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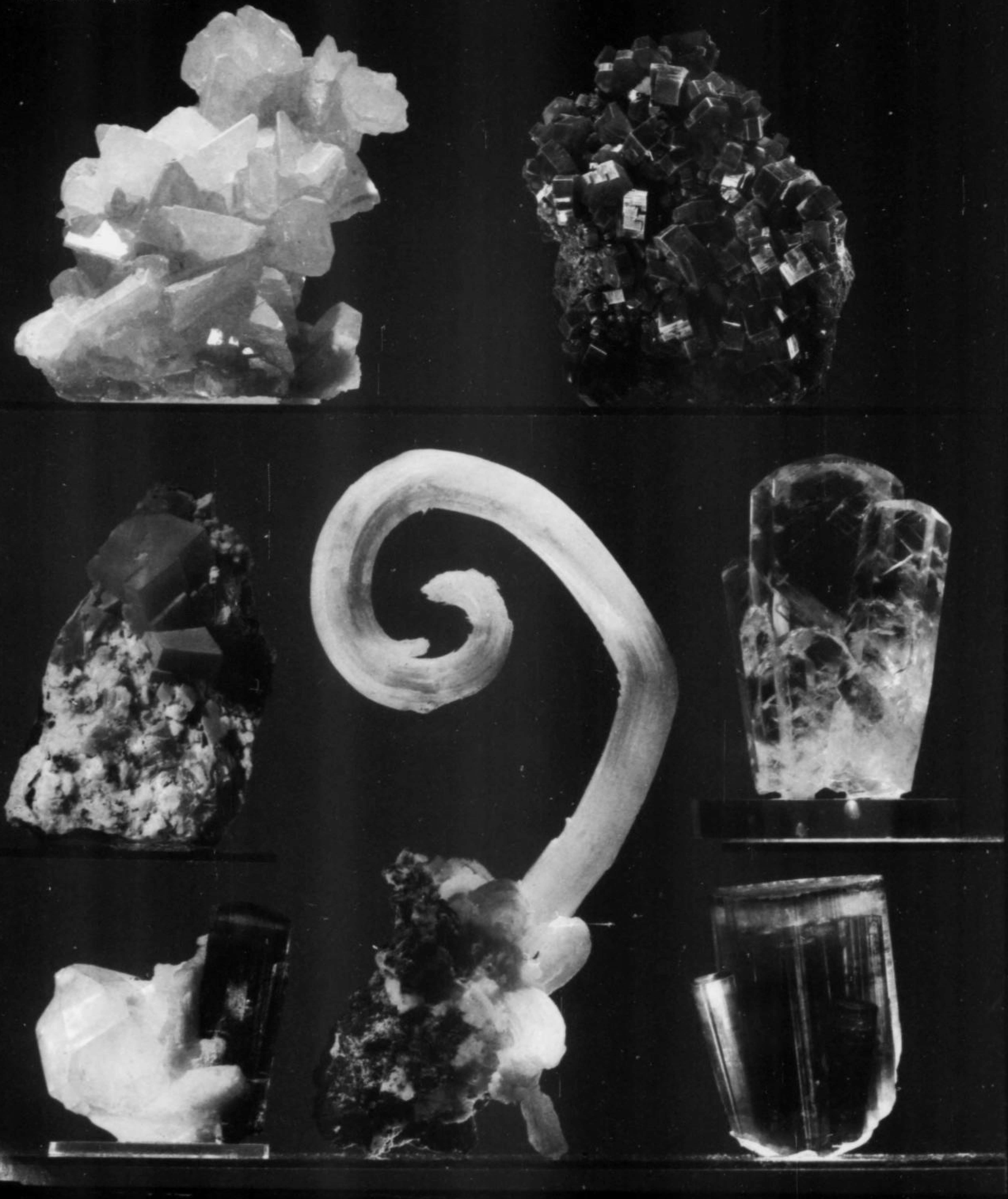

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COVER: ZOISITE (variety Tanzanite) from near Arusha, Tanzania. The crystal is 3.5 cm tall. Collection of William Larson; photo by Harold and Erica Van Pelt.

FAMOUS MINERAL LOCALITIES:

the Kingsgate Mines

NEW SOUTH WALES, AUSTRALIA

Brian M. England
Broken Hill Proprietary Company Limited
Central Research Laboratories
P.O. Box 188, Wallsend
New South Wales 2287, Australia

The unusual quartz pipe deposits of the Kingsgate mining area were among Australia's leading producers of molybdenite and bismuth in the early 1900s. In the course of active mining some of the world's finest specimens of molybdenite were recovered, along with outstanding bismuth, bismuthinite and quartz. These and other minerals are still found in the old workings, providing exceptional cabinet and micromount material.

INTRODUCTION

The Kingsgate mining area lies in rugged, heavily wooded country near the eastern edge of the New England Tableland in northeastern New South Wales, 30 km by road east of Glen Innes (Fig. 1).

Totaling over 60 separate workings scattered over a relatively small area, the mines were originally worked for bismuth in the late 1800s. Around the turn of the century they became Australia's principal source of molybdenum and during World War II provided limited amounts of piezoelectric quartz for the radio industry.

The deposits occur in two distinct groups (Fig. 2), known as the northern and southern workings. The southern group contains some of the most famous deposits, including Sachs' Old 45, Giant Blow, and the Monkey Shaft, all lying on the steep, wooded slopes of Glen Innes Gully just to the west of the Yarrow River.

Little has been published on the development of these deposits. This paper brings together the known facts concerning the history of the Kingsgate mines, as well as providing an up to date description of their geology and mineralogy.

HISTORY

Glen Innes lies in the center of what was, in the late 1800s, one of the richest and most important tin mining districts in the world.

The early prospectors, moving out in search of new tin deposits around 1870, must have surely seen the bold outcrops of white quartz in the Kingsgate area. But the outcrops would have appeared strange and perhaps unpromising to these old tin miners accustomed to greissen veins and the alluvial deposits typical of the New England Tableland region.

Exactly when the deposits were discovered is not known, but the first recorded activity in the area was in 1872, when an Adelaide-based company acquired a lease covering the outcrop of the Wolfram pipe for the purpose of tin mining. Soon afterwards the outcrop, now called the Water shaft, was found to contain cassiterite, but the yield was insignificant and the deposit was quickly abandoned. At this stage neither bismuth or molybdenite had been detected in the outcrops.

In 1877, J. Feeney, a stockman on Yarrow Creek Station (which encompassed the Kingsgate deposits), found a heavy metallic

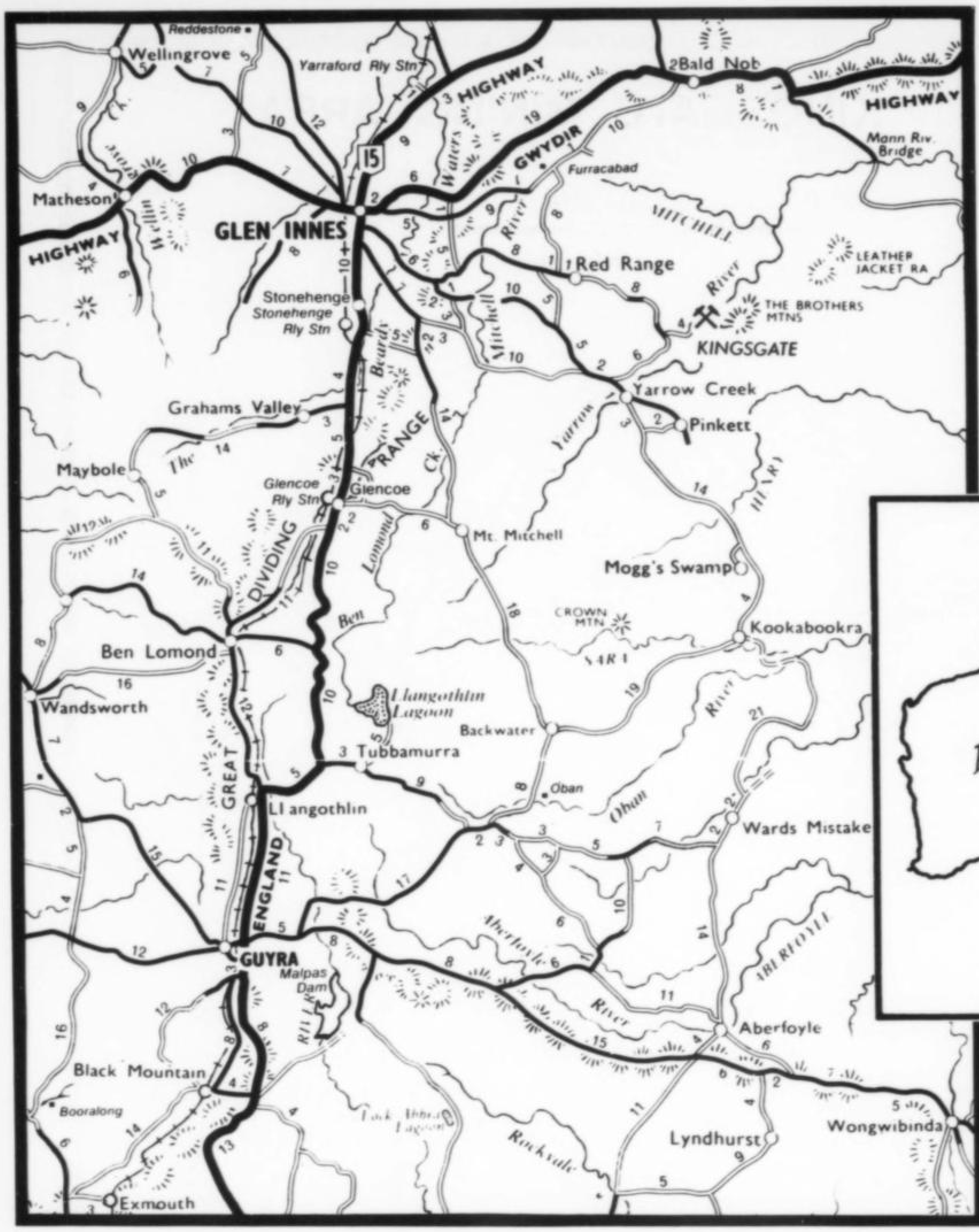


Figure 1. **Map of part of the New England Tableland region of New South Wales showing the location of the Kingsgate mining area. Distances are shown in kilometers.**

mineral on the surface near the old tin mine. His curiosity aroused, Feeney sent the specimen to the State Department of Mines in Sydney for identification. It was native bismuth.

About the same time a prospector named Hughie Quinn found yellow encrustations in the quartz outcrop of the pipe known as Number Five on Leatherjacket Hill. Impressed by the brilliant color he took samples to W. H. Yates, who operated a tin mine on the Severn River near Bald Knob. Yates immediately identified the mineral as "bismuth ochre" (bismutite). Samples were shown to the local member of Parliament, Mr. Ferguson, who strongly advised both Quinn and Yates to commence mining for bismuth, which was fetching a good price at the time. So, in 1879, Quinn and Ferguson took up part of the original tin mining lease, while Feeney and partners took up another lease to the north.

Some excitement was aroused amongst miners in the New England Tableland area by this activity, especially when Yates panned rich native bismuth from a large quartz outcrop (Pipe 24) near the Yarrow River at Cattle Camp. This was in 1880 and in the same year Yates secured the lease on the block covering this and numerous other quartz outcrops in the area which lay immediately to the north of Glen Innes Gully.

Figure 2. **Detailed map** ***(opposite page)*** **of Kingsgate mining area, showing location of quartz pipes, roads and major treatment plants.**

1 – Quinn's Find
2 – Number Six
5 – One and Nine
7 – Water shaft (Tin Show)
8 – Black shaft (26 East)
9 – Bill Miller's hole
10 – Old 26 (Little tunnel)
11 – Mick's shaft
13 – 25 North
14 – Old 25
15 – Weidmeyer's cutting
16 – Martin's hole
18 – Schoolhouse Blow
19 – Magazine (Windlass shaft)
21 – 28 South
23 – Forty North
24 – Forty
25 – Forty South
26 – Jim Marshall's hole
28 – Arsenic Blow
29 – Hard Blow
30 – Sachs Folly
32 – 25 West
33 – 25 South
34 – Mt. Morgan
35 – Granite shaft
37 – Tom Key's hole (Chimney shaft)
40 – Jubilee
41 – Road Block
43 – Christie's Blow
45 – Jack's at Home
47 – Swamp Blow
50 – Nield's Blow
51 – Reef Blow
F – Potter's claim
G – Reef Blow
H – Giant Blow

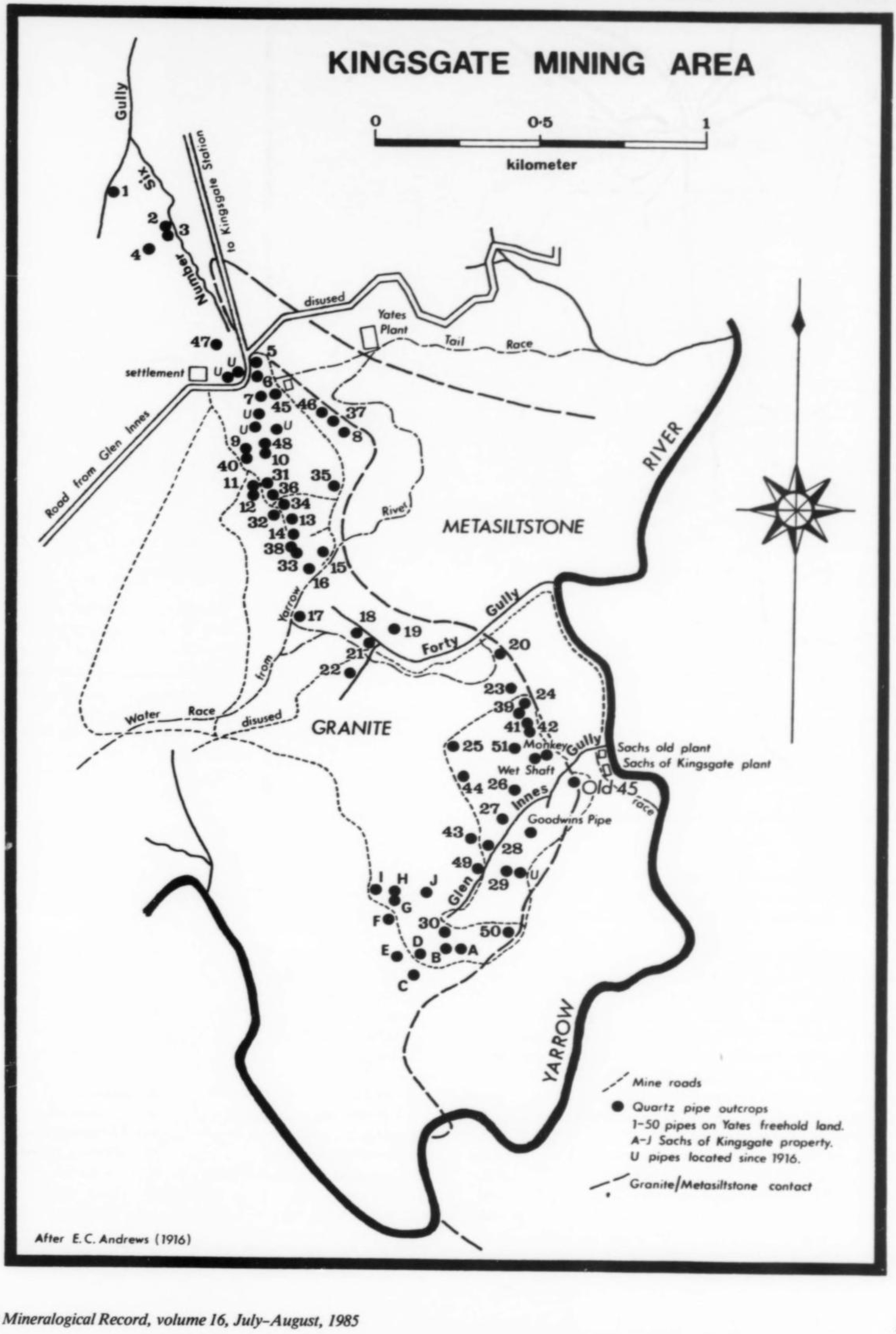

KINGSGATE MINING AREA
0
0·5
1
kilometer
Gully
Six
Number
to Kingsgate Station
disused
Yates Plant
Tail Race
settlement
Road from Glen Innes
RIVER
METASILTSTONE
River
Yarrow
from
Forty Gully
Water Race
disused
GRANITE
Monkey Gully
Wet Shaft
Sachs old plant
Sachs of Kingsgate plant
Old 45
race
Innes
Goodwins Pipe
Glen
YARROW
Mine roads
Quartz pipe outcrops
1–50 pipes on Yates freehold land.
A–J Sachs of Kingsgate property.
U pipes located since 1916.
Granite/Metasiltstone contact
After E.C. Andrews (1916)

Figure 3. **Sachs of Kingsgate. Mr. H. Marshall (manager of Sachs of Kingsgate in 1915), Misses Freda and Pauline Sachs (Speckhardt) and E. C. Andrews, Geological Surveyor N.S.W. Department of Mines, in the cut adjoining Goodwin's pipe, Glen Innes Gully. Photo courtesy Department of Mineral Resources, N.S.W. Government.**

Towards the end of 1880, Feeney sold his block to a Glen Innes storekeeper by the name of Lewis. At this stage the leaseholders in the area decided to amalgamate and the Kingsgate Bismuth Company was formed. All land between the leases already in the possession of the company as well as all other land containing quartz outcrops was secured by the company. The area which was later to become the famous Block 45 lease was not taken up by the Kingsgate Bismuth Company since no quartz outcrops had been observed in that area. It was to become the richest lease of all in later years.

The action of the Kingsgate Bismuth Company in consolidating the land surrounding the working mines led to other parties prospecting the immediate area. One of these was the Glen Innes Molybdenite and Bismuth Company, formed to prospect that area of unleased land on the southern slopes of Glen Innes Gully. It was this company which uncovered the 45 Pipe.

Following the consolidation of the older leases and the securing of new land, the Kingsgate Bismuth Company continued to work the mines, discarding as waste any molybdenite produced.

In 1883, all these properties were purchased by David Marks and E. Vickery who worked the mines steadily with W. H. Yates as manager until around 1889. At least 40 men were employed during this period. An access road to the southern group of deposits and a 4.8-km water race from the Yarrow River to the mines in the northern group were constructed at this time.

Between 1883 and 1889 Marks and Vickery produced 219.8 metric tons of 45% bismuth concentrate at a cost of $74,236 to the company. However, apart from a few tons mined and sold in 1885 and 1887, no molybdenite was saved; most was discarded in the mine dumps or treatment plant residues where it remains to the present day. Financially this venture proved a costly failure, partly due to the primitive treatment procedures used to separate the bismuth. To quote from E. C. Andrews (1916):

> The ore was first hand-picked at the mine and was then carted about ½ mile to the concentrating works. Here it was put through a Blake crusher driven by a water wheel. It was generally crushed twice, or until it all passed through the grating of an inclined trommel having a mesh of 4 holes to the inch. The crushed material was then treated in a sluice box having a fall of 9 inches in a length of 12 feet. While being sluiced it was worked gently with a shovel and also with a birch broom, and by these means concentrates of 20% grade were obtained. These concentrates were again treated in a smaller sluice box with a slighter fall and in this way they were cleaned to a 50% tenor. The finely crushed molybdenite was all got rid of by gently stirring the contents of the sluice box with the shovel and broom. The concentrates were afterwards dried and shifted, and the coarse fragments of molybdenite picked out by hand. The ore, thus cleaned, was exported.

The mines lay idle between 1889 and 1892 due to the cost involved in mining and treating the bismuth ore. Also the low price for bismuth at that time did little to encourage further mining.

From 1893 the mines were leased on a royalty basis. In 1902 Valentine Sachs purchased the Old 45 deposit from the Glen Innes Molybdenite and Bismuth Company and soon after commencing production discovered the huge mass of molybdenite for which the mine is world famous.

In 1905 W. H. Yates purchased from Marks and Vickery the leases he formerly managed for them. Yates now had control of most of the Kingsgate Field and until 1912 the deposits were

Figure 4. **Sachs mill, on the west bank of the Yarrow River, later used by Sachs of Kingsgate prior to the construction of their new mill a short distance upstream. From E. C. Andrews (1916).**

worked partly on wages and partly by contract.

In 1912, Sachs of Kingsgate Molybdenite and Bismuth Syndicate (Fig. 3) took out a lease covering the access road into Glen Innes Gully between Yates' freehold land (Block 40) and the Glen Innes Molybdenite and Bismuth Company's lease on the southern slopes of the gully. The pipes in this new lease included the Giant Blow, Road Cut, Goodwin's, Wet shaft, Monkey shaft, and the Arsenic shaft. Initially Sachs' old plant (Fig. 4) was used to treat the ore but in September 1915 a new plant (Fig. 5) was erected a short distance upstream on the Yarrow River. This was the most expensive and most efficient plant erected at Kingsgate.

In 1912 Yates erected plants (the Number 40 mill and the Upper mill) to process the molybdenite-bismuth ores. The mines at this stage were being worked on a system of day wages, with 35 men employed. This appears to have been the first period during which molybdenite ore was purposely mined at Kingsgate.

Despite record prices for molybdenum during World War I, apparently no mining took place at Kingsgate.

In 1918, Yates' holdings were taken over by Kingsgate Molybdenite N.L. The manager of the new company (Harley B. Wright), in his report to the New South Wales Department of Mines for 1919, disclosed plans to connect Pipe 13 in the northern group by a tramway haulage system with Pipe 23, situated at the northern end of the southern group of mines. Also a road of easy gradient was built from Pipe 13 to the Upper mill, thus bringing all the pipes within easy access.

Up until 1918, each working mine had been serviced by its own steam boiler and ancillary equipment. To reduce the costs of mining the company also undertook the installation of a centrally located air-compressor plant, with lines branching to the pipes being worked to provide air for jackhammers, air hoists, pumping and ventilation where required.

During 1918 Kingsgate Molybdenite N.L. raised 2294 metric tons of ore from the mines in the northern group, producing 100 tons of milling ore. On average, 100 tons of mined pipe material yielded 44 tons of milling ore. Till the end of 1919 this company, together with T. Lancaster, were the only producers from the Kingsgate area.

During 1920 to 1923 a fall in the price of molybdenum caused the closure of the mines and since then production has been low and sporadic, with long periods of idleness.

At the outbreak of World War II the Kingsgate mines were investigated as a possible source of piezoelectric quartz. As early as 1926, the New South Wales Department of Mines had found that limited amounts of this material could be obtained from a few of the Kingsgate pipes.

Between 1940 and 1942 Amalgamated Wireless (Australia) Limited began prospecting the pipes and during that period sufficient piezoelectric quartz was produced from them to satisfy the Australian demand. Despite twinning and other imperfections, which rendered most of the Kingsgate crystals useless for the radio industry, a total of 182 kg of suitable material was obtained by M. W. J. Priest (on behalf of AWA), mainly by turning over the huge dumps of the Old 25 lease (i.e., the Old 25 and 25 North mines). In Glen Innes Gully, the Arsenic shaft (pipe 28), Pipe 44, the Wet shaft, and the Giant Blow were dewatered and worked for crystals. During this period the Arsenic shaft appears to have been the main producer. Eclipse (N.S.W.) Pty. Ltd. and Radio Corporation Pty. Ltd. were also involved in mining quartz crystals during 1944.

In 1942 Sachs of Kingsgate were prospecting and working some of the pipes along Glen Innes Gully. According to New South

Figure 5. **Sachs of Kingsgate mill, erected in 1915, showing tramway terminus and ore chute with draft horses and slide in the foreground, used to haul firewood. Photo courtesy Department of Mineral Resources, N.S.W. Government.**

Wales Geological Survey Mine Records, both the Monkey shaft and the Wet shaft were to be placed in operation, with a planned production rate of 9 and 7 metric tons per day respectively. The ore was to be treated by the mill already on the site, which had a capacity of 5 to 7 tons per day and consisted of roll crushers, screens, etc. driven by a 10444 W Robey steam engine. The mines had been equipped with steam winches, a blacksmith's shop and forge as well as huts to accommodate 14 miners. Prior to this, horses were used for ore haulage. Most of the mines at this stage had already been connected by rail with the mill on the Yarrow River. There appear to be no records to show how long this renewed mining lasted.

Between 1948 and 1952, Kingsgate Mining Industries prospected the area and produced ore from a few of the deposits, but there is no record of which pipes were brought into production.

In 1966 Carpentaria Exploration Company Pty. Ltd. investigated the potential for the development of a high-tonnage low-grade open cut mine. A total of 79 percussion drill holes were put down in the two areas of maximum pipe concentration, but the results were very discouraging.

The area was reinvestigated in 1969 by A. O. G. Minerals Pty. Ltd., but again the results were very disappointing and no mining took place.

Since 1969, mining leases at Kingsgate have changed hands many times, but none of these ownership changes led to renewed mining.

Percussion and diamond drilling programs have been conducted on different occasions in the vicinity of Sachs' Old 45 but no economic mineralization was found. Recently some interest has been shown in reworking the older mine dumps along Glen Innes Gully and this area is currently under lease, rendering it off limits to any unauthorized visitors.

As recently as 1973, a virgin quartz-feldspar pipe was found at Kingsgate by a farmer clearing a paddock. However no metallic minerals were found and the outcrop was abandoned at a depth of 0.5 m (Weber *et al.*, 1978).

Records of production from the Kingsgate mines are incomplete but it appears that at least 348 metric tons of molybdenite and 200 tons of bismuth concentrates have been produced.

The foregoing history was gleaned primarily from Wright (1919), Booker (1942), Hanlon (1943), Nicholson (1966), and Anonymous (1942).

GEOLOGY

The earliest investigations into the geological nature of the Kingsgate deposits were carried out by Wilkinson (1881, 1883), followed by those of Andrews (1906, 1916), Blanchard (1947) and Garretty (1953). Lawrence and Markham (1962) have provided a detailed description of the mineralogy.

There is still some uncertainty concerning the interpretation of local geology and controls for ore emplacement. However, the general nature of the deposits can be summarized as follows:

The most prominent rock type at Kingsgate is a coarse, mottled gray hornblende-biotite adamellite. This rock outcrops prominently to the east of the mining area but it is not considered to be the host rock for the deposits. The actual host rock appears to be a silicic granite, now weathered on the surface to a thick gravelly soil. The

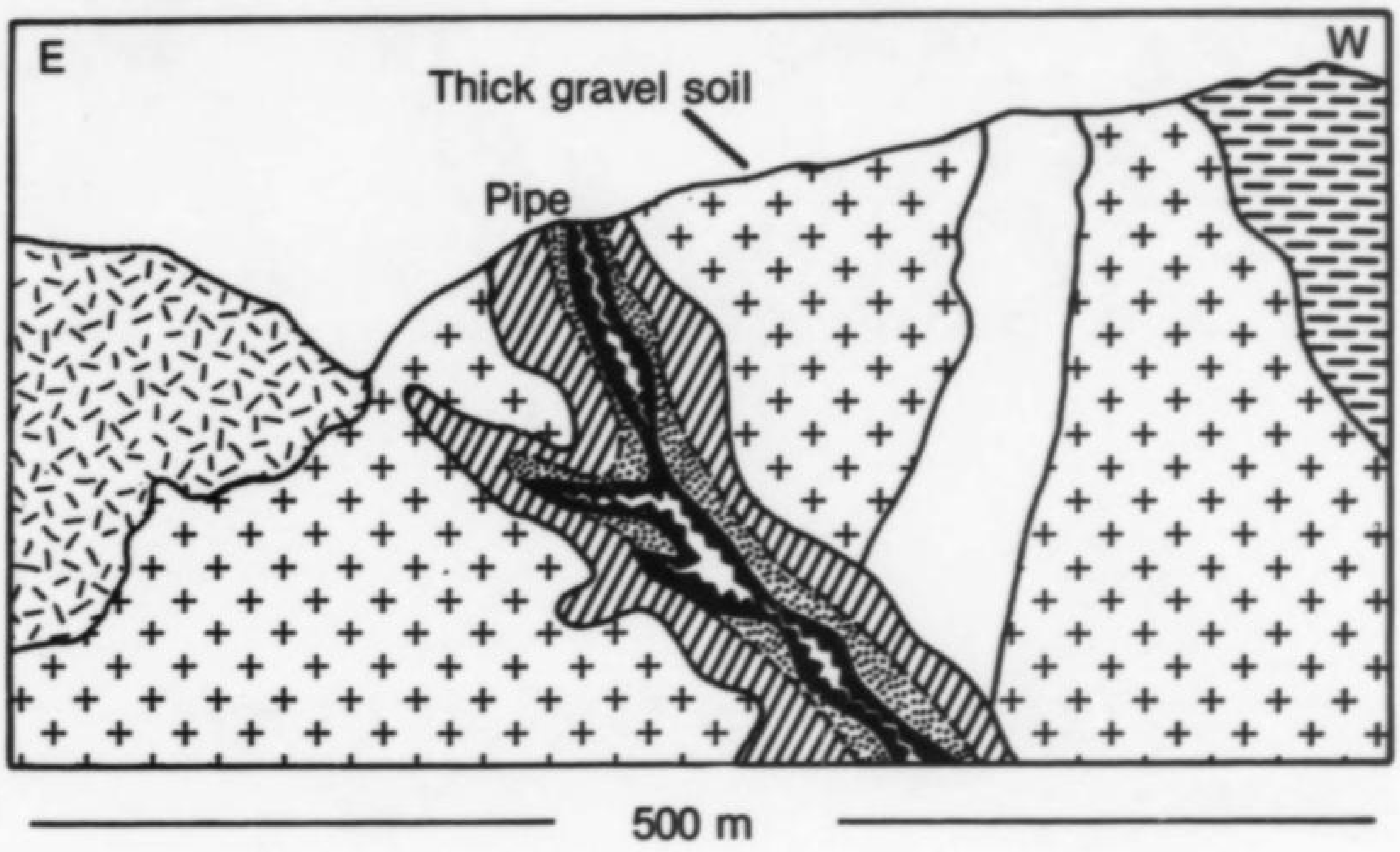
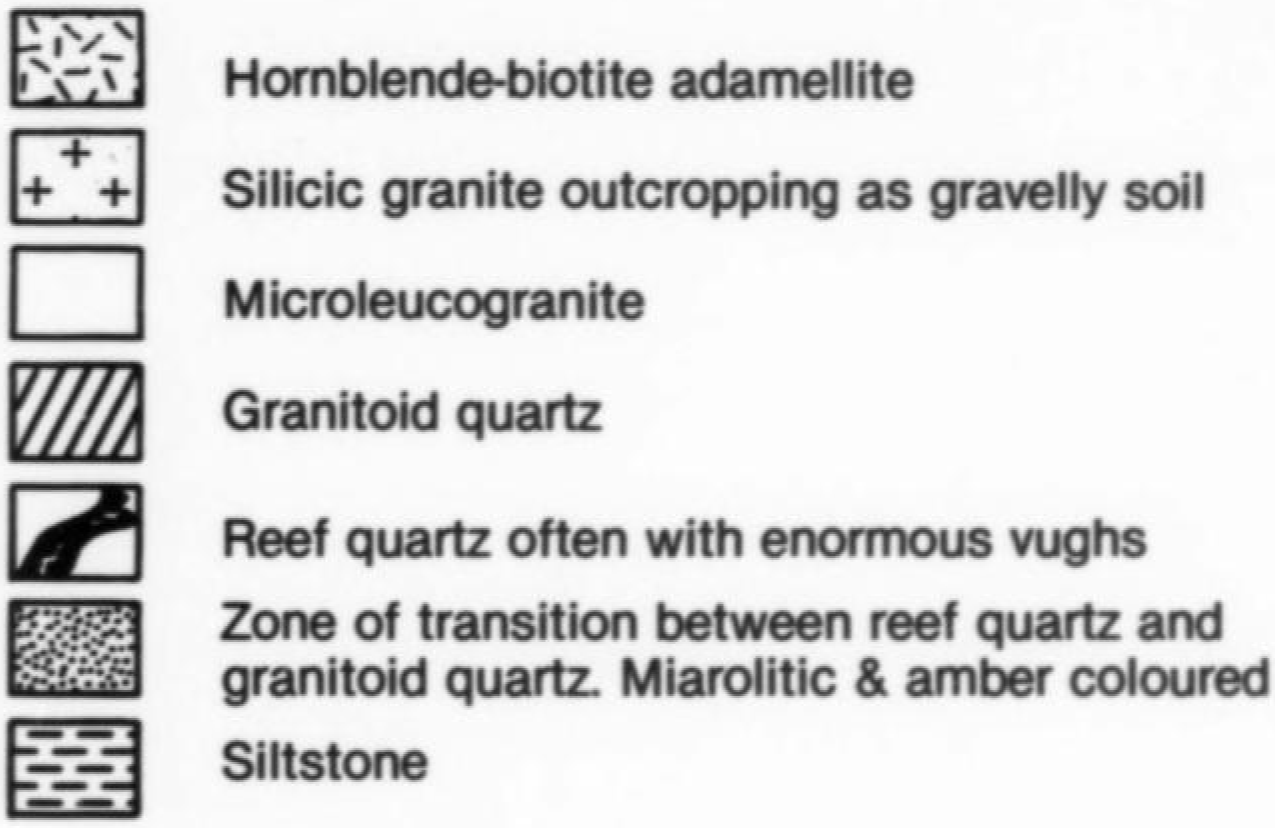


Figure 6. **Schematic diagram of a quartz pipe at Kingsgate (modified from Lawrence and Markham, 1962).**



orebodies occur as pipe-like masses in this silicic granite, which appears to intrude the adamellite. All the pipes lie within 270 m of a Permian metasiltstone contact (Fig. 2).

