AUSTRALIAN
MINING
HISTORY
ASSOCIATION

ANNUAL CONFERENCE

Hahndorf, South Australia

12–18 September 2011

Australia's Earliest Mining Era
Mount Lofty Ranges 1841-1851

Worthing Mine Enginehouse, Hallett Cove

Aerial view of the Angas Mine open cut and treatment plant

Powder magazine and enginehouse chimney, Bremer Mine

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CONTENTS

AUSTRALIAN MINING HISTORY ASSOCIATION

PRESIDENT'S FOREWORD

The AMHA executive thanks you for attending our 17th Annual Conference and welcomes you to Hahndorf. We are pleased to continue our growing tradition of holding stand-alone conferences in significant centres of mining interest. This year it is in Hahndorf in the Mount Lofty Ranges, the site of *Australia's Earliest Mining Era* which took place between 1841 and 1851. The AMHA conferences are an essential activity for our members as they provide wonderful opportunities for exchange of research themes, ideas and sources and complement our published Journal.

Mines in the Mount Lofty Ranges have produced a wide range of commodities; both metalliferous, including copper, silver, lead, zinc, gold and pyrite; and non-metallic, including building stone, clay and slate. Wheal Gawler, opened in 1841, at Glen Osmond was Australia's first metalliferous mine and marked the beginning of a mining boom that led to the discovery of many further deposits, including the important copper deposits at Kapunda and Burra. This mining boom saved the economy of the new Colony of South Australia. Numerous sites of historic mining interest throughout the Adelaide Hills will be visited during the conference, allowing delegates a first-hand experience of the mining heritage of the area. Recent years have seen renewed mining activity in the Mount Lofty Ranges, with the opening of the Angas Zinc Mine near Strathalbyn and the redevelopment of the Kanmantoo Copper Mine. Thank you to the Managers of these two mines for providing presentations and guided tours of their operations.

These conferences would not happen without the significant work of AMHA members and for this I thank Greg Drew for his leadership and enthusiasm with support from Ross Both. I would also like to thank the following members of the local community who were part of the team: Kath Rayner (Willunga National Trust), Jim Killick (Mount Lofty Historical Society), Harold Gallasch (Hahndorf Traders) and Phillip Tanner (City of Onkaparinga). I also thank the local community for their support, in particular the District Council of Mount Barker who have generously sponsored the Welcome Reception.

Dr Ruth Kerr, OAM
President, AMHA

MAYORAL MESSAGE

I would like to welcome distinguished guests, ladies and gentlemen to our beautiful District. I also would like to acknowledge that we are meeting on the traditional lands of the Peramangk People and recognise their spiritual connection to these lands.

Thank you for attending the 17th Annual Australian Mining History Conference. This event brings together people, like me, who are interested in the historical development of this region, arguably one of the most picturesque places in Australia! Thanks to Dr Ruth Kerr (president) and Mr Greg Drew (conference director) for initiating this exciting conference and holding it in our beautiful region.

It is my pleasure to welcome Elected Members, council staff, delegates and the many exciting speakers that will enlighten us over the next week at various tours of local mines. I am very proud of our District - no wonder that the District was one of the first areas in South Australia to be settled by Europeans with a number of towns settled by German immigrants. Today, the District is still a beautiful and well visited region, nestled in the Mount Lofty Ranges and close to the capital city of Adelaide - it is no surprise to me that we are one of the fastest growing councils in Australia.

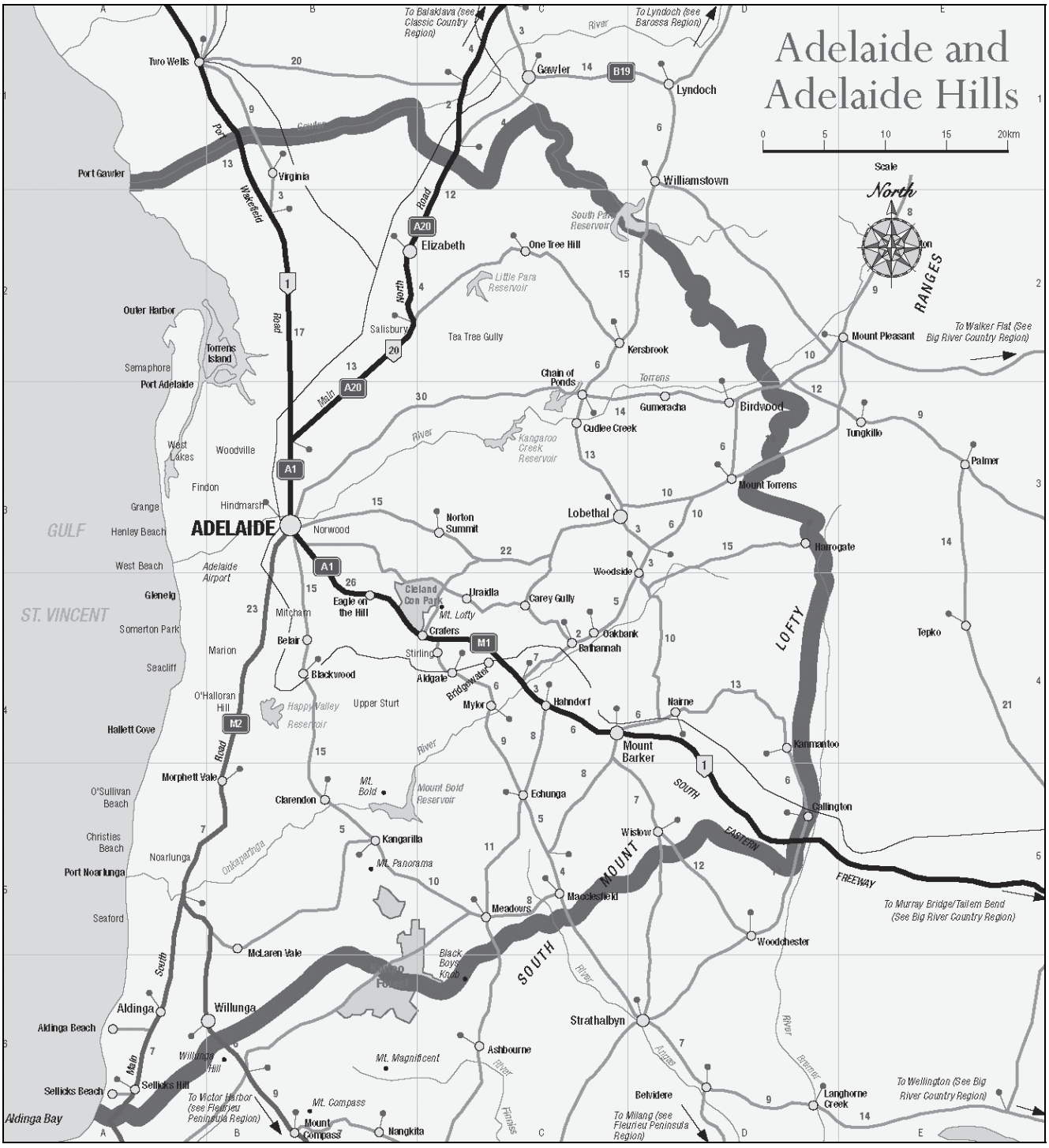
I am very pleased that we are hosting the Annual Mining History Association Conference and the opportunity it provides to educate residents and visitors of our strong mining history. Finally I would like to say that I am very happy to support this significant conference. On behalf of the District Council of Mount Barker and residents of the district I would like to welcome all delegates to the 17th annual conference of the Australian Mining History Association.

Ann Ferguson
Mayor of Mount Barker

WELCOME TO THE ADELAIDE HILLS

The Adelaide Hills are part of the Mount Lofty Ranges which stretch from the southernmost point of the Fleurieu Peninsula northwards for over 300km and are centred on the largest town in the area, Mount Barker, which has a population of around 29,000 and is one of Australia's fastest growing towns. It was amongst the first areas of South Australia to be settled by Europeans and a number of towns in the Hills were started as German settlements

The region is a premier wine region within Australia and also one of the oldest. The veritable maze of valleys and sub-valleys, with slopes offering every conceivable aspect, means there is as much mesoclimatic variation as one can find anywhere in Australia, making generalisations of wine type very hazardous. The first vines were planted in the Hills in 1839, three years after South Australia was settled and there are now over 50 wineries within the Hills region. The centrepiece of the whole area is, however, Hahndorf - the oldest surviving German settlement in Australia. The Adelaide Hills offer you numerous walking and cycling trails, great attractions, welcoming cellar doors, quality pubs and restaurants, good shopping, an abundance of fresh local produce and a wide range of accommodation.



INTRODUCTION

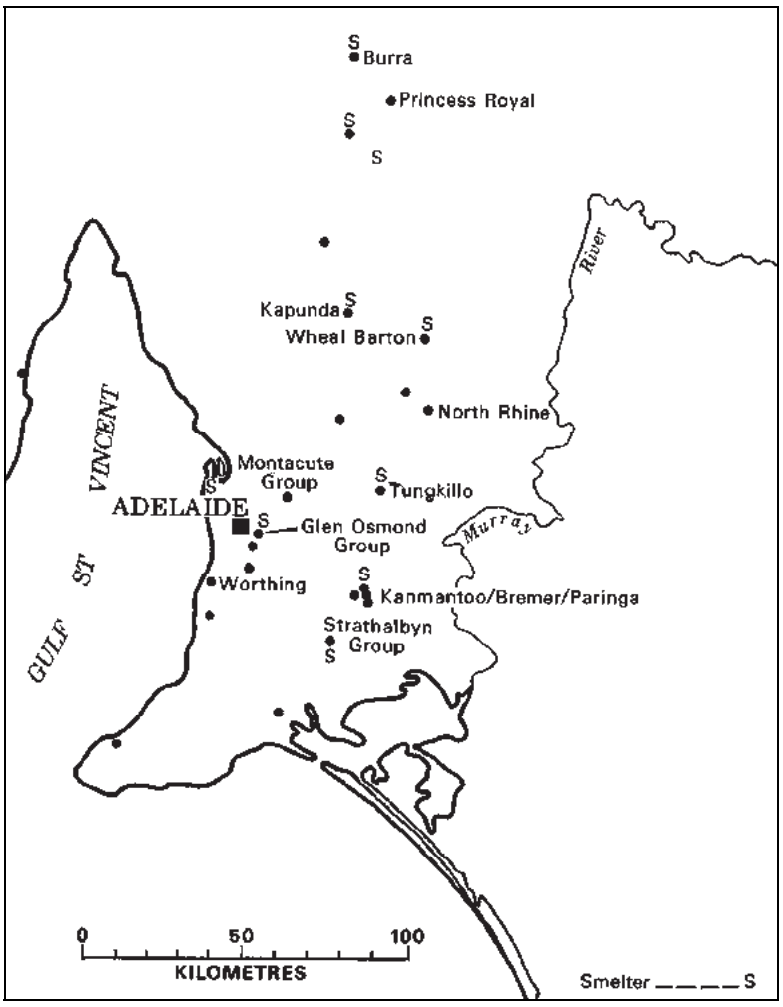
AUSTRALIA'S FIRST MINING ERA

During the period 1841-1851, the Mount Lofty Ranges were the site of Australia's first mining era. This was the decade prior to the discovery of gold in the eastern States when virtually all of the metalliferous mines in Australia were located in South Australia and whose population grew, as a result, from 15,000 in 1841 to 64,000 in 1851.

The 1840s mining boom followed the discovery of silver-lead ore at Glen Osmond, in the foothills of the Mount Lofty Ranges on the outskirts of Adelaide. The Glen Osmond discoveries were quickly followed by the discovery and exploitation of a large number of mines, the most significant being the copper deposits at Kapunda (1844) and Burra (1845). These developments came at a crucial time in the history of South Australia; in the early 1840s the newly created colony was on the verge of bankruptcy and was saved from collapse by the mining boom.

The mining of copper ores at Kapunda and Burra caused the first major decentralisation away from Adelaide and by 1850, Burra with a population of 5000 was the largest inland town in Australia and seventh largest overall. In 1850, minerals constituted 67% of the value of exports from the Colony and wool 29%. A large proportion of the population was directly or indirectly dependent on mining and South Australia was the third largest copper producer in the world.

These mineral deposits, the first exploited less than five years after first settlement of the Colony, had a profound effect on settlement. They brought about a major influx of capital and immigrants into the Colony after the depression of the early 1840s and provided employment for a large number of people. Land was surveyed for mineral tenements, mining townships and agricultural purposes. Basic road networks were established during this period to cart ore to Port Adelaide for shipment to Wales and also deliver heavy machinery to the mines.



Mines of Australia's First Mining Era. PIRSA Plan 1986-0343

THE FIRST DISCOVERIES

Glen Osmond

The first metalliferous mine in Australia, Wheal Gawler, commenced operations within sight of Adelaide in 1841. Land at Glen Osmond had been surveyed into sections and sold in the late 1830s and, according to the existing Land Sale Regulations, mineral rights belonged to the land owners. The Glen Osmond mines were small, employing up to 200 people at one time, but they were the first to attract Cornish miners as settlers to South Australia. Mining ceased by 1851 partly due to the exodus of miners to the newly discovered Victorian goldfields.

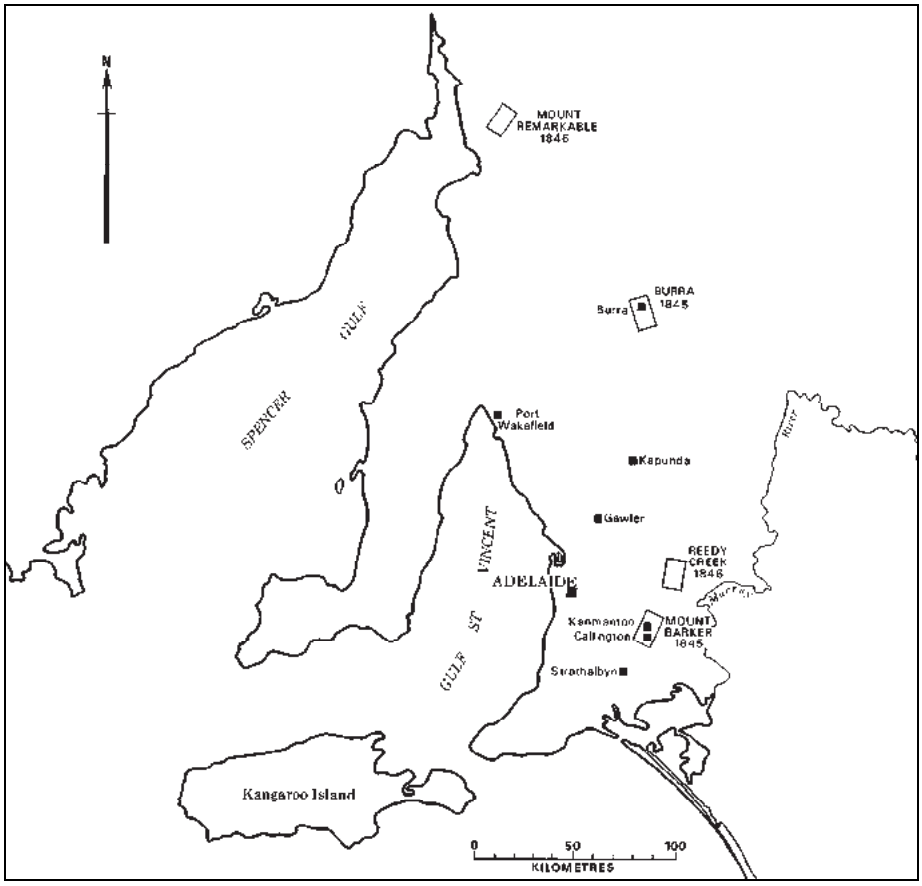
Kapunda

In 1842, Francis Dutton and Captain Charles Bagot jointly discovered copper on unsurveyed Crown land near the present town of Kapunda. Very little land outside the Adelaide area had been surveyed and sold at that time and the 1842 Act for the Sale of Waste Land of the Crown stipulated that such land had to be sold at auction in 80 acre lots at a minimum price of £1 per acre. Keeping their discovery a secret, Captain Bagot requested an 80 acre section be surveyed around the outcrop, and put in a tender of £80 which was accepted in January 1843. This section became the Kapunda Mine which in due course made Bagot and Dutton wealthy.

Mining operations commenced in January 1844 and by 1846, several rows of miners' cottages had been constructed on the mining property, the first company housing in Australia. In 1845, the first horse whim in the Colony was erected to drain water from the mine but it was incapable of handling the volume and in 1848, the first Cornish beam engine in Australia was erected. By 1850, the mine employed 300 men and boys and copper to the value of nearly £1 million was produced up to closure in 1879.

SPECIAL MINERAL SURVEYS

Following the discovery of copper on Crown land at Kapunda and its subsequent survey and purchase for £80, regulations originally issued in 1842 stipulating that the minimum amount of land that could be purchased in unsurveyed districts was 20,000 acres at one pound per acre, were brought into force. This became, therefore, the only way to acquire mineral rights on unsurveyed Crown land after 1844. Four such special (or *monster*) surveys were made and purchased before the system was abolished in 1851: Burra Creek (1845), Mt. Barker (1845), Mt. Remarkable (1846) and Reedy Creek (1846).



Special Mineral Surveys 1845-1846. PIRSA Plan 1986-0342

Burra Creek Special Survey

The first discoveries of minerals outside the surveyed districts were near Burra Burra Creek in 1845, by two shepherds at two separate localities. To acquire the mineral rights, the Burra Creek Special Survey was jointly purchased in late 1845 by two parties that were formed to raise the sum of £20,000. These parties were the South Australian Mining Association (SAMA) and the Princess Royal Mining Company (PRMC).
After purchase, the survey, measuring 8 miles by 4 miles was laid out to incorporate the two discoveries, one in each half and lots were drawn to determine ownership of the two halves. SAMA gained the northern half and what was to become the Burra Burra Mine. PRMC won the southern half and what was considered to be the more impressive outcrop but the ore quickly petered out at depth and operations at the Princess Royal mine ceased in 1851.

Mining commenced at the Burra Burra mine in September 1845. It was soon to become the largest mine in Australia and produced 80,000t of dressed ore up to 1851 with peak production of 23,000t in 1851 which was about 5% of the world's copper production. Its orebody was so rich that it was it was referred to as the *Monster Mine* and the *Eighth Wonder of the World* and during its first six years of operation issued 15 dividends of 200%. More than 1000 men and boys were employed on the mine and a further 1000 were employed as carters, woodcutters and smelter men.

Mt. Remarkable Special Survey

After a report that a hill of copper had been seen at the head of Spencer Gulf a special survey of 20,000 acres was applied for and granted in May 1846 to the Mt. Remarkable Mining Company However, the company proved unsuccessful and was dissolved in 1851. In 1852, the townships of Bangor and Melrose were laid out at the southern and northern ends of the survey, respectively, and sold with the remainder of the company property at auction in January 1853.

Reedy Creek (Tungkillo) Special Survey

This survey of 20,000 acres was purchased in September 1846 by the Australian Mining Company to acquire mineral rights to a copper discovery in the vicinity of Reedy Creek, 50km east of Adelaide. Operations commenced at the Tungkillo Mine in 1847 and Cornish miners and captains were brought to the Colony by the company to work the mine. In 1849, the company surveyed a mining township on its land near the mine. The township, named Southend, had a population of 600 people at its peak in 1850 but was virtually abandoned when the mine closed in 1851.

Mount Barker Special Survey

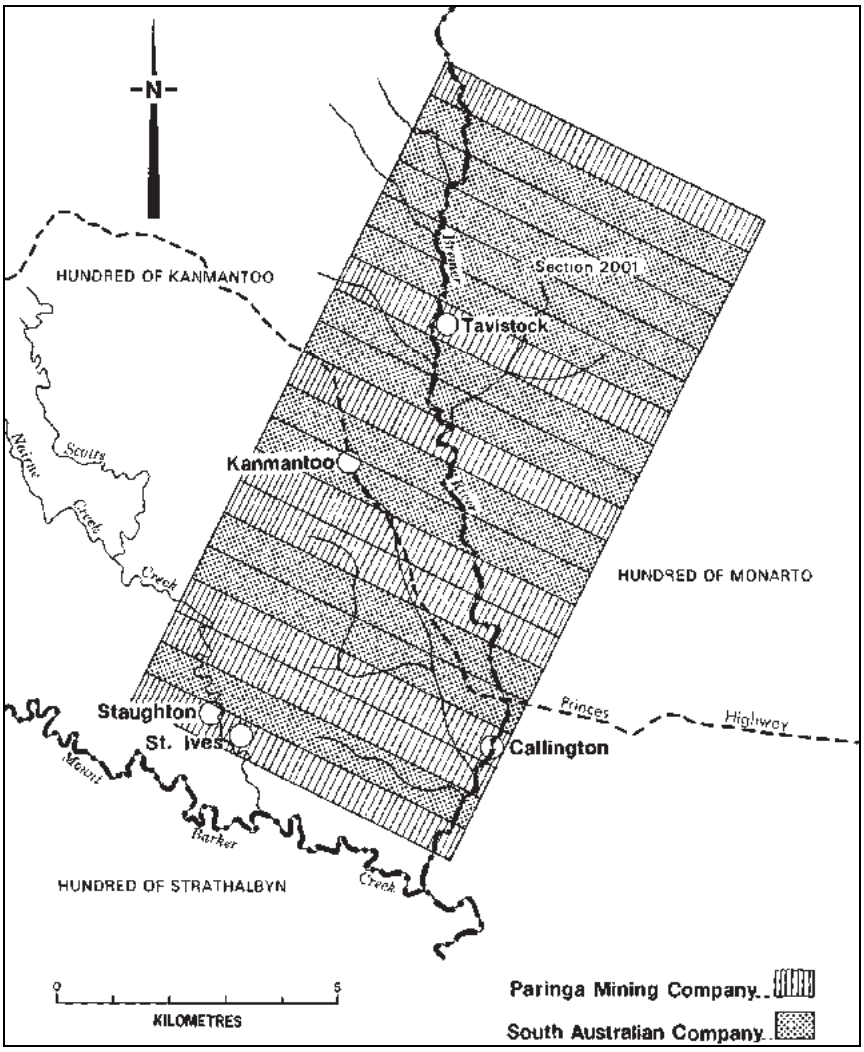
In 1845, encouraged by reports of mineralisation in the Mount Lofty Ranges, the South Australian Company sent two Cornish miners to explore the Mount Barker district. The South Australian Company was a private joint-stock company formed in England in 1836; although the main aim of the company was to encourage investment in commerce, shipping, land, livestock and building in South Australia, it also kept in mind the possibility of investment in mining. The Cornishmen reported to the company's secretary in South Australia, William Giles that they had found a rich deposit of copper ore, and this was confirmed by the company's geologist, J.C. Dixon. The company directors in England instructed Giles to purchase the freehold of the land, and accordingly, Giles applied to the Treasury for the area he wanted.

Giles' application was refused as an earlier application for a part of the land had already been granted to Duncan and Lachlan MacFarlane of Mount Barker, who wanted the land for grazing their sheep. The South Australian Company was not accustomed to being thwarted and sought the intervention of the newly-arrived Governor Robe on their behalf. However, the MacFarlane brothers, who were by now undoubtedly well aware of the mineral find, refused to give way to the South Australian Company and were supported by a group of influential Adelaide men. Eventually a compromise was reached when the two parties agreed to make a combined application for a special survey of 20,000 acres at the regulation price of £1 an acre. Robe agreed to this and the MacFarlanes, together with their financial supporters, formed the Paringa Mining Company with sufficient capital to purchase 8000 acres, with the South Australian Company to purchase the balance of the 20,000 acres.

The survey took place in January 1846 and the two companies agreed to divide the survey into 20 strips, each of 1000 acres, and to select one strip at a time, with the choice of the first strip decided by drawing lots.
The South Australian Company won the right to first choice and selected strip 5, which was described in a newspaper report as *containing a most magnificent lode of great extent, with innumerable smaller lodes* … and fully bearing out the official report that the whole survey was a *field of copper*.

The MacFarlane group's first choice was strip 4, *in all respects similar to the first choice.* The South Australian Company chose the name Kanmantoo for their mine while the MacFarlane group's orebody became the Paringa Mine.

Mining commenced at Kanmantoo in 1846 and by 1850, a number of other mines had been established, most bearing the names of famous Cornish mines including Wheal Prosper, Wheal Friendship, Wheal Mary, Wheal Harmony and Wheal Maria. The most important mines were Kanmantoo, Paringa (1846) and Bremer (1850). The companies divided their land into mining *setts* in the Cornish fashion and offered them for lease. By 1850, the mining townships of St. Ives (1846), Kanmantoo (1849) and Callington (1850) had been laid out by the companies to serve the nearby mines. Other townships surveyed were Tavistock and Staughton in 1846, and Kanmantoo South in 1857. St Ives, and Callington were named after famous Cornish towns and the area was known as *the Cornwall of the Colony*.



Mount Barker Special Survey 1846. PIRSA Plan 1981-0649

LATER MINES

The end of Australia's first era in 1851 also saw the end of the Special Mineral Surveys which resulted in the Burra Mine and mines in the Kanmantoo-Callington district. Other early mines in the Adelaide Hills required land to be purchased as 80 acre sections to acquire the mineral rights (eg. the Strathalbyn Mine).

In 1851, the first regulations were issued for mining leases and gold mining on Crown land. Examples of mines worked under these regulations include the Jupiter Creek and Old Echunga Diggings. However much of the Adelaide Hills was privately owned and hence the mineral rights belonged to the landowners. As a result mines were established by agreement with landowners usually by payment of a royalty of the value of all minerals raised. Examples of mines worked under this arrangement include the Worthing, Aclare, Balhannah, Grunthal and Bird-in-Hand mines.

GEOLOGY OF THE ADELAIDE HILLS

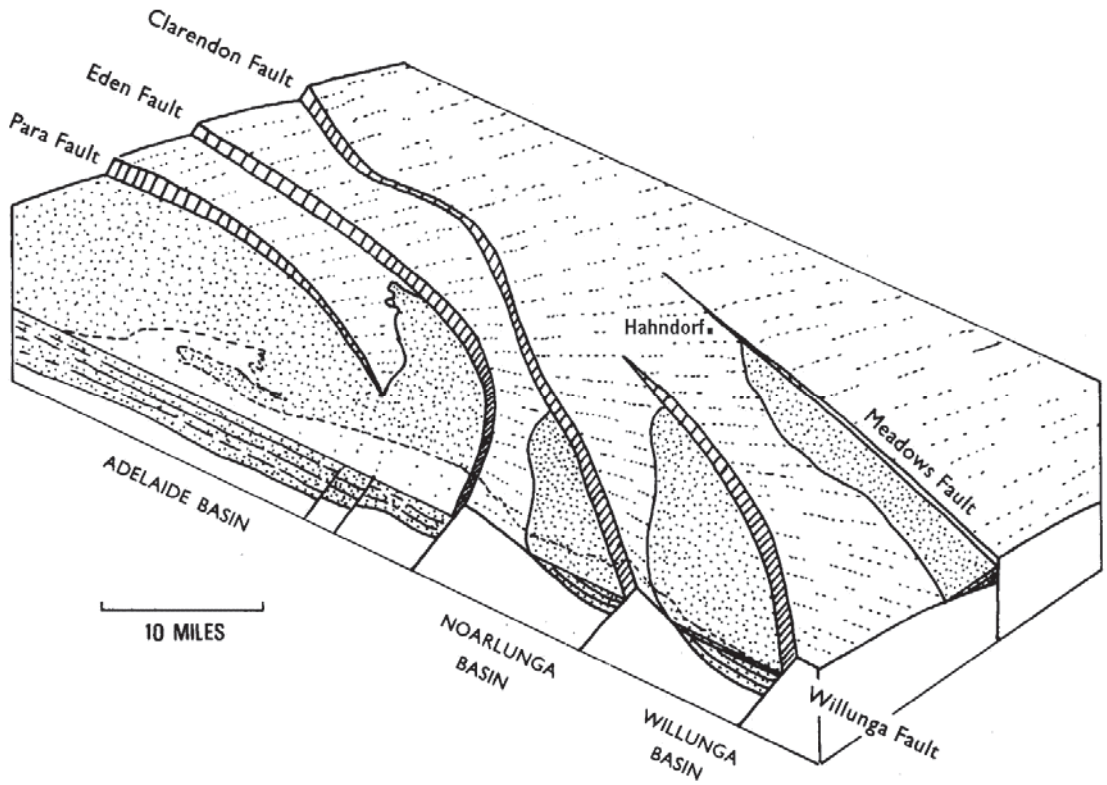
The Mount Lofty Ranges are comprised of rocks of the Proterozoic Barossa Complex and Adelaidean System and the Cambrian Kanmantoo Group. Metamorphic rocks of the Barossa Complex have a minimum age of about 1600 million years and occur as "windows" in the younger Adelaidean System which was deposited as sediments in an elongate basin known as the Adelaide Geosyncline, active from about 800 million years ago. Sedimentation in the Adelaide Geosyncline ceased about 570 million years ago when the eastern margin began to subside rapidly forming the Kanmantoo Trough which runs in an arc around the eastern side of the Mount Lofty Ranges. As it subsided it filled with sediments which during subsequent earth movements were converted to metamorphic rocks.

About 500 million years ago, major earth movements (the Delamerian Orogeny) converted the sediments of the Adelaide Geosyncline and Kanmantoo Trough into a north-south mountain range over a period of about 50 million years. The area was then subjected to a period of extensive weathering and erosion which lasted some 400 million years and converted the mountain range to a generally flat landscape (peneplain) by the beginning of the Tertiary period, about 60 million years ago.

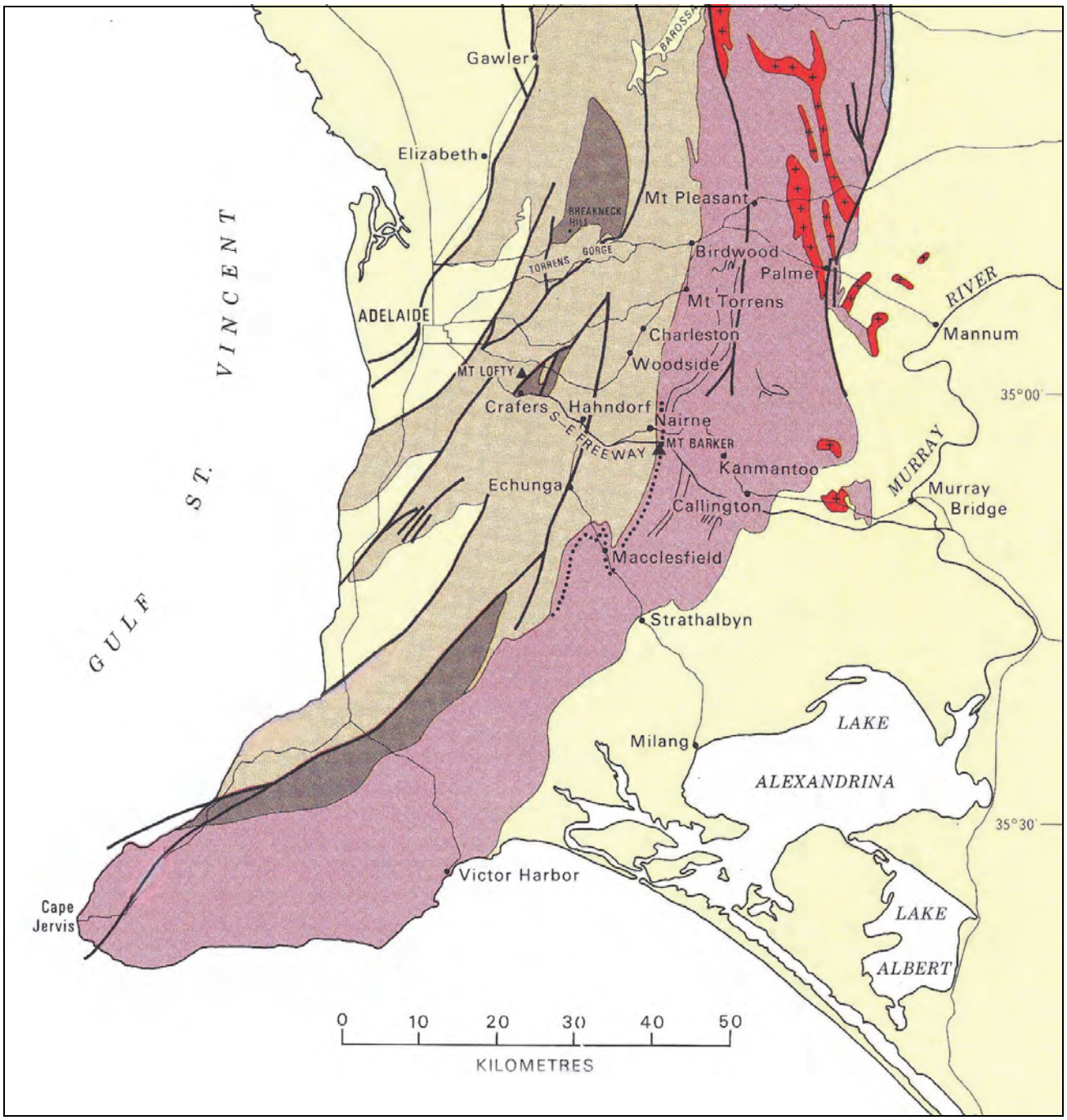
During the early Tertiary, old faults became active again, disturbing the flat landscape and forming the present day Mount Lofty Ranges as a series of uplifted fault blocks. As a result of these movements certain areas began to subside forming basins in which sediments accumulated (e.g. Adelaide, Noarlunga and Willunga Basins). Sedimentation was initially from freshwater streams draining the surrounding highlands but later the sea covered low lying areas and marine sediments were deposited.

Further block faulting in the mid-Tertiary accentuated the horsts and grabens and initiated further extensive erosion of the uplifted blocks (horsts) with the sediments being transported to low lying areas such as the Meadows Basin where sand and gravel (along with gold) were deposited in ancient lakes and river valleys about 10 to 15 million years ago.

