# THE KINGSGATE MINES

John Paix Glen Innes 1988 ©

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## HISTORY OF THE KINGSGATE MINES

Following the first exploration of the Glen Innes area in 1835 by Duval and Chandler (the "Beardies"), squatters soon moved in and took possession of the more fertile and accessible parts. Kingsgate lies on the eastern side of this more favourable country and was settled by 1848. In those early years, little attention was given to the possibility of valuable minerals being found in the district. Things were soon to change.

The gold rushes which began in 1851 brought enormous numbers of immigrants into the country and inevitably prospectors were drawn to the streams and gullies of New England. Gold was discovered at Nundle in 1852 and east of Tenterfield in 1859. Along with the gold, the miners sometimes found dense black sand, more of a nuisance than anything else. First recognised as the valuable mineral cassiterite (tin oxide) at Dundee in 1853, it was not until 1872 that its potential was realised. In that year the great rushes to Tingha, Elsmore and Emmaville began.

In less than a year, prospectors were scouring New England from Armidale to the Queensland border and beyond, seeking this new "black gold". They found it in a host of places - Tingha, Newstead, Elsmore, Vegetable Creek, Torrington, Bald Nob, Wilson's Downfall, Stanthorpe and many more. As with gold, the rock outcrops from which the alluvial mineral was derived were eagerly sought too, for these offered the possibility of more permanent mines and greater wealth.

So it was that in 1872 prospectors acting on behalf of an Adelaide company came to Kingsgate, where 80 acres of land were secured for the purpose of mining tin. Small quantities of cassiterite were indeed found in the quartz outcrops, but, like the gold miners before them, the tin miners failed to notice or appreciate the other valuable minerals found there. The site was soon abandoned.

In 1877, a stockman on Yarrow Creek Station named J. Feeney picked up a large piece of a metallic mineral in the vicinity of the old tin workings. It was sent to Sydney for identification where it was shown to be native bismuth. About the same time, Hughie Quinn, a prospector, noticed a yellow

encrustation on a quartz outcrop on Leatherjacket Hill. (The site later became known as the No. 5 pipe, the famous "One and Nine".) Believing it to be sulfur, he showed it to Mr. W.H. Yates who was at that time mining tin on the Severn River near Bald Nob. Yates determined the mineral to be bismuth ochre (bismite or bismuth oxide, $Bi_2O_3$). The specimen was then shown to Mr. Ferguson, a Member of Parliament at that time, who recommended that the land on which the outcrops occurred be secured.

In 1879, Quinn and Ferguson leased 60 acres of the original tin leases for the purpose of mining bismuth. This prompted Feeney to secure a block lower down the gully, in company with John Rush and Mr. Say. Acting on advice from Quinn, Yates visited the area in 1880 and washed rich native bismuth from the rubble of a quartz pipe at a locality near the Yarrow River known locally as the Cattle Camp which he proceeded to lease for mining also. (This was evidently the No. 24 pipe, known as "the Forty" mine.) Meanwhile, Feeney sold his lease to Mr. Lewis, a storekeeper in Glen Innes, who, observing the isolated nature of the leases, suggested that all should be amalgamated. The Kingsgate Bismuth Company was thus formed and the holders then proceeded to obtain leases on the land between their blocks and on adjoining land where quartz outcrops were to be found.

Active prospecting for further quartz outcrops was also carried out by another local group, calling themselves the "Glen Innes Company". They located outcrops overlooked by the Kingsgate Bismuth Company and secured a lease of 25 acres. It was on this land that the famous "Old 45" pipe was later discovered.

The Kingsgate Company worked its mines until 1883, when they sold out to Messrs D. Marks and E. Vickery. Mr. Yates continued on as manager until 1889 when mining ceased, mainly due to the primitive recovery methods in use then. At this time, only bismuth minerals were recovered, the associated molybdenite being discarded. It was during this period that access roads and a water race from the Yarrow River were constructed. The Glen Innes Company followed a similar pattern, closing down operations in 1890 due to poor returns. Over the next few years, Yates continued to mine some bismuth and a number of other small mineral recoveries were made by prospectors.

In 1901, Mr. Valentine Sachs secured the land formerly leased by the Glen Innes Company and mined the main pipe on his block (No. 45) successfully until 1912. By 1907, molybdenite was beginning to contribute significantly to the profitability of the mines.

Marks and Vickery's mines continued to produce ore intermittently until 1905 when the property was sold to Yates. He progressively improved the milling and concentration of the ore. In 1912 Yates erected the Number 40 mill and the Upper mill to process the ore. At this stage 35 men were employed. In 1918 the

mines were sold to Kingsgate Molybdenite NL which planned a great expansion of production. It was intended to install a tramway haulage system and to centralise the air compressing plant to supply the various mines with the compressed air necessary to operate mining equipment.

Mr. Sachs sold his lease to the Glen Innes Molybdenite and Bismuth Company in 1912, which had little success in continuing operations. Sachs, meanwhile, took up further mining leases between those of the two companies under the name of the "Sachs of Kingsgate Molybdenite and Bismuth Syndicate". Further leases were secured by him to the south of the existing mines but in 1917 Sachs sold his leases to Thomas Lancaster who continued with limited mining and prospecting.

The outbreak of World War 1 greatly increased the demand for molybdenite, as molybdenum had become a vital metal in the manufacture of hardened steel for guns, tanks etc. Agreements with the British government to purchase molybdenite ran out in 1920 and the price of the mineral dropped so dramatically that there was virtually no market at all for several years. Only ore rich in bismuth had any value and little of this remained in the pipes being mined.

By the commencement of World War 11 the demand for molybdenite was being adequately met by the great mines at Climax, Colorado. The Kingsgate mines met a new need, however, as they became a source of flawless quartz crystals for use in radio equipment. Messrs M Priest, AA Goodwin and H Goodwin were involved in mining at this time but eventually the workings were taken over by AWA and Radio Corporation.

Mr H Quodling managed the quartz mining for AWA and around 10 men were employed extracting crystals from the old dumps with some coming from new work in the old shafts. The market for quartz declined rapidly from 1945 and activity ceased once more.

