THE MINERALOGICAL RECORD

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THE MINERALOGICAL RECORD

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Articles

Columns

COVER: CUPRIAN ADAMITE, 5.6 cm, from the Tsumeb mine, Tsumeb, Namibia. Sandor Fuss collection; Jeff Scovil photo.

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*Continued on p. 360

notes from the EDITORS

Airport Inspections

We have been hearing horror stories lately about collectors having their carry-on luggage inspected by clumsy, careless security personnel who damage or destroy fragile specimens in the process. If, after seeing your carry-on items on the X-ray screen at the security check-point, an inspector decides that your stuff merits a closer look, there is nothing you can do to stop him. The inspector will not allow you to touch your carry-on items during the inspection, but will insist upon going through them himself, poking and prodding and handling whatever he chooses. If he accidentally damages something you will have no recourse.

With the huge numbers of travelers coming into and out of Tucson during the Tucson Show, it occurred to me that perhaps some special arrangement could be made whereby the mineralogical traveler identifies himself somehow and is given an inspection in a side room where he would be allowed to personally unpack, handle and show the questioned items for the inspector, thereby protecting them from damage while fulfilling the need for airline security. I thought that perhaps the TGMS or the Mineralogical Record could make preprinted cards available identifying the bearer as a collector, dealer, scientist or show-goer who would qualify for a special inspection.

To that end I spoke with Mollie Crawford, Assistant Federal Security Director with the Transportation Security Administration here in Tucson. She informed me that, unfortunately, Federal regulations are written specifically to preclude special treatment for anyone, even airline pilots themselves. The feeling is that if a Bad Guy were allowed to handle and show the contents of his own carry-on luggage during an inspection he could potentially conceal or divert attention from prohibited items by sleight-of-hand. Any special treatment given could be exploited and abused. The point is well taken.

The T.S.A. has received no end of bitter complaints about this situation from all quarters. Minerals are not the only fragile items that people wish to protect in their carry-on luggage, and these days all checked luggage is X-rayed and subject to being opened and thoroughly inspected as well. So there is no longer any safe way to carry fragile mineral specimens with you on a commercial airline when traveling to or from a mineral show, whether you are a dealer, an exhibitor, or just a collector who has purchased a few nice specimens. If the specimens are small enough and are also non-metallic, you might carry them through in your pocket, but other than that you should be aware that a clumsy inspection is a very real possibility.

Sorbonne Collection Endangered

"Begun by Haüy in 1809 and nurtured by such luminaries as Beudant and Delafosse, the mineral collection of the Sorbonne (University of Paris) achieved international stature with the acquisition of a part of the Vesigné Collection in 1953. The beautifully engineered Exhibition Room, opened in 1970, does justice to this remarkable collection." So wrote Sorbonne curator Pierre Bariand (now retired) in his article on the museum in vol. 13, no. 1.

A planned rebuilding of the university campus in Paris is now threatening this world-famous mineral collection. Plans currently call for placing the collection in storage where it will remain inaccessible to the public for at least two or three years. The plan involves eventually placing a small selection of the better specimens in a temporary exhibit while the bulk of the collection would remain in storage for yet another two to four years. Several movings of the stored specimens may be involved. We wouldn't be surprised to see that storage period stretch into a decade, or perhaps for the whole idea of permanently re-exhibiting the collection as before to be eventually forgotten by the university administration.

Any time a major collection such as this is put into storage it becomes seriously endangered by theft, loss and breakage; the public (including a whole generation of school children) suffers a serious loss because of no longer having access; the scientific community is cut off from access to research material; photo-documentation for publication becomes impossible; and even routine curatorial work for specimen preservation is blocked.

Specimens form the core of mineralogy as we know it, and when a major international repository is threatened we need to speak up. *Mineralogical Record* readers can help. Send a letter expressing your admiration for the collection, and your opposition to the closing because of the above-mentioned consequences. Request that an alternative plan be developed which is more favorable to the continuous preservation, exhibition and accessibility of this highly important collection. (If you have not personally visited the museum, check out the above-mentioned article on the collection.) Let your voice be heard.

Letters should be sent to:

Collection de Minéraux, case 73
4, Place Jussieu
F-75252 Paris Cedex 05, France

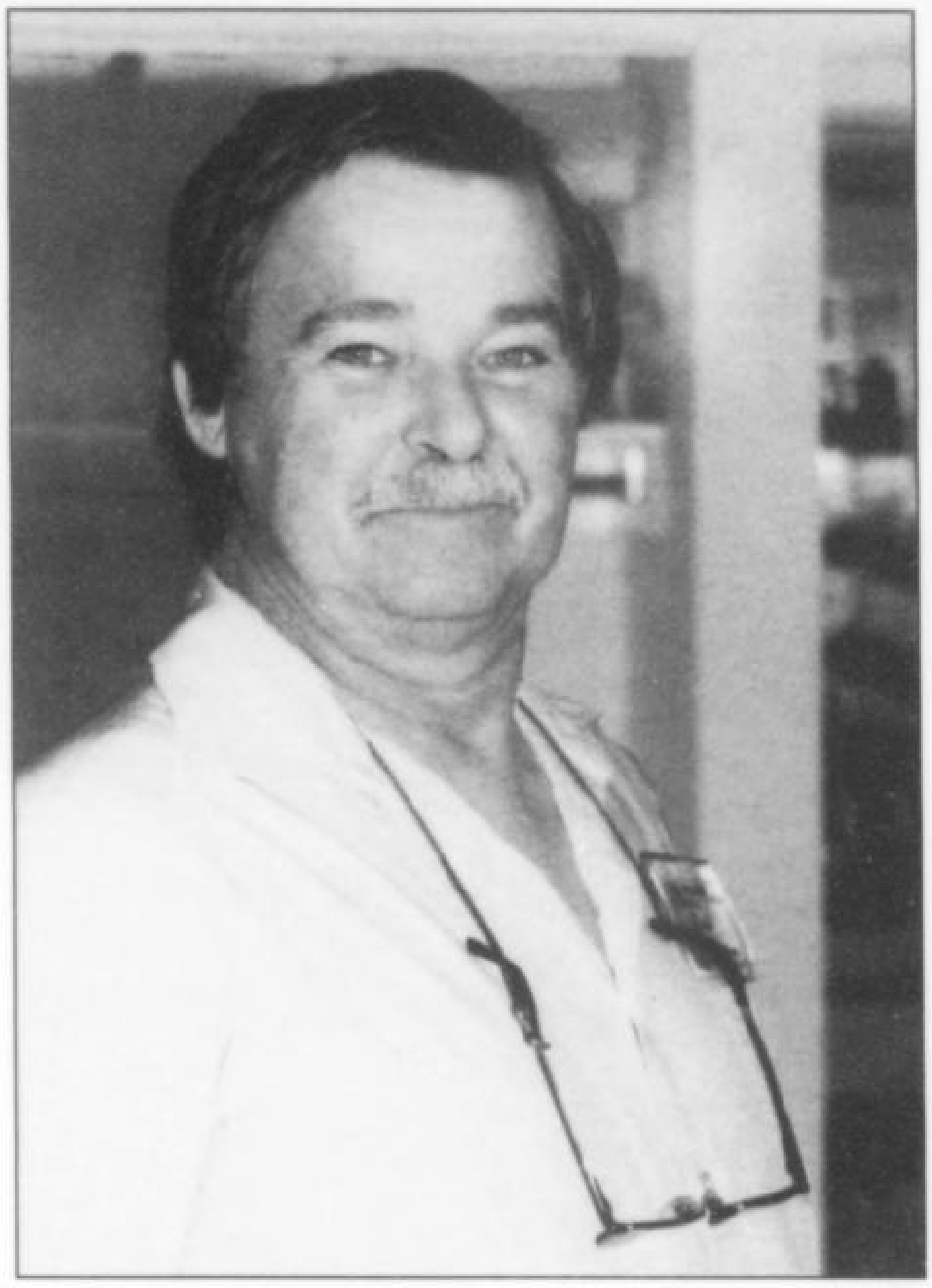
Died, David Michael Shannon, 62

Long-time Arizona mineral collector and dealer David Shannon died in Mesa on January 2, 2004 following a flare-up of a painful chronic spinal condition.

Born in Moline, Illinois in 1942, David was about two years old when his family moved to Chula Vista, California where his father founded Clarkson Laboratories, an assaying and chemical analysis service. His father's work with ore samples inspired David's interest in minerals. In 1948 his family moved to San Diego, and in 1952 David began his field-collecting career at the age of ten. Two years later he bought his first mineral specimen from Ralph Merrill of Minerals Unlimited. He purchased his own Jeep for field collecting at the age of 13 and had a friend drive him out to collecting sites until he was old enough to drive himself.

David earned a bachelor's degree in chemical engineering from the University of California at San Diego, then took a job with Union Dynamics (working with explosives). In 1968 he decided that the open spaces of Arizona held more potential for the serious field collector, and so he moved there, taking a job as a chemist with the Rogers Corporation in Chandler. He went out collecting nearly every weekend, often with one or more of his five sons, to obscure and remote mines and occurrences all over southern Arizona, where he made numerous important finds.

In 1974 David started his mineral business as a part-time operation, and went full-time nine years later in 1983, supplying rare species, mineral books, microscopes, mounting clay, specimen



Kent England

David M. Shannon (1942–2004)

boxes of various kinds, Plexiglas mounting squares and other equipment and supplies, besides providing a useful service dealing in out-of-print issues of the *Mineralogical Record*. In 1995 the rare lead mineral *shannonite* (Pb_2OCO_3) from the Grand Reef mine in Graham County, Arizona was named in his honor. David had helped collect the first samples, as well as those of other species new to science including artroeite, calcioaravaipaite and woodwardite. In 1995 David also made his first buying trip outside the U.S., to Namibia.

David was a field collector of over 50 years experience, specializing in systematic mineralogy. He had a fine systematic collection of his own, carefully mounted and labeled in 5-cm (miniature-size) Perky boxes and arrayed on shelves covering the walls of his basement. Through his company he also helped museums and systematic collectors around the world fill out their collections, often with his own self-collected specimens. A great many published scientific papers have cited him as the source of the study specimens which were essential for the research being reported. He was a regular dealer at the Tucson and Denver shows, an intelligent and scrupulously honest business man, and a good friend to many people in the mineral world.

At the time of his death David was the proud grandfather to twelve grandchildren and one great-grandchild. His mineral business will be continued by his son, Mike Shannon.

INSTRUCTIONS FOR AUTHORS

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History of the

THE OKIEP COPPER DISTRICT

Namaqualand, Northern Cape Province South Africa

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The copper mines in the Okiep district of Namaqualand are steeped in the history of South African mining and geology. The most famous mineral specimen-producing copper mine in the district was the Jan Coetzee mine, where several thousand quartz specimens were collected in 1966. Excellent specimens of chalcopyrite, fluorite, calcite, gypsum and chalcocite have been collected from other mines in the district such as Nababeep West and Okiep.

INTRODUCTION

Dutch colonialists discovered the Okiep deposits in 1685, although the indigenous Africans may have previously worked copper there for several hundred years. The first mine to be opened by Europeans in South Africa is located in the Okiep district, and the first South African mining company was formed there in 1852 to mine copper from the deposits. Other notable "firsts" for the region include the first South African geological report and the first geological map produced in this country, both of which describe and depict the Namaqualand copper fields.

Fluctuating copper prices, coupled with a remote and hostile setting, have resulted in varying degrees of success and failure in the 150-year ("modern") history of the mines. Derelict and abandoned mining apparatus, some imported from Cornwall, can still be seen scattered around at a few of the old mines.

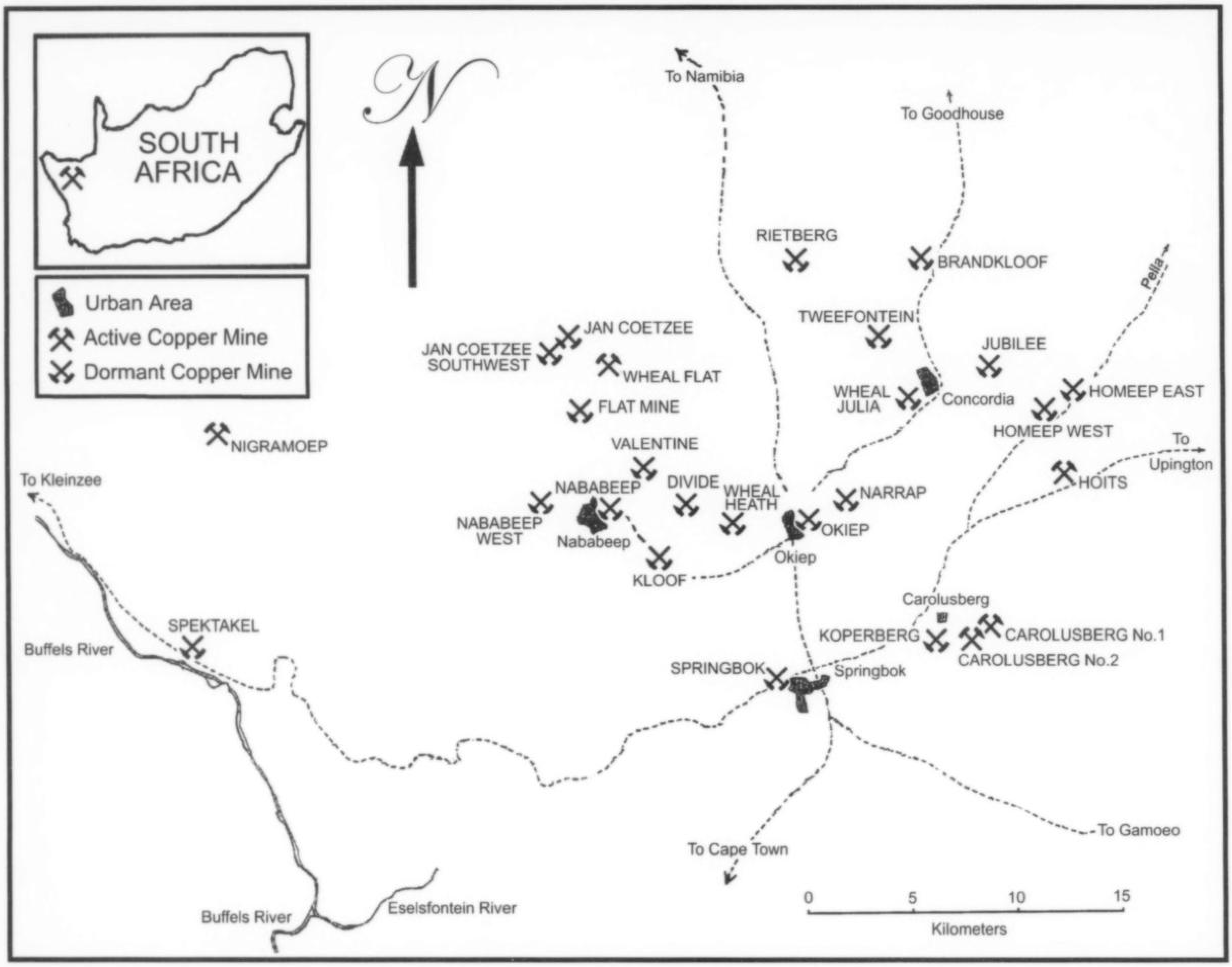


***Figure 1.* Location of the Okiep copper district in Namaqualand, Northern Cape Province. From this map, it can be seen that four mines (Nigramoep, Hoits, Carolusberg No. 1 and Carolusberg No. 2) were still operating in the late 1990's. They are now all closed (Modified from Wilson, 1998).**

LOCATION

The Okiep copper district covers an area of approximately 3000 km^2 in the Northern Cape Province and includes the towns of Springbok, Nababeep, Okiep, Concordia and Carolusberg. The geographic region is referred to as Namaqualand.

The greater part of the copper district consists of a highly dissected mountainous terrain that flattens eastward, merging with the Bushmanland plain. The average elevation is 900 meters above sea level, rising in places to about 1300 meters. The area has an average annual rainfall of only 17.5 cm.