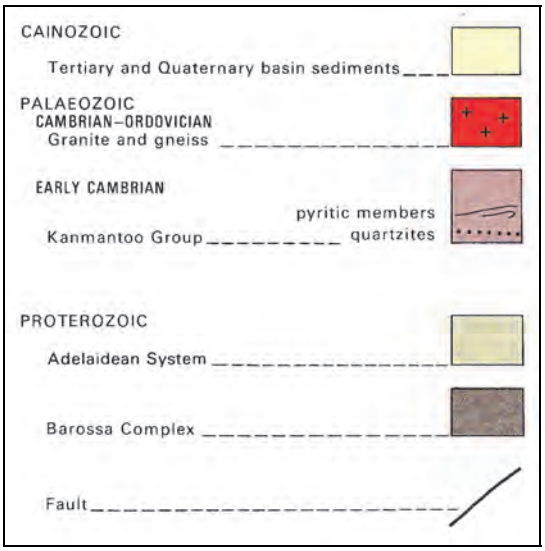
About two million years ago, further uplift along the old fault lines resulted in a period of erosion which has continued to the present day. Vigorous erosion associated with this uplift has produced deeply incised valleys and gorges (e.g. Sturt and Onkaparinga Gorges). The present relief is generally rounded with flat topped ridges which formed part of the pre-Tertiary erosional surface before block faulting and erosion brought about dissection.



Simplified block diagram of the Adelaide Hills showing uplifted fault blocks and Tertiary basins
(from Talbot and Nesbitt,1968)



Generalised geological plan of the Mount Lofty Ranges. PIRSA Plan 1978-0823



MINERAL DEPOSITS OF THE ADELAIDE HILLS

Gold

Gold has been worked throughout the Adelaide Hills from both quartz veins and alluvial deposits. Gold-bearing quartz veins occur principally in the Adelaidean sedimentary rocks and are often associated with fault structures. The most important reef mines were located on the Woodside Goldfield, the largest producer being Bird-in-Hand Mine which produced 10,500 oz from 1882-1886. Recent exploration drilling at Bird-in-Hand has indicated a resource of 237,000 oz to a depth of 400m and a pre-feasibility study into the possible redevelopment of the Bird in Hand Mine is currently being undertaken.

The bulk of the gold produced was from alluvial deposits. These include buried deposits or leads of Tertiary age which occur at depths of up to 10m near Echunga and modern deposits in present day drainage channels washed from nearby leads and reefs. The largest production of alluvial gold was from the Old Echunga Diggings (100,000 oz) and Jupiter Creek Diggings (30,000 oz) which are part of the Echunga Goldfield.

Silver-Lead-Zinc

Silver, lead and zinc occur as vein and stratiform deposits in metamorphosed rocks of the Kanmantoo Group in the Kanmantoo-Strathalbyn mineral field. The most significant silver-lead mine in the field was Aclare which produced about 14,500t of ore from 1859-1896. Wheal Ellen produced about 8000t of ore from 1857-1866 and 5000t of pyrite for sulphuric acid in 1908-1911. The ores at both mines contained a high content of zinc in the form of sphalerite which created significant difficulties in metal recoveries at a time before the invention of the flotation process. The Angas zinc-lead-silver deposit was discovered in 1991 and mining commenced in 2007 with annual production of 400,000t of ore expected to continue until about 2014.

Silver-lead veins (principally galena) also occur in Adelaidean sedimentary rocks. Australia's first metalliferous mines were developed on outcrops of silver-lead ores in the foothills of the Mount Lofty Ranges at Glen Osmond in 1841. About 2500t of hand-picked ore was produced up to 1851. The Mount Malvern Mine (1859-1925) produced almost 2000t of silver-lead ore and 10,000 oz of silver were produced from the Almanda Mine (1868-1871).

Pyrite

Large reserves of pyrite occur in pyritic beds within the Kanmantoo Group. Between 1955 and 1972, open cut mining of pyrite at Brukunga produced more than 1Mt of concentrate from about 5.5Mt of pyritic ore. This has left a legacy of environmental problems with acidic drainage waters from the pyrite quarry, waste dumps and tailings dam. In 1977, the State Government accepted responsibility for rehabilitation of Brukunga and, in 1980, commissioned a lime neutralisation plant to treat acid water.

Copper

Copper is widespread as vein deposits in Kanmantoo Group metamorphic rocks which were prospected extensively from the mid1840s. The most significant mines were in the Kanmantoo district: Kanmantoo (1845), Paringa (1846) and Bremer (1848). The largest of these was the Bremer Mine which produced about 35,000t of ore up to closure in 1875. The old Kanmantoo Mine was reworked in 1971-1976 when 4.5Mt of ore was produced by open cut mining and a new operation to expand the pit and produce a further 16Mt of ore will commence in 2011. The Tungkillo Mine produced 37,000t of copper-gold ore in five phases of operation from 1846-1971.

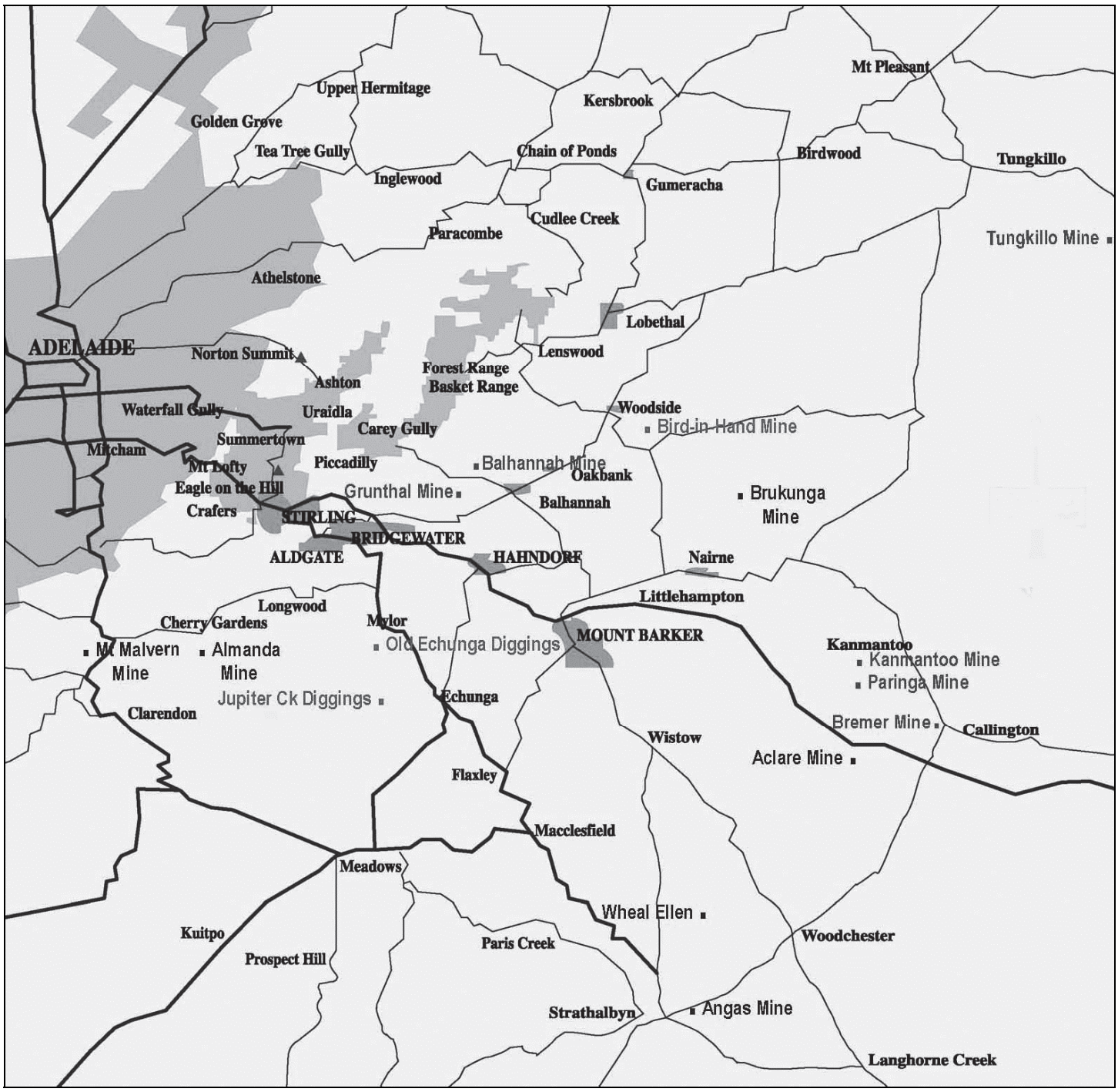
Several veins in Adelaidean sedimentary rocks were also worked for copper. Between 1869 and 1875, about 200t of copper and 9t of bismuth were produced from the Balhannah Mine and the nearby Grunthal Mine produced about 200t of copper from 1870-1876. The Worthing Mine near Hallett Cove was explored from 1849-1856 with little or no ore production but is noteworthy today as the site of the oldest remaining Cornish enginehouse in Australia.

Building Stone

Adelaidean slate was quarried at Willunga where four separate quarries were the major source of roofing slate in Australia from 1840-1933. Walling and paving material is being produced today. Wistow slate, a walling and paving stone, is quarried from schists of the Kanmantoo Group.

Clay

The deeply weathered bedrock of the Adelaide Hills has been quarried at a number places for building bricks, refractory ware, pottery and ceramics. The Littlehampton Brickworks were established in 1892 to produce high quality firebricks for use in smelting works and foundries from white clay mined from an adjacent quarry. Today it produces specialty bricks and pavers.



Historic Mines of the Adelaide Hills

PROGRAM

PRE-CONFERENCE TOURS

Monday 12 September

8.15–5.30 pm	**Tour 1. Strathalbyn-Kanmantoo Mining District** Includes Wheal Ellen, Angas, Aclare, Kanmantoo and Paringa mines

Tuesday 13 September

	Tour 2: Willunga Township and Slate Quarries
8.45 am	Bus departs for Willunga
10.00-10.30 am	***Paper*** – Alma Hotel, Willunga
	Deb Morgan *A town built on slate: Willunga and its quarries*
10.30-11.00 am	Morning Tea
11.00-1.00 pm	**Tours of Slate Museum and Slate Trail**
1.00-2.00 pm	Lunch – Alma Hotel
2.00-4.00 pm	**Tours of Bangor Quarry and Bastian Martin's Quarries**
4.00 pm	Return to Hahndorf
6.00 pm	Bus departs for Welcome Reception
6.30-8.30 pm	Registration and Welcome Reception, Auchendarroch House, 17 Adelaide Rd, Mt Barker
8.30 pm	Bus returns to Hahndorf

Wednesday 14 September

8.00-8.45 am	Registration – Hahndorf Institute
8.50-9.10 am	President's Welcome and Announcements
9.10-10.30 am	***First Session of Papers*** – *Chair:* Ross Both
	Keynote Speaker
	Philip Payton *The Cornish Crucible? The Mount Lofty Ranges and South Australia's early mining history*
	Mary Callaghan *Geraldine Mine, Western Australia – the end of civilisation*
10.30-11.00 am	Morning Tea
11.00-12.00 pm	***Second Session of Papers*** – *Chair:* Roger Kellaway
	Ross Both *Early mines of the Adelaide Hills*
	Chris Haslam *The 1962 Kanmantoo copper discovery and its aftermath: a triple whammy*
12.00-1.00 pm	Lunch – Hahndorf Institute
1.00-3.20 pm	**Tour A1. Jupiter Creek Diggings** OR **Tour B1. Littlehampton Brickworks Tour**
3.20-3.40 pm	Afternoon Tea
3.40-5.30 pm	***Third Session of Papers*** – *Chair:* Philip Payton
	Keynote Speaker
	Charles Fahey *The first wave – South Australians and the Victorian Gold Rushes*
	Moira Drew *Overland Gold – researching the journey to the goldfields in the early 1850s*
	Brian Hill *The 'Merican Expert L. R. Menzies and his role in a Sth Australian mining fiasco*
7.00 pm	AMHA Executive Special Meeting – Heritage Room, Old Mill, 98 Main Rd, Hahndorf

Thursday 15 September

8.30-10.50 am	**Tour A2. Jupiter Creek Diggings** OR **Tour B2. Littlehampton Brickworks Tour**
11.10-12.30 pm	***Fourth Session of Papers*** – *Chair:* Ruth Kerr
	Keynote Speaker
	Geoffrey Blainey *Australian Copper Mines: the growth of a giant*
	Nic Haygarth *From Flea Flat to the Shotgun Carnival: J.H. Robinson, mining fields photographer*
	12.30-1.30 pm Lunch – Hahndorf Institute
1.30-3.00 pm	***Fifth Session of Papers*** – *Chair:* Adrian Hutton
	Jason Shute *When is a store not a store? When it's a smelting house*
	Roger Kellaway *The Rosny Copper Smelter 1846-1850*
	Leonie Knapman *Mittagong – marriage of the Iron Age and modern shopping*
3.00-3.30 pm	Afternoon Tea

NOTE: All excursions depart from and return to the rear of the Hahndorf Institute

3.30-4.30 pm	***Sixth Session of Papers*** – *Chair:* David Branagan
	Cam Schubert *The Kanmantoo Copper Mine development*
	Katherine Laughton *The Angas Zinc Mine: history and operation to date*
5.45 pm	Bus departs for Dinner
6.15-10.00 pm	Conference Dinner – Bird-in-Hand Winery, cnr Bird-in-Hand and Pfeiffer Rds, Woodside
10.00 pm	Bus returns to Hahndorf

Friday 16 September

9.00-10.30 pm	***Seventh Session of Papers*** – *Chair:* Rob Vernon
	Greg Drew *The significance of South Australia's Cornish Mining Heritage*
	David Bannear *The Castlemaine Diggings National Heritage Park: why are we blind to the things we do not feel?*
	Chris Carter *Snowball Creek Copper Mine, Gundagai, New South Wales*
10.30-11.00 am	Morning Tea
11.00-12.30 pm	***Eighth Session of Papers*** – *Chair:* Brian Hill
	Robin McLachlan *Blame Paddy! Assessing the Klondike goldrush from afar*
	Sheila Kelly *The Treadwell Gold Mines open up the Alaska Frontier 1881-1917*
	Barry McGowan *Diggers, dredges and dancing girls: the Araluen goldfield of New South Wales*
12.30-1.30 pm	Lunch – Hahndorf Institute
	Tour C. Brukunga Mine Tour
1.30 pm	Bus departs for Brukunga
2.00-2.30 pm	***Paper*** – Brukunga Institute
	Ross Stevens *The Law of Unintended Consequences: mining at Brukunga and its environmental aftermath*
2.30-4.15 pm	**Tours of Brukunga Mine and Treatment Plant**
4.15 pm	Bus returns to Hahndorf
5.00 pm	AMHA Annual General Meeting – Hahndorf Institute
Evening	Free

Saturday 17 September

	Tour D. Callington and Bremer Mine Tour
8.15 am	Bus departs for Callington
9.00-10.00 am	**Callington Township Tour**
10.00-11.00 am	**Bremer Mine Tour** and Morning Tea at former Callington Police Station
11.00 am	Bus returns to Hahndorf
11.30-12.30 pm	***Ninth Session of Papers*** – *Chair:* Keith Johns
	Bernard O'Neil & Barry Cooper *Johannes Menge (1788-1852). The South Australian Company's Mine and Quarry Agent and Geologist*
	David Branagan *Alfred Selwyn in South Australia, 1859*
12.30-1.30 pm	Lunch – Hahndorf Institute
1.30-3.00 pm	***Tenth Session of Papers*** – *Chair:* Mel Davies
	Rob Vernon *The first geophysical surveys for minerals in Australia*
	Philip Hart *The New Zealand Exploration Company and Aroha Gold Mines Ltd*
	Lloyd Carpenter *The hard men of Bendigo: confronting the mythology of the Central Otago gold rush*
3.00-3.30 pm	Afternoon Tea
3.30-5.00 pm	***Eleventh Session of Papers*** – *Chair:* Nic Haygarth
	Adrian Hutton *Retorting and Refining: the heart of the Joadja Creek Oil Shale Industry*
	Peter Claughton *Silver in Queensland: a preliminary study of ore processing techniques*
	John Ferguson *Gold production at Gympie, 1867-2009*
5.00-5.15 pm	Closing
7.00-10.00 pm	Social Evening - Hahndorf Institute

POST-CONFERENCE TOUR

Sunday 18 September

8.00 am–5.30 pm	**Tour 3. Mines in the Hahndorf-Hallett Cove area**
	Includes the Chapel Hill Diggings, Almanda Mine, Worthing Mine and the Old Reynella Quarries, Grunthal Mine and Balhannah Mine

ABSTRACTS

The Castlemaine Diggings National Heritage Park: why are we blind to the things we do not feel?

David Bannear
Archaeologist, Heritage Victoria

Central Victoria experienced over 150 gold rushes from 1851 to 1903. Some were immense, some were small. Melbourne became the way-station at the start of the colonial journey of thousands of expectant journeys. During 1852-53, when gold fever was at its height, nearly 200,000 men, women and children disembarked at Melbourne.

Ballarat, Castlemaine and Bendigo were the goldfields whose names echoed (reverberated) across the globe, triggering the surge. From these goldfields the rushes spidered outwards like veins, carrying the gold-lured population throughout the fledgling colony.

My illustrated talk will introduce you to some of the mining relics that can be found in the forest surrounding Castlemaine and which are associated with the defining moment of Victorian Rush – the rush to the Mount Alexander Diggings. I will also talk about how despite this goldfield receiving various levels of heritage recognition since 2001, an important part of the archaeological legacy was threatened by a strategy to ecologically strengthen the forest – the forest's feebleness in the eyes of ecologists was in fact one of the land's greatest mining relics.

Australian Copper Mines: the growth of a giant

Geoffrey Blainey, AC
Patron, Australian Mining History Association

Australian copper mining, beginning near Adelaide in the 1840s, preceded gold as an important industry. It also hastened the rise of gold because it attracted to Australia experienced mining men and their technology, mainly from Cornwall.

South Australia usually was the dominant copper producer for the next half century. By 1940, copper ranked fourth in aggregate value of output amongst the main Australian minerals, coming far behind gold and coal and not far behind silver-lead. Copper was the only major mineral where, so far, four different states had contributed strongly to the output – usually one or two states dominated the output of each major mineral. Curiously, the two great gold regions, Victoria and Western Australia, were the weakest in copper.

From the 1950s, one copperfield – Mt Isa – utterly dwarfed all others, an unusual event. Its sheer dominance ended in the 1990s when the astonishing Olympic Dam (South Australia) challenged Mt Isa.

Themes discussed will include new patterns in discovering copper; decline of Australian ownership; industrial relations and safety; and what makes copper mining distinctive.

Early mines of the Adelaide Hills

Ross A. Both

The 1840s mining boom in South Australia followed the discovery of silver-lead ore at Glen Osmond, in the foothills of the Mount Lofty Ranges on the outskirts of Adelaide. This was quickly followed by the discovery and exploitation of a large number of mines during *Australia's Earliest Mining Era*. These developments came at a crucial time in the history of South Australia; in the early 1840s the newly created colony was close to bankruptcy and was saved from collapse by the mining boom.

Copper is widespread as vein deposits in metamorphic rocks of the Cambrian Kanmantoo Group. The most significant early operations were the Kanmantoo, Paringa and Bremer mines in the Kanmantoo district and the Kitticoola Mine in granite host rock in the northern Adelaide Hills. Several veins in sedimentary rocks of the Proterozoic Adelaidean System were also worked for copper, including the Balhannah, Grunthal and Montacute mines.

The Aclare Mine and Wheal Ellen were the main silver and lead producers in the Kanmantoo Group but were unprofitable because of metallurgical problems due to high contents of zinc and other metals in the ore. Silver and lead were also produced from veins in Adelaidean rocks, with Glen Osmond, Almanda and Mount

Malvern the main producers. Gold has been mined from both alluvial and reef deposits in the Adelaide Hills. The Echunga Goldfield was the major producer, mainly from alluvial deposits in Tertiary gravels and modern drainage channels. The Bird-in-Hand Mine in the Woodside Goldfield was the largest of the reef mines.

Alfred Selwyn in South Australia, 1859

David Branagan
School of Geosciences, University of Sydney

In 1859 Alfred Selwyn (1824 – 1902) was one of the most respected geologists in Australia, having established an efficient Geological Survey organisation in Victoria and gained the confidence of mining and government officials. Selwyn was invited by the SA Government to visit South Australia to assess the potential of the Colony for gold and coal occurrences and the potential for good supplies of underground water.

He spent two months (May-June) on his survey, beginning in the Hahndorf-Echunga district. He then examined southern parts of the Colony from Cape Jervis and Encounter Bay returning to Adelaide via Nairne and Strathalbyn. He then travelled north in company with the SA Surveyor-General, G.W. Goyder, travelling from the Cape Jervis as far north as Wilpena, examining known mineral occurrences, although he was denied entry to Burra! He was particularly impressed by the splendour of Wilpena, 'a synclinal undulation of the upper sandstones', and made other significant observations on the regional geology.

Having seen plenty of the Flinders Ranges, he and his companion set off for the Barrier Ranges, but an infection, from an injury caused when he was skinning a kangaroo, forced him to return hastily to Burra for medical assistance. What might have resulted had Selwyn made it to Broken Hill in 1859? Would he have seen and understood the significance of the 'Gossan', more than twenty years early?

While his report indicated little evidence of significant gold or coal occurrences he was the first to recognise evidence of former glaciation in the Inman Valley.

The Geraldine Mine – the end of civilisation

Mary Callaghan
Western Australian Museum, Geraldton, W.A.

This paper traces the history, and relates the stories, behind Western Australia's first commercially viable mine - the Geraldine, which began operations in 1849 after a rich lode of galena was discovered in the bed of the Murchison River, 500km north of Perth. News of the discovery caused great excitement in the struggling Swan River Colony. The recently appointed Governor FitzGerald insisted on inspecting the site himself and despite an eventful expedition to the location, he enthusiastically embraced the idea of developing a mine to generate much needed wealth in the colony. On his return to Perth, he wasted no time in canvassing the idea with prominent businessmen who went on to form the Geraldine Mining Company. Over the following decades, English gentlemen, Cornish mining captains, convicts and free men faced enormous challenges working the Geraldine Mine, the earliest mine on the rich Northampton Mineral Field, in a place that was aptly referred to as 'the end of civilisation'.

The hard men of Bendigo: confronting the mythology of the Central Otago gold rush

Lloyd Carpenter
School of Humanities, University of Canterbury, NZ

The Otago gold rush left New Zealand with a legacy of a mining heritage landscape, a mythology around the life of the miners and a local identity "The Southern Man" constructed around these. I will look at some of this legacy and heritage as it particularly relates to Bendigo in Central Otago. The common belief is that these were hard men for hard times and while this was the case for Bendigo, the real picture of daily life in this starkly beautiful place is far more complicated than that commonly discussed and used to sell New Zealand consumer goods today.

Bendigo became a community: a place for families, gardens, social occasions, cultural events and meetings, and a place where some families remained for over 40 years. Nevertheless, Bendigo was also a place of heartache: where miners' houses were destroyed at the whim of capricious shareholders, where miners were hurt or killed deep underground, where livelihoods turned on the weather-influenced flow of a water in a sluice race, and the chance discovery and exploitation of quartz lodes which promised wealth on one hand and penury on the

other, and where business owners and hotel keepers sought to establish a permanent place at a time when settlements, mining wealth and populations rose and fell in mere days.

I will also briefly discuss the results of my recent research into the peculiarly affectionate way New Zealand miners viewed the Australian Bendigo in their writing and memories.

Snowball Creek Copper Mine, Gundagai, New South Wales

Christopher Carter
School of Archaeology and Anthropology, Australian National University, Canberra

The Snowball Creek Copper Mine is located in the South-West Slopes Region of NS, in the vicinity of the Adelong goldfield. It operated intermittently from the 1870s to the early 1900s. While gold was the lure for the majority to come to the area, this mine attracted a group of miners who had the expertise to exploit the copper ore which had been found in the area. Expertise was required not only to extract but also to process the ore as it was too costly to transport in its raw state.

The Snowball Creek Mine was a small operation, one of several in the region; it required an experienced labour force to both extract and process ore. The operator was able to engage a Cornish mining team to operate the mine during this period and they established a small settlement adjacent to the mine and smelting works. While its success was rather limited, mines of this type collectively contributed to the regional economy and provided a social and economic base for the miners and their families. This paper will examine the archaeological evidence of the mining settlement and its place within the broader history of Cornish miners in this region.

Silver in Queensland: a preliminary study of ore processing techniques

Peter Claughton
University of Exeter, UK

In the late 1880s there was a rush of silver mining companies formed to work deposits in Queensland and northern New South Wales. Few if any of those companies would have made a long term profit; in fact probably only a few of them made any profit at all. This 'silver boom', as it regularly referred to, was stimulated by discoveries of high grade silver-rich ores and the perceived high price of silver on the international market.

Although the price of silver in the latter part of the 19th century maintained a high price longer than other non-ferrous metals it had been falling steadily since 1883 and was to collapse dramatically after 1890. In addition to falling prices the mining companies had to cope with the economic realities of working in remote areas with limited resources; where bringing the silver-rich ores to surface was only the first in a long series of difficult processes.

This paper examines the choices made in processing the ores prior to shipping to markets outside Australia. It considers potential sources of further information on how and why particular methods of processing were chosen or rejected; what benefits, if any, were or might have been derived from those processes. In addition to conventional historical and archaeological sources, consideration is given to the use of archaeometallurgical analysis as a possible line of research to expand our understanding of the processes, particularly the smelting techniques, used in Queensland and northern New South Wales.

The significance of South Australia's Cornish Mining Heritage

Greg Drew
Australian Mining History Association

In 2006, the Cornwall and West Devon Mining Landscape was inscribed on the World Heritage List. World Heritage status recognises Cornish mining's fundamental influence on World hard rock mining, ore dressing and in particular steam engine technology during the 19th century. During this time Cornwall developed a distinctive regional identity which took on global significance with mass migration of Cornish culture after 1840.

The Australian Cornish Mining Heritage Site (ACMHS) consists of two areas – the Burra and Moonta Mines State Heritage Areas – which contain the most authentic and historically significant components of the Cornish Mining Landscape in Australia for the period 1845 to 1923. The ACMHS has been shortlisted for assessment for National Heritage listing by mid-2013. The ultimate aim is have the ACMHS joined as a Transnational

World Heritage Listing, involving Cornwall, South Australia, Mexico, Spain and South Africa, to the existing Cornish World Heritage Site. This would recognise that the distinctive mining landscapes in those locations were derived directly from the Cornish mining landscape.

To enable the ACMHS to be linked to the Cornish Mining World Heritage Site it will need to reflect the impact of the revolution caused by Cornish mining and ore processing technology which took place in Cornwall in the late 18th and early 19th centuries and was transferred to South Australia after the early 1840s. The evidence can be clearly seen in the transfer of Cornish mining and mineral processing methods, steam technology and associated cultural traditions such as mine management and employment systems to South Australia from the 1840s until the early 20th century.

Overland Gold - researching the journey to the goldfields in the early 1850s

Moira Drew
Cornish Association of Victoria

This paper will describe research into overland travel between South Australia and the early Victorian goldfields and introduce the website where the collected information is being made available.

Research into the overland experience of a group of Cornish miners who left Burra in early 1852 has indicated that little comprehensive information is available, and that a number of other family historians sought to fill similar gaps in their family stories. Of particular interest is detail relating to the routes taken, modes of travel, conditions experienced and the numbers of people involved.

While travel between Burra and Bendigo was the initial focus, and the Cornish involvement is significant, the project covers overland travel generally between South Australia and Victoria in the first years of the gold 'rush', primarily 1851 and 1852. Information sources being sought include diaries and family accounts, newspaper reports, records held by collecting institutions and regional historical societies, published sources and references providing context for the period. Once existing sources are identified, attempts will be made to locate records not so readily available.

A summary of results so far will be given along with an overview of the contents of the website. Case studies of several groups who travelled will be presented. Through the establishment of this resource it is hoped to to encourage the sharing of information and raise the level of awareness of this period of extensive migration in Australian history.

The first wave – South Australians and the Victorian Gold Rushes

Charles Fahey
School of Historical and European Studies, La Trobe University, Melbourne

This paper will examine the migration of South Australians to the Victorian goldfields. When gold was discovered in Victoria in 1851, the news quickly spread to South Australia, and South Australians were among the first to dig for gold. Among the early diggers on the gold fields were Isaac Edward Dyason and Edward Snell, both of whom left vivid accounts of the early rushes. Both did remarkably well from digging. The paper will use their accounts to look at life on the early diggings. However, Snell and Dyason were only two of the hundreds who came from South Australia, and the paper will examine this broader migration through analysis of vital records. The paper will argue that the South Australians were important in the move from shallow alluvial mining to more complex deep lead and quartz reef mining. The paper will also explore the continuing link between Victorian mining communities and South Australian mining areas in the years after the great alluvial rushes.

Gold production at Gympie, 1867-2009

John Ferguson
Australian Mining History Association

Gold was discovered at Gympie in 1867 and provided Queensland with its first significant rush and goldfield. Production was continuous until 1924, then restricted to sporadic retreatment of tailings. Modern hard rock mining was resumed in 1994 but ceased again in 2009. Such timeframes, and now the absence of any mining or exploration, dilute an under-appreciated historical legacy. This paper defines the production and grades attained during the different eras and periods of historical and modern mining.

The Gympie Goldfield was characterized by a high frequency of visible gold and relatively high grades. The gold from narrow veins was free milling and suitable for mercury amalgamation. During the Historical period, many single-shaft mines were located on multiple reefs within the Phoenix and Monkland structural blocks. During the Modern Revival, only one mine operated within the Monkland structural block, using several old shafts plus a new decline shaft. While narrow Gympie veins were the major type of orebody during the Historic period, the Inglewood dyke structure yielded more gold during the Modern Revival.

The Historical period, 1867-1979, involved production of approx 4.5 million oz of bullion. Combined with the 470,000 oz from the Modern Revival period, 1980-2009, the Life of Goldfield total is approx 5 million bullion oz. The relative contributions from the sequential Alluvial, Shallow Reefing, Deep Reefing, Interlude and Modern Revival eras are estimated as 3%, 7%, 80%, 1% and 9%, respectively.

The New Zealand Exploration Company and Aroha Gold Mines Ltd

Philip Hart
University of Waikato, NZ

During the mining boom of the 1890s, 'the Rothschilds' were reported to be investing in Waiorongomai mines. Although no Rothschild had shares in their names, close associates did, through being shareholders in the New Zealand Exploration Company, an offshoot of the Rothschild's Exploration Company. A subsidiary company, Aroha Gold Mines Ltd, was in turn floated to work mines at Waiorongomai. Two friends, a German and a Frenchman involved in the early days of the Thames goldfield, Baron James de Hirsch and Jules George Wilson, were the catalysts for tempting overseas investors, notably those with links to the Paris Rothschilds, to the district. They were encouraged by reports provided by a leading Victorian geologist, Edward John Dunn. Because of his over-enthusiasm, capital was wasted testing reefs that lacked the values he claimed, and over 20 months a low level tunnel intended to be two and a half miles long was driven without success. Directors and investors included prominent financiers, and, like other exploration companies of the time, the New Zealand Exploration Company was profitable for its shareholders, even if the mines were a failure. This was the last significant investment of capital into the Waiorongomai field, which was doomed not because of lack of capital but because, despite Dunn, it lacked payable ore.

The 1962 Kanmantoo copper discovery and its aftermath: a triple whammy

Chris Haslam

In 1960, with only 10 years of mine life remaining, Broken Hill South Limited commenced planning an exploration program in Eastern Australia. The campaign would be innovative, and apply a leading-edge geophysical method (IP) to appraise brownfields areas near large known deposits. Being an entirely new venture for the company, it was decided to "bed down" the operating procedures in an area with good infrastructure, and with easy access from Broken Hill. The Kanmantoo district was chosen, despite its modest production, and field work commenced in 1962. A regional IP survey defined strong anomalism extending several kilometres north from the old workings, and the first drillhole intersected an encouraging 1% copper over a core length of 90m.

Further drilling established the geometry of the deposit, and in 1968 a 58m shaft was sunk to provide a bulk sample for metallurgical testwork. Open pit mining and ore treatment began in 1971 at an annual rate of 830,000t. However, low copper prices prevailed during the 1970s, rendering the operation marginal, and mining was suspended in 1976.

In the early 1980s CRA acquired a group of copper assets, including the 'mothballed' Kanmantoo mine. Copper prices have always been cyclical, but CRA took the surprising step of auctioning the mine plant and equipment, though copper prices were already 30% higher than the average for the 1970s: five years later they had trebled! Kanmantoo, without a treatment plant, became a 'stranded asset' - but that provided the opportunity for Hillgrove.

From Flea Flat to the Shotgun Carnival: J.H. Robinson, mining fields photographer

Nic Haygarth
Freelance Historian and Honorary Associate, University of Tasmania

From 1913 to 1953 John Henry ('JH' or 'Jackie') Robinson framed Tasmania's Waratah district from a tripod. While working for the Mount Bischoff Tin Mining Company granted Robinson all-areas access to a great mining operation, his shutter also celebrated the social life of the region's tight-knit community. The amateur's only studio set - of sun streaming across a rickety garden fence - backdropped many portraits. Waratah was Tasmania's original 'window' on the West Coast wilderness, inspiring Marie Bjelke Petersen's romance novel *Jewelled Nights*. Robinson doubled as stills photographer for the movie shoot of that book as he chronicled life on the Savage River osmiridium fields.