In 1948, Mr. E. Moskovits, acting for Kingsgate Mining Industries Pty Ltd, began producing molybdenite and wolfram concentrates, mostly by retreating old dump material. This period of production closed in 1952.

In 1966 and again in 1969 the field was investigated for its potential for the development of a low grade open cut mine. After extensive field work and testing by drilling, which brought discouraging results, the area was left to the fossickers once more.

**KINGSGATE MINERALS**

The modern visitor to Kingsgate mines is probably hoping to find specimens of the minerals for which the place is justly famous. It is a classic locality for quartz crystals and molybdenite in particular but many more minerals are likely to be found on the dumps. More than 30 different minerals have been recorded at Kingsgate and the collector should have no difficulty finding specimens of at least 10 of these. They fall into two categories: ore minerals and rock-forming minerals and this is the order in which we shall examine them.

**ORE MINERALS**

**Molybdenite**, $MoS_2$. This is the most obvious of the metallic minerals, easily recognised by its high metallic lustre and extreme softness. With a hardness of only 1 - 1.5, it will readily mark the fingers when handled. It is widespread on the mullock heaps, standing out against the white quartz in which it is frequently embedded. Careful searching will reveal specimens showing the hexagonal crystal shape and others displaying alteration to the yellow mineral ferrimolybdite. Specimens may also be found in which the crystals are found together as small rosettes.

**Bismuth**, Bi. A much more difficult mineral to find on the dumps, due to its greater value. Native bismuth is a brittle silver-white mineral with a distinctly pinkish tinge. It is relatively soft (2 - 2.5) and has a shiny silver-white streak, which is easily seen when specimens are rubbed against a piece of white quartz. The bismuth was usually found as masses between quartz crystals and occasionally as wires within white or transparent quartz.

**Wolframite** (variety ferberite), $(Fe,Mn)WO_4$. A dense, brown to black mineral, wolframite is found scattered in pieces through the dumps. It has a prominent cleavage, making it easy to recognise because of the flat, lustrous surfaces created. It is comparatively scarce, but easy to recognise.

**Cassiterite**, $SnO_2$ (tinstone). It was this mineral which the first prospectors were seeking at Kingsgate in 1872. It is scarce, being found in few of the pipes. Cassiterite is a hard, dense mineral, usually brown or black. Despite its colour, its streak is white unlike any of the other dark minerals likely to be found at Kingsgate.

**Arsenopyrite**, FeAsS (mispickel, arsenical pyrites). Another mineral with a metallic lustre, arsenopyrite is silver-white in colour with a black streak. It is much harder than bismuth and easily distinguished from it by its streak. It occurs plentifully in some pipes, usually as large masses in white reef quartz but is scarce in most.

**Bismuthinite**, $Bi_2S_3$. This is a rare mineral which was encountered in some pipes at Kingsgate in masses several kilograms in weight. It resembles native bismuth, with which it is often found, but is somewhat darker both in colour and streak.

**Ferrimolybdite**, $Fe_2(MoO_4)_3.8H_2O$ (molybdite, molybdic ochre). Once thought to be molybdenum oxide, this canary yellow mineral is a common alteration product of molybdenite, with which it is often found. When found as crystals it occurs as tufts of acicular crystals up to 1 cm long.

**Powellite**, $CaMoO_4$, with some tungsten substituting for molybdenum. Powellite forms by the alteration of molybdenite and is itself altered to ferrimolybdite. It is a rare mineral found in tetragonal crystals of bipyramidal habit of hardness 3.5 - 4. Its colour varies from yellow through greenish blue to nearly black.

**Bismite**, $Bi_2O_3$ (bismuth ochre). This is a somewhat earthy yellow to greyish green mineral found as an oxidation product of bismuth and bismuthinite, with which it is likely to be found. It occurs as fibrous masses in cavities in the quartz.

**Bismutite**, $(BiO)_2CO_3$. Another secondary bismuth mineral, this was one of the first bismuth minerals to be recognised at Kingsgate. It occurs as straw-yellow pseudomorphs after bismuthinite. It has sometimes been mistaken for gold by beginners, as it occasionally turns up in the prospector's dish. Unlike gold, particles of bismutite can easily be crushed to a powder.

**Scorodite**, $FeAsO_4.2H_2O$ forms as an oxidation product of arsenopyrite. It is found as green botryoidal masses lining cavities in reef quartz formerly occupied by arsenopyrite.

**Pyrrhotite**, FeS, is occasionally found on the dumps. It has a metallic lustre, with a typically yellow-grey colour. Its streak is dark greyish black. The mineral is frequently slightly magnetic and oxidises on exposure to an iridescent surface.

**Pyrite**, $FeS_2$, is occasionally found as pale brass-yellow cubes with an intense metallic lustre. Its streak is typically greenish black.

**Chalcopyrite**, $CuFeS_2$, resembles pyrite but has a more golden colour. Surfaces are frequently tarnished and iridescent.

**Galena**, PbS, occurs from time to time as brilliant grey cubes, which cleave easily in a cubic fashion. Galena is denser than most minerals with a metallic lustre.

**Galenobismutite**, $PbBi_2S_4$, has been reported as greenish silver coloured masses up to 5cm across in molybdenite.

**Ikunolite**, $Bi_4(S,Se)_3$, is a rare mineral which has been reported at Kingsgate as plates and foliated masses with a prominent basal cleavage, lead-grey in colour.

**Joseite**, $Bi_3TeS$, is another rare mineral reported from Kingsgate. It is a soft greyish mineral displaying one perfect cleavage.

**Cosalite**, $Pb_2Bi_2S_5$, has been found from time to time as metallic lead-grey needle-like crystals.

**Pyrargyrite**, $Ag_3SbS_3$ (ruby silver), has been reported as soft, deep red prisms. The crystals display an adamantine lustre.

**Gold**, Au and **Silver**, Ag, have appeared in significant quantities in some chemical analyses of ore samples.

**Brookite**, **gudmundite**, **sphalerite**, **chalcocite**, **covellite**, **marcasite**, **smythite**, **goethite**, **ilsemannite**, **tungstite** and **wulfenite** have all become recorded at various times.