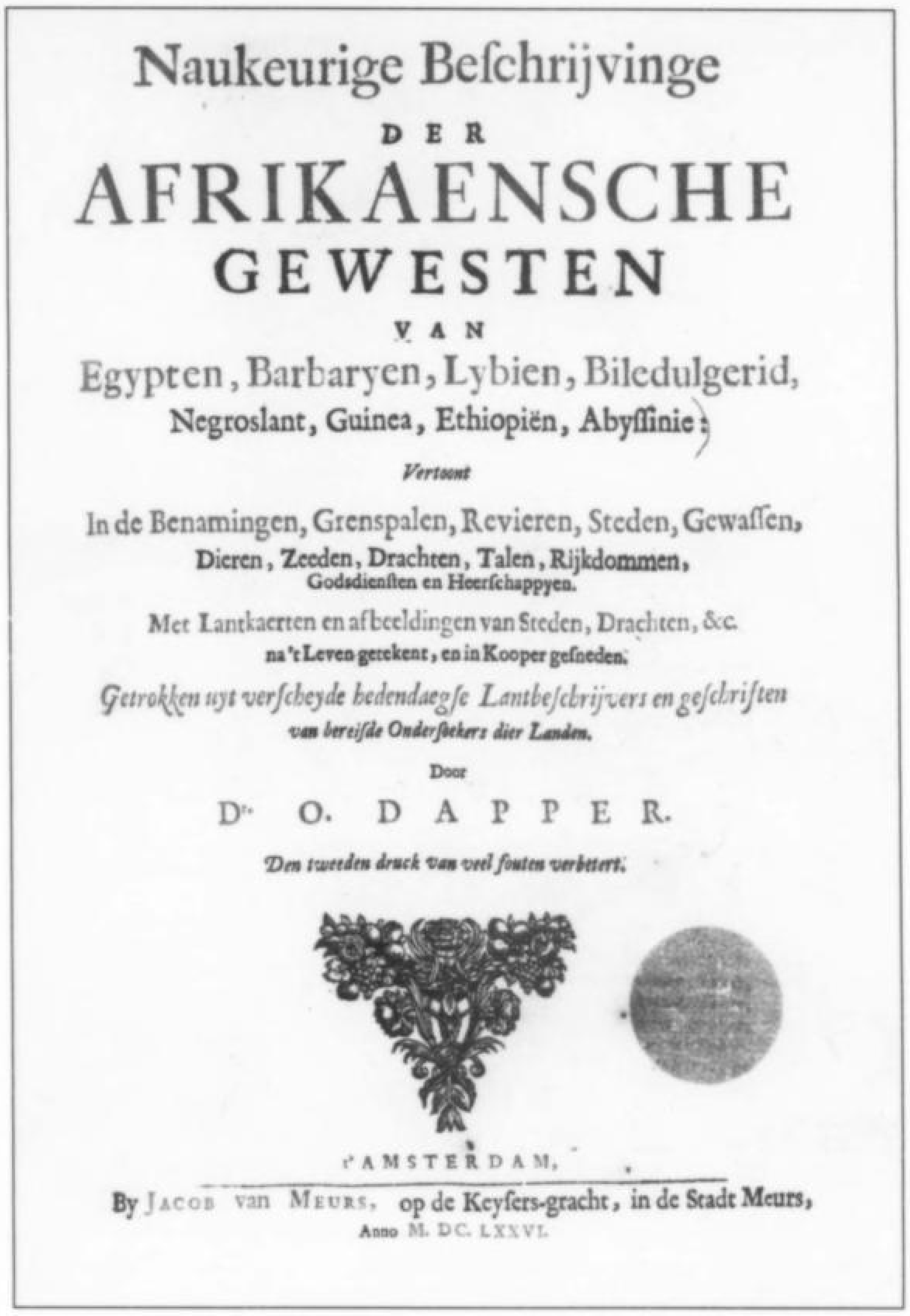
HISTORY

> Copper! It is a malleable, enduring metal that has served man for untold centuries. Certainly it has served Namaqualand well. More than anything else it has made Namaqualand what it is, and to mention the one without the other is to censor history. (Steenkamp, 1975, p. 37)

Pre-European Copper Mining

Copper was mined for centuries in southern Africa, the most noteworthy localities being in Zimbabwe, eastern Botswana and the northeastern parts of South Africa (Miller, 1995). Two localities, at Palabora and Messina, were later discovered by Europeans and developed into significant copper mines. Radiocarbon testing of charcoal samples from the former site date it back to 770 AD, making it the oldest known site for pre-European mining anywhere in southern Africa (Mason, 1982).

There is, therefore, well-documented evidence for pre-European copper mining in some parts of southern Africa, but the Namaqualand region is somewhat problematical. The local Namaqua people were wearing copper bands on their arms and ankles when they first met the Dutch explorers in the 1660's, and it was this fact that prompted the first expeditions to find the "copper mountain." Even earlier, when the Portuguese explorer Bartholomew Diaz landed on the western shores of the southern African continent on route to the East Indies, he too encountered Africans wearing copper ornaments. The copper may have been traded from other regions,



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Negroslant, Guinea, Ethiopiën, Abyſſinie:
Vertoont
In de Benamingen, Grenspalen, Revieren, Steden, Gewaſſen,
Dieren, Zeeden, Drachten, Talen, Rijkdommen,
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Met Lantkaerten en afbeeldingen van Steden, Drachten, &c.
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Door
Dr. O. DAPPER.
Den tweeden druck van veel fouten verbetert.

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By JACOB van MEURS, op de Keyſers-gracht, in de Stadt Meurs,
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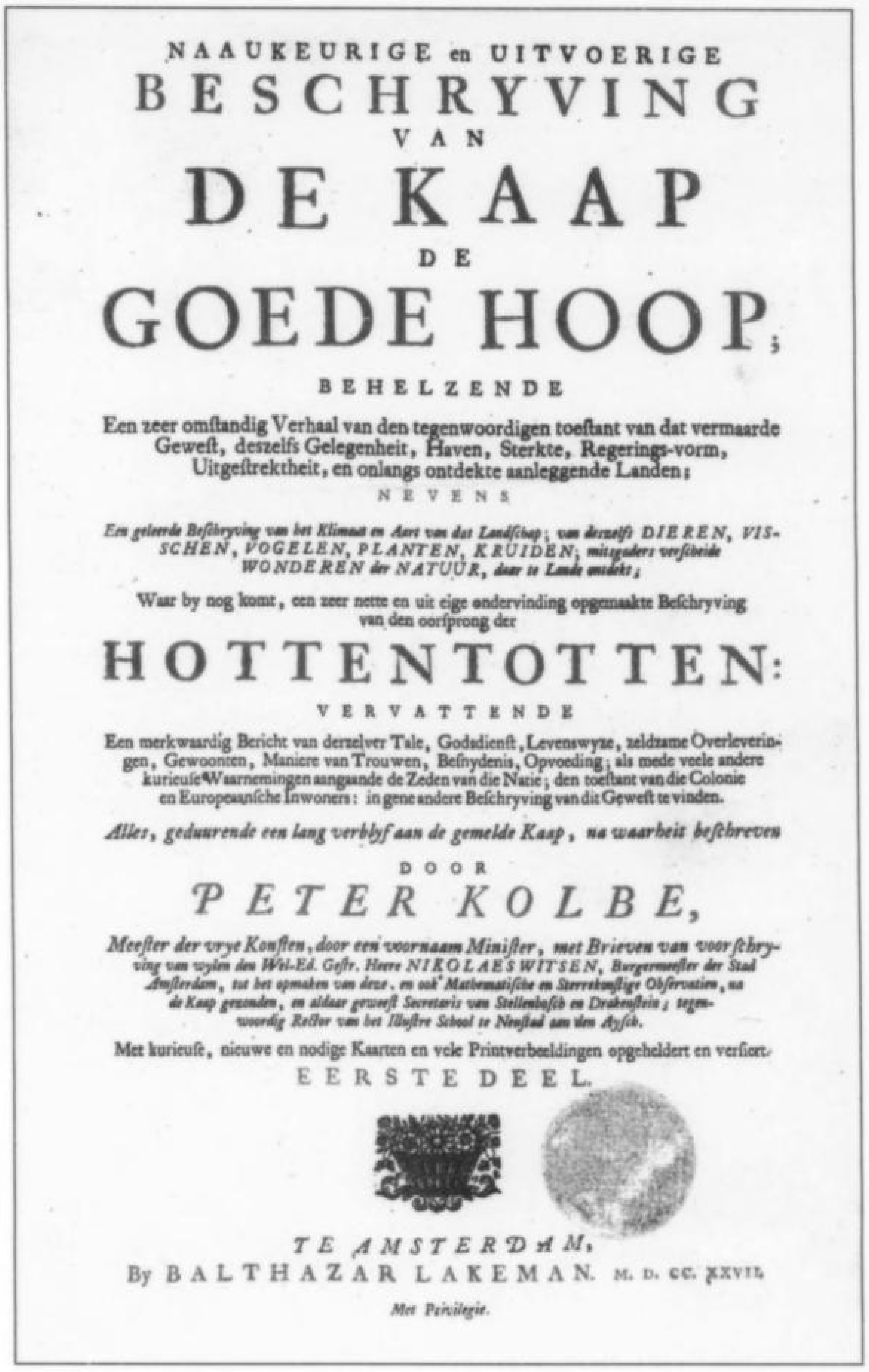

NAAUKEURIGE en UITVOERIGE
BESCHRYVING
VAN
DE KAAP
DE
GOEDE HOOP;
BEHELZENDE
Een zeer omſtandig Verhaal van den tegenwoordigen toeſtant van dat vermaarde
Geweſt, deszelfs Gelegenheit, Haven, Sterkte, Regerings-vorm,
Uitgeſtrektheit, en onlangs ontdekte aanleggende Landen;
NEVENS
Een geleerde Beſchryving van het Klimaat en Aart van dat Landſchap; van deszelfs DIEREN, VISSCHEN, VOGELEN, PLANTEN, KRUIDEN; mitsgaders verſcheide WONDEREN der NATUUR, daar te Lande ontdekt;
Waar by nog komt, een zeer nette en uit eige ondervinding opgemaakte Beſchryving
van den oorſprong der
HOTTENTOTTEN:
VERVATTENDE
Een merkwaardig Bericht van derzelver Tale, Godsdienſt, Levenswyze, zeldzame Overleveringen, Gewoonten, Maniere van Trouwen, Beſnydenis, Opvoeding; als mede veele andere kurieuſe Waarnemingen aangaande de Zeden van die Natie; den toeſtant van die Colonie en Europeaanſche Inwoners: in gene andere Beſchryving van dit Geweſt te vinden.
Alles, geduurende een lang verblyf aan de gemelde Kaap, na waarheit beſchreven
DOOR
PETER KOLBE,
Meeſter der vrye Konſten, door een voornaam Miniſter, met Brieven van voorſchryving van wylen den Wel-Ed. Geſtr. Heere NIKOLAES WITSEN, Burgermeeſter der Stad Amſterdam, tot het opmaken van deze, en ook Mathematiſche en Sterrekonſtige Obſervatien, na de Kaap gezonden, en aldaar geweeſt Secretaris van Stellenboſch en Drakenſtein; tegenwoordig Rector van het Illuſtre School te Neuſtad aan den Aysch.
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***Figure 2.* Color facsimiles of the title pages of the works of Dapper (1676) and Kolbe (1727). Both publications mention the copper deposits of Namaqualand.**

perhaps from Namibia to the north or from the Transvaal and eastern Botswana—no unequivocal *archaeological* evidence has been found in Namaqualand to prove that the copper worn by the locals was in fact mined there. The Dutch explorers found oxidized copper ore well-exposed on the surface in several places, so the lack of proven African mining in this region is somewhat perplexing (Miller, 1995). Moreover, despite the absence of archaeological evidence, other historical documents clearly show "Hottentots" working and smelting iron (Kolbe, 1727) and possibly copper as well.

European Exploration and Development

17th Century

The Okiep copper district's history is almost as old as European colonization in South Africa; its beginning postdates Jan van Riebeck's landing and occupation of the Cape in 1652 by only a few years. The first European exploration parties that were sent forth into the interior of Namaqualand started out from the Cape of Good Hope, dispatched to find the "legendary" golden wealth of King Monomotapa (Dapper, 1676; Steenkamp, 1975). In 1660, van Riebeck sent the first exploratory team into the interior of northwestern South Africa. Between 1660 and 1664, a total of six expeditions were undertaken, although none found either the gold or copper; these discoveries were to come later. Nonetheless, these early travelers did return to the Cape settlement with geographic information that was to be an invaluable aid to later investigators. They also amassed valuable data on the flora and fauna of the region.

The last of these early expeditions was led by Sergeant Jonas de la Guerre, who, with a party of 14 men, set out from the Dutch fort on October 11, 1663. His directive was still to seek out the Monomotapa kingdom, a challenge he was not to fulfill. Unlike the parties before him, Guerre did not even reach the Orange River. Yet he ventured close to the outcrop of copper deposits that were later located in the northern region of the Kamiesberg.

The first European to discover and sample copper close to the town of Springbok (Springbokfontein) was Governor Simon van der Stel, who personally explored the area in 1685. But the way was prepared for him by two earlier investigators who usually receive little mention in the South African history books or in the many tourist guides that exist for the area. After de la Guerre's expedition in 1663, no further trips had been made until van der Stel arrived in 1679 as the new governor in the Cape. Van der Stel's motives for exploration were still founded in the belief that a golden kingdom existed in the hinterland. This belief seemed supported when some copper ore was brought to Cape Town by the indigenous Namaqua people, and samples were sent to Holland for analysis. The ore proved to be high in copper, and the Council of Seventeen in Holland despatched word back to the Cape that van der Stel should seek its source. So, towards the close of 1682, a Dutch East India Company soldier, Olof Bergh, was sent inland to find the site of the copper ore (Mossop, 1931).

Bergh was a 39-year-old Swede. His party consisted of six

Figure 3. **A typically romanticized 17th-century etching of African flora and fauna. From Dapper (1676).**

supply wagons, 111 oxen, a cart and 30 soldiers. Logistical problems on route, mainly a lack of water and rumors of marauding Namaqua, forced them to turn back for the Cape settlement before finding any copper. However, in the following year, on August 27, 1683, Bergh again set out with an even larger party, which included cartographers, prospectors and diarists. This trek too had to be abandoned because of insufficient water supplies.

Undaunted, in December of the same year, van der Stel sent off another expedition, this time under the leadership of another Company soldier, Izaak Schrijver (Mossop, 1931). Before the party left, however, van der Stel personally interrogated some Namaqua who had visited Cape Town, and they informed him of a copper mountain only 15 days' travel from the Cape. For the first time, a European expedition succeeded in finding the copper deposits in the Springbok/Okiep area, and in May 1684, Schrijver returned with samples of the copper ore that he and his party had collected at the "copper mountain." Holland's Special High Commissioner, Hendrik Adriaan van Reede tot Drakenstein, then granted permission to van der Stel to personally undertake a trip to Namaqualand.

Finally van der Stel had obtained permission to make a personal visit to the area. He departed on August 25, 1685 with the largest entourage yet: 56 Europeans with 46 servants, several slaves, interpreters, 15 wagons, 8 carts, 200 extra oxen, 13 horses, 8 mules and his own personal coach! The expedition reached its destination—what is today the town of Springbok—on October 21, 1685. Three shafts were sunk and many ore samples collected.

Because van Reede had authorized the expedition, van der Stel named three places after him: the Drakenstein mountains in the Western Cape Province, the Reedebergen, and the hill labeled "H.V.R." on the field sketch of the "copper mountain." (Van Reede was also a botanist of note, and collected material for a work entitled *Hortus indicus malabaricus*).