The Kingsgate pipes show an unusually complex structure (Fig. 6), frequently changing both direction and dip. They are characterized by branches, dilations and restrictions, with the dilated areas containing huge caverns lined with quartz crystals of enomous size. The pipes vary from 13.7 m to over 140 m in length and from 1 m to 20 m in diameter.

It appears that most of the pipes have an altered granite aureole and generally contain a number of intergradational zones, with the central portion composed of massive crystalline white quartz, often containing enormous vugs (Andrews, 1916). In the footwall sections below this massive quartz there is a zone of black to amber miarolitic granular quartz often called "granitoid quartz" (Lawrence and Markham, 1962), in which the cavities contain small crystals of molybdenite, bismuthinite and a number of other minerals. Beneath this zone there is usually a region of altered granite in which the feldspars have been replaced by mica (sericite) and this grades into the coarse silicic granite country rock. These zones are not continuous around the entire perimeter of the pipe, but appear to be restricted to the footwall region. The molybdenite and bismuth minerals, although disseminated sporadically throughout the body of the pipes, are commonly concentrated in the "collar," with the highest concentration of ore minerals (especially bismuth) in the footwall zone between the miarolitic amber quartz and the altered granite. For this reason, only the footwall section of many of the pipes has been mined.

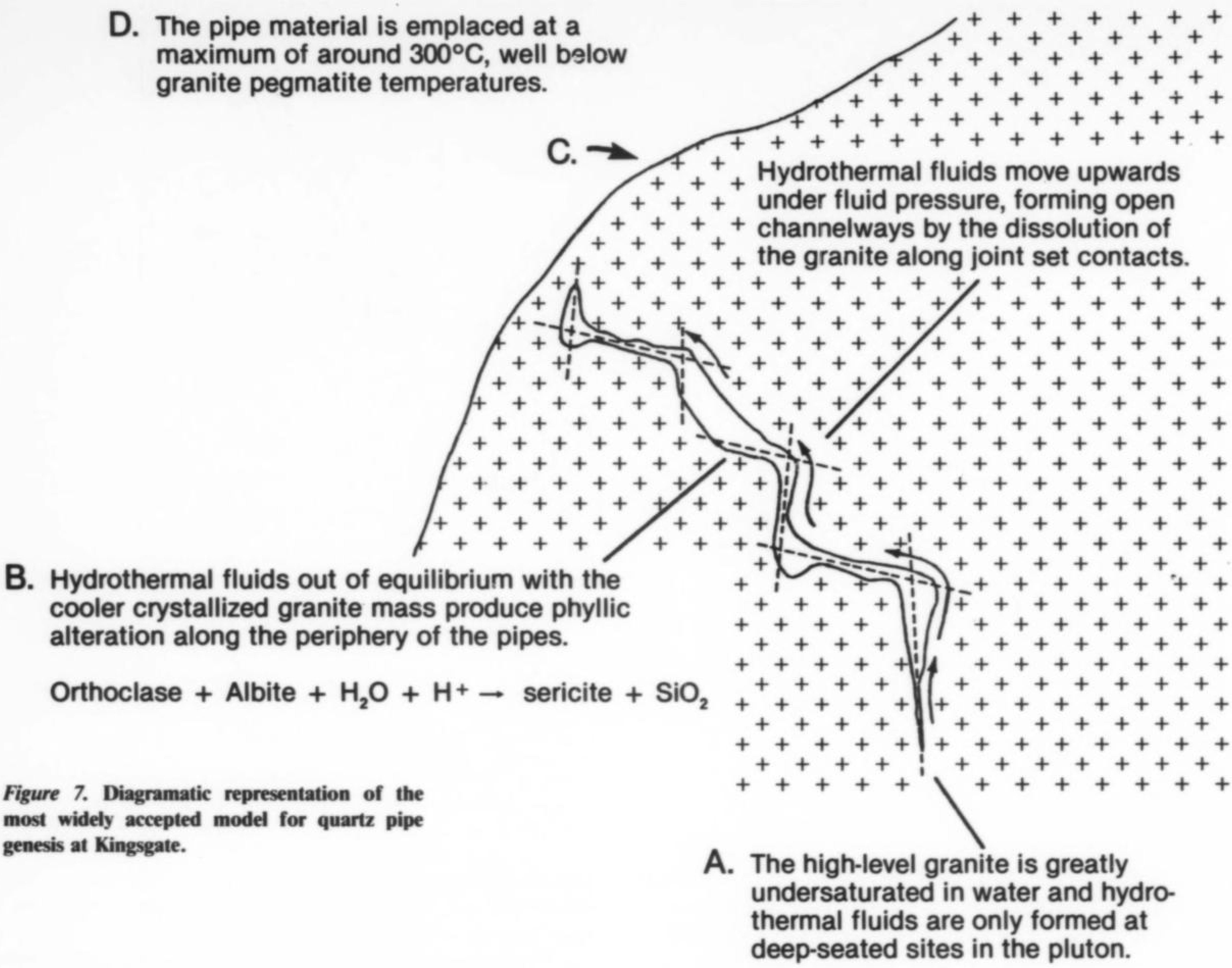


Figure 7. **Diagramatic representation of the most widely accepted model for quartz pipe genesis at Kingsgate.**

Origin of the Pipes

Andrews (1916), in his general classification and description of the pipe deposits of eastern Australia, outlined several factors which he considered important in establishing the origin of the deposits:

1. The direction of typical pipes varies considerably. Bulges and sheet-like masses occur as variations in the roughly cylindrical to eliptical cross-sections. Branching is common. Andrews considers this indicative of the influence of planes of weakness in the form of cooling joints along which residual hydrothermal fluids migrated, resulting in replacement of the granite at the intersections of joint planes.

2. If the granite itself provided some structural control, why is it that the *assumed* joints, at those intersection the pipes are presumed to have formed, are so rarely in evidence? The principal joint planes in the granite appear to post-date the mineralization, which is never contained in them.

3. The pipe material shows no sharp boundary with the host silicic granite. Hydrothermal alteration and replacement of the granite is evident.

4. The mineralogy of the pipes, in which a gradation occurs from granite, to granite with feldspars altered to sericite, in turn grading into massive crystalline quartz, suggests that the transition from granite to quartz may have been one of replacement.

5. Some of the Kingsgate deposits are *not* true pipes. In these instances the ore minerals occur in silicified granite in which the feldspars have been largely altered to sericite. One such pipe (Number 35 or Granite Pipe) splits into two branches, one of granite, the other of quartz rimmed by altered granite. These particular pipes may represent the initial alteration stage in the formation of true quartz pipes.

From this evidence Andrews concluded that the quartz pipes originated by hydrothermal alteration and replacement of the granite. The actual process of pipe formation can be outlined as follows:

During the final stages of crystallization of the high-level, greatly water-undersaturated granitic magma, progressive concentration of water and other volatiles in the residual melt fraction led to the physical separation of an ore-forming aqueous fluid phase. This fluid phase, in addition to containing SiO_2, CO_2, SO_2, H_2S, hydrogen halides and metal complexes, would have had the capability of dissolving finite amounts of silicates. The implication at Kingsgate is that these late hydrothermal fluids eroded substantial pipe-like conduits along joint plane intersections and permeated laterally into the adjacent granite to produce alteration envelopes of quartz (inner) and sericite greissen (outer). The ore-localizing joint systems may in fact have been initiated by hydraulic fracturing resulting from the high fluid pressure typically associated with trapped residual hydrothermal fluids during the later stages of cooling of granitic plutons. This model is presented diagramatically in Fig. 7.

The ore minerals are commonly concentrated near dilational zones in the pipes, where deposition may have been induced by a sudden, localized fall in either pressure or temperature, depending on the physical nature of the mineralizing fluid. Although the pre-

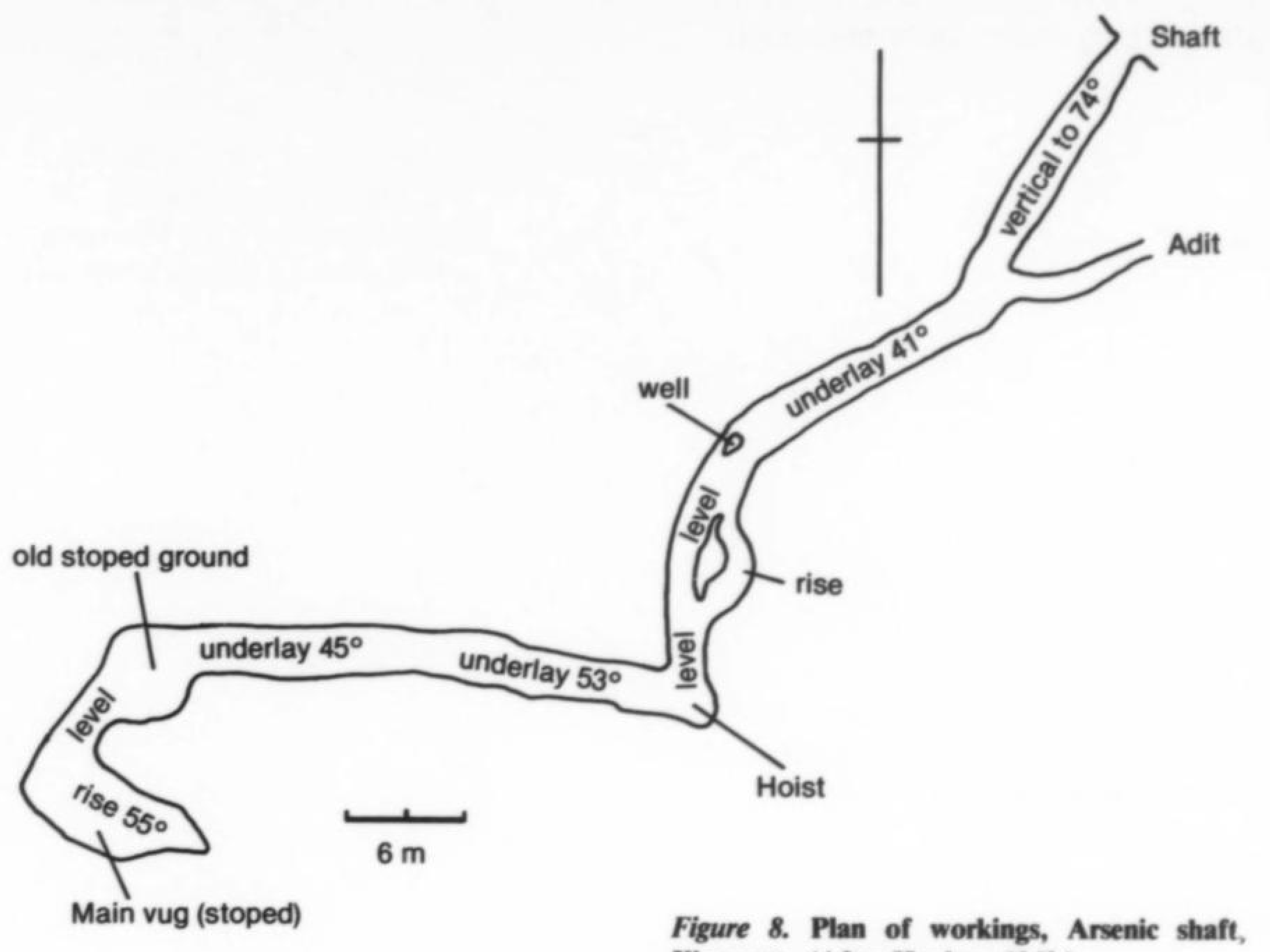


Figure 8. **Plan of workings, Arsenic shaft, Kingsgate. (After Hanlon, 1943.)**

cipitation of molybdenite (and other sulfides) is generally believed to be controlled principally by temperature gradients, fluid/mineral equilibria studies suggest that deposition can be effectively induced by reaction of the ore-forming fluid (in which molybdenum is most likely to be present as $HMoO_4^-$ and MoO_3F^- complexes) with the K-feldspar component of the host rock (Bloom, 1984). This may well explain the observed zonal distribution of molybdenite in the quartz pipes at Kingsgate.

The ubiquitous abundance of quartz is a direct result of the dependence of quartz solubility in hydrothermal systems on both temperature and pressure. Thus, as the fluid moves into regions of progressively lower temperature and pressure towards the surface the amount of silica required to produce saturation (and hence initiate deposition) decreases and the excess silica is continually precipitated on the walls of the conduit. Copious amounts of free silica are also produced by the alteration of feldspars in the host granite to sericite, thus adding to the total volume of quartz deposited.

Fluid inclusion homogenization temperatures (minimum temperatures of the ore-forming fluids) determined for quartz in the Kingsgate pipes yield temperatures of 160–360° C, although no measurements were done on primary fluid inclusions (J. Lusk, Earth Sciences Department, Macquarie University, Sydney, personal communication). While actual ore emplacement temperatures may have been considerably higher than these determined values (as evidenced by the presence of cassiterite in the Water shaft), they remained well below those normally associated with granitic pegmatite veins.

Lawrence and Markham (1962) proposed a radically different origin for the deposits. They considered that there may have been no structural control in terms of a predetermined access. They regard the pipes as chonolithic intrusions which represent an ultrasilicic final magmatic differentiate of the host silicic granite and which eventually graded into hydrothermal bodies. These intrusions would have been emplaced prior to the complete crystallization of the granite magma.

Alternatively, Weber (Weber *et al.*, 1978) surmised that the pipes may have been formed by hydrothermal fluids expelled from the crystallizing magma as a series of "bubbles," ascending via the same route to become trapped near the more rapidly crystallizing granite margin (hydrothermal fluid streaming).

Although largely discounted by some more recent workers (for example Weber *et al.*, 1978), Andrews' (1916) model involving intersecting joint sets as the primary mineralization control remains the most plausible.

There is no authenticated evidence of a pipe having completely died out at depth at Kingsgate. Goodwin's pipe and others are said to have been worked out, but narrow constrictions are often followed by wider sections containing bonanza ore concentrations as shown by the remarkable Sachs' pipe.

MINES

Southern Group

Arsenic shaft (Number 28 on Fig. 2)

Also known as Hagan's Tribute, this deposit was first worked as an open cut and then as an underlie shaft to a depth of 63 m. A vertical shaft was also sunk on the pipe to reduce mining and ore handling costs.

In vertical section the pipe forms a series of steps and levels (Fig. 8). It was large, with a diameter of 2.5 to 3 m, and a considerable amount of bismuth and molybdenite were produced from the footwall zone. Caverns up to 3 m long were common and contained large quartz crystals of unusual clarity. This was one of the pipes worked by Amalgamated Wireless (Australia) Pty. Ltd. for piezoelectric quartz between 1940 and 1942. It appears to have been the major producer of this material in the Kingsgate area.

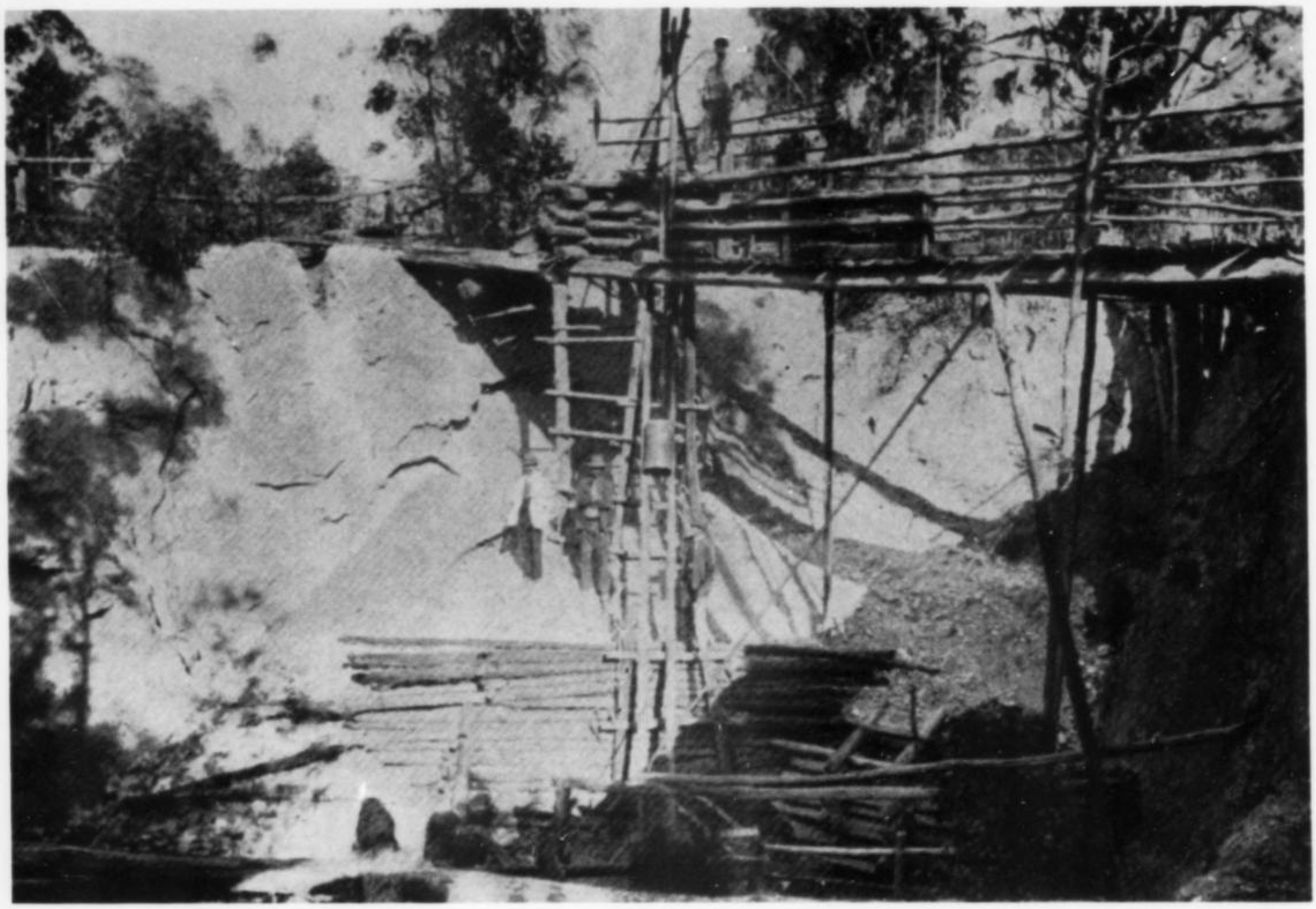


Figure 9. **Open cut on Forty pipe, Yates property, Kingsgate around 1915. From E. C. Andrews (1916).**

Forty (Number 24 on Fig. 2)

This deposit, so named because it was the first of the pipes to be worked on Block 40, outcropped as an enormous body of white quartz which yielded very rich bismuth from the surface rubble. The pipe was worked to a depth of 6 m by open cut (Fig. 9), excavated simply by removing the whole outcrop and upper portion of the pipe. An "enormous" quantity of bismuth was reportedly produced from the open cut.

Later the footwall section of the pipe was worked to a depth of 27 m by Henry Marshall and others, and between 1911 and 1915 W. H. Yates continued the workings to a total depth of 92 m. A sketch of the footwall showing in the working face at the end of 1915 is shown in Fig. 10. Only the footwall of this deposit has been worked; the underground workings have since collapsed.

Giant Blow (Pipe H)

This pipe outcropped as a huge vug containing quartz crystals with bismuth and molybdenite. The quartz crystals reached enormous size and most were doubly terminated. The pipe was especially rich in molybdenite and small dumps of rich ore remain at the mine entrance.

From the material available on the mine dumps it appears that, for the most part, the molybdenite occurred as rosettes of hexagonal tabular crystals up to 5 cm in diameter enclosed in white to amber, strongly fractured quartz. Many fine specimens have been collected from this material.

The quartz in this pipe was remarkably clear and free from inclusions and considerable attention was focused on this deposit as a possible source of piezoelectric quartz. However twinning prevented all but minor exploitation of these otherwise remarkable crystals.

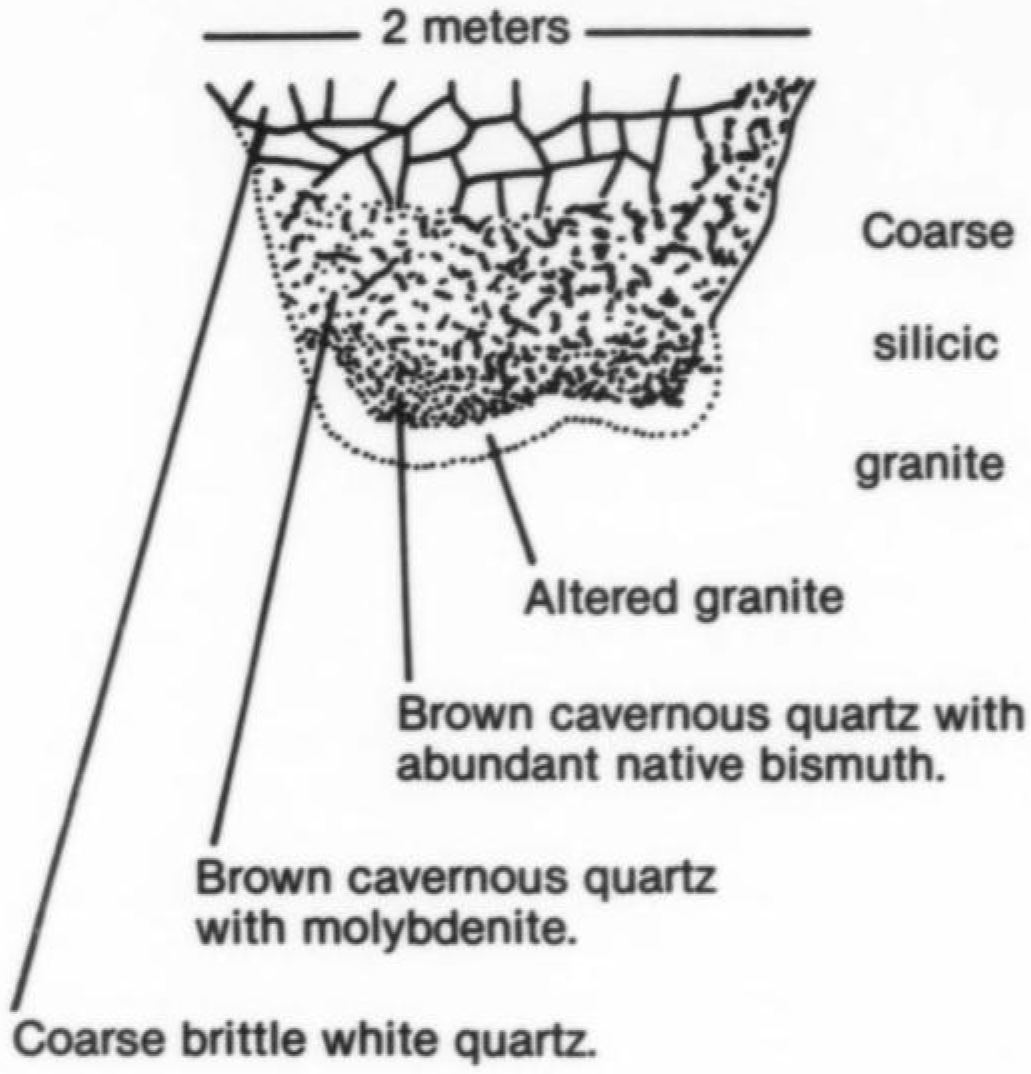


Figure 10. **A sketch of the footwall at the working face of Forty pipe in 1915; depth 92 meters. From E. C. Andrews (1916).**

The pipe appears to have had a diameter of about 6 m and was worked by a small open cut and then by stoping from the surface. The underground workings remain accessible via either the open cut or an adit driven to the base of the workings to facilitate ore extraction.

Figure 11. **Goodwin's pipe, Sachs of Kingsgate, around 1915. From E. C. Andrews (1916).**

Goodwin's pipe

This pipe was of considerable size and was worked for both bismuth and molybdenite to a depth of 61 m. The outcrop of the pipe was approached by a cutting just above creek level and the ore was raised by hand windlass erected over the excavation (Fig. 11). In the roof of the excavation above the windlass shaft cross-sections of the pipe, rich in molybdenite, can still be seen. The workings are flooded to the level of the cutting. However, the extensive mine dumps can provide interesting specimens.

Goodwin's pipe appears to have been the only pipe at Kingsgate to have contained calcite as a gangue mineral. The calcite generally occurred as coarse, cleavable masses and occasionally as rough scalenohedral crystals enclosing molybdenite in the quartz vugs.

The occurrence of calcite cementing fragmented quartz pipe material, a common association in the dumps of Goodwin's pipe, can be explained in terms of the physico-chemical nature of the hydrothermal system. The solubility of calcite actually increases with decreasing temperature and this mineral will precipitate only if the partial pressure of carbon dioxide, in equilibrium with dissolved calcium carbonate in the hydrothermal fluid, drops substantially. This can occur if the fluid undergoes boiling due to sudden expansion on explosively entering a significant dilation in the conduit through a constriction initially blocked by a build up of quartz. The fragmentation of this blockage would be immediately accompanied by the precipitation of calcite if the hydrothermal fluid contained even a very low concentration of dissolved calcium carbonate. This was almost certainly the case in Goodwin's pipe.

The abundance of fragmented and strongly fractured quartz in many of the Kingsgate pipes suggests that episodic explosive fracturing of blocked conduits under the influence of a relatively high fluid pressure was characteristic. The rare occurrence of calcite under these conditions indicates that the ore fluids involved did not typically contain even a trace of dissolved calcium carbonate.

Monkey shaft

This is one of the few pipes in the Kingsgate area which indicate that joints in the granite may indeed have had some primary control on ore emplacement.

The deposit was worked as a true vein for 13.7 m, the jointed white quartz filling the fissure varying from 0.6 to 7.6 m in width. The vein was followed vertically for 7.6 m, then on a 1-in-5 slope toward the west for 12 m, at which point it had reached a thickness of about 1.2 m. Beyond this flat portion it was traced vertically for 2 m at which point it took the form of a true quartz pipe over 2.4 m across.

By 1915 the mine had been abandoned and the workings became flooded to the level of the adit driven just above creek level. The adit is still accessible but the deeper workings are not.

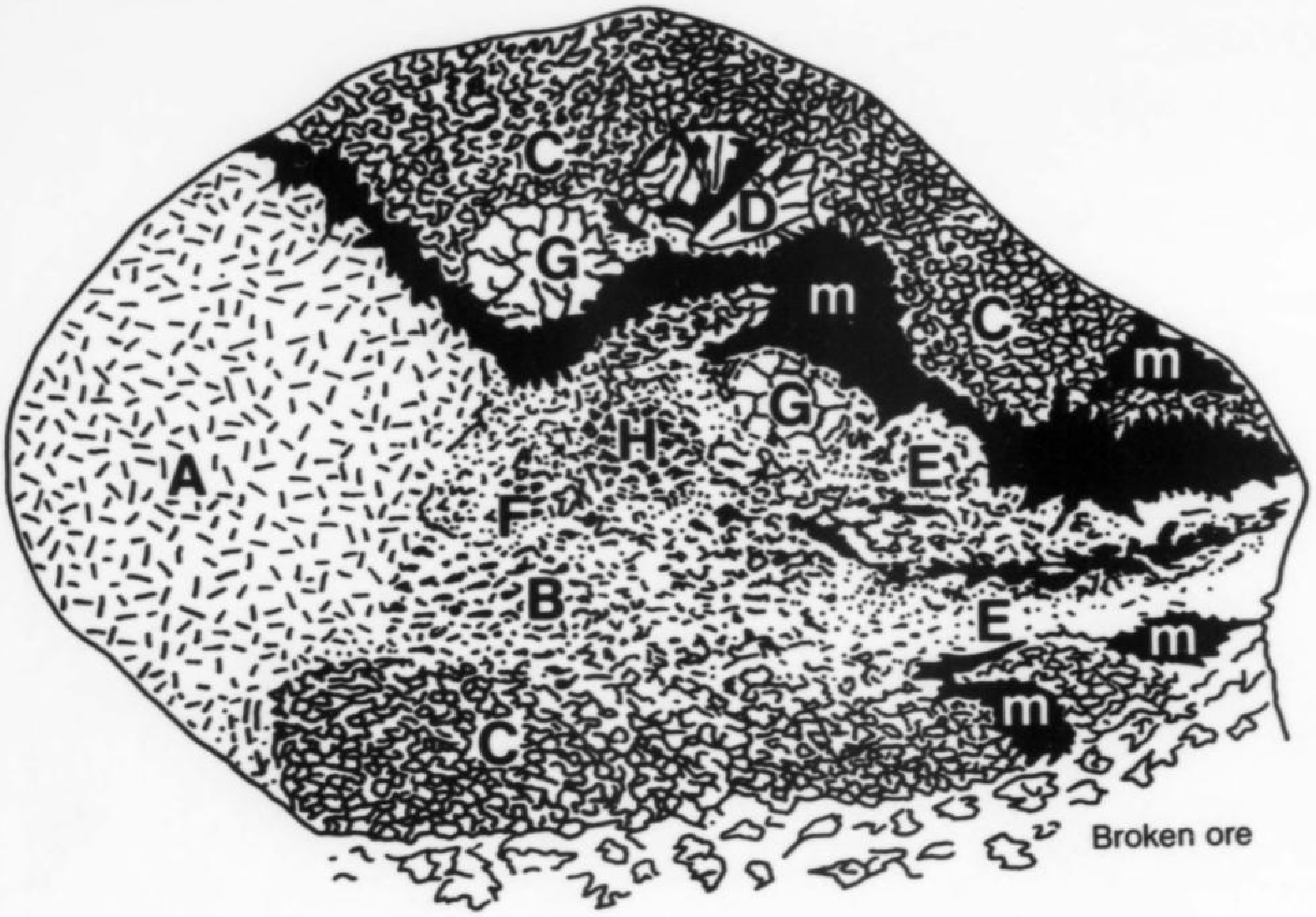


Figure 12. Sketch plan of Sachs pipe at depth of 76 m (250 feet) showing extent of mineralization (after E. C. Andrews, 1916). Diameter of section of 4.6 m.
A. Coarse silicic granite with sericitization of feldspars
B. Altered granite grading to granular quartz with molybdenite
C. Granular quartz with abundant molybdenite
D. Quartz crystals with patches of molybdenite
E. White massive quartz
F. Glassy quartz adjacent to altered granite
G. Massive quartz
H. Granite almost completely altered to sericite
M. Molybdenite with associated bismuth and bismuthinite

Figure 13. Sachs mine (Old 45), Kingsgate, showing 3 specimens weighing 254, 305 and 36 kg respectively, torn from one mass of molybdenite. From E. C. Andrews (1916).

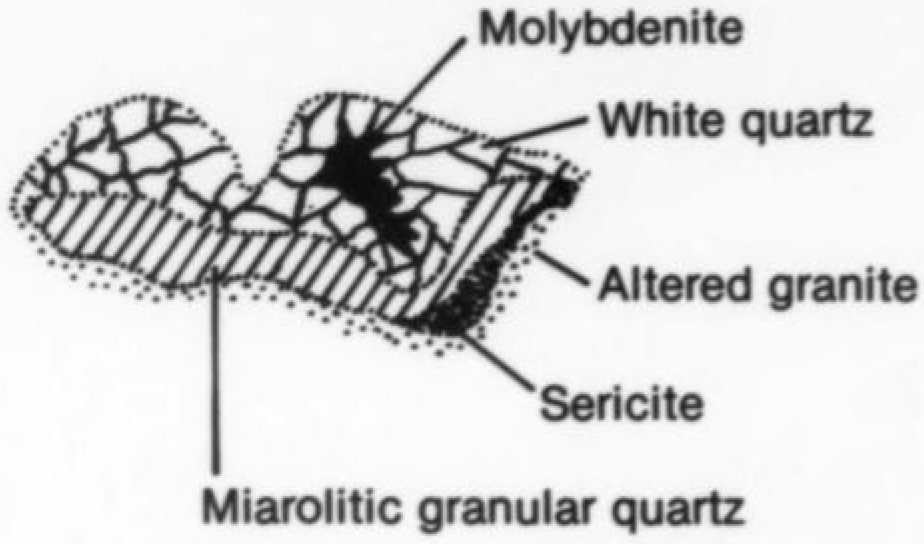


Figure 14. **Sketch of face in No. 45 pipe at depth of 91.5 m (300 feet) in September 1915. From E. C. Andrews (1916).**

Figure 15. **Sachs Old 45 and environs, around 1915. Photo courtesy Department of Mineral Resources, N.S.W. Government.**

Sachs' pipe (Old 45)

This was certainly the most famous of the Kingsgate pipes and one of the world's richest molybdenite producers.

The deposit was not taken up by the original Kingsgate Bismuth Company and it was not until 1880 that the Glen Innes Molybdenite and Bismuth Company stumbled onto the outcrop, which just happened to lie within their newly acquired lease.

Originally worked for bismuth, the mine passed through several owners, including Henry Marshall who abandoned the lease in 1890 because the molybdenite content of the ore was hindering the extraction of bismuth. The mine was worked sporadically between 1896 and 1898 with only a small amount of ore being produced. A mill to treat the ore had been constructed on the west bank of the Yarrow River.

In 1902 the mine was taken up by Valentine Sachs, who commenced shipping ore to Sydney in the same year. After following the pipe only a short distance, Sachs came upon a great expansion (Fig. 12) and from the large chamber excavated at that point (15 m long and 6 m wide) many tons of pure molybdenite were mined (Fig. 13). At least 81 metric tons of molybdenite were won from this deposit prior to 1911.

A few years after this phenomenal discovery the continuation of the pipe was lost and although Sachs went to considerable expense in trying to relocate the pipe he was unsuccessful and, in 1912, the mine passed back into the hands of the Glen Innes Molybdenite and Bismuth Company.

After clearing the rubble from the floor of the mine a small bunch of quartz no more than 46 cm across was uncovered and this was followed for a distance of at least 24 m from the excavated chamber, at which point good ore was still being won (Fig. 14). The total length of the workings exceeds 91.5 m. The mine and environs are shown in Fig. 15.

