the most persistent at Moonta, worked for a length of about 1000 m and extending to a depth of more than 700 m.
1. Richmans Enginehouse and Tailings Dump
Richmans 32 inch Cornish beam rotative engine was erected in 1860 to power crushing and concentrating machinery for treatment of low-grade ore. The coarse tailings were placed on the adjacent tailings heap. Buddles were added in 1875 to concentrate the fines from the process and the resultant slimes placed on large flat areas to the north and west.

2. Warmingtons Shaft
This was one of the principal shafts from 1862 until 1900 reaching a depth of 585 m. Ore was hauled by Prankards Cornish Winding Engine from 1867 until 1901 when replaced by Taylors Horizontal Engine.

3. Prankerds Enginehouse
Prankerds 22 inch-Cornish beam winding engine was erected in 1867 to haul from Taylors, Taylors North and Stirlings shafts, and power crushing and concentrating equipment. After 1874, it was used mainly for hauling, and operated until 1901.
4. **Taylors Shaft and Enginehouse**

Taylors Shaft was the principal shaft on Elders Lode reaching a depth of 768 m. Hauling was originally undertaken by Prankerds Engine which was replaced in 1901 by Taylors horizontal winding engine. In 1868, pumps in Taylors Shaft were connected by flat rods to Hughes Engine 300 m to the south. Hughes Engine continued to operate those pumps until the mine closed in 1923.

5. **Flatrod Channel**

Flat rods, which ran from Hughes Engine to operate pumps in Taylors Shaft, were located just below the ground on rollers in this open channel.

6. **Hughes Shaft**

Hughes 60-inch Cornish pumping engine was erected in 1865 at Hughes Shaft, the principal pump shaft on Elders Lode. The shaft was sunk vertically to 128 m where it intersected Elders Lode which it followed on the underlay to the 365 m level. Flat rods connected to balance bob operated pumps in Taylors Shaft. In the vicinity are the remains of Elders Winding house (1863), Hughes engine pool, mine stables and the 1930s Moonta Mining Scheme concentration plant. The shaft collar was reconstructed in 1992 using precast concrete panels and bearers to allow stabilisation and conservation of the condenser pit and balance bob supports.

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Hughes Enginehouse pumping arrangement
TREUERS LODE

Treuers Lode is located about 100 m west of Elders Lode. It was worked principally after 1900 in conjunction with the Karkarilla Lode of the Hamley Mine to a depth of 180 m.

7. Treuers Shaft

Treuers Shaft was the main shaft on Treuers Lode which was worked over a length of 400 m and to a depth of 220 m. It was a major producing area after 1900. A new headframe and horizontal winding engine were erected in 1906.

Treuers Shaft and enginehouse, c.1907
Location of sites on Moonta Mine Walks
THE CENTRAL LODES

The lodes of the central belt were largely worked out by 1900 and included McDonnells (Fergussons), Greens and Beddomes lodes.

8. Ryans Tailings Heap
This dump contains tailings from Ryans concentration plant which operated from 1864 until 1906.

McDonnells Lode was worked to a depth of 340 m over a length of 800 m.

9. Ryans Shaft
Ryans Shaft which marks the northern end of McDonnells Lode, commenced in 1861 on the site where Patrick Ryan first discovered copper ore. Ryans Enginehouse was erected nearby in 1865 and worked until 1906. It contained a 32-inch horizontal engine which powered pumps and a crushing and concentrating plant.

10. Dominicks Shaft
Ryans Engine operated Cornish pumps in Dominicks Shaft which was 265 m deep.

11. McDonnells Shaft
This shaft marks the southern end of McDonnells Lode and was connected to Fergussons Lode to the south at the 55 m level.
12. Hancocks Tailings Heap
This dump contained the waste from Hancocks concentration plant which operated from 1874 until 1900. The dump was leached after 1901 as part of the Cementation Process. Pipelines which conveyed the copper solution to the Precipitation Works can be seen in the vicinity. Nearby is Prince Alfred Shaft on the southern end of Fergussons Lode.

13. Fergussons Shaft
Fergussons Shaft marks the northern end of Fergussons Lode and was 373 m deep. Nearby are extensive ore floors with rail beds.
Greens Lode was worked over a length of about 500 m.

14. Bowers Shaft
Nearby was Bowers Enginehouse which hauled and pumped from several shafts in the area. It was erected in 1866 and housed an 18-inch beam engine which was replaced by a 22 inch horizontal engine in 1877

15. Greens Shaft
This shaft was the principal shaft on Greens Lode and was 375 m deep

16. Hancocks Enginehouse
Hancocks 35-inch Cornish beam rotative engine was erected in 1874 to increase the mine’s crushing and concentrating capacity. The plant comprised the tall enginehouse and adjacent stone crusherhouse and timber jiggerhouse. Hancocks Engine also powered pumps by flatrods in Greens, Prince Alfred and Beddomes Shafts. The complex was demolished in 1904 but foundations and mounting bolts survive.
Beddomes Lode was worked to a depth of 440 m and extended into the Hamley Mine property to the south.

17. Lloyds South Shaft
Lloyds South Shaft near the centre of Beddomes Lode was worked to 183 m. Nearby was Beddomes Engine which was erected in 1875 to haul from Beddomes and Lloyds Shafts.