'The 'Merican Expert' L.R. Menzies and his role in a South Australian mining fiasco

Brian Hill
Australian Mining History Association

American 'mining expert' L.R. Menzies, the discoverer of the Menzies gold field in W.A., was the promoter of a gold mining venture in South Australia which in 1898 resulted in the biggest mining fiasco in the colony's history. Menzies floated the Menzies Barossa Gold Mining Company NL which installed the biggest stamp battery in the colony on the renamed Menzies Barossa gold mine in the Barossa Goldfield: the 40-head stamp mill dwarfed all other gold treatment plants in S.A. Designed to treat 600t a week, the mill ran for only a couple of weeks and crushed only 1,500t when it was shut down and the mine closed after a calamitous crushing result when only 30 oz of gold rather than the anticipated 750 oz were recovered. Instead of the expected half an ounce to the ton, the grade of ore in the mine turned out to be only 10 grains of gold per ton which was 1/25th of the predicted grade that had been used to justify the decision to install the large mill. Menzies later wrote a curious autobiography noted for its wild claims and tall yarns.

Retorting and Refining: the heart of the Joadja Creek Oil Shale Industry

Adrian Hutton
School of Earth and Environmental Sciences, University of Wollongong

Much of the Joadja Creek story has been published in book form or articles. However, one area that has been relatively neglected is the retorting and refining sections of the operation. Oil shale (examples are kerosene shale from Joadja Creek and Glen Davis, and tasmanite from Tasmania) is the feedstock of the oil shale industries, past, present and future.

Oil shale is a rock composed of mineral matter and solid organic matter derived mostly from algae. In rock form, oil shale has little use. However, when heated in the absence of air, the solid organic matter decomposes to vapours which can be cooled to liquids with a similar composition to the crude oil which is the mainstay of modern petroleum plants. At Joadja Creek, the retorts were 'D" shaped retorts which were heated from below by either wood or coal. The organic matter in the oil shale decomposed to gases which were condensed in water-cooled equipment and the synthetic crude oil carried by pipes to the refinery section some 150m away from the retorts. In processes not unlike those in modern oil refineries, the synthetic crude oil was separated into useable products such as kerosene, paraffin wax, oils and greases. Some of the refinery products were used in the manufacture of products such as soap and candles.

This paper presents the retorting and refining story of Joadja Creek.

The Rosny Copper Smelter 1846-1850

Roger Kellaway
University of Tasmania

A plan was developed in 1846 to link Tasmanian coal with South Australian copper. Ships travelling south would carry copper ore to Schouten Island and return to Adelaide with a cargo of coal. Smelters at each site would refine copper at half the cost of smelters located in Britain. This concept led to the formation of the Australasian Smelting Company in 1848. The Hobart shares were quickly taken up and a local board formed comprising prominent members of the business community. In Adelaide, investors were slower in getting behind the scheme though eventually sufficient shares were sold to allow a provisional committee to be formed.

At some stage, a division occurred within the company. The Australasian Smelting Company continued to develop the Schouten Island coal mine while a separate company – the Exmouth Smelting Company – began erecting a smelter at Rosny on the Derwent directly opposite Hobart. The major force behind the Rosny smelter was Charles Swanston, Managing Director of the Derwent Bank. Technical expertise was provided by Richard Rodda, a mining expert recruited from South Australia.

The Rosny works may never have been fully operational though small quantities of copper ore were imported from South Australia and New Zealand and the company occasionally advertised for charcoal. Swanston had trouble in separating the interests of the bank from his personal speculations. When Swanston's financial irregularities were discovered, the smelter scheme quickly unravelled as the works were found to be on land not owned by Swanston but by the bank. Rodda tried to keep the scheme alive but in the end returned to South Australia. The Rosny Estate, including the works, was sold to Askin and Morrison. Though both were connected with the Schouten Island group, nothing appears to have done to finish the smelter. The works gradually fell into ruins; the chimney remaining as a prominent waterfront feature for the next 60+ years.

Treadwell Gold Mines open up the Alaska Frontier 1881-1917

Sheila Kelly
Mining History Association (US)

A century ago, for a moment in time, Treadwell, Alaska was the largest hard rock gold mining operation in the world. The mammoth lode of low grade ore discovered in 1880 on Douglas Island opened up southeast Alaska to trade and tourism and put Juneau on the map. The company town with four mines and five mills housing 960 pounding stamps boasted gracious living complete with club house and heated swimming pool for families that included Sheila Kelly's father and aunts. Her grandfather was a machinist for Treadwell.

Constant refinements of technology and processes resulted in steadily increasing profits. At the same time, underground caving in the mined-out stopes accelerated. A high spring tide triggered a cataclysmic drama on April 22, 1917, when the waters of Gastineau Channel gouged a hole in the weakened surface and poured into a sinkhole, flooding three of the mines. The fabled town was promptly abandoned but it had already established a place in history as the first large scale industrial mining operation that shaped the future of Alaska. Kelly's presentation features stories and rare historic images from her book, *Treadwell Gold, An Alaska Saga of Riches and Ruin,* (University of Alaska Press, 2010).

Mittagong – Marriage of the Iron Age and modern shopping

Leonie Knapman
Australian Mining History Association

Australia's earliest iron works were supposedly officially opened in Mittagong in August 1848. However, in 2011 the remains of an earlier site, now preserved as a display in a parking lot under 'Mittagong Market Place' - a Woolworths store - were discovered. It seems an unlikely place to discover Australia's beginnings as an industrialised nation and it would have been lost except for the role played by Woolworths in conserving the archaeological remains of Australia's first iron smelter.

Excavations for the building foundations of the store uncovered extensive relics of the original iron works, including foundations of the rolling mills and an associated fly/drive wheel pit, timber dampeners for a tilt hammer used in forging, puddling furnaces used to produce wrought iron, and a number of chimney bases and boiler houses.

Woolworths agreed to integrate the discoveries into the development of the site. In doing so they had to forgo sixty car spaces in their underground car park to allow a display space of 40m x 45m to showcase the ruins. Heritage display boards have been erected to help visitors understand the significance of the relics. Until these discoveries, the earliest known surviving foundations of the Fitzroy Iron Works were to the east, near a public reserve, appropriately called Iron Mines Oval.

The Angas Zinc Mine: history and operation to date

Katherine Laughton
Senior Mining Engineer, Angas Zinc Mine, Terramin Australia Limited

Located on the Fleurieu Peninsula in Australia's oldest base metals mining belt, Terramin's Angas Zinc mine continues to show that the viability of these older mining areas is still alive and strong. Positioned in close proximity to the town of Strathalbyn, mining at the Angas Zinc Mine is not, however, without its challenges. The Angas Zinc Mine orebody was discovered in 1991 and the first product shipped in 2008; the mine is now producing approximately 400,000t of zinc/lead ore per year. This presentation will outline the recent history of the Angas Zinc Mine at Strathalbyn, looking at the challenges so far, and the future ahead.

Diggers, dredges and dancing girls: the Araluen goldfield of New South Wales

Barry McGowan
Visiting Fellow, Australian National University

The Araluen goldfield was the largest alluvial goldfield in New South Wales and one of the most productive and enduring in Australia. Mining commenced in 1851, with a long boom beginning in 1858. By the mid-1860s, the population was about 10,000, if not more, and the small syndicates of working miners had given way to large companies with subscribed capital. Notwithstanding a succession of debilitating floods, the main boom lasted until 1871, when floods wiped out many claims. Araluen then entered a slow but steady period of decline, which ended in 1900 with the advent of bucket dredging aided by New Zealand expertise and capital. The last dredge clanked to a halt in 1926.

As the title to the paper suggests, Araluen was famous for more than its gold; its alleged saturnalias and orgies in the 1860s, along with the depredations of bushrangers such as Ben Hall and the Clarke gang, gave much concern to the authorities. Hotel owners hired teams of dancing girls, the new arrivals taking to the floor after an obligatory foot bathing in tubs of champagne. In my paper I address the unusual and intriguing mining history of this field, and discuss the dichotomy between the alleged excesses of the miners and other reports, which portray Araluen as firmly in the grip of middle class values such as respectability and domesticity.

Blame Paddy! Assessing the Klondike goldrush from afar

Robin McLachlan
School of Humanities and Social Sciences, Charles Sturt University, Bathurst

Billinger is going to lecture on the Klondike. Fudge!
He has never been there.
Well, neither have the people who will hear him lecture.

This joke appeared in Australian and New Zealand newspapers in early 1898, a time when many were making the decision whether to join the rush to the Klondike goldfield. While newspapers carried up-to-date telegraphic reports, thanks to the undersea cable, and filled their columns with the latest copy from American and Canadian newspapers arriving on steamers, trustworthy eyewitness reports from expert Australian or New Zealand miners were notably absent. There was virtually no-one in the colonies in early 1898 with first-hand knowledge of conditions in the Yukon, let alone the true nature of the Klondike goldfield. Nonetheless, hundreds of Australians and New Zealanders bought all available berths on scheduled and chartered steamers heading for west coast North America. And, hundreds returned home by year's end, pockets empty and chorusing a common line that they had been duped into going. Sour grapes or legitimate gripe? What was the quality of the information available to prospective Antipodean Stampeders?

This paper will assess the nature and reliability of Klondike information available in early 1898. It will be shown that it was a complex slurry of fact and fiction, knowingly shaped by shipping companies, outfitting merchants and other potential beneficiaries, including the Canadian government. Enterprising "experts" added to the mix with lectures and individual consultations – at a price. The final push to "Ho for Klondike", however, may have come from the reported opinion of Australia's sporting celebrity on the spot, Paddy Slavin.

A town built on slate: Willunga and its quarries

Deb Morgan
Heritage Policy Unit, Department of Environment and Natural Resources, SA

As the first wave of immigrants flooded into the new colony of South Australia and spread out across the Adelaide Plain and surrounding districts, one of their first priorities was to get a roof over their heads. For most early settlers this was initially a canvas tent, but more durable shelters soon appeared. Imported building materials were in limited supply, and were expensive, so all but the wealthiest settlers had to make do with primitive huts constructed using whatever materials were at hand – bark and split slabs from the abundant native timber, reeds, mud and thatch.

Some settlers spent months or years in temporary shelters, enduring the extremes of the South Australian climate whilst they waited for government surveys to be completed so they could take possession of their land and set about building permanent homes for themselves and their families. Local sources of suitable, affordable building materials, including timber, stone and bricks, were desperately needed to meet demand.

The time was ripe for an observant young Devonshire man, recently arrived in newly-settled District C, to make an important discovery: one which would give the infant settlement of Willunga a substantial economic boost and leave a lasting impression on its character which is still observable today.

This paper will present an overview of the development of the township and its slate quarries over the nineteenth and early twentieth centuries.

Johannes Menge (1788–1852)
The South Australian Company's Mine and Quarry Agent and Geologist

Bernard O'Neil [1] and Barry Cooper [2]
[1] O'Neil Historical & Editorial Services
[2] School of Natural and Built Environments, University of South Australia

Johannes Menge's pioneering work on the mineralogy and geology of South Australia in the period from his appointment as the South Australian Company's Mine and Quarry Agent and Geologist in 1836 continues to be reappraised. In particular, his approach to mineral exploration is little understood. This co-presentation will provide an update of recent findings on Menge's life, his career and exploits, with a focus on his assessments of the geology of Kangaroo Island in 1838. Both his official Company post and his limited mineral exploration on the island were pacesetters for Australia. Indeed, Menge was one of the earliest Australian mineral exploration geologists. A short film depicting Menge's explorations in the Barossa Valley will be shown after the presentation.

The Cornish Crucible: the Mount Lofty Ranges and South Australia's early mining history

Philip Payton
Institute of Cornish Studies, University of Exeter Cornwall Campus, UK

In discussions of 'Australia's Earliest Mining Era', to use the phrase coined by the late Ian Auhl, the focus is overwhelmingly (and understandably) on the rapid development of the Kapunda and Burra Burra copper mines. The narrative, after a deferential nod in the direction of the Glen Osmond silver-lead workings, usually moves swiftly on to the altogether more significant (or so it is inferred) Kapunda and Burra Burra mines, which soon after their discoveries in the mid-1840s won international acclaim and gained for South Australia its apt sobriquet, 'the Copper Kingdom'. However, with one or two notable exceptions, the early and enduring significance of the Adelaide Hills – the Mount Lofty Ranges – has been overlooked, or at least underestimated. This paper sets out to redress the balance, by looking again at the Hills mining activity, especially in this early period, and by arguing that much that came to characterise the South Australian mining industry – in particular its enduring Cornish flavour – was first evident in the Hills. Place names such as Callington, St Ives, Tavistock and the enigmatic 'Kelynack' more than hint at a Cornish (and West Devon) influence, while tell-tale mine names like Wheal Prosper, Wheal Fortune and Wheal Harmony likewise speak volumes. Moreover, within this 'Cornwall of the colony', as the local press dubbed it, were Cornish settlers – miners and their families and others – who brought their social and cultural influence to bear within in the locality. In this way, the Hills were indeed South Australia's 'Cornish crucible'.

The Kanmantoo Copper Mine development

Cam Schubert
General Manager, Kanmantoo Copper Mines

The Kanmantoo Copper Mines project is located in the Adelaide Hills region of South Australia, an area which has recorded production of over 39,000t of copper metal, but remains one of the most under explored and prospective base metal provinces in Australia, showing outstanding potential for copper-gold and silver-lead-zinc mineralisation.

The project contains the old Kanmantoo Copper Mine pit, which was in operation from 1970 until 1976, but work by Hillgrove since 2004 has proved up an additional Indicated and Inferred Mineral Resource of 32.2Mt grading 0.9% copper (292,200t metal) and 0.2g/t gold (191,100 oz).

The Kanmantoo Project has outstanding potential as one of the few remaining 'brownfield' copper-gold opportunities in Australia. With licensing and planning now completed and finance in place, Hillgrove is now undertaking construction of the second hand Pilbara ore processing plant and surrounding buildings, as well as the tailings storage facility and administrative offices, with the aim of bringing the mine into production by the last quarter of 2011. Ample water is available to operate the mine, with the majority of its process water coming from treated waste water from the District Council of Mt Barker Laratinga Water Treatment Plant.

The potential for further discoveries and growth of the global copper/gold resource at Kanmantoo is high. The deposit appears to remain open along strike and down dip where additional drilling could materially increase the resource inventory. The Kanmantoo Mine development is poised to go into production in late 2011 for what will be Australia's latest mid-sized copper mine.

When is a store not a store? When it's a smelting house

Jason Shute

Burra could have more of its history on its hands than it presently believes. Its claim that the substantial stone building at the mine entrance is the mine store, of 1847 vintage, is impressive enough, but what if it is something more and somewhat older? What if it is none other than the colony's earliest mine smelting house? Any one hundred-by-thirty foot building of masonry construction, being erected in the Burra Mine's vicinity as early as New Year 1846, had to be one of the more impressive structures in 'rural' South Australia of the time. Records show that the Mining Association's forlorn hopes for local smelting soon saw the smelter declared redundant, certainly by June 1848, even before the Patent Copper Company's smelting initiative of that September. However, one does not throw away such a valuable investment; one utilises it for some other purpose.

This paper suggests that ST Gill's watercolours of the building bear testimony to the fact that we are perceiving the very same structure, occupying precisely the same spot at the mine entrance, through the three-year period of its transformation from Smelting House to Store. Gill throws only one spanner in the works of our straight-forward acceptance of the evidence for the transformation as indicated in the SAMA records: his depiction of an upper storey of some dimension. Today's building is clearly of single storey. Can this circle be squared, rendering Burra more a significant heritage than it currently knows?

The Law of Unintended Consequences: mining at Brukunga and its environmental aftermath

Ross Stevens
Mine Completion Group, Primary Industries & Resources South Australia

The best laid schemes of Mice and Men oft go awry,
And leave us nothing but grief and pain,
For promised joy!- Robert Burns 1785

It all started after World War II: returning serviceman and assisted immigrants were encouraged by the South Australian Government to clear and develop the land and increase agricultural production in the state. Australia realised it was isolated from the UK and promoted self-sufficiency, population growth and agricultural development. The problem was that the poor quality South Australian soils required superphosphate fertiliser to sustain cultivated crops. In the 1950s there was a critical shortage of sulphuric acid for superphosphate production. The Brukunga Mine was encouraged and sponsored by both the State and Commonwealth Governments to ensure that Australia was self-sufficient in supplies of sulphur for

superphosphate production. Pyritic minerals were quarried at Brukunga as a source of sulphur for the production of sulphuric acid, which was then used to manufacture fertiliser in Adelaide. The mine commenced production in June 1955 and continued for 17 years, closing on 31st May 1972.

The first of the unintended consequence was from the very beginning of the mining - the natural oxidation of pyrite minerals as they were exposed to air and water, resulting in the formation of sulphuric acid drainage seeping from the waste rock dumps, tailings dam and mine voids. The acid drainage dissolved heavy metals from the rock causing heavy metal pollution. Aided by Dawesley Creek that flowed through the mine site, the acid drainage and heavy metal pollution were carried downstream into Mt Barker Creek, Bremer River and Lake Alexandrina, impacting the freshwater ecosystem and rendering the water unfit for drinking, stock watering or irrigation.

This presentation will focus on the evolution of post-mining remediation strategies, starting with work done by the mining company, the transfer of the site to government control, the building of the treatment plant, the diversion of Dawesley Creek and finally the current strategy. Despite the best laid schemes, each stage of remediation has triggered the Law of Unintended Consequences. The presentation will discuss the ramifications of each of the Unintended Consequences and end with how the current strategy plans to beat this Law.

The first geophysical surveys for minerals in Australia

Rob Vernon
Colectivo Proyecto Arrayanes, Linares, Spain and Welsh Mines Society, UK

In the last decade of the 19th century the Englishmen Leo Daft and Alfred Williams developed an earth resistance surveying method for prospecting for mineral lodes. After field trials in the USA, they brought the method to England in 1900 and established the first geophysical prospecting company in the world, the *Electrical Ore-Finding Company Limited.*

Ernest Lidgey, was originally a State mining geologist working in the goldfields of Victoria. However, he gave up this position, and came to England to promote Australian gold mining. Whilst in London he heard about the Electrical Ore-Finder, and decided to gain a licence from the inventors to bring a set of equipment and operators to Australia in 1903.

Initially, geophysical surveys were conducted on the Hampton Plains Estate to the south of Kalgoorlie, Western Australia, and later at Kalgoorlie. Nothing conclusive came from the surveys and others took up the venture to use the equipment in the Cobar district of New South Wales, and on gold prospects in Victoria, for example.

In South Australia surveys were conducted at Port Lincoln, Kapunda and Kadina. The last known ore-finding surveys were conducted in October 1907 at the Hamley Copper Mine, Moonta. Development work was conducted from Treuer's Crosscut to intersect a lode identified by the Ore-Finder survey. Despite the exploratory work continuing until the end of that year, no lode was found.

This is apparently the first recorded use of geophysical prospection for minerals in Australia. The paper describes the equipment and the surveys conducted.

AMHA DINNER PRESENTATION

Bird-in-Hand Winery, Thursday Sept 15 Presenter: Greg Drew

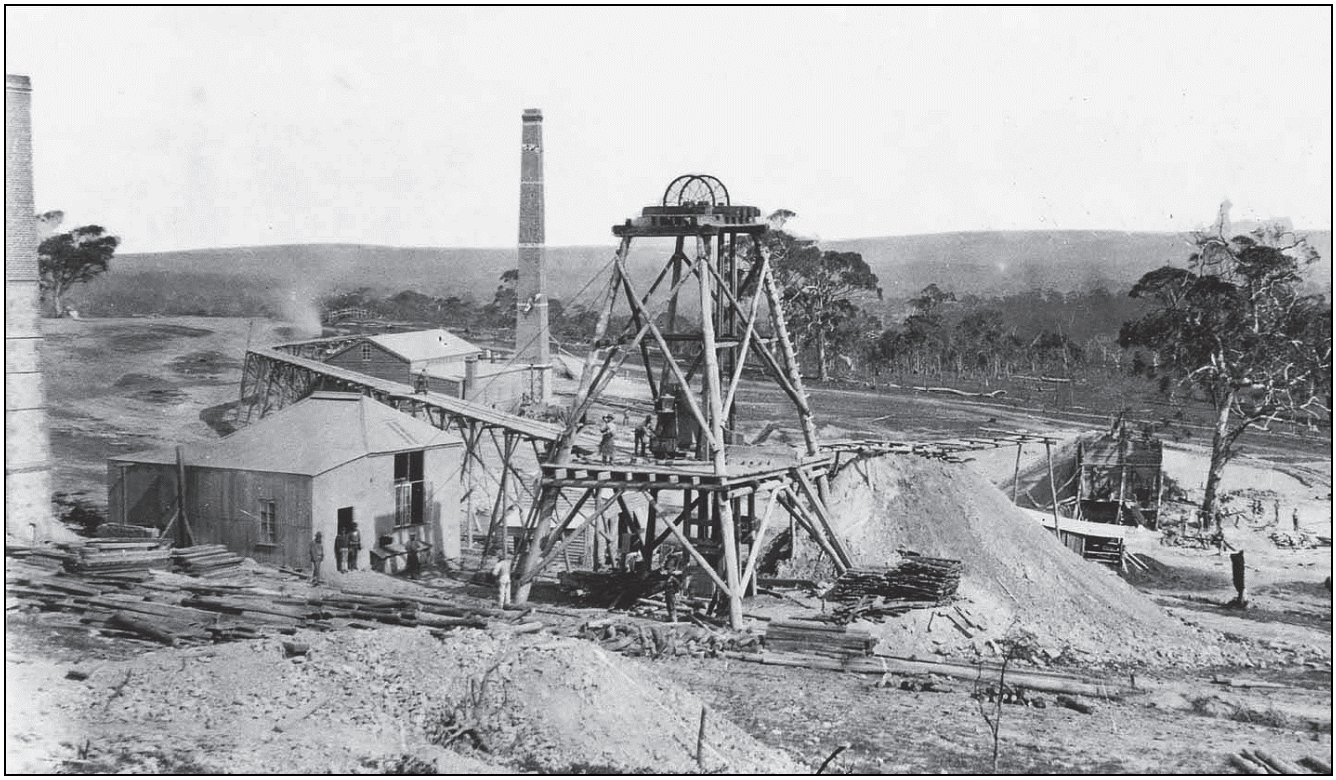
WOODSIDE GOLDFIELD

The first discovery of gold in the Woodside area was made in early 1880 by a Mr Mitchell while clearing his farming property with explosives to remove tree roots. A glittering tangle of quartz and gold worth £300 was exposed and after removing further rich specimens several shafts were sunk and £650 worth of gold recovered. The Woodside Gold Mining Company was formed in July 1881 with two copper kings, Sir Thomas Elder and Mr Barr Smith amongst the shareholders. However the results were disappointing and the company wound up in late 1882. A number of quartz reefs were subsequently discovered several kilometres east of Woodside.

The Bird-in-Hand Mine

In July 1881, a prospector David McCracken discovered two gold bearing reefs to the east of Woodside and an initial crushing of 12t yielded 22 oz of gold. The Bird-in-Hand Gold Mining Company was formed and thus was established the Bird-in-Hand Mine which led ultimately to the discovery and opening up of other mines nearby. Mining began in late 1881, a main shaft was commenced and a 10-head stamp battery and small steam engine from Melbourne commenced operation in early 1882 and Captain Henry Cock from the Bendigo goldfields was appointed manager. By the end of 1882, the mine was reported as *the premier gold mine in South Australia* and employed about 70 men. The township of Reefton Heights was surveyed on the mine property but it appears that employees' houses were chiefly wooden structures and, today, none remain.

In 1883, a new 20-head battery powered by a 40hp steam engine from Martin and Company of Gawler was erected; the battery was the largest erected in South Australia at that time. A small steam engine was also installed at Main Shaft for hauling and operating pumping equipment which eventually proved inadequate for dewatering the mine. A 120m-long elevated tramway was erected from the landing brace at Main Shaft to convey ore to the battery house.

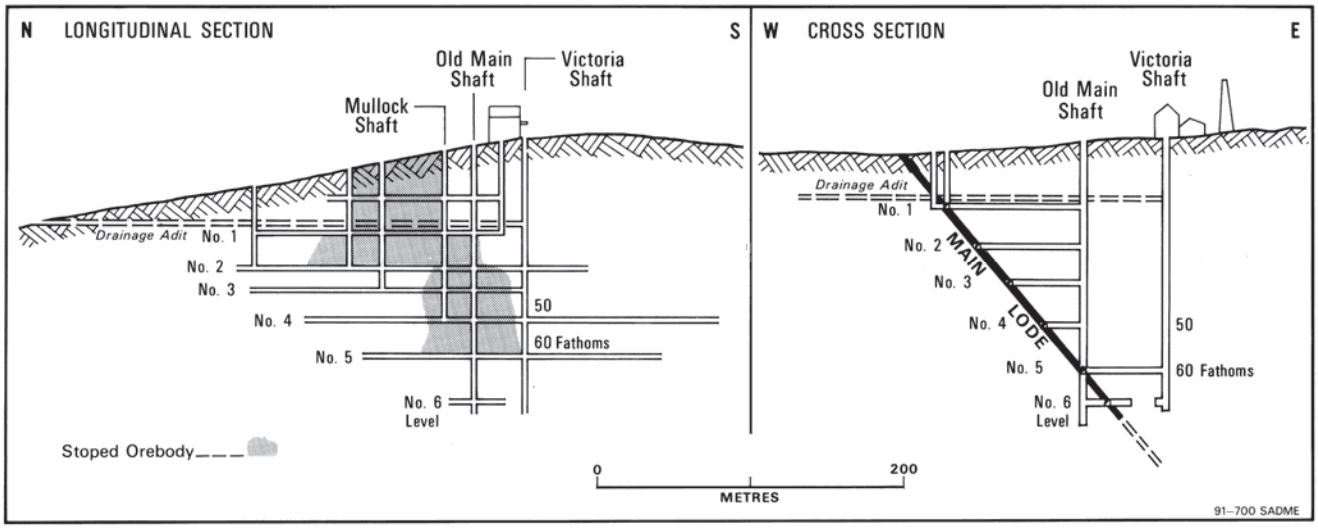


Bird-in-Hand Mine c.1883. At centre is Old Main Shaft and adjacent winding engine. The tramway takes ore to the battery in the background. PIRSA Photo 032948

John Warren, an experienced Cornish mine captain from the Paramatta Mine near Moonta, was placed in charge of the mine in 1886 and, with the aid of a Government subsidy of £3000, purchased a 50-inch Cornish pumping engine from the Bon Accord Mine near Burra complete with two Cornish boilers and 120m of pitwork, balance bob and capstan. Production of ore was suspended while work was concentrated on sinking a new engine shaft (named Victoria Shaft) to intersect the reef about 60m below the deepest workings, which had been virtually worked out.

This engine was originally installed as Roachs Engine at Burra in 1849, the first Cornish beam pumping engine in Australia. It was re-erected at the nearby Bon Accord Mine in 1859 where it operated until 1861.
The cylinder and bob arrived by rail at Balhannah in October 1886 and, by early 1887, the engine was fixed in the traditional Cornish enginehouse by May Brothers of Gawler. A formal opening ceremony was held on 13 April 1887 in front of the directors, representatives of the gold mining industry and shareholders.

By the beginning of 1888, Victoria Shaft had reached the 60 fathom level (110m) but great difficulty was experienced with the large volume of water encountered in a crosscut at that level. To solve the problem, additional pumps were fixed in the shaft and a 360m long drainage adit was constructed at the 34m level, relieving the engine of about one third of its load and effecting a great saving in fuel and wear and tear on the machinery. This work was completed by April 1888 and the engine restarted with a pumping capacity of 1000 gallons per minute. By June, the water in Victoria Shaft was removed and development work at the 60 fathom level recommenced. Unfortunately, difficulties in raising finance for development, due to the Broken Hill silver boom, led to closure of the mine in July 1889, leaving the engine shaft still 36m from the Main Reef.



Cross Sections of the Bird-in-Hand Mine. PIRSA Plan 1991-0700

The mine was reworked in 1891 under Captain Craze and dewatered in 18 days to allow an inspection. The Woodside Consolidated Syndicate purchased the mine in 1896. It was again dewatered and test crushings were carried out on reef material. Although no further mining was carried out, the old tailings dumps were cyanided in 1897. The Cornish engine was still in place in 1901 but presumably was removed for scrap sometime after.

General view of the Bird-in-Hand Mine, 1899. At left is the battery house with an overhead tramway leading to Old Main Shaft. At centre is a Cornish enginehouse containing a 50-inch pumping from Burra at Victoria Shaft. PIRSA Photo 033767

The mine was subsequently purchased by the Commonwealth Government for the nearby Woodside Army Barracks in 1927 and used as its water supply from 1933 (when it was re-opened by the Bird-in-Hand Gold Mines NL) until 1967. The old workings were dewatered with electric pumps, cleared, restored and the engine shaft deepened by 18m. The enginehouse was converted for use as switch room, engineers' quarters, change house and assay laboratory. The company wound up in July 1935, but the mine was worked by tributers until 1938. The enginehouse and chimney were demolished in the 1950s. The Bird-in-Hand Mine was the largest on the Woodside Goldfield, producing about 10,500.oz of gold from more than 22,000t of ore, principally between 1882 and 1886.

Other mines in the Bird-in-Hand Group
The northernmost mine was Two-in-the-Bush; then Bird-in-Hand, followed in order by Bird-in-Hand Extended, Ridge, Nest Egg, and Fountain Head. In total, about 200 men were employed.

The **Two-in-the Bush Mine** was discovered by McCracken in 1882 and plant including a 10 head battery was installed and a Main Shaft extended to 80m. Work was suspended in 1886 due to poor crushing results and a heavy inflow of water after producing 397oz from 2230t. The **Bird-in-Hand Extended Mine** was worked by five men in 1882 but was little more than a prospecting venture. The **Ridge Mine** commenced operations in May 1882 and installed the second-hand battery and plant from the nearby Bird-in-Hand Mine. A number of shafts were sunk on the reef the deepest being 64m and 2722t of ore treated by the battery yielded 517.oz of gold between 1882 and 1885. The **Nest Egg Mine** opened in 1882 when three shafts were commenced on a 1m wide quartz lode and pumping and hauling machinery were installed. The pumping gear was unable to control the water and the company was wound up in 1884. The **Fountain Head Mine** also operated from 1882 to 1884 when work ceased due to the lack of finance. All of these mines were taken up by the Bird-in-Hand Gold Mines NL between 1934 and 1935 and old workings cleaned out and extended in some cases but gold values were low. The area continued to be worked by tributers from shallow shafts up to 1938.

The Broken Hill Connection
The Bird-in-the-Hand management contained several names that were to become connected inseparably with the Broken Hill mining boom of the late 19th Century. S.R. Wilson was responsible for the erection of the first battery at the Bird-in-Hand Mine in 1882 and was also manager of the nearby Ridge Mine. Wilson, who was a brother of BHP director W.R. Wilson, replaced William Jamieson the first general manager of the BHP Mine in 1884. Under S.R. Wilson's management the enormous size of the Broken Hill orebody was established which resulted in the floating of three new companies – Block 10, Block 14 and British BHP in 1887 and 1888.
He resigned in 1887 to become manager of the Bloc 14 and British mines and was replaced by W.H. Patton. John Warren, manager of the Bird-in-Hand Mine from 1886-1888, was manager of the Block 10 Mine from 1890-1902 and was recognised as one of the great Broken Hill captains.

Geology and Workings
Gold mineralisation occurs within quartz-sulphide reefs in weathered Precambrian metasediments. The Bird-in-Hand line of reefs extends for northwards for about 4km with the Bird-in-Hand Mine located at the centre. The Main Reef dips at about 45º to the east and was worked from a vertical Main Shaft with drives to the orebody at six levels.

Recent Exploration
Between 2005 and 2008, Maximus Resources Ltd drilled a series of holes to intersect the Bird-in-Hand reef down dip from the original workings. This established a total resource of 237,000 oz (598,000t @ 12.3g/t indicated and inferred) at depth between 100m and 430m below the surface. The local community expressed concerns over possible development of a mine, particularly the lowering of the local water table which is about 30m below the surface compared with a potential mine depth of 500m. A mineral claim was subsequently registered in August 2008 on the condition that pump tests, aquifer recharge tests and feasibility studies be carried out prior to a mineral lease application. No application for a mining lease had been made to September 2011. The company is now focussed on other nearby old gold mines to develop a target of 800,000 to 1.1Mt @ 15-20g/t gold.