The workings of Sachs' pipe are approached by a tunnel 30.5 m in length which intersects the pipe 9.2 m from the surface. The entire workings remain accessible.

The dumps of this mine are one of the few sites at Kingsgate where specimens of bismuth and bismuthinite can still be collected.

Wet shaft (Water cut)

This was a large quartz pipe containing both molybdenite and bismuth. The diameter of the pipe at the working face in 1915 was about 2.4 m and up until then it had been an important producer. Bismuth appeared to be more abundant in the footwall, enclosed in amber miarolitic granular quartz, while the molybdenite was virtu-

Figure 16. **Open cut of the Old 25 pipe, Kingsgate, showing the entrance to the underground workings. Photograph by the author, December 1983.**

Figure 17. **An area of the waste dumps of the Old 25 pipe, Kingsgate, now considerably overturned by collectors. However good specimens of molybdenite and bismuth are still found. Photograph by the author, December 1983.**

ally restricted to a higher zone. The pipe contained large vugs lined with very large quartz crystals, usually white in color.

Northern Group

Granite shaft (Number 35 on Fig. 2)

This deposit was a large silicified granite pipe containing masses of quartz and had a diameter of 4.3 m. For the first 30 m the bismuth and molybdenite occurred in the granite itself before the pipe split into two branches, one being granitic in character and the other developing into a true quartz pipe.

Mount Morgan (Number 34 on Fig. 2)

This deposit outcropped towards the top of a small granite pinnacle on the highest point of the plateau overlooking the majority of the Kingsgate pipes. The pipe was large, being as much as 7.6 m across in places. It has been worked on a shallow underlie for a length of 69 m and is still accessible.

Old 25 (Number 14 on Fig. 2)

Worked to a depth of 76 m on a 45° slope, this was one of the largest pipes on the Kingsgate field. The size of the deposit at the working face in 1911 was 12 by 12 m. The pipe was originally worked as a large shallow open cut (Fig. 16) and then by stoping out the pipe as it plunged towards the southeast. A haulage tunnel was driven to the base of the workings. The entire workings are still accessible and have been considerably enlarged and extended by collectors in recent years in the search for quartz and molybdenite specimens.

Attempts were made by local authorities in 1975 to seal off the mine by blasing in the entrance but the only result was the discovery of many superb coarsely crystallized molybdenite specimens associated with quartz, arsenopyrite, ferrimolybdite and scorodite.

The extensive dumps of the Old 25 (Fig. 17) have provided an abundance of gem quality quartz in a variety of colors, as well as miarolitic white to amber quartz containing superb molybdenite with ferrimolybdite, wulfenite, galena, bismuth, bismuthinite, bismite, bismutite, goethite, muscovite and quartz of exceptional micromount quality.

One and Nine tunnel (Number 5 on Fig. 2)

Named the "One and Nine" because it lies astride mining leases one and nine this deposit was one of the most important and one of the first to be exploited. It is a typical quartz pipe with several economically important branches. Near the surface the pipe had only a very slight inclination towards the granite-siltstone contact. This upper part of the deposit lay in that section of the workings known locally as the "Open Cut." At the base of the open cut two branches appeared, after which the pipe dipped steeply for 21 m, then flattened for 15 m to the working face. Several branches were also discovered at this lower level.

Figure 18. **Vertical shaft for working No. 25 North pipe, Yates property, Kingsgate, showing improvised headframe, horse used to raise ore, and miners. From E. C. Andrews (1916).**

The pipe consisted of white and black quartz with large caverns lined with crystals up to 1.2 m in length. The quartz was heavily jointed and contained considerable quantities of bismuth and molybdenite.

Tin shaft (Number 7 on Fig. 2)
This was the only pipe on the Kingsgate field to contain cassiterite. The pipe dipped vertically with a diameter of 1.8 m and has been worked to a depth of only 12 m.

25 North (Number 13 on Fig. 2)
This deposit was also very large, being up to 7.6 m across, and was one of the most important on the field (Fig. 18). It has been worked to a total depth of 152 m on a 1-in-2 slope. Several branches, varying from 7.6 m to 15 m in length and steeply inclined toward the surface, occur between the surface and a depth of 92 m. The pipe was worked for both molybdenite and bismuth and production of the latter was quite significant. The mine entrance has been blocked by rubble and the workings are no longer accessible.

Wolfram pipe (Number 10 on Fig. 2)
Also known as the Old 26 or Little tunnel, this was the first of the Kingsgate pipes to be prospected and was originally worked as a large open cut. A haulage tunnel (now collapsed) was later driven to the base of the workings. The pipe has been worked to a depth of 30 m and reached a maximum diameter of 3.7 m. A considerable amount of wolframite and arsenopyrite were mined.

MINERALS

Over 30 minerals have been recorded from the Kingsgate pipes (Table 1). However many of these are only present in very small amounts and are usually only seen in polished ore sections. Only the minerals having collector significance will be described here.

Primary Minerals

Arsenopyrite FeAsS
Arsenopyrite has been found in only a few of the Kingsgate mines, usually as large masses in white reef quartz towards the core of the pipes. It is only rarely found associated with bismuth minerals or molybdenite. However, X-ray fluorescence (XRF) analysis of deeply oxidized arsenopyrite from the Old 25 pipe showed the presence of approximately 1% bismuth, although the mineral responsible could not be isolated for identification.

Most of the arsenopyrite is massive, with a coarse bladed appearance due to extensive oxidation along cleavages to scorodite. Some specimens show almost complete replacement.

The Old 25 pipe provided massive specimens of arsenopyrite enclosing transparent, doubly terminated quartz crystals, which themselves contained inclusions of idiomorphic arsenopyrite.

However, it is not the arsenopyrite itself which interests collectors, but the spectacular scorodite druses associated with it.

Bismuth Bi
Native bismuth was the major economic mineral in the early days of mining at Kingsgate and it was abundant in many of the pipes. Masses up to 14 kg in weight were occasionally found, particularly in the upper workings of Forty pipe.

The bismuth usually occurred as moldings between quartz crystals in vugs throughout the amber quartz of the footwall zone. When removed, these moldings showed the hexagonal impressions of the termination faces of the quartz crystals (Fig. 19). Very occasionally the bismuth occurred as crude trigonal crystals (Fig. 20).

The native metal is nearly always associated with the sulfide bismuthinite, the latter occurring as graphic intergrowths or as surface coatings. Some masses of bismuth were found completely enclosed within balls of foliated molybdenite up to 10 cm in diameter.

One interesting occurrence is the presence of bismuth wires arranged in parallel within transparent or white quartz. These wires were up to 6 mm in diameter and very occasionally reached 5 cm in length. Cleavage in the wires suggests that they are single crystals and not polygranular aggregates. Their occurrence is rather problematical but they may simply be infillings of cylindrical cavities produced by gas streaming within the crystallizing quartz. One specimen has wires which appeared to be elongated triangular prisms, which may in fact be elongated rhombohedral crystals formed simultaneously with the enclosing quartz (Lawrence and Markham, 1962). Specimens of these wires can still be found in the dumps of Sachs' pipe.

Analysis of bismuth have shown a silver content ranging up to 1645 g/t and gold content of up to 40.115 g/t (Andrews, 1916).

Bismuthinite Bi_2S_3
One of the important ore minerals at Kingsgate, bismuthinite was most abundant in the footwall region of the pipes, enclosed by dark, granular, cavernous quartz. Assays showed that much of the bismuthinite contained gold and silver. The bismuthinite occurred as large bladed aggregates to several kg in weight, often directly associated with native bismuth and commonly molded between quartz crystals in vugs (Fig. 21). It also occurred as delicate groups of acicular crystals in vugs in the amber quartz (Fig. 22). In open vugs, where molybdenite rosettes were perched on quartz crystals, felted masses of acicular bismuthinite occurred between the molybdenite crystals. The larger masses of bismuthinite were generally associated with galenobismutite and more rarely cosalite.

Specimens of bismuthinite are now not common at Kingsgate. Fine acicular crystals in quartz vugs (Fig. 23) have recently been found in the underground workings and dumps of the Old 25 pipe, either deposited directly on quartz or associated with muscovite and often partly or completely pseudomorphed by bismutite.

Figure 19. Native bismuth showing the hexagonal impressions produced by the termination faces of quartz crystals. Australian Museum specimen D/30936, presented by the family of the late W. H. Yates in 1931. Specimen is 19 cm across. Photograph by the author.

Figure 20. Crude trigonal crystal of native bismuth. Australian Museum specimen D/30942, presented by the family of the late W. H. Yates in 1931. Crystal is 5.5 cm long. Photograph by the author.

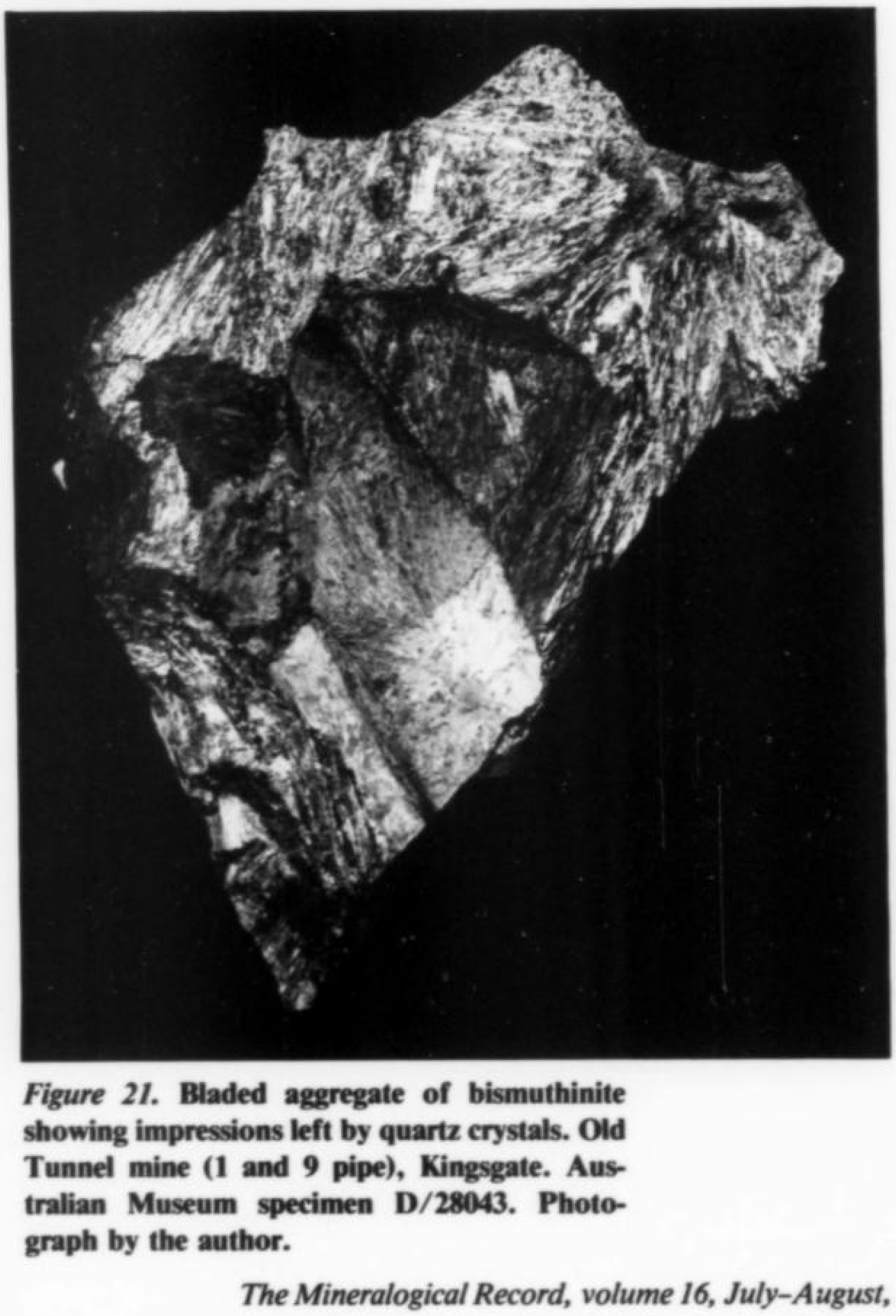


Figure 21. Bladed aggregate of bismuthinite showing impressions left by quartz crystals. Old Tunnel mine (1 and 9 pipe), Kingsgate. Australian Museum specimen D/28043. Photograph by the author.

Figure 22. **Acicular crystals of bismuthinite, once common in vugs in the quartz pipe mined as the Water cut (Wet shaft), Glen Innes Gully, Kingsgate. Australian Museum specimen D/35922 (purchased from Miss Sachs), 3 cm diameter. Photograph by the author.**

Figure 23. **Jackstraw group of bismuthinite crystals with quartz crystal and muscovite. From the miarolitic quartz of Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 1 mm. Author's specimen and photograph.**

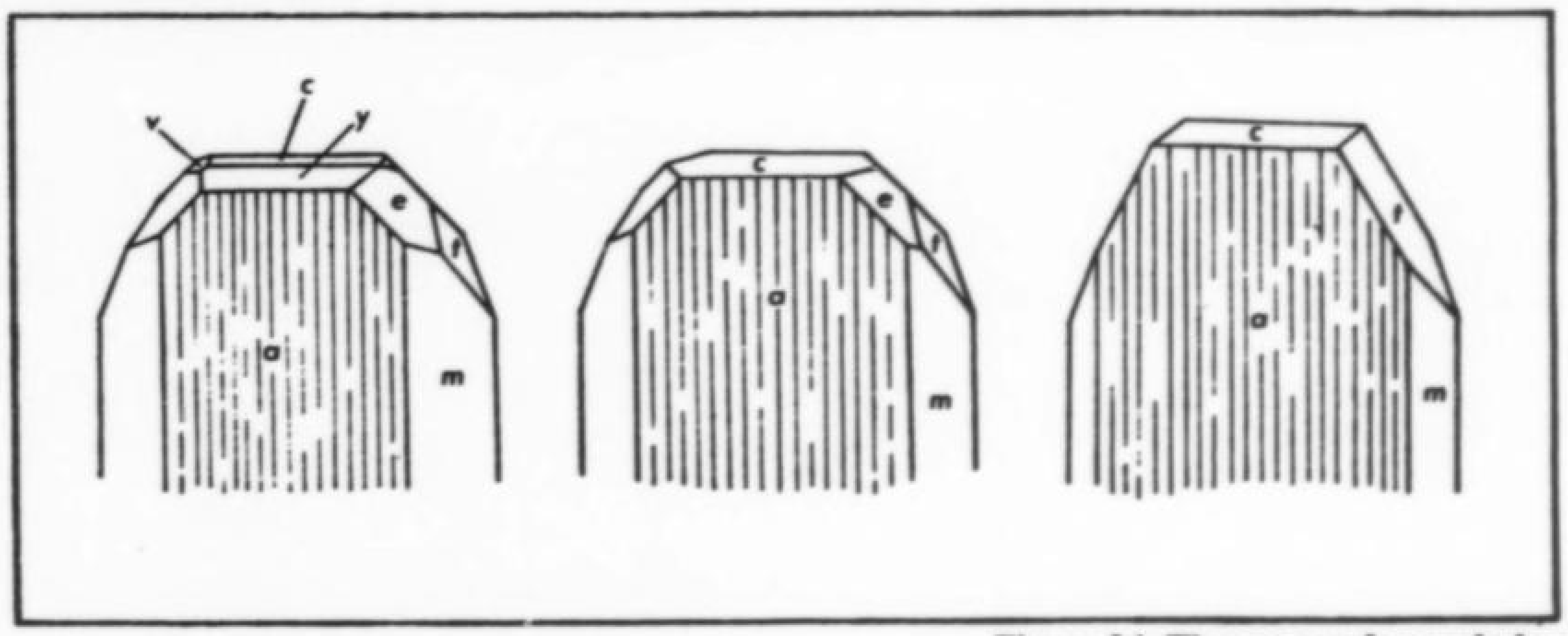


Figure 24. **The range of morphology shown by crystals of brookite from 25 North pipe, Kingsgate. Drawings by the author.**

Figure 25. **Brookite crystals associated with muscovite and quartz. 25 North pipe dumps, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

Brookite TiO_2

This orthorhombic polymorph of titanium dioxide appears to be very rare at Kingsgate and its occurrence in the quartz pipes is here recorded for the first time.

Kingsgate brookite occurs as brown, transparent to opaque crystals, tabular on *a*{100} and reaching a maximum observed diameter of 1 mm. Crystal habits comprise various combinations of *a*{100}, *m*{110}, *t*{011}, *e*{122}, *y*{401} and *c*{001}. The *a*{100} faces are heavily striated parallel to the vertical axis due to oscillatory development of *a*{100} and *m*{110} faces (Fig. 24).

The brookite occurs on quartz crystals associated with later muscovite (Fig. 25) in cavities in white quartz found on the dumps of the 25 North pipe. It was identified by chemical composition determined using energy-dispersive electron probe microanalysis and by crystal morphology. Insufficient material is currently available to allow confirmation by X-ray diffraction.

The presence of brookite in the quartz pipes probably represents the redistribution of titanium originally present as Ti^{+4} replacing (Fe,Mg) in octahedral sites in the biotite of the host granite.

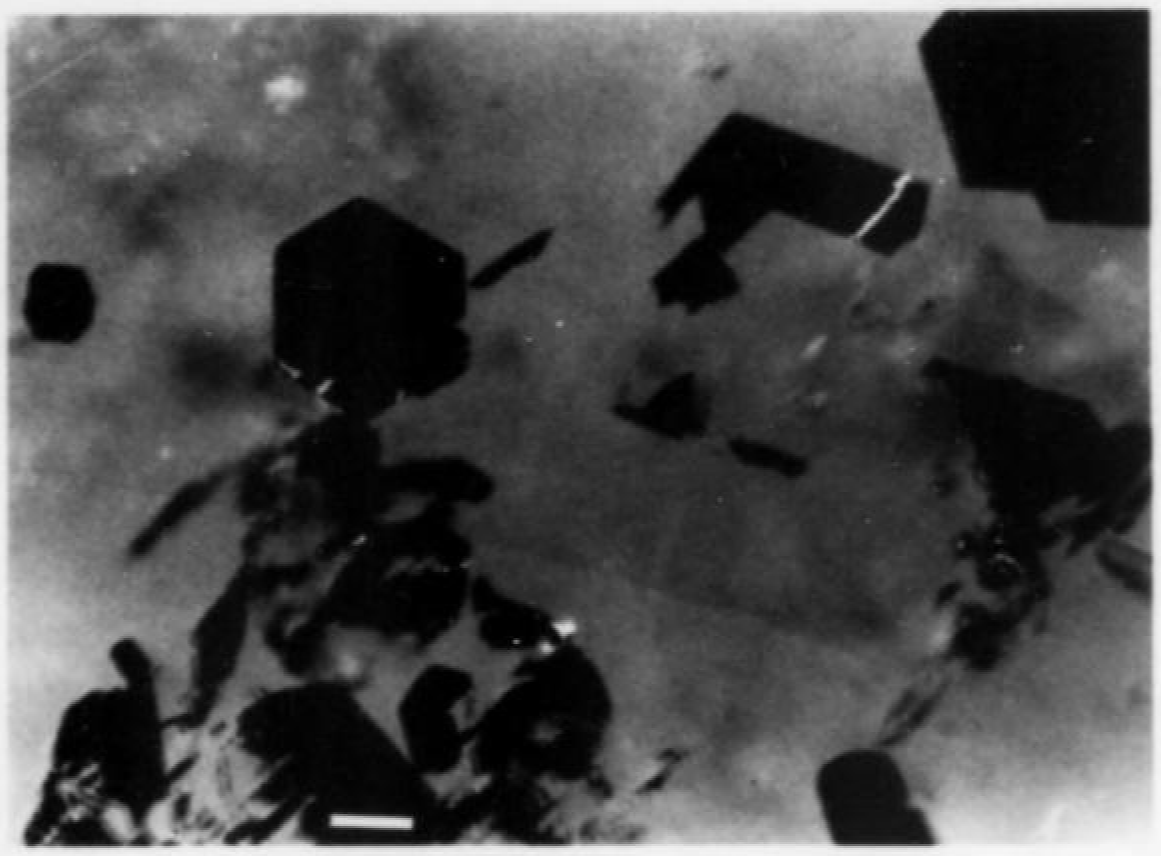


Figure 26. **Molybdenite crystals enclosed in calcite. Goodwin's pipe, Kingsgate N.S.W. Scale bar is 0.1 mm. Author's specimen and photograph.**

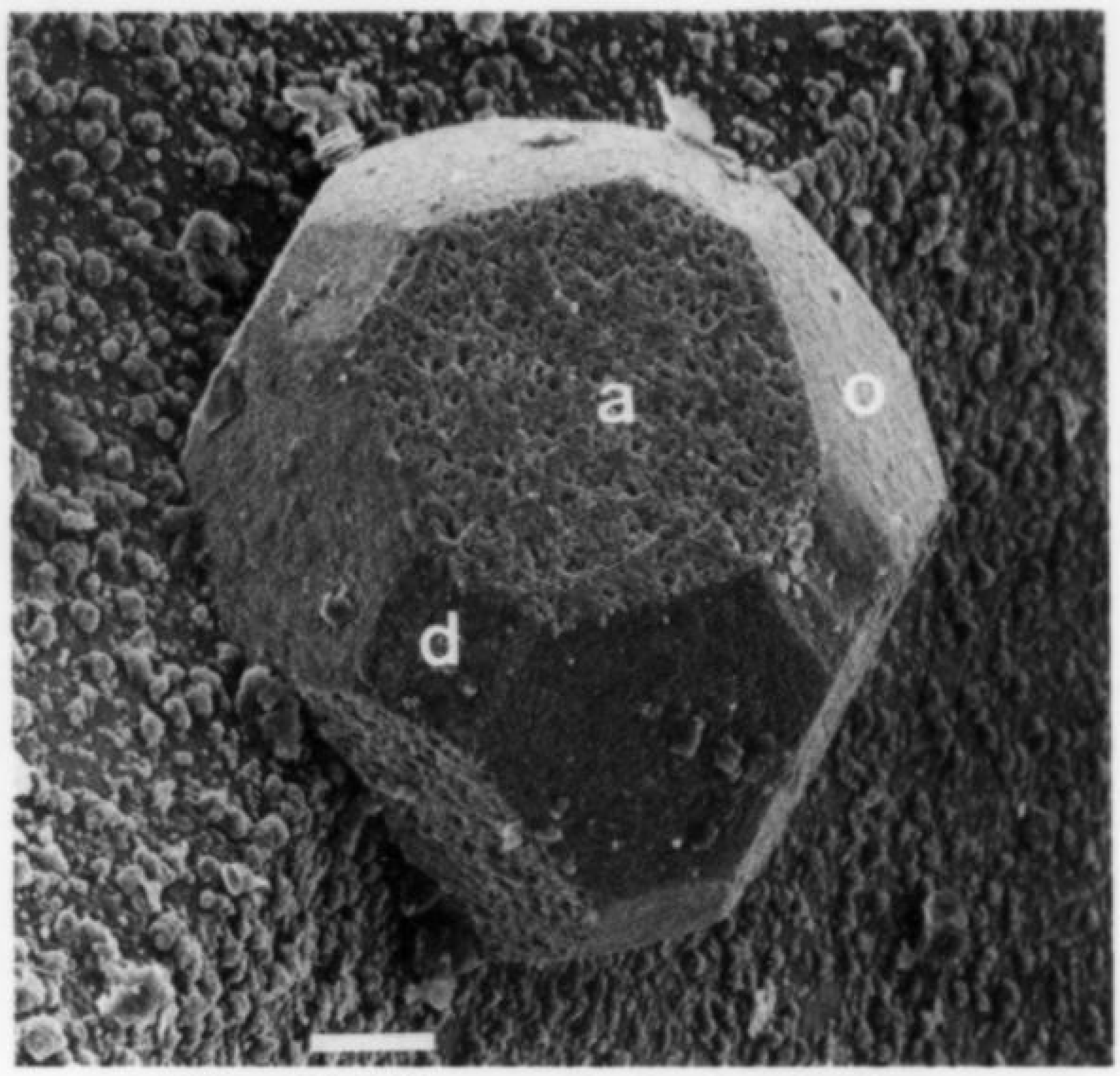


Figure 27. **Galena crystal showing the forms** ***a*{100}, *o*{111} and *d*{110}, on quartz. From the miarolitic quartz of the Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 10 micrometers. Author's specimen and photograph.**

Calcite $CaCO_3$

Calcite is rare at Kingsgate and the only occurrence noted is on the dumps of Goodwin's pipe. Here it either cements large volumes of fractured quartz, or occurs as cleavable masses of scalenohedral crystals to a few cm long in vugs. The calcite crystals often contain hexagonal flakes of molybdenite (Fig. 26) occluded in a narrow zone parallel to the scalenohedral faces.

Specimens in the Australian Museum collection, Sydney, are listed as having been found in Sachs' mine, Kingsgate. However, these probably also originated from Goodwin's pipe which was one of the several deposits worked by the Sachs of Kingsgate Syndicate.

Ferberite $(Fe,Mn)WO_4$

Kingsgate wolframite lies in the ferberite range with Fe:Mn of 11.6:6.7 (Lawrence and Markham, 1962). It was not abundant and its occurrence was restricted to only a few of the pipes. Lustrous black masses up to several cm embedded in white reef quartz have been found in the Wolfram pipe and in the Old 25 pipe.

Galena PbS

Galena is rare at Kingsgate. The only occurrences observed have been in association with sphalerite in Pipe 43, with bismuth in massive pyrrhotite-chalcopyrite ore from the Granite shaft, and as microcrystals showing the *a*{100} form or more complex combinations of *a*{100}, *o*{111} and *d*{110} (Fig. 27) lining small vugs in amber quartz from the Old 25 pipe.

Galenobismutite $PbBi_2S_4$

Galenobismutite was occasionally seen as greenish silver-colored masses up to 5 cm across in molybdenite (Lawrence and Markham, 1962).

Ikunolite $Bi_4(S,Se)_3$

This is certainly the rarest of the minerals recorded from Kingsgate. Specimens labeled tetradymite in the collection of the Australian Museum, Sydney, were found to be ikunolite. Despite old records, tetradymite has not been found to occur in the Kingsgate pipes.

The ikunolite occurs as plates and foliated masses up to 3 cm across. One specimen consists of a wedge-shaped mass almost 1 kg in weight, its shape resulting from molding between quartz crystals (Lawrence and Markham, 1962). It can be associated directly with native bismuth, molybdenite (usually as augen-like inclusions), or intergrown with bismuthinite. Specimens show a perfect {0001} cleavage and a splendent lead-gray color (Fig. 28).

Figure 28. **Ikunolite, Kingsgate mines. Australian Museum specimen D/35883, purchased from Miss F. Sachs in 1941 and formerly labeled "tetradymite with bismuth." Specimen is 2 cm in diameter. Photograph by the author.**

An unusual feature of Kingsgate ikunolite is the high lead content (up to 5.5% by weight) compared to specimens from other recorded occurrences. The lead appears to be present as an atomic substitution for bismuth in the structure (Markham, 1962). Hence the Kingsgate material can be termed plumbian ikunolite.

Figure 29. **Tabular hexagonal molybdenite crystals encased in white quartz. Road shaft, Kingsgate, N.S.W. Australian Museum specimen D/40828, presented by Professor David Brown in 1961. 5 cm in diameter. Photograph by the author. (This specimen appeared as Plate 9 in *Contributions to the mineralogy of N.S.W., Mineral Resources No. 34,* Geological Survey of N.S.W., 1926.)**

Figure 30. **Molybdenite crystals with quartz crystals from Sachs' mine, Kingsgate. Specimen is 14 cm across. From the collection of the New South Wales Government Department of Mineral Resources Geological and Mining Museum, Sydney (specimen number M19815). Photograph by David Barnes, Department of Mineral Resources. Used on the cover of *Mineral Resources Bulletin 43, Molybdenum in New South Wales* and reproduced here by the courtesy of the Department of Mineral Resources.**

Figure 31. **Molybdenite crystal collected from the dumps of the Old 25 pipe, Kingsgate. Specimen 3 cm in diameter. Author's specimen (M68.12.2), and photograph.**

Molybdenite MoS_2

Although discarded by early mining operations, molybdenite later became one of the most important ore minerals at Kingsgate. The dumps of many of the older workings contain an abundance of this mineral.

Although the molybdenite occurs as small flakes in the silicic granite and granitoid quartz in the vicinity of the pipes it is never abundant there, but reaches its greatest concentration in the pipes themselves, where it is most plentiful in the zone of transition between the granitoid quartz and the reef quartz forming the core. This zone contains vugs in which the molybdenite occurs as large crystalline masses together with bismuth minerals. It commonly forms well-shaped tabular hexagonal crystals from a few millimeters to over 12 cm in diameter, either encased in fractured quartz (Fig. 29) or resting on quartz crystals in vugs (Fig. 30). Crystals with composite prism faces on 5 cm in length have been found.

The molybdenite crystals are usually composite in nature with several thin tabular individuals arranged in sub-parallel growth to form rosettes.

When examined in polished section at 90° to the basal cleavage the molybdenite crystals from some of the pipes (particularly the Giant Blow, Old 25, and Sachs' pipe) show augen-like inclusions of bismuth, bismuthinite, joseite A and B, ikunolite and gold.

Because molybdenite was of no value in the early days of mining, many of the Kingsgate pipes provide considerable potential for further recovery of fine specimens. Among these are the Giant Blow and Old 25 deposits. The dumps and underground workings of the Old 25 pipe have provided exceptional specimens in recent years, principally as sharp hexagonal plates to 3 cm in amber to white quartz (Fig. 31). The occurrence of molybdenite in the Giant Blow has already been described.

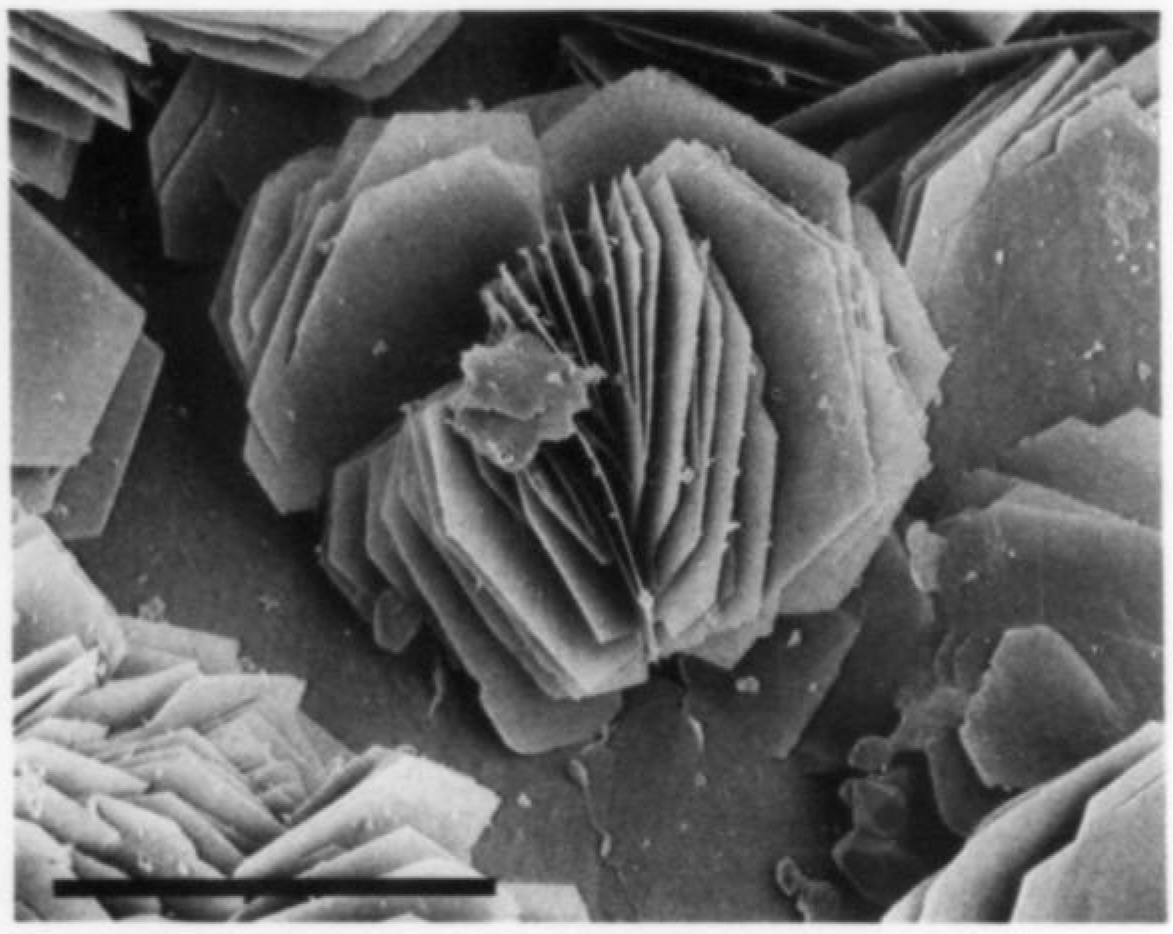


***Figure 32.* Rosettes of muscovite on quartz, Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

***Figure 33.* Hexagonal plates of muscovite associated with microcrystallized quartz, on the rhombohedron face of a larger quartz crystal. From the miarolitic quartz of the Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

Muscovite $KAl_2(Si_3Al)O_{10}(OH,F)_2$

Muscovite is present in the altered granite aureole which surrounds many of the Kingsgate pipes, where it formed as an alteration product of the K-feldspar of the original granite during emplacement of the pipe material.