18. Beddomes Shaft
Beddomes Shaft was the principal shaft on Beddomes Lode at a depth of 476 m.

19. Hamley Mine (Karkarilla)
Ore was discovered in 1861 on leases south of the Moonta Mine. Operations commenced in 1862 on an extension of Treuers Lode and the mine named Karkarilla. In 1868, the company was reformed as the Hamley Mining Co. and worked an extension of Beddomes Lode.

A 24-inch horizontal engine was erected in 1874 to power winding, crushing and concentrating machinery. At peak production in the mid 1870s up to 200 men and boys were employed but the mine closed in 1888. It was reworked by tributors in the early 1900s and sold to the WMMS Co. in 1916. Total production is estimated of 10,000 t of copper.
YELTA MINE

Ore was discovered in 1861 on leases north of the Moonta Mine. Operations commenced on a small scale in 1863 under the management of Captain H.R. Hancock near the southwest corner of the leases. The main lode was discovered in 1868 and up to 100 were employed over the next few years. A 22-inch horizontal engine (the Yelta) was erected in 1871 to power pumping, winding, crushing and dressing machinery. The mine closed in 1877 due to falling copper prices after producing 1700 t of copper.

In 1903, the mine was acquired by a French company in conjunction with the Paramatta Mine. Two blast furnaces were erected and the mine operated until 1907. In 1910, the SA government purchased the mine and a remaining shoot of ore mined until closure in 1913. During this period about 7000 t of ore were smelted producing 270 t of copper with a loss of £36,000. About 330 kg of molybdenite was handpicked from the ore and sold. Total production from the Yelta Mine is estimated at 4300 t of copper.

Between 1906 and 1916, the SA government worked a lode along the eastern boundary of the Yelta leases as part of the Yelta Mine. It was reworked by tribute parties as the Wild Dog Mine from 1924-1929 and by the Moonta Mining Scheme as part of the Subsidised Mining Program from 1929-1938. Total production was 1920 t of copper.
NE-SW longitudinal section of the Yelta Mine
**WHEAL HUGHES**

The discovery of copper ore during the cutting of the Moonta-Wallaroo tramway in 1865 led to the Paramatta group of mines – Paramatta, Poona, Wheal James and Wheal Hughes. Wheal Hughes commenced operations in 1866 and produced a small amount of ore from three shallow shafts until it was abandoned in the late 1870s. A small steam engine was erected in 1875.

Exploration in the district found a new deposit at Wheal Hughes which was worked by open cut and underground mines between 1990 and 1994. This produced 288,000 t of ore averaging 3.5% copper and 0.67 g/ t gold. Following closure Wheal Hughes has been developed as a tourist mine and is now South Australia’s leading underground mine experience.

**POONA MINE**

The Poona Mine was first worked for several years in the late 1860s. A small amount of ore was extracted from several shafts sunk along the Poona Lode which was exposed in a cutting of the Moonta-Wallaroo tramway.

Exploration discovered an extension of the Poona Lode which was worked by open cut and underground operations between 1988 and 1992. This produced 188,000 t of ore averaging 4.76% copper and 1.45 g/ t gold.

**PARAMATTA MINE**

The Paramatta Mine commenced operations in 1866 on a small scale with up to 130 employed. In 1869, a 24-inch horizontal engine was installed to operate pumping, winding and dressing machinery. Other improvements included blacksmiths and carpenters shops, assay office and manager’s residence. The mine closed in 1878 after producing 1374 t of ore valued at £187,000 and paying £40,000 in dividends.

The mine was reopened by a French company in 1899 and worked in conjunction with the adjoining Wheal Hughes and Wheal James. In 1904, it was amalgamated with the Yelta Mine. New concentrating machinery was erected and the Main Shaft extended from 133 m to 247 m by 1907 when operations were suspended due to falling grades and copper prices. Total production of the Paramatta Mine is estimated at 4400 t of copper.
PARAMATTA MINE
LONGITUDINAL SECTION of UNDERGROUND WORKINGS.
SCALE

Paramatta Mine Main Shaft and concentration plant, c.1900
GEOLOGY OF WHEAL HUGHES AND POONA MINE

The Poona and Wheal Hughes deposits are typical of the Moonta district. The Poona vein strikes ENE and dips approximately 45º NNW, within a shear zone, and is offset into three segments by faults perpendicular to the shear plane. The Wheal Hughes deposit is unusual for the Moonta field, in that the main part consists of a multiple vein system. The veins strike NE and dip 45º NW, and are hosted by a 25 m wide shear zone. The NE part of the Wheal Hughes deposit, known as Leighton's Lode, consists of a single vein separated from the main deposit by a cross-cutting fault.

Adjacent to the Poona and Wheal Hughes orebodies, the host porphyry has been altered to chlorite, tourmaline and sericite. Tourmaline is more abundant in the alteration zone associated with the main part of the Wheal Hughes orebody, where the zone is up to several metres in thickness. Leighton's Lode segment and Poona have narrower alteration zones. The oxidized porphyry above both deposits is extensively kaolinized and the upper sections of the Wheal Hughes veins are also partly surrounded by a zone of supergene kaolinite.