**ROCK-FORMING MINERALS**

**Quartz** ($SiO_2$) is the overwhelmingly obvious mineral to be found at Kingsgate. The pipes consist essentially of quartz in which the ore minerals are embedded. The quartz varies a great deal from massive to individual crystals up to 200 kg in weight, from milky to glass clear, smoky and rutilated. It is found as single crystals and as a variety of twin types. It is found alone and in company with crystals of the various ore minerals. Specimens of all types can still be found on the dumps and have made their way into collections all over Australia and beyond.

**Rock Crystal**. This is the term applied to the colourless variety of quartz which is much sought after for faceting, carving and just as specimens. It is not as simple as it might seem to find completely flawless material. Thousands of collectors have been to Kingsgate over the years to gather just such specimens. It will probably be necessary to search the more remote dumps and to dig deeply into them to locate the best material.

**Smoky Quartz** (cairngorm). Also much sought after, the colour of this variety ranges from a smoky yellow to brown or almost black. The colour is believed to be the result of partial decomposition of the quartz by exposure to radiation

from radioactive minerals. The presence of aluminium substituting for silicon atoms in the crystal lattice seems also to be essential. Smoky quartz can sometimes be decolorised by heat, the effect becoming noticeable above 225$^{o}$ and rapid above 450$^{o}$. Some of the colour can be retained in a deeply coloured specimen by stopping the process before it is complete.

**Citrine** is the yellow to orange variety of quartz. Its colour appears to be due to the presence of small amounts of colloidal hydrated iron (111) oxide. Good specimens are not easy to find at Kingsgate, but some types of smoky quartz, evidently containing the necessary impurity, will turn into citrine when heated.

**Amethyst**, the much admired violet variety of quartz, is even scarcer at Kingsgate than citrine, which it much resembles chemically. The colour is due to the presence of iron (111) possibly substituting for silicon in the lattice. Strong heat will convert amethyst into an orange citrine.

**Quartz with Inclusions**. The following have been reported from Kingsgate: rutilated quartz (grass stone) contains fine needles of rutile ($TiO_2$) penetrating the quartz. It has occasionally been found at Kingsgate. Arsenopyrite, bismuth, bismuthinite and molybdenite are fairly frequently found.

**Calcite** ($CaCO_3$) occurs in white cleavable masses in some pipes.

**Muscovite** mica, as the variety **sericite**, is plentiful in the pipes, where it has been produced by the alteration of the original felspar. It can be recognised by its silky lustre, softness and lack of visible crystals.

**Topaz** and **garnet** (variety unspecified) have been reported from the dumps. Finding these would have to be regarded as a bonus.

**THE GEOLOGY OF KINGSGATE**

The casual visitor may overlook the intimate relationship between the ore bearing pipes and the granite/metamorphics contact, but the miners were well aware that the ore bodies were always found within the granite and never more than a few hundred metres from its margin. That this is more than a co-incidence was borne out during mining when it was often found that the pipes dipped into the earth more or less parallel to the contact.

It will be necessary to examine briefly the geological structure of the district to understand the origin of the mineral deposits. The rocks throughout New England reveal a complex history of marine and nonmarine sedimentation, explosive volcanic activity and widespread intrusion of granitic magma. This is consistent with what is found today along growing continental margins, where marine sediments are subducted beneath thicker continental crust by plate movements. Such a situation occurs today in Japan, which probably resembles the New England of the late Palaeozoic era. At Kingsgate, metamorphosed sediments of probable Permian age have been intruded by late Permian/early Triassic granite. Mineralisation is confined to 70 or more roughly cylindrical ore bodies within the granite, at a short distance from its intrusive contact.

Molybdenum mineralisation in New England is mostly located in a NE/SW trending zone including the deposits at Wunglebung, Deepwater, Glen Eden, Kingsgate and Booralong. At each place the mineralisation is near an intrusive granite margin, sometimes in pipe formations (as at Kingsgate and Deepwater) and sometimes associated with aplite and pegmatite bodies within the granite (as at Booralong). Similar relationships have been observed in North Queensland deposits. It would appear that volatile components of the magma, containing quartz, sulfur, bismuth and molybdenum in solution, have crystallised within the mostly solidified granite at a late stage of the cooling of the intrusion.

The most prominent of the igneous rocks at Kingsgate is a coarse, mottled grey adamellite, rich in quartz and orthoclase, nonporphyritic and with no apparent structure. It differs noticeably from the tin bearing granites seen, for example, at Torrington. The common dark minerals within the granite are biotite and hornblende. However, this rock does not appear to be the actual host rock for the deposits, which is more likely to a very acid granite usually not seen in outcrop but generally reduced to a thick gravelly soil. Several other granitic bodies also outcrop in the area. The former sedimentary rocks intruded by the granite may be seen in road cuttings below the mines and along the Yarrow

River. They are essentially altered siltstone of presumed Permian age. No fossils are known from these rocks at Kingsgate, but Permian marine fossils have been found in similar rocks further south.

There has been considerable speculation as to the reasons why the Kingsgate mineralisation occurs in the way it does. The best that can be said is that the pipes are separate intrusions into the main plutonic mass, whose location has been controlled by the pressure and temperature conditions prevailing at the time. The pipes are very irregular in shape and structure and frequently change direction, dip and diameter as they are followed downwards. Some are characterised by branches, others by their variation in diameter from a few centimetres to many metres across. In some the minerals completely fill the pipe, in others there are open spaces lined with huge quartz crystals. All are of the same essential character, being composed in part of granite in which the felspar has been altered to sericite, in part of quartz and in part of veins and segregations of ore minerals.

Sach's Pipe (the Old 45) has been studied in some detail. More information on individual pipes is to be found in the next chapter.

**DESCRIPTION AND LOCATION OF THE MAIN PIPES**

For much of this information, we are indebted to the geologists of the NSW Geological Survey, in particular to Mr. E.C. Andrews, whose work "*The Molybdenum Industry in New South Wales*" was published in 1916. To avoid any confusion with names and the numbering system, it needs to be understood that the numbers appearing on the map in Andrews' report are those assigned by Mr. W.H. Yates to pipes under his control in 1915. Numbers appearing as part of names refer to the Portions of Parish Kingsgate and therefore relate to the original mining leases of the 19th Century. Pipes under Sachs' control at that time or under the control of other miners and prospectors were either not numbered at all or assigned letters. The descriptions which follow treat the pipes essentially in order from the north, Portion by Portion.