A summary (below) of van der Stel's own journal entries describes the 16 days spent exploring for copper (Waterhouse, 1932, p. 136–138):

> *October 1685*
>
> ***Sunday the 21st.*** We left this camp at 5.30 and set our course east and uphill and after various changes of direction reached a plain. Crossing this we came to a very high mountain, which was just one single rock, and on the top of which, so the Amaquas told us, is a spring of very good water. We left this mountain on our right hand and marched for some distance over another very wide plain until we reached a ravine and, entering it, found ourselves at our destination, viz. the Copper Mountains. . . . The soil here is gravely and sandy.
>
> ***Monday the 22nd.*** The Honourable Commander and the foreman miner began to explore the mountains, the former going east and the latter west. They started work at different points to examine the mineral nature of the rock. The mountains were coloured from top to bottom with verdigris, likewise the loose rocks, which gave the Honourable Commander and the foreman miner good hope of finding something of importance . . . it was decided to make a beginning the next day.
>
> ***Tuesday the 23rd.*** At daybreak the miners began at two points, and found themselves on an unusually wide vein. The deeper they dug, the better the mineral appeared.
>
> ***Wednesday the 24th.*** The miners continued their work. Meanwhile the Honourable Commander sent the foreman miner with others to climb the highest mountain, which lay to the west, and to investigate its nature and search for minerals. . . .

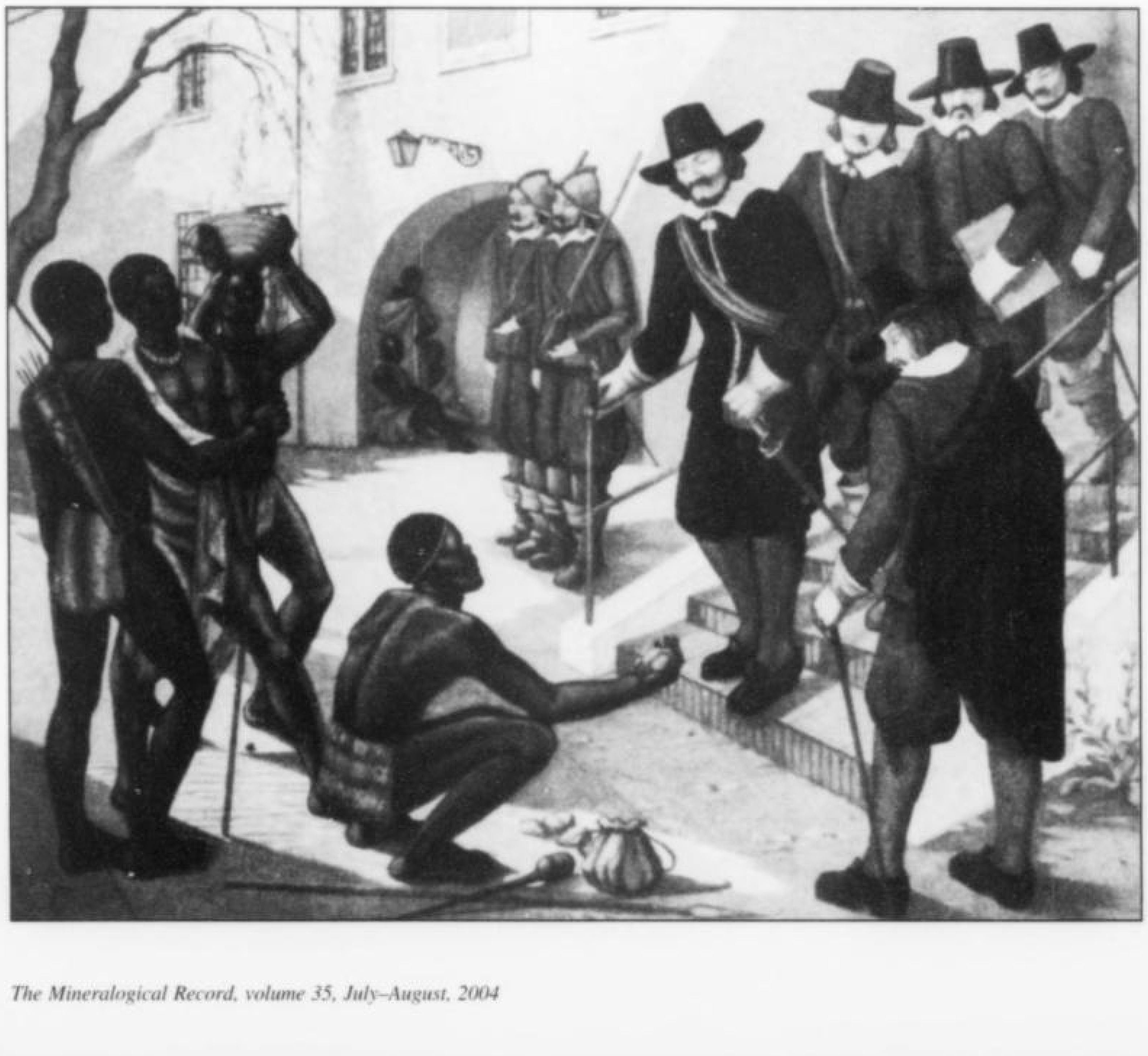


Figure 4. **A map of southern Africa dated 1686, the year following van der Stel's trip to the "copper mountain." The map is from the "Voyage de Siam des Péres Jesuites" and is titled "Country and people of the Cape of Good Hope." The mountain due east of "Namaquas" is presumed to be the "Copper Mountain." Note the reference at the top right to "Monomatapa," the fabled country of gold that many early explorers sought unsuccessfully to discover. (From Trotter, 1903.)**

Figure 5. **Simon van der Stel standing on the bottom step, receiving a party of "Namaqua Hottentots." They are presenting him with copper ore samples from the "Copper Mountain." These samples, and other indigenous information about the copper deposits, eventually led to van der Stel personally leading the 1685 expedition to discover the deposits. (Anonymous, undated; the painting is from a mural painting in South Africa House, London.)**

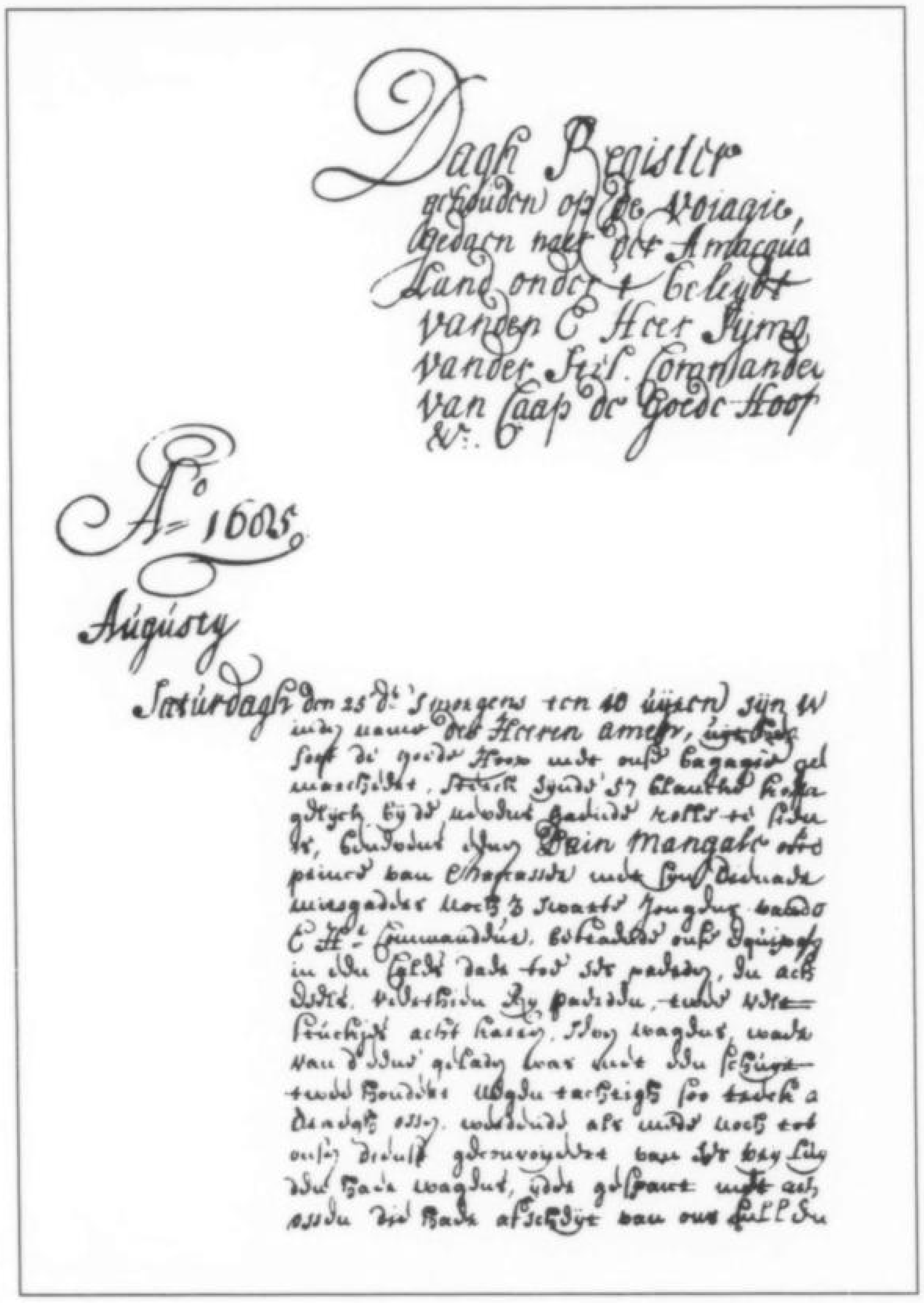
Figure 6. **Van der Stel's sketch map of Koperberg. On the reverse side of the sketch is an extensive explanation of the diagram. (i) "A.A.A.": The Copper Mountain(s) explored by Simon van der Stel in October, 1685. (ii) "H.V.R.": "A mountain consisting entirely of copper ore from top to bottom." (iii) "St M.": Another significant "mountain of ore" and part of the same vein outcropping at H.V.R. (iv) "S.V.S.": Abbreviation for Simon van der Stel, the High Commander of the expedition. There were equally good exposures of copper ore on this hill. (v) "B.B.B.": Another copper lode (vi) "C": A fountain or spring with continuously flowing water. From Waterhouse (1932).**

Meanwhile the Amaquas informed the Honourable Commander that there was still another mountain about three miles away, coloured with verdigris like the mountains here . . .

Thursday the 25th. At 3.30 in the morning the sergeant left with 10 men for the above-mentioned place. They returned about six o'clock in the evening bringing some stones which showed an efflorescence of the kind already described and they reported further that they had found the mineral in a plain where there was no water. . . . The Honourable Commander was still busy with a few men inspecting the mountains in various places and he found the mineral to be one and the same wherever he went.

Friday the 26th. The Honourable Commander began to build the testing and smelting furnaces, which occupied him the whole day . . .

Saturday the 27th. At ten o'clock the miners, seeing that they were now clear of loose stones, began to bore and fired the first charge, which was very successful, disclosing particularly good mineral . . .


Dagh Register
gehouden op de voiagie,
gedaen naer der Amacqua
Land onder 't beleyt
vanden E. Heer Simon
vander Stel, Commandeur
van Caap de Goede Hoop
&c.

A° 1685

Augusty

Saturdagh den 25 d° 's morgens ten 10 uuren sijn w

Figure 7. **The first page of the 1685 diary of Simon van der Stel. The text describes the departure from the Cape on August 25th and lists the number of people in the party and their provisions. From Waterhouse (1932).**

Figure 8. **The site of the original exploration excavations made by Simon van der Stel in 1685 on the slope of the central hill. The adit is now a National Monument and protected by steel palisade fencing. The dumps (left) are from the modern mining era. Bruce Cairncross photograph.**

Sunday the 28th. At daybreak the Honourable Commander, with the foreman miner and a few others, rode out to inspect the mountains that extend to the east and found that they continued for several miles, showing veins of mineral with an outcrop of verdigris. Meanwhile the miners were still hard at work.

Monday the 29th. About midday the miners fired two more charges, disclosing excellent mineral.

Tuesday the 30th. The Honourable Commander went to visit the workings and found them satisfactory . . .

Wednesday the 31st. Work at the mines was continued and the Honourable Commander intended to make decisive tests, but as the facilities here were inadequate, this matter was postponed until the return to the Cape of Good Hope.

Thursday the 1st (November). The miners had bored to about the height of two men in one place and not quite so deep in another, and they found that the mineral became better and better.

Friday the 2nd. The Honourable Commander climbed the mountain which lay west of us and resolved as he had determined to depart very soon, to start work on it for a day or two, to see how it would turn out, because a vein of at least two fathoms in breadth was visible here. Meanwhile, in the other two mines they were very busy blasting, in order to loosen some ore, which the Honourable Commander intended to take away with him.

Saturday the 3rd. The miners began work on the above-mentioned vein and found that it looked remarkably promising. No work was done on the other shafts this day.

Sunday the 4th. Preparations were completed for our departure to the coast the next day. In the meantime, the men were still busy excavating the above-mentioned vein to a greater depth and carrying down specimens to take away.

Monday the 5th. At 6.30 in the morning, in misty weather, we left the Copper Mountains by the same route we had used in our approach. . . .

In addition to van der Stel's official diary entries recording the discovery and excavation, a second written document is known which is probably the first report ever written by a mining person on a "mining venture" in South Africa. The original document, written by Friederich Mathias von Werlinghof, is filed in the State Archives in Cape Town; Waterhouse (1953) published a translation, in English, of this Dutch document. A somewhat earlier transcription of this travelog was also translated and published, together with the original Dutch script, by Rogers (1917). The report is dated 18 March, 1686, the year after van der Stel's expedition to Namaqualand. Von Werlinghof, the "foreman miner" referred to by van der Stel in his journal, provides additional descriptions of the excavations (Waterhouse, 1953, p. 11):

> . . . We therefore set out from the Cape of Good Hope on the 25th of August last year, 1685, and crossed the Oliphants River after travelling for about a month. The Honourable Commander and I . . . incessantly and most carefully enquired concerning the nature of the mountains, inspecting them most thoroughly to see if any would yield minerals. . . . We reached the Copper Mountain at last after much hardship and delay and the Honourable Commander and I most carefully, zealously and laboriously investigated all the circumstances. Having examined and selected the most suitable spots, we set about prospecting for minerals, first at a certain place to which the Honourable Commander gave the name H.V.R., where, as we excavated, we found copper ore interspersed

> with solid copper and, sinking the shaft there to three fathoms we found it the deeper the better, the said ores containing good silver, as the samples show. . . . A musket shot away and to one side of this mine the Honourable Commander, on my advice, started a second excavation and there at $1^1/_2$ fathoms we made another trial. We found this place conveniently situated to produce copper and silver of the same sort as above but rather richer both in ores and metals . . . this place was called St M . . .
>
> . . . a third excavation, at one or two musket shots distance on the other side of the first mine, we found here too the mine contained mineral of the same sort as the above . . . this spot was called S.V.S. . . . this whole region is permeated by salt and sulphur, a certain indication that it is rich in minerals, it being definitely established, in the opinion of all expert miners, that all minerals are generated and coagulated by natural heat and these two substances, salt and sulphur. . . . I declare the above to be my report and experience, given the 18th March 1686 at the Castle of Good Hope.

The site at which the Van der Stel party excavated into the copper-stained norite is today a National Monument. It also later became the site of the presently dormant Koperberg Central mine.

After 25 years of exploration involving several expeditions, nothing further was done about developing the copper deposits for 150 years! Although the copper ore yielded high values, van der Stel decided that it was uneconomical to mine copper in the remote Namaqualand area. At the time there was no infrastructure, almost no water, and no suitable harbor facility from which to ship the ore.

