Mines and wartime: Molybdenum at Black Range, New South Wales

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A number of mining operations sought Molybdenum at Black Range, near Bega, New South Wales, particularly around the time of the First World War. Their story and their remains today provide a local insight into this aspect of Australian mining history.

Molybdenum is an element (Mo), and in its pure form is a metal. It is not free in nature and when mined the ore is Molybdenum disulphide (MoS_2) known as Molybdenite. Molybdenum is known for its high melting point and is used in alloys requiring high strength and the ability to withstand extreme heat and wear. These uses include weapons, engines, drills, saws, heater filaments, petroleum production and other industrial roles. Molybdenum is also used in lubricants. The element is essential for plants and is used in agriculture. It is essential to human health (where it is a catalyst and helps break down nucleic acids) and its isotopes have medical applications.

The name Molybdenum is derived from the ancient Greek word for lead, as the metal was mistaken for lead and graphite. It was first recognised as a new element by German Carl Wilhelm Scheele in 1778, and the metal was first isolated three years later by Swede Peter Jacob Hjelm. During the nineteenth century difficulties in extracting the metal hampered its use but by the early twentieth century a froth flotation process had been developed.

It was just prior to and during the First World War that demand for Molybdenum rose sharply as it was found to be highly useful in armour plating and could replace tungsten in high speed steels.[1]

The German steel and weapons maker Krupp, based in Essen, discovered the importance of Molybdenum alloys in making armour plate in around 1899 and the patent on the process expired in 1909. Consequently, Britain and then France began using Molybdenum for their armaments and munitions manufacture which included armour plate, munitions toolmaking and stabilizers for high explosives. There was a resultant rapid escalation in price from 100 to 200 pounds per ton,[2] and it soon doubled again to 400 pounds. There was a great scramble for the metal by both sides of the conflict once war broke out: Germans used Molybdenum in arms production, in Zeppelin construction, and perhaps the most well-known use, in their massive howitzer 'Big Bertha', where the Molybdenum steel alloys were able to withstand the high heat of the propellants used by the gun. German agents had been assiduously buying up Molybdenum (including from Australian sources) until only three months prior to the outbreak of war.[3]

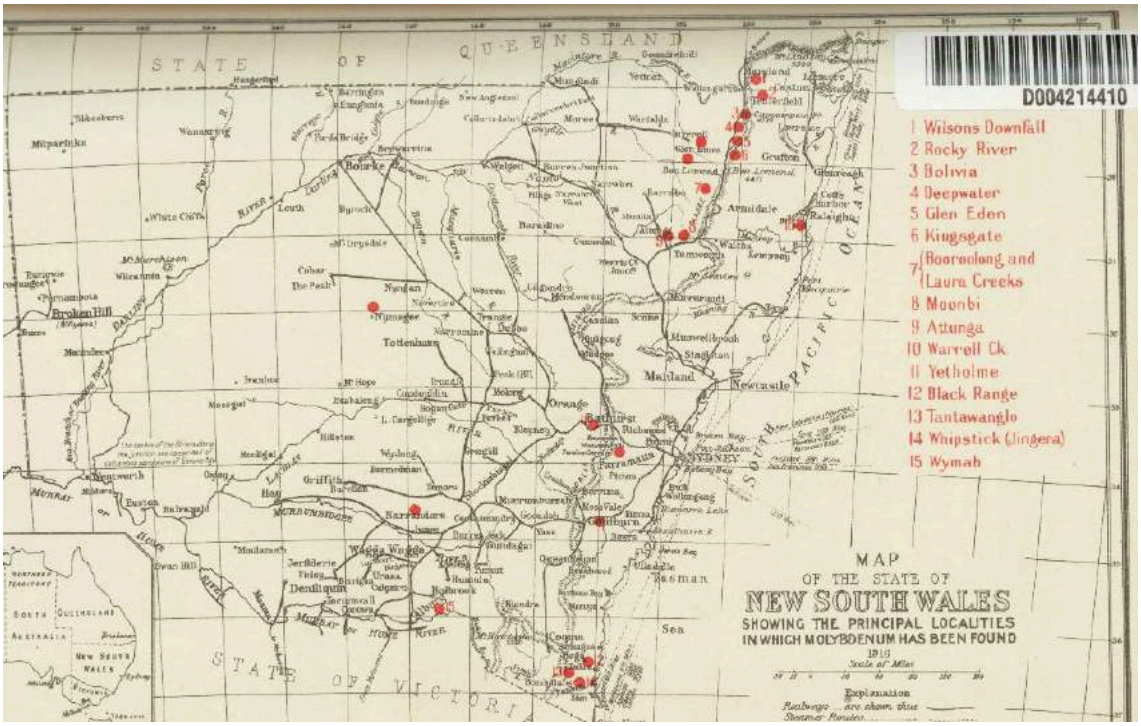
Britain urgently sought imports. Australia's High Commissioner in London sent cables to the Australian Government seeking Molybdenum for Britain, at prices exceeding £700 per ton in London. A contract was subsequently signed with Australia