**Portion 24**.

1. Known as “Quinn's Find” - a prospect only.

**Portion 6**. (originally leased by Feeney, Rush and Say in 1879)

2. Dips at 1:2; a branching pipe, an unimportant producer.

3. Prospect only.

4. Small vertical pipe.

**Portion 1**.

47. The “Swamp Blow”. A prospect north of the present main road in a swampy area.

5. Usually known as the "One and Nine" from its location on the portion boundaries. This pipe has been an important producer of both bismuth and molybdenite and is apparently the site of Quinn's discovery of "sulfur" in 1877. The upper part of the pipe has been mined as an open cut which now lies quite close to the main road. In cross section, the pipe varied in diameter from 1 to 8 metres. It has been mined to a depth of about 85 metres, and consisted essentially of a gangue of well crystallised quartz with rich deposits of bismuth and molybdenite. Vughs lined with crystals of white and black quartz crystals up to 1.2 metres in length were found. Several branches of the main pipe were noted at depth.

6. Prospect only.

**Portion 9**.
7. The “Water Shaft”, “Tin Shaft” or “Tin Show”. This was the second pipe to be prospected in 1872. Small quantities of cassiterite were found in the quartz. The pipe, which is nearly vertical, has been prospected to a depth of 12 metres.

45. Known as "Jack's at Home". Prospect only.

46. Prospect only.

**Portion 100**. (Originally in four blocks, leased by Quinn & Ferguson in 1879)
9. “Bill Miller's Hole”. A fairly large but poor pipe prospected to a depth of 10 metres.

40. “Jubilee Pipe”. A surface prospect only.

48. Prospect only.

10. The “Wolfram Pipe”, “Wolfram Blow”, “Old 26” or “Little Tunnel”. This particular pipe was the one originally prospected in 1872. While it contains a little cassiterite in a massive white quartz gangue, the pipe is notable for the quantities of wolframite and arsenopyrite it contains along with the usual bismuth and molybdenite. Both can be readily found on the dumps. Initially mined as an open cut, it was later worked by a tunnel to a depth of 30 metres. The maximum diameter reported was 3.7 metres. Commercial quantities of wolframite were mined here in 1950-52.

31. Prospect only.

37. “Tom Key's Hole” or the “Chimney Shaft”. A fairly small, steeply dipping pipe worked to a depth of over 45 metres.

8. The “Black Shaft” or “26 East”. This large pipe produced substantial quantities of ore in the early days, when it was followed down to a vertical depth of over 40 metres.

11. “Mick's Shaft”. A vertical pipe of moderate dimensions.

12. Prospected at the surface only

35. The “Granite Shaft”. Instead of the usual quartz, the molybdenite and bismuth were found here in a gangue of granite, in which the felspar was largely sericitised. The pipe, a moderately deep one, dips steeply and branches into two at depth. It has been mined to a depth of at least 40 metres. For the

first 30 metres, the ore occurred in the granite itself. One branch continued as granite, the other was a typical quartz pipe.

36. Known as the “25 Northwest No.2 Pipe”. It is small and has been prospected to only a shallow depth.

34. The “Mount Morgan Pipe” is a large pipe (up to 7.6 metres across) located at the highest point on the plateau, on top of a rocky knoll on the left of the access track. It dips quite steeply to a depth of more than 50 metres below the surface. The workings are still fairly accessible but should not be entered.

32. The “25 West”. A surface prospect only.

13. The “25 North”. This pipe has been one of the largest producers of both bismuth and molybdenite at Kingsgate. It has been followed down to over 150 metres from the surface, at first at a fairly shallow angle, then more steeply when it became necessary to sink a vertical shaft to facilitate mining. The pipe branches at several places. The quartz gangue was in places marked by large vughs which were lined by huge quartz crystals. The dumps of this mine yielded quantities of radio quality quartz during World War 11.

14. The “Old 25”. This was another pipe first mined as an open cut and later mined underground. Mined to a depth of 76 metres, the Old 25 was one of the largest pipes on the field. A haulage tunnel was driven into the base of the workings to facilitate access. Most of the workings are still accessible but should not be entered. The mine lies to the right of the access track and its dump also yielded crystals during the war. More recently the dumps have yielded many fine mineral specimens.

38. “25 South No.2”. A fairly shallow prospecting shaft.

33. “25 South”. Similar to its neighbour.

15. “Weidmeyer's Cutting”. A vertical pipe of moderate dimensions mined to a depth of 30 metres.

16. “Martin's Hole”. A small vertical pipe.

**Portion 27**.
17. Prospect only.

**Portion 28**.
18. “Schoolhouse Blow”. Prospect only.

19. “Magazine” or “Windlass Shaft”. Prospect only.

21. “28 South”. Prospected on the surface only.

**Portion 42**.
20. Prospect only.

**Portion 49**.
22. Prospect only.

**Portion 40**. (Yates' original lease of 1880)
23. “Forty North”. This was another of the very productive pipes. It was originally abandoned because of its poor showing on the surface, but rich bismuth ore was later discovered in it by the discharge of water from a race eroding the weathered granite. The pipe descends in stages to at least 30 metres below the surface. The quartz gangue was at times either massive or cavernous, containing grey and black crystals. Both bismuth and molybdenite were mined in large amounts.

24. “Forty” adjoins Forty North to the south. The surface rubble of white quartz yielded much bismuth which was followed downwards in an open cut for about 6 metres. In later years the pipe was followed vertically for about 90 metres, continuing to produce quantities of bismuth and lesser quantities of molybdenite. The quartz occurred in massive form and as large white and smoky crystals.

39. Prospect only.

41. “Road Block Pipe”. A small unimportant hole about 10 metres deep.

42. Prospect only.

25. “Forty South”. Another small producer about 20 metres deep.

51. “The Reef Blow” is a pipe with three main branches, initially mined in a gently inclined tunnel which later became vertical. Both bismuth and molybdenite were produced.