However, of greater mineralogical interest is the occurrence of druses of crystallized muscovite (Fig. 32) in vugs in the miarolitic quartz of the Old 25 and 25 North pipes, where it appears to have been the first mineral deposited after quartz. It forms the substrate for many of the primary and secondary minerals deposited in the miarolitic cavities, including late-stage microcystallined quartz (Fig. 33).

The muscovite crystals reach a diameter of 1.5 mm and are generally lustrous, translucent to transparent, and pale yellow in color.

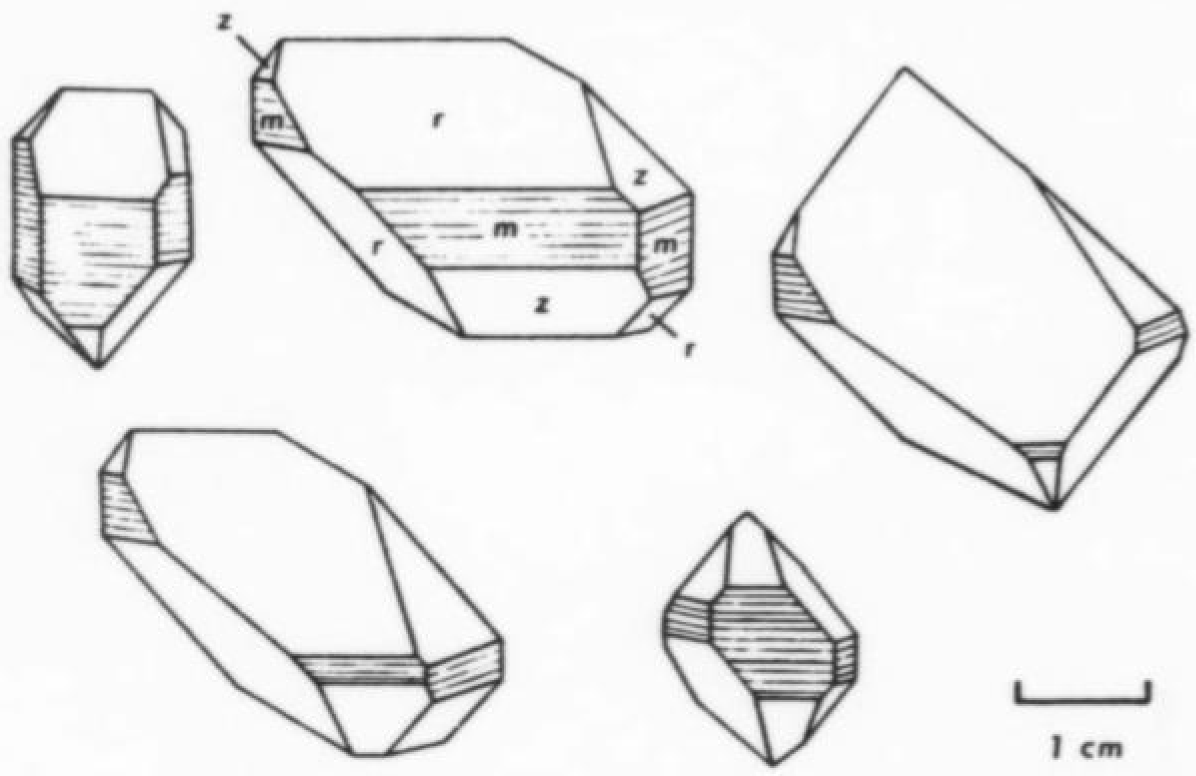


***Figure 34.* The range in crystal morphology shown by quartz crystals from the Giant Blow (pipe H), Kingsgate. Author's specimens and drawings.**

Quartz SiO_2

Vugs in the miarolitic amber-colored quartz on the footwall and large caverns in the central reef quartz zone of the Kingsgate pipes contained quartz crystals from less than 1 mm to over 3 m in length. Large masses of flawless amber to colorless quartz were found in many of the pipes and provided exceptional lapidary material.

The crystals are typically prismatic, well-proportioned and commonly transparent, although in some vugs the crystals have an outer coating of drusy quartz, sericite, or more rarely indeterminate powdery iron and manganese oxides. Larger crystals show variation in color, being smoky to amber at their base and grading to colorless at the termination or vice-versa.

Phantoms are a common feature and sectorial interpenetration twinning (Brazil law) parallel to the *c* axis is revealed in many crystals by the alternation of triangular prisms of smoky color with areas of clear quartz in sections cut at 90° to the *c* axis. In fact, in some completely transparent crystals, the individual twin components can be traced through the body of the crystal by observing the color zones. Color zoning parallel to the rhombohedron faces is typical of Kingsgate quartz, usually taking the form of thin amber to smoky bands unevenly dispersed through colorless quartz.

In the great majority of Kingsgate quartz crystals the terminating rhombohedrons are either unequally developed, with $r\{10\bar{1}1\}$ predominating, or asymmetrically displaced. The prism $m\{10\bar{1}0\}$ is always strongly developed, with prominent lateral striations, and druses of crystals showing terminating rhombohedrons only are unknown from Kingsgate. Neither the trigonal pyramid nor

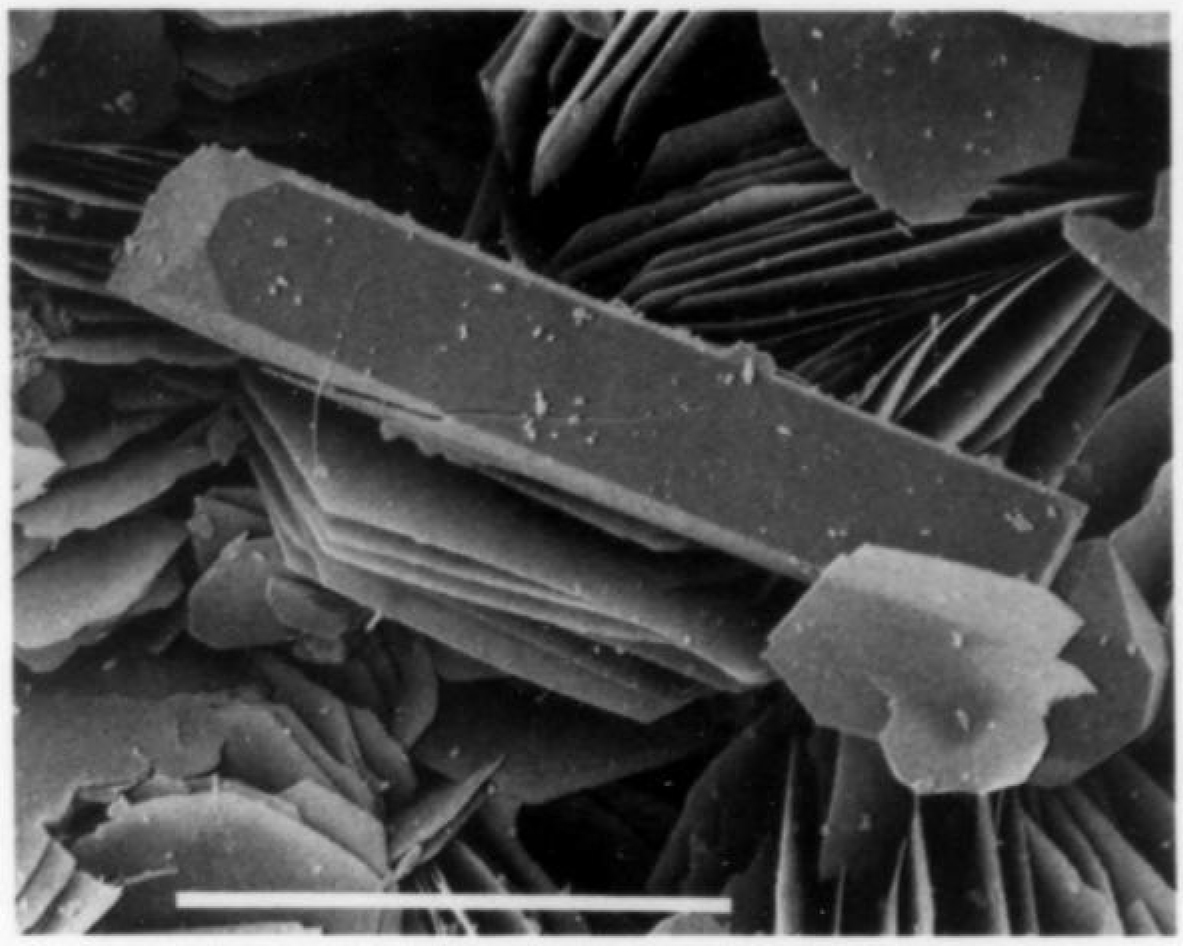


***Figure 35.* Asymmetrically distorted quartz crystal on crystallized muscovite. From the miarolitic quartz of the Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

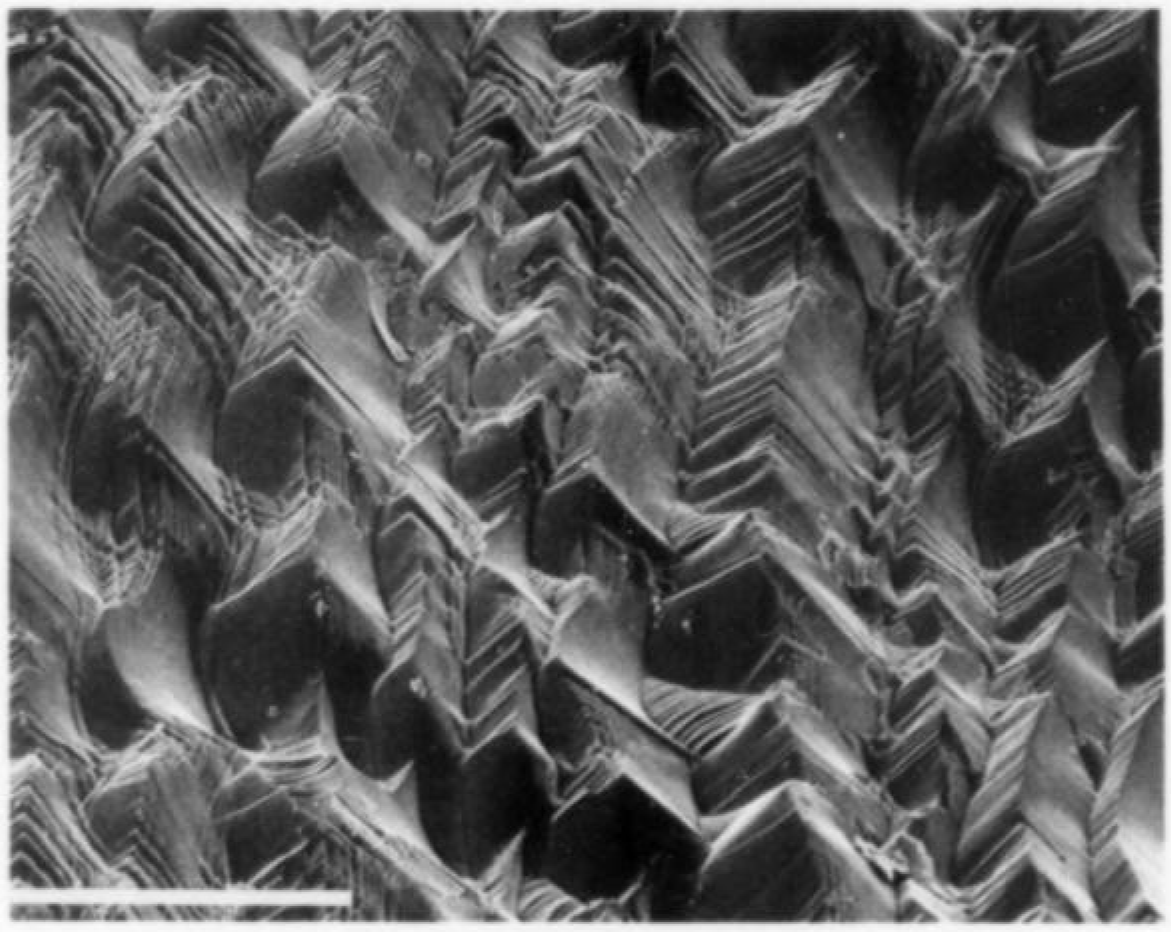


***Figure 36.* Interference fracture pattern in quartz from Goodwin's pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

trigonal trapezohedron have been observed by the author, so that the crystals are essentially simple in morphology.

Asymmetrically distorted crystals are common in the dumps of the Giant Blow (Pipe H) at the head of Glen Innes Gully. These crystals show no point of attachment and display a surprising range in morphology (Fig. 34), including thin plates and even rare rhombohedrons, which closely resemble cubes due to the interfacial angle of 85°46′ in $r\{10\bar{1}1\}$.

Late-stage micro quartz crystals associated with crystallized muscovite in small vugs in white quartz on the dumps of the 25 North/Old 25 deposits show interesting asymmetrical distortion in which preferred lateral extension of 4 of the 6 faces in $r\{10\bar{1}1\}$ gives the crystal a pseudo-monoclinic symmetry (Fig. 35).

An interesting feature of Kingsgate quartz is the tendency for large crystals to show well-defined incipient cleavage planes parallel to the faces of one of the terminating rhombohedrons.

Inclusions in Kingsgate quartz are varied and often spectacular. The presence of wires of bismuth has already been mentioned. Flakes and rosettes of molybdenite are often found in transparent quartz, as are needles of bismuthinite. Various oxides, including brown goethite and straw-yellow bismutite have been occluded in zones parallel to the crystal faces in some specimens. Arsenopyrite occurs as idiomorphic and often grossly elongated crystals in clear to smoky quartz, some of the crystals being up to 5 cm in length and 4 mm in width. Occasionally the quartz crystals contain three-phase fluid inclusions which occupy euhedral cavities or "negative crystals."

Fragmentation of large areas of quartz was a feature of many of the pipes and often large crystals had been shattered to sharp angular plates and recemented by subsequent deposition of quartz or rarely, as in Goodwin's pipe, calcite. The mechanism by which these features were produced has already been discussed. Some crystals, fractured from the cavern walls, have developed secondary terminations comprising a multitude of parallel viscinal faces.

An unusual occurrence, noted on the dumps of Goodwin's pipe, is the presence of compacted masses of deformed and poorly developed quartz crystals with interstitial molybdenite and calcite. This implies that migration of the growing crystals occurred within the pipe under the influence of the hydrothermal fluid stream.

Also on the dumps of Goodwin's pipe and various other deposits, fracture surfaces normal to the *c* axis of some crystals show an unusual cross-hatched fracture pattern (Fig. 36). This may be a result of Brazil Law twinning in the crystals, with the intersection of sub-conchoidal fractures initiated in adjacent twin components.

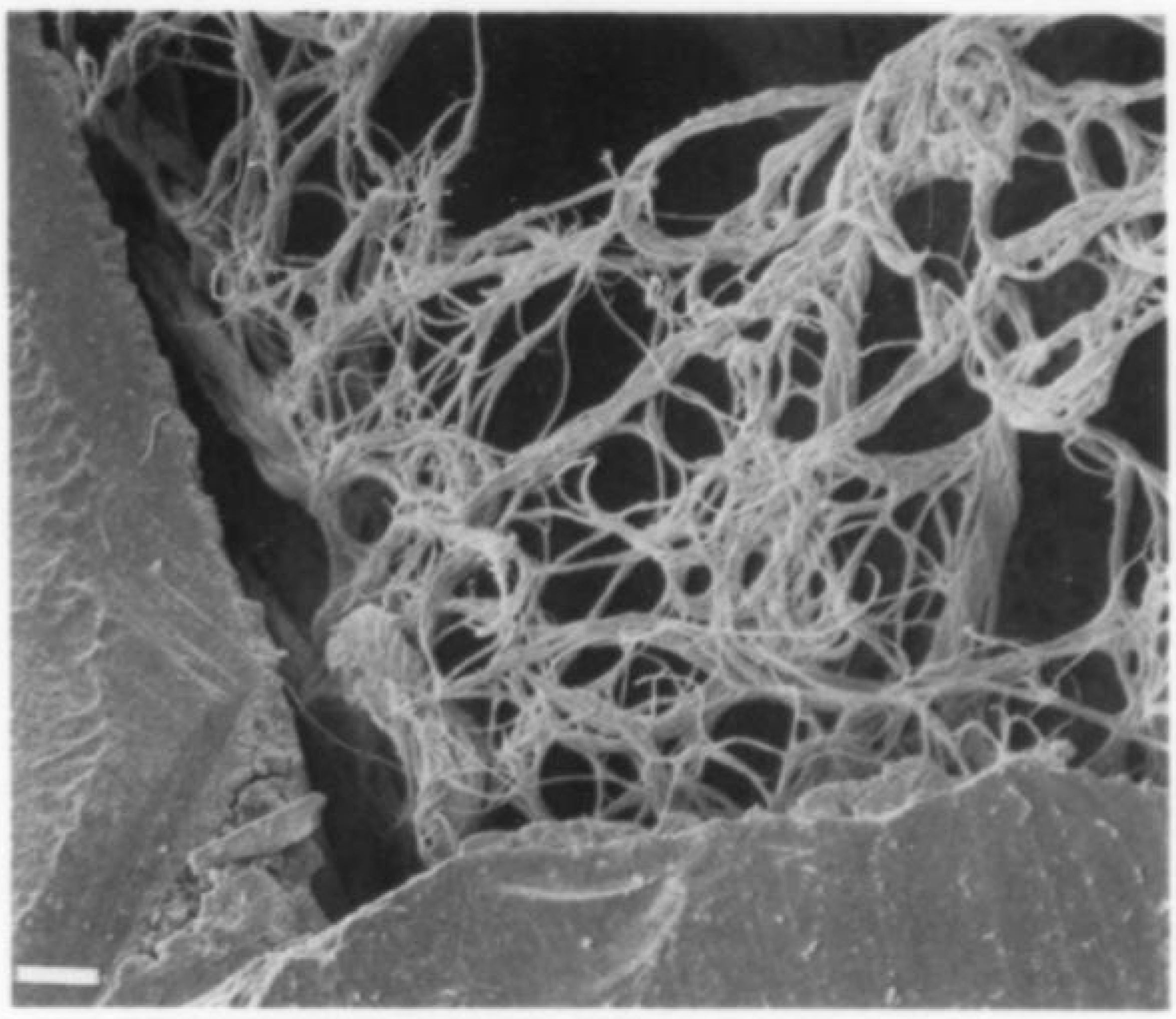


***Figure 37.* Fibrous bismite in miarolitic quartz from the Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 10 micrometers. Author's specimen and photograph.**

Secondary Minerals

Bismite Bi_2O_3

Bismite appears to be less common at Kingsgate than bismutite. It generally occurs as white to pale yellow-brown, fibrous, felted or lace-like masses (Fig. 37) coating quartz and other minerals in cavities in the amber-colored or white quartz of the footwall region of the pipes. The morphology of Kingsgate bismite closely resembles compacted spider webs and in the past much of this material has probably been discarded by collectors as such. The identity of this mineral was confirmed by X-ray powder diffraction, although the pattern obtained was somewhat indistinct due to contamination and the low volume of material available for characterization.

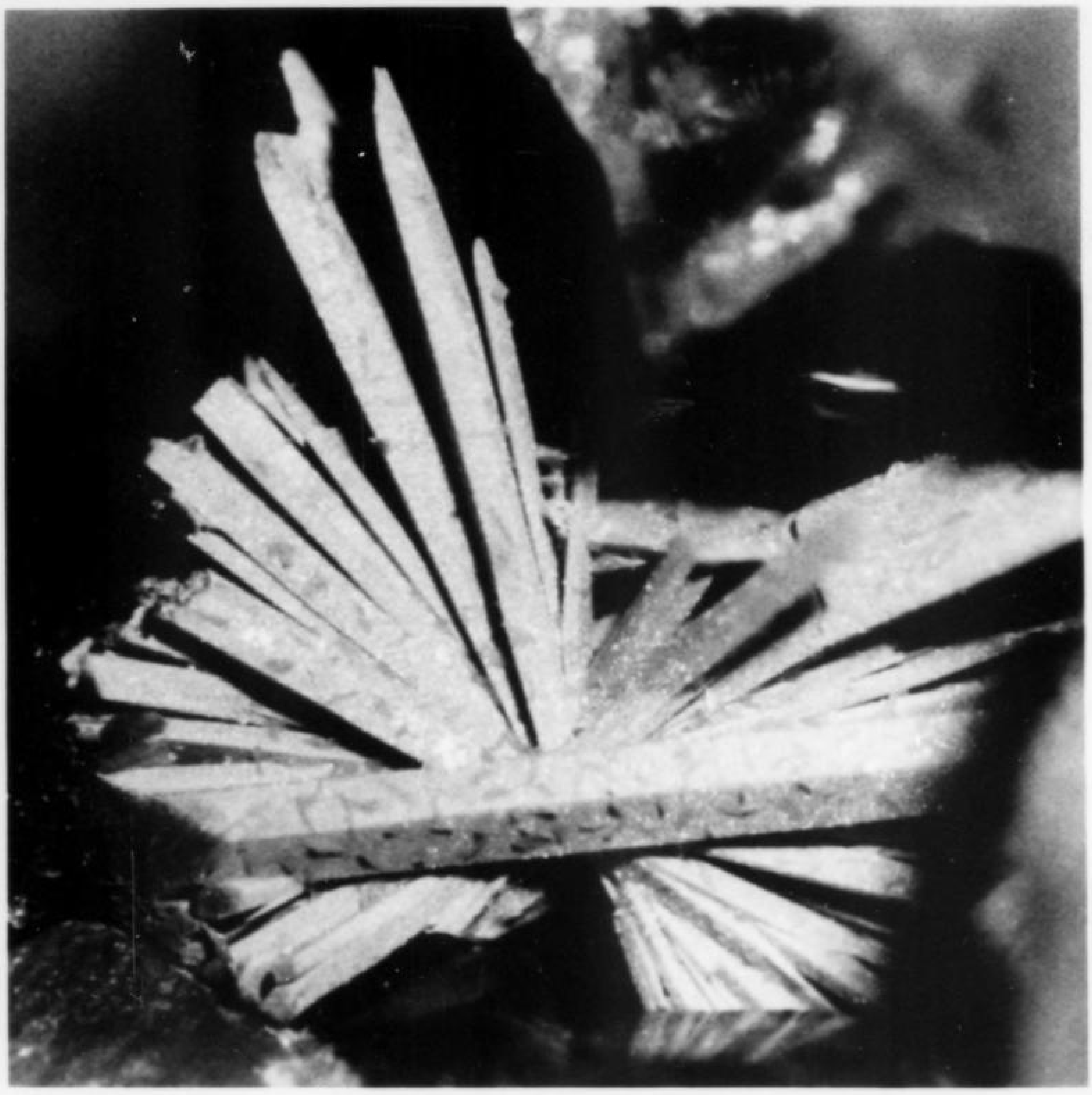
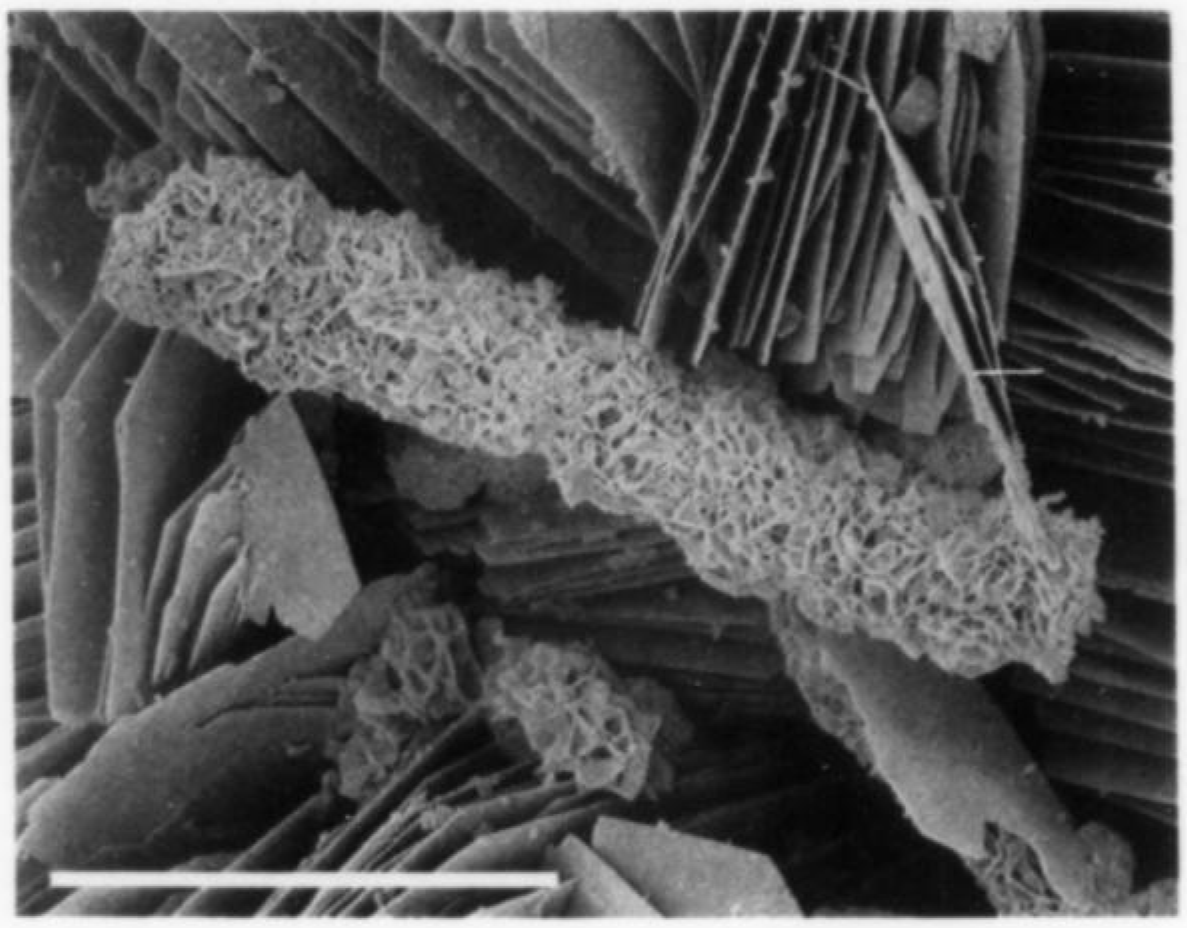


***Figure 38.* Bismutite pseudomorphs after a stellate group of bismuthinite crystals in cavity in quartz, Old 25 pipe, Kingsgate. Crystal group is 2 mm in diameter. Author's specimen and photograph.**

***Figure 39.* Platy bismutite coating and replacing prismatic bismuthinite on crystallized muscovite. From the miarolitic quartz in the Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**



Bismutite $Bi_2(CO_3)O_2$

Bismutite was the most prominent of the secondary bismuth ores and was the first bismuth mineral to be recognized at Kingsgate. It is most common as straw-yellow pseudomorphs after bismuthinite.

Miarolitic quartz from the Old 25 and 25 North pipes contains jackstraw to stellate groups of bismuthinite needles completely replaced by bismutite (Fig. 38). These pseudomorphs take the form of either a thin outer shell with the interior filled by delicate filigree networks of platy bismutite, or encrusting masses enveloping the bismuthinite (Fig. 39).

Rarely, rosettes of transparent, straw-yellow, thin, tabular crystals to 0.5 mm occur implanted on quartz (Fig. 40) and are accompanied by wulfenite and bismite. As with many of the secondary minerals found in the Kingsgate pipes these rosetted bismutite groups occasionally show secondary overgrowths (Fig. 41).

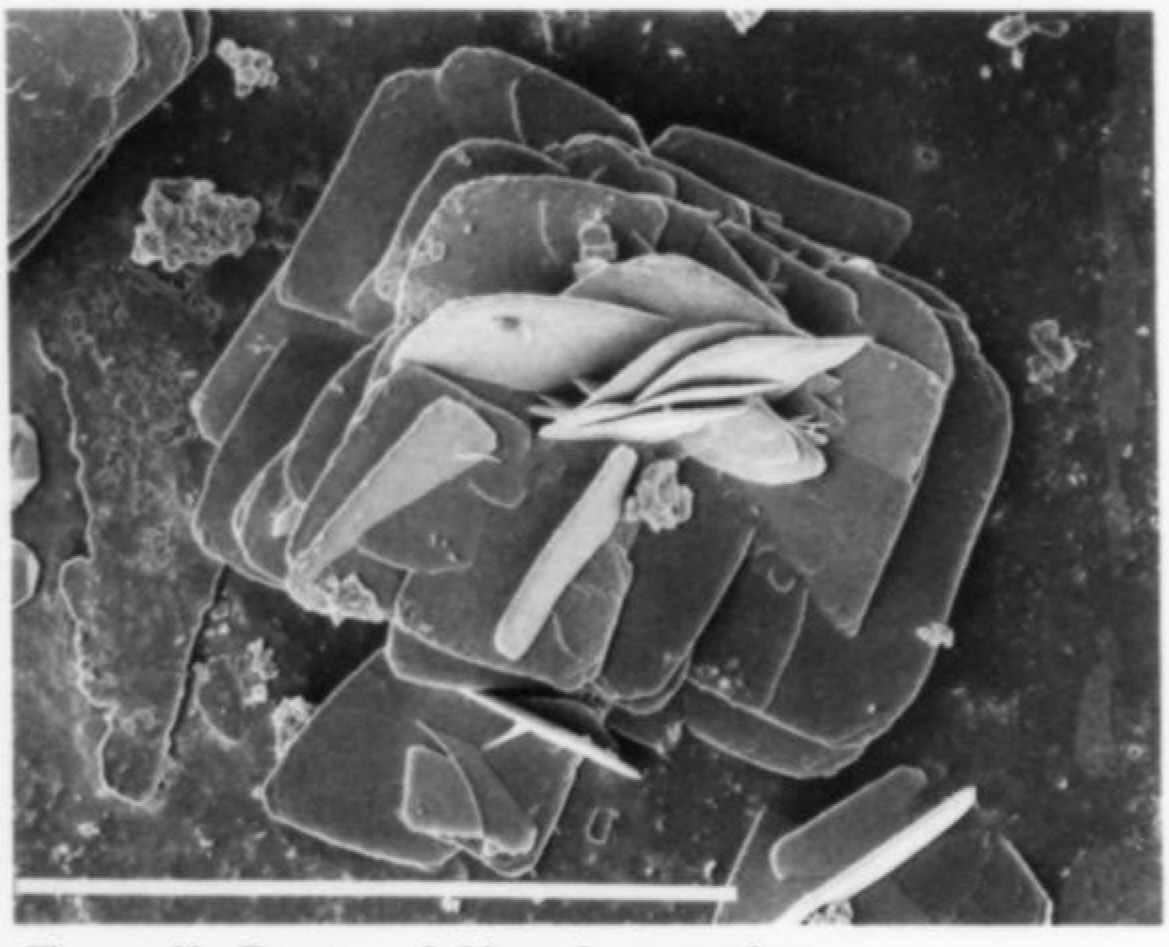


***Figure 40.* Rosette of bismutite crystals on quartz, Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

Ferrimolybdite $Fe_2(MoO_4)_3 \cdot 8H_2O$ (?)

This attractive iron molybdate forms as an oxidation product of molybdenite and is often found in the tabular cavities formerly occupied by that mineral, where it occurs as a pale yellow powder. Occasionally, where transported to cavities in solution, it has recrystallized to produce bright canary-yellow tufts of acicular crystals (Fig. 42), rarely more than 1 cm in length, on quartz crystals. These provide exceptional thumbnail and micromount specimens.

Crystallized ferrimolybdite is most abundant on the dumps and workings of the Old 25 and 25 North pipes.