***Figure 9.* A 1726 stuiver piece (copper coin) of the Dutch East India Company. This is the reverse side and bears the letters "VOC"—Vereenigde Oos-Indische Compagnie." The obverse side displays the crowned lion of Holland. From Trotter (1903).**

18th Century

An early 18th-century publication by Kolbe (1727) reported on "Hottentots" working metal. In his two volumes titled "Beschryving van De Kaap Goede Hoop" Kolbe mentions the copper ores "a few hundred miles inland, where the copper melts in the sun." He also states that the local Africans knew how to "treat copper" and provides evidence for their metallurgical prowess. The "Hottentots" preferred copper to gold because of the way it shines in the sun; apparently they did not value gold and silver at all because they had no use for money!

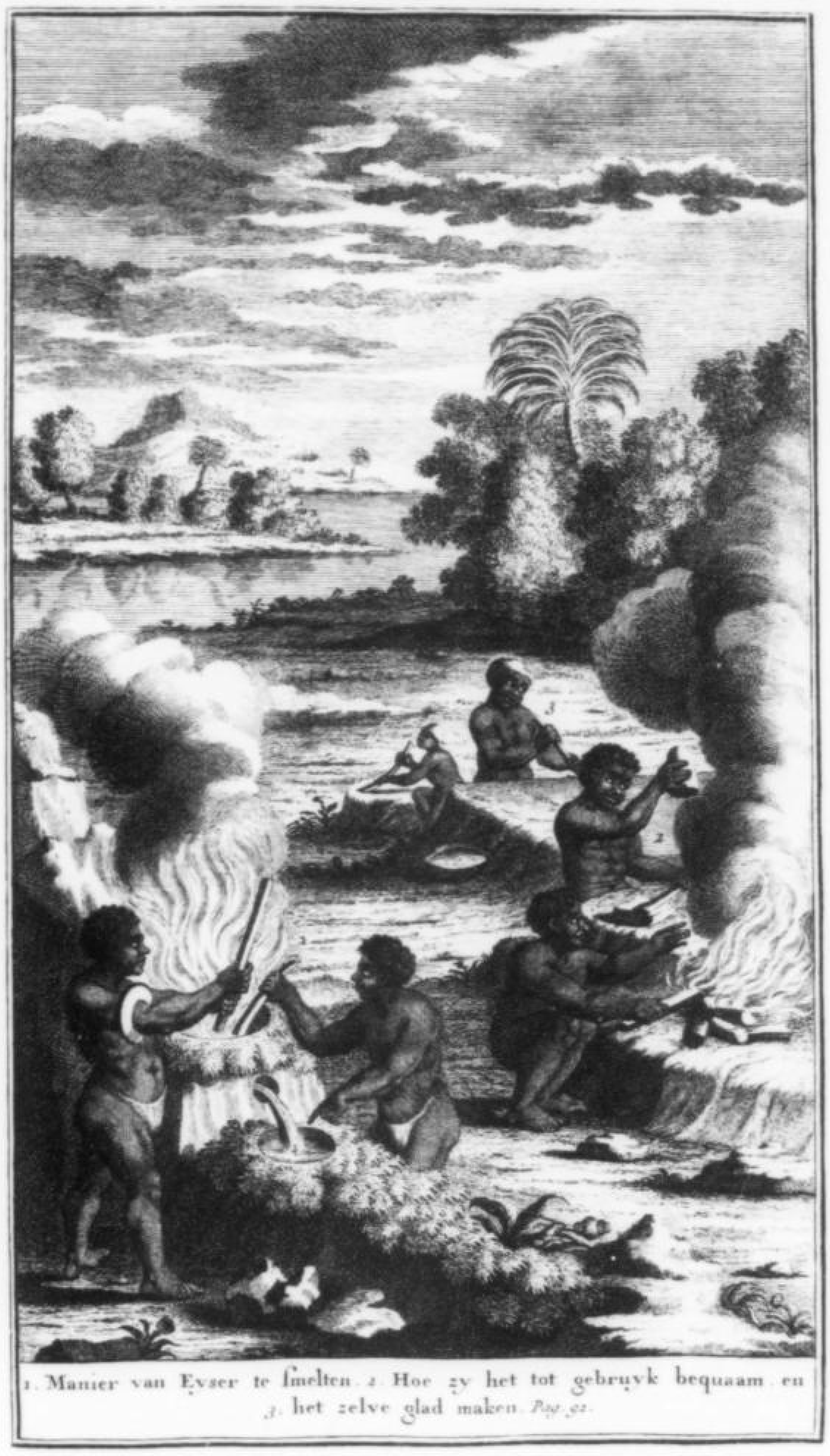


***Figure 10.* "Hottentots" processing iron ore in the 18th Century. The captions reads: 1. Manner of smelting the iron. 2. Converting it for usage. 3. Making it "smooth." From Kolbe (1727).**

A little more than 100 years after van der Stel's expedition, several other European explorers trekked to and through Namaqualand and the adjacent regions. Most made mention of the copper deposits, but still no development took place. These expeditions were more focussed on zoological, botanical and ethnological observations. One of the first documented trips was by Colonel Gordon in 1777; he was followed by Lieutenant Patterson in 1778, Le Valliant in 1781 (Le Valliant, 1791), and, during the next century, Thompson in 1827. In one of Gordon's later travels to the copper deposits, in 1779, he and Patterson made some exploratory diggings but these were not succeeded by any significant workings. William Patterson's work, entitled "A Narrative of Four Journeys into the Country of the Hottentots and Caffraria," published in 1789, was the first book in English that described experiences and travel in South Africa (Forbes, 1965).

Patterson was a Scot who had been commissioned by the Countess of Strathmore to travel to South Africa to collect botanical specimens. He later traveled to Australia, where he became Lieutenant-Governor of New South Wales. During late 1778, he visited the present-day site of Springbok, and he records visiting several "mines," although these were merely prospecting pits. He collected ore samples and pronounced them "very rich."

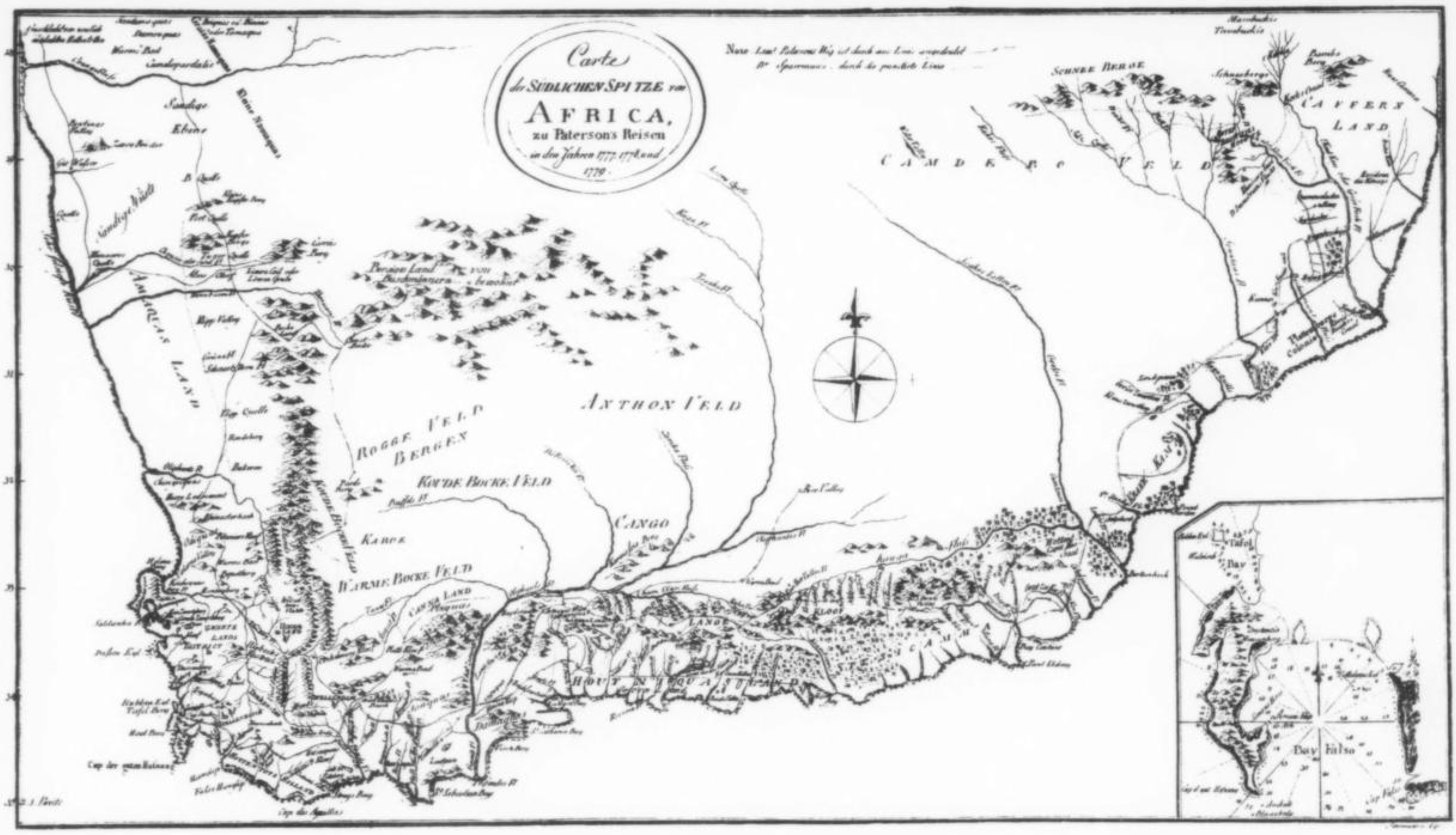


Figure 11. **The route map of the journeys undertaken by William Paterson between 1777 and 1779. The copper fields are illustrated in the northwest section, identified as "Kupferberge" and "Kleine Kupferberge." From Forbes (1965).**

Figure 12. **Late 17th-century map of southern Africa drawn by Balthazar Lakeman. The pentagonal structure illustrated at bottom-left is the Fort at Cape Town, with each of the 5 points (numbered) named after Dutch exploration ships. Source: AFRICA (undated)** ***On maps from the Twelfth to the Eighteenth Century (auf Karten des 12. bis 18. Jahrhundrets*****. (Rand Afrikaans University Rare Books Collection). Edition Leipzig.**

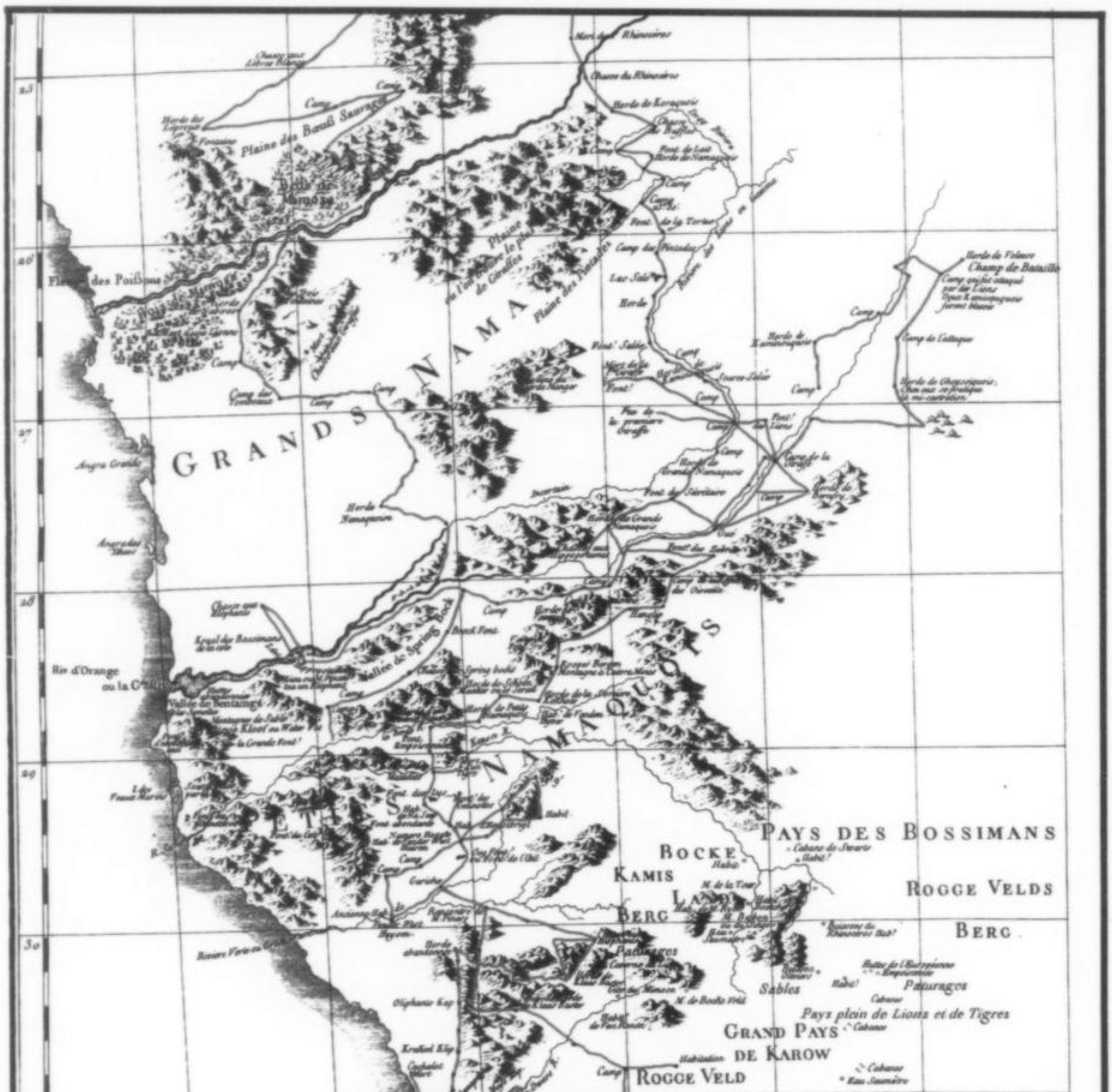


Figure 13. **The route traveled by Le Valliant in 1791. Note the copper deposits are clearly marked as "Kooper Bergen" between latitudes 28° and 29° and longitude 15° and 16°. (From Le Valliant, 1791.)**

Accounts of another late 18th-century journey (Barrow, 1801) contain cursory comments on observations of geology in southern Africa. Although published in the early 1800's, this document recounts Barrow's travels during 1797 and 1798. He makes mention of, amongst other things, "the natural history of such objects as occurred in the animal, vegetable and mineral kingdoms" (quoted from the title page).