and many old mines were re-opened, as well as new ones being found. The difficulties of treating the ore, which had previously hampered the industry were now starting to be addressed with new treatment works being constructed at a number of sites. Poor prices had also depressed the industry in Australia prior to the war but this handicap was now being radically overturned. The world's leading producers of Molybdenum at the time of the First World War were, perhaps surprisingly, Queensland (the largest – mainly in the far north), followed by New South Wales, and then Norway. Many other countries were known to have deposits of the product, but they were yet to be successfully exploited. In New South Wales the mines were in the eastern half of the state, and the main ones included Kingsgate near Glenn Innes, and Whipstick near Pambula. Among the dozen or so other NSW Molybdenum localities, was Black Range.[4]

Black Range lies to the south of Bega. Heavily timbered, it rises to around 300m above sea level and its steep and rugged flanks stand in strong contrast to the gentle dairy flats along the Bega River below. Its geology is marked by post-Devonian granite intrusions (all NSW Molybdenite deposits were associated with granite), and with Devonian sediments in the range's higher areas. Conglomerate cliffs are found near several of the mine sites.

The best description of the Black Range mines is found in the 1916 report by NSW Government Geological Surveyor E.C Andrews. Spurred by the wartime demand for the metal, his report gave an overview of Molybdenum and its uses, followed by detailed descriptions of all the NSW mining localities. During the years leading up to his report, annual NSW Molybdenite production had increased from 15 tons in 1902 to over 60 tons by the first year of the war in 1914.[5]

Figure 1: *Map of NSW showing Molybdenum mining locations*



Source: E.C. Andrews, *The Molybdenum Industry in New South Wales*, Mineral Resources No. 24, New South Wales Department of Mines, 1916.

Andrews was assisted in his Black Range excursion and reporting by Messrs Edwards, Jackson and Wachman, although whether they provided information or assisted with access is not known. Certainly, access was difficult, and Andrews commented on the convoluted route to the mines which he attributed to the rugged terrain. It seems that the more direct route available today via Black Range Road was not available and he may have used what is now Wallagoot Lane and the Jellat North Fire Trail; such a route would also explain why Andrews described the mines from south to north rather than the other way around.[6]

A distinguishing feature of the Black Range deposits was their presence in 'true lodes of considerable width, composed of compact white to translucent quartz'. The quartz was in granite and near or in contact with Devonian sediments, and the Molybdenite was 'of the paint variety, being very thin and fine, and scattered throughout the joints in the stone'.[7]

Moving from north to south along the range, the first mine encountered is Scotts, and Andrews said this mine had 'been sunk on the lode many years ago to a depth of 40 feet'. His comment indicates that Black Range Molybdenite mining had been going on for some time prior to the war, possibly as early as the late nineteenth century (though Molybdenum didn't start being included in NSW Department of Mines *Annual Reports* until 1901). The lode crossed the range through siliceous granite, running almost due east-west. Bismuth, often found with Molybdenite, was also reportedly found here, as was a small quantity of gold and silver. Limited gold and silver mining took place in the Black Range-Bega-Tanja area in the late 1800s and early 1900s.[8]