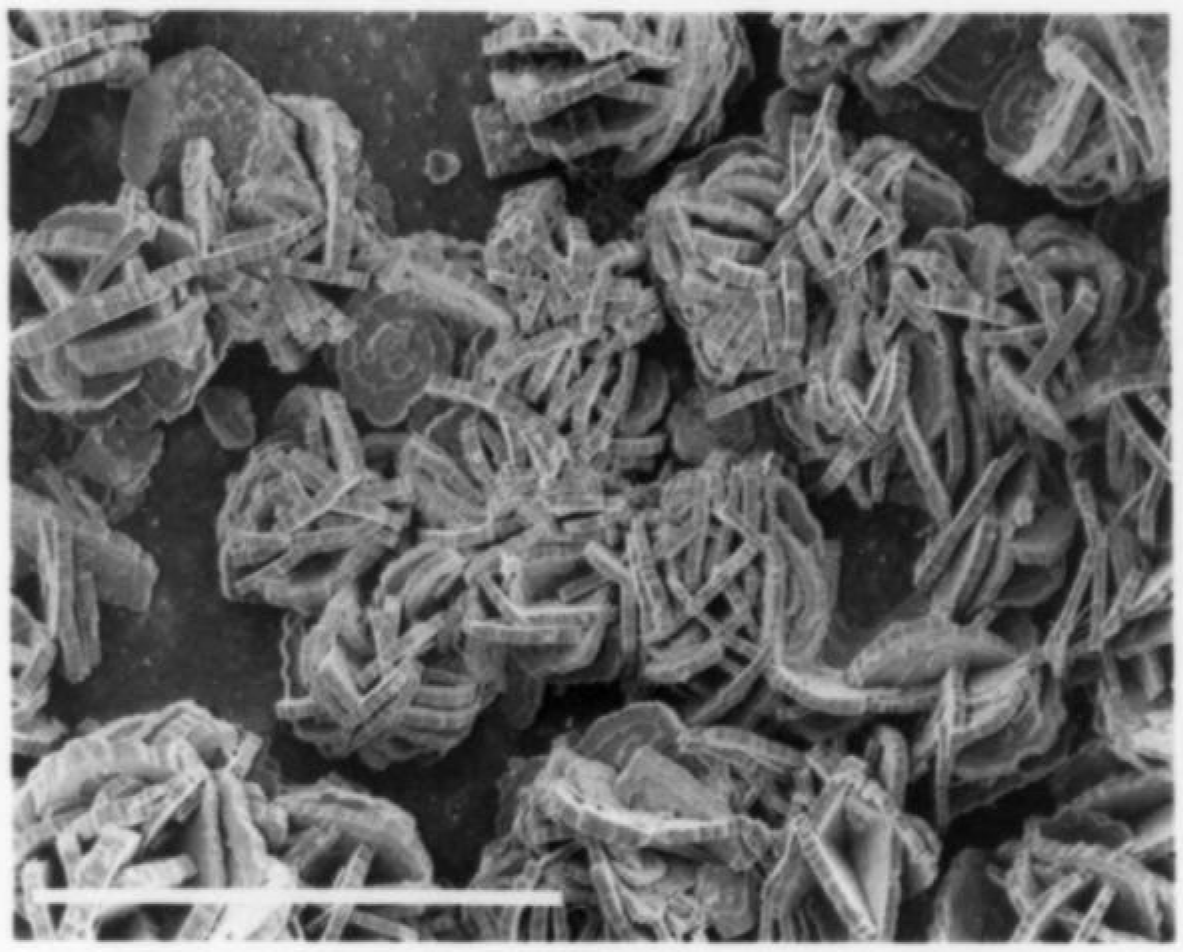


Figure 41. **Tabular bismutite crystals showing secondary overgrowths, on quartz. Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

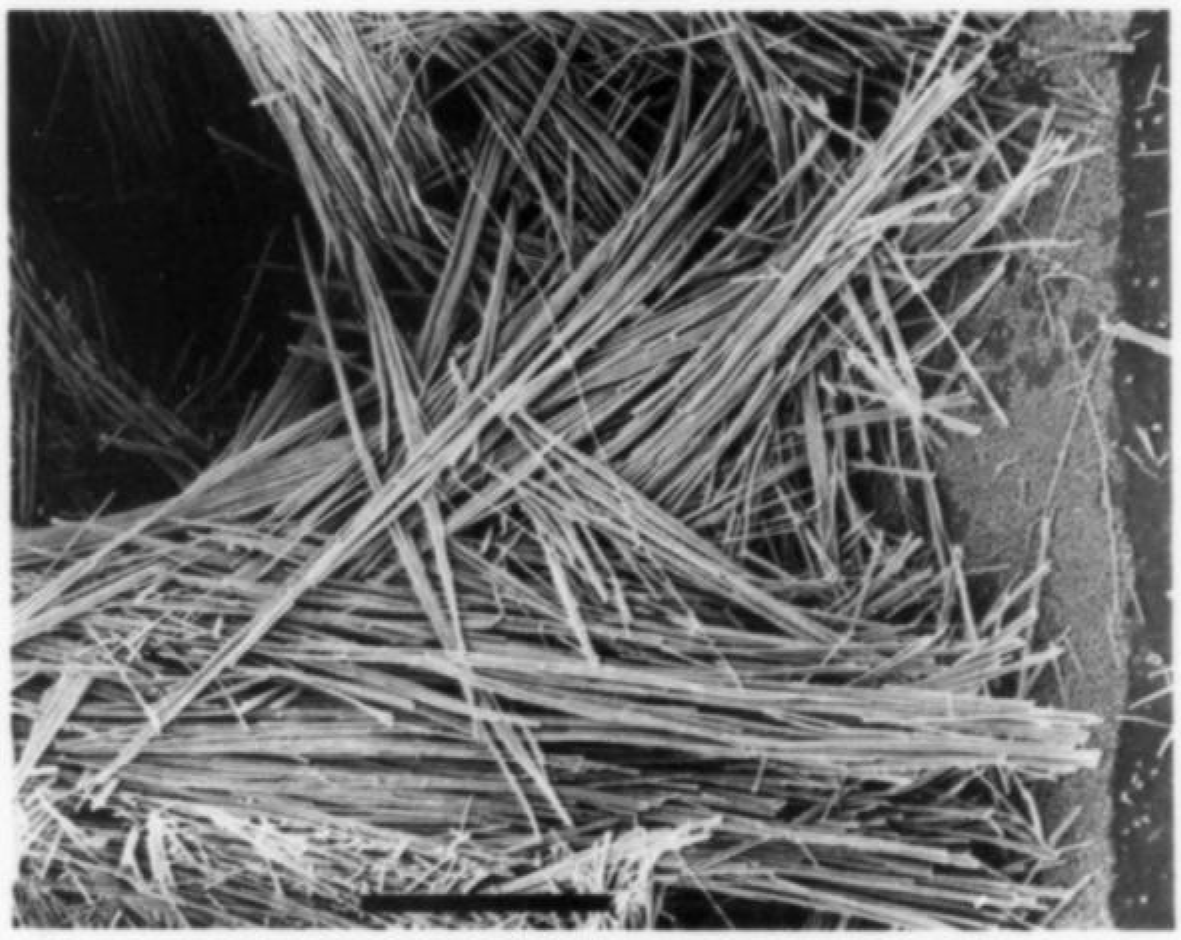


Figure 42. **Acicular ferrimolybdite in miarolitic cavities in quartz, Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

Goethite FeO(OH)

Goethite is present as a weathering product of the pyrite occasionally associated with molybdenite zones in the pipes, particularly in the Old 25 and 25 North pipes. It occurs as brown mamillary (Fig. 43) to microbotryoidal crusts (Fig. 44) on and between quartz crystals. A zone of limonite gossan containing goethite pseudomorphs after pyrite was located in the upper portion of the 25 North pipe.

Very occasionally, quartz crystals in miarolitic cavities are coated by isolated to matted divergent groups of brown acicular goethite crystals to 0.04 mm in length (Fig. 45).

Scorodite $FeAsO_4 \cdot 2H_2O$

This green iron arsenate occurs at Kingsgate as an oxidation product of arsenopyrite. The most common habit is microbotryoidal masses up to several cm across lining cavities in reef quartz formerly occupied by massive arsenopyrite.

Abundant leached fissures and oxidation cavities in the massive

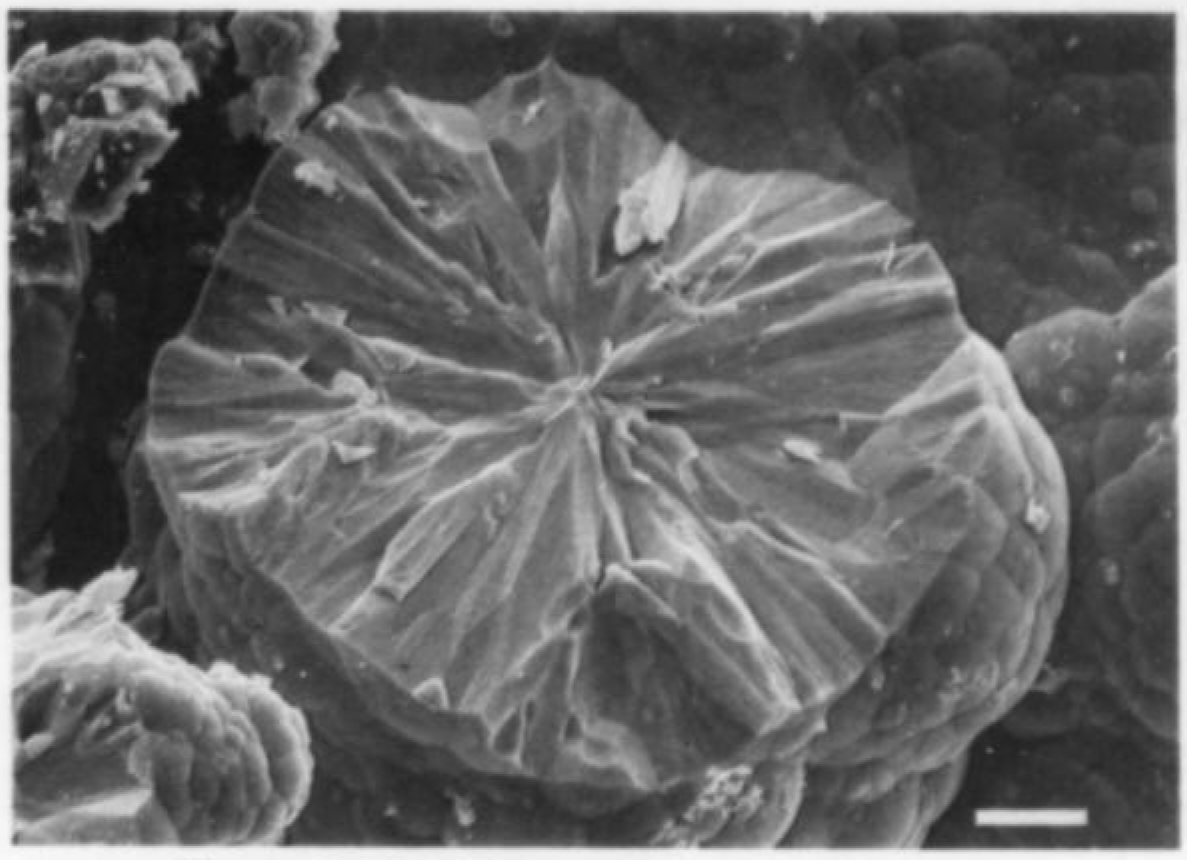


Figure 43. **Mamillary goethite with radial internal texture lining cavity in miarolitic quartz, Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 10 micrometers. Author's specimen and photograph.**

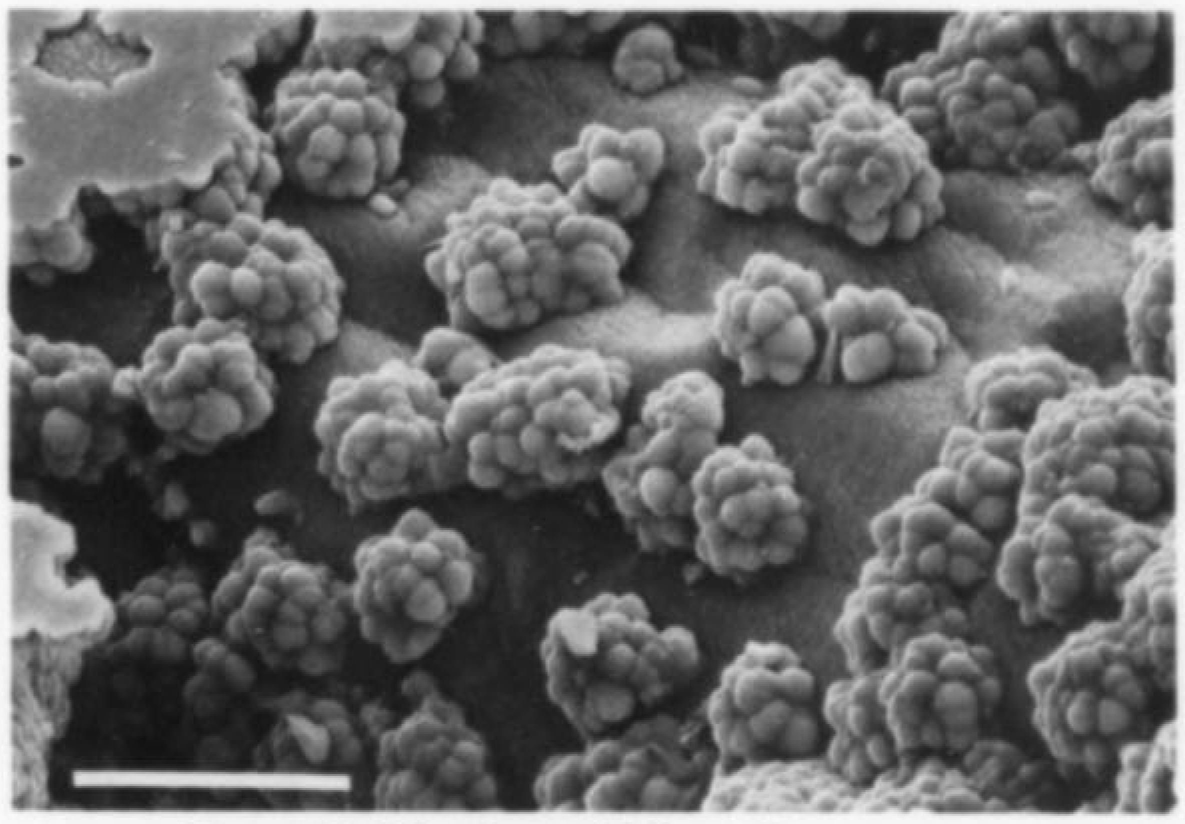


Figure 44. **Microbotryoidal goethite on quartz in cavity in miarolitic quartz, Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 10 micrometers. Author's specimen and photograph.**

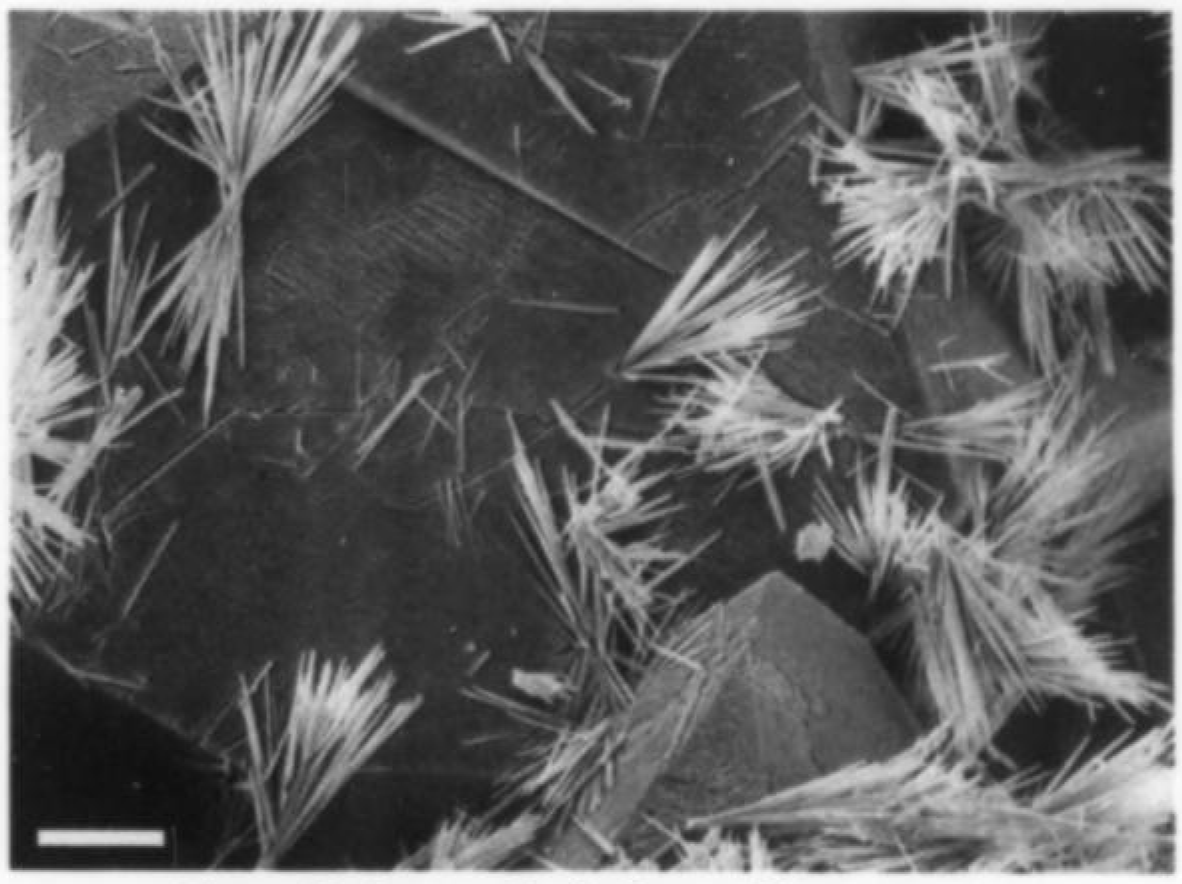


Figure 45. **Sprays of acicular goethite on quartz crystals, Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 10 micrometers. Author's specimen and photograph.**

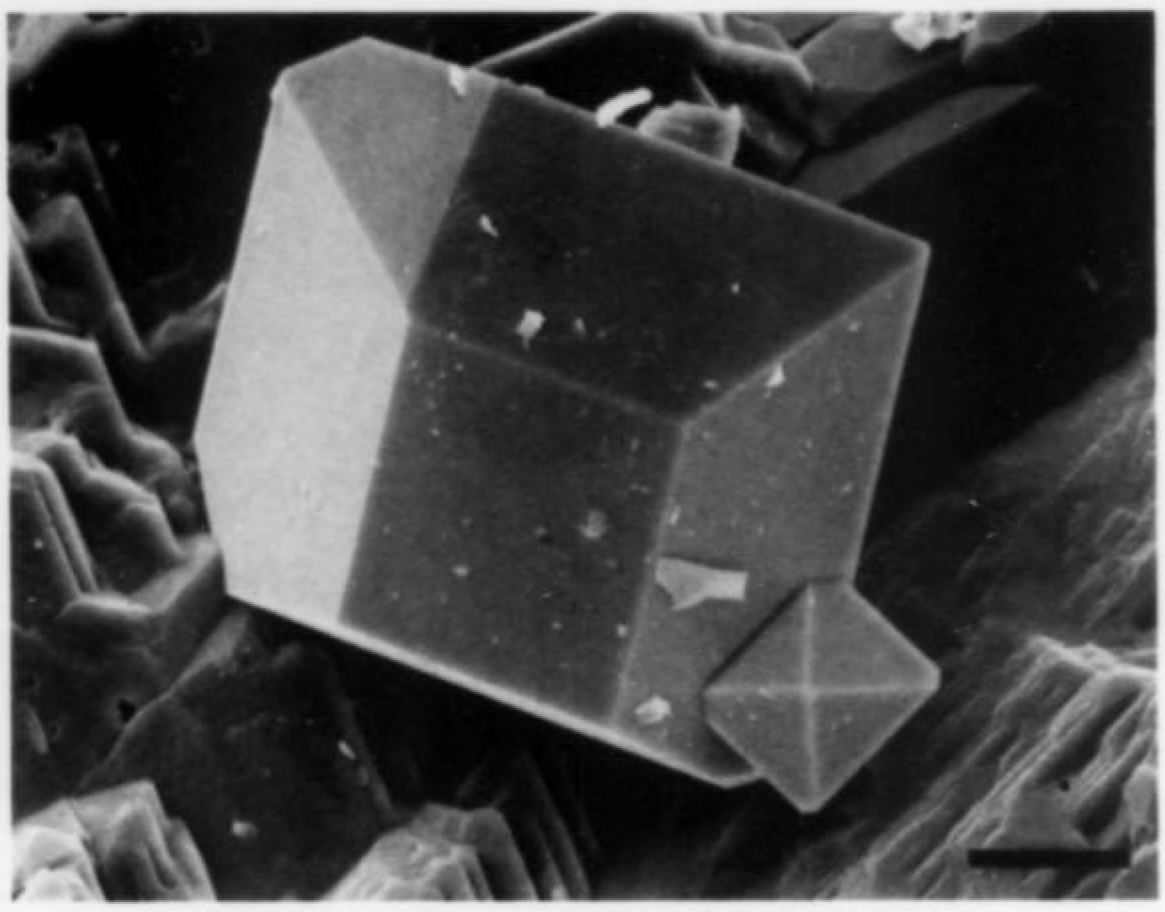


Figure 46. **Idiomorphic scorodite crystals showing the forms *a*{100}, *d*{120} and *p*{111}, Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 10 micrometers. Author's specimen and photograph.**

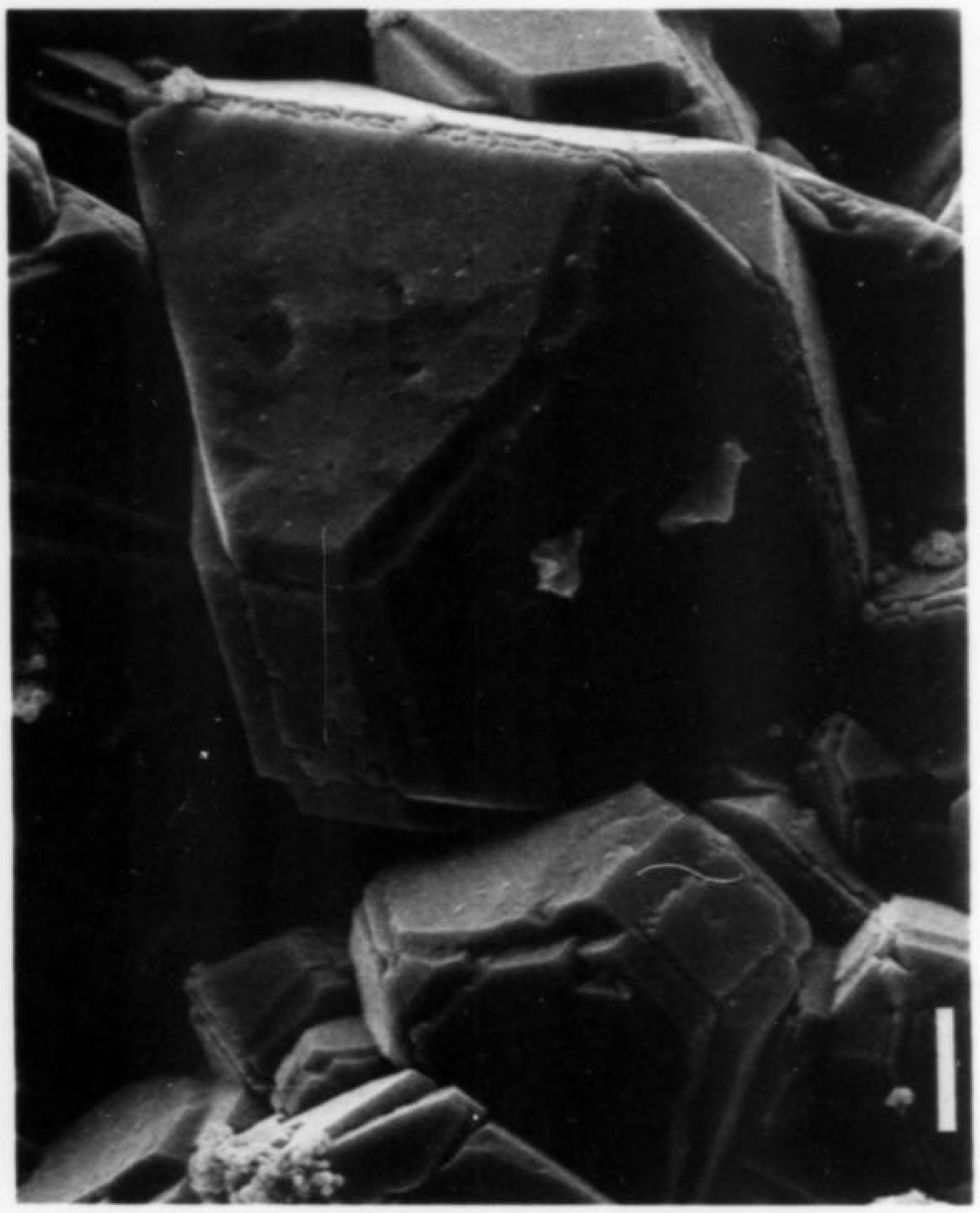


Figure 47. **Complex scorodite overgrowths, Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 10 micrometers. Author's specimen and photograph.**

arsenopyrite are lined with druses of lustrous, dark green, microcrystallized scorodite. Scanning electron microscopy (SEM) of these crystals shows the presence of orthorhombic forms characteristic of this mineral (Fig. 46). Isolated areas of these scorodite druses comprise complex overgrowths (Fig. 47), the exact nature of which is still not understood. Studies are presently being conducted on the nature and origin of this unusual habit and a detailed account of Kingsgate scorodite is being prepared for separate publication.

Figure 48. **Bipyramidal wulfenite crystals on limonite-coated quartz. Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar is 0.1 mm. Author's specimen and photograph.**

Wulfenite $PbMoO_4$

Wulfenite, although previously unrecognized from Kingsgate, is actually quite common although limited in occurrence. Scanning electron microscopy has revealed two distinct habits:

1. Lustrous well-formed steep bipyramids of a red-brown color (Fig. 48).

2. Crystals of a more complex habit showing unusual secondary overgrowths (Fig. 49). Here growth of the wulfenite crystals has been interrupted by a coating of very fine, powdery limonite. However, addition of material to the crystal lattice continued at tiny isolated "clean" areas on the crystal faces. The resulting small outgrowths were able to extend beyond the limonite coated surfaces and begin to envelop the original crystal, gradually occluding the limonite coating, while retaining the morphology of the earlier formed wulfenite crystals.

Both habits occur implanted on quartz crystals in vugs in amber-

Table 1. **Minerals of the Kingsgate pipes**

Primary	
Native Metals	**Tungstates**
Bismuth †	Wolframite
Gold	
Sulfides	*Secondary*
Arsenopyrite †	**Sulfides**
Bismuthinite †	Chalcocite
Chalcopyrite	Covellite
Galena	Marcasite
Gudmundite (?)	Smythite (?)
Ikunolite	**Non-sulfides**
Joseite-A	Bismite
Joseite-B	Bismutite †
Molybdenite †	Ferrimolybdite †
Pyrite	Goethite *
Pyrrhotite †	Ilsemannite
Sphalerite	Powellite (?)
Sulfosalts	Scorodite †
Cosalite	Tungstite
Galenobismutite	Wulfenite *
Pyrargyrite	*Gangue*
Oxides	Calcite
Brookite *	Quartz †
Cassiterite	Sericite

* Minerals not previously recorded from Kingsgate
† Most abundant species

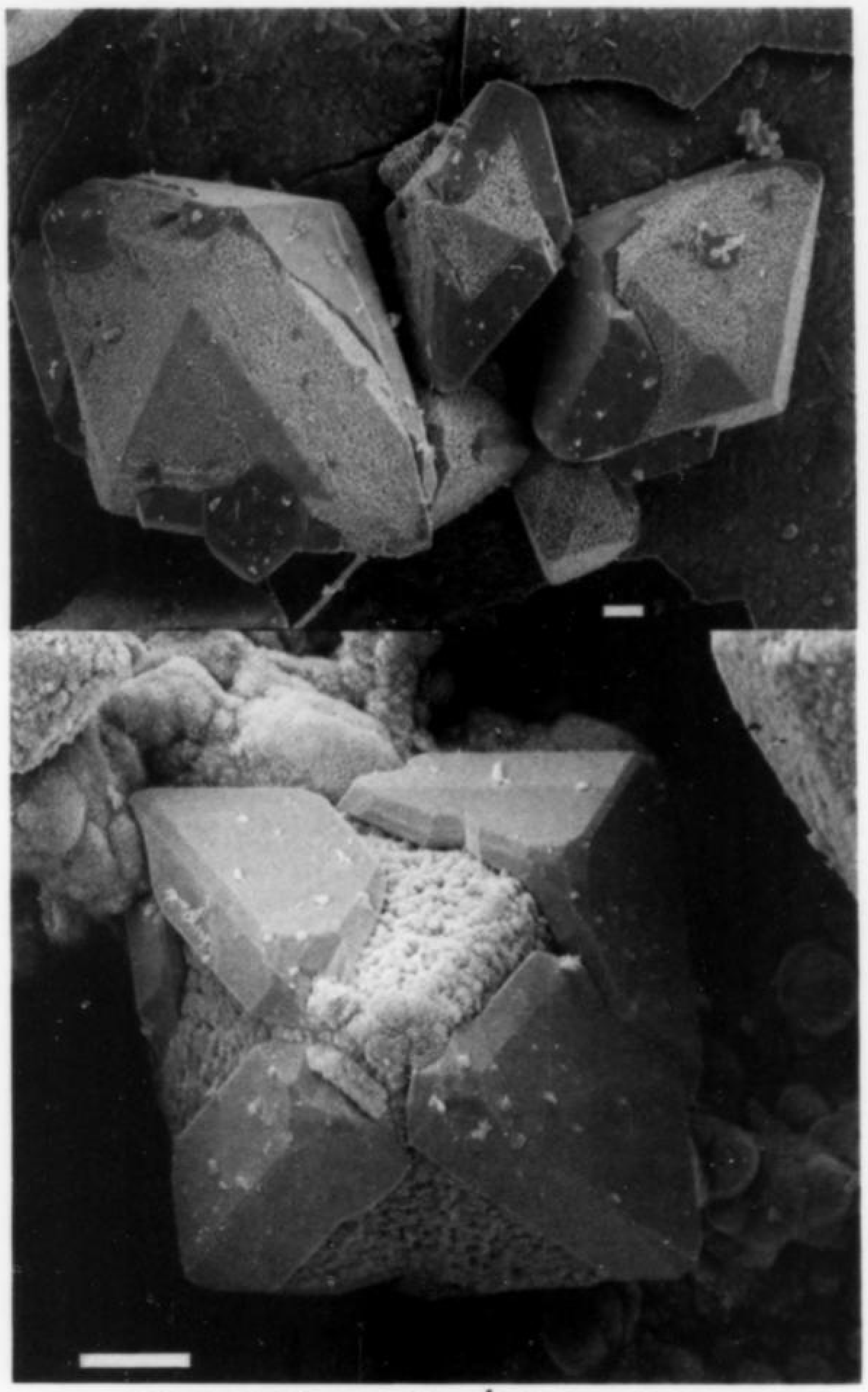


Figure 49. **Bipyramidal wulfenite crystals showing growth interruption and subsequent partial overgrowth, resting on limonite-coated quartz. Old 25 pipe, Kingsgate. Scanning electron micrograph. Scale bar in each micrograph is 10 micrometers. Author's specimen and photograph.**

colored to white quartz. The crystals reach a maximum of 2 mm in length and were identified by their chemical composition determined using energy-dispersive electron probe microanalysis and by their crystal morphology.

Other minerals present in the specimens include molybdenite, galena, ferrimolybdite and sericite, although these are not directly associated with the wulfenite crystals. All specimens found to date have come from the dumps of the Old 25 and 25 North pipes.

THE FUTURE OF THE KINGSGATE MINES

Indications are that ore reserves at Kingsgate have not been exhausted, particularly as regards molybdenite. However, because of the scattered nature of the deposits and their unpredictable ore grades, the economic potential of the area is low and it is unlikely that large-scale mining will take place in the future due to the formidable exploration and mining costs involved.

Even without renewed mining, the Kingsgate deposits still offer unlimited scope for collecting and will continue to do so for many years to come.

ACKNOWLEDGMENTS

Appreciation is expressed to the Department of Mineral Resources, New South Wales Government, for assistance given in compiling details of the history of the Kingsgate mines and for permission to reproduce departmental photographs. The assistance of Ottie Mueller of the Photography Section of the department is gratefully acknowledged.

The Australian Museum, Sydney, gave the author access to the collection and permission to photograph a selection of Kingsgate specimens. Ross Pogson of the Earth Science Department provided valuable assistance.

Appreciation is also expressed to the management of the Broken Hill Proprietary Company Limited Central Research Laboratories for the use of the equipment and resources of the Laboratories. Scanning electron microscopy of the microcrystallized minerals was carried out using the Philips model 505 SEM/EDAX model PV9100/65 energy-dispersive X-ray analyzer installed at these Laboratories.

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Aluminum phosphate minerals from
Mauldin Mountain
Montgomery County, Arkansas

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INTRODUCTION

Aluminum phosphate minerals (primarily wavellite and variscite) were discovered in Arkansas during the early 1800s. In 1830, "peganite" was described as a new mineral (Breithaupt, 1830), however, it was subsequently found to be variscite and was discredited (Chester, 1878). Studies of variscite from Garland County by Čech and Slansky (1965) show it to be a Lucin-type variscite. Except for one rather insignificant occurrence of wavellite in the Batesville manganese district, Independence County, in northeast Arkansas (Shockley, 1948), all of the Arkansas aluminum phosphate occurrences are in the Ouachita Mountains of west central Arkansas.

The locations of many Arkansas wavellite and variscite specimens quoted in the literature and in various collections are given erroneously as Pencil Bluff, Magnet Cove or Hot Springs. No wavellite occurs at Pencil Bluff, though Clyde Garmon, who dug and sold wavellite and variscite from Dug Hill for many years, has a roadside shop there. Small amounts of wavellite occur at both of the latter locations but it is generally not of specimen quality. Up until about 6 years ago 90% or more of Arkansas wavellite specimens came from the vicinity of Avant, particularly from Dug Hill or nearby diggings. Avant (previously called Cedar Glades and Buckville) is located in Garland County just north of the north shore of Lake Ouachita. Dug Hill is 2.4 km (1.3 miles) north of Avant.

Traces of wavellite and variscite occur in Arkansas novaculite of Devonian age but most of the phosphates in this formation are iron phosphates. Kidwellite, strengite, phosphosiderite, cacoxenite, beraunite, dufrenite, rockbridgeite, lipscombite, laubmannite and some blue to green aluminum phosphate minerals have been described by Kidwell (1977). The blue to green aluminum phosphate mineral from the Mona Lisa mine on Porter Ridge, Polk County, has been confirmed as turquoise (Pete J. Dunn, personal communication). Dunn identified the material from Coon Creek and Buckeye Mountain, also in Polk County, as planerite. The Union Carbide vanadium mine at Potash Sulphur Springs, Garland County, is an exception. At this location wavellite and variscite and some of the iron phosphate minerals are present in significant amounts. However, very little material from this mine is available because of collecting restrictions.