19th and 20th Centuries

After Patterson's trek to Springbokfontein, no attempt was made to exploit or further investigate the copper deposits in Namaqualand. Then, in 1837, Captain James Alexander, on his sojourns through the area, located a copper deposit approximately 176 km (80 miles) from the mouth of the Orange River (Alexander, 1838). He sampled some of this ore:

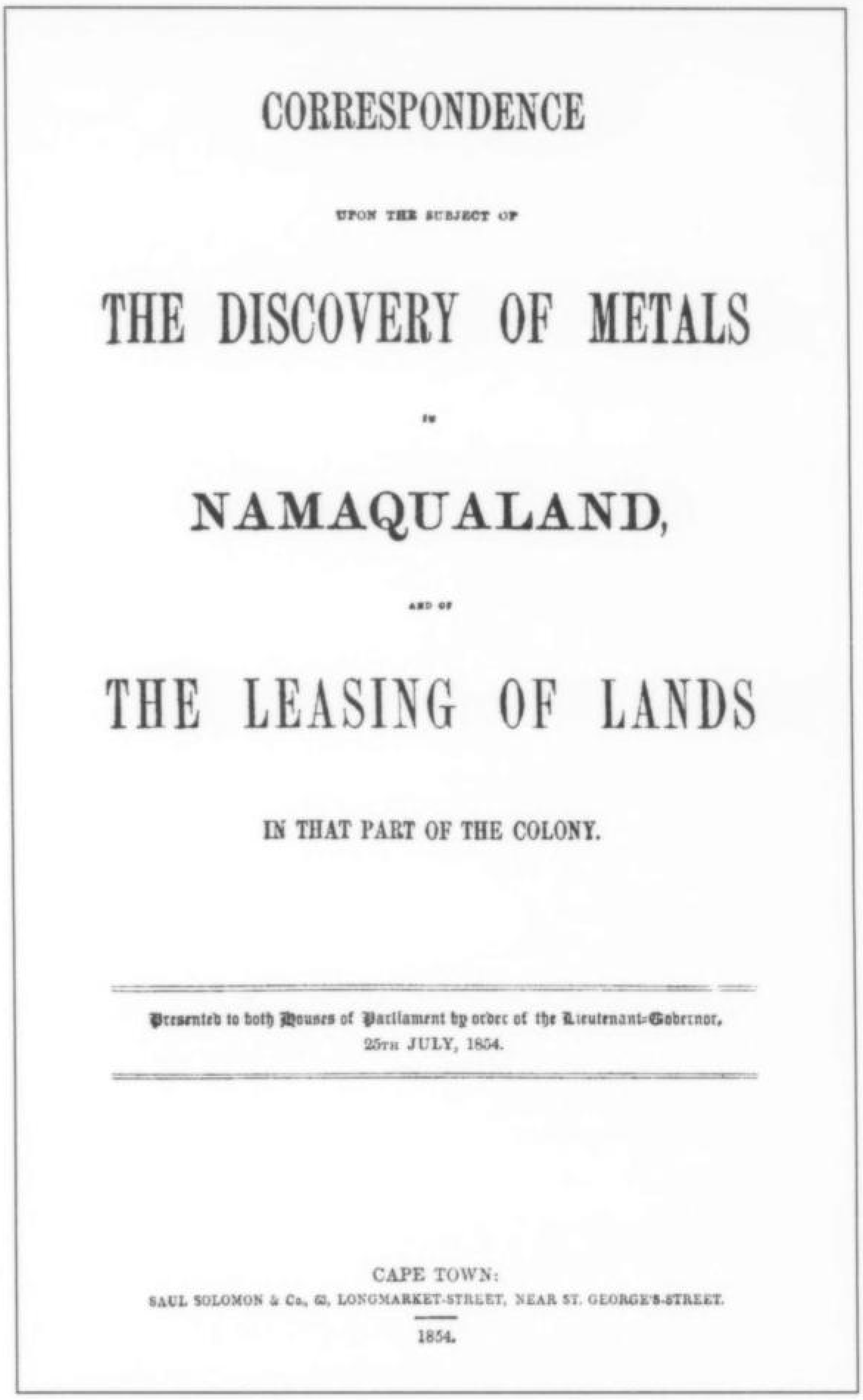
> I brought away a quantity of this ore from the river, which was assayed by Sir John Herschel, at the Cape, and from a picked specimen, sixty-five per cent. of metal was the return; another specimen, taken at random from the others, yielded twenty-eight per cent. in London. Now the richest of the South American mines yield only twenty-five. In consequence of the discovery of this accessible Orange river copper (and there is also I know rich copper one day's journey north-east of Keerom, within the colony), several men in business in London have communicated with me regarding the establishment of an Orange River copper company. (Alexander, 1838, pages 118–119)

Alexander's samples were in fact passed on to George Thompson, who was to become renowned for his travels in South Africa (Thompson, 1827). Thompson handpicked the best samples and passed them on to Herschel for analyses (Williams, 1948). The material that was assayed in London was taken there by Samuel Bennett, and it was Bennett who later unsuccessfully tried to form a company to work the deposit discovered by Alexander. More unsuccessful attempts to form mining companies were made in 1846 and 1848. It was not until 1852, when the company called Philips & King, of Cape Town, was founded and commenced operations at Sprinbokfontein, that commercial mining began. Philips and King had earlier, in March 1850, purchased the farm Springbokfontein, now known as Springbok, from the Cloete family for £50 (van Zyl, 1967).

The early explorers were followed some years later by other more geologically qualified people, most notably Andrew Bain, E. J. Dunn, Andrew Wyley and Charles Bell.

Andrew Geddes Bain was born in Scotland in 1797 and died in Cape Town on October 20, 1864 (Levin, 1997). Bain became an explorer in southern Africa while working as a saddler in the town of Graaff Reinett. He subsequently became an engineer of note and constructed some of the most impressive roads in the southern Cape mountains, the Bain's Kloof Pass being one of the most highly lauded. During an inspection trip on horseback in June 1854 to Clanwilliam, Bain traveled further on to the town of Springbok in the Namaqualand area. When he returned to Cape Town, he wrote a geological report based on his short visit (Bain, 1854). This publication is historically significant, because it was the first geological report published in South Africa. He later published extensively on geological and paleontological topics and became an acknowledged expert, even though he was completely self-taught.

Another famous 19th-century geologist, **William Guybon Atherstone**, also paid a visit to Namaqualand in 1854. He spent five months traveling in the region and visiting most of the mines: a considerable feat, as there were few towns and fewer watering holes (Rogers, 1937). Atherstone wrote in the *Eastern Province Monthly Magazine* (1857) about his travels. He also produced a geological map of the Namaqualand copper region and mistakenly indicated the hills as being the same formations as those that form Table Mountain at Cape Town. Atherstone was one of the first to notice the presence of molybdenite at the Concordia mine.



CORRESPONDENCE

UPON THE SUBJECT OF

THE DISCOVERY OF METALS

IN

NAMAQUALAND,

AND OF

THE LEASING OF LANDS

IN THAT PART OF THE COLONY.

Presented to both Houses of Parliament by order of the Lieutenant-Governor,
25TH JULY, 1854.

CAPE TOWN:
SAUL SOLOMON & Co., 63, LONGMARKET-STREET, NEAR ST. GEORGE'S-STREET.
1854.

Figure 14. **A copy of the title page of the 1854 Cape of Good Hope Parliamentary report containing A.G. Bain's report on his trip to Namaqualand. This is the first geological report published in South Africa. (From Bain, 1854.)**

Charles D. Bell was the Surveyor General in the Cape Colony during the mid-19th Century. By his own admission, he was not a geologist or mineralogist (Bell, 1855); nonetheless he published a report on his three-month visit to the copper fields of Namaqualand, one year after Bain's pioneering report. This report is rather verbose and contains much detail on the local population, climate, physical features and other details. Even so, Bell describes several of the mines, and reports his meeting with some of the Cornish miners:

> I have conversed with the sanguine, the doubtful and the despondent; also with the Cornish miners, who have left me in

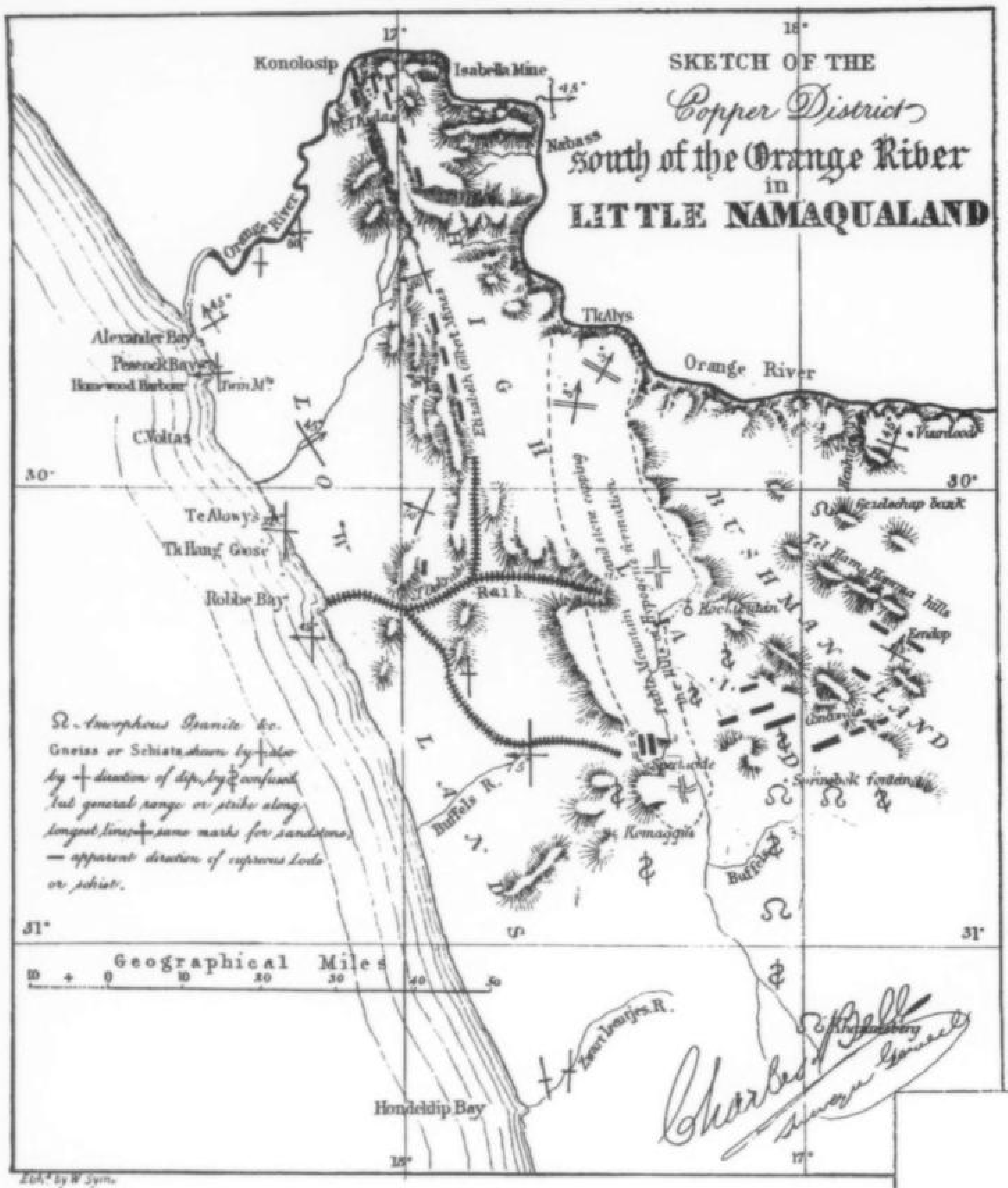


Figure 15. **C. D. Bell's 1855 map of the Okiep (Namaqualand) copper district, autographed by Bell. Springbokfontein and Specktackle [*sic*] appear in the southeast portion. (From Bell, 1855.)**

Figure 16. **A sketch of the mines drawn by C. D. Bell. This illustrates the general granite-gneiss terrain and the steeply dipping orebodies. (From Bell, 1855.)**

> difficulty as to whether I should consider them in the second or first-mentioned class. I am confident that none of them are in the third. (Bell, 1855, page 18)

Bell also collected 54 samples of rock and copper ore from mines such as Concordia, Hester Maria and Wheal Julia. These included bornite, feldspar, hornblende, horseflesh (?) ore, malachite and gray ore. Perhaps of more interest, Bell included a map and sketches of mines he visited. He was an artist of note, and the sketches accurately show the typical scenery of the area. Apart from his geological and artistic prowess, Bell also became famous amongst philatelists because he designed the well-known "Cape Triangular" stamps that are much sought after today (Simons, 1998).

Andrew Wyley was a geologist originally from the Geological Survey of Ireland who arrived at Cape Town in 1854 (Rogers, 1937). Wyley's main contributions to the development of the Namaqualand copper deposits are two publications that appeared as reports laid before Parliament (Wyley, 1856 and 1857). These articles were never widely read because they were printed in somewhat obscure publications and not in the scientific journals of the day. But of all the reports up to that time, Wyley's were by far the most detailed and accurate regarding the mineralogy and the geology of the Namaqualand copper deposits. He lists every mine and prospect and gives as detailed a description as each warrants, sometimes referring to well-crystallized minerals and suites of ore minerals. For example, he described ruby copper (cuprite) and dioptase ("green silicate of copper") from Hester Maria and Tweifontein-129; large crystals of quartz from Rate Kraal-180; molybdenite from Hester Maria and No. 6; epidote from Missionary Drift "forming large and fine crystals in the quartz veins"

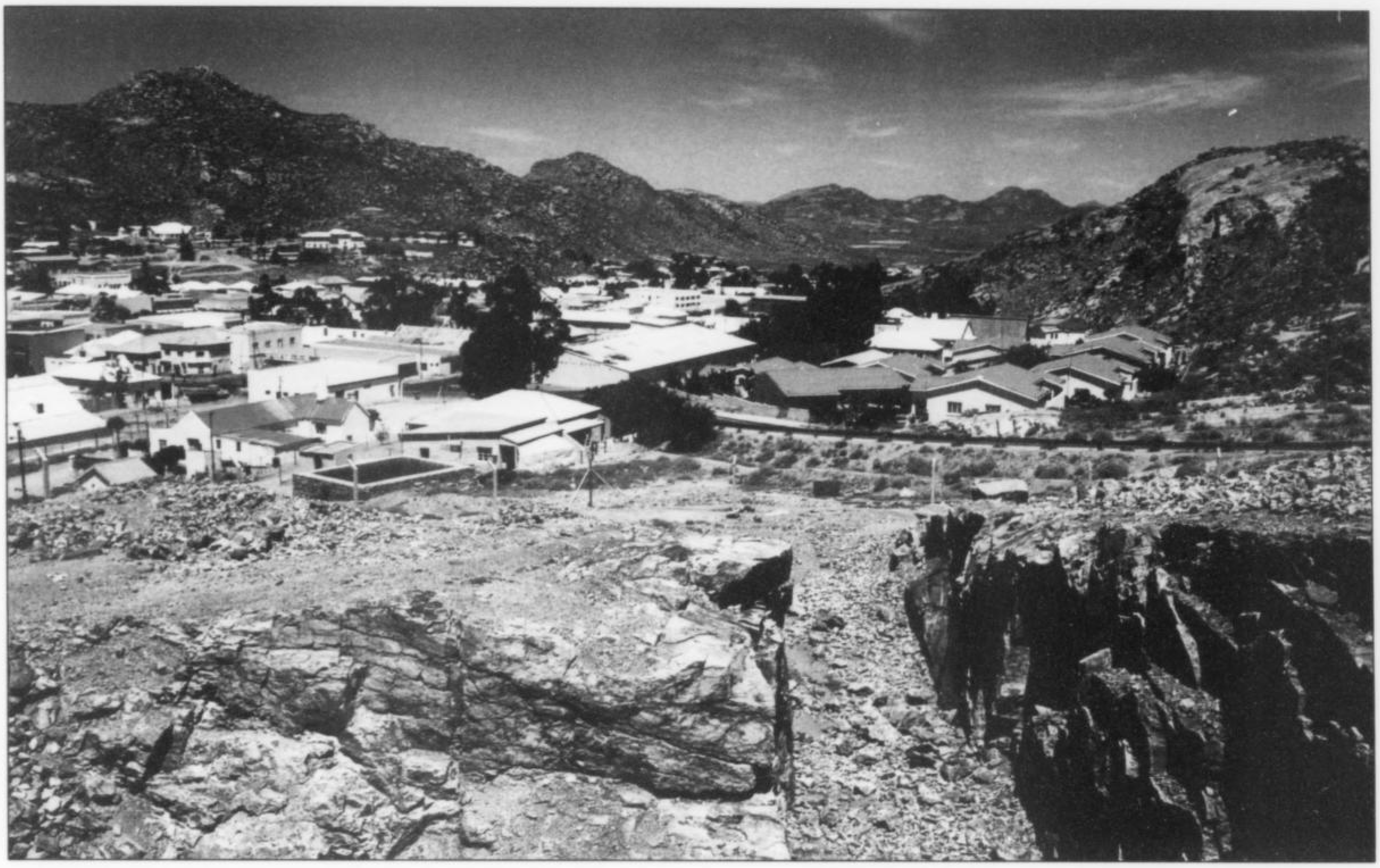


***Figure 17.* A view of the town of Springbok viewed from the old Blue mine that overlooks the town. This was the first mine to be commercially exploited in the district and was opened in 1852. Bruce Cairncross photograph, 1993.**