TOURS

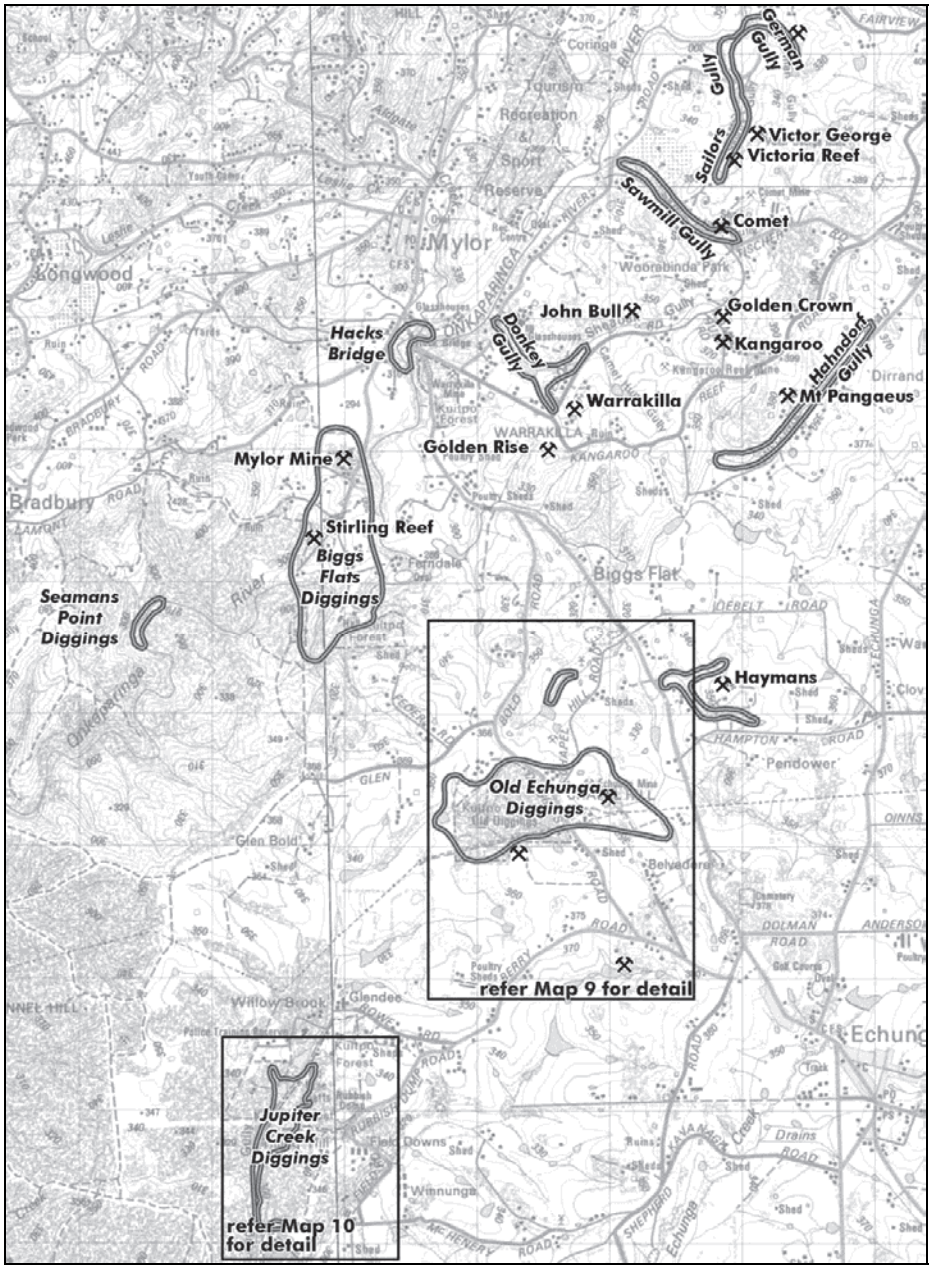
TOUR A: JUPITER CREEK DIGGINGS

Wednesday Sept 14, 1.00- 3.20 pm Guide: Greg Drew
Thursday Sept 15, 8.30-10.50 am

Echunga Goldfield

Echunga was the first proclaimed goldfield in South Australia, in 1852. It was the state's most important goldfield, with an estimated production of several hundred thousand ounces. The field stretches south-westerly for 15km from Hahndorf to Mount Bold Reservoir and consists of two principal areas: the Old Echunga Diggings (or Chapel Hill Diggings) and Jupiter Creek Diggings. These sites are listed on the Register of State Heritage Items and are two of the most important fossicking areas in the state.

An interesting historical note about the Echunga Goldfield concerns McTaggart's land which was opened as an alluvial goldfield in 1893 with 146 mining licences being issued on the opening day. The first results proved poor but richer areas were later found and a number of reefs were worked on a small scale, the most successful being the Boulder claim held by Messrs' DeRose, Pearce and Brookman. This trio later discovered the Great Boulder Mine in Western Australia.



Echunga Goldfield. PIRSA Plan 201070-009

Jupiter Creek Diggings

In 1868, Thomas Plane and Henry Sanders discovered alluvial gold near Jupiter Creek and subsequently received rewards from the Government. The Jupiter Creek Diggings produced between 25,000 and 30,000 oz of gold with mining and prospecting taking place during four main periods:

1868-1871

News of the initial discovery led to a rush involving 1200 people at its peak and a township was established including general stores and hotel. Up to 200 tents and crude huts were scattered throughout the diggings. The richest areas were Whites Gully, Fosters Gully, Golden Point and Surface Point and several small nuggets were reported, the largest weighing 12 oz. However, the area was a *poor man's diggings* by comparison to the Victorian fields, with no fortunes being made. By the end of 1868, the population had dwindled to several hundred persons and when the alluvium had been largely worked over by mid-1869, reef mining became the great hope for the continued prosperity of the field. Although prospects were discovered and small companies, such as the Beatrice, were formed to exploit them, all had gone into liquidation by 1871 without producing a significant amount of gold. A small number of alluvial prospectors stayed on the field but company operations ceased.

1884-1890s

In 1884, several small nuggets were discovered on the dump of an abandoned shaft, sparking renewed interest in reef prospecting at Jupiter Creek. The Crystal, South Crystal, and Phoenix mines were established but never yielded gold in payable quantities. The Crystal Mine operated for nearly 11 years and produced 1500 oz of gold.

1904-1907

An attempt to treat the alluvial deposits in bulk, by large scale hydraulic sluicing was unsuccessful owing to the low grade of the material.

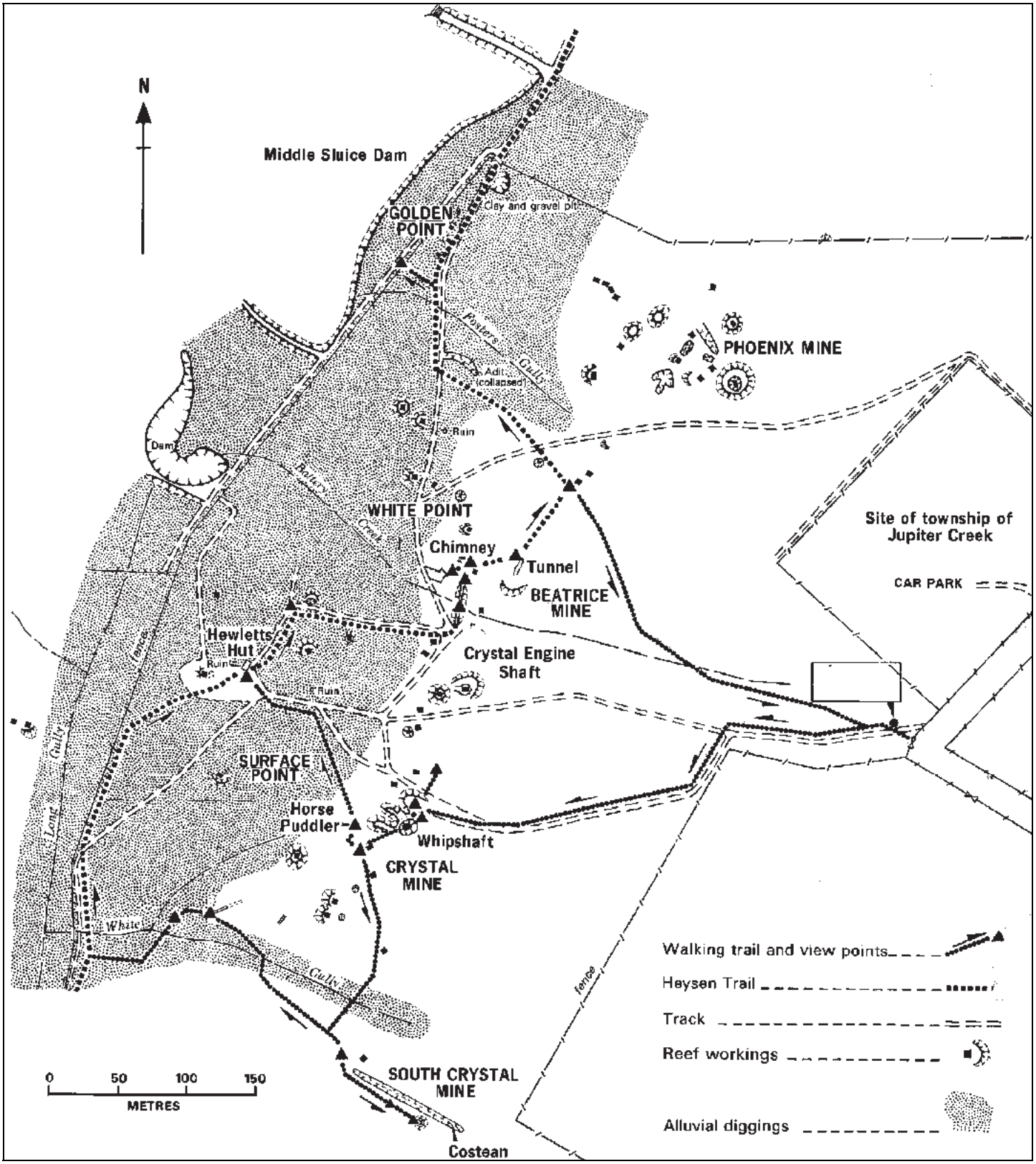
1930s

Widespread unemployment during the depression years and a change in the gold standard leading to a rise in the price of gold caused interest in old diggings, and prospectors at Jupiter Creek recovered a small amount of gold.

Geology

Freshwater sand, gravel and ironstone conglomerate of Tertiary age cover the elevated areas and unconformably overlie weathered slate and quartzite of Precambrian age. Gold occurs principally as alluvial deposits in leads of Tertiary age and in modem alluvium. The depth of the Tertiary deposits varies from less than a metre at Jupiter Creek to over 15m at Chapel Hill. The sources of alluvial gold were numerous thin quartz-ironstone veins on adjacent hillsides, but these rarely proved to be economic propositions.

Gold prospectors on the Forest Range Goldfield, Adelaide Hills, c.1887. PIRSA Photo 032957



Jupiter Creek Diggings. PIRSA Plan 1984-0121

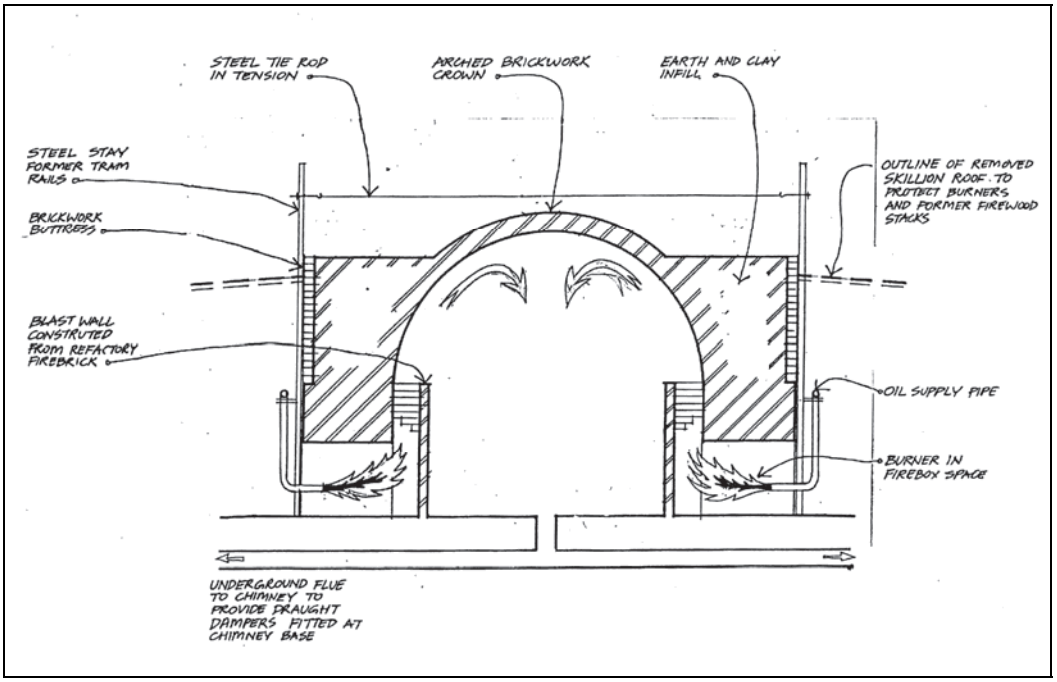
TOUR B: LITTLEHAMPTON BRICKWORKS

Wednesday Sept 14, 1.00- 3.20 pm Guides: Littlehampton Brick Company
Thursday Sept 15, 8.30-10.50 am

In the mid-1900s, up to 30 small brickworks operated throughout country South Australia, mainly in the Mount Lofty Ranges including eight in the Adelaide Hills. The first was J.S. Watts Brickworks near Nairne which began producing firebricks in 1863 to satisfy the demand of mining and smelting companies at Kanmantoo and Callington and closed in 1985. Brickmaking began at Littlehampton in the 1880s after the construction of the Adelaide Hills railway using excellent deposits of brick clay. These brickworks were at their peak in the early 1900s when up to 100 men were employed. By the 1960s, only the Littlehampton Brickworks remained due to competition from metropolitan brickworks.

A syndicate of brickmakers formed the Littlehampton Brick Company Ltd works in 1910 and opened a new works in 1912. As there was little demand for house bricks due to the distance from the metropolitan area, the Littlehampton brickworks produced mainly fire bricks for smelting works and foundries, bakers' ovens, locomotives etc. and vitrified pavers for stables and pavements. The bricks were made by semi-dry process using weathered shale from a quarry 300m to the east. The shale was drilled and blasted, shovelled into side-tipping trucks and hand-pushed down an incline to the plant. It was crushed to a powder, and mixed with the minimum of water to make it workable before being subjected to great pressure in a mould, which turned it out as a finished brick. The process was extremely efficient because the bricks were so dry they could be taken immediately to the kilns without requiring any drying time. About 250-300t of raw material were required per week. Motor trucks were introduced in the 1950s.

By the 1950s, the plant consisted of pans and rolls for grinding the shale which was then fed to large presses which produced the dry bricks ready for firing in five down-draught kilns with a total capacity of 3.65 million bricks annually. All products were manually handled throughout the plant until the late 1950s. Two of the original kilns survive. Today the modern kiln can fire 90,000 bricks in just two days burning time, allowing more than six million bricks and pavers to be produced per year for the local and overseas markets.



Down-draught Kiln

The most impressive surviving relics are two of the kilns and their smokestacks. The kilns consist of a rectangular shape with a domed roof and slotted floor leading to flues below. Green bricks were stacked in the kiln until full and the hatchways sealed with bricks. Fires were lit in fireboxes along the side and hot gases passed up to the curved roof, down through the bricks and then via underground flues to the adjacent chimney. Temperatures in excess of 1000º C were required to achieve a durable clay brick. When the desired temperature was reached, fires were allowed to die, the kiln cooled down and fired bricks were removed. Initially firewood was burnt but in the 1950s they were converted to gas and remained in service until the 1980s when replaced by continuous tunnel kilns.

TOUR C: BRUKUNGA MINE AND TREATMENT PLANT

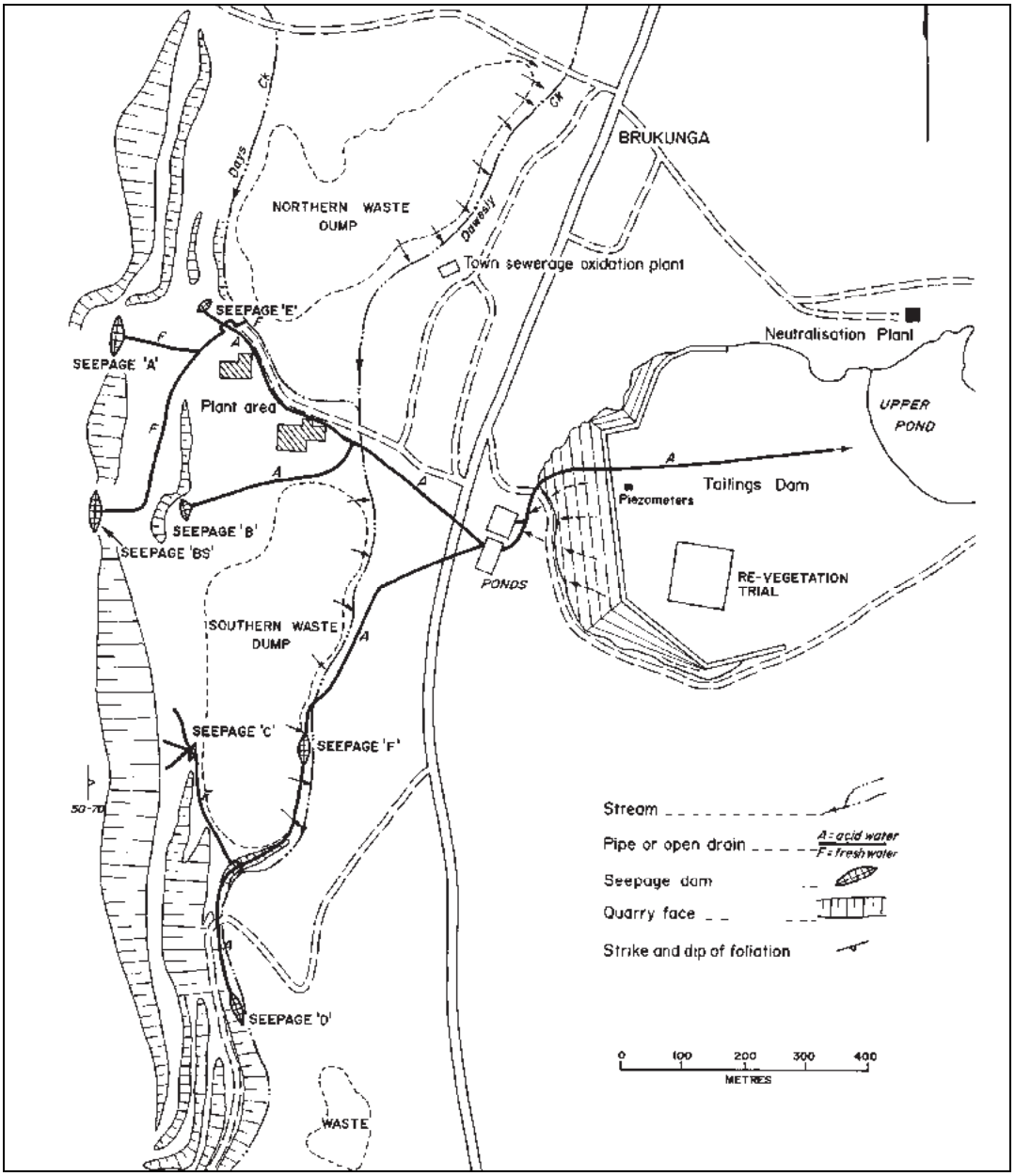
Friday Sept 16, 1.30-5.00 pm Guide: Ross Stevens, PIRSA

The development of Brukunga Mine was encouraged and sponsored by both the State and Federal Governments as part of the drive for self-sufficiency and full employment. The State Government fostered the formation of the company, Naime Pyrites Pty Ltd, a consortium of three fertiliser manufacturers and a mine operator: Cresco Fertilisers; Adelaide Chemical Company; Wallaroo-Mt Lyell Fertilisers; and BHP.

The mine commenced production in 1955 and continued for 17 years until 1972 when the Government withdrew the pyrite subsidy. The mine produced 5.5Mt of iron sulphide ore at 380,000t annually. The ore which averaged 11% sulphur, was crushed and concentrated onsite to 40% sulphur. The ore is a mix of two iron-sulphide minerals, these being pyrite and pyrrhotite. It was quarried from the side of two steep hills using a power shovel and trucks. The ore was concentrated by crushing and grinding to fine sand and the tailings were pumped to fill an adjacent shallow farm valley. The mine concentrate was trucked to a rail siding at Naime and then railed to Port Adelaide where it was converted to sulphuric acid. Imported phosphate rock was treated with the acid to produce superphosphate fertiliser to sustain the rapid expansion in agriculture.

Environmental Concerns

At closure the quarry bench was 1.8km long with two high walls 70 m and 85 m. Approximately 8Mt of overburden containing 2% sulphur had been excavated and discarded into two large rock-dumps and 3.5Mt of sand tailings containing 1.7% sulphur had been pumped to the adjacent valley.



Brukunga Mine and Treatment Plant. PIRSA Plan S12408

The main environmental concern at Brukunga is caused by the natural oxidation of the iron minerals pyrite and pyrrhotite in air and water to form sulphuric acid drainage. The small amount of pyrite still remaining in the waste rock dumps and the tailings dam causes acid drainage to seep out at base of the dumps. The acid waters also dissolve small amounts of other metals from the minerals and the resultant seepage contaminates the flow in Dawesley Creek as the creek passes through the mine site. This results in acid metalliferous drainage from the site.

In August 1977, the State Government accepted responsibility for rehabilitation of Brukunga and the present rehabilitation strategy consists of:

- a treatment plant to collect and neutralise the acid drainage water
- a water monitoring program to identify the acid generation processes and their rate of change with respect to flow conditions at key sites within the area
- diversion of uncontaminated water directly into Dawesley Creek
- rehabilitation and revegetation of mine cuts, waste dumps and tailings dam.

The lime neutralisation plant commenced in 1980 and within five years of treatment the 10ha lake of acid water was removed from the tailings dam. The source of contaminated feed for the plant is made up of the seepage percolating through the tailings dam and from seepage collected by 12 float-activated pumps spread about the Mine site. Acid water is collected from the quarry bench, the waste rock dumps, and post-2003 from the section of creek bed isolated by the diversion drain. The collected water is held in two ponds located at the base of the tailings dam and pumped to the plant.

Despite all the work done from 1980 to 2003 to intercept and treat acid drainage only about half the contaminated water from the site was captured and treated, the remaining escaped to Dawesley Creek. On completion of a diversion drain in June 2003, it became possible to intercept 90-95% of the contaminated water, with most of the loss occurring during high rainfall events, when there is greatest dilution helping to produce lower concentrations in the stream.

The Lime Treatment Plant

The inputs to the plant are hydrated lime, at pH 12, dilute sulphuric acid at pH 2.3 and oxygen provided by air blowers to ensure the chemical reactions are complete before the mix leaves the plant. The outputs are gypsum precipitate and water, which are physically separated in the thickener. The precipitate sinks to the bottom and is drawn from underneath by variable speed hose-pumps. The water overflows into the trough around the top of the tank. The overflow water is clarified in a large concrete lined pond, providing time for residual particles to settle before the water is returned to the creek via an open channel. The process of lime neutralisation occurs in a series of three mixing tanks providing retention time for completion of the chemical reactions. In May 2005, a second parallel series of three larger tanks were installed to effectively double the treatment capacity of the plant. Grasses and native trees have been progressively established since 1988 in the thin layer of imported soil used to cover the once barren sand-tailings dam.

A whole of site remediation strategy is currently being developed to reassess the proposed third stage of the program. The South Australian Government's overall remediation objectives for Brukunga include substantially limiting or avoiding the need to intercept and treat acid waters indefinitely; returning all or part of the site back to productive use(s) or for environmental / ecosystem values; and applying leading practice to site management and remediation options. Current projects include:

- A geochemical and geotechnical investigation into the waste rock dumps, tailings and natural borrow material to determine if there is suitable material on site that may be used as a cover material in any of the proposed remediation options.
- Waste rock dump trials, involving seven 1000t shaped waste rock piles receiving various treatments and irrigated to simulate rainfall to develop long-term management strategies for the waste rock and water.

TOUR D: CALLINGTON AND BREMER MINE

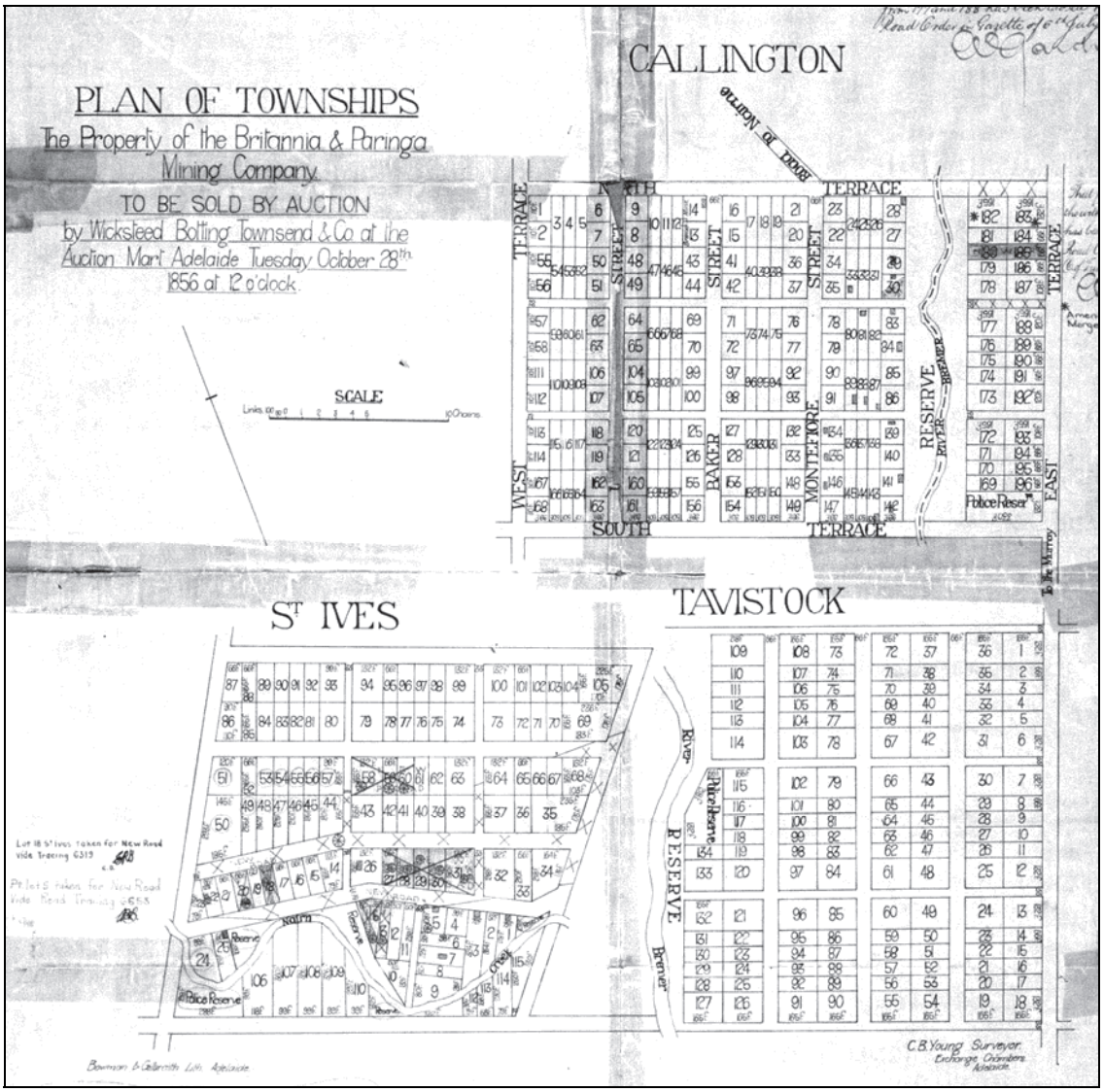
Saturday Sept 17, 8.15-11.30 am Guides: Greg Drew and Harry Seager

Callington

In late 1848, copper ore was discovered near the Bremer River in rock broken by the wheels of a dray. The land belonged to the Paringa Mining Company which mined the rich, shallow oxidised cap of the lode but then sold the land containing the mine to the Bremer Mining Company in 1849. The Paringa company, anticipating an increase in the mining population laid out the village of Callington adjacent to the Bremer Mine near where the new road from Adelaide crossed the Bremer River. It consisted of 196 allotments and a Police Reserve on either side of the river and was named after the famous Cornish town. Other mining villages surveyed in the district at this time were St Ives, Tavistock and Kanmantoo. The first settlers were predominantly Cornish miners who built small cottages of stone with shingle roofs, many of which survive making Callington a well preserved mid-19th century mining township.

Although surveyed, the town was not officially named for some time and birth certificates listed the location as Bremer. The first hotel, the Callington Inn opened for business in 1851 when Thomas Lean was granted his publican's licence. Very little work was done at the mine apart from some tributing and even that came to an end when the miners left for the Victorian goldfields. In 1856, the Paringa company (which had been reformed as the Britannia and Paringa Mining Company) auctioned off the unsold blocks in Callington and sold the Bremer Mine to the Worthing Mining Company

Callington's population reached a peak of 600 in the 1860s when the mine employed up to 140 men and the town had six stores, a bank and by 1867, a daily coach service to Adelaide. During this period there were three churches; Primitive Methodist (1851), Wesleyan Methodist (1852) and Lutheran (1864).



Townships of Callington, St. Ives and Tavistock, 1856. PIRSA Photo 036034

Callington Police Station
In 1865, the community petitioned the government for a police station to be erected at Callington as the township was subjected to thieving mainly of a petty nature, and there was no police station within 12 miles. A mounted police trooper was temporarily placed at Callington in 1866 and the police station erected in late 1867. It was identical to one built at Truro just north of the Barossa Valley. It consists of an office and residence with three cells and stables across a courtyard at the rear. The station was busiest during the mining period when offences ranged from drunkenness to armed robbery. It closed in 1889 when it had become a one man operation.

Bremer Mine

A copper lode was discovered near the Bremer River in 1848 and, by 1850, the mine was leased to the Bremer Mining Company. The mining township of Callington was surveyed around the mine for the expected increase in the mining population. Lack of capital prevented the installation of dewatering equipment and mining was restricted to several shafts sunk to the water table. About 450t of high grade ore were produced up to 1852 when work ceased due to the Victorian gold rush.

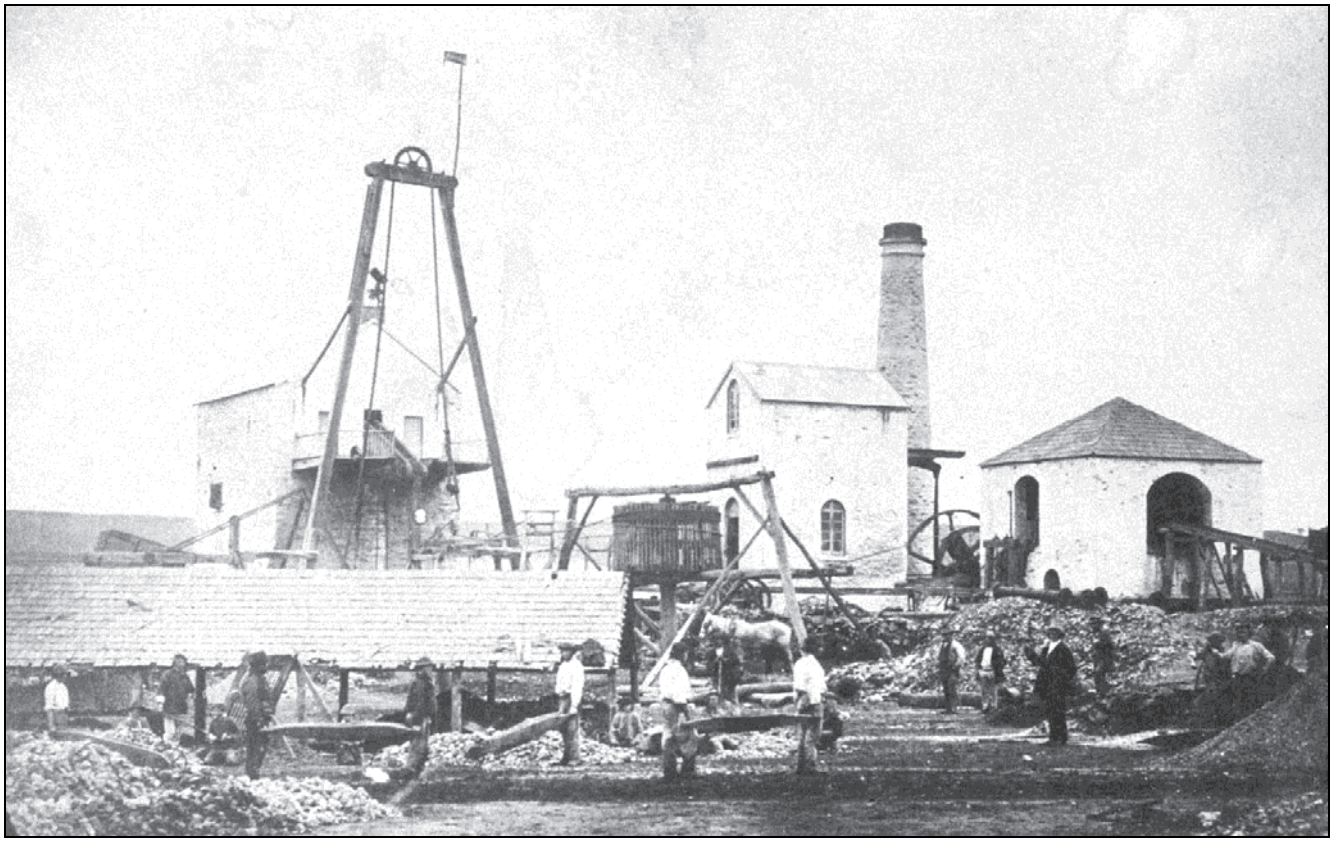
In 1856, the mine was sold to the Worthing Mining Company which transferred operations from the Worthing Mine near Hallett Cove. A 14-inch horizontal engine was installed in 1857 at Lean Shaft to enable mining operations to proceed below the water table. However, the engine was unable to cope with the water and a 60-inch Cornish pumping engine was erected at Leggs Shaft in 1859. This enabled the mine to be developed to the 103 fathom level over the next ten years.

Smelting works, consisting of two calcining and two reducing furnaces, were erected at the mine in 1859, and in the following year a 22-inch beam rotative engine was transferred to the Bremer Mine from the Worthing Mine (20km south of Adelaide) and used for hauling and to power crushing and ore-dressing machinery. Dressing machinery consisted of a stonebreaker, crushing rolls, self-acting plunger jiggers and a Bryans Rake buddle. The ore was hand-picked and the high grade crushed and sent direct to the nearby smelters and the low grade dressed to 15-50%. To overcome the problem in refining the ore caused by the presence of bismuth, the Scotts Creek Smelting Works at Dawesley was purchased in 1864 and used for refining the copper regulus from the Bremer smelter.