**Portion 41**.
44. A small pipe mined for quartz in 1942.

26. “Jim Marshall's Hole”. A surface prospect only.

27. Prospect only.

28. Known as the “Arsenic Blow”, “Arsenic Shaft” or “Hagen's Tribute”. This is another of the pipes known from the early days of the field. Like many of the pipes, it was first mined as an open cut but subsequently underground as the

dip of the pipe changed from vertical to nearly horizontal and vertical again as the pipe was followed down. The pipe was approximately 3 metres in diameter and was traced downwards for about 60 metres. The gangue was, as usual, quartz - sometimes massive and frequently cavernous. Some of the vughs encountered were more than 3 metres long, lined with large quartz crystals. In 1942 the old shaft was dewatered and the mine worked again specifically for quartz crystal. The Arsenic Shaft appears to have been the main producer of crystal at Kingsgate.

43. “Christie's Blow”. A prospect only.

**ML 45 and Adjoining Leases**.
“Monkey Shaft”. Described as more of a vein than a pipe, it was worked to a depth of about 13 metres. At depth the vein gave way to a true quartz pipe. This deposit was among several in this corner of the field tested for crystal in 1942.

“The Wet Shaft”, “Water Cut” or “Wet Cut”. This pipe was mined to a depth of about 60 metres, producing good yields of both bismuth and molybdenite. The quartz gangue was noticeably cavernous and the dumps were turned over for crystal during the war.

The “Old 45” or “Sachs' Pipe”. This pipe is the most famous of all those at Kingsgate because of the exceptional masses of molybdenite extracted from it. It probably produced more mineral than any other pipe on the field. It was first worked for bismuth but was then abandoned because of the high molybdenite content of the ore which made it difficult for the miners to produce a pure bismuth concentrate. In 1902 the mine was reopened by Mr. Valentine Sachs, who soon discovered a large vugh more than 15 metres across. This extraordinary cavity was lined with massive quartz and molybdenite crystals. One piece of solid molybdenite removed was said to have weighed about 1 tonne. After producing many tonnes of ore, Sachs evidently lost the course of the pipe and therefore sold the mine. The new owners subsequently discovered that the pipe had constricted to only 50 cm in diameter. They followed the pipe downwards, but no further bonanzas of ore were located. The total length of the workings approaches 100 metres, most of which is still accessible.

“Goodwin's Pipe” was mined to a depth of about 60 metres at an angle of about 45$^{o}$. Good yields of bismuth and molybdenite were obtained. Because access was from a cutting just above creek level, the workings are now completely flooded. Calcite cementing pieces of quartz pipe material was a feature of this pipe.

**Portion 44**.
29. “The Hard Blow”. A small pipe mined to only a shallow depth.

49. Prospect only.

30. “Sachs' Folly”. Prospected on the surface only.

50. “Nield's Blow”. Prospect only.

**ML 90** (formerly “Sachs' Prospecting Area”.
F. This pipe, also known as “Potter's Claim”, yielded fairly large amounts of ore.

G. Known as the “Reef Blow”. (Not to be confused with Pipe 51 also of that name.) This is another of those pipes which appeared more like a vein in places. It produced good yields of molybdenite.

H. “The Giant Blow” is well known for the very large doubly terminated quartz crystals found in the gangue. These were first located right at the surface. The pipe produced quantities of bismuth and molybdenite from an open cut which was then followed down into underground workings. These are still accessible.

I. No details available.

J. No details available.

**ML 55** (formerly “Pauline Speckhardt's Lease”
A. A small pipe containing both bismuth and molybdenite in minor quantities.

B. This fairly small pipe produced many tonnes of rich ore containing both metals.

C. This pipe, followed down for more than 30 metres, produced bismuth in fair amounts.

D. No details available.

E. No details available.

**Mines South of Yarrow River**.
From Kingsgate, the boundary between the Permian metasediments and the granite has been traced southwards for many kilometres. Ore bearing pipes have been found in two areas across the Yarrow River not far from the Kingsgate pipes and obviously related to them.

**Portion 19, Parish Yarrow**.
The “Dodger Claim” (“Maurer's Claim”) includes 4 pipes near the granite boundary.

1. Yielded good quantities of both bismuth and molybdenite. The pipe is relatively large by Kingsgate standards.

2. A smaller pipe with smaller quantities of molybdenite.

3. Another pipe of moderate size followed down for at least 20 metres. Good quantities of both bismuth and molybdenite were mined along with large amounts of well crystallised quartz, generally smoky.

4. Similar to the previous pipe.

**Portions 20-23**.
More pipes have been prospected in this area, a little north of the Pretty Valley Road.

**EXTRACTS FROM PREVIOUSLY PUBLISHED SOURCES**
**Annual Report of the Department of Mines, N.S.W. for 1882**. pp 27-29.
"*The formations here are granite and altered slate, forming rough broken country, with valleys about 500 feet deep. The line of junction is well defined and the bismuth lodes occur in the granite in proximity to this line or within about 400 yards from it.*

*The mode of occurrence of these so-called lodes is very remarkable; they are "pipe-veins" or oval masses of quartz of variable thickness, descending in a more or less vertical direction in the granite, as though well-like caverns of very irregular diameter have been formed in the granite and filled with quartz and metallic minerals.*

*Thus in one lode in the Kingsgate Company's property two masses of quartz (which the Manager, Mr. W. Yates, informed me were 30 feet apart at the surface), on being followed down, united and formed one large pipe-vein about 27 feet in diameter and of irregular shape, from portions of it protruding here and there into the granite. Nests of bismuth ore (native bismuth, sulphide, carbonate and oxide of bismuth) were obtained about these protruding portions as well as through the mass of quartz; and in order to take out the vein-stone a large excavation about 60 feet by 40 feet has been made.*

*The vein has only been sunk upon to a depth of 50 feet. The quartz is of a coarsely crystalline nature and contains, in patches, a considerable quantity of molybdenite. The metallic bismuth and sulphide occur in the solid quartz, but the carbonate and oxide lie chiefly in the joint fissures in the quartz.*