***Table 1.* Copper Mines and Copper Prospects in 1857 as listed and described by Wyley (1857).**

'Abiekop
Application 440
Application 851
Application 845
Application 770
Application 771
Application 773
Application 774
Application 991
Arribies
Arribies-188
Bell Mine
Brandkloof-184
Byzondermeid
Chabeeses
Concordia
Eendoorn
Eendop-163
Eenriet-153
Ezelsfontein
Fanning's Mine-20
Fielding's Mine
Gonnakuriep
Hartebest Fontein-121
Henkries Flat
Hester Maria-13
Hester Maria-(Flat)
Honey Mine
Isabella Mine
Karap-I30 Tatap
Kilduncan-214
'Kodas-9
Konolosiep
Missionary Drift
Nababeep
New Burra Burra-6
No. 6
No. 51
No. 852
Numees
'Ookiep
Rate Kraal-180
Reitberg
Sand Hoogte
Schaap River
Spektaakle [*sic*] No. 1
Springbokfontein
Stinkfontein Centres
Tweifontein [*sic*]-129
Waaipoort-111 & 112
Wheal Alfred-191
Wheal Georgina-12
Wheal Julia-10
Witte Oog
v Windhoek-249
Zwartput-156

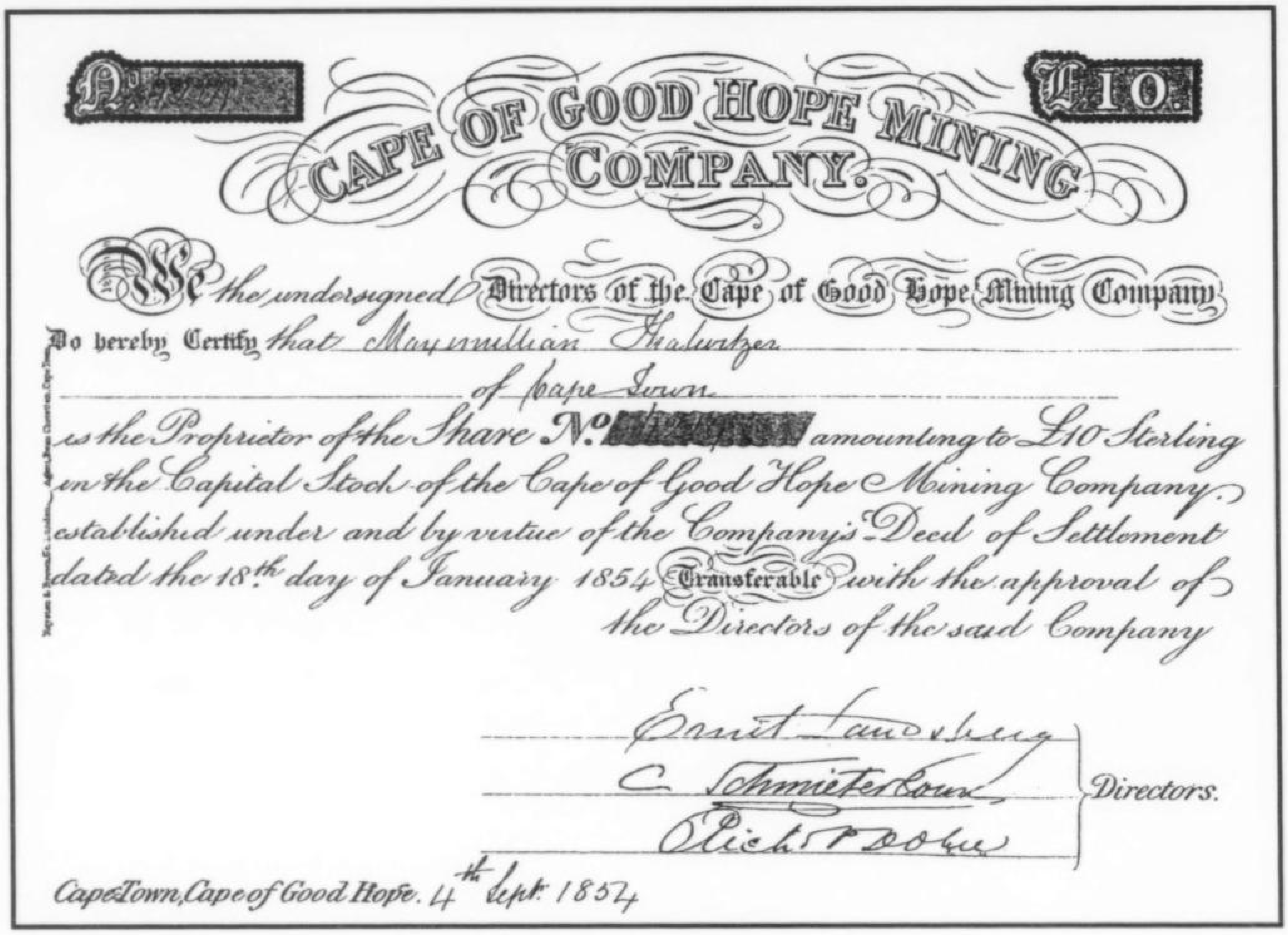
(Wyley, 1857, page 23); fine garnets "one inch in diameter" from Application 774; and specular iron "forming handsome specimens."

In a biography of Wyley (Rogers, 1937) it is stated that Wyley sent ore samples to the Geological Museum of the British Survey in South Kensington, London:

> In the Geological Museum of the British Survey at South Kensington, the copper ores of Namaqualand are illustrated by specimens taken home by Wyley, and some are of particular interest because they come from near the outcrop at places such as Spektakel and Kodas, where the outcrops have been removed by mining. (Rogers, 1937, page 62)

As part of the current study an attempt was made to trace these samples and any accompanying labels or documentation. The search proved interesting. The Museum of the British Geology Survey (BGS), formerly known as the "Museum of Practical Geology incorporating the Geological Survey of Great Britain," was transferred to the Natural History Museum in the 1980's (Stuart Hollyer, personal communication, September 1999). The latter museum has an "economic" collection which today still contains the Wyley samples (Alan Hart, personal communication, October 1999). It appears that these may be the only preserved historical specimens of copper ore from the early pioneer days.

A similar but unsuccessful search was made in South Africa to try to locate any other historical ore samples that were collected either by the Dutch expeditions or by the early to mid-19th Century Cape Colony geologists. The historical records clearly state that



No [illegible]

£10.

CAPE OF GOOD HOPE MINING COMPANY.

We the undersigned Directors of the Cape of Good Hope Mining Company

Do hereby Certify that Maxmillian Thalwitzer

of Cape Town

is the Proprietor of the Share No. [redacted] amounting to £10 Sterling in the Capital Stock of the Cape of Good Hope Mining Company. established under and by virtue of the Company's Deed of Settlement dated the 18th day of January 1854 Transferable with the approval of the Directors of the said Company

Ernst Landsberg
C. Schmieterlow
Rich. P. Dobie
Directors.

Cape Town, Cape of Good Hope. 4th Sept. 1854

Figure 18. **One of the oldest known share certificates for a South African mining company, dated 1854.**

samples were collected and returned to Cape Town and that these were accessioned into the national repositories. However, a search of the databases of the South African Museum in Cape Town, the Transvaal Museum in Pretoria and the Museum Africa collection proved fruitless.

From October 1871 until February 1872, **E. J. Dunn** traveled through Namaqualand on behalf of the Cape Government, and the results of this tour were promptly published (Dunn, 1872). His report describes a few insignificant deposits of gold as well as the copper mines and their ores. The mines that were operating when Dunn visited the area were the Okiep, Spektakel, Springbok and Concordia. Like Atherstone, Dunn claimed that the rocks were the same as those noted at Table Mountain on his 1887 geological map of South Africa. Wyley, however, noted that no fossils occurred in the rocks of Table Mountain, and none could be found in the rocks outcropping around Springbok.

Serious exploitation of the copper deposits only commenced in 1852, with the opening of the Blue mine on the outskirts of Springbok. Initially, numerous small companies were active. Phillips & King were the first mine operators in the district, working the Springbokfontein deposit. This company also owned the Spektakle [*sic*], Nababeep and Okiep mines (Wyley, 1857). Eventually the Cape Copper Company took over and managed the Nababeep, Okiep, and Spektakel mines, while the Namaqua Copper Company worked in the Concordia area, northeast of Okiep (Williams, 1948). Production by the Cape Copper Company ceased in 1919 as a result of the post-war economic slump, and the Namaqua Copper Company closed its mines in 1931. The O'okiep Copper Company Limited was formed in 1937, and by 1939 it had acquired the assets of both the Cape Copper Company and the Namaqua Copper Company.

Total production from the district before the take-over by the O'okiep Copper Company amounted to approximately 2.2 million tonnes of sorted ore and concentrates at an average grade of 14% copper. The main contributors were the Okiep Mine (907,000 tonnes at 21% copper), Nababeep South (816,000 tonnes at 5.5% copper) and Tweefontein (at least 139,000 tonnes at 25% copper).

During the early years of mining activity, owing to the occurrence of rich ore in large tonnages, only high-grade ore was exported for smelting in England. After some years, local partial pyritic smelting with Welsh coke was introduced, and for many years a matte of about 50% copper was the principal product of the district. This was shipped to England for further smelting and refining. A noteworthy feature of the copper from Namaqualand was its lack of impurities. The fines were treated by sintering and briquetting. In later years the Namaqualand Copper Co. installed an Elmore flotation plant at Concordia. Leaching of copper from tailings dumps, from oxide ore, and from material unsuitable for smelting or treatment by the Elmore plant was also carried out successfully (Cairncross and Dixon, 1995).

Ore reserves totaled 9 million tonnes at 2.45% copper when the O'okiep Copper Company commenced production in 1937. This ore was blocked out in three mines, at Nababeep, Okiep, and Narrap. To date, 18 new mines, with individual reserves ranging from 200,000 tonnes to 37 million tons, have been discovered, amounting in total to approximately 100 million tonnes of ore. Of the 27 mines that were operated by the O'okiep Copper Company since 1937, only two, the Carolusberg and Nigramoep mines, continued operating until the late 1990's. Carolusberg finally closed in 1998. The O'okiep Copper Company was managed by Gold Fields of South Africa Ltd. until being bought out by Metorex (Pty) Ltd.

Figure 19. **The abandoned mine offices and headgear at the Jan Coetzee mine. The Rooiberg Granite forms the "koppies" (hills) in the background. Bruce Cairncross photograph, 1993.**

PRINCIPAL MINES IN THE DISTRICT

As noted over 140 years ago in Wyley's (1857) report, dozens of copper deposits had been discovered by the middle of the 19th Century. Many of these were small and soon mined out, while others were never exploited at all, being too small and/or too low-grade. Some of the more important ones that did produce ore (and mineral specimens) are briefly described below. Many specimens from the Okiep mines are in the collections of the Museum of the Council for Geoscience in Pretoria and in the Johannesburg Geological Museum. Unfortunately, most labels merely list "Okiep copper mines" as the locality, not noting the specific mine. The Nababeep West mine is an exception, as is the Jan Coetzee mine, although the latter is well-known and fairly well documented while the former is unknown from a geological, historical and mineralogical standpoint, even within the South African mineral collecting fraternity.

Hoits mine

The Hoits mine was prospected in 1907 with the sinking of a preliminary shaft to a depth of 31 meters. The orebody was only discovered, however, when the geophysical team, after ground magnetic and gravity surveys of the largely sand-covered area, directed the drilling. Geological mapping and prospecting was conducted in the 1950's and 1960's, and production was started in 1975. At the end of 1993, ore produced and ore in reserve totaled 4.6 million tonnes at 1.74% copper.

Homeep East mine

Small-scale mining at the Homeep East mine was carried out intermittently from as early as 1854 through to 1931. The maximum depth attained by the workings in this period was about 80 meters. The O'okiep Copper Company explored Homeep East by surface diamond drilling in 1950 and again from 1967 to 1973, and an ore reserve of 895,930 tonnes at 1.27% copper was proven. The bottom of this ore body was located at 150 meters below the surface. Production commenced in April 1974, and mining was discontinued in March 1976 after exhaustion of the ore above the 320 level.

Jan Coetzee mine

The Jan Coetzee mine is one of the most famous in the district for mineral specimens, particularly large quartz crystals. It is located about 11 km north of Nababeep. The mine was originally worked as early as 1888, when it was prospected by the Cape Copper Company, but it was abandoned in 1907 (Anonymous, 1968). Three small adits, several prospecting pits and an 80-meter-deep shaft were opened between 1888 and 1894. Some isolated orebodies were discovered during these times, but no extractive mining was undertaken, and the prospect was then abandoned in favor of the Flat mine. It was reopened in 1964 by the O'okiep Copper Company when ore reserves of 1.5 million tons were proven, and finally closed in 1971. The mine is located on the Jan Coetzee Fontein farm, which was a portion of the original Nababeep farm. It was known by several names, including Jan Coetzee's

Figure 20. **Another relic from the bygone mining era. An old steam engine stands abandoned at the Narrap mine. Bruce Cairncross photograph, 1993.**

Fontein mine, Jan Coetzee's mine, Kotze's mine and Coetzee's mine. During the relatively short modern life of the small Jan Coetzee mine (1964–1971) it produced 1.89 million tonnes at 1.06% copper.

In 1966 a spectacular quartz crystal pocket was discovered in this mine (von Bezing and Kotze, 1993). Before this, the mine had been rather unremarkable as far as specimen production was concerned. This find remains unique in the district. While tunneling away from the shaft on the 88-meter level, in a southerly direction, one of the miners, a Mr. Kennedy, noticed an area of decomposed rock on the sidewall of the drift. While testing for stability with a crowbar, he broke into a chamber measuring 12 x 12 meters across and some 6 meters high. The floor, walls and roof were covered by thousands of quartz crystals of all sizes. Most of the larger crystals were lying on the floor, partially embedded in a layer of green chlorite 15 cm thick. Smaller second-generation clusters were coating the sidewalls and most of the crystal fragments.

A conservative estimate is that about 50,000 single crystals and clusters amounting to several metric tonnes were removed. The largest crystals measure 180 cm and weigh some 250 kg. Most major private and public collections in South Africa now have examples, and many specimens have reached Europe and the United States. Large crystals have also been used as gate posts in front of a local hotel, others as decorations on graves! The crystals are generally colorless to smoky, with green chlorite preferentially coating only some faces, dulling the luster slightly. On the chlorite-coated faces of most of the crystals and fragments, gray calcite (rounded scalenohedrons) and small (up to 1 cm) prismatic, yellow barite crystals are found: this combination makes specimens from the Jan Coetzee pocket easily identifiable. Minute crystals of chalcopyrite are also common, and these may reach 1 cm in size. Most of the larger quartz crystals are tapering prisms with evidence of basal tectonic fracture and rehealing, resulting in pseudo-doubly terminated crystals. Many of the second-generation quartz crystals are complex and distorted. Calcite, massive and in crystals, was also found. As with so many mineral deposits, the mine is now closed and the pocket is no longer accessible. The dumps are closed to the public and, in any event, do not yield any collectable crystals. Specimens still periodically become available from recycled collections.

Although the Jan Coetzee mine is famous among collectors for its quartz crystals, other specimens of note have also been found here. These include chalcopyrite crystals, purple fluorite octahedrons up to 10 cm on edge, showy calcite specimens, sphalerite and dolomite.

Koperberg-Carolusberg mines

Although the Simon van der Stel expedition dug the first shallow pits in the copper-stained outcrops at Koperberg in 1685, very little work was undertaken in the Koperberg-Carolusberg mines until the O'okiep Copper Company started exploration in 1939. Diamond drilling was concentrated at Carolusberg West, where the west-plunging "A" orebody, the upper part of which was later exploited in an open pit mine, was first included in the Company ore reserves in 1947. The diamond drills first intersected the vertically plunging hypersthenite orebodies in 1957. Further contributions to ore reserves came from discoveries in the 1960's of several small, but some rich, orebodies at Carolusberg Central and of the extensive east-plunging ore zone at Koperberg Central.