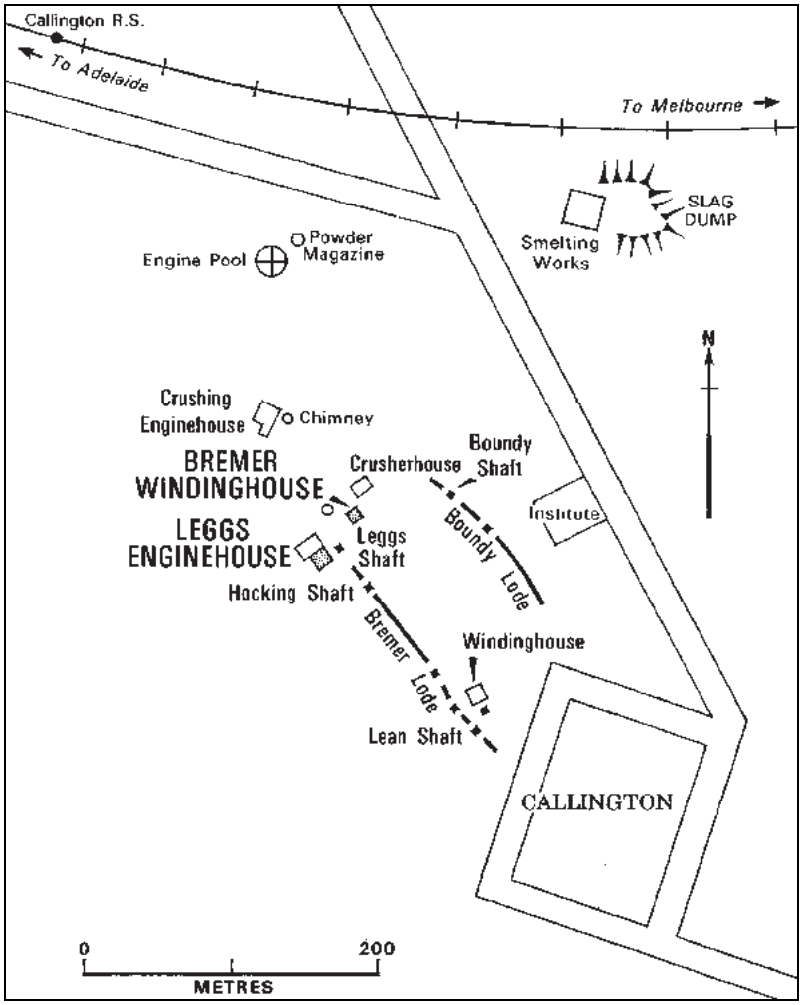
The mine reached a peak in 1866, when 140 men and boys were employed and about 350t of ore per month were produced. During this period the manager, Alfred Hallett, ran the mine with such efficiency that it was referred to as the *model mine of South Australia*. However, the company suspended operations in July 1870, due to the increased mining costs and falling copper prices, without a dividend having been paid.

The Bremer Mining Company reopened the mine in March 1872, under Captain Thomas Prisk, and after taking seven months to dewater the mine, operations consisted of extracting ore left by the previous company, mainly on the 93 and 103 fathom levels. New machinery powered by a 22-inch horizontal engine was erected in 1874 for crushing and concentrating the ore and a Hancock jig was added in 1872. The mine closed in 1875 after the known ore reserves had been removed. Total production of the Bremer Mine was about 35,000t of hand-picked copper ore averaging 8 to 10% copper.

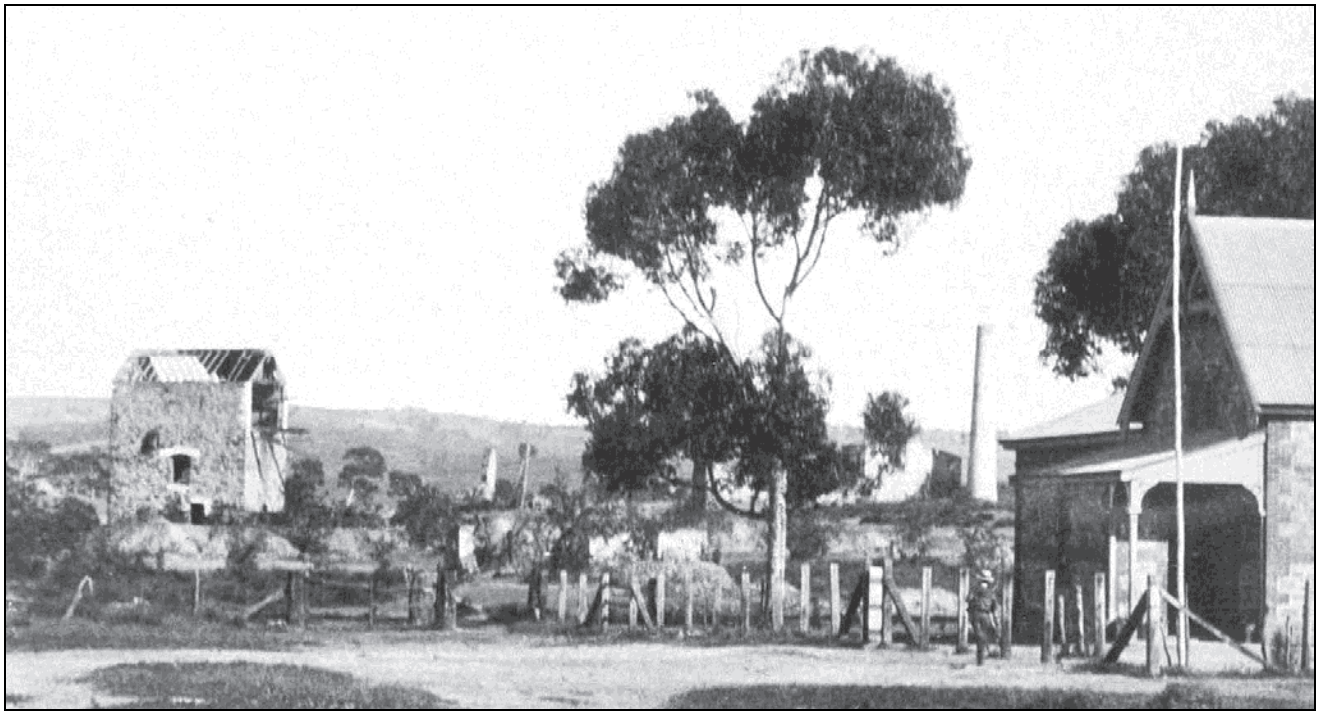
In 1907, the Callington Mining Company attempted to reopen the mine but the new pumping equipment failed to lower the water below 21m and the mine was abandoned in the same year. During the early 1970s, the tailings dumps which remained from the dressing operations were treated by leaching and precipitation. Exploration was also conducted and included four diamond drill holes totalling 1300m which detected two mineralised pipe-like shoots. One drill hole intersected 23m at 1.1% copper below the Bremer Lode and the other intersected 53m at 0.24% copper below the Boundy Lode. This indicated a resource of 600,000t of ore at 1.1% copper below 240m. The site is listed on the Register of State Heritage Items.



Bremer Mine, c.1863. Leggs engine house at left housed a 60-inch engine erected in 1859. The building to the left of the chimney housed the 22-inch engine transferred from the Worthing Mine in 1860. Note the pickey boys seated at the rear of the ore floor, in front of the shingle roofed structure. PIRSA photo 033235



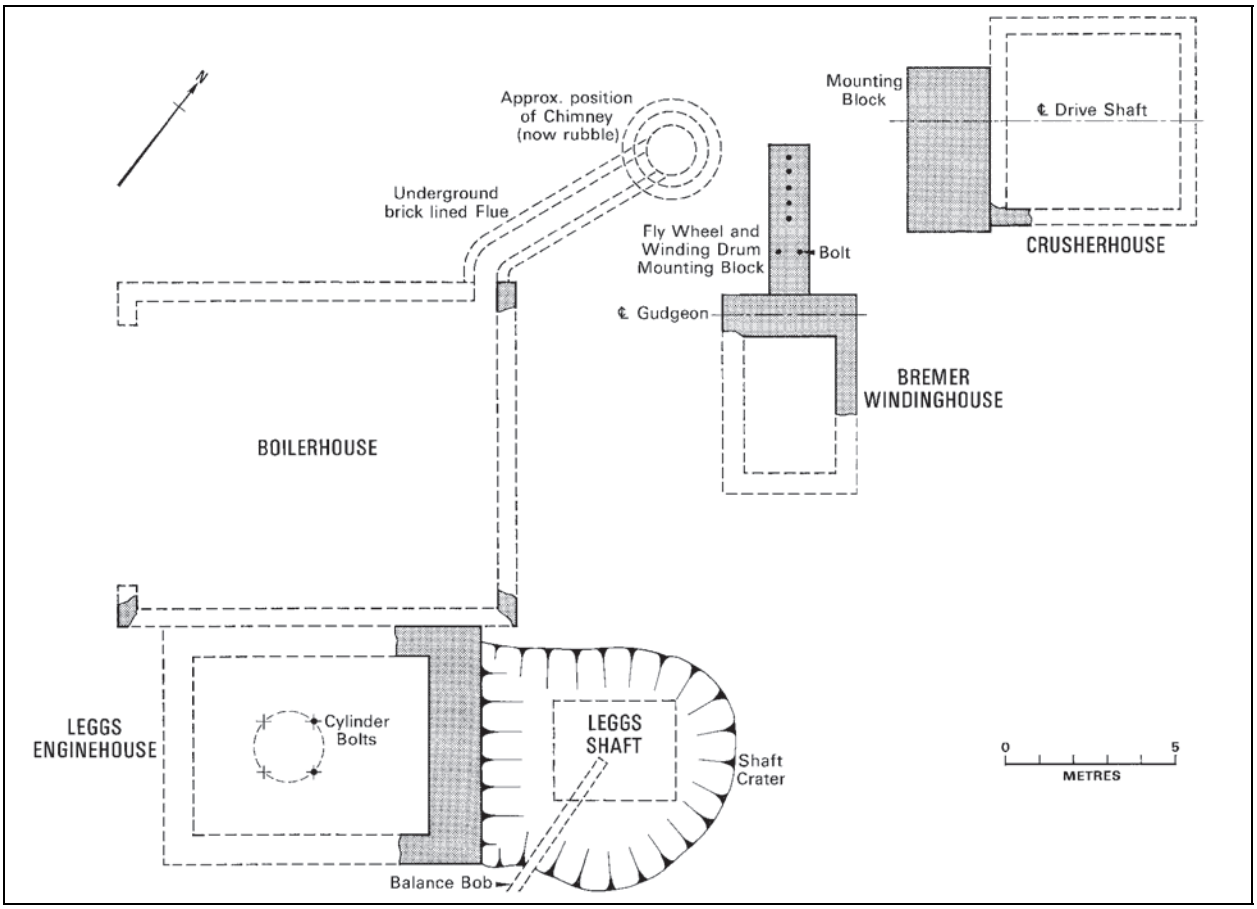
Bremer Mine surface plan, c.1875. PIRSA plan 1991-0691.



Bremer Mine, c.1910. At left are the ruins of the pumping enginehouse with the Callington School at right. PIRSA Photo 040122

Geology and Workings

The mine area lies in a NE trending belt of Kanmantoo Group schists. Two major copper lodes were worked: the Bremer and Boundy lodes. The Bremer Lode was 30-75cm wide, 110m long at the surface and dipped 70º west. A further ore shoot was found at the 53 fathom level north of the outcropping ore-and persisted to the 103 fathom level. The Boundy Lode 100m to the east, was explored by drives from cross cuts from the main workings but was too low in grade for profitable mining. Oxides and carbonates were exploited to the 23 fathom level below which sulphides were encountered in a quartz-calcite lode.



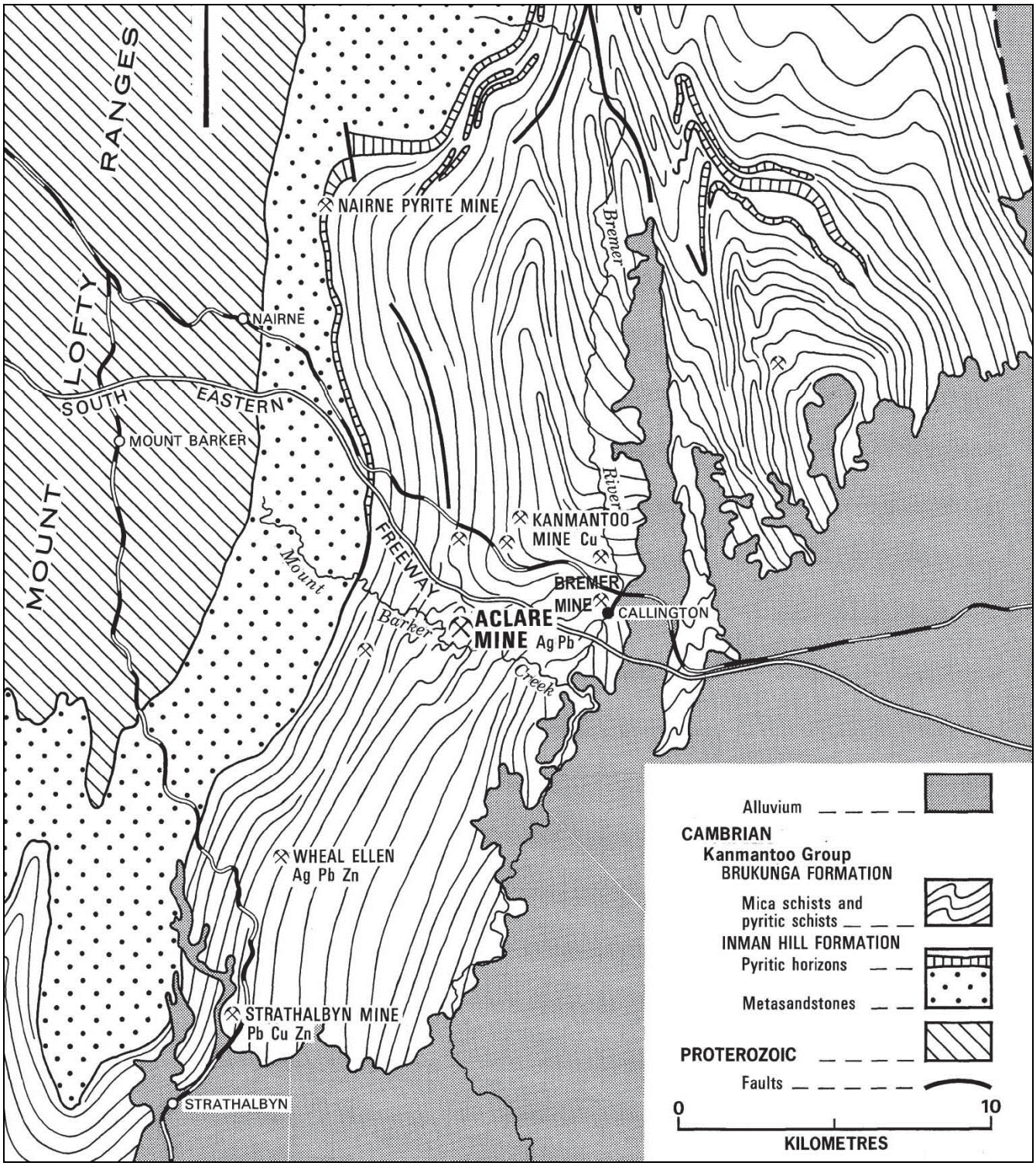
Layout of the Cornish pumping enginehouse and windinghouse, Bremer Mine PIRSA Plan 1991-0693

PRE-CONFERENCE TOURS

TOUR 1: KANMANTOO-STRATHALBYN MINING DISTRICT

Monday Sept 12, 8.15-5.30 pm Guides: Greg Drew and Ross Both
Monday Sept 19, 8.15-5.30 pm Guide: Greg Drew

The Kanmantoo-Strathalbyn Mineral Field is located on the eastern flank of the Mount Lofty Ranges, approximately 50 km south-east of Adelaide. The deposits are hosted by rocks of the Kanmantoo Group, a sequence of metamorphosed sedimentary rocks of Cambrian age.

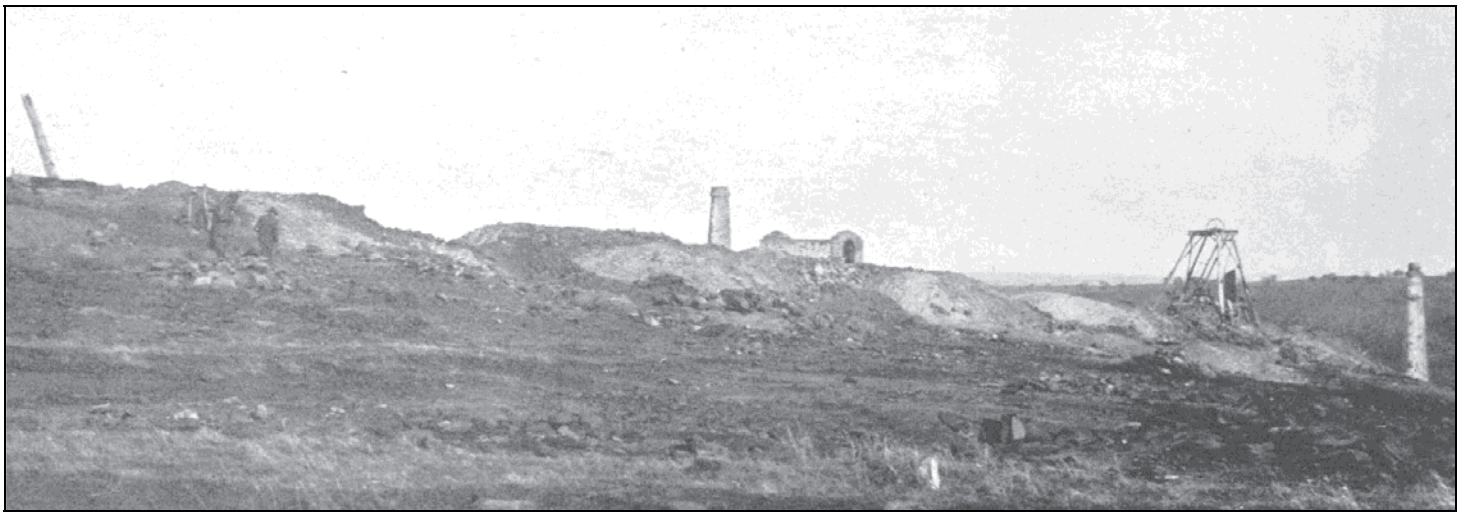


Geology of the Kanmantoo-Strathalbyn Mineral Field. PIRSA Plan 1981-0947

Wheal Ellen

Details of early operations at Wheal Ellen are sketchy; the mine apparently began under private ownership in early 1857, with a workforce of about one hundred men and produced 1500t of rich silver-lead ore in the first year of operation. By 1860, Cornish ore dressing machinery had been erected under the supervision of Captain Paynter and the mine had produced 2000t of carbonate ore and 2000t of sulphide ore. A blast furnace had also been erected. H.R. Hancock was engaged by the mine owners in 1859 and was responsible for mine management from 1861-1862. He later became famous as the manager of the Moonta Mine.

In 1861, the Wheal Ellen (South Australia) Mining Company Ltd. was formed in England and purchased the mine. The company erected a small horizontal steam engine for dewatering the mine and a calcining furnace and chimney. About 100 were employed during this period. By the end of 1862, the new furnace had been completed and the blast furnace rebuilt. However, the costs involved exceeded the income from production and the company was wound up in 1865. Production data are incomplete but, on the basis of available information, it is unlikely that more than about 8000t of silver-lead ore were produced at an overall grade of about 25% lead and about 20 oz/t silver. Gold was also recovered from both the sulphide ore and the gossan.



Wheal Ellen looking southeast, 1908. At the centre are the ruins of the pumping enginehouse and the tall chimney marks the site of the blast furnace. PIRSA Photo 034143

The Wheal Ellen Mining Co, formed in Adelaide in 1888, mined 40t of gold-bearing gossan before the mine was again closed in 1889. The property was acquired by the Commonwealth Silver-Lead Company Ltd. of Sydney in 1908 and worked until 1911. About 5000t of pyrite were mined for sulphuric acid production and a five-head stamp battery was erected and 404 oz of gold recovered from gossan and pyritic ore.

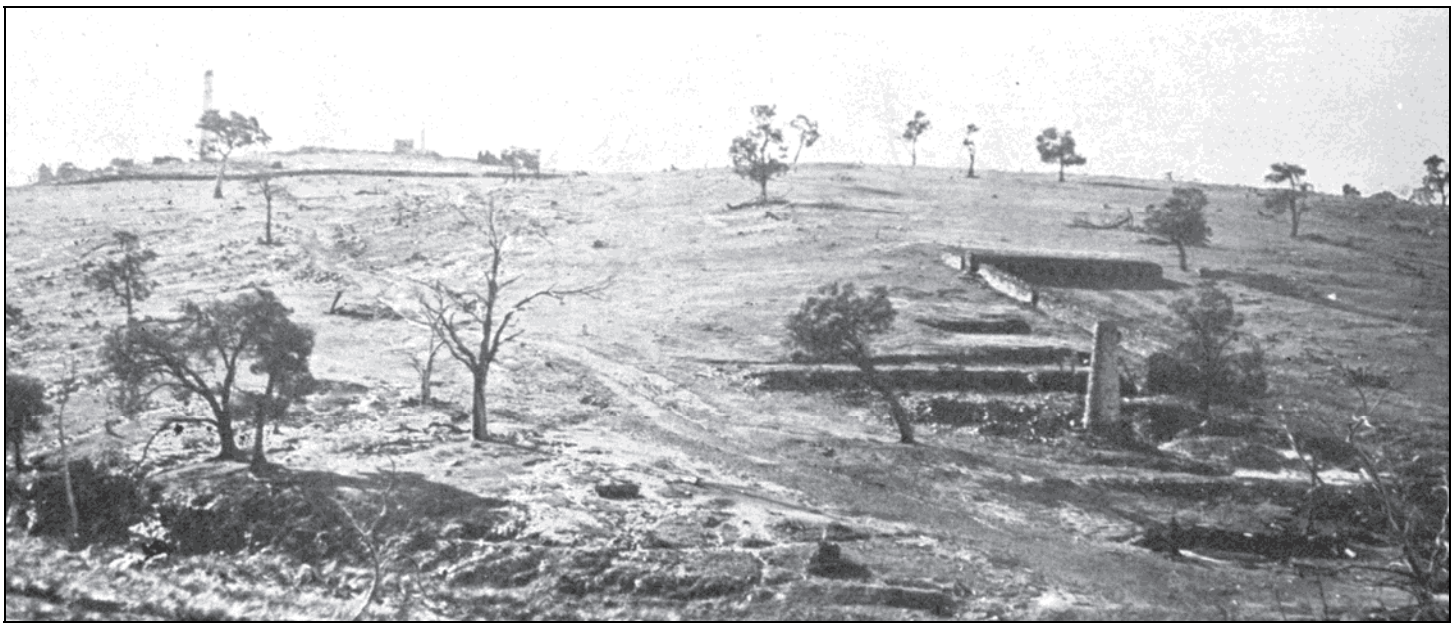
Geology and Workings

The Wheal Ellen orebody was an interbedded, tabular deposit 0.3-4.3m thick within micaceous sandstone which dips steeply to the east. The sulphide orebody consisted principally of pyrite, galena and sphalerite which was oxidised to a depth of 36m. The orebody was worked by five shafts over a length of about 230m and to a depth of 110m at the southern end. Recent exploration drilling has demonstrated the continuity of high grade poly-metallic mineralization with significant intersections up to 150m below the surface. It is shaping up as a resource that could support a third mine development in the area, following on from the Angas Mine and Kanmantoo Mine developments.

Ore Dressing

Cornish ore dressing machinery was erected about 700m south of the mine workings near a creek which would have supplied water required by the plant for most of the year. The machinery included Cornish stamps, buddles and probably mechanical jiggers. The chimney and foundations of the ore dressing plant and the boiler and engine which drove the machinery, as well as coarse tailings, survive on the bank above the creek. Higher still are the remains of the calcining furnace and a slag dump. Dressed sulphide ore was fired in the calcining furnace to drive off sulphur and other volatiles (including arsenic) prior to smelting in the blast furnace which was located about 400m to the north just below the mine workings.

An above ground flue running from the calciner is largely intact and ends in a distinctive labyrinth. The labyrinth was built to collect arsenic which was a common by-product of silver-lead ores and its design is derived from the processes adopted in Cornwall to treat these ores. It consists of a labyrinth of chambers built of slabs of stone in a zig zag arrangement where arsenious oxide condensed as soot. The labyrinth demonstrates the application of Cornish mining technology in 19th century South Australia and is listed on the Register of State Heritage Items. It is almost certainly the only one of its kind in Australia.



Wheal Ellen ore dressing and calcining site, 1908. PIRSA Photo 034142

Angas Mine

The Angas zinc-lead-silver deposit which is seven km along strike from Wheal Ellen, was discovered in 1991 during an exploration program by Aberfoyle Resources Ltd. but was considered too small to be an economic mining proposition. Follow-up drilling by Terramin Australia Ltd. from 2004-2007 demonstrated probable ore reserves of 2.15Mt of ore grading 7.6% zinc, 2.9% lead, 0.2% copper, 31g/t silver and 0.5g/t gold, plus indicated and inferred resources of 0.53Mt grading 3.3% zinc, 1.6% lead, 0.1% copper, 20g/t silver, and 0.4g/t gold. Underground development commenced in July 2007 and ore production and first shipment of concentrates was achieved in July 2008. The ore is processed to produce a zinc concentrate and a lead-copper-gold-silver concentrate. The mine life is expected to be seven years, with ore production of 400,000t per year.

Economic mineralisation is contained within a garnetiferous host unit and extends approximately 700m along strike and 500m down dip. The width varies between less than 0.5m to 20m. Sphalerite, galena and chalcopyrite are associated with variable concentrations of pyrite and pyrrhotite. The ore occurs in three north-south oriented zones of mineralisation. The largest is Rankine with the smaller but higher grade Garwood along strike to the south. The orebody is shallow with the Rankine zone outcropping.

The Angas orebody is accessed through a portal at the bottom of a box-cut. A 5m by 5m decline provides access to the ore body, ramping down at 1:7 which will reach 2.8km from the portal. The orebody is mined using bench stoping with progressive fill. The rock is drilled and blasted from vertical stopes which are later backfilled for stability. The mine levels are 20 vertical metres apart and the current design depth is approximately 400m below surface. The majority of stope production is carried out using teleremote loading. Forty-tonne articulated dump trucks haul the ore to a surface stockpile ready for processing.

Aclare Mine

Silver-lead ore was discovered on St. Ives Farm by the operators of Wheal Ellen and the first ore produced in 1859 from what later became known as the Aclare Mine. Although Aclare was the largest of the silver-lead mines in the district, with an estimated production of 14, 584t of ore averaging 8.8% lead and 36 oz/t silver, it was a source of frustration to investors over a 40 year period. In addition to silver and lead, the ore had a high content of zinc and significant contents of arsenic, antimony and copper, all of which contributed to metallurgical difficulties in processing the ore.

The Wheal Ellen smelter was unable to cope with the complex Aclare ore and operations soon ceased. In the 1870s, the then landowner, Francis Singleton, employed a few miners to work the deposit on a small scale. Since the ore being mined at that stage was zinc-free lead carbonate it presented no difficulties in smelting and Singleton was able to make a small profit from the operation – the only time Aclare was to yield a profit.

Increasing metal prices in 1881 brought renewed enthusiasm and English capital to the South Australian mines, leading Singleton to float the Aclare Silver Mining Company N.L. in 1882. Mining work concentrated on developing adits to locate and extract the ore, but all were abandoned without achieving their aims. By 1883, the company was faced with serious difficulties: the price of silver had fallen as a consequence of increased exports of the metal from the USA, and the carbonate ore at Aclare was by then depleted, leaving the complex sulphide ore to be mined. The zinc content still presented problems in smelting the ore, making recovery of the silver and lead uneconomic. By 1884, the company was in financial difficulties, having spent most of its capital on the unproductive adits and being unable to sell the sulphide ore.

The spectacular success of the Broken Hill Mine led to renewed interest in abandoned silver-lead deposits in South Australia, including Aclare. A group of Adelaide investors formed the Aclare Silver-Lead Mining Syndicate in 1888 and purchased the mineral rights from Singleton. In the following year, the mineral rights were sold to an English company, the Kangarilla Proprietary Silver Mines of South Australia Ltd. The new company held high hopes for a smelting process developed by Haverman and Cunningham at Newcastle-on-Tyne for separating the silver and lead from the zinc but yet again this method was not able to economically treat the Aclare ore.

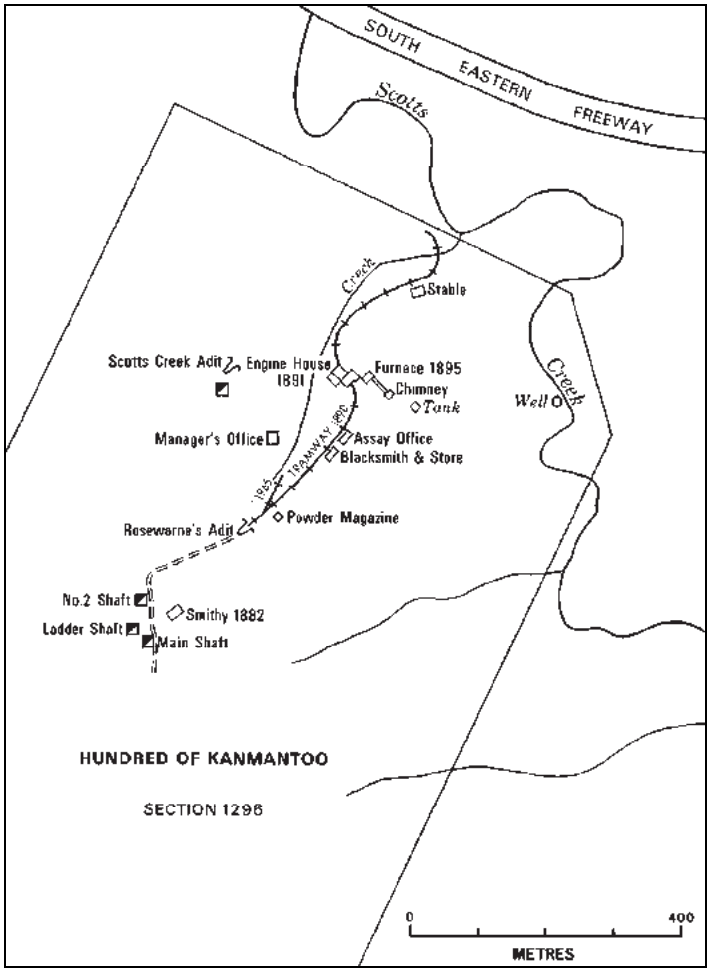
In 1891, D.D. Rosewarne, the former Inspector of Mines, was appointed to manage the company's business interests in Australia. He promptly set about investigating ore processing techniques and was impressed by the potential of the Molesworth calcining furnace developed at the South Australian School of Mines.
The Molesworth company agreed to build a furnace at their expense and Rosewarne had buildings erected for the concentrating plant and purchased equipment, including the French-made Castelnau concentrator, a 25hp horizontal steam engine, a 10hp beam engine and two large Cornish boilers. By late 1891, the prospects for Aclare at last looked promising, with a modern plant installed and the price of silver having risen, but the mood of optimism soon ended. The end of the year saw the Australian mining industry in a general depression due to falling metal prices, and operations at Aclare were brought to a standstill in February 1892 by a drought that deprived the mine of water for its operations. The company was also in serious financial difficulties because of overspending on the plant. Rosewarne resigned in March 1892 and the company was wound up in June.

A new company, the Kangarilla Silver Mines Ltd., was formed to take over the old company's property and assets and to meet all its debts and liabilities. A trial in Glasgow with a two ton batch of Aclare ore, using a new leaching process developed by the metallurgists French and Stewart, was successful in extracting the metals and the company was convinced they had finally found the answer to treating the ore. A new Board was formed and H.G. Thorpe, an industrial chemist from Glasgow, was appointed to go to Aclare as mine manager and set up the French-Stewart process.

The first trial of the new furnace in May 1895 was disappointing: it was found that the existing crushing plant did not crush the ore to the size required by the French-Stewart process, leading to poor silver recovery.
A new crushing plant was needed but the company had exhausted its capital and investors were not interested in providing further funds. The price of silver was still low and all interest was now in gold mining in Western Australia. The mine closed in 1896 and the company was wound up in 1899 and there has been no further mining at Aclare. The site is listed on the Register of State Heritage Items.

Geology

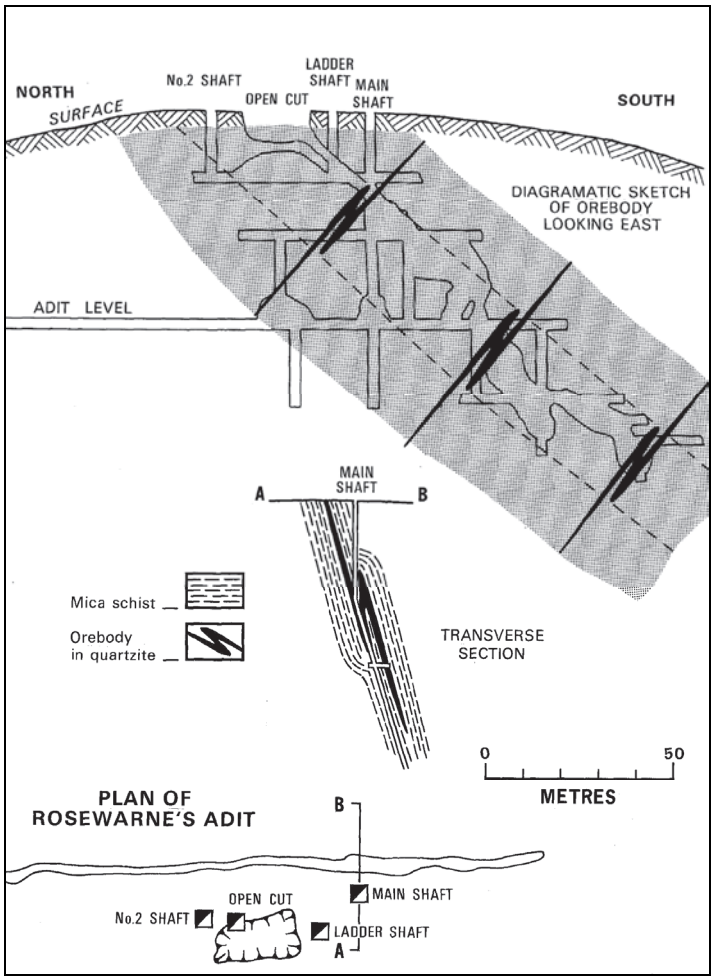
The mine area occurs in an area of Kanmantoo Group schists and quartzites. The orebody occurs in a 0.5- 4m thick quartzite which outcrops on the top of the hill over a length of 60m. The ore consists of an aggregate of numerous folded layers of sulphide-rich and sulphide-poor quartzite, the main sulphides being galena and sphalerite. The layering in the ore is considered to be sedimentary in origin. Later metamorphism has deformed and recrystallised the original sulphide-rich sands to their present form. The orebody is tabular, dips 60-70º east and plunges south at about 40º on the eastern limb of a southerly plunging anticline. The ore horizon has been drag folded and the mine stopes follow the plunge of the drag fold. From the surface to a depth of 9m oxidation produced a carbonate ore depleted in zinc but enriched in lead and silver (av. 50% Pb and 90 oz Ag/t). Below the level of oxidation in the sulphide zone the ore averaged 12% Zn, 7% Pb and 20 oz Ag/t.