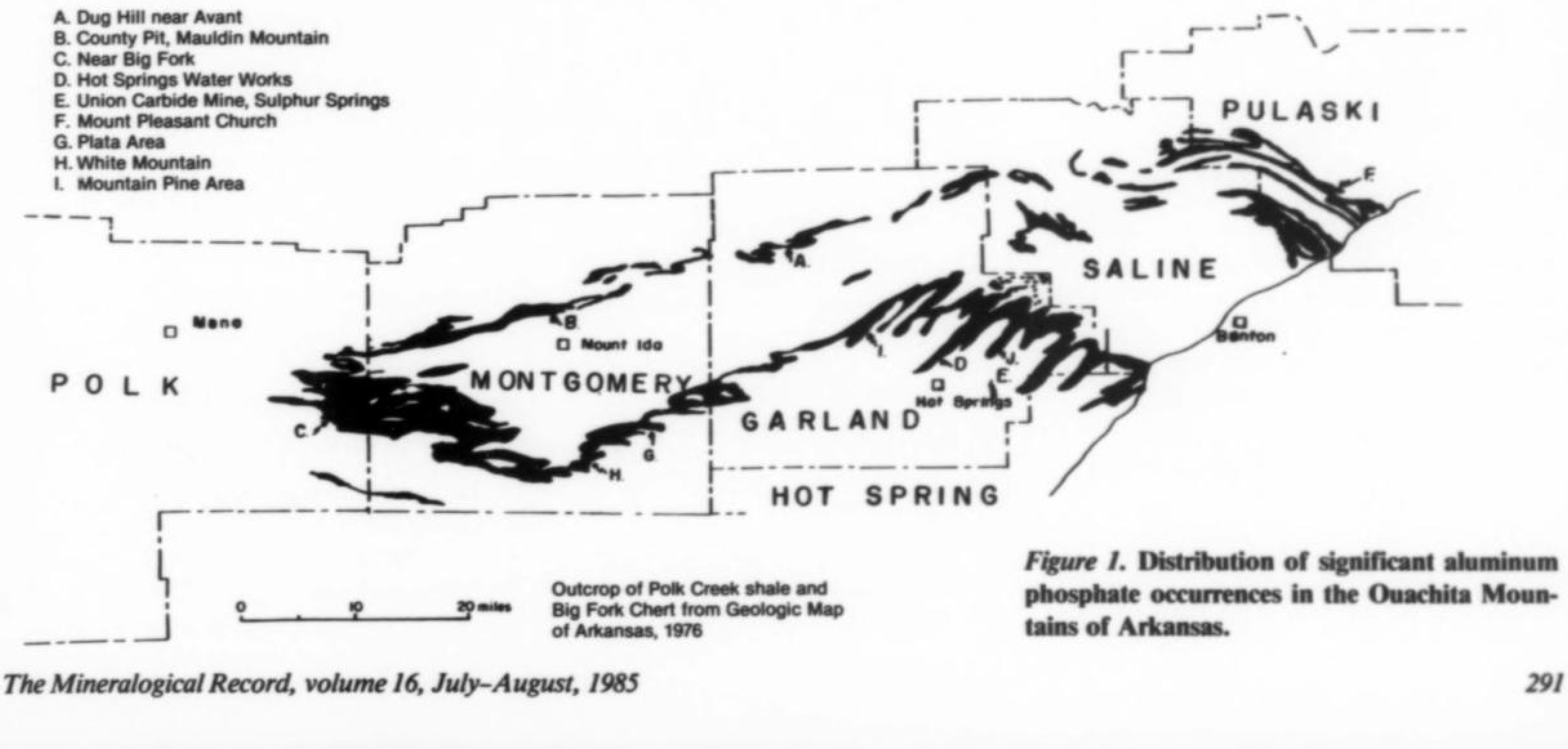

Figure 1. **Distribution of significant aluminum phosphate occurrences in the Ouachita Mountains of Arkansas.**

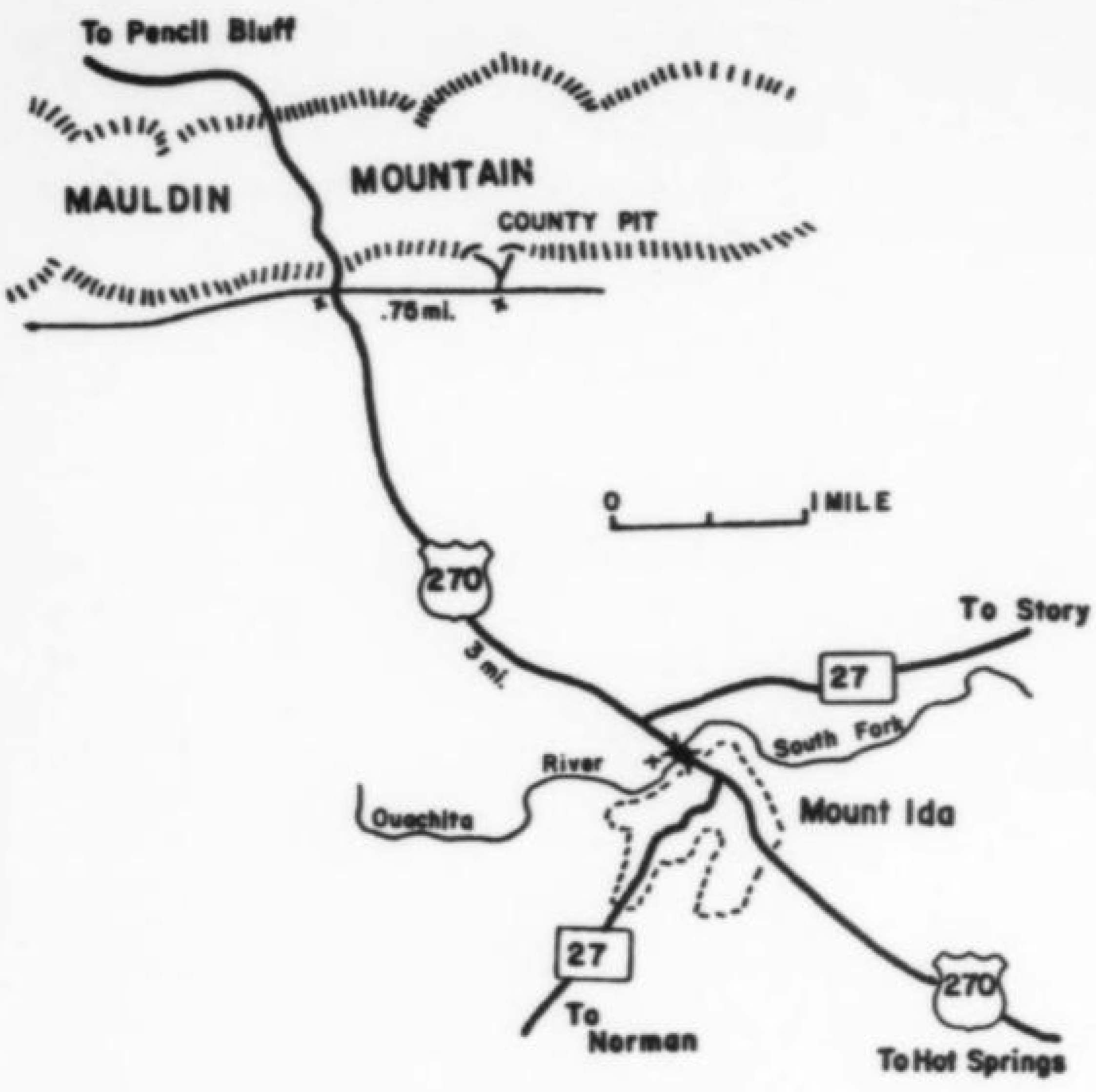

Figure 2. **Location of the County pit, Mauldin Mountain, Montgomery County, Arkansas.**

The most significant aluminum phosphate mineralization occurs in the Big Fork chert and Polk Creek shale of Ordovician age. It is not surprising that traces of wavellite were found in the county road-metal pit which was excavated in the Big Fork chert formation at Mauldin Mountain during the middle 1970s. The amount of wavellite increased as the cut went deeper into the mountainside. In 1977 or early 1978 the first good specimen material was uncovered. During the next two years, whenever the zone with wavellite was worked, the more promising rock went into a truck and was hauled to one of the local mineral dealers where it was trimmed, cleaned and sold wholesale for from $1 to $6 per pound. It was a good deal for everyone, particularly for the collector who got to the dealer before the material was picked over. It was cheaper to buy than dig, haul home, then clean and trim the vast amount of material required to get the choice specimens. Like most bonanzas, it did not last. Since 1980 the amount of wavellite in the quarry has increased but the number of good specimens has decreased and there has been practically no material available to the local dealers. The primary reason for this seems to be a decrease in the number of large cavities which are required for the formation of good wavellite specimens.

LOCATION

The Mauldin Mountain locality is situated on the south flank of the mountain about 4.8 km (3 miles) northwest of Mount Ida in Montgomery County. There are two cuts reached by the same entrance road. The one to the west is known as the State pit and has had only trace amounts of the phosphate minerals exposed to date. The eastern cut is called the County pit and is the source of most of the aluminum phosphate minerals.

GEOLOGY

The County pit at Mauldin Mountain has been excavated into the steeply dipping and highly disturbed beds of the Big Fork chert and Polk Creek shale. The predominant rock in the quarry is a dense, black to dark-gray chert. There are lesser amounts of a gray to black shale. Both rock types are fractured, jointed and contain discontinuous milky quartz veins up to 10 cm thick. Quartz crystals in these veins are small and uncommon. The phosphate minerals occur in fracture zones, joints, bedding planes and what appear to be erosional or leached cavities in the chert, shale and quartz veins. At present (1984) aluminum phosphate minerals occur only in the central part of the cut in a zone about 30 meters wide and in a small area on the west of the main mineralized zone. The main zone extends to the north in the rocks at the top of the quarry.

MINERALS

Wavellite $Al_3(PO_4)_2(OH,F)_3 \cdot 5H_2O$

Wavellite occurs as spheres, hemispheres, botryoidal coatings, single crystals and groups of divergent crystals (Figs. 6, 7, 8). The color ranges from green to pale green to a yellow green. It is the lighter green color that helps to distinguish the Mauldin Mountain wavellite from the darker green material from Dug Hill. The spheres and hemispheres range in size from 1 mm to over 2 cm. The first specimens found are characterized by spheres having smoother outer surfaces and prominant concentric internal layering with a subordinate internal radiating structure. However, more recently, specimens with a strong internal radiating structure and crystal terminations, making a rough outer surface, have been found. This latter type is similar to much of the Dug Hill wavellite. Individual wavellite crystals occurring alone are up to 2 mm long. They are a pale green to yellowish or almost colorless. Typical forms are shown in figure 3. Most of the wavellite has a thin coating of iron oxide that can be removed with a short soaking in cold oxalic acid. (See also the method of Waller, 1980; Ed.) some of the more esthetic, lightly stained wavellite may erroneously be called orange wavellite.

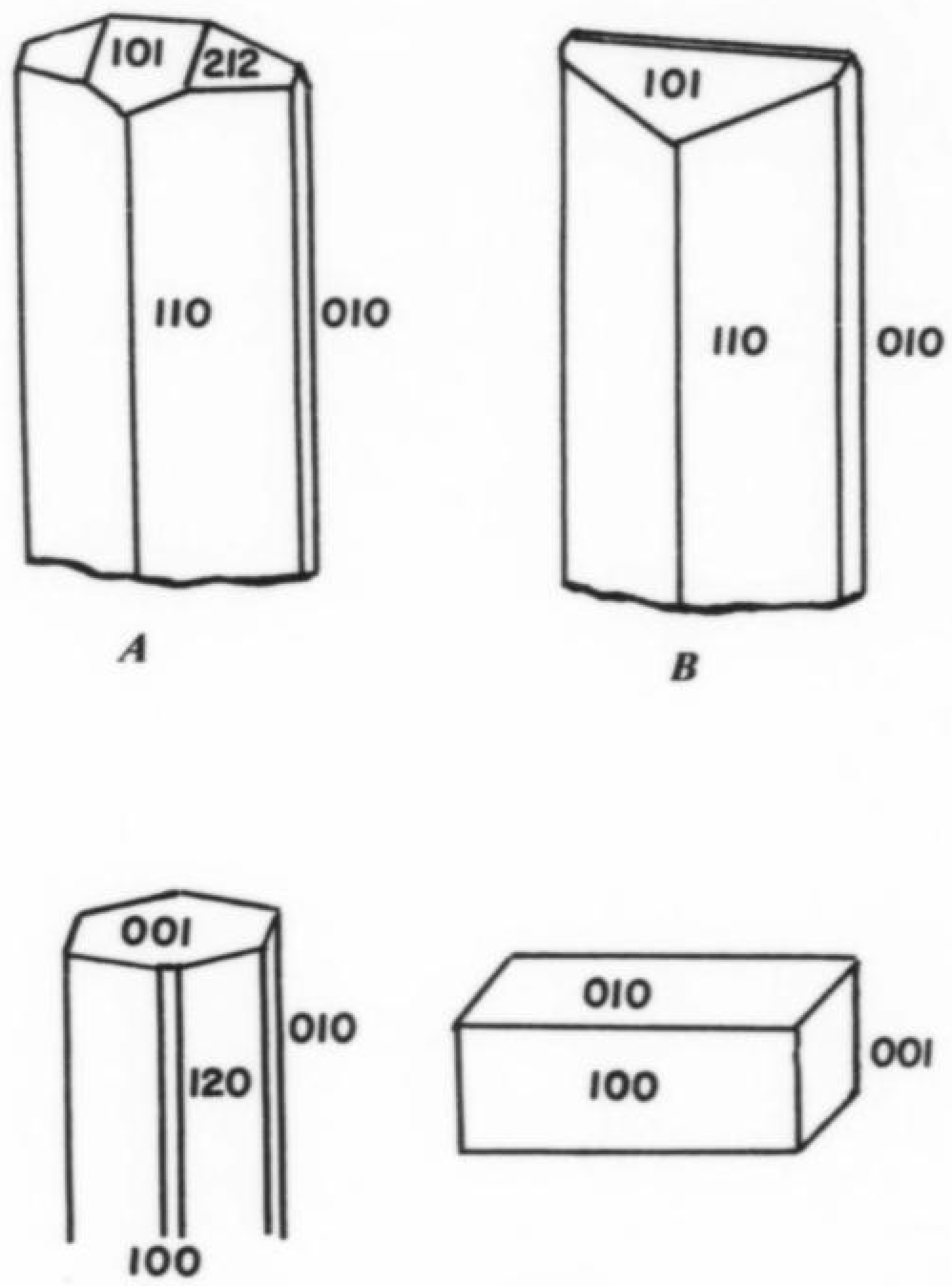

Figure 3. **A and B: Typical wavellite crystal forms (from Shannon, 1922). C: Pseudohexagonal variscite (from Chester, 1878). D: Typical form of drusy variscite (from Holt, 1972).**

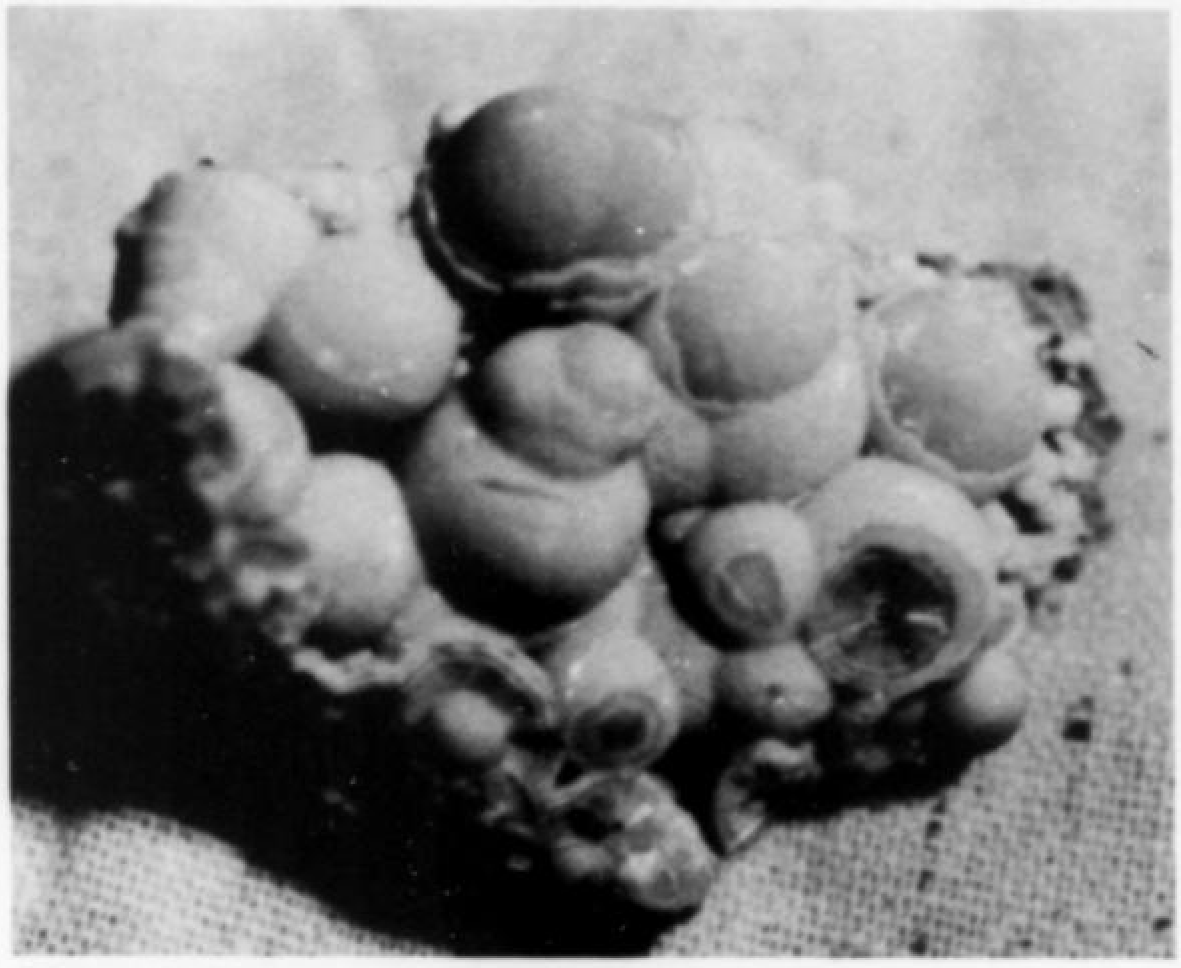

Figure 4. **Spheres of wavellite, County pit, Mauldin Mountain, 1978. The specimen is 6 cm long.**

1982, however, as excavation has progressed, it has become conspicuous and abundant, occurring predominantly as clear to light green coatings of drusy rectangular-faced crystals. Individual crystal faces are less than 0.2 mm in maximum dimension. This drusy variscite may coat blue planerite and appear blue itself. Some also coats a white opaque material which also is variscite. Variscite also occurs as groups of pseudohexagonal prismatic crystals up to 1 mm long (Fig. 9). A third type of variscite, found in sheaf-like crystal groups at Dug Hill (Holt, 1972), has not been seen at Mauldin Mountain.

Planerite

Prior to 1982, the area to the west and adjacent to the wavellite zone contained a pale blue to greenish mineral which occurred as thin coatings and small (as much as 2 mm across) spheres. Internally, these spheres may show a faint concentric structure. Unpublished X-ray diffraction work by A. K. Kidwell and P. J. Dunn has shown the material to best fit the pattern for planerite. Electron microprobe analyses of planerite from Mauldin Mountain by P. J.

Figure 5. **Wavellite zone, County pit, Mauldin Mountain, 1979.**

Dunn (personal communication) combined with determinations of H_2O^+ and H_2O^- (E. E. Foord and J. Taggart, personal communication, 1984) by Karl Fisher Titration show the mineral to indeed be planerite. Planerite is currently before the I.M.A. Committee on New Minerals and New Mineral Names, being voted upon to restore species status. The entire turquoise group is the subject of a complete re-examination by Foord and Taggart currently in preparation.

At Mauldin Mountain planerite was common and generally occurred alone. When it rarely occurred with wavellite, it was clearly the first-formed mineral. Since 1982 most of the planerite has been found covered by a thin coating of clear to pale green drusy variscite which may be mixed with metavariscite. When wavellite is present it occurs on variscite. Interesting specimens with micro-

Wavellite pseudomorphs

Dull black to gray spheres from 1 to 2 cm were commonly found in the wavellite zone from 1977 to 1979. Many spheres are hard and may pop out of the matrix whole. Rarely they show internal concentric banding and radiating structure like wavellite. Some spheres may be part normal wavellite and part pseudomorphs. Holt (1972) described similar material from Dug Hill. Pseudomorphs after wavellite also occur at the Union Carbide vanadium mine, Potash Sulphur Springs, in Garland County. Holt's X-ray diffraction work showed the material to be amorphous and he concluded that they were probably a clay pseudomorph (aluminum silicate) after wavellite.

Variscite $AlPO_4 \cdot 2H_2O$

In 1977 variscite at Mauldin Mountain was known only as thin inconspicuous coatings and tiny, pale green spheres; since about

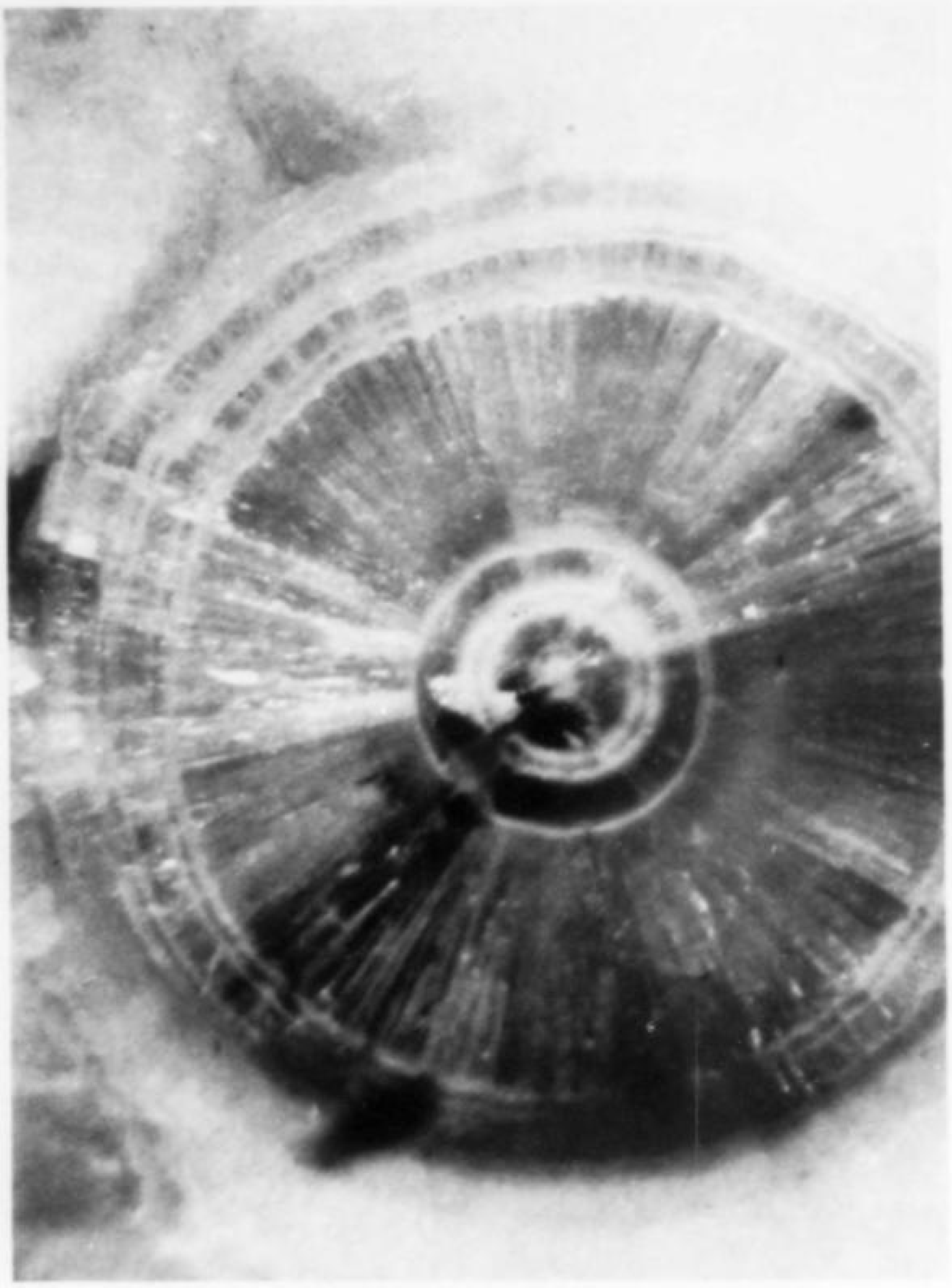

Figure 6. **A broken 8-mm sphere of wavellite showing radiating and concentric structure, County pit, Mauldin Mountain.**

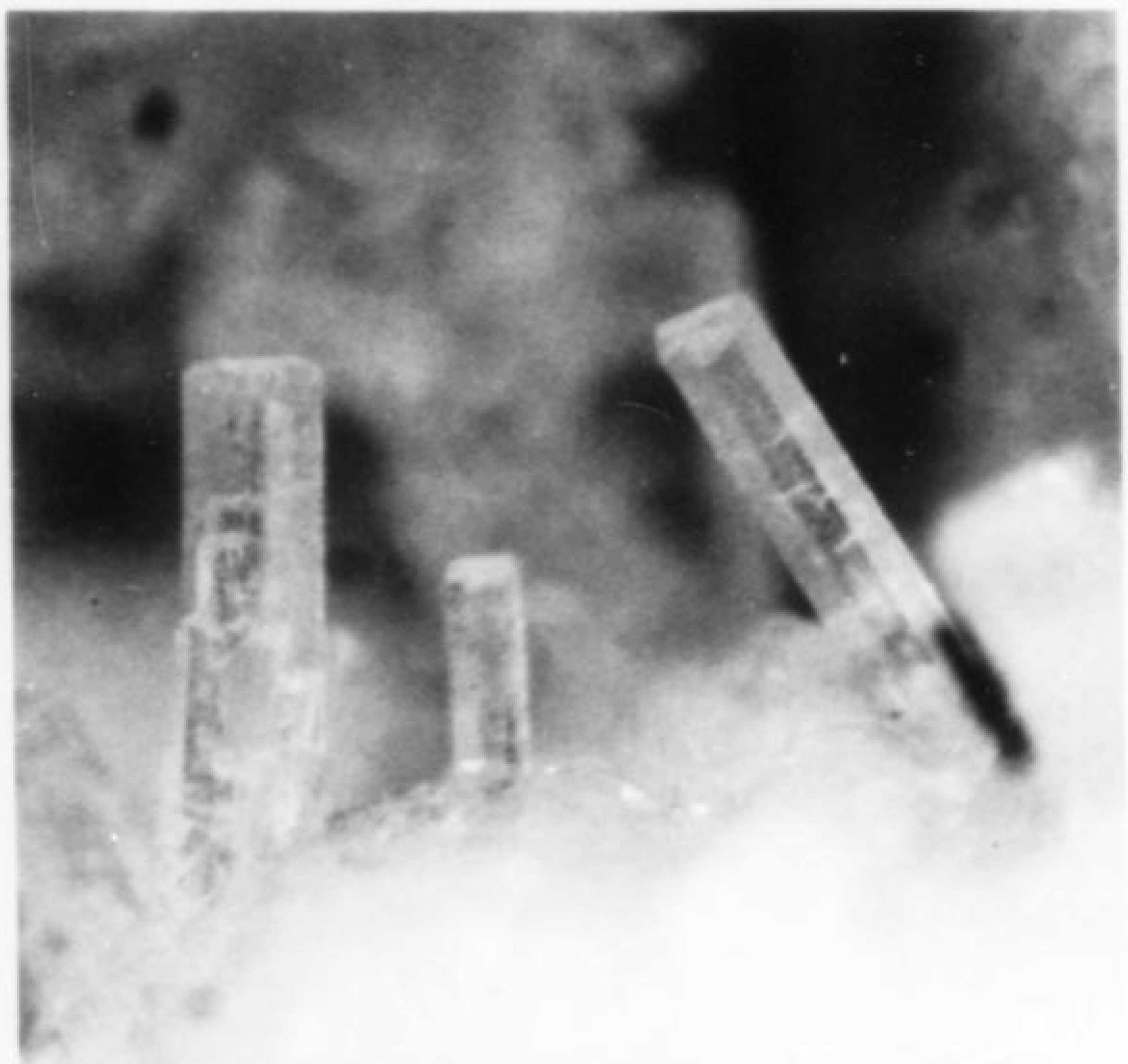

Figure 8. **Single crystals of wavellite; the longest is 2 mm. County pit, Mauldin Mountain.**

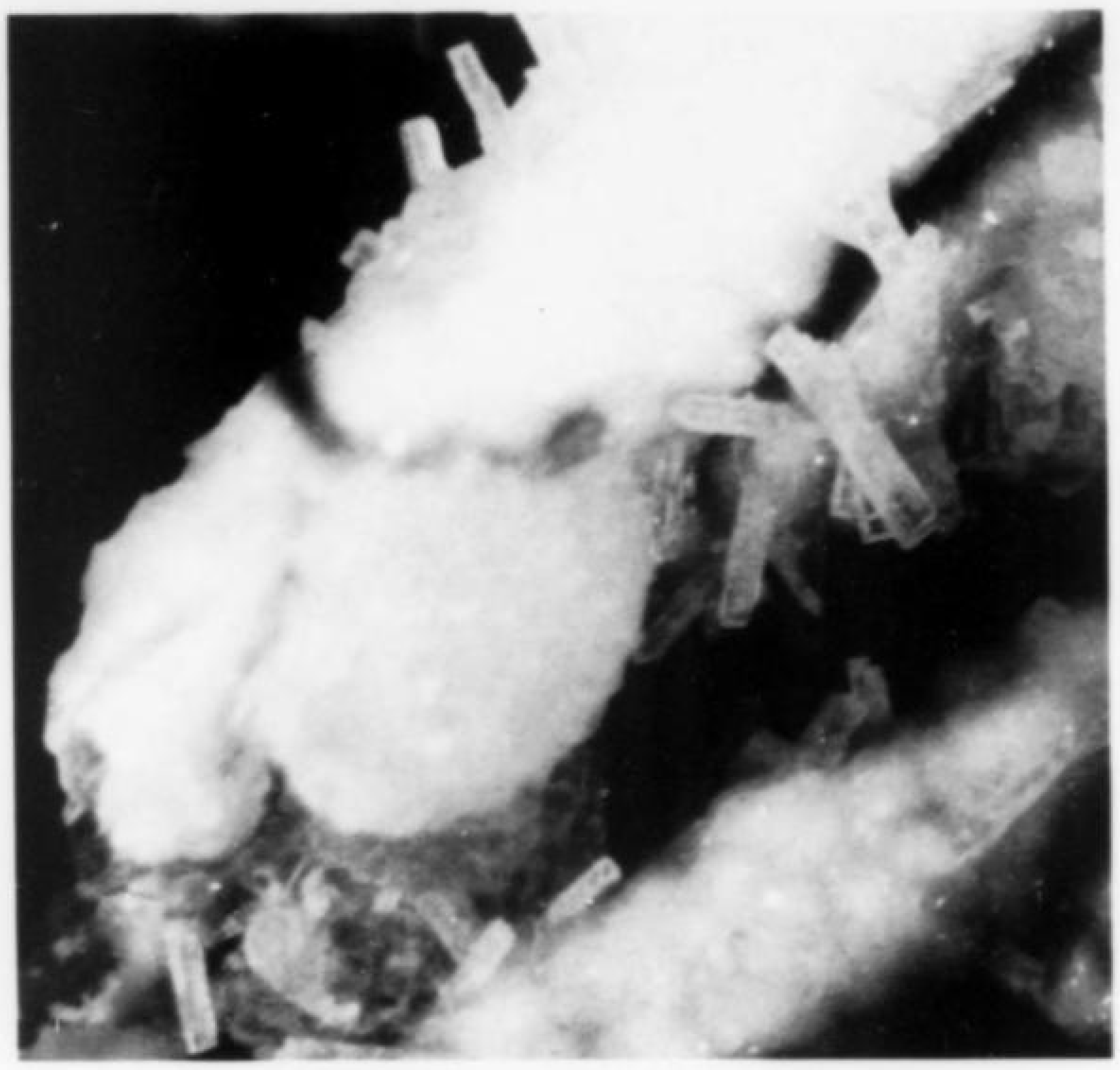

Figure 7. **Wavellite crystals, about 1.5 mm long, with hemispheres of wavellite on drusy variscite, County pit, Mauldin Mountain.**

Figure 9. **Pseudohexagonal variscite crystals, 0.5 mm long, County pit, Mauldin Mountain.**

crystals of wavellite studding drusy variscite which in turn almost completely coats hemispheres of planerite can be collected.

Metavariscite $AlPO_4 \cdot 2H_2O$

Drusy mixtures of metavariscite and variscite were X-ray identified (P. J. Dunn, personal communication) from material supplied by Julian Cranfil and A. L. Kidwell in 1983. This is the first metavariscite reported from the Arkansas wavellite deposits. No distinct crystals have been observed.

Crandallite $CaAl_3(PO_4)_2(OH)_5 \cdot H_2O$

Although crandallite occurs as white, opaque alteration pseudomorphs after wavellite at one deposit near Dug Hill and at Cadoo Gap (A. L. Kidwell, personal communication), its presence has not been confirmed at Mauldin Mountain.