A little further south was Josephs Mine. Andrews reported on the 'powerful quartz lode' here and his map of the mines shows that the shaft had been sunk to 60 feet. However, no deposits of commercial value had been found to that time. North-east was Finucane and Edwards' claim with two shafts. The name Finucane persists today in Finucane Lane, which meets the Princes Highway just south of Bega. Andrews wrote 'the lode traverses very rugged country' and that in addition to the shafts there had been prospecting test holes at other points on Finucane's Reef. The westerly shaft was about 60 feet deep, and that to the east was, in 1916, 20 feet deep. A parcel of several tons was picked from the crude ore during March 1916 and was to be treated at the new treatment plant at the nearby Queensgate Mine. Andrews commented that 'there is actually a considerable amount of molybdenite' in the Scotts and Finucane lodes, 'but it is not known as yet definitely whether the percentage is high enough to repay mining and treatment expenses'. He said further that the Molybdenite was of the 'paint variety', as at the Queensgate and he felt the various lodes were 'intimately related'.[9]

The Queensgate Mine was on Jacksons Reef further south-east. 'The country is rugged and covered with brush growth', wrote Andrews, and here the granite had intruded into the sedimentary rocks irregularly, forming numerous sills. The quartz lode was once again east-west in orientation and had been traced for up to 200 yards, with a width of over three feet. Aided by money from the Mines Department's Prospecting Vote, miners had sunk the shaft to more than 50 feet, 'and molybdenite may be seen as though painted throughout the joints of the stone'. Almost 50 tons of stone had been

stacked for treatment by March 1916, and after Andrews' visit a drive 100 feet long was put in and a further 75 tons of ore won. Molybdenite in the ore was at about 2 per cent. One wonders whether the name Queensgate was inspired by the richer and better-known Kingsgate mine near Glen Innes?[10]

Further east along Jacksons Reef was the claim of Gleeson and Party. Their shaft, on a continuation of the Queensgate lode, was about the same depth as Josephs (Fig. 2), that is, 60 feet, with the lode averaging more than a foot wide. 'Molybdenite occurs in fine flakes throughout the stone', reported Andrews. The lode at Gleesons was close to the intrusive granite contact point with the sedimentary rock.[11]

Figure 2: *Josephs Mine*

Source: Author's photo 2019.

The treatment plant at the Queensgate had been completed not long before Andrews' visit, at a cost of about £1,300. The geological surveyor took several photographs of both it and the mine, but these have not reproduced well in the report, though machinery seen in the images includes drive wheels and belts and a substantial building. Fortunately, Andrews' written description of the plant was not lacking in detail. The ore was fed by hand into a Dodge rock-breaker (Dodge presumably being the motor). From here via an endless belt the broken ore passed through a set of Jacques rolls and was crushed further. The broken material was then fed over shaking screens and the correct sized material elevated to the mixing vat. Via a belt and piping, the pulp then went to a shaking trough and on to the concentrator consisting of concrete troughs of various sizes. The Molybdenite was treated in the froth flotation process and was to be recovered along channels leading from the trough compartments.[12]

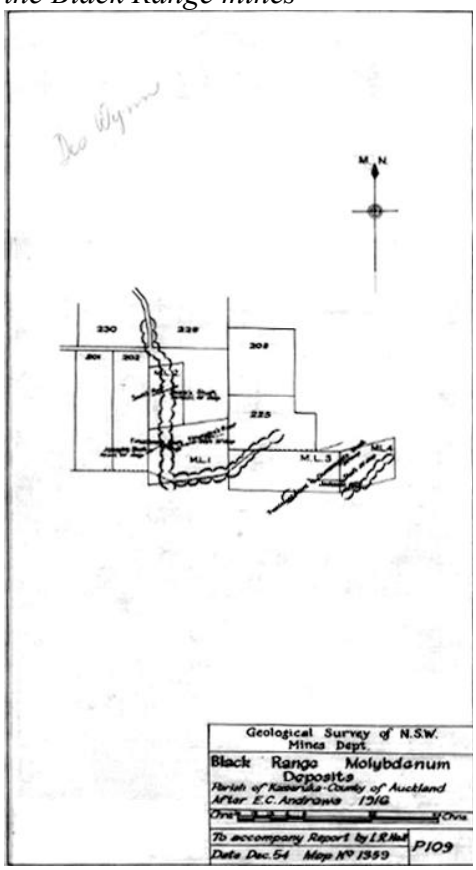
Mines and wartime: Molybdenum at Black Range