Layout of the Aclare Mine, 1895. PIRSA Plan 1981-0831

Workings

The mine was first worked from a series of shafts at the top of the hill. The main shaft was sunk to a depth of 79m, the first 30m being vertical and the remainder down the dip of the orebody. Near this shaft rich carbonate ore was extracted from an open cut to a depth of about 9m. Driving and stoping from these shafts was carried out and high-grade ore was hauled by a horse whim. Later an adit was driven in a south-westerly direction from the northeast side of the hill above the level of the treatment plant for 250m to where the orebody was intersected and driven for about 80m. A considerable amount of work was carried out to a depth of about 35m below the adit level with ore hauled by windlass to adit level, loaded in trucks and pulled along the tramline to the treatment plant.



Aclare Mine section…. PIRSA Plan 1982-0015

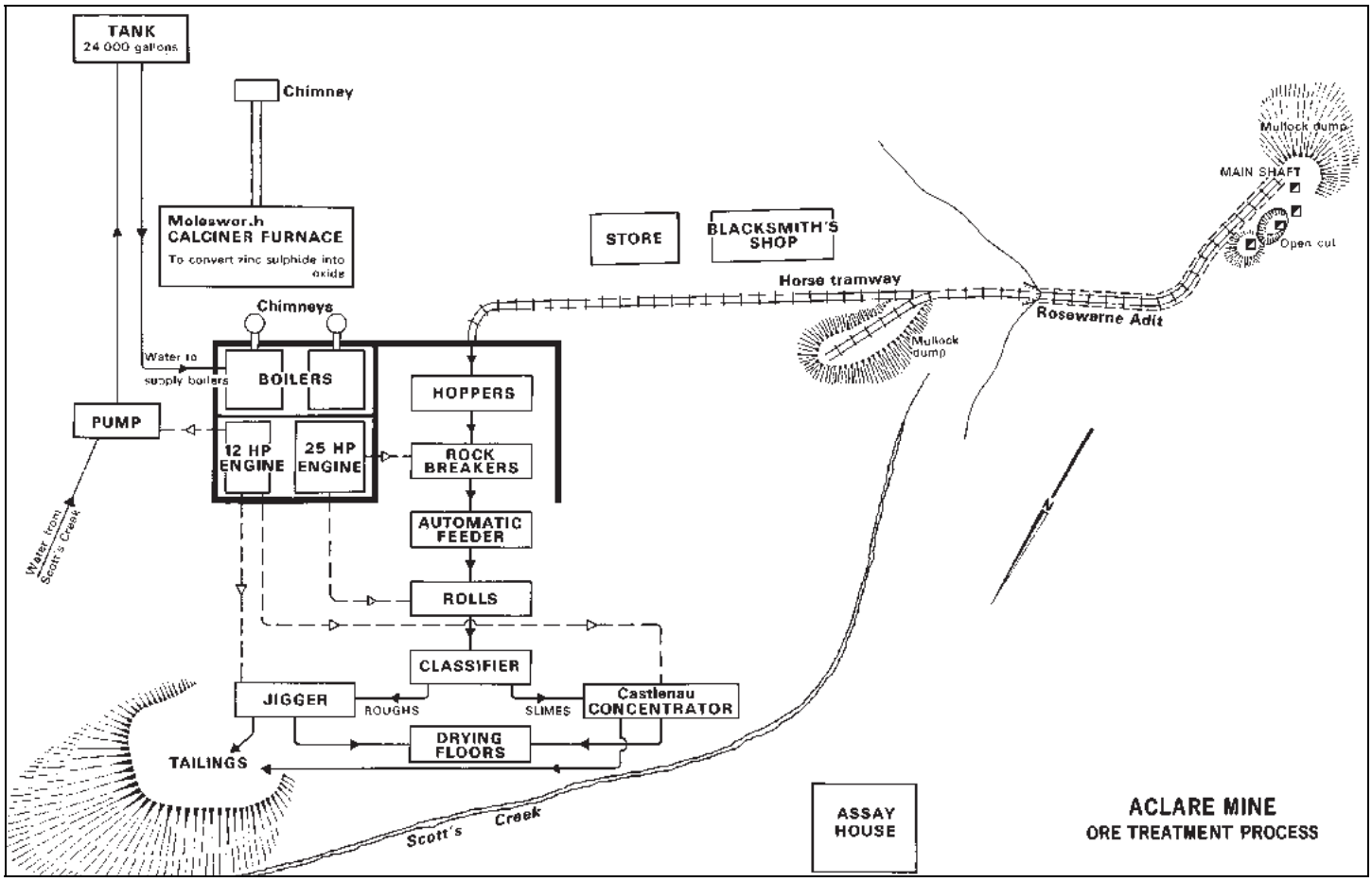
Ore Processing

Up to the early 1880s, the mine worked zinc free carbonate ore near the surface which was hand-picked at the surface, bagged and send to smelters at Port Adelaide where the lead and silver could be easily separated. Once sulphide ore was reached, zinc values increased but zinc could not be separated by smelting methods of the period.

In 1891, a new treatment plant was erected to treat the sulphide ore by initially crushing to separate grains of galena (lead sulphide) and sphalerite (zinc sulphide). The ore passed through a rock breaker and then Cornish rolls which crushed it to sand size. A classifier then separated the crushed ore into coarse sands (roughs) and finer slimes. The classifier was a settling tank with a sloping bottom and an agitation mechanism which allowed the roughs to settle to the bottom.

The roughs then passed to a jigger which was a box with a perforated bottom. The shaking action of the jigger caused the heaviest material in the mixture to sink to the bottom and pass through the perforations forming a concentrate. The overflow was run to the tailings dumps. Slimes from the classifier were fed to Castelnau Concentrator which consisted of an endless rubber belt about 8m long, 1.5m wide with a side slope, and distributed by water. Separation was apparently achieved by the speed of the belt, force of the jets and differences in specific gravity of the minerals.

In 1895, a brick furnace was erected to trial the French-Stewart leaching process. Finely crushed ore mixed with a flux was furnaced at red heat for 30 minutes with no stirring. It was then removed, allowed to cool and placed in a leaching vessel where lead, silver and zinc would be leached out and precipitated.



Aclare Mine ore treatment process, *c*.1895. PIRSA Plan 1980-0557

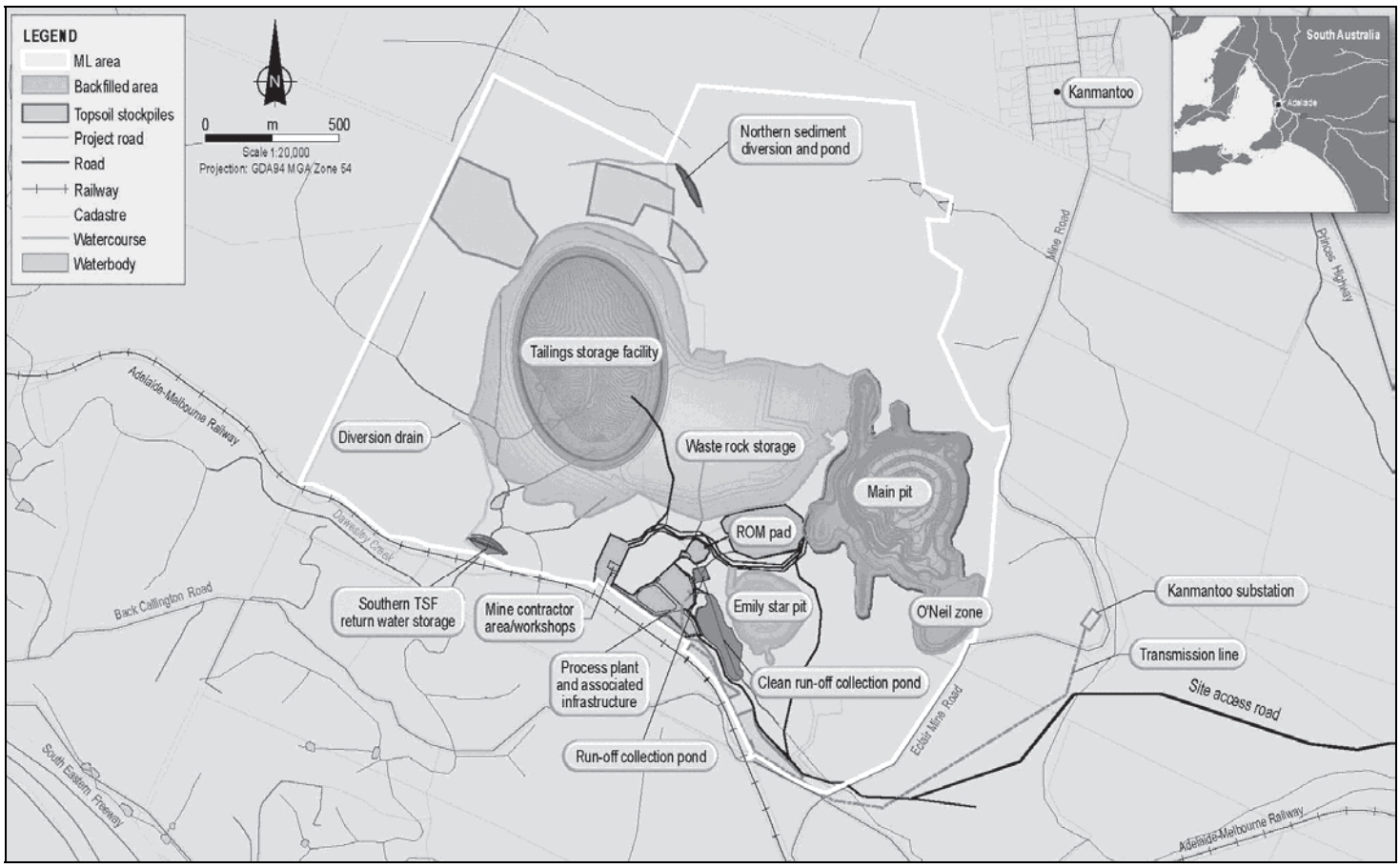
Kanmantoo Mine

The South Australian Company worked several pipe-like ore bodies down to depths of 60m. Ore dressed to grades of 25-30% copper was shipped to Swansea (Wales) for smelting and returned an average of about £15 per ton. Local smelting began in 1848, enabling treatment of ore with 12% copper, too poor for the Swansea market. In 1851 the South Australian Company, disappointed with the lack of profitability of the mine, decided to withdraw from mining and to concentrate on its pastoral activities.

There was little further activity on the mine until local syndicates took up leases in 1856 and produced small quantities of high grade ore. In 1861, the Kanmantoo Mining and Smelting Company was formed and initially worked the mine at a profit. Operations were suspended in 1865 due to a combination of scarcity of ore, falling copper price and lack of wood for smelting. In 1866, the New Kanmantoo Mining and Smelting Company took over the property and worked it continuously until 1874, although production and sales data suggest that it may have been profitable only in 1872. Limited prospecting activity was carried out in 1906-1907 and, in 1912, a small syndicate made an unsuccessful attempt to reopen one of the lodes. Total production from the mine in the period prior to World War I was 18,929t of ore averaging approximately 13% copper.

In the 1950s, Broken Hill South Ltd., aware that the future life of its mine at Broken Hill was limited, began an aggressive Australia-wide mineral exploration program through its subsidiary Mines Exploration Pty. Ltd. Investigations in the Kanmantoo district were commenced in 1962 and an induced polarization anomaly found over the hill containing the old Kanmantoo Mine. Subsequent diamond drilling of the anomaly indicated the existence of a mineable resource and in 1969 the decision was taken to develop an open pit mine by a new company, Kanmantoo Mines Ltd.

Mining commenced in 1971 and after returning profits in the financial years 1972-73 and 1973-74, the company suffered heavy losses in the following two financial years as a consequence of a dramatic fall in copper prices. Plans to develop an underground mine below the open pit were abandoned and the mine closed in June 1976 after having produced 4.05Mt of sulphide ore and 0.5Mt of oxidised ore at an average grade of 0.87% copper and 0.07g/t gold. Hillgrove Resources Ltd began further exploration at the Kanmantoo Mine in 2004 and the company has proved up a resource of 32Mt grading 0.9% copper and 0.2g/t gold. Production is planned to commence in late 2011.

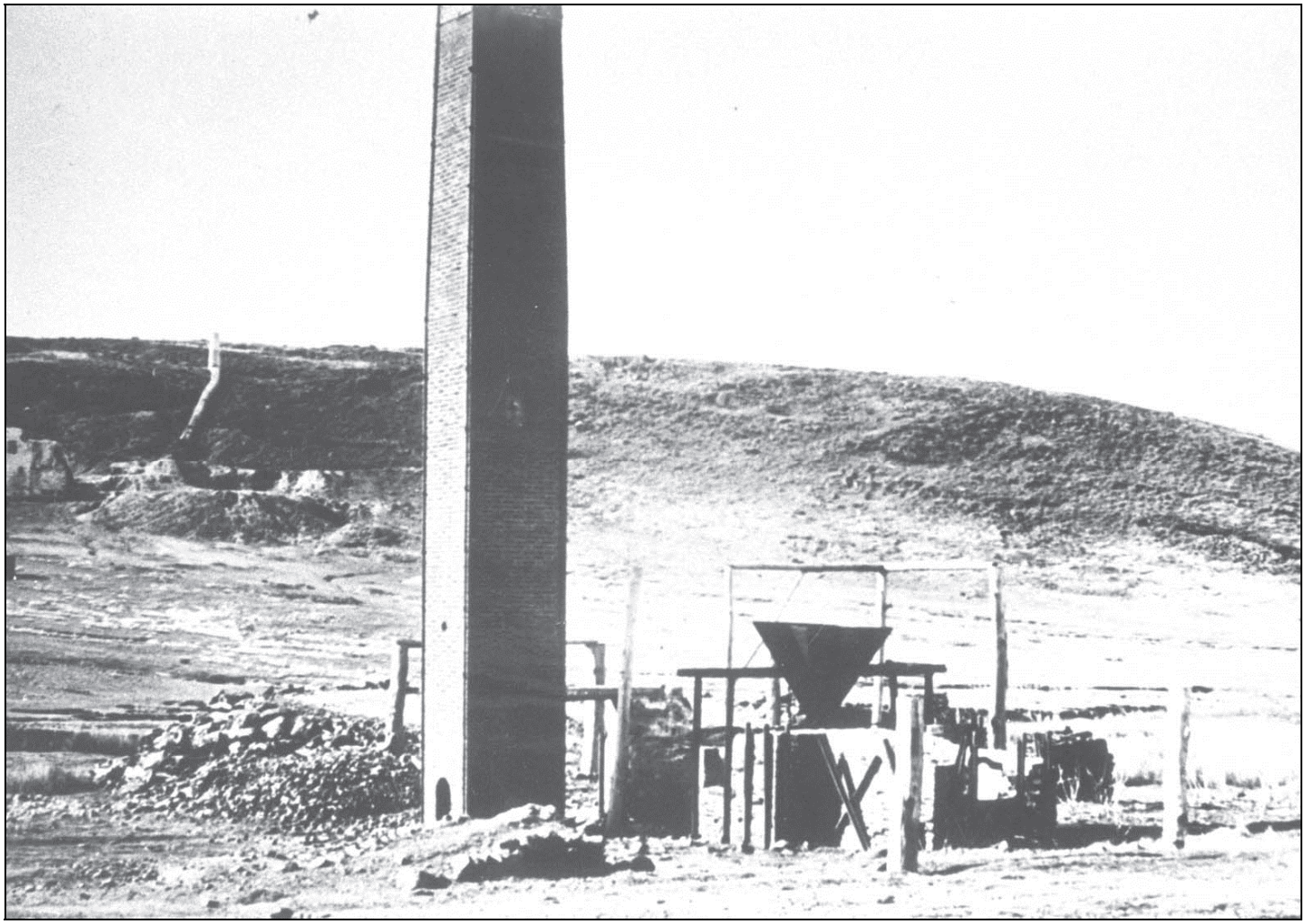


Hillgrove Resources Kanmantoo Mine layout, 2011.

Paringa Mine

The Paringa Mining Company operated the mine from 1846 to 1851 in small workings on several lodes but was unprofitable throughout this period. A silver-lead lode was discovered on the property in 1847 but it too proved unprofitable. The only activity between 1851 and 1869 was the production of small parcels of ore from shallow prospecting workings.

In 1869, the New Paringa Mining Company reopened the mine and installed steam power to work the mine. A 35hp horizontal steam engine commenced operations in 1873 and a smelter was erected in the same year. However, insufficient payable ore was found and the mine closed again in 1874. A further attempt to reopen the mine in 1907 was also unsuccessful. Ore production from the Paringa mine was 972t averaging 21% copper, with the major part produced during the period of operation by the Paringa Mining Company. The site is now part of the new Kanmantoo Mine operated by Hillgrove Resources.



Paringa Mine smelter looking east towards the mine workings and enginehouse. PIRSA Photo 035854

Smelters in the Adelaide Hills

Between 1848 and 1874, 21 Welsh-style smelting works were erected in South Australia in the Mount Lofty and Flinders Ranges. By far the largest concentration was in the Adelaide Hills where 11 works were erected, mainly in the Strathalbyn-Kanmantoo Mineral Field.

Bremer

The first commercially successful copper smelter in Australia was erected near Callington on the bank of the Bremer River in 1848. It was built by Cornishmen Mauris and John Thomas, who had smelting experience in Cornwall, Wales and Chile. A Welsh-style smelting furnace commenced smelting low-grade ore (12% copper) from the nearby Kanmantoo Mine using local timber as fuel. The ore was reduced to regulus (50% copper) in a single firing. Three further firings produced up to 95% copper. A blast furnace was introduced in late 1849. The Thomas brothers contracted with the South Australian Company but the smelter closed in 1852 when miners left for the Victorian goldfields.

Glen Osmond

The Glen Osmond Union Mining Company contracted with C.S. Penney to build a smelting works at Glen Osmond in 1849. This incorporated the latest smelting principles and was built in the floor of a valley with a long flue to a chimney on the hill. Because of dispute with Osmond Gilles over the rent, and the closure of the mines in 1852, it only operated for a short period.

Scotts Creek

These works were built by W. Dawes in 1857 near Scotts Creek, about 3km east of Nairne where wood and water were abundant. In 1858, the township of Dawesley was laid out around the smelting works. Operations commenced in June 1857 under the direction of R.V. Rodda treating ore from the Kanmantoo Mine and producing a regulus of 50 to 60% copper. In 1861, the Kanmantoo Mine and Scotts Creek Smelting Works were offered to the newly formed Kanmantoo Mining and Smelting Company. The works then consisted of calcining, reducing and refining furnaces capable of reducing 150t of ore per month, together with superintendent's residence, smelters' cottages, offices, smith's shop, weighbridge and ore sheds.

The works were sold to the Worthing Mining Company in May 1864 for £3000 to treat regulus from their Callington Smelter. In 1867, when a refinery capable of producing 98.5% copper commenced operations at Scotts Creek, regulus was no longer sold to the E&A Copper Company's works at Port Adelaide. Copper concentrate from the Balhannah Mine was treated at the Scotts Creek works between 1870 and 1876. Operations ceased in 1878.

Callington

The Thomas brothers erected a smelter in 1860 for the Worthing Mining Company near their Bremer Mine adjacent to the township of Callington. By1861, the works consisted of one calcining and two smelting furnaces capable of reducing 60t of ore per week. Up to 1863, the regulus was sent to England for refining but between 1863 and 1867 it was sold to the E&A Copper Company. By 1868, the works consisted of two calcining and two smelting furnaces and regulus was sent to the Scotts Creek works for refining.

Wheal Ellen (see p. 40)

Kanmantoo Mine

The Kanmantoo Mining and Smelting Company decided to erect a new smelter on the mine following the sale of the Scotts Creek works in 1864. The company was reformed into the New Kanmantoo Mining and Smelting Company in 1866 and, in 1867, Thomas Mansell was appointed superintendent of the smelter. The new company worked the mine until 1874, supplying regulus to the E&A Copper Company between 1866 and 1873.

Paringa Mine

The Paringa Mine, first worked in 1846, was reworked by the Paringa Mining Company in 1870. Ore was sold to the Scotts Creek works until a smelter was erected at the mine in 1873. Between 1874 and 1880, 196t of regulus containing 48t of copper were sold to the E&A Copper Company. The smelter closed about 1880 but the slag heap still remains.

Nairne Creek

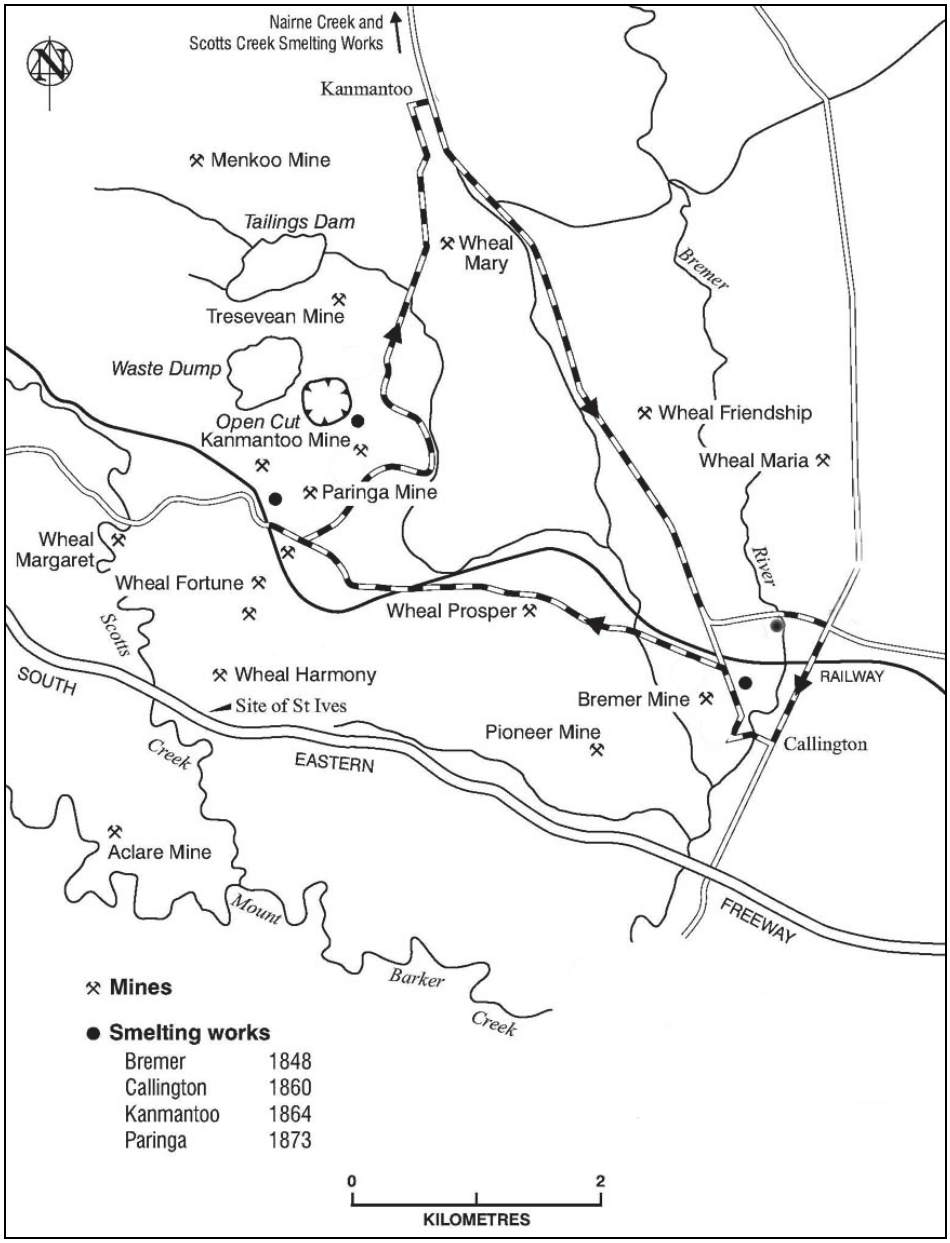
This smelter sold regulus and rough copper to the E&A Copper Company between 1871 and 1874. In 1866, the Nairne United Mining and Smelting Company's smelter was sold at auction to the West Kanmantoo Mining Company. Between May 1865 and October 1866, 129t of regulus were delivered from the Nairne United

smelter to the E&A Copper Company. No other details are known, although it is possible that it later became the Nairne Creek smelter.

Grunthal Mine
The Grunthal Mining Company erected a smelting works at which it produced about 409t of 50% copper matte between October 1874 and May 1876 when the mine was closed. The produce was sold to the E&A Copper Company at Port Adelaide. Three brick chimneys 21m high were still standing in 1915.

Tungkillo Mine
The Australian Mining Company worked the Reedy Creek Mine in 1847 and sent hand-picked ore to Port Adelaide. It had a successful trial smelting at the Yatala smelter in 1849 and probably built its own smelter prior to closure of the mine in 1852. The mine was re-opened in 1867 and plans were made to erect one furnace. Nothing remains of the furnace but the flue system survives.

Birdwood
Captain Killicoat of the Burra Smelting Works recommended the construction of a smelter at Blumberg (Birdwood) late in 1867 to treat ore from the Tungkillo Mine. This consisted of two furnaces under a galvanised iron roof connected to a 15m chimney which could smelt 50t per week. Records indicate a cartage rate of about 40t per month from the mine to the smelter and 28t of rough copper of 91.4% purity were delivered to the E&A Copper Company at Port Adelaide in 1868-70. In 1899, about 2000t of slag were treated at the Mount Torrens Battery to recover gold.

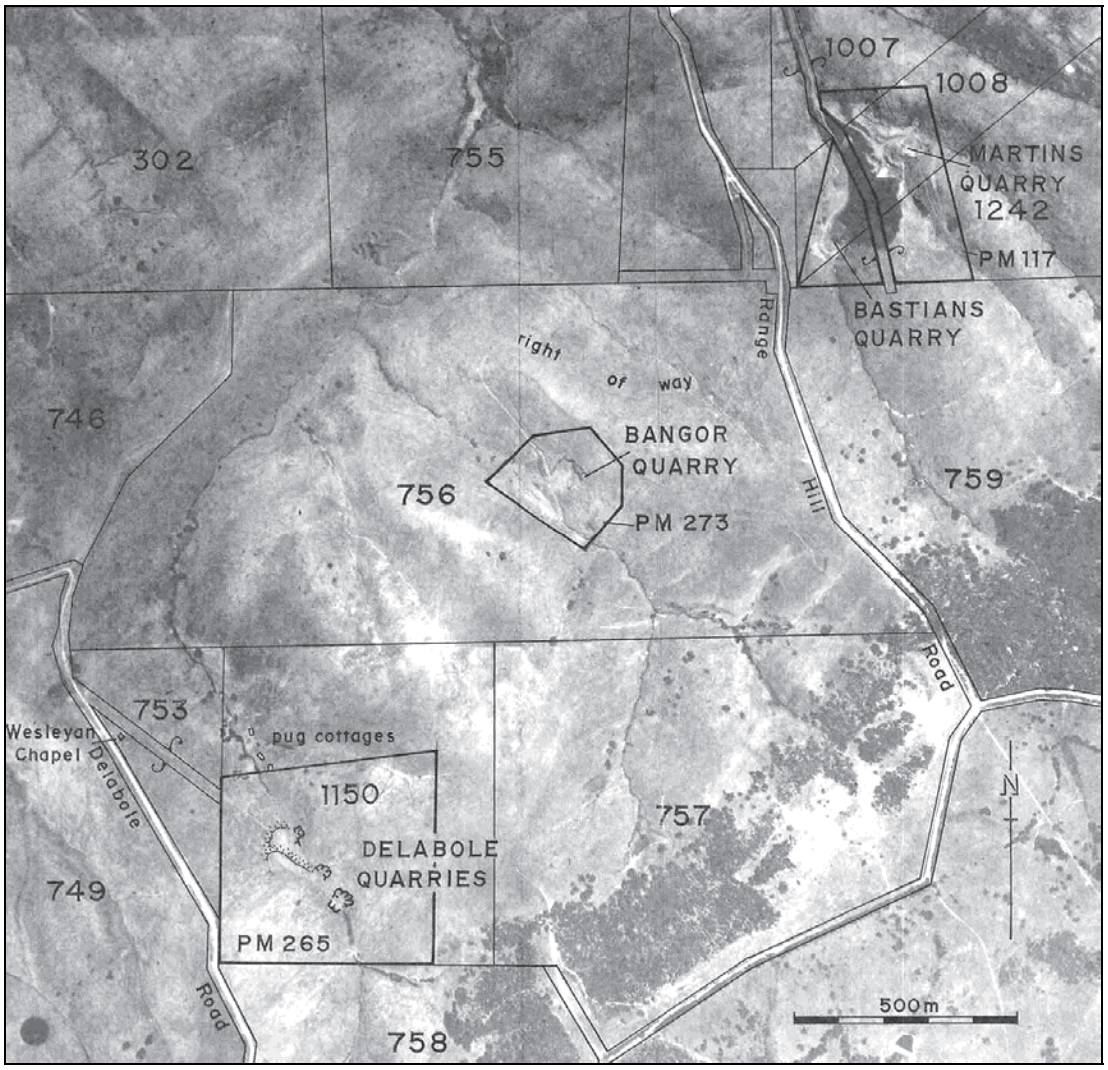


Smelters in the Kanmantoo district. PIRSA Plan 1998-01269

TOUR 2: WILLUNGA TOWNSHIP AND SLATE QUARRIES

Tuesday Sept 13, 8.45-5.00 pm Guides: Willunga National Trust

In 1840, an outcrop of slate was discovered in the hills behind Willunga by a farmer, William Loud, who shortly after opened Loud's Quarry. Sampson Dawe, who was familiar with slate quarrying in Cornwall was appointed manager. By 1842, three major quarries were discovered nearby in the same slate formation, and over 150,000 roofing slates had been shipped from the Willunga quarries. They were taken by bullock drays to the coast at Port Willunga and shipped to Port Adelaide, Melbourne and Sydney.



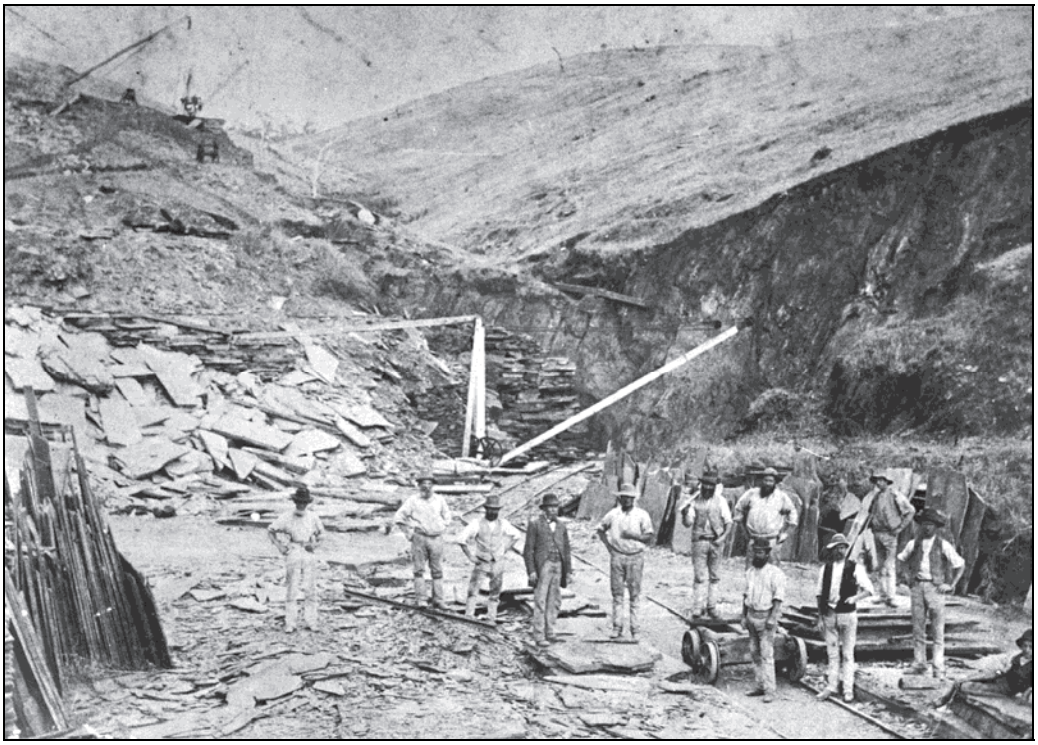
Plan of the Willunga Quarries, PIRSA Plan 1975-0761

Delabole Quarry

The Delabole Quarry was established by Dawe in 1841, deriving its name from the Delabole Slate Quarry in Cornwall. Loud's Quarry closed soon after the opening of the Delabole Quarry as its slate was superior to Loud's making it a more viable venture. In 1861, Dawe sold the Delabole Quarry to J. Allen who in turn sold it to the Australian Delabole Slate Company in 1865. In 1866, six worker's cottages were erected close to the quarry faces and a foreman's office and residence on the road to the quarry. The workers also erected a Wesleyan Chapel on the hill opposite the cottages. While the Delabole Quarry was the main supplier of roofing slate in Australia from 1840 to 1893, the growing popularity of galvanised and other roofing materials in the later 19th century saw interest in slate fall. The quarry suffered a slow decline in its workings until the land was sold for grazing in 1903.