COLLECTING

Collecting at Mauldin Mountain has been generally allowed without permission or restrictions. Successful collecting usually requires stout digging equipment, hammers and bars coupled with much physical effort. However, if you should be the first collector

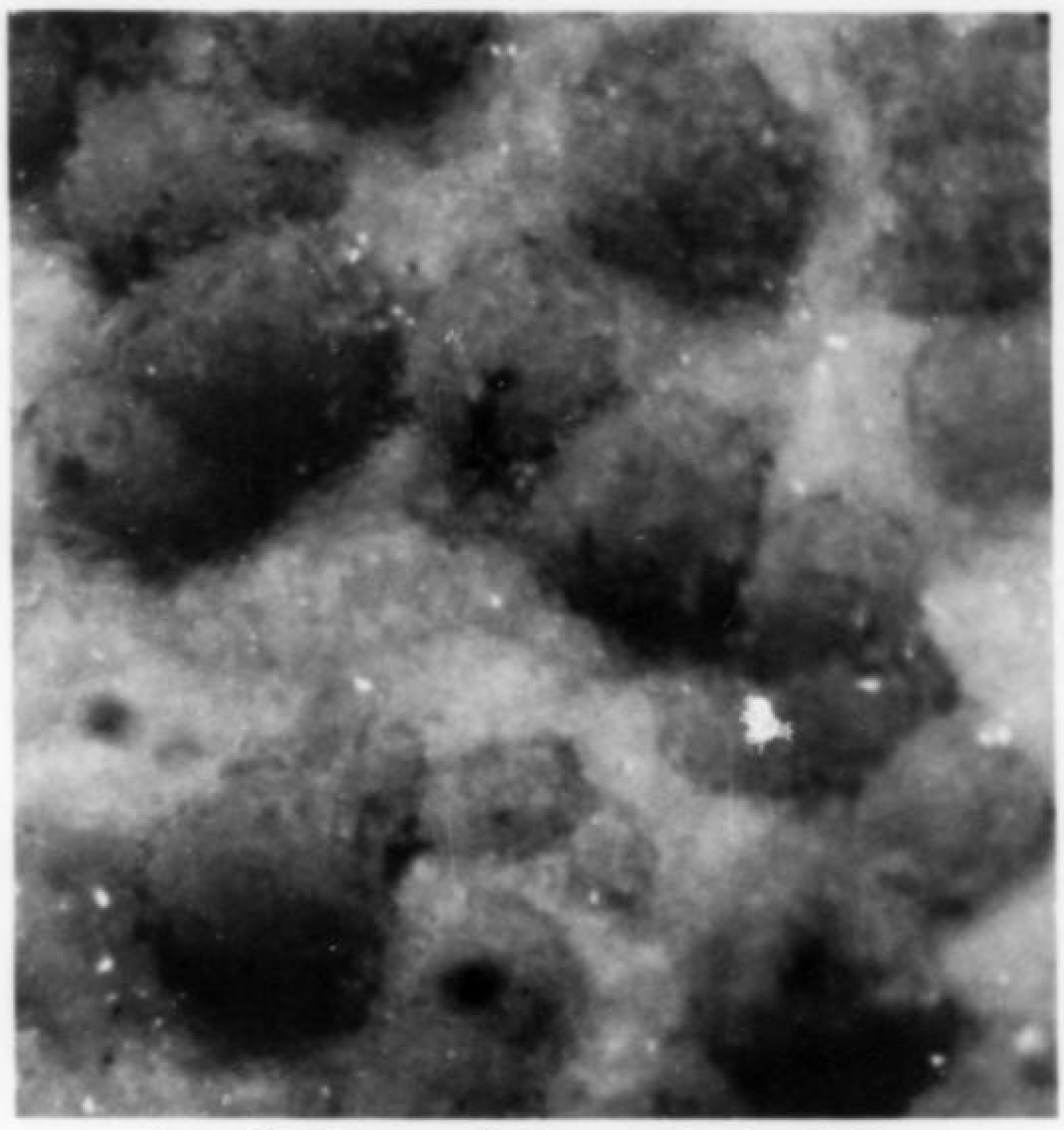

Figure 10. **Drusy variscite covering hemispheres of planerite, County pit, Mauldin Mountain, 1983.**

at the location after a good rain, good specimens may often be picked up off the surface.

ACKNOWLEDGMENTS

I would like to thank Albert L. Kidwell of Houston, Texas, and Henry deLinde of Mabelvale, Arkansas, for their constructive comments and for their companionship during many hours of successful collecting in the Ouachita Mountains. I would also like to thank Pete J. Dunn and Eugene E. Foord for sharing their knowledge of the aluminum phosphates and for their critical and constructive comments on the manuscript.

All photographs and specimens are the author's.

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What's New in Minerals?

TUCSON SHOW 1985

With February temperatures falling below zero over much of the country (and in Europe), and snow making matters worse, local people were feeling pretty smug about the weather here in Tucson before the show. But then it turned cold here too, and when it actually *snowed* in Tucson the situation began to look ominous. Fortunately the sun came out and shone brightly throughout most of show week, and it turned out to be one of our better years, weather-wise. Attendance was good too, about 16,700 people.

The biggest news in minerals this year was the discovery of some remarkable creedite on level 5 of the Potosi mine, Santo Domingo, Santa Eulalia district, Chihuahua, Mexico. Three major lots were recovered. The first lot, which surfaced at the 1984 Detroit Show, was of small size, less than 50 good specimens, but the color of the crystals is a deep amethystine purple, and some single crystals reach 5 cm in size. The second and third lots were larger, totalling several thousand specimens, but with only about 20 and 40 top-quality pieces respectively. The second and third lot specimens are a medium to pale purple, and crystals from the third lot tend to have dark brown included material which makes them less attractive. Mario Vizcarra (*El Paso Rock Shop,* 3315 Alameda, El Paso, TX 79905), Delma Perry (*Artrox,* El Paso) and Dalton and Consie Prince (*Collector's Choice*) had most of the creedite, though much has by now been wholesaled to other dealers, especially John Barlow.

The best pieces from the three creedite lots are quite attractive. The crystals are commonly over 1 cm, and many exceed 2 cm. Luster and clarity are typically excellent, especially in the first and second lots, and the crystals tend to occur in esthetic sprays, bunches and rosettes on matrix. Thumbnail to cabinet sizes were recovered. Prices are a bit steep on the top pieces, but middle-range material is much more affordable and relatively plentiful, at least for the present.

A surprising lot of dioptase appeared at the show. The specimens are from the old classic locality at Reneville, Congo, and were being offered by Paul Obeniche (*Saint-Roy,* 1, rue Paul Cézanne, 75008 Paris, France) in Guilbert Gauthier's booth at the main show. Several dozen fine pieces in all size ranges were available. There is no matrix, and the larger cabinet specimens show that the crystals occur as large vugs in solid dioptase. The individual crystals generally measure 1 to 2 cm and have cloud-like pale-colored inclusions (perhaps just micro voids) which give the crystals a mottled, bright green color as opposed to the greenish black of Tsumeb crystals. The top pieces in Obeniche's lot are truly superb museum-quality specimens. As I've always said, collectors are well advised to buy when something is plentiful and the selection is good. Usually that is only possible with a new discovery, but here was a very rare opportunity to do so with an old classic from a mine that has been closed for 40 years.

A similar opportunity arises every few years when a major collection comes on the market. Just before the show this year, Wayne and Dona Leicht (*Kristalle*) acquired the collection of former

***Figure 1.* Yes, that's snow. Photo by Earl Bentley.**

Mineralogical Record columnist and associate editor, and long-time Arizona expert, Richard Bideaux. Dick retained the thumbnails, but the miniatures and small cabinet pieces include some exceptionally esthetic items. It was a rare chance to obtain superb specimens with noteworthy pedigree.

Wayne and Dona also had some newly mined gold specimens from their locality at Michigan Bluff, California, and also some new golds from the Golden Amethyst mine near Winnemucca, Humboldt County, Nevada. A new discovery of very nice cinnabar crystals to 1 cm on matrix was represented by about 30 specimens; these are from a 10-meter prospect pit near Poverty Peak, Humboldt County, Nevada.

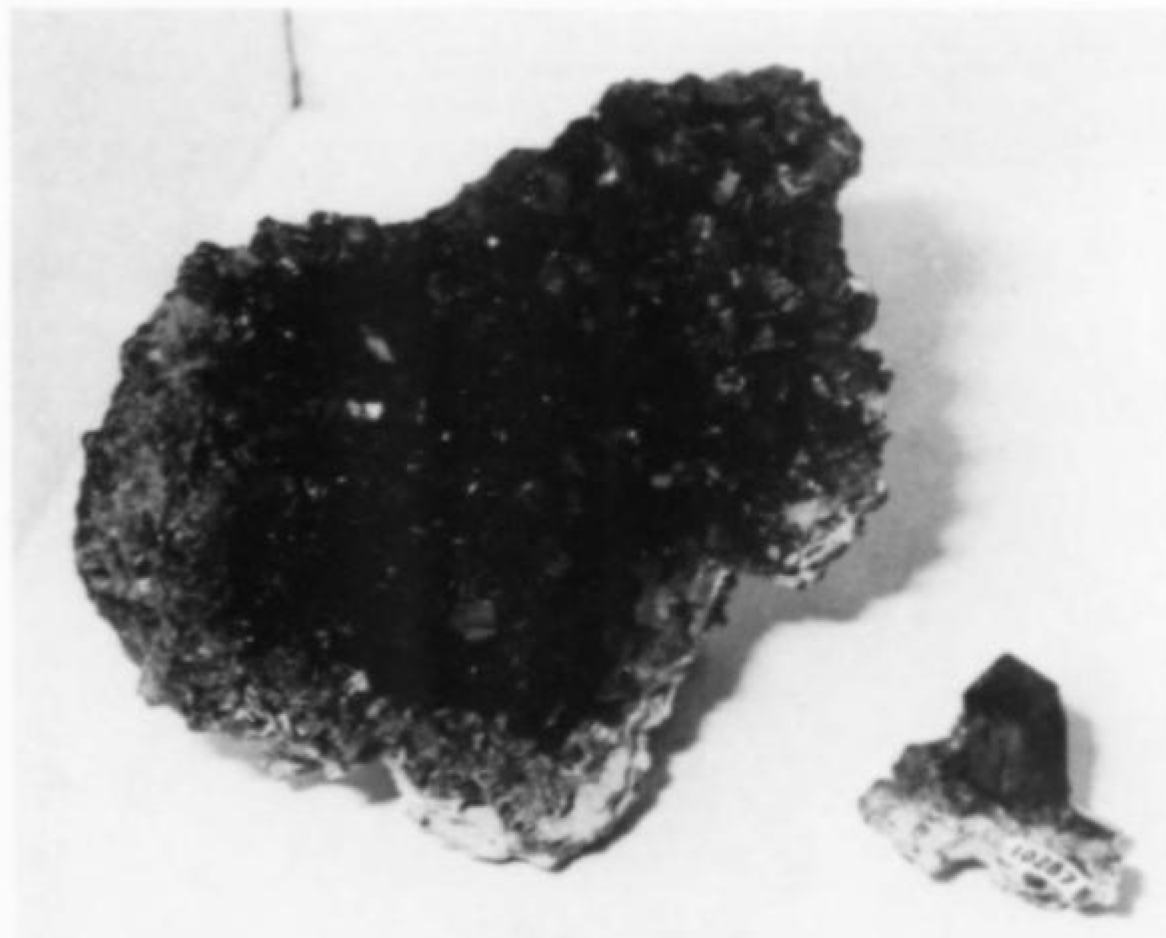


***Figure 2.* Dioptase from Reneville, Congo, in the Sorbonne case. The miniature at right has a single crystal about 3 cm in size.**

Two fellows in the Desert Inn, Steve Green (P.O. Box 10404, Denver, CO 80210) and Chris Boyd (6925 Fifth Ave., E182, Scottsdale, AZ 85251), going under the name *New Deal Minerals,* filled their motel room with only two occurrences: amethyst from Veracruz, Mexico, and green andradite* from south-central Mexico. They first came upon the andradite occurrence in 1982 and have been developing it ever since. Though they prefer not to specify the exact location, they will say that it is actually a string of occurrences

*Electron microprobe analysis by Carol Stockton, G.I.A., indicates a composition equivalent to 74 weight % andradite, 17% grossular and 3% schorlomite.

Figure 3. **Credite crystal 3.5 cm tall, from the Potosi mine, Santo Domingo, Santa Eulalia district, Chihuahua, Mexico. Miguel Romero collection, obtained from Maria Vizcarra.**

Figure 4. **Creedite sprays, each about 3 cm across, on matrix from the Potosi mine, Santo Domingo, Santa Eulalia district, Chihuahua, Mexico. Dalton and Consie Prince specimen; photo by Ed Raines.**

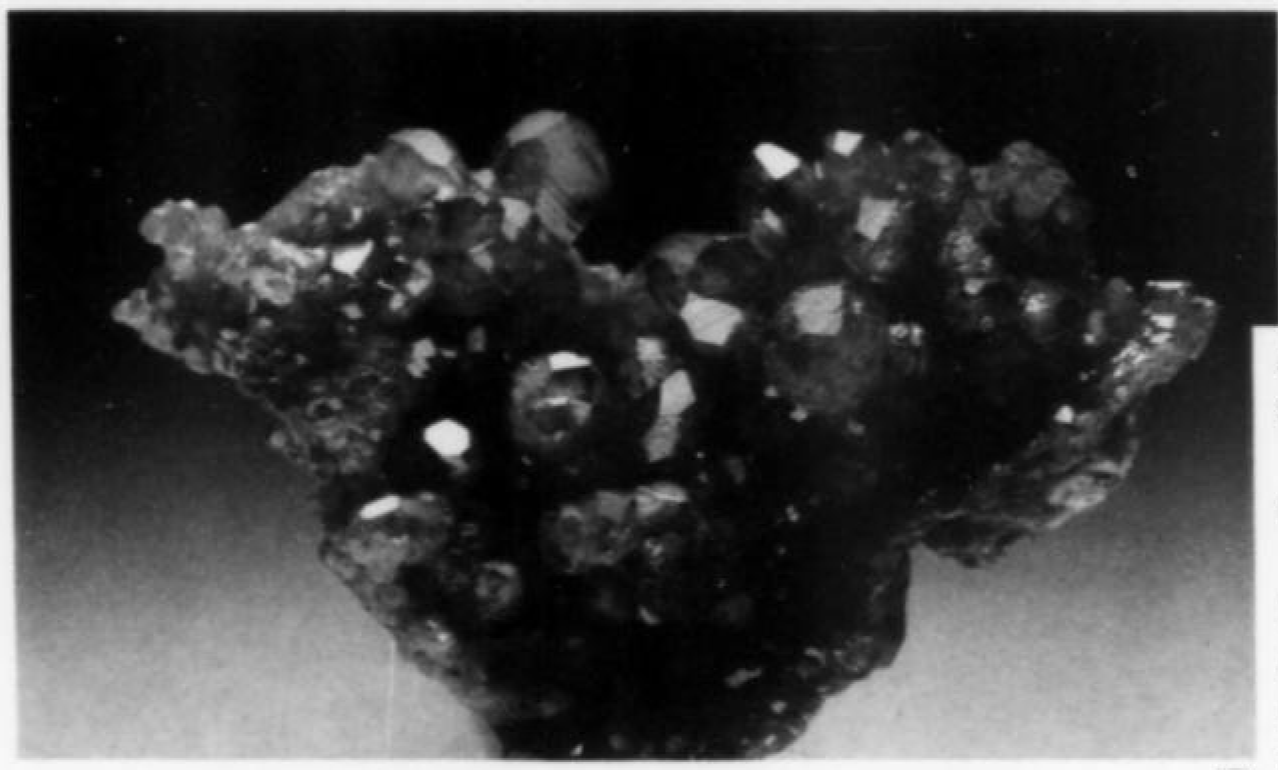


Figure 5. **Andradite crystal group 3.9 cm across from south-central Mexico. Steve Green and Chris Boyd specimen.**

which they have worked on the surface at four points. The andradite varies from greenish brown to a bright, clean green which gemologists might call *demantoid.* The crystals, generally to about 1 cm in size, vary from full dodecahedrons to full trapezohedrons, in some cases having hoppered faces. Crystals on matrix, individual or in clusters, are the common habit, but some peculiar spherical shells have also been recovered. The shells, up to perhaps 20 cm in diameter, are ovoid in shape and consist only of andradite, with crystal faces showing on both the inside and outside surfaces. Associations include calcite crystals, quartz crystals, and occasionally an asbestiform mineral.

Many other specimens were to be seen at the main show and in the motels. Here is a sampling of some of them:

- Fluorite, in transparent, colorless to bluish violet crystals having a tabular aspect, flattened along the 3-fold axis. The crystals are 2 to 3 cm in thickness and pehaps twice that in width, and appear to be penetration twins composed mostly of dodecahedron and octahedron faces, except for a few tiny re-entrant angles composed of cube faces. These have come recently from Naica, Chihuahua, Mexico, via Jack Young (*Lyko Mineral and Gem,* 5226 Doniphan Dr., El Paso, TX 79932), Dalton and Consie Prince (*Collector's Choice*), and others; the specimens I studied had been obtained from Jack Young by Gene Schlepp (*Western Minerals*).
- Tourmaline from the Himalaya mine, Pala, California. The suggestion about buying when material is abundant certainly applies to the beautiful Himalaya mine tourmalines being mined by Bill Larson (*Pala International*). They have an extremely large assortment currently on hand, and Bill prepared a dazzling display case containing dozens and dozens of fine crystals. No one can really say how long their vein will last, but when it runs out, watch how these specimens suddenly become hard to find and prices go up.

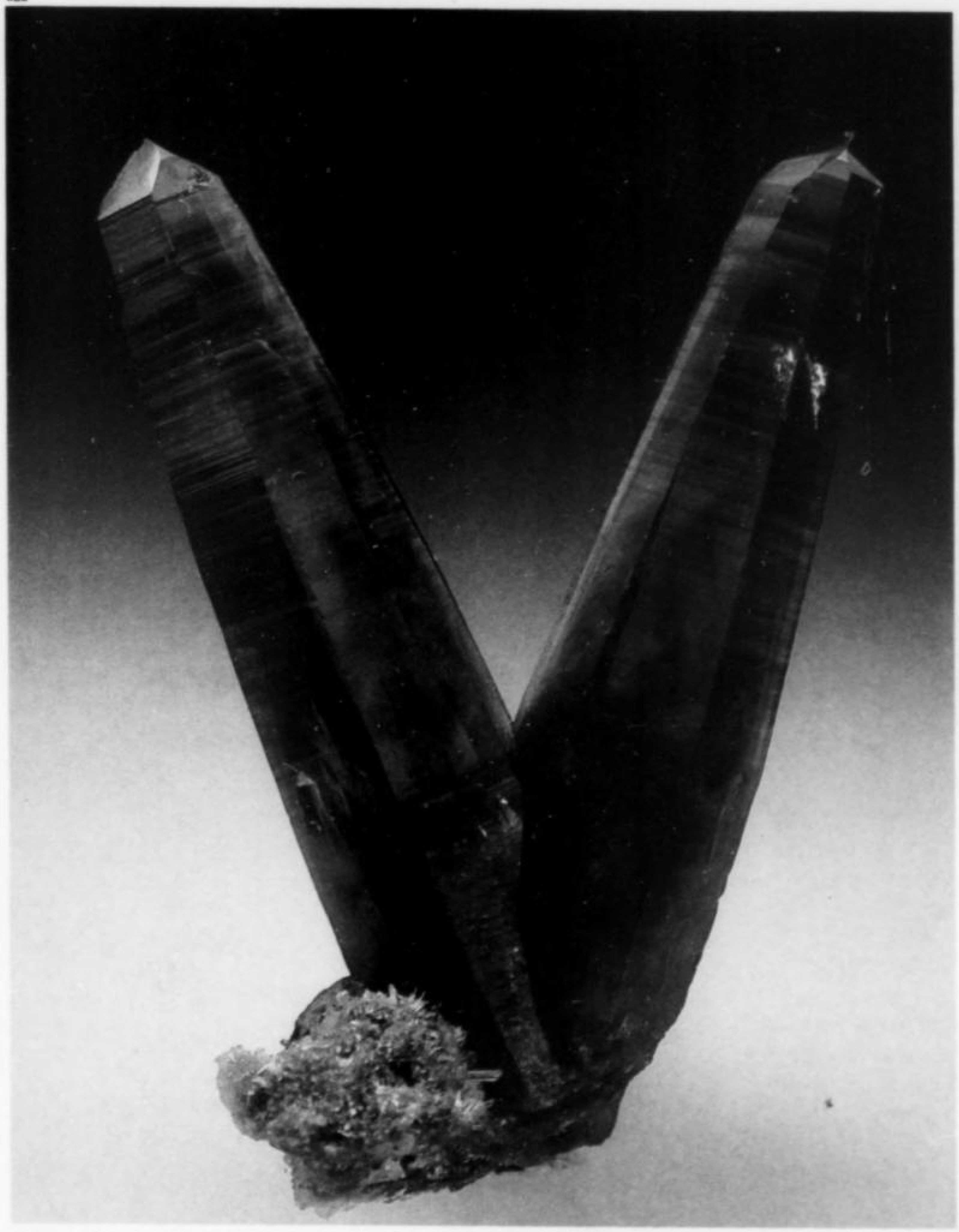


Figure 6. Amethyst crystals to 6.2 cm from Guerrero, Mexico. Gene Schlepp specimens.

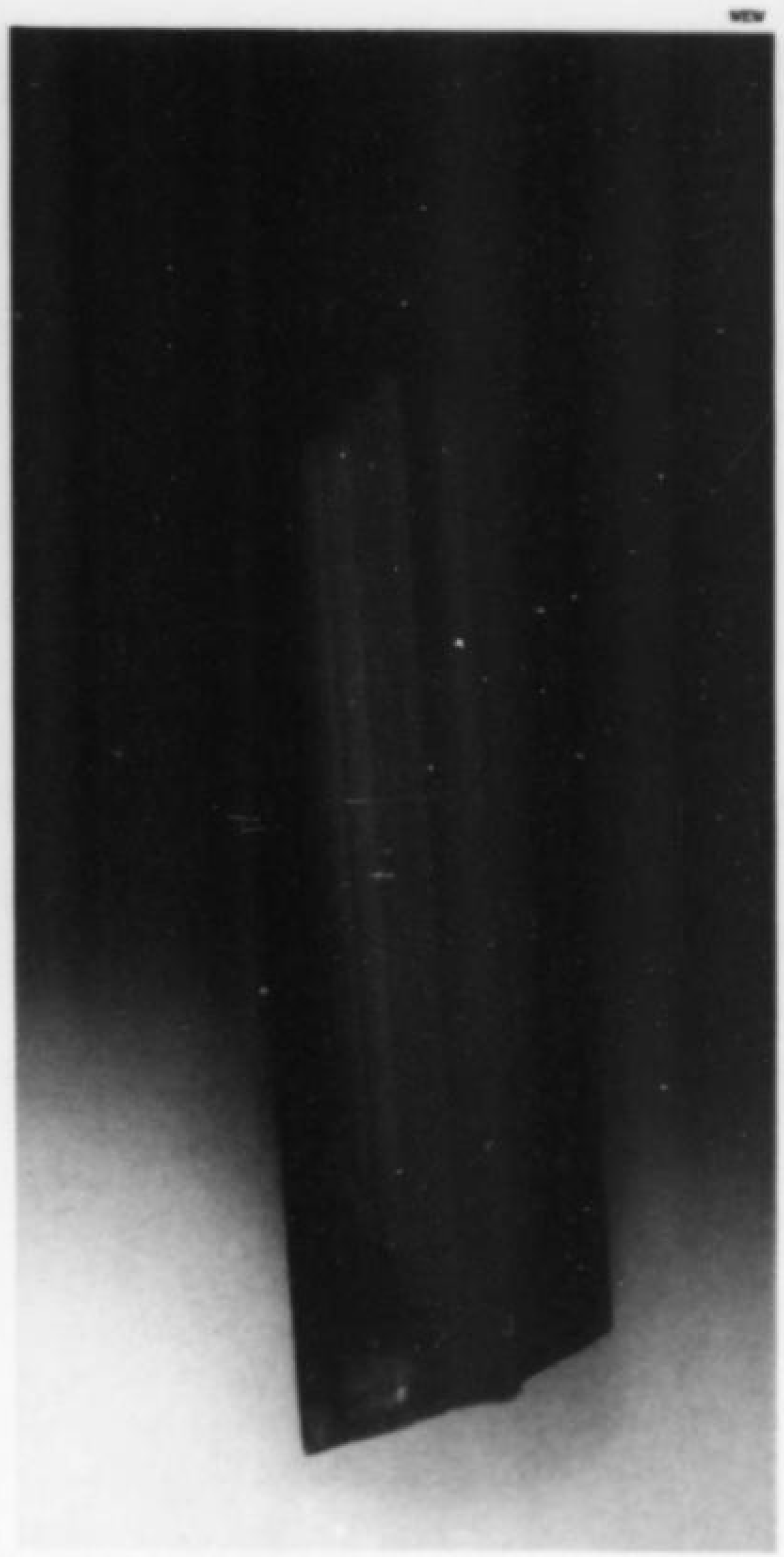
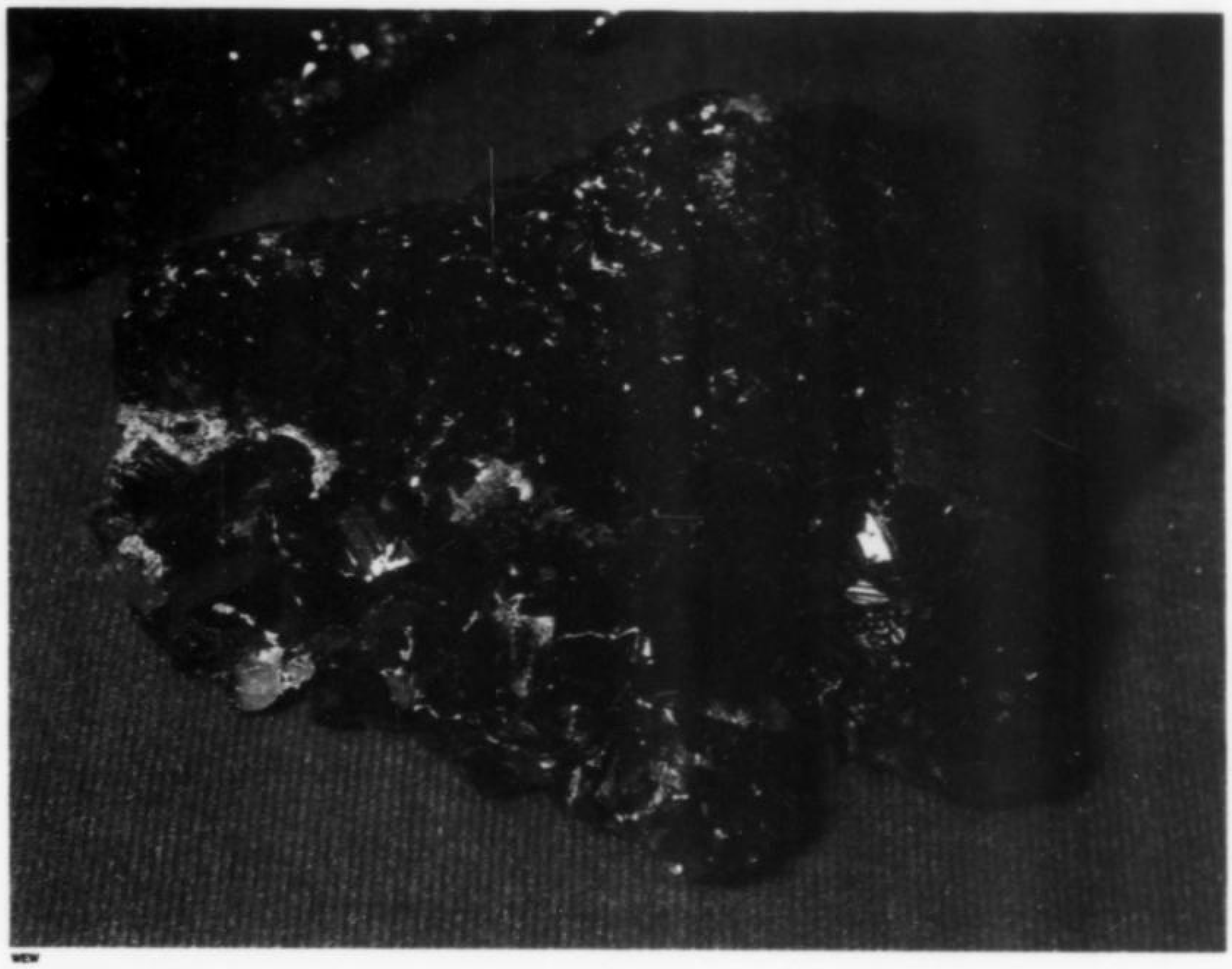


Figure 7. Rhodonite crystal 2.9 cm tall from Broken Hill, New South Wales, Australia. This is probably the finest single crystal of rhodonite known. Robert Noble specimen.

Figure 8. Realgar from China, in the case of the National Geological Museum of China. The specimen is about 11 cm across.



Plenty of folks will then be kicking themselves for not getting one when the selection was good. Crystals 2 or 3 cm wide and 10 cm long, mostly pink with green to colorless areas, and some having associated lepidolite are numerous. Larger and smaller crystals are being found as well.

• Robert Noble, one of the authors of the *Catalogue of South Australian Minerals,* was carrying around in his pocket what is probably the finest single crystal of rhodonite known. Almost 3 cm long and totally flawless, the beautiful crystal was found in 1966 in the ZC mine, Broken Hill, New South Wales, Australia (see photo).

• Amethyst, an extremely nice lot of several flats of specimens from Guerrero, Mexico. The availability of good Guerrero amethyst comes and goes, but this was one of the best lots in years, with esthetic, well-formed, deeply colored crystals 3 to 8 cm in size, singly and in groups. Gene Schlepp (*Western Minerals*) had these at his booth in the main show.

• Cuboctahedral galena from Naica, Chihuahua, Mexico, in lustrous crystal groups. Gene Schlepp had several flats of these too. The crystals have very smooth, bright faces rather like the galena from the Mogul mine, Tipperary, Ireland (see vol. 15, no. 3, p. 168). Crystal size ranges from about 1 to 3 cm.

• David Crawford (1808 Harlem Blvd., Rockville, IL 61103) brought a large collection of Graves Mountain, Georgia, minerals to his room at the Travelodge. Magnificent rutile twins on matrix were the highlight, as well as many specimens of the unique kyanite crystals characteristic of Graves Mountain.

• Aquamarine crystals 1 to 3 cm in length from a new location: Sabon Wana, Nanarawa Eggon, Plateau state, Nigeria. The crystals, which were available at the Desert Inn from Simon Harrison, are pale in color and nicely terminated. The locality has reportedly produced some emeralds too.

• Fine, large, attractive specimens of amethyst geodes and crystal crusts from Artigas, Uruguay. Uruguayan amethyst has been around for a long time, but this year an exceptional quantity of beautiful pieces was available through many dealers including Jewel Tunnel Imports and Aurora Minerals (16 Niagara Ave., Freeport, NY 11520).

• Several dozen crystals of green tourmaline to 25 cm in length from the Agua Boa mine, San Jose da Safira, Minas Gerais, Brazil. Many nice thumbnails were available as well, showing tourmaline with lepidolite crystals. These were to be found in the Hawthorneden booth at the main show.

• Quite a few meteorites, including the rarely available Brenham Pallasite (a sort of steel Swiss cheese with the holes filled by olivine crystals). Specimens were available from Sharon Cisneros (*Mineralogical Research Co.*) at the main show.

• Sharon also had a remarkable hyalophane crystal 11.5 cm (4.5 inches) across, from Zagradski Creek, near Busovaka, Bosna, Yugoslavia. Hyalophane is a barium feldspar not normally seen in display-quality specimens, but this crystal is lustrous, milky white and well formed.

• Vanadinite in variegated yellow to orange crystals from the J. C. Holmes prospect near Patagonia, Arizona. This is one of Arizona's new "classic" localities, and an article on it is nearly complete. The specimens at the show were available from Bill Panczner.

• Dark red-brown dravite crystals, very lustrous and reaching about 2 cm in size, from the famous locality at Brumado, Bahia, Brazil. Attractive clusters were available from Chris Wright (*Wright's Rock Shop*) and Ken and Betty Roberts (*Roberts Minerals*) in their booths at the main show. Most are miniatures, some with associated dolomite rhombs.

• Ken and Betty Roberts also had (under the counter) two flats of excellent white celestite crystals on sulfur from La Grasta, Enna, Sicily. Most are cabinet size.