The Carolusberg mine is situated some 7 kilometers to the east of Springbok, close to where Simon van der Stel prospected. The mine exploits the largest complex of orebodies found in the copper

Figure 21. **All that remains of the original buildings at the Tweefontein mine, near Concordia—the derelict Cornish-built ore chutes. The opencast mine was located just behind this construction. Bruce Cairncross photograph, 1993.**

district, totalling 37.5 million tonnes at 1.55% Cu.

Attractive surface indications motivated many trials as far back as 1868, but the ore was always found to be too low-grade. Mining started in 1956 with the stripping of the oxide capping from the "A" orebody, which was treated by heap leaching. Mining of this orebody continued by open-cut means until the No. 1 Shaft was sunk in 1961, reaching a final depth of 862 meters. By then the Carolusberg plant, now with a 4,000-tonne-per-day concentrator, was ready to treat the sulfide ore from the lower sections of the "A" orebody and the deeper "C" and "D" orebodies, which were found by persistent tracing of ore stringers.

Sinking of the No. 2 Shaft commenced in December 1979, after the Deep Orebodies had been partially explored from the 759-meter level. Shaft bottom, 1690 meters below surface, was reached in May 1982. Production from No. 2 Shaft commenced in August 1983, and at the same time all stoping from No. 1 Shaft ceased. The

Figure 22. **A sketch of Springbokfontein in 1854, two years after the first copper mine began operations. From the Library of Parliament, Cape Town.**

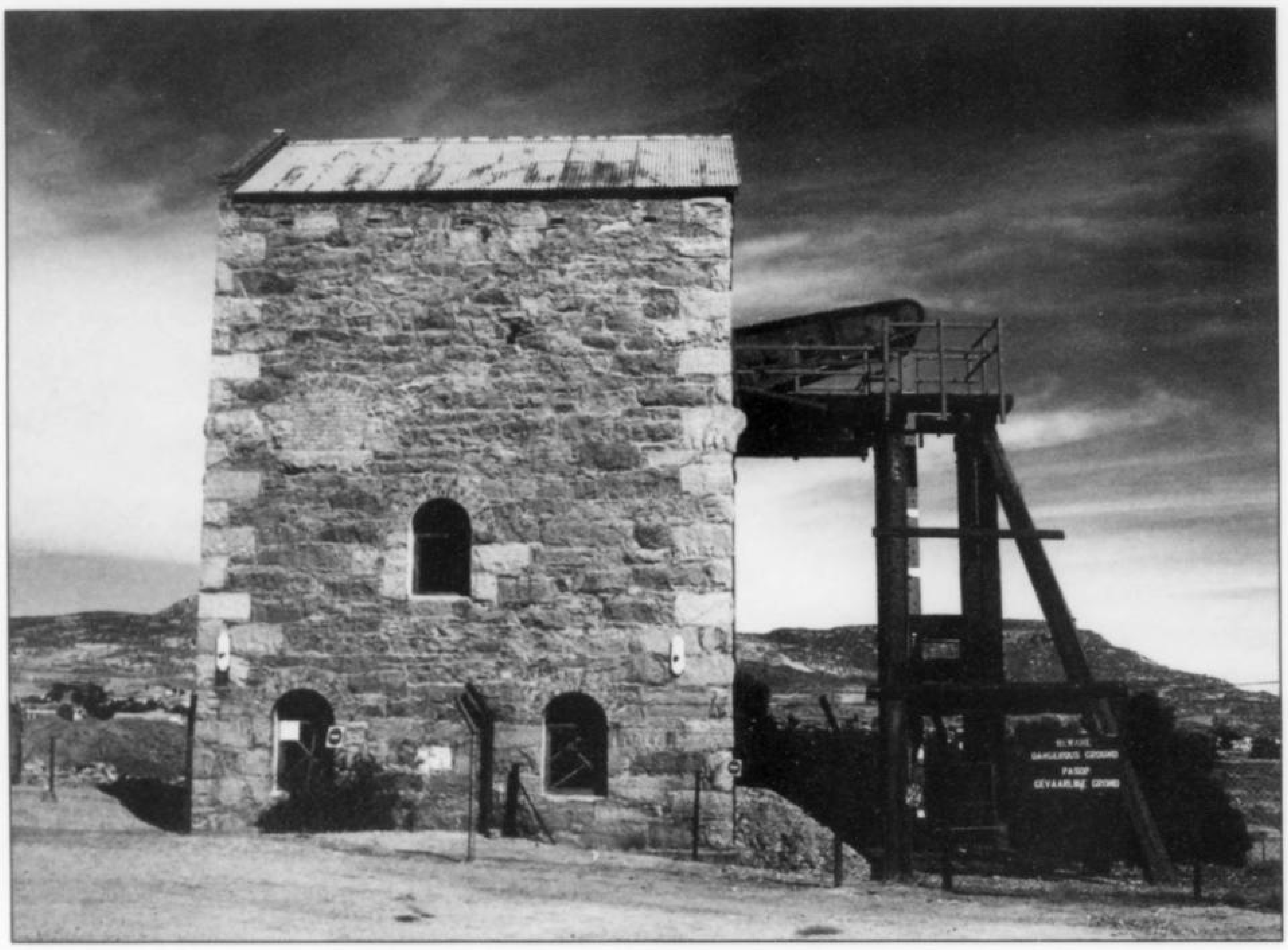


***Figure 23.* The old Cornish beam pump at Okiep. The 50-inch pump was installed in 1882 to dewater the Okiep mine. The Cornish pump is reputed to be the only complete one of this type remaining in the Southern Hemisphere. This building and the single piston pump inside were declared a National Monument in 1978. Bruce Cairncross photograph, 1993.**

Deep Orebodies extend downwards to approximately 1600 meters below the surface.

Okiep mine

The Okiep mine is one of the largest and oldest in the district (Marais, 1987). Pioneer mining started from a mineralized outcrop of an intrusive body of the Koperberg Suite. This was followed a century later by exploitation of ore discovered (at progressively greater depth) by the application of geophysics, supported by systematic mapping and surface and underground diamond drilling. The geological setting of the Okiep mine is of special interest because of the confinement of the deeper part of the copper-bearing intrusive to a steeply dipping pipe of megabreccia.

The Okiep orebody is reported to have outcropped at only one point, in a knoll hardly more than 6 meters across. The surface exposure of mineralized basic rock led into what was later named the West Okiep orebody, in which most of the early mining was carried out. The mining area west of the Main Shaft is alluvium-covered.

The first records of the Okiep mine are dated 1856, when a shaft with a "splendid show of copper" is mentioned. By the end of that year the shaft was 12 meters deep. In 1864 a small engine was erected which operated the pumps and roll crushers, and later a whim engine was installed. In the 1860's Okiep became the most important mine of the Cape Copper Company. By 1873 the mine was 116 meters deep, and large quantities of water had been encountered. A breakdown of the pump caused the lower levels to flood, disrupting operations. This mishap prompted the directors to purchase a 30-inch Cornish pump. By 1882 the mine was at a depth of 208 meters and the 30-inch Cornish pump was proving insufficient to handle the water. A second 50-inch Cornish pump, designed by John Hocking and built by Harveys of Hayle, was therefore obtained. As far as is known, this pump is the only complete Cornish pump remaining in the Southern Hemisphere. Other artifacts of early mining equipment and mining techniques can still be seen at the old mines today.

The Okiep Mine contributed approximately 9.4 million tonnes of ore at 1.95% copper to the reserves of the O'okiep Copper Company.

Spektakel mine

Phillips and King obtained a lease to work Spektakel mine in 1853. Work commenced the next year, and by 1856 three pits had been sunk. Production increased to such an extent that by 1861 Spektakel was producing more tonnage than the O'okiep mine. Two years later, the village at Spektakel was the biggest in Namaqualand. During this same year, the mine began to decline. Work almost came to a halt in 1867 but production resumed in 1868, and in 1869 a mission school was established. This seems to have been the pattern for Spektakel for the rest of its life—boom times followed by threats of closure.

In 1871 there was sufficient population living at Spektakel to warrant the publishing of *The Spektakel Examiner and Times and Namaqualand General Advertiser*. This newspaper was originally

Figure 24. **Miners about to begin their shift at the O'okiep mine ca. 1900. Note the candleholders on the hardhats. Photograph courtesy of the Nababeep Mining Museum.**

Figure 25. **A view looking west toward the Spektakel mine (see locality map) located below Spektakel Pass. The semi-arid landscape and small scrubby vegetation is typical of the region. Bruce Cairncross photograph, 1993.**

handwritten and contained information and news concerning the local conditions at that time.

In 1884 a Cornish pump was erected, operating inclined rods and a horizontal engine for crushing. Final closure of the mine took place in 1901, during the Second Anglo-Boer War. In fact, the last entry in the manager's report reads "Mine abandoned due to marauding Boers"! Reasonable specimens of native copper were found at the Spektakel mine.

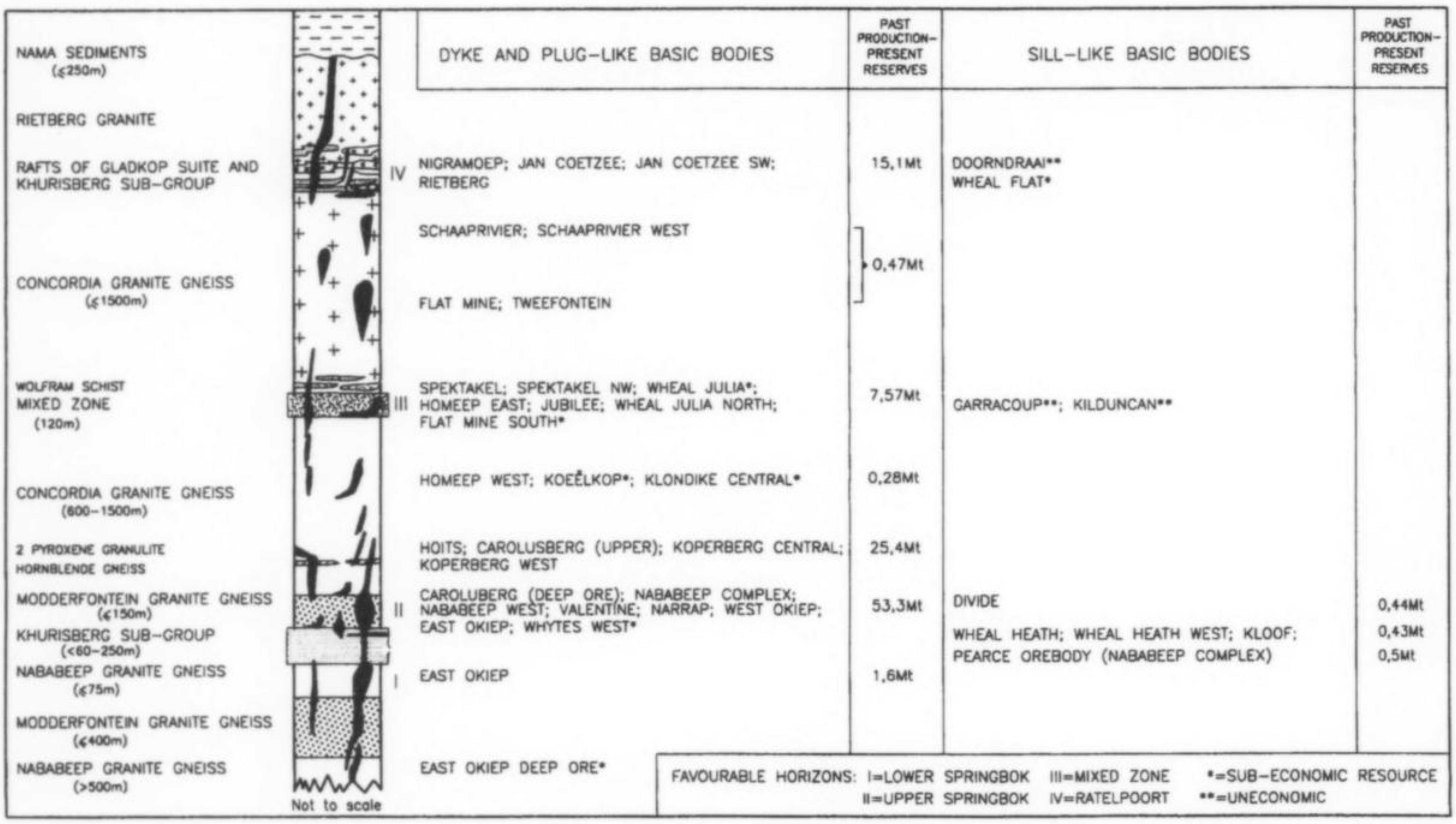


***Figure 26.* A generalized geological column (left) for the Okiep copper district. Note that the copper mineralization occurs at several levels within the sequence. The mines are listed to the right of the geology—the Jan Coetzee mine was located in an orebody at the top of the sequence. From Potgieter (1996).**

GEOLOGY

The Okiep copper district is situated in the Proterozoic Namaqualand Metamorphic Complex (Gibson and Kisters, 1996; Potgieter, 1996). The older, unmineralized rocks have undergone high-grade metamorphism and polyphase deformation and are lithostratigraphically assigned to the Okiep Group and Gladkop Suite (Potgieter, 1996). Several sill-like granites and orthogneisses, the Spektakel Suite and Little Namaqualand Suite, intrude these older gneisses and metavolcanic and metasedimentary rocks. The youngest set of intrusions is a swarm of east-trending mafic to intermediate bodies called the Koperberg Suite, consisting of anorthosite, diorite and norite. It is the mafic rocks that contain the copper mineralization. These rocks are generally irregular, dike-like bodies, usually 60 to 100 meters wide and seldom exceeding 1 kilometer long, which strike to the east and dip steeply to the north. The dike-like bodies are commonly associated with, and structurally controlled by, east-trending structural features referred to as "steep structures" (Kisters *et al.*, 1994). Mineralization occurs as finely disseminated sulfides, coarse-grained sulfides, vein-like aggregates and, locally, massive concentrations (Wilson, 1998). The surface to near-surface expression of the colorful oxidized sulfides that attracted the interest of the early explorers is seldom more than 6 meters deep. In a few instances, basic rocks are also emplaced along breccia bodies referred to as "megabreccias."