Martin and Bastian's Quarry

This quarry was opened by James Gregory in 1842 but closed after 19 months. In 1846, Dawe and Thomas Polkinghorne, took up this lease and the quarry became known as Martins Quarry after the land owner. Thomas Martin immigrated to South Australia in 1847 and was a quarry worker in Willunga slate quarries before he purchased land containing the quarry. A second quarry face was opened up near Martin's by Sampson Bastian. Martin and Bastian's Quarry was worked until 1912 by Thomas Martin Jr after his father's death in 1900.



Slate workers in Martin's Quarry, c.1890. *PIRSA Photo 032232*

Bangor Quarry

Bangor Quarry was initially opened in 1842 by Thomas Williams and named after a Welsh quarry. In 1856, the quarry was being leased by Kernick, Male and Cobbledick, experienced Cornish stone dressers who had been working a quarry owned by the Martin family. After the first 21 year lease expired, they took out a further 7 year lease and then the quarry passed through several owners before being abandoned. In 1917, John Dunstan, a Sydney architect, and William Noller, a builder and contractor, tendered for the quarry and The Australian Slate Company was formed to operate the quarry. By 1919, the quarry was producing between 500,000 and two million roofing slates per year. The First World War affected the availability of galvanised iron, and slate was the ideal replacement. However from the late 1920s, the availability of terracotta tiles for roofing saw a renewed decline and by the 1940s, the quarry was only producing walling and paving flags. Between 1917 and 1944, Bangor Quarry produced more than 12 million roofing slates making it the largest producer in Australia. Bangor Quarry and Martin and Bastian's Quarry continue to operate commercially today.

Splitting shed at Bangor Quarry on opening day of the new plant, 1921. *PIRSA Photo 032330*

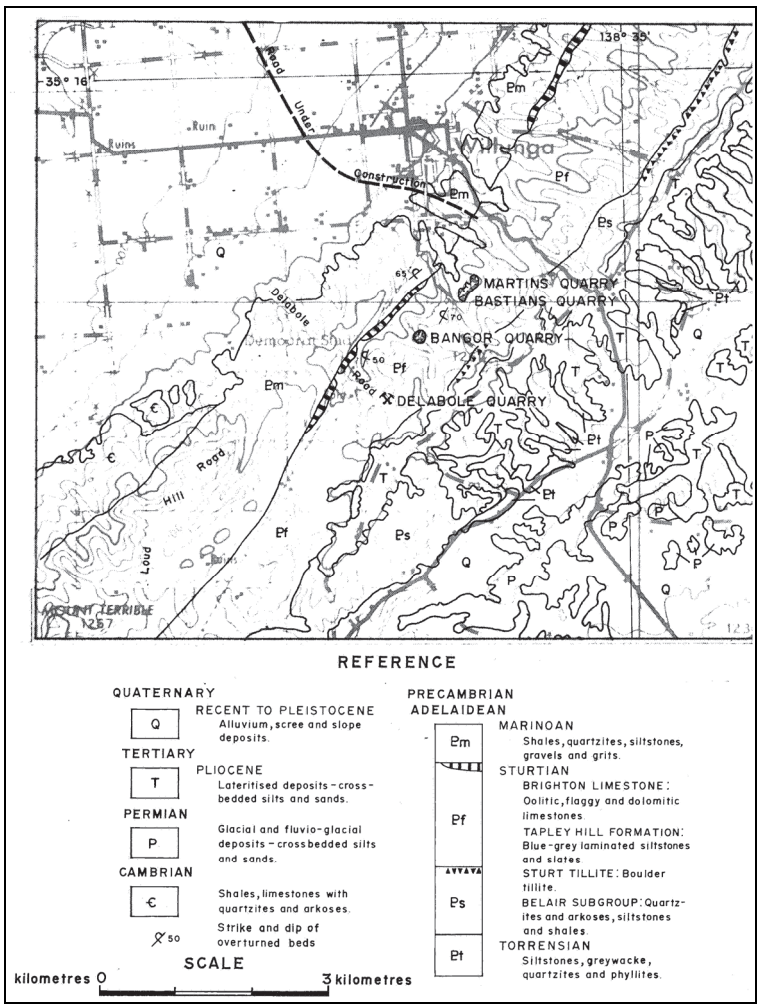
Geology

The Willunga Quarries are located in the Sellicks Hill Range which is a major fault scarp known as the Willunga Fault. This separates the folded Precambrian rocks from the shallow Willunga Basin to the west which is filled with Tertiary sediments. The Willunga slate deposits belong to the dolomitic siltstones of the Tapley Hill Formation which is part of the Adelaidean rocks forming the Mount Lofty Ranges. The deposits extend over a length of 2.3km in a zone about 600m wide.

Slate is a fine grained metamorphic rock derived from clay and characterised by an excellent cleavage which allows the rock to split into thin laminae. It is usually found in regions of broken strata which have been subjected to considerable folding. Willunga slate splits readily and cleanly along cleavage planes which are coincidental with bedding.

Slate could only be obtained from well-defined zones which accounted for only about 20% of the quarry faces. The zones were up to 11m wide with well-developed parting along closely spaced bedding planes suitable for roofing. The remainder is siltrock consisting of interbedded siltstone and fine sandstone with poor parting along widely spaced bedding planes suitable only for paving and walling stone.

A total of about 22 million roofing slates were produced from Willunga and some roofs in Adelaide and Willunga of high quality Willunga slate are still in good condition after more than 100 years.



Geology of the Willunga Slate Deposits. PIRSA Plan S12001

Quarrying Methods

The traditional techniques used in the Welsh and Cornish slate quarries were brought to Willunga by immigrant slate miners and craftsmen. In the 19th century the *opening-in* was accomplished by prising a large slab of slate from the quarry face either by hand chisels or the judicious use of explosives in a joint or fracture plane.
At Bangor Quarry jack hammer drills or pneumatic chisels were used after 1919. Sheets were wedged from the slab using plug and feathers. These sheets were hauled away from the working face by winches and later by a steam driven crane of 5t capacity with a 18m jib. The slabs were left to weather for several days before transporting by rail truck to the splitting shed. The quarry face reached a height of 60m, but the floor has been filled with waste and the face is now only 26m high.

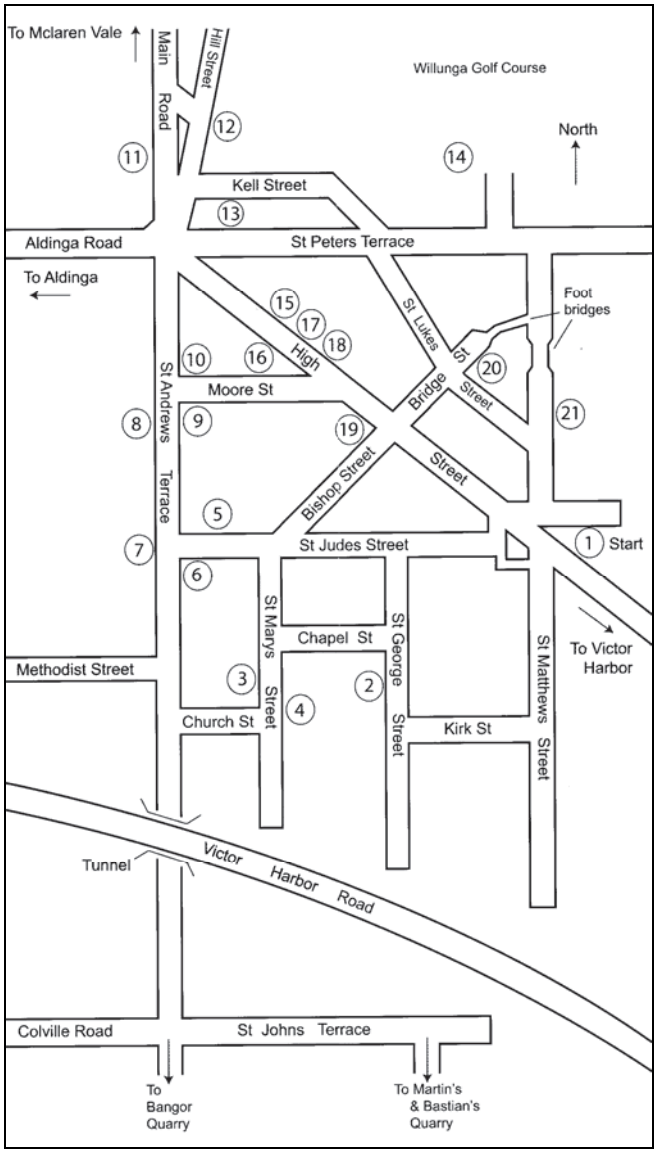
Inside the shed, splitting to required thickness was done by hand chisel. However, the slate was trimmed to size using a machine akin to a lawn mower with a curved blade rotating about a horizontal axis. In 1924, equipment in the shed comprised a multi-tubular boiler, steam driven air compressor, 30hp mill engine, 18hp workshop engine, nine slate dressing machines, sand sawing plant for cutting flagstones and a rubbing machine for smoothing surfaces.

Willunga Slate Museum

The Willunga Slate Museum is housed in the police stables of the old Willunga Courthouse and Police Station complex, which also houses the Willunga Courthouse Museum. This interpretive museum describes how slate is formed, its discovery in the hills behind Willunga and the development of the slate extraction industry to the present day. Many Cornish miners came to Willunga to work in the slate quarries, and the dangerous work of the quarrymen and the lifestyle of their families are told. The museum also has a collection of slate working tools and examples of the many uses to which the versatile slate stone has been put. A feature is a hand-powered slate trimmer used to make the thousands of roofing tiles shipped out to all parts of Australia.

Willunga Slate Trail

The Willunga Slate Trail highlights Willunga's heritage as the *Slate Capital of SA* and includes quarrymen's cottages, early public buildings and highlights many examples of the use of slate, including cemetery headstones.



Willunga Slate Trail

1. Willunga Slate Museum
2. St George Street
3. Sibly House (8 St Mary's Street)
4. St Mary's Street
5. Spargo's Cottage (3 St Jude's Street)
6. Wesleyan Church and Cemetery
7. Arthur's Cottage (34 St Andrews Tce)
8. *Glantawe* residence (20 St Andrews Tce)
9. Dawes' residence (19 St Andrews Tce)
10. Nos 13 & 9 St Andrews Tce
11. Show Hall
12. Alma Hotel and early store
13. St Peters Terrace cottages
14. Waverley Park
15. 13 & 17 High Street
16. Shop and residence (22 High Street)
17. Former Primitive Methodist Church
18. Oddfellows Hall
19. Former Church of Christ
20. Bassett Boys' schoolroom
21. Bridge and cottages

POST-CONFERENCE TOUR

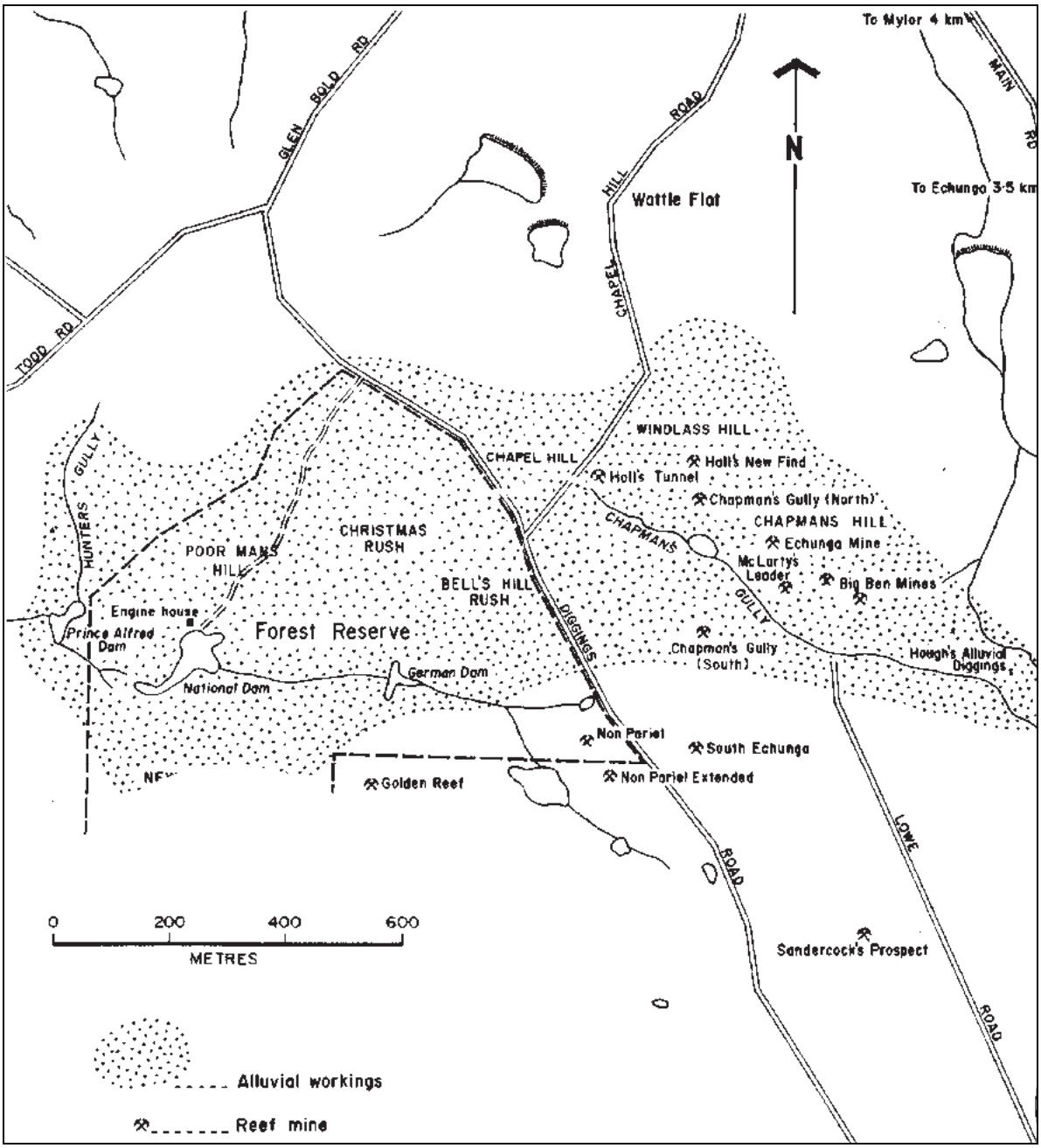
TOUR 3: MINES IN THE HAHNDORF-HALLETT COVE AREA

Sunday Sept 18 10, 8.00- 5.30 pm Guide: Greg Drew

Old Echunga Diggings

When William Chapman discovered alluvial gold at Chapmans Gully in 1852, a rush involving up to 700 people took place and within three months over 5000 oz were produced, including nuggets up to 5 oz. Several rushes followed in the immediate area, the most notable being Windlass Hill, where yields averaged 3-6 oz per dray load of alluvium. Reefs were discovered nearby and two mines, Echunga and Big Ben, were worked intermittently for the next 90 years.

West of Chapel Hill, a number of minor rushes took place during the mid-1850s on alluvial leads. Most significant of these were Christmas Rush (1854), Poor Man's Hill Rush (1855) and New Rush (1858). Many small nuggets up to 1.5 oz were found but the yields were very variable, the highest reported being 12 oz per bucket and 150 oz from one claim at Christmas Rush. Total production of the Old Echunga Diggings was approximately 100,000 oz.

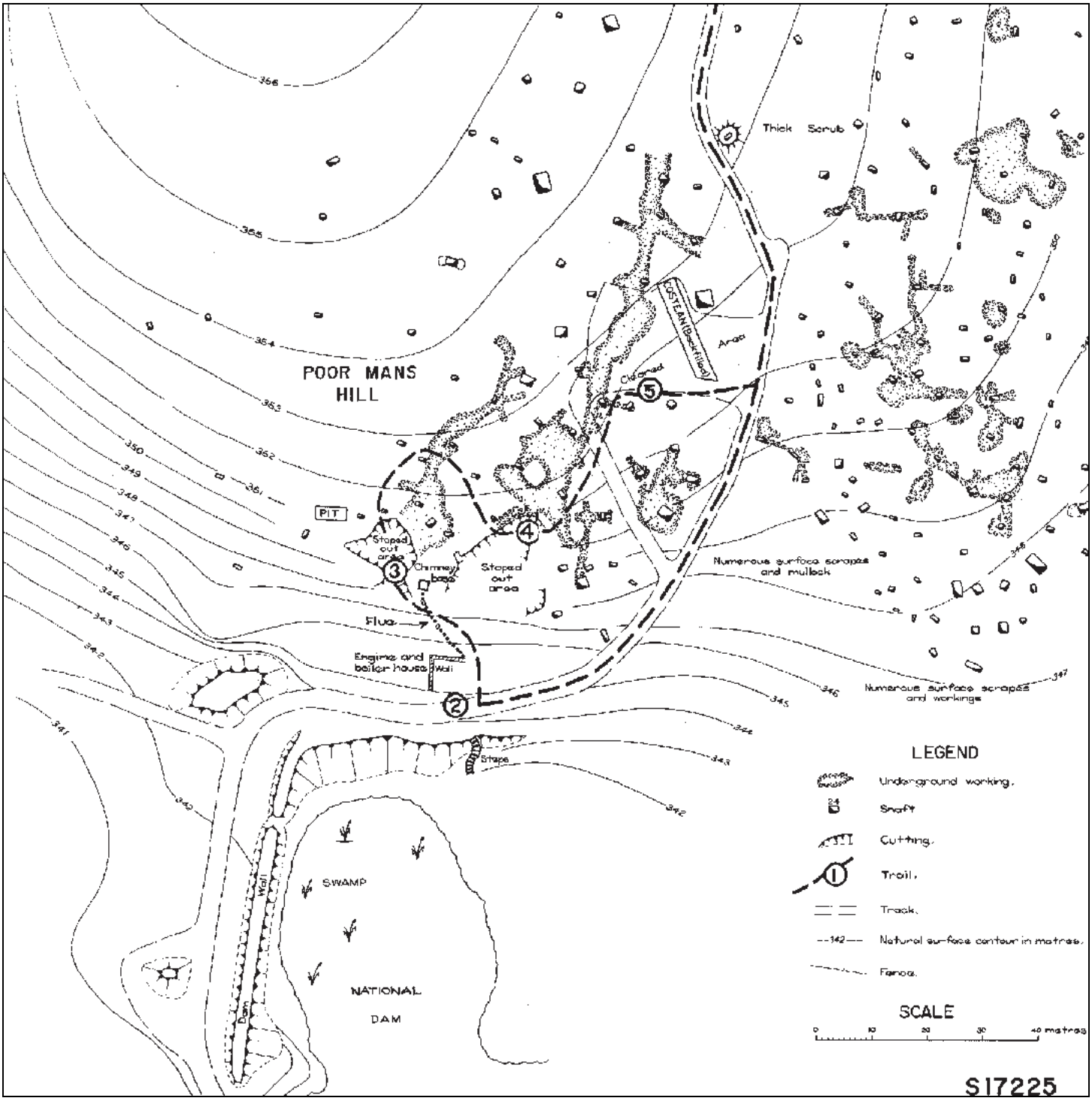


Old Echunga Diggings. PIRSA Plan S18809

Poor Man's Hill Rush

The track to the National Dam passes through Poor Man's Hill Rush and many well preserved examples of alluvial shafts can be seen. These shafts were sunk to depths of 10m through the ferruginised Tertiary gravels to the weathered Precambrian bedrock where the gold was concentrated. Diamonds, topaz and rubies were reportedly found with gold by the early diggers.

In 1866, the National Dam Gold Mining Company was formed to work the alluvial deposits of Poor Man's Hill Rush on a larger scale. A 10-head stamp battery and boilerhouse were erected at the foot of Poor Man's Hill. A large dam (National Dam) was constructed and a tunnel driven 75m into the hill behind the battery along an alluvial gutter connecting older alluvial shafts. Operations ceased in 1869. These diggings were reworked in the 1880s, 1890s and 1930s.



Poor Man's Hill Rush, Old Echunga Diggings, Echunga. PIRSA Plan S17225

Almanda Mine

In 1850, the wheels of a dray hauling produce to Adelaide broke off pieces of rock which were recognised to contain copper. A shaft was sunk to 9m and the mine was named Wheal Maria. A small quantity of ore was removed but the shaft was soon abandoned. In 1862, new leases were acquired and the mine renamed Wheal Mary Anne. A new shaft was sunk to a depth of 27m and a few dray loads of ore were produced but the mine was abandoned again by 1865. A company, comprised mainly of Kapunda shareholders, attempted to develop the lode in 1866 and sent ore to the Port Adelaide Smelting Works.

In 1868, William Ey, a German assayer, noticed abandoned copper ore from Wheal Mary Anne at Port Adelaide, which he recognised to contain silver. Following successful experiments which proved that the silver could be extracted by amalgamation, Ey and James Gawen acquired leases over the site in June 1868. A trial crushing of ore produced two ingots of silver weighing 131 oz (4kg) which were exhibited at the Adelaide Stock Exchange and the Almanda Silver Mining Association was formed in July 1868. The announcement of rich silver ore at the Almanda Mine created a rush for claims along the length of Scott Creek and 235 claims were pegged. Most of these were incorporated into the six companies that were formed but only the Almanda and Potosi companies passed the prospecting stage.

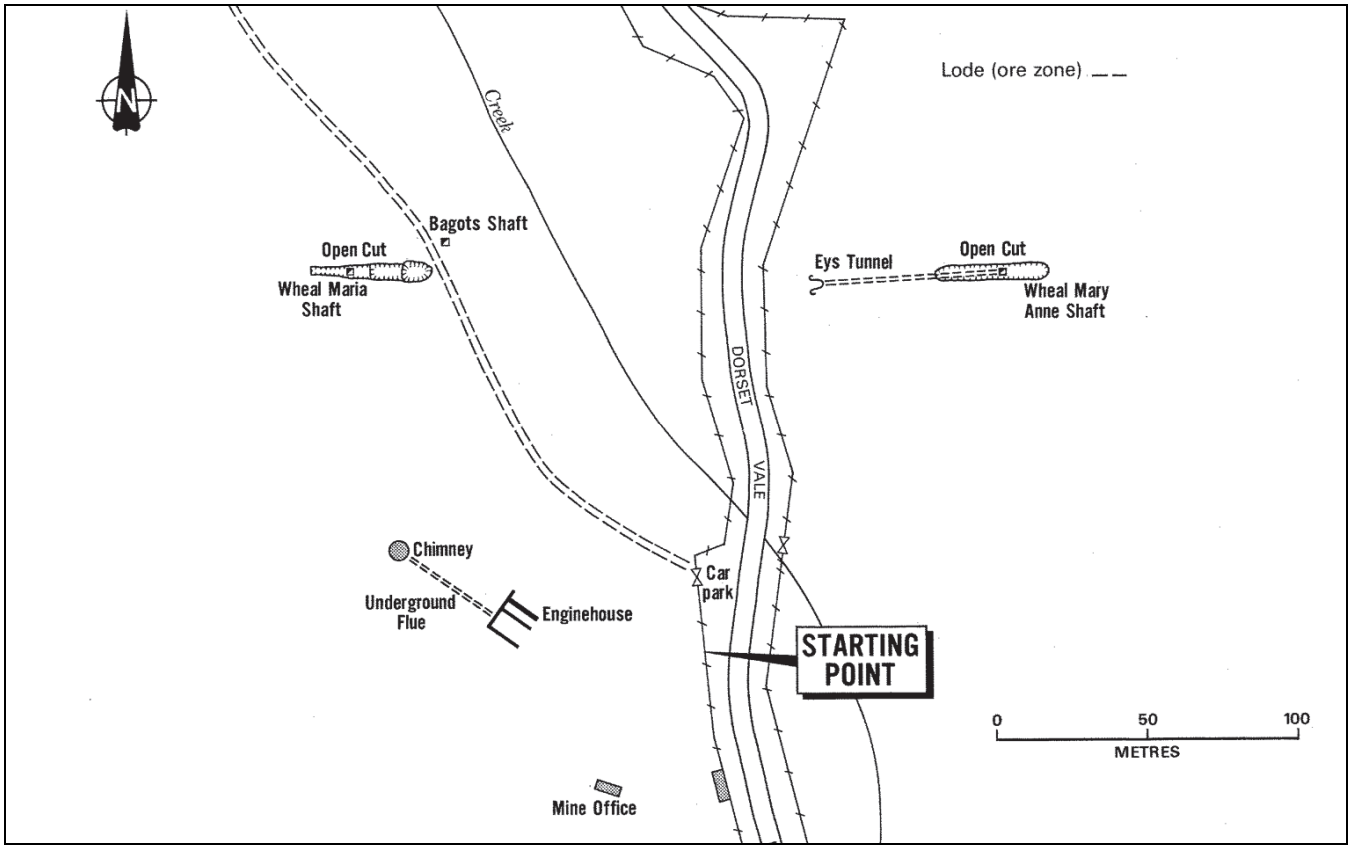
By August 1868, twenty miners were employed under Captain Henkel, and Ey supervised the erection of a treatment plant, which comprised a 10-head stamp battery, Chilean mill and concentration tables. This plant proved ineffective and was replaced by a more powerful horizontal steam engine, 15-head battery and improved concentrating machinery in 1869. About 1500t of ore, mainly from Eys Workings, had been stockpiled when the new plant commenced in July 1869.

A sketch of the Almanda Silver Mine, 1868 by W.A. Cawthorne showing the first ore treatment plant. *PIRSA Photo 039592*

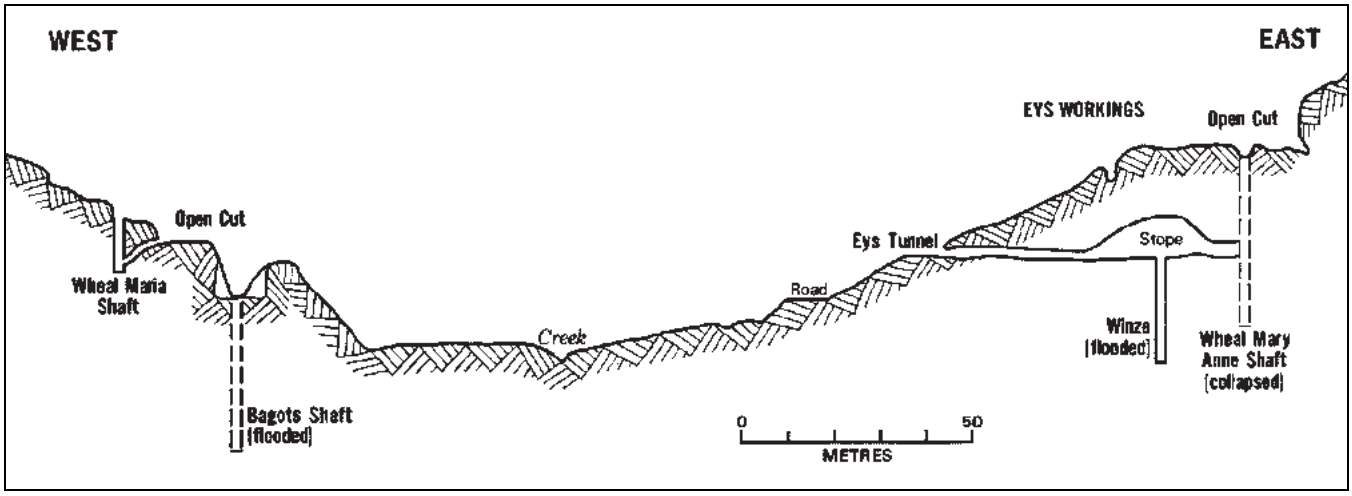
Operations proved uneconomic and, by early 1870, work was suspended. The company was dissolved in 1871 and the machinery, cottages and plant sold for £650. The mine was reworked in 1877, 1881, and 1887. Total production was 10,000 oz (310kg) from 2000t of ore. The SA Department of Mines carried out detailed exploration including diamond drilling between 1968 and 1972. Drilling delineated about 6000t of ore, averaging 0.8% copper and 180gm/t silver below Eys Workings. The site is listed on the Register of State Heritage Items.

Geology and Workings

The mineralised lode or ore zone occurs along a steeply dipping, east-west trending fault zone within deeply weathered shale of Precambrian age. The lode outcrops as a narrow iron-rich band up to 1.5m wide over a length of 800m. Within the lode were veins of siderite (iron carbonate) containing small amounts of chalcopyrite, tetrahedrite (silver sulfosalt) and other sulphide minerals. This was mined from two sets of underground workings located on both sides of a narrow valley. Those on the eastern side of the valley are known as Eys Workings and include a tunnel and open cut, where the lode was mined over a length of 20m. On the western side is the site of the Wheal Maria Shaft and a small open cut along the exposed lode.



Plan of the Almanda Mine. PIRSA Plan 1991-0457



Longitudinal Section of the Almanda Mine. PIRSA Plan 1991-0459

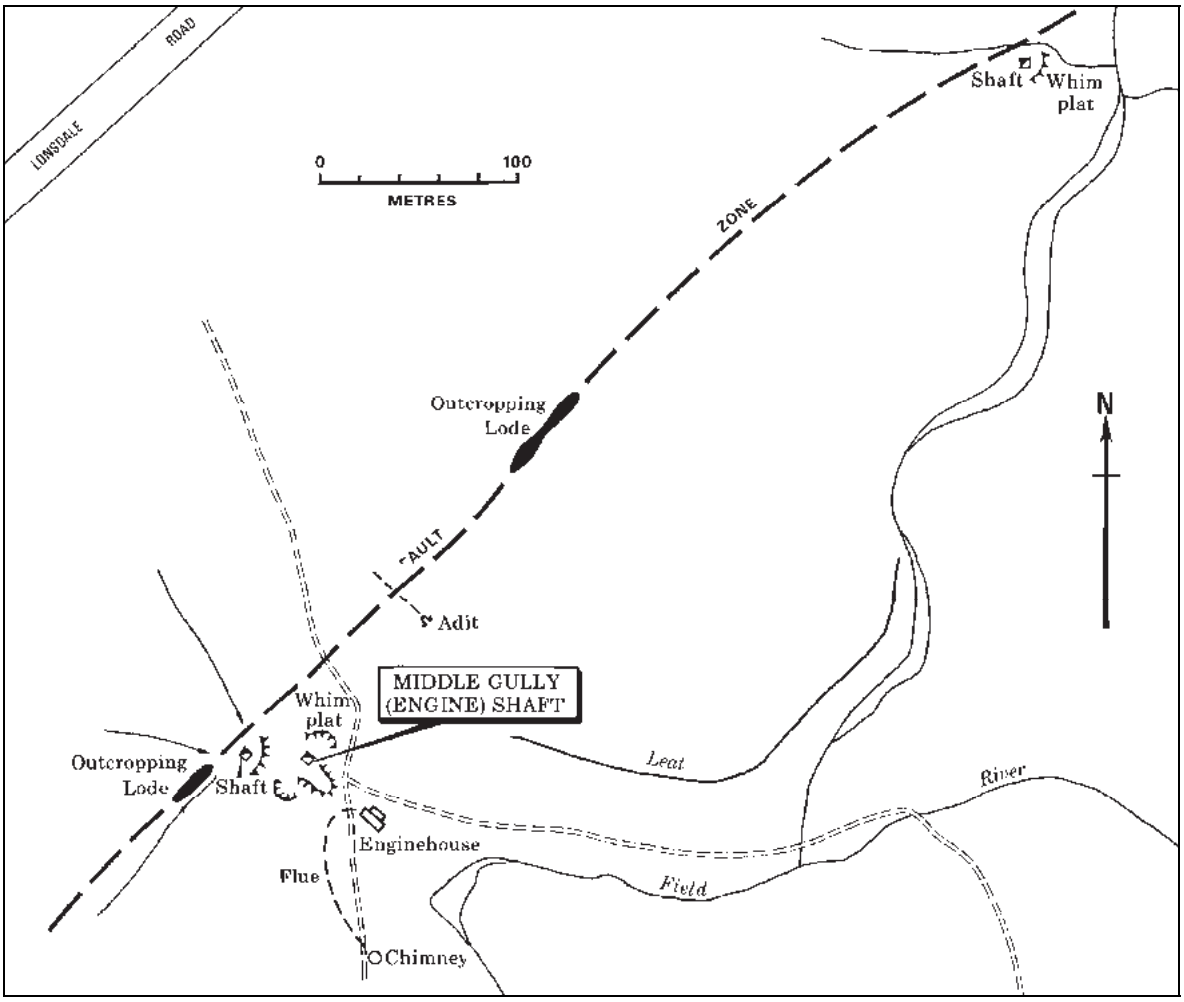
Worthing Mine

Copper ore was discovered in 1847 on the property known as Worthing Farm, belonging to John and Alfred Hallett. An association was formed and Captain John Phillips and five Cornish miners were despatched to the Colony and, within a year of their arrival, had proved the existence of copper lodes on the property.

The Worthing Mining Company was formed in 1849 and operations began under the general management of Alfred Hallett, with Captain John Richards as underground manager. Three shafts were sunk over a length of about 600m along the lode. A horse whim, ten miner's cottages, captain's residence, office, stores and powder magazine were erected and waterwheel was ordered from Cornwall. Up to 30 men were employed and a small community developed on the mine.

By early 1850, Captain Phillips decided that power was necessary to develop the property and an Engine Shaft was selected for the engine. Sinking of Engine Shaft reaching 16m by June 1850, when work was suspended awaiting the erection of a horse whim to remove water. A whim was erected in July but was not able to keep the water down and work again was suspended pending the erection of a steam engine. A second-hand Cornish beam engine was purchased in Cornwall for £500 and shipped in November 1850. Construction of an enginehouse adjacent to Engine Shaft was completed in August 1851, when the engine started work keeping the water *in fork* at four and a half strokes per minute. Operations were then focussed at the Engine Shaft and surrounds. By the end of 1852, operations were suspended due to the exodus of miners to the Victorian Goldfields. No ore production was recorded.