*Sometimes masses of native bismuth are found between crystals of quartz in the vein, and when removed the impress of the quartz crystals is well shown. Some splendid specimens, from 4 to 6 lbs. in weight, from this mine were presented by*

*the company to the Mining and Geological Museum; some of them have been forwarded to the Amsterdam Exhibition.*

*The largest mass of native bismuth found here weighed nearly 30 lbs.*

*Other similar veins, but smaller, have been proved, though only for a few feet in depth; one contains much arsenical pyrites and hexagonal plates of molybdenite. An average sample of these sulphides gave on assay metallic bismuth, 2.6%, fine gold, at the rate of 8 dwts per ton, silver, at the rate of 3 ozs, 5 dwts per ton.*

*Several veins of a similar nature have been opened at the Glen Innes Company's property, which adjoins that of the Kingsgate Company. The Company is now sinking upon a vein which is said to have been 1 foot wide at the surface, but when I saw it at a depth of 40 feet, the lowest level then reached, it was 4 feet wide. This vein is in granite, and close to the boundary of the slate formation. The vein stuff is thickly studded with large brilliant steel-grey plates of molybdenite, some of them being more than 3 inches in diameter. Nodules of native bismuth, larger than walnuts, with carbonate, sulphide and oxide of bismuth, occur through the vein, and in greater quantity in places where the molybdenite becomes abundant.*

*Some of the lodes at Kingsgate were originally taken up in 1871 for tin mining, but it is said that J. Feeney, a stockman on Yarrow Creek Station, was the first discoverer of the bismuth, in the year 1877. I am informed that the quantity of bismuth ore raised from these mines during the last four years is about 40 tons. Hitherto the vein-stuff has been very imperfectly treated by hand-crushing and washing, and there is no doubt that by this rude process much of the fine oxide and carbonate of bismuth have been lost. It will always be a difficult matter to save these ores, when they are in a fine state of division, by the simple process of "streaming" or washing. In my opinion reduction furnaces should be used.*

*The Kingsgate Company is now cutting a long race for bringing water from the Yarrow Creek to the mines for the purpose of washing the ore on a large scale. When efficient appliances have been introduced for the treatment of the ores I believe that the bismuth mines of the district will become of considerable importance.*"

**ditto**, p77 "*Two local companies hold all the land in which this metal has been found in payable quantities at Kingsgate, but beyond sinking trial shafts and raising sufficient ore to pay current expenses nothing has been done to place the industry on a permanent footing. The Kingsgate Bismuth has I believe entered into an agreement with some Sydney capitalists to transfer their rights in the mines on an early date, and the bulk of the purchase money has been paid.*

*On completion of the sale, and when in the hands of the new and wealthy proprietary it is reasonable to suppose that greater energy will be brought to bear*

*in developing what appears to be a valuable property. The Glen Innes Company possesses an equally rich tract of mineral land, but as in the former case operations at this mine are hindered by the want of sufficient capital to carry the initiatory proceedings to a successful issue.*

*The native bismuth forwarded by me to the Department for transmission to the Amsterdam Exhibition was obtained from pockets in the quartz matrix at this place, but usually the ore is more evenly disseminated through the lode. One parcel of ore from this mine showed under assay by the Government Analyst 123 ounces of silver to the ton.*

*Account sales of bismuth ore in London are of too conflicting a character to be quoted as determining the value of the material in the home market.*"

**Annual Report of the Department of Mines, N.S.W. for 1887** p 88.
"*It is very difficult to obtain reliable data on which to found an estimate of the output and value of this metal, as the manager of the only mine actually at work (the Kingsgate), acting under instructions from his principals, declines to give any information on those points. A personal inspection of the mine early in January showed me that 40 men and 20 boys were at work at various shafts and tunnels on the company's lands, and that a large amount of excavation had been effected during the year in searching for the mineral. The ore is not found in fissure lodes, as is usually the case with other metals, but in irregular shaped cavities termed "pipes", which have been followed downwards in the granite rocks to a depth in some instances of 100 feet.*

*The ore is roughly broken, hand-picked, and worked before being bagged for shipment to England, and averages about 50% under this treatment.*

*According to the railway returns, 35 tons 9cwt. 1 qr. 25 lbs were forwarded during the year to Newcastle; and I believe this to have been about the output of the mine for the past twelve months.*

*At the adjoining (Glen Innes) mine, very little work has been done, in consequence, I believe, of a want of sufficient capital; but it is to all appearance as rich in bismuth as its neighbour, and is said moreover to contain some valuable ores of silver.*

*The country is generally of coarse granitic formation, overlaid in places with a thin crust of basalt. The bismuth-bearing granite rock is well defined, and cut off on the north, east and west by a broad belt of slate, beyond which in those directions none of that metal has been found.*"

**Annual Report of the Department of Mines, N.S.W. for 1918** pp 52-53.

"*The principle mine is that now worked by the Kingsgate Molybdenite No Liability. This was, in February, acquired from Mr. W.H. Yates, and is one of the biggest producers of molybdenite and bismuth in New England. Whilst held by Mr. Yates (up to 5th February 1918) 11 tons 3 cwt. of molybdenite ore were raised, valued at £1 454, and 2 tons 12 cwt. of bismuth were won, valued at £992.*

*Operations were carried out by the new company from the 5th March to the 25th October, 1918, and during that time 1 018 tons of molybdenite valued at £2 112 13s 5d, also 7.5 tons of bismuth, valued at £2 288 . Forty five men are employed on this mine. There are fifty-four known and proved pipes on this property containing molybdenite and bismuth, the majority of which have not yet been worked.*

*The value of the old mill is estimated at £2 000, but active mining operations have ceased and a new milling and mining plant (estimated to cost £14 000) is now in the course of erection and should be operating in April, 1919. The new mill will comprise a No 1 Dodge breaker, 25 X 14 rolls, May Brothers jig, four Wilfley tables, two forward down grinding pans, two vanners, an eight-cell minerals separation flotation plant, and a one-cell mineral separation subaeration machine. The power will consist of two 100 H.P. multitubular boilers, one 165 H.P. Davy Paxman cross compound steam engine, one 35 H.P. Tangye engine with electric generator and motors. The mining plant will consist of a 14 in. X 12 in. belt-driven Ingersoll-Rand compressor, four jack hammer drills and one stope-hammer drill. One and half miles of 3.5 in., 2 in., and 1.5 in. pipe line for compressed air mains is now being laid for drilling, hauling, ventilating and pumping.*