In the middle of the First World War the Black Range prospects were looking positive, and this state of affairs was noted at many other Molybdenite mines around NSW and Queensland. NSW production in 1917 was over 70 tons, and over 92 tons the following year. However, the prosperity was to be short-lived, for following the end of the war in 1918, demand was greatly reduced, and the contract with Britain expired in March 1920. The market then collapsed. Forty tons had been produced up to March that year,

but as the NSW Department of Mines *Annual Report* stated, with the end of the contract 'there was practically no sale for molybdenite, and production suffered in consequence'. No Molybdenite was produced in 1921, and from then until the late 1930s production limped along, usually in single figure tonnages, rising only in 1939 to 25 tons, then falling again during the Second World War when, presumably, other locations supplied war needs.[13]

In 1954, L.R. Hall of the NSW Department of Mines' Geological Survey did a geological mining survey and mapped a wide range of mining localities on the south coast. These included Black Range, with Hall basing his map on that produced by Andrews in 1916. This mapping project coincided with growing awareness of the value of Molybdenum to agriculture, including on the south coast. Newspapers reported 'outstanding results' from applying the element to pasture crops, including in the Bega district.[14]

Figure 3: *L.R. Hall's 1954 map of the Black Range mines*



Source: Based on Andrews' 1916 map, NSW Department of Mines, Geological Survey.

However, the Black Range mines continued to fade from memory. Two of the most long-standing families in the Bega district are the Gowings and the Russells. Daniel Gowing was a mid-nineteenth century settler who played a key role in campaigning for construction of the now heritage listed Tathra Wharf, and for the Jellat School founded in 1871. One of his descendants by several generations is Anton Gowing, who visited one of the mines in his youth in the early 1960s, accompanied by his father Tony. The mines were long abandoned but Anton found the site of interest due to its historical nature.

Rob Russell is also descended from a family long established in the area (he is sixth generation Russell) and is a Gowing on his mother's side (five generations). Rob also visited the mines as a boy, in the late 1960s-early 1970s. The mines appeared long abandoned to him even then, and his father Kevin, born in 1923, had no knowledge of the mines working in his lifetime. The oral record aligns with the archival. Apart from this type of rare visit, the mines lay forgotten by the community at large and the ever-encroaching bush continued to slowly reclaim them.[15]

Despite the decline in NSW Molybdenum mining, metallurgical advances during the twentieth century eventually allowed for a resurgence in Molybdenum mining elsewhere, as well as for peacetime uses. Very large deposits overseas were able to be opened up, while the Second World War saw further exploitation of the metal.

Today the main supplies of Molybdenum come from North America, Chile, Peru and China; these three areas supply over 90% of the world's production, which presently is about 200,000 tonnes annually.[16] Following a price spike in Molybdenum oxide in 2004-05 to around US$46 per pound, the price is now around US$12.[17] By comparison, Australia's production and exploration are very meagre. However, in good news for the Australian industry in 2019 the Australian Radiation Protection and Nuclear Safety Agency granted the Australian Nuclear Science and Technology Organisation permission to begin production of Molybdenum-99 (Mo-99) for Australian and international markets at Lucas Heights. Mo-99 is the 'parent isotope' of Technetium-99m, which is used for diagnostic imaging of cancer tumours and cardiac and renal imaging. The irony is extreme, as in the early twentieth century Australian Molybdenum was used to destroy lives – now it is used to save them.[18]

Figure 4: *Queensgate Mine; the quartz seam is very visible at left.*

Source: Author's photo 2019.

What survives today of the Black Range mines? Using Andrews' and Hall's maps I set about locating remaining sites. Crucially, those maps showed the relationship of the shafts and the treatment plant to nearby portion boundaries, and also the portion numbers. From there I went to the local parish map (Parish of Kameruka, 1926) to find out where the portions were located. From there it was on to the present-day topographical map (Bega and Wolumla sheets) on which the cadastral boundary data was shown, superimposed over topographical features and tracks. I then marked on a copy of the topo the likely locations of the mines.

I sought and found Scotts, Josephs, Queensgate, Finucane's two shafts (one more like a small open cut), Gleesons Mine, plus the treatment works site. The sites are in thick forest and while the first two are not far from tracks, the rest require longer walks and some steep descents down thickly forested slopes. Each of the shafts is impressive for reflecting the amount of hard manual labour expended by men with hand tools and primitive explosives in search of the metal. Scotts is partly filled by rubbish. Josephs is half filled by water (interesting given its location almost on the top of Black Range - an indication of springs, certainly) and features some remnant timbering. Queensgate is particularly impressive [Fig. 4], with some timberwork and a strong sense of depth (especially when you are leaning over the top to get a look and a photo!). The same can be said for Finucane's main shaft, which disappears into mysterious dark depths; there is also hand-packed stonework along part of the old access track too. Gleesons by contrast is shallow, indicating a likely shaft collapse at some time. At two of the three shafts the quartz seam followed down by the miners is readily visible, particularly at Queensgate. Quartz mullock is present in considerable volume at the sites, and shallow prospecting excavations are found at various points on the range.