Engine Shaft had reached 48m when the mine closed. The engine was restarted in April 1856, when a contract to sink the engine shaft to intersect the lode at 91m was let to Captain Alfred Phillips. The engine forked the water to the bottom of the shaft within three weeks, working at seven strokes per minute and allowed sinking to proceed. This operation ceased by the end of 1856 and, in 1857, the company transferred operations to the recently purchased Bremer Mine, near Callington. In 1860, the Worthing Engine was transferred to the Bremer Mine, and re-erected in 1861 to power winding, crushing and dressing equipment.



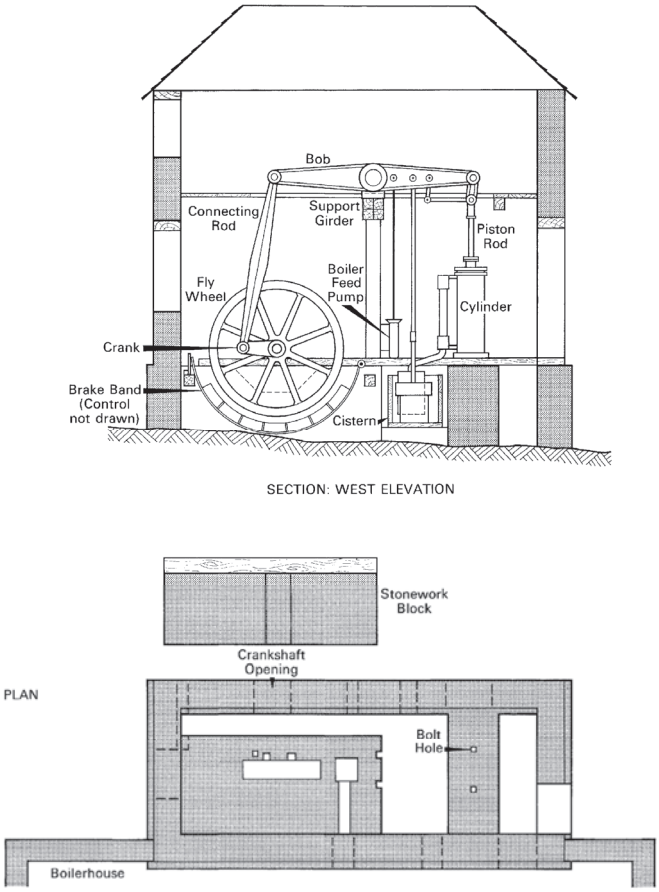
Plan of the Worthing Mine. PIRSA Plan 1987-0234

The Worthing Enginehouse

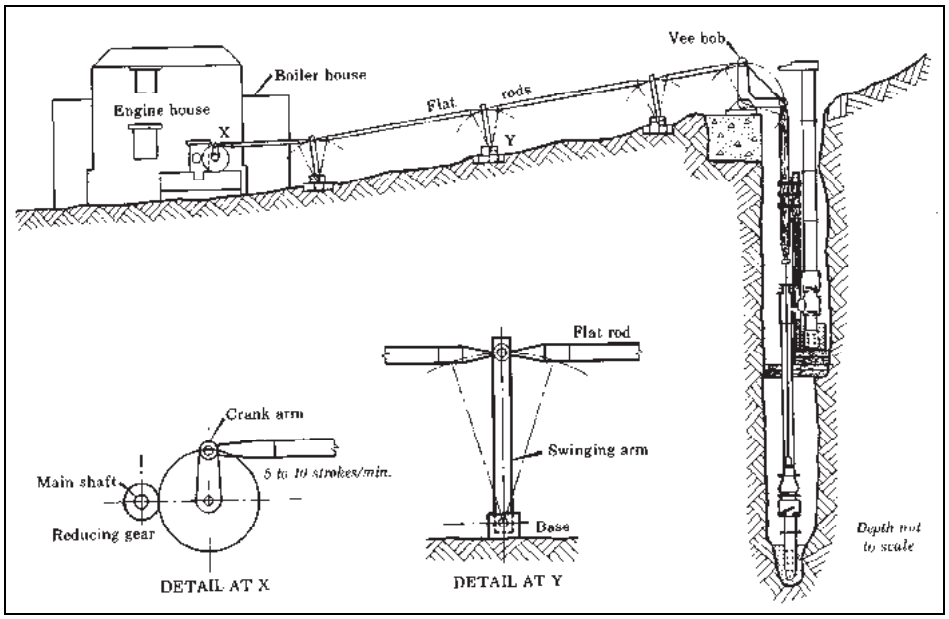
The Worthing Enginehouse is the oldest remaining Cornish enginehouse in Australia and the site is of national and international significance. Few details of the engine are available but the enginehouse, standing largely intact except for its roof, enables a general description of the engine to be given.
The enginehouse, built of limestone from the site, is located about 40m from Engine Shaft. There is no bob wall, all upper openings being windows. From the proportion of the building and the arrangement of stonework at the base, the following description of the engine can be given with reasonable certainty.

The engine was a double-acting steam engine, with vertical cylinder diameter of 22-inch and a stroke of 6ft. A horizontal beam 18ft long was pivoted on a wooden cross member built into the side walls of the building. One end of the beam was connected by a linkage to the top of the piston rod, which caused the beam to oscillate. The other end of the beam was connected by a sweep (or connecting) rod to the crank on the main shaft. The crankshaft was extended through the eastern wall of the building, on the outside of which was a crank to drive flat rods to operate a pump in the shaft and a winding drum for hauling from the shaft. A dog clutch would have enabled the driver to engage gearing to drive whichever of the two functions was required. Inside the house, adjacent to the eastern wall, was a 12ft diameter flywheel, on which was a brake band with toggle action operation to stop and hold the engine while hauling. Outside the eastern wall is a block of masonry which comprised the base for the winding drum operated by the crankshaft passing through an opening in the enginehouse wall.

The adjacent boilerhouse, now in ruins, housed one Cornish boiler which was connected to the chimney by a long flue, running in an arc from the northern end of the boilerhouse. The chimney, about 20m high and built of random limestone with red brick cap, is in good condition. Engine Shaft, which is filled with stone to the surface, is directly in line with the winding drum mounting. A level platform for a horse whim or man capstan is adjacent to the shaft and a large masonry block, presumably for the flat rod operated V-bob, has toppled into the shaft crater.



The Worthing Enginehouse. PIRSA Plan 1991-0690



Operation of pump and flat rods. PIRSA Plan 187-0237

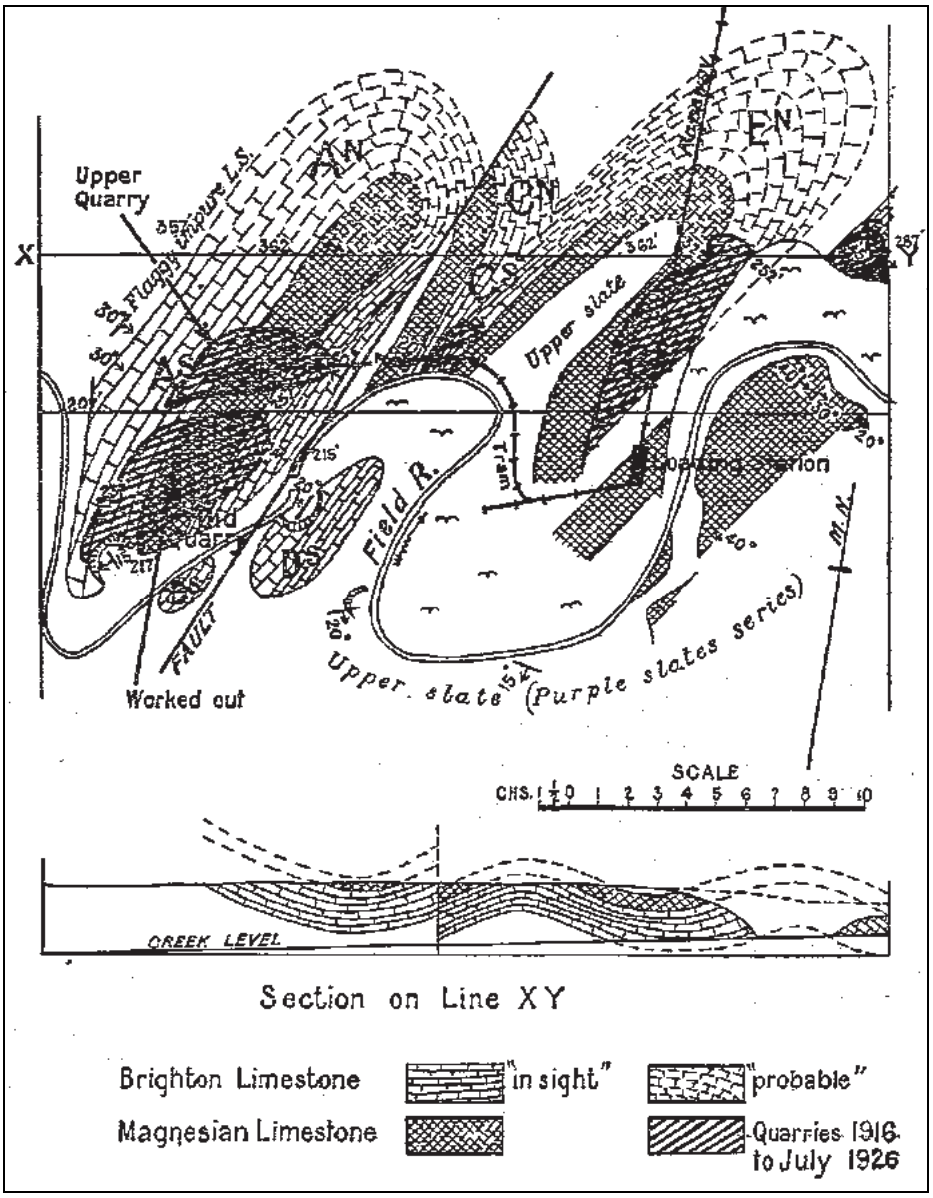
Reynella Quarries

Cement manufacture in Australia commenced in 1882 with the establishment by William Lewis of the Brighton Cement works in South Australia but competition forced its closure the following year. In 1892, the South Australian Portland Cement Company Ltd. established a cement plant capable of producing 3000t of cement annually near the original works. It used as raw product a dense limestone from a quarry alongside the works and from a series of quarries at Reynella 6km to the south.

By the 1920s, the plant was producing about 37,000t of cement annually but due to exhaustion of limestone in the original quarries at Reynella the operations were transferred in 1944 to more extensive deposits about two km to the west. The company eventually transferred its plant to Angaston in 1953, where plentiful supplies of high grade marble were available. The Linwood Quarry at Brighton and the newer Reynella Quarry have since been developed into major aggregate quarries for metropolitan Adelaide.

Old Reynella Quarries

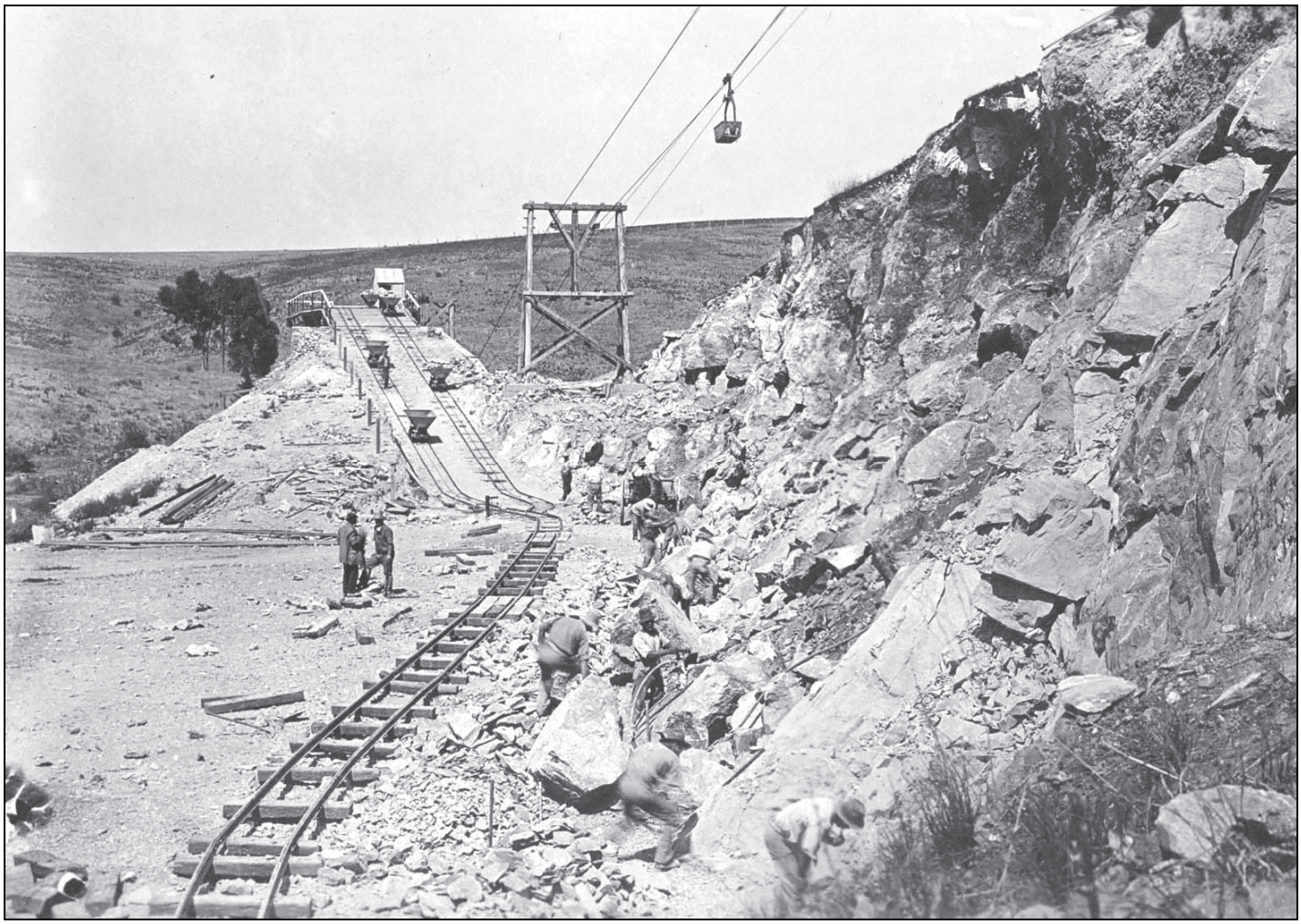
The Reynella Quarries are located along the Field River which has cut deeply into a sequence of Adelaidean calcareous slates and limestone's which are about 600-700 million years old. The alternation of hard and soft beds has produced steep cliffs and sharp meanders with the strata prominently exposed high on the banks on both sides of the river. The limestone formation which hosts the quarries is known as the Brighton Limestone and in the old quarries located near the Southern Expressway it is 12-20m in thickness. There it has been folded into a series of folds (anticlines and synclines) which plunge to the SW. This means that the limestone disappears beneath the Field River to the south and thins out to the north. A strike fault which runs SW-NE made part of the limestone more accessible for quarrying.



Geology of the Old Reynella Quarries (from Jack, 1912)

In the 1920s, the quarry consisted of four working faces on the western synclinal structure with faces ranging from 12-25m high. The north-western quarry was opened by driving a tunnel 40m westwards from an existing quarry and connecting to the surface by a shaft forming the centre of a glory hole. The largest quarry was located on the eastern synclinal structure and commenced operation about 1920 when new plant was installed. The rock was quarried by drilling blasting holes 3-6m deep with compressed air drills. After blasting, larger rocks were further shattered by secondary blasting and reduced to about 20cm or less by hand spalling. High grade limestone was separated from waste material on the quarry floor and loaded into side-tipping trucks which were hauled by a tractor in trains of five trucks to 200t capacity storage bins above the crusher.

Prior to 1920, broken rock was carted by horse drays to the Brighton works but about 1920 a new crushing plant was linked to the works by a 6km bi-cable aerial ropeway which was supported by 52 wooden trestles up to 21m in height and had a capacity of 400t per day. The buckets, which were automatically connected to and released from the travelling steel cable, had a capacity of about 0.5t and travelled at 6 km/hour. Wire-netting protected quarry workers from falling rock or buckets. The ropeway was the longest in Australia when installed. After the old quarries closed in 1944, the ropeway was extended 2km westwards to the new quarries and continued to operate until 1952.



Old Reynella Quarry, 1928. Broken stone was hauled along the rail line to the crushing plant and aerial ropeway loading station in the background. PIRSA Photo N005070

Grunthal Mine

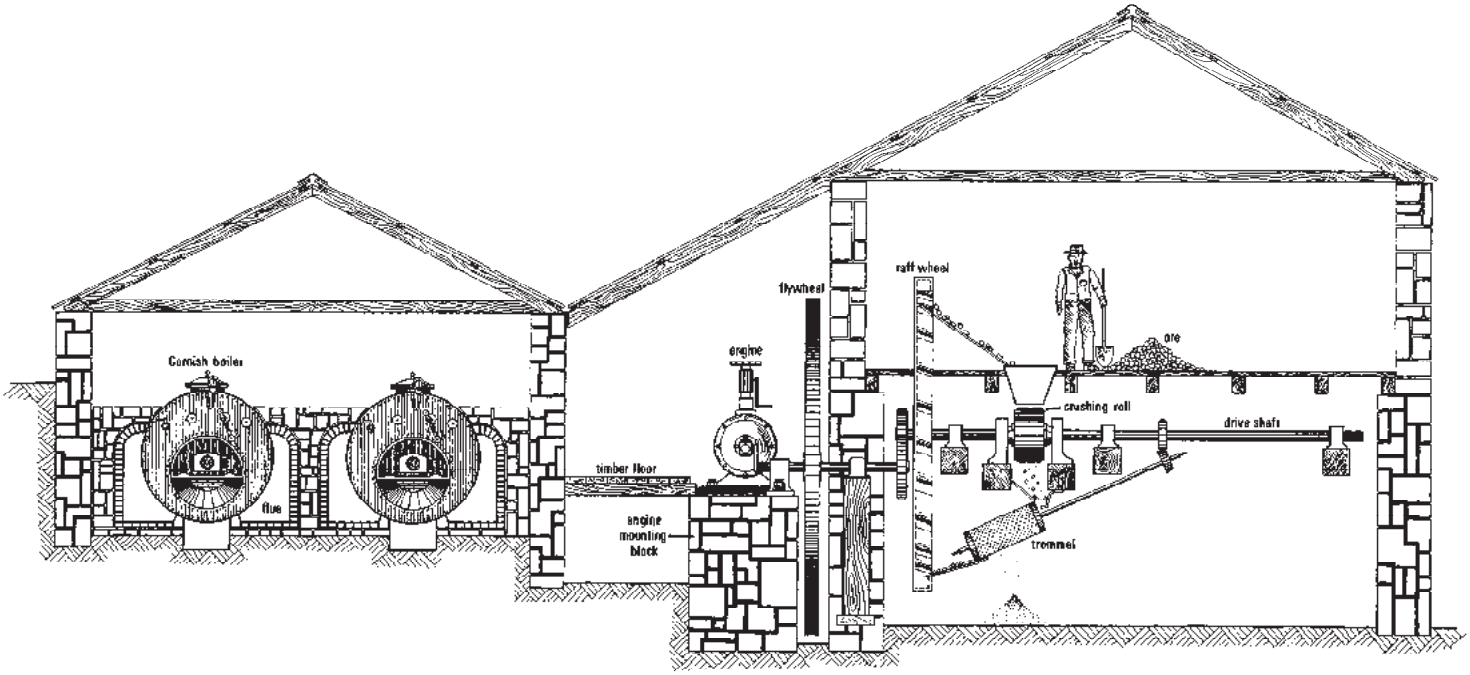
In late 1869, a quartz vein containing copper carbonate ore was discovered in a surface outcrop and the land owners commenced mining operations in early 1870 sinking three shafts to depths of 8m to test the orebody. As a result, the Grunthal Mining Company was formed in 1871 to develop the mine and commenced sinking a main shaft which reached 73m in depth. Machinery for pumping, crushing and concentrating the ore was ordered from the Andrew Jones Foundry in Adelaide and erected in 1872 in a complex of stone buildings adjacent to the west of Main Shaft. Other buildings included a manager's house of 11 rooms overlooking the mine, stables, office and store. A smelting works with three tall brick chimneys was built to treat the concentrated ore and between October 1874 and May 1876, 410t of 50% copper matte was sold to the E&A Smelting Works at Port Adelaide. The mine closed in May 1876 due to falling copper prices.

Mine Buildings

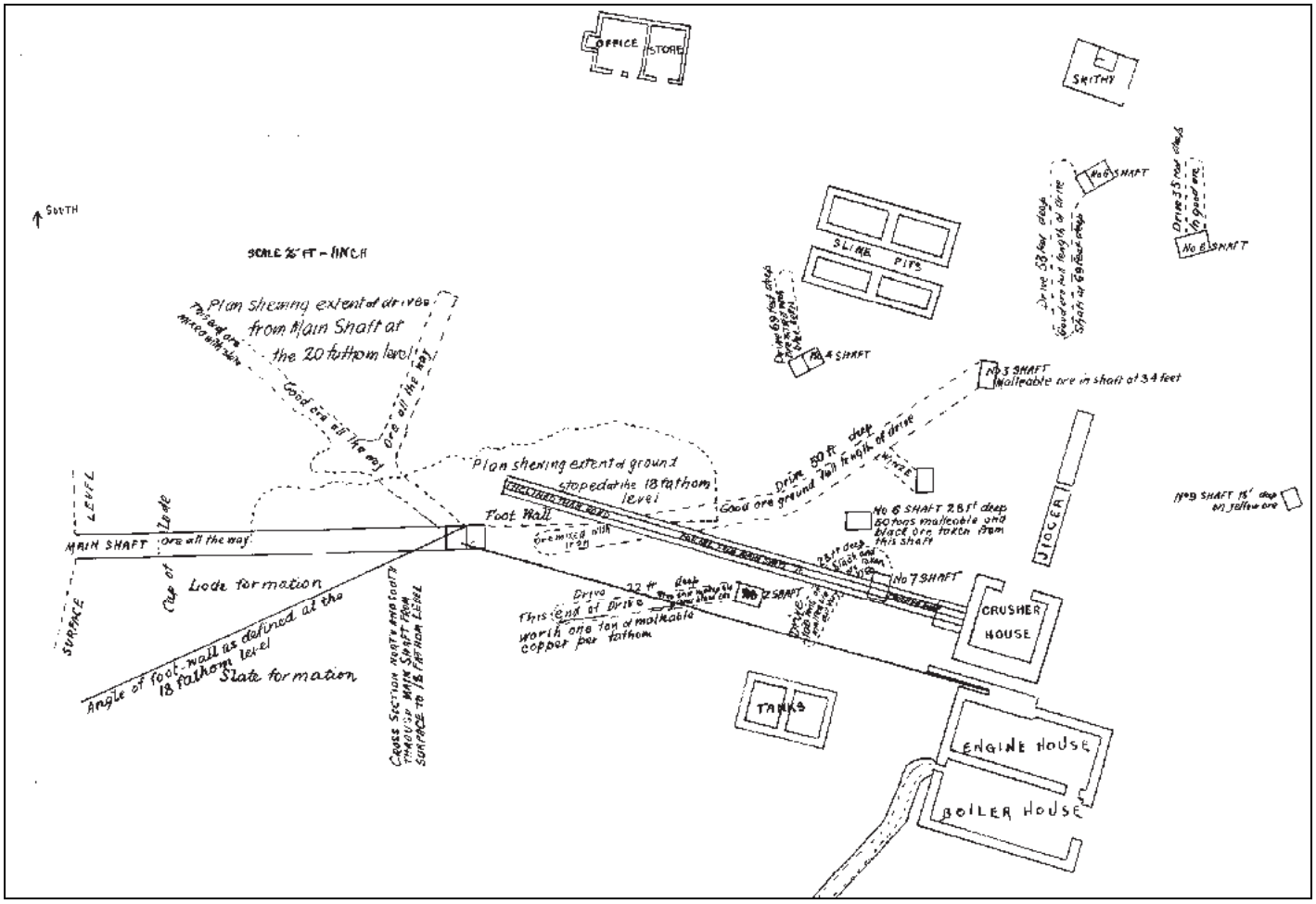
The substantial stone mine buildings erected in 1872 survive in good condition on a property adjacent to the Adelaide-Melbourne rail line. They consist of three separate components: enginehouse at the centre with a boilerhouse and crusherhouse on either side. At least a dozen similar buildings were erected throughout South Australian mining districts in the 1860-1880 period. The enginehouse contained a large horizontal steam engine with steam supplied from two Cornish boilers in the boilerhouse which was connected by an above ground flue to a chimney near the rail line. A similar complex containing machinery from the Jones Foundry was erected at the nearby the Balhannah Mine in 1873 so it is very likely that the engine was identical: 45hp and about 22-inch diameter cylinder. A drive shaft from the engine powered Cornish pumps in Main Shaft 50m to the east via flatrods, and crushing machinery in the crusherhouse as well as a large jigger and hauled ore trucks up an incline tramway to the crusherhouse.

The crusherhouse contained a pair of cast iron Cornish rolls about 40cm in diameter which reduced the ore to coarse sand size. These rolls, placed horizontally and nearly in contact revolved towards each other, the power being provided to one of the rolls by the engine. The second roll was geared off the powered one and worked in movable bearings, compressed by weighted levers. This was to allow any unyielding piece to pass through. Ore was fed into the rolls from a hopper bin set into the floor of the crusher house. The crushed material dropped into a rotating cylindrical sieve, the fines passing through and the oversized discharged into the buckets of a raff (or lifting) wheel, which emptied its load back into the hopper on the first floor for re-crushing. The crushed ore was passed to a jigger which produced an 18-20% copper concentrate.

The Grunthal Gold Mining Company prospected for gold in 1882 and in 1935, the Grunthal Gold Mines Ltd. dewatered the mine to undertake sampling but the copper and gold values were too low to warrant further exploration.



Section through a Cornish crusherhouse complex *c*.1870. PIRSA Plan 1999-0555



Plan of the Grunthal Mine, *c*.1876. PIRSA Plan DM1913-1042

Balhannah Mine

Following the discovery of payable alluvial gold in the Onkaparinga River near Balhannah in the late 1860s, copper-bismuth ore was discovered by William Ey about 2km west of Balhannah in July 1869. The Balhannah Mining Company was formed to work the privately owned property and employed two miners who opened out a 2m wide lode and within a few weeks had produced a 5t sample of ore containing 70% copper. Mining operations commenced in August 1869 under Captain Burtt who managed the mine until March 1870 when Edward Henkel was appointed manager. Henkel was an experienced miner from the Hartz mountains in Germany and had worked previously at the Wheal Gawler Mine at Glen Osmond and the Almanda Mine at Scott Creek (where Ey had also been employed).

The ore was initially handpicked, bagged and sent to the Port Adelaide smelting works but by late 1869, two jigging machines were installed to concentrate the low grade Cu-Bi ore. Many small pieces of gold were picked out of the jiggers. By late 1870, a small steam engine had been erected to power pumps at the Engine Shaft and 4-head stamp battery installed to crush gold-bearing quartz material. In 1871, G.H. Cousins was engaged to construct a smelting works to reduce ore to bismuth by smelting in plumbago pots and the mine was thought to be *one of the finest bismuth mines in the world.*

In 1872, the company purchased the freehold of the property and set about equipping the mine with heavier machinery which cost about £3000. It was thought that there was sufficient bismuth in the mine to cover the cost with the value of bismuth being about £900/t in 1872. The new machinery consisting of a 45hp 22-inch horizontal steam engine from the foundry of Andrew Jones in Adelaide, two boilers, and crushing and concentrating equipment was erected in handsome sandstone buildings adjacent to a new Main Shaft about 150m east of the old Engine Shaft. The buildings consisted of an enginehouse measuring 4.9mx12.2m and 6.1m high, boilerhouse containing two Cornish boilers, and a crusherhouse measuring 7.3mx6.1m. The engine powered pumping equipment in the adjacent shaft, the crusher and jigging machines which were located on the eastern wall of the crusher. The complex commenced operations at a formal opening ceremony in January 1873.

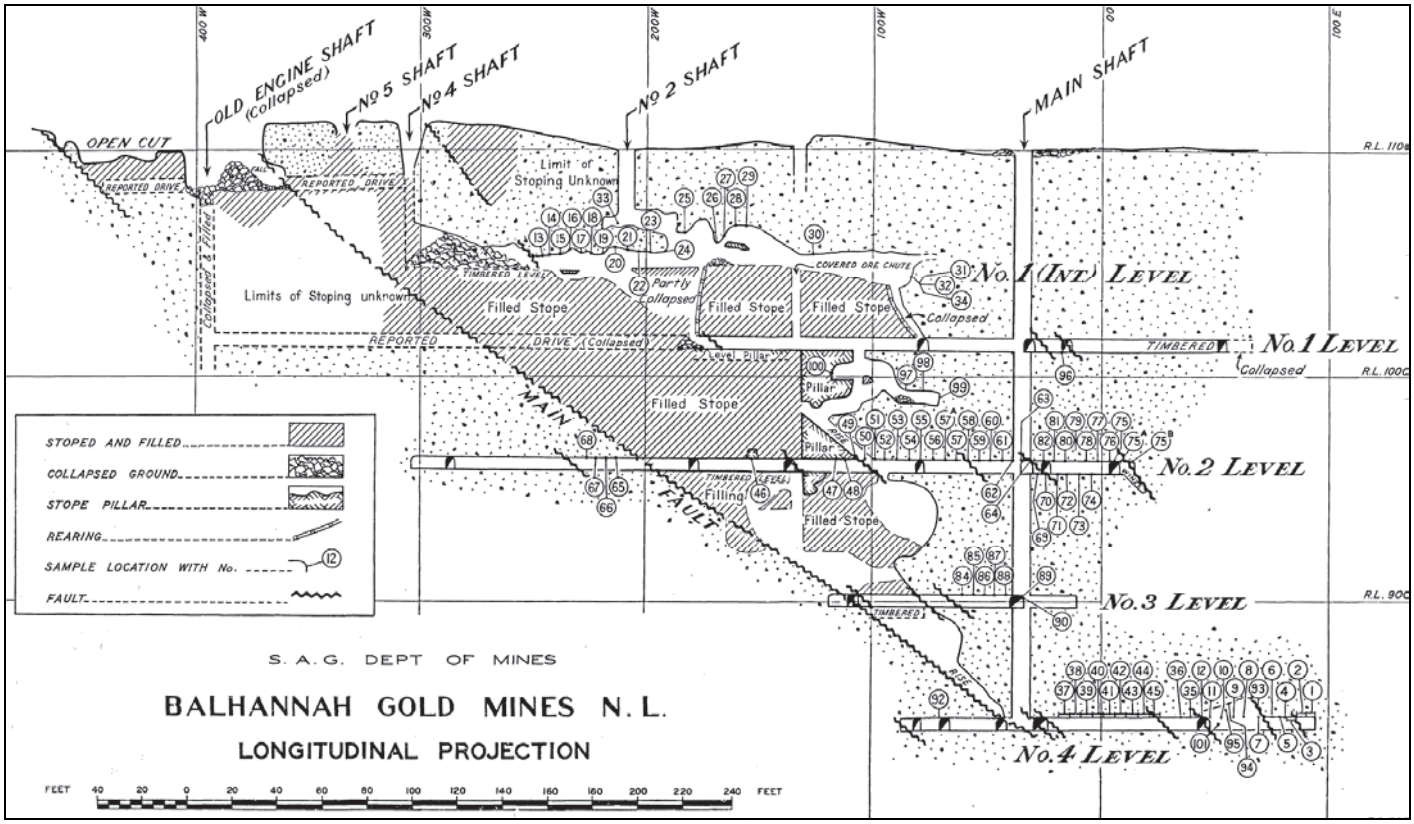
Balhannah Mine, 1873.
Broken ore from the new Main Shaft (left) was loaded into ore trucks and hauled up the incline tramway to the crusherhouse where it was crushed by Cornish rolls and passed to a large jig on the right hand side of the building. All power was supplied by a 22-inch steam engine located in the long building behind the crusherhouse. The engine also operated pumps in the shaft by a horizontal flatrod. *PIRSA Photo 034030*

During the next three years, operations were focussed at the Main Shaft but expenses continued to exceed proceeds from the sale of ore and the mine closed in 1876. In 1881, the Balhannah Freehold Gold Mining Company was formed to work the mine for gold and dewatered and sampled the workings but no mining was undertaken. The Moonta Mining Company purchased the mine in 1883, removed the machinery and sold the mine in 1886. A syndicate held the mine from 1893-1899 and carried out some prospecting. It was sold again in 1923 and 1929. In 1935, H. McCarthy secured the mine and formed the Balhannah Mines N.L. which dewatered the mine and made several attempts to work the mine over the next few decades.

Geology and Workings

The mine occurs within black carbonaceous schist that had been deformed by several periods of folding and faulting. Copper, gold and bismuth mineralisation occurs in thin quartz- carbonate veins which cross cut the rocks within faults or joints. The main vein occurs along a fault and ore was extracted from one ore shoot which was 150m long, up to 4.5m wide. The veins are oxidised near the surface with primary mineralisation encountered from 10-30m below the surface. Primary mineralisation consists of pyrite, chalcopyrite, bismuthinite and gold. The main vein was worked from five shafts along the line of the lode, the deepest being the vertical Main Shaft at 78m. The ore shoot was stoped from the surface near old Engine Shaft to No.3 Level just east of Main Shaft.

An estimated 2500t of ore was raised at about 7% copper and concentrated to 18-20% copper by crushing and jigging. The total recorded production from 1869-1875 is 170t of copper and 9t of bismuth.



Longitudinal Section of the Balhannah Mine. PIRSA Plan 1950-0265

Balhannah Mine enginehouse complex after conversion to a residence, 2011. PIRSA Photo 050380

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