*It is proposed to mine 75 tons of pipe material per day, and by hand picking or sorting reduce it to 25 tons per day for milling purpose.*

*The Glen Innes Molybdenite and Bismuth Syndicate. This syndicate are the holders of a lease of 25.5 acres, being portion of mineral lease 45 at Kingsgate. Practically no work has been carried out during the year as the syndicate have exhausted their capital, but an attempt is being made to raise further capital to enable them to continue sinking in an endeavour to obtain the rich pipe formation which was lost some years ago.*"

**Annual Report of the Department of Mines, N.S.W., for 1920** p34.
"*The Kingsgate Molybdenite Co. treated 2 294 tons of pipe formation for a return of 8 tons 15 cwts of molybdenite concentrates valued at £4 370. Machinery to the value of £24 000 has been erected by this company. The deposits at Kingsgate rank among the richest in the Commonwealth and occasionally heavy masses of the mineral are found in a solid formation in the pipes.*

*The Glen Innes Molybdenite and Bismuth Syndicate won £120 worth of molybdenite during the year. A.A. Veness and party treated 60 tons of ore for a return of 16 cwt. valued at £408. Marshall and party raised 100 tons, 40 tons of*

*which yielded 7 cwt 3 qrs. of molybdenite valued at £141. Other owners produced smaller quantities.*"

**Annual Report of the Department of Mines, N.S.W., for 1921** p 34.
"*There has been no production of molybdenite during the year as there has been no sale for the mineral.*"

**Annual Report of the Department of Mines, N.S.W., for 1948** p 29.
"*During the year, J.W. Webster drove a tunnel some 120 feet to cut a bismuth pipe some 75 feet below its outcrop. At the end of the year the tunnel had not reached the pipe. E.E. Moscovits pumped out a number of bismuth bearing pipes on the south end of the field. During the coming year he expects to proceed with mining operations and the erection of a treatment plant.*"

**Department of Mines, N.S.W. - Geological Reports 1939-1945**. p 80.
"*The Kingsgate deposits are situated about 20 miles east of Glen Innes. Quartz pipes formerly worked for molybdenite and bismuth have yielded a small amount of quartz suitable for radio-communication purposes.*

*Since the outbreak of war a considerable amount of work has been done by M.W.J. Priest, on behalf of Amalgamated Wireless (Aust.) Ltd. and by J. Webster. To date Priest has recovered approximately 400 lbs weight of suitable crystal, principally by turning over the dumps on the "Old 45" lease. Webster's production is not known.*

*The Arsenic Shaft on M.L. 45 has been unwatered and reconditioned. Mining operations are now being carried out on the quartz pipe disclosed.*

*An old shaft approximately 60 feet deep on pipe No. 44 situated on Block 41 has been cleaned out and mining operations are now in progress. A small quantity of suitable crystal has been obtained from this shaft.*

*The Water Cut (Wet Shaft) on M.L. 45 parish Kingsgate is now being unwatered with aid from the Prospecting Vote. Perhaps the best samples of crystal recovered so far came from the dumps from this shaft.*

*It would appear that there are prospects of obtaining supplies of suitable crystal from the Kingsgate deposits, but it cannot be too strongly emphasised that the proportion of usable material will be very low and that mining costs will be very high.*"

**The Molybdenum Industry in N.S.W. by E.C. Andrews (N.S.W. Department of Mines, 1916)** p 9. A description of W.H. Yates' treatment plant in 1915.

"*The capacity is about 5 tons a day, and the cost of the plant erected was about £1 000. Two men and a boy are employed on the plant.*

*Ore with an average content of 3% bismuth and molybdenite is handfed from a plat to a No. 2 Dodge rockbreaker, and there crushed to pieces about 1 inch diameter. From the rockbreaker the ore passes through two sets of rollers, each having screens to save the large flakes of molybdenite as over-size. This over-size is re-rolled to reduce the quartz to a smaller gauge. Underneath the second pair or rolls a shaking screen is fixed. The holes in this shaking screen are about 1/12 inch diameter. The under-size passes on to a Wilfley table to save the bismuth, the tailing being stored pending probable improvements in treatment, such as some form of oil concentration.*

*The over-size from the 1/12 inch screen is carried to a third set of rolls where it is crushed to 1/20 inch gauge, and screened. Much of the over-size from this process is cleaned by hand-sieving. The first part of the over-size, however, is recrushed in rolls set close together, and passed over screens of 1/32 inch mesh. The over-size from this varies from 92-95% molybdenite. The under-size is a product rich in molybdenite, but considered below 90% fine.*

*A plant of type similar to this but costing, according to report, about £1 500, has been erected by the Glen Innes Molybdenite Mining Company on the Old 45, or Sachs' lease. A similar plant belongs to the "Sachs of Kingsgate" Company.*"

**Ditto** p9. A Description of a Typical Pipe.
"*If such a pipe be examined in cross-section from footwall to hanging wall it would be found that the granite country has been altered just below the footwall, the felspars being replaced by nests of hydrous mica, while in the footwall itself whole masses of this mica, soft and yellowish in colour, may be found. Granite would also be found in which the felspars had been replaced, first by certain products, then by mica, and this mica, in turn, by quartz, the original granite having been changed at this stage to a tough and granular quartzite.*

*The footwall of the pipe would consist typically of tight, granular, and interlocking quartz, of a dark colour, containing grains and massive crystalline native bismuth. Above this the quartz would be tight, dark and massive, with numerous small vughs showing portions of crystalline quartz, with bismuth and molybdenite. Above this much cairngorm is developed, typically crystalline in many places, and carrying little bismuth. Above this again, massive and crystalline quartz is commonly found. The quartz may be white, massive and brittle, or it may be in the form of huge crystals whose pointed ends project into large cavities. Quartz crystals also may lie in the cavities or may occur in the solid massive quartz. These crystals may vary in weight from a fraction of an ounce to £300 or £400, while they occur as forms closed by pyramids or points at both ends. The cavities mentioned here may be as much as 12 to 20 feet in length and several feet high besides being of considerable width. The hanging wall consists generally of*