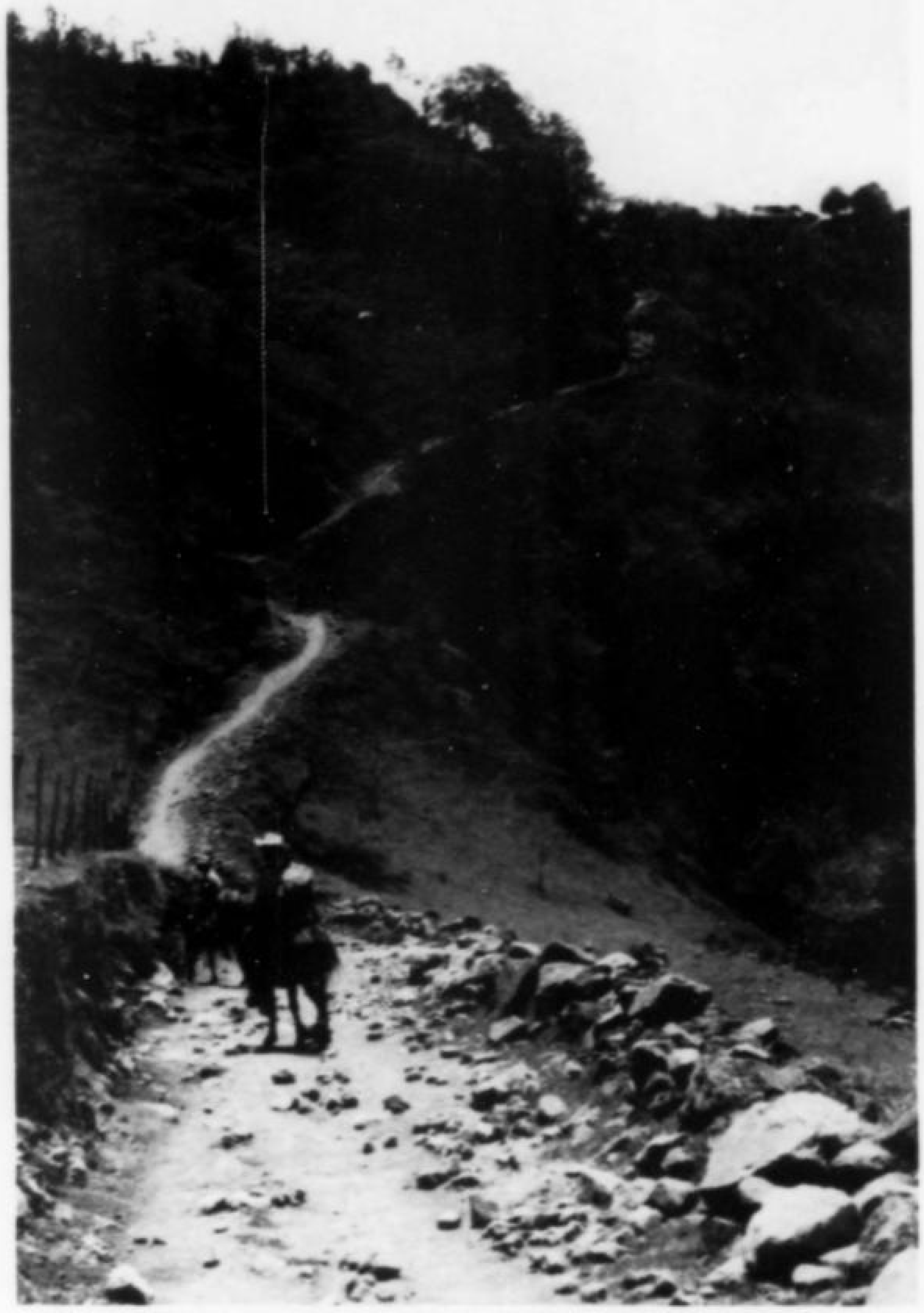


Figure 9. **Mule trail leading into the remote region of south-central Mexico where fine andradite garnets are currently being found. Steve Green photo.**

• Also in the Roberts' display were a few extremely nice azurite groups from the Touissit mine, Morocco. The crystals, to about 5 cm, have an interesting pillow-shaped rectangular-tabular habit.

• J. Chaver (Breton de los Herreros-11, Madrid, Spain) had many flats of newly collected hematite crystals from Jaen, Andalusia, Spain. The crystals are thin to thick tabular, and 5 mm to 7 cm across. None have any matrix. They resemble slightly the crystals from Monte Calvario, Catania, Italy (see vol. 14, no. 1, p. 55, Fig. 6).

• A great deal of fine malachite has been coming out of the copper mines at Lubumbashi, Zaire, lately. Many dealers have some of this material, but the best and largest stalactites in groups to 25 cm tall were to be found at the Desert Inn, in the room of Chatta Sami (P.O. Box 2979, Lubumbashi, Zaire). Some specimens have been polished, and make rather striking display pieces nonetheless. A bluish green surface to some of the stalactites suggests the presence of other copper minerals.

• Excellent single crystals of the various Afghanistan gem species (topaz, tourmaline, spodumene, etc.) were available in large quantity from Ali Baigzad (2420 Pacific Dr. #32, Santa Clara, CA 95051) in his room at the Desert Inn. Being an Afghani himself and speaking the local language, Ali has something of an advantage in that troubled and dangerous country.

• Hamel Mining and Minerals, at the main show, had a case of specimens for sale which all came from localities in the recent Nevada issue. Sulfur from Steamboat Springs was available there,

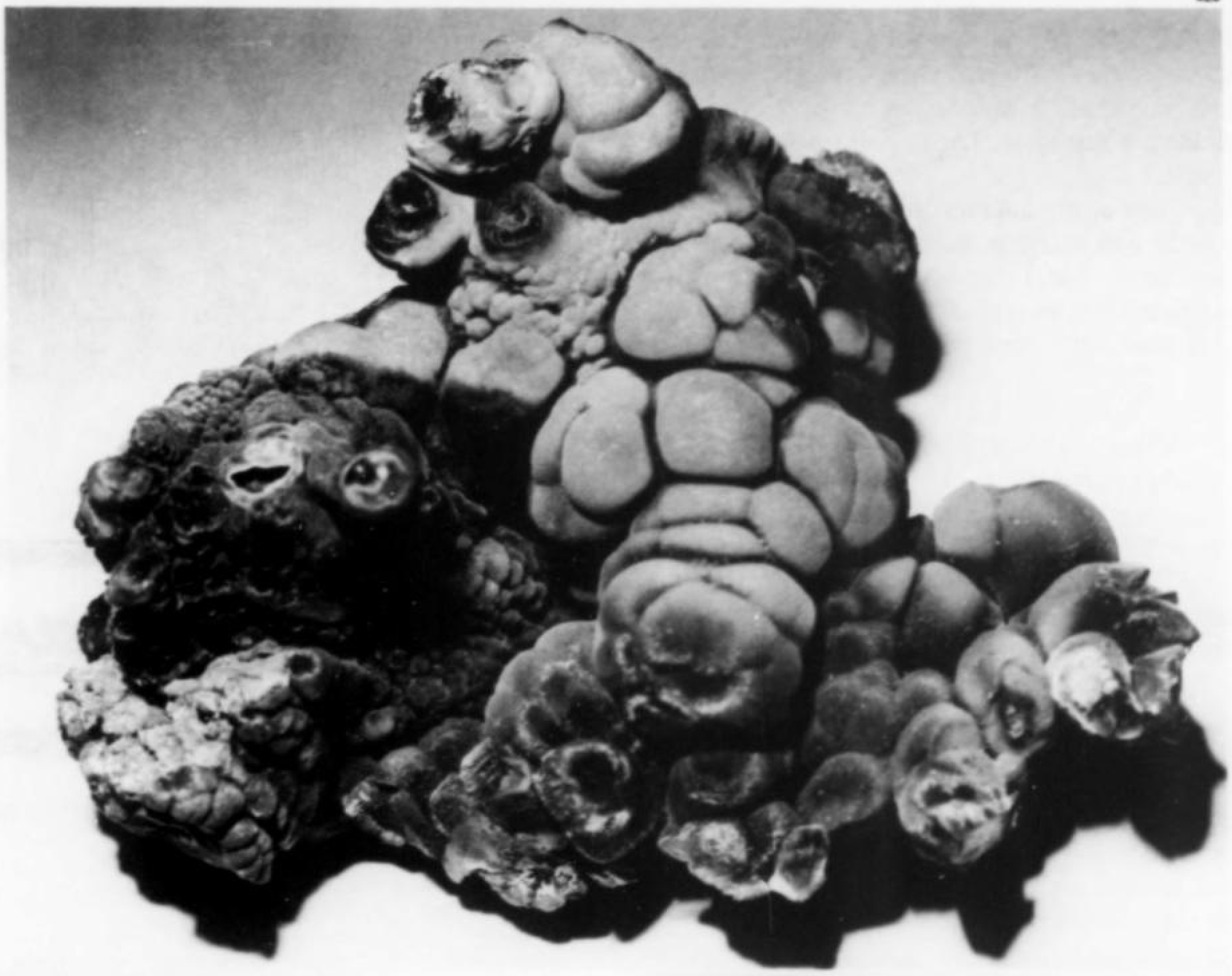


Figure 10. **Botryoidal velvet malachite, about 10 cm across, from Shilu, Yangchung Xian, Guangdong province, China. Sharon Cisneros specimen.**

Figure 11. **The world's best spangolite specimen, having individual crystals up to 1.6 cm on matrix, from the Copper Queen mine, Bisbee. Houston Museum of Natural History collection.**

Figure 12. **Stibnite, Iyo, Japan; the group measures about 25 cm tall. Houston Museum of Natural History specimen.**

Kent England

Figure 13. **Western Minerals booth, main show.**

Figure 14. **Pete Bancroft's case of Western memorabilia.**

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as well as from a number of other dealers. The crystals are generally large (2 to 6 cm) and very inexpensive.

Overall I would say that specimen quality was noticeably up at this year's Tucson Show. The dealers seem to be refining their stocks or working a little harder at getting the best grade of material. Of course there are more high prices around too, but collectors and curators seemed ready to pay the prices this year (within reason at least) and most dealers were very pleased with their sales.

So much for the interests of the typical collector. In a different vein, the metaphysical crowd was also out in force this year, going from room to room and dealer to dealer leaving their fingerprints all over the crystals. Their apparent method is to feel crystals in an attempt to sense the "power" in each one. Those with the most "power" (quartz seems to be very popular) are purchased for use in healing the sick, meditation, or whatever. One enterprising dealer I spoke with was thinking of wiring a spark coil to a few native copper specimens and giving the mystics a little jolt, as a way of stimulating sales. If that is done, we'll have to add a new category to the list of mineral fakes: "falsified supernatural characteristics."

Rare Books

Book collecting is becoming increasingly popular among mineral collectors these days, and this year's Tucson Show was a great one for the bibliophile. An amazing number of truly rare titles was available as well as hundreds of less rare but no less interesting books and journals.

Figure 15. **Group display of rare books and a crystal model set presented by members of the Geo-Literary Society.**

Figure 16. **Recently mined tourmaline crystals, most of them pink, from the Himalaya mine, Pala, California. Pala International specimens.**

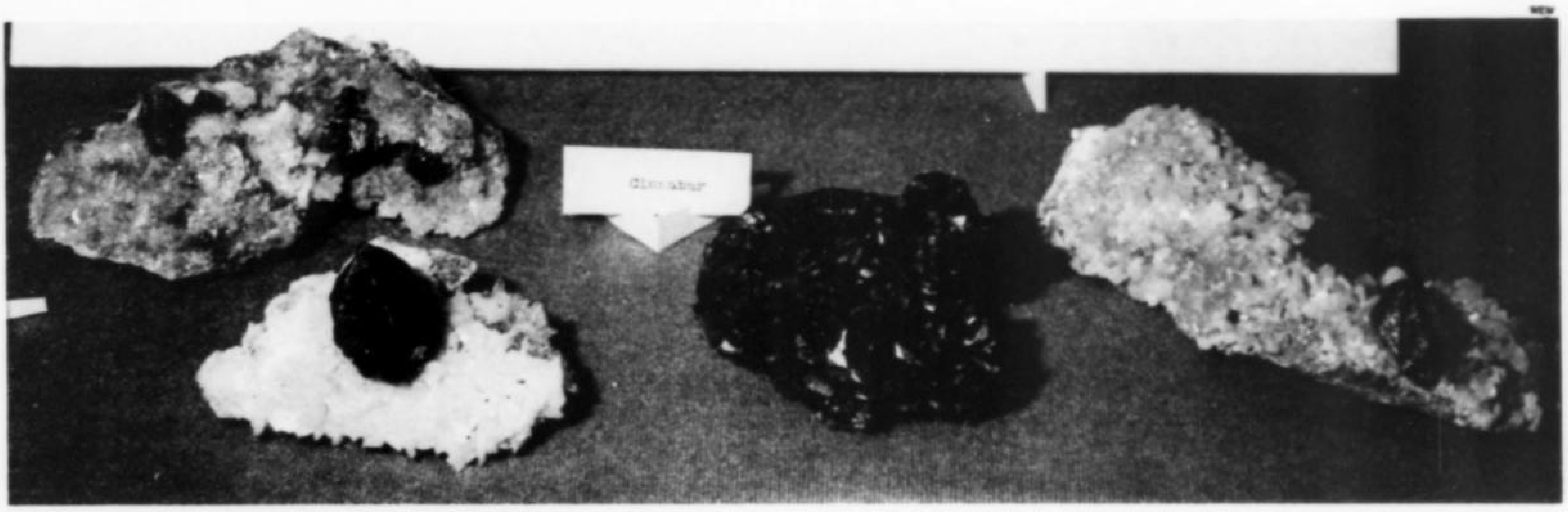

Figure 17. **Large cinnabar crystals on matrix in the case of the National Geological Museum, China.**

Kent England

Figure 18. **Hu Chengzhi, National Geological Museum, People's Republic of China, setting up their showcase.**

Kent England

Figure 19. **Future mineral dealer takes a hot dog break.**

Russell and Alexandra Filer (*Geoscience Books and Prints,* 13057 California Street, Yucaipa, CA 92399) issued a catalog just in time for the show. In addition to a book and print list it contains 41 pages devoted to reproductions of illustrations and title pages and a nicely written "Historical overview to mineralogy."

Among the very rare items offered by the Filers were the following:

The Lapidary of Alfonso X (Lapidario del Rey de Alfonso X), an 1881 color facsimile reprint of a unique illuminated manuscript prepared for King Alfonso of Spain in the year 1278. ($350.)

BIRINGUCCIO, V. (1678) *Pirotechnia.* Considered to be the first printed work to cover the whole field of metallurgy. In Italian ($995), but a 1959 English translation was also available ($60).

GREW, N. (1681) *Museum Regalis Societatis,* in which the author discusses the various specimens in the first scientific museum in England, including 22 engraved plates, three of which show minerals and crystals. ($575.)

HENCKEL, J.-F. [1725] (1760) *Pyritologie.* This is a French translation of an early German work on pyrite and marcasite, "information concerning the form, localities, sources and origin, including iron, copper, sulphur, arsenic, silver, gold and metallic earths, as learned from specimens in many collections [and from] descents into mines . . . ." ($595.)

HILL, J. (1748) *A History of Fossils.* In those days a "fossil" was "anything dug up," and so the term covered minerals as well; 12 engraved plates. ($605.)

KIRWAN, R. (1794, 1796) *Elements of Mineralogy.* Two volumes, published in London; this second edition is an enlargement of his first edition, which was the first systematic mineralogy published in English. ($595.)

Also available were a couple of recent reprints I had been unaware of: the first edition of William Phillips' (1816) *Outline of Mineralogy and Geology* ($25), and the first edition of Parker Cleaveland's (1816) *Elementary Treatise on Mineralogy and Geology* ($60), both issued in 1978 by Arno Press, New York, as part of their History of Geology collection.

Filer's can be found each year during Show Week at the Travelodge.

Mary Murphy (who wishes that her address be given only as "New York" . . . very exclusive) had a relatively small but very high-powered selection available in the Desert Inn. Highlights include:

LEONARDUS, C. (1750) *The Mirror of Stones,* the first and only English edition of the influential 1502 original (*Speculum Lapidum*). ($775.)

BOYLE, R. (1672) *An Essay about the Origine and Virtues of Gems,* by the man famous for "Boyle's law" in physics. ($875.)

HILL, J. (1774) *Theophrastus' History of Stones,* in original Greek with running translation and commentary in English. ($675.)

SIMONIN, L. (1869) *Underground Life or Mines and Miners,* the much sought-after English edition, with many fascinating engravings of mining scenes worldwide. ($295.)

von POTT, H. A. G. (1842) *Schriften der in St. Petersburg Gestifteten Russisch-Kaiserlichen Gesellschaft für die Gesammte Mineralogie,* two volumes, the history and discoveries in Russian mineralogy from 1817 to 1842, with hand-colored illustrations of emeralds and chrysoberyls. ($625.)

Don Olson (P.O. Box 766, Cedarburg, WI 53012) had for sale a collection of books in his room at the Desert Inn. Rare items were many, but the following is a sample:

DANA, J. D. (1844) *A System of Mineralogy,* the rare second edition which is the most difficult of all the Danas to obtain. ($250.)

PHILLIPS, W. (1844) *An Elementary Treatise on Mineralogy,* fifth edition, prepared by Francis Alger (and hence known as "Alger's Phillips's Mineralogy"). This copy is inscribed by Alger to Benjamen Silliman, and was bequeathed by Silliman to James D. Dana, who also signed it. ($200.)

HAMLIN, A. C. (1873) *The Tourmaline,* classic work with color illustrations of crystals and special reference to Maine tourmalines. ($125.)

COLLINS, J. H. (1871) *Mineralogy of Cornwall and Devon,* leather-bound, a thorough treatment of all the minerals and localities. ($300.)

CRONSTEDT, A. F. (1787–1788) *System of Mineralogy,* English translation in two volumes of the classic work in Swedish by the father of blowpipe analysis. ($300.)

GRATACAP, L. P. (1912) *A Popular Guide to Minerals,* a hard-to-find volume profusely illustrated with specimens from the Bement Collection acquired by the American Museum of Natural History. ($100.)

Jack Garvin (321 N. Golden Mall, Burbank, CA 91502; formerly *Hollywood Book Shop*) was set up as usual in the Sheraton, and his stock included:

de BOODT, A. B. (1636) *Gemmarum et Lapidum Historia,* second edition, an early classic, in contemporary vellum binding. ($400.) This is remarkable because Don Olson in the Desert Inn had the same title, but the *third* edition (1647), bound together with Johannes de Laet's 1647 commentary on Theophrastus.

PARACELSUS (1650) *A New Light on Alchymie,* with an added treatise on sulfur by Micheel Santivogius, plus a "Chymicall Dictionary explaining hard places and words met withall in the writings of Paracelsus and other obscure authors," in English. ($1250.)

WOLTERSDORFF, J. L. (1755) *Systema Minerale in quo Regni Mineralis Producta Omnia Systematice . . .,* in German, original binding. ($125.)

While in Jack's room I saw a copy of a new book which every book collector will have to obtain as a reference: *Geology Emerging* (1984) by D. C. Ward and A. V. Corozzi; $45, 565 pages, from the Publications Office, University of Illinois. Bibliophiles might also enjoy another recent publication: *Wealth Inexhaustible, a History of America's Mineral Industries to 1850* (1985) by M. H. Hazen and R. M. Hazen, authors of the compendious and indispensible *American Geological Literature, 1669 to 1850* (see the review in vol. 15, no. 1, p. 47). The new book is available for $42 from Van Nostrand Reinhold, 135 West 50th Street, New York, NY 10020.

More rare books turned up at the main show. Wayne and Dona Leicht were offering a four-volume set of Sowerby's *British Mineralogy* (1804–1811) containing hundreds of hand-colored copper plate engravings. In contemporary binding, the four volumes were priced at $2500, and would have commanded much more if the large fifth volume of 1817 had been included.

Herb Obodda brought a few interesting items as well, including a first edition (1837) of Dana's *System of Mineralogy,* among other rarities.

Up in the wholesale section, Si and Ann Frazier had a large selection of old and new books; down on the main floor Mark and Jeanette Rogers had more (mostly new); and quite a few other dealers at the main show and in the motels had books. Some even had complete sets and individual back issues of the *Mineralogical Record*!

Before leaving books it should be mentioned that the prices quoted here are *asking* prices; whether those prices are firm or negotiable, whether the books actually sold at those prices or not, and whether those prices are above or below currently accepted market value, I can't say.

Displays

Dioptase was the featured mineral this year, and fine specimens could be seen in many cases. Ken and Betty Roberts' "Distinguished Gathering" case centered on rhodochrosite from the Hallapon mine, Pasto Bueno, Peru. They also filled a showcase with rare, fancy and mechanical miners' candlesticks. John Barlow's superb case contained several excellent creedite specimens, among other things. The newly founded Houston Museum of Natural Science (formed recently by the acquisition of the unparalleled Perkins Sams collection) provided a case of cabinet specimens. Hu Chengzhi from the National Geological Museum, Beijing (Peking), China, returned again this year with a case of cinnabars, realgars, azurites, zircons, etc. . . . all recently mined in China. (Following the show, most of the displayed items from China were acquired by Gene Schlepp, *Western Minerals.*) Pierre Bariand, curator at the Sorbonne in Paris, brought an exquisite case of dioptase from various localities. And Herb Obodda mounted an interesting display of minerals, mostly calcites, from the classic German locality of St. Andreasberg.

This short listing covers only a sampling of the many superb cases to be seen at this year's Tucson Show. There is no other show, anywhere in the world, which can match Tucson when it comes to displays. Many exhibits do not lend themselves to easy description, and the competition cases are so numerous and so fine that I wouldn't know where to start.

Consider that it requires nearly two weeks of concentrated, active study to see and appreciate everything . . . then imagine how little of all that can be included on these pages. The entire Tucson Show phenomenon really must be experienced personally, and I can only urge readers to come and see for themselves next year. Currently in preparation is an article on the Tucson Show designed as an overview and guide for the first-time visitor, parallel in concept to the recent article on the Munich Show (vol. 15, no. 3, p. 131). We hope it will help our more reluctant readers overcome any lingering resistance to making that first of many trips.

Saturday Night

For many people the Saturday night program makes a fitting and entertaining climax to show week. This year the show committee experimented a bit by having the show close at 7 p.m., and the Saturday night program begin at 8 p.m. The idea was to allow the show dealers an hour to get dinner and still have time to return for the program. I had some momentary visions of everyone getting involved in a third round of margueritas and forgetting to come back. But we ended up with a packed house of mellow (as opposed to starving) people, so the experiment was a success.

Starting things off was Bill Panczner's polished and professional presentation, complete with music, on three of Mexico's famous localities. Much of the information was drawn from Bill's forthcoming book on the *Minerals of Mexico,* which promises to be a blockbuster. The Mineralogical Record Book Department will be carrying it (so watch the ads), as well as a special leather-bound edition for people who like to pamper themselves.

Following the lecture was a short intermission, followed by the TGMS awards ceremony. Winners this year of the most prestigious prizes were:

McDole trophy ("best rocks in the show"):
James and Dawn Minette

Kent England

Figure 20. **Bill Panczner, dressed in a native Tarahumara Indian outfit in preparation for his Saturday night lecture and slide program on famous localities in Mexico.**

Figure 21. **Walt Risch holds auction item where everyone can see it, at the Mineralogical Record's Saturday night fund-raiser.**

Figure 22. **John Patrick (left) presents the coveted McDole award to James and Dawn Minette.**

Lidstrom trophy ("best single specimen"):
Richard Tripp (for an English barite)

The Friends of Mineralogy also presented their award for the best article to appear in the *Mineralogical Record* in 1984. The winners were George Robinson and Steven Chamberlain for their article on the Sterling mine.

Of course minerals are one thing, but the Mineralogical Record Tennis Tournament is entirely another thing! Here would be an appropriate place to mention the sweating, puffing, panting winners:

Men's singles: Ulrich Dernbach
Men's doubles: Ulrich Dernbach & Helmut Brückner
Women's singles: Gale Thomssen (!)
Mixed doubles: Barbara Shelton & Wayne Leicht

The auction then got underway with Gary Hansen as auctioneer, and, in addition to being a great deal of fun for everyone, it raised a significant sum for the *Mineralogical Record.* Our silent auction, now in its third year, ran throughout the show and was very successful as well. Considering some of the special issues we have in preparation (I won't spoil the suspense by revealing what they are), the extra funds will come in very handy indeed.

This year our staff of volunteers numbered over 40 people, and together, under Auction Manager Don Olson, they did a magnificent job. Approximately 10% of the Mineralogical Record's entire annual income is generated during the four days of the Tucson Show—through the auctions and through our subscription and bookselling table. So the work of these people, as well as the generosity of our auction donors and buyers, is a critical factor in the continuing prosperity of the Mineralogical Record. Below are listed the people who helped at this year's show, and those who have sat in for us at show tables throughout the previous year. (Auction donors and other donors are listed following this column.)

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Without the kind assistance and cooperation of the Tucson Gem and Mineral Society, as well as the other organizations which provide us with space at their shows, none of this could have taken place. It has been a pleasure to work with these people, and we are very grateful.

Finally, I'd like to thank Steven Morehead, who has put in many hours proofreading galleys for us.

This year, on the Tuesday preceding the show, the second annual Mineralogical Record Special Friends Party was held at the Sheraton, where everyone munched on munchies, sipped drinks, and generally had a nice time. This coming year (at the 1986 Tucson Show) we have decided to forego the sending of invitations and open the party to anyone who considers himself a "special friend" of the Mineralogical Record. Almost anything will qualify you. Advertisers, authors, donors, volunteers, photographers, directors, associate editors, owners of complete sets, recent subscribers who *wish* they had complete sets, all are welcome. We'll publish a formal invitation in the November-December issue. If nothing else will tempt you, isn't *that* a good reason to visit the Tucson Show next year? *

W.E.W.

Kent England

Figure 23. **Okay, so you lost the bid . . . you don't have to get ugly about it! (Jaye Smith—*the Rocksmiths*—and recently acquisitioned husband, Bill Lawrence, at the Mineralogical Record auction.)**

*Dates for the 1986 Tucson Show are February 13-16. The featured mineral will be rhodochrosite.

Annual list of donors to the

MINERALOGICAL RECORD

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I know all the readers of the *Mineralogical Record* will join me in saying thanks to these generous people who help to keep our magazine going year after year. W.E.W.

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Letters

WHY ACKNOWLEDGMENTS?

You will find enclosed $43-U.S. for two years' subscription to your generally excellent magazine. At $57-Canadian, I am becoming no little concerned about my ability to continue. However, here we are for another two years. Go ahead, take my money, I'll starve.

I do feel, though, that I am entitled to one mild complaint. In volume 15, numbers 1-6, I count a total of approximately seven (7) full pages of acknowledgments. What purpose do these serve? Do the people being acknowledged take note of such things? Do your subscribers read them?

S. Sheridan
Oshawa, Ontario

First of all, I sympathize with all of our many non-U.S. subscribers regarding the exchange rate these days. If it makes things any easier to accept, let me point out that, unlike most magazines, we do not charge a higher rate for non-U.S. subscriptions even though they cost us over $3 more to mail. Everybody pays the same; this amounts to a discount or subsidy for our foreign subscribers . . . we want and need to keep you signed up, and we hope you'll bear with us.

And we also try to keep an international balance in publication. During 1982–84, the amount of page space we devoted to locality-oriented articles was 51% U.S. and 49% non-U.S.

As to acknowledgments, by my own count, I get 39 column-inches or about 2 pages total of acknowledgments in articles, plus 2.75 pages devoted to thanking all of the Mineralogical Record's 1984 donors. But let's not quibble . . . I understand your question.

In the U.S. (although not in some other countries) it is customary to thank people who provided help which proved valuable. I think this is good because people deserve *thanks when they give help. Some people are mentioned often in acknowledgments, though they may rarely, if ever, appear as authors; their cumulative contribution is great, though rather spread out, and their name should be made known. (And, believe me, they* do *take note of the recognition.) Funding institutions and people who financially support research also deserve thanks and recognition, for without them much research would be impossible.*

From the reader's standpoint, the acknowledgments are also valuable, just as it is valuable to have literature references in the text to show which data have come from other sources. Astute readers take nothing for granted . . . they want to know *where the information comes from so the source can be considered and the data double-checked if necessary. If an unusual mineral is reported from a locality, the skeptical reader may want to know where, how, and by whom was it identified. Just as people may wish to communicate with an author about some particular point, they may also wish to contact a contributor mentioned in the acknowledgments. So, in addition to an expression of sincere gratitude, the acknowledgments serve as useful data related to the article, and as a stimulus to communication between researchers.*

Regarding the Mineralogical Record's own annual acknowledgment list of donors, I personally think all *readers owe them thanks and should know who they are.*

Ed.

MICROMOUNTING MUSEUMS

I read with great interest your comments regarding public exhibits of micromounts and the utilization of micromount collections in museums. Perhaps the following information regarding the collection here at the Arizona-Sonora Desert Museum will be of interest to your readers.

Our micromount exhibit opened to the public in November, 1981, and since that time has been seen by well over one million visitors! Public response to the exhibit has been phenomenal and it is certainly one of the most popular components of our mineral gallery. It is a pleasure to stand nearby and watch (and listen!) as visitors, especially children, discover for themselves the beauty of the mineral kingdom as soon through the microscope. While there are difficulties encountered in designing a truly effective display for such small and fragile objects, our experience has shown that visitor response clearly justifies the effort and expense involved. Micromounts *can* and *should* be displayed. We urge other museums to give it a try and will gladly assist any other institution contemplating such an exhibit.

The Desert Museum's micromount collection, one of the largest in existence, contains over 9,000 specimens from worldwide locations. Within a few months, computerization of the collection catalog will be complete, resulting in the production of comprehensive species and locality lists to accompany the specimens. The collection is securely housed in the Earth Science Center vault along with the other mineralogical collections and is available for study. Such a large and fine collection exists solely because of the generosity of numerous donors who have contributed their own personal collections. We hope the collection will continue to grow and we invite additional donations. We expect to increasingly promote utilization of the collection for scientific and educational purposes so that it can become a significant resource for the mineralogical community, both professional and amateur.

Robert G. Middleton
Conservator, Earth Sciences
Arizona-Sonora Desert Museum, Tucson

MAJUBA HILL ACKNOWLEDGMENT

An unintentional omission occurred in the acknowledgments section of our recent article on Majuba Hill in the Nevada Issue. Our sincerest thanks and apologies to D. Hartshorn, the Gulf Chemical Company geologist currently supervising the property. On a number of occasions his hospitality and generosity allowed us the opportunity to examine and collect in the various mine workings.

M. Jensen
Crystal Bay, Nevada

THAT'S A LOT OF EGGS!

In the article on the Miguel Romero Mineralogical Museum in the March-April issue, the text originally stated that the Romero family chickens produced 100 million eggs daily. This seemed like a lot, and just before that issue went to press we checked with Miguel, who told us the correct number should be 4 million. This correction was marked on the final printer's proof, but apparently not clearly enough, because what ended up being printed was a figure of *400* million! We would have shelled out a lot to prevent such an error, and we hope that Dr. Romero is not feeling fried about our scrambled figures. Eggs aside, his collection deserves a standing *ovation*.

Ed.

FRENCH MICROMINERALOGISTS

We have the pleasure to announce the creation of a French national association of micromount collectors: ***Association Française de Micromineralogie*** (A.F.M.). Our purpose is to promote contact among all micromount collectors, in France and throughout the world. For information, write to Bertrand Duriez, 56 rue de la Tombe Issoire, 75014 Paris, France.

Pierre Gatel
President, A.F.M.

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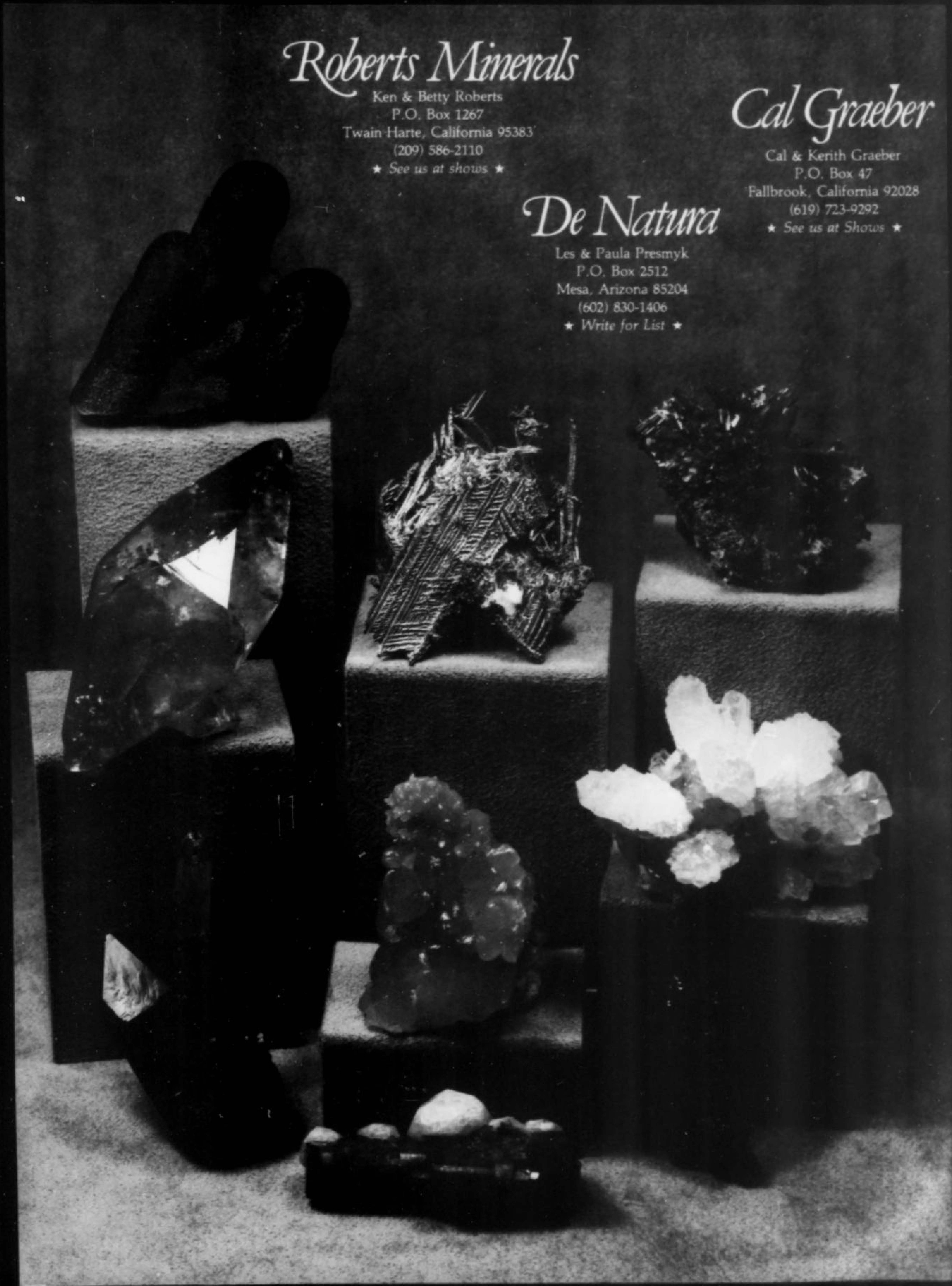
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