Figure 5: *Concrete troughs at the treatment plant.*

Source: Author's photo 2019.

Figure 6: *Molybdenite in quartz mullock at Scotts Mine.*

Source: Author's photo 2019, with assistance from John Magee.

At the treatment plant, the main surviving element is the concrete troughs [Fig. 5], and part of a foundation of the crusher complex is still visible. There is a windlass/hand winch and an old-style ship's water tank, but a very small amount of timber framing is all that survives of the buildings. Terraces are benched into the steep slope and would have been the locations of huts and perhaps the bottom of the access track. A longer section of the access track is found on the slopes above Gleesons shaft. This track and its direction provide further support for my earlier assertion about the direction of access available to Andrews in 1916. It should be noted that the sites are on private land and permission from the owner/s should be sought prior to any attempt to enter.

The Black Range Molybdenum mines survive today to remind us of one local NSW manifestation of an important industry from the years of the First World War,

when, as usual, international markets shaped the fortunes of local mining endeavours deep in the Australian bush.

Figure 7: *Hand-packed stonework on the Finucane Track*

Source: Author's photo 2019.

Endnotes

[1] Royal Society of Chemistry http://www.rsc.org/periodic-table/element/42/molybdenum accessed 19 June 2019; accessed 19 June 2019; LiveScience, https://www.livescience.com/34687-molybdenum.html accessed 19 June 2019.

[2] Unit conversion in this paper: 1 foot = 0.3048 m, 1 yard = 0.9144 m; 1 pound (lb) = 0.454 kg, 1 ton (long) = 2,240 pounds (lbs) = 1.01604 tonnes.

[3] *The Northern Miner*, 15 April 1915; LiveScience, https://www.livescience.com/34687-molybdenum.html accessed 19 June 2019.

[4] *The Northern Miner*, 15 April 1915; E.C. Andrews, *The Molybdenum Industry in New South Wales*, Mineral Resources No. 24, New South Wales Department of Mines, 1916; *Sydney Morning Herald*, 8 June 1915; *The Australian Worker*, 10 June 1915.

[5] Andrews, *The Molybdenum Industry in New South Wales,* p. 22; *Nambucca and Bellinger News,* 9 February 1917; *The Sun*, 11 February 1917; NSW Department of Mines *Annual Report,* 1919.

[6] Andrews, *The Molybdenum Industry in New South Wales*, pp. 3, 60.

[7] *Ibid.,* pp. 35-36.

[8] *Ibid.,* p. 62; NSW Department of Mines *Annual Reports*, 1889, 1895-99, 1901.

[9] Andrews, *The Molybdenum Industry in New South Wales,* pp. 35, 36, 62.

[10] *Ibid.,* pp. 60-62.

[11] *Ibid.,* p. 62.

[12] *Ibid.,* pp.12-13.

[13] NSW Department of Mines, *Annual Reports*, 1919-46.

[14] L.R. Hall, 'Black Range Molybdenum Deposits', NSW Department of Mines Geological Survey, December 1954; NSW Department of Mines *Annual Report* 1954; *Weekly Times* (Melbourne), 2 June 1954; *The Farmer and Settler*, 7 October 1955.

[15] Anton Gowing and Rob Russell, personal communication to author, 21 and 22 June 2019.

[16] Royal Society of Chemistry, http://www.rsc.org/periodic-table/element/42/molybdenum accessed 19 June 2019; LiveScience https://www.livescience.com/34687-molybdenum.html accessed 19 June 2019.

[17] http://www.infomine.com/investment/metal-prices/molybdenum-oxide/all/ accessed 19 June 2019.

[18] https://www.arpansa.gov.au/news/arpansa-authorises-ansto-cpmmence-routine-production-molybdenum-99-anm-facility accessed 19 June 2019.