*massive quartz containing nests of secondary mica which in many places is clearly a replacement of the felspar of the country rock.*"

**Ditto** p98 - The Molybdenite Bonanza in the Old 45 Pipe.
"*Mr. Valentine Sachs secured a lease of the No. 45 Block, and he commenced to send ore to Sydney in 1902 from the pipe, the ore being carted along the private road through the Kingsgate Freehold. A large and rich patch of molybdenite and bismuth ore was found by Mr. Sachs at a place where the pipe had been enlarged considerably. One very large piece of pure molybdenite was found in the great chamber excavated in the enlargement. The piece exceeded one ton in weight and had to be torn in pieces before it could be brought to the surface. A chamber about 60 feet in length, with a width and height varying from 12 to 25 feet, was excavated in the enlargement, and many tons of molybdenite were won therefrom.*

*The continuation of the pipe was lost, however, by Mr. Sachs, and after an eventful history the mine was acquired in 1912 by the Glen Innes Molybdenite and Bismuth Company; and in the same year the company known as the "Sachs of Kingsgate Molybdenite and Bismuth Syndicate" took up a lease for mining over a road lying between Mr. Yates freehold and the Glen Innes Molybdenite and Bismuth Company's lease.*

*The newcomers experienced great difficulty in finding the continuation of the 45 pipe below the great chamber excavated by Mr. Sachs. It was found, however, to have suffered a local constriction, the quartz immediately below the chamber not exceeding 18 inches in diameter and having a vertical direction.*"

**Ditto** p 110.
"*Mr. Hagen, manager for the company, made a careful examination in directions generally towards the claystone or slate in the vicinity. He actually cut the claystone in one place within a distance of 18 feet from the "hanging wall" of the deposit near the base of the old rich chamber. The floor of the chamber was then cleaned out and a bunch of quartz exposed therein about 18 inches in diameter, according to the statement of Mr. Hagen. This was then followed in a vertical direction for a depth of 30 feet, the size of the deposit being 4 or 5 feet in diameter, at a depth of a few feet below the chamber. Thence it was followed easterly for a distance of 25 feet along a very slight slope. At this point the pipe was still small, and it was followed thence in a vertical direction for a distance of 15 feet, where it appeared to split into two, each branch being small, one directed towards the north-north-east at a steep angle and the other towards the east first and then south-east at a steep angle.*

*The workings are approached by a tunnel about 100 feet in length, which intersects the pipe at a depth of 30 feet approximately below the outcrop in a vertical direction. The pipe in this upper portion dipped at an angle of 45 degrees, thence, for a distance of 50 feet, in a direction south-south-east it had a negligible slope, while beyond this division for a distance of about 100 feet or thereabouts,*

*the pipe maintained a direction, generally easterly, at a slope of about 1 in 2 (26 degrees).*

*In the lower portion of this underlie the great chamber was excavated, from which the rich body of molybdenite and bismuth was won.*"

**Molybdenum in N.S.W. (N.S.W. Department of Mines, 1978)** pp 53-55.
"*The famous Kingsgate pipes have yielded more molybdenum than any other deposits in the state. Indeed, Kingsgate is second only to Wolfram Camp, Queensland (also pipes), in molybdenite production in Australia. Total production of concentrates is approximately 350 t molybdenite, 200 t bismuth and 12 t wolframite-bismuth. Much of the ore was found as small bonanzas in a few of the pipes, of which No.45 (Sachs') is the most famous. One mass of pure molybdenite from this mine weighed more than a tonne. The mines at Kingsgate were opened in the early 1880's. They declined after the late 1920's. During World War 11, piezoelectric quartz, used in radio equipment, was mined from the pipes. There has been no production since 1951.*

*Some seventy pipes have been found, of which fifty-four have been productive. They are located in a 3 km long belt trending a few degrees west of magnetic north. All the pipes occur within the granite and near its contact with the sediments. The sediments lie to the east of the deposits, and the intrusive contact dips to the east at 20$^{o}$ - 30$^{o}$, that is, away from the pipes. In plan, nearly 95% of all pipes are within 300m of the contact. Prior to erosion, the true distance of all pipes from the contact may have been even less.*

*The pipes vary from 15m to more than 150m in length, and in diameter from 1m to 20m. The most common diameter is in the range 2 - 8m, but a uniform diameter is rarely maintained for more than 30m. The direction and angle of plunge of pipes, although quite variable, tend to parallel the granite contact (20$^{o}$ - 30$^{o}$ towards the east), but all variations from flat to vertical also occur. Only a few pipes have been worked for more than 75m downslope. There is no authentic case of a pipe having completely died out at depth, but work often ceased when the pipe dimensions narrowed and the pipe's tortuous course introduced difficulties in servicing beyond the capacity of the operators.*"

**The Mineral Deposits of N.S.W. (N.S.W. Department of Mines, 1974)** p 360.
"*The origin of these and all the other pipes in the block is still a matter of conjecture. C.S. Wilkinson (according to Andrews 1916) held that the granite developed cavities near its margin as a result of contraction upon cooling at a relatively rapid rate. Two unsatisfactory aspects of this theory are firstly that it does not explain the pipe-like shapes and secondly it could be argued that homogeneous granite, on cooling, would produce joints. Andrews (1916) himself postulated that the pipes were formed by the action of hydrothermal solutions, which arrived by planes of weakness and acted strongly upon the host rock, producing alteration and replacement. However, the nature of the planes of*

*weakness is unexplained and they are not in evidence today. (Observed joints, as stated appear to post-date the pipes). Lawrence and Markham (1962, p72) considered the pipes to be intrusive in origin and to represent "an ultra acidic final magmatic differentiate" of the acid granite host. They believed that "there may be no structural control in the sense of a predetermined access", and likened the pipes to chonoliths. Lawrence was quoted by Nicholson (1966) as having suggested that the intrusion may have taken place prior to the complete crystallisation of the granite. This third theory, too, does not account for the pipe-like shapes of the bodies.*"