The copper content of the Koperberg Suite is erratic and varies from traces to several percent in different parts of the same body and even over very small distances. The distribution, shape and dimensions of copper orebodies within the Koperberg Suite are

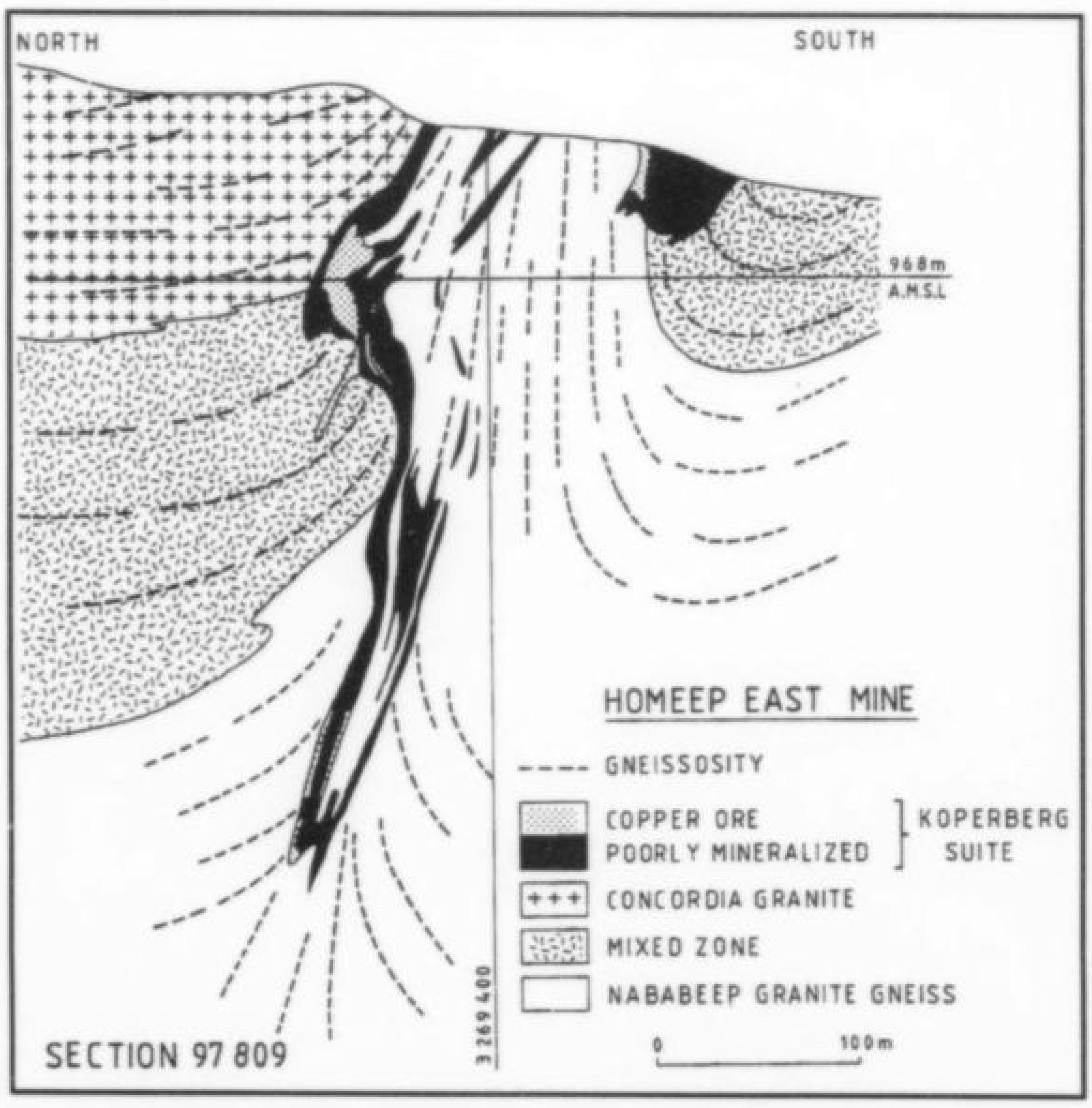


***Figure 27.* Geological cross-section through the Homeep East mine. Note the typical "steep structure" indicated by the dashed lines. From Potgieter (1996).**

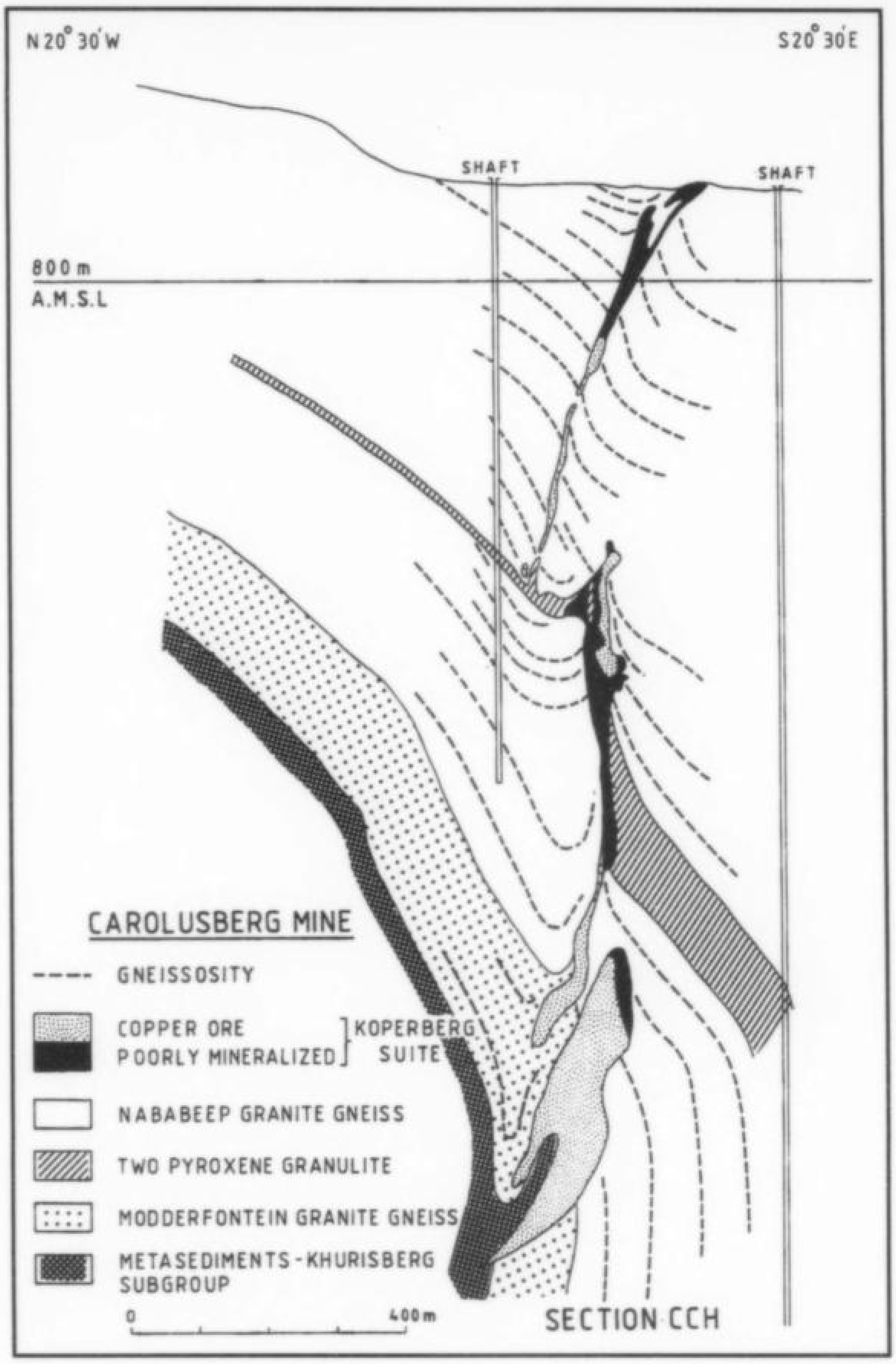


Figure 28. **A geological cross-section through the Carolusberg mine. The eastern shaft extended to depth of about 1500 meters. From Potgieter (1996).**

also extremely variable. Copper sulfides, mainly chalcopyrite, bornite, and subsidiary chalcocite, occur as disseminations to vein-like aggregates. Substantial massive concentrations have formed in a few places. In addition to copper, the Okiep district also has economic deposits of tungsten (Bowles, 1988).

MINERALOGY

The mineralogy of the copper ores from the Okiep mines is relatively simple. **Chalcopyrite** and **bornite** are the most abundant copper-bearing minerals. Where **chalcocite** is encountered, it is usually a product of the alteration of bornite (Lombaard *et al.*, 1986). **Pyrrhotite** is present in some of the deposits, most notably the old East Okiep, Narrap and Wheal Heath mines (van Zyl, 1967). **Magnetite** and **hematite** are generally present and sometimes abundant. Recrystallized hematite forms attractive, shiny rosettes. **Molybdenite** is often seen, and small quantities of **linnaeite**, **millerite**, and **sphalerite** are sometimes present in the ore. The sulfides and magnetite partly replace the silicate minerals. **Anthophyllite** and **tremolite**, both present in small amounts, formed after the primary silicates and ore minerals. The Namaqualand copper ores are also generally found to contain small amounts of gold, recovered by electrolytic refining from the copper produced. In the oxidized zones and in areas of recrystallization on secondary fault plains and cavities, **chalcocite**, **cuprite, tenorite, malachite, azurite, chrysocolla**, and various sulfates replace the original copper sulfides.

Some of the copper mines have produced outstanding mineral

Table 2. **Minerals from the Okiep Copper Mines.**

Allophane	$Al_2SiO_5 \cdot nH_2O$	Hessite	Ag_2Te
Anhydrite	$CaSO_4$	Ilmenite	$Fe^{2+}TiO_3$
Azurite	$Cu_3^{2+}(CO)_3(OH)_2$	Linnaeite	$Co^{2+}Co^{3+}S_4$
Barite*	$BaSO_4$	Mackinawite	Fe_9S_8
Bornite+	Cu_5FeS_4	Magnetite	$Fe^{2+}Fe_2^{3+}O_4$
Brochantite	$Cu_4^{2+}(SO_4)(OH)_6$	Malachite	$Cu_2^{2+}(CO_3)(OH)_2$
Calcite*	$CaCO_3$	Melonite	$NiTe_2$
Chalcanthite	$Cu^{2+}SO_4 \cdot 5H_2O$	Millerite	NiS
Chalcocite*+	Cu_2S	Molybdenite	MoS_2
Chalcopyrite*+	$CuFeS_2$	Orthoclase	$KAlSi_3O_8$
Chrysocolla	$(Cu^{2+},Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$	Pentlandite	$(Fe,Ni)_9S_8$
Coloradoite	$HgTe$	Prehnite	$Ca_2Al_2Si_3O_{10}(OH)_2$
Copper *+	Cu	Pumpellyite-(Fe^{3+})	$Ca_2(Fe^{3+},Mg,Fe^{2+})(Al,Fe^{3+})_2(SiO_4)$- $(SiO_7)(OH)_2 \cdot H_2O$
Covellite	CuS		
Cubanite	$Cu_2Fe_2S_3$	Pyrite	FeS_2
Cuprite	$Cu_2^{1+}O$	Pyrrhotite	$Fe_{1-x}S$
Cyanophyllite	$Cu_5^{2+}Al_2(Sb^{5+}O_4)_3(OH)_7 \cdot 9H_2O$	Rickardite	Cu_7Te_5
Cyanotrichite	$Cu_4^{2+}Al_2(SO_4)(OH)_{12} \cdot 2H_2O$	Quartz*	SiO_2
Epidote*	$Ca_2(Fe^{3+},Al)_3(SiO_4)_3(OH)$	Smithsonite	$ZnCO_3$
Ferro-axinite	$Ca_2Fe^{2+}Al_2BSi_4O_{15}(OH)$	Sphalerite*	$(Zn,Fe)S$
Fluorapatite	$Ca_5(PO_4)_3F$	Spinel	$MgAl_2O_4$
Fluorite*	CaF_2	Stilbite*	$(Na,K,Ca_{0.5})_9[Al_9Si_{27}O_{72}] \cdot 28H_2O$
Galena	PbS	Sylvanite	$(Au,Ag)_2Te_4$
Goethite	α-$Fe^{3+}O(OH)$	Tenorite	$Cu^{2+}O$
Gypsum+	$CaSO_4 \cdot 2H_2O$	Tetradymite	Bi_2Te_2S
Hematite*	α-Fe_2O_3	Valleriite	$4(Fe,Cu)S \cdot 3(Mg,Al)(OH)_2$

+ = Main copper ore minerals * = Found as macro-collectable crystals

Figure 29. **Two large barite crystals partially coated by chlorite and associated with minor quartz, from the Nababeep West mine. The vertically oriented crystal measures 14.5 x 20 cm. Desmond Sacco collection; Bruce Cairncross photograph.**

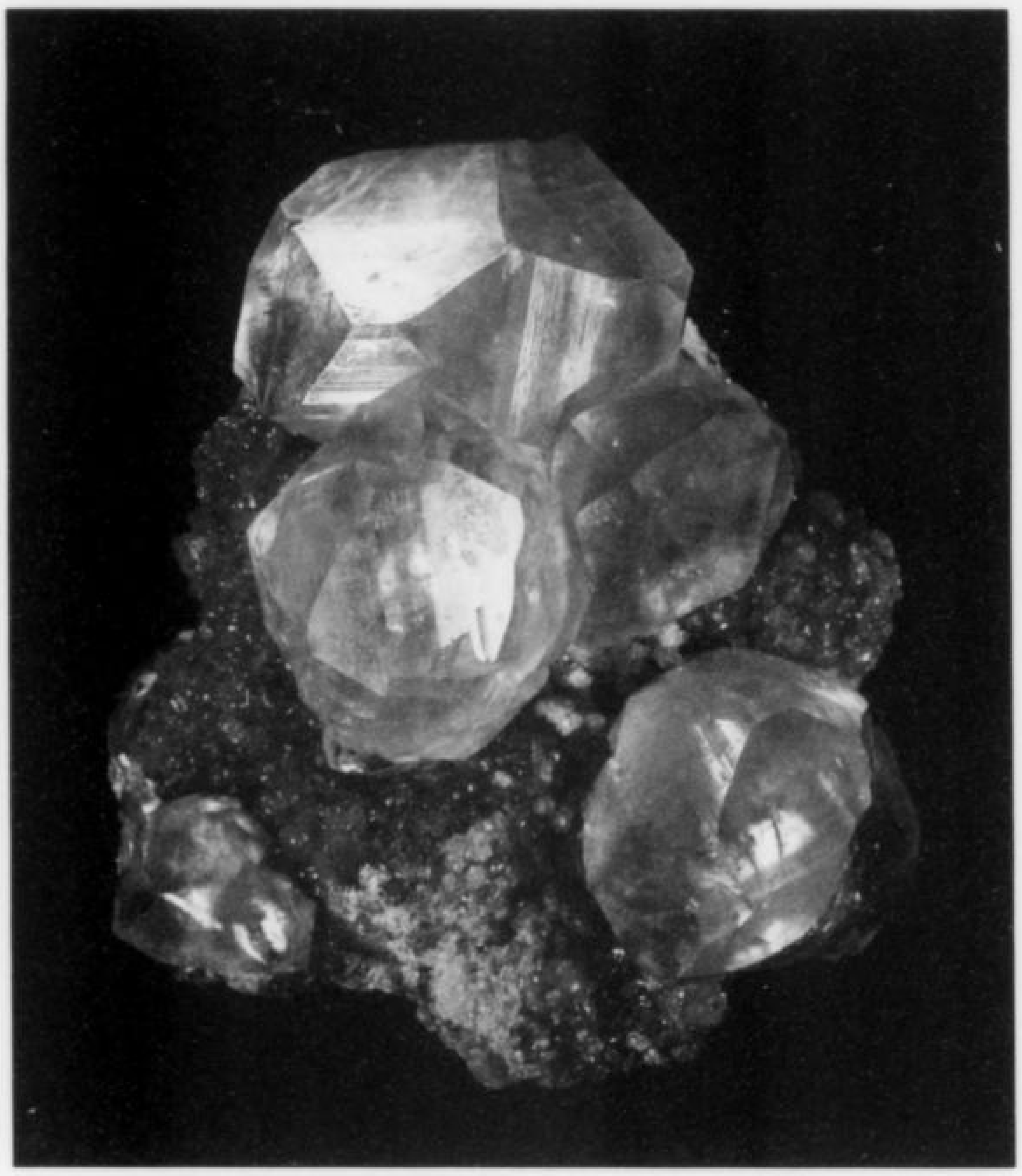


Figure 30. **A cluster of calcite crystals on quartz-coated matrix, 7.2 cm, from the Jan Coetzee mine. Desmond Sacco collection; Bruce Cairncross photograph.**

Figure 31. **A complex 2-cm-diameter calcite crystal on a chlorite-rich matrix from the Jan Coetzee mine. Desmond Sacco collection; Bruce Cairncross photograph.**

Figure 32. **Portion of a large plate of calcite crystals with associated small purple cuboctahedral fluorite crystals from the Jan Coetzee Mine. The largest calcite is 4.2 cm. Nababeep Mining Museum specimen. Bruce Cairncross photograph, 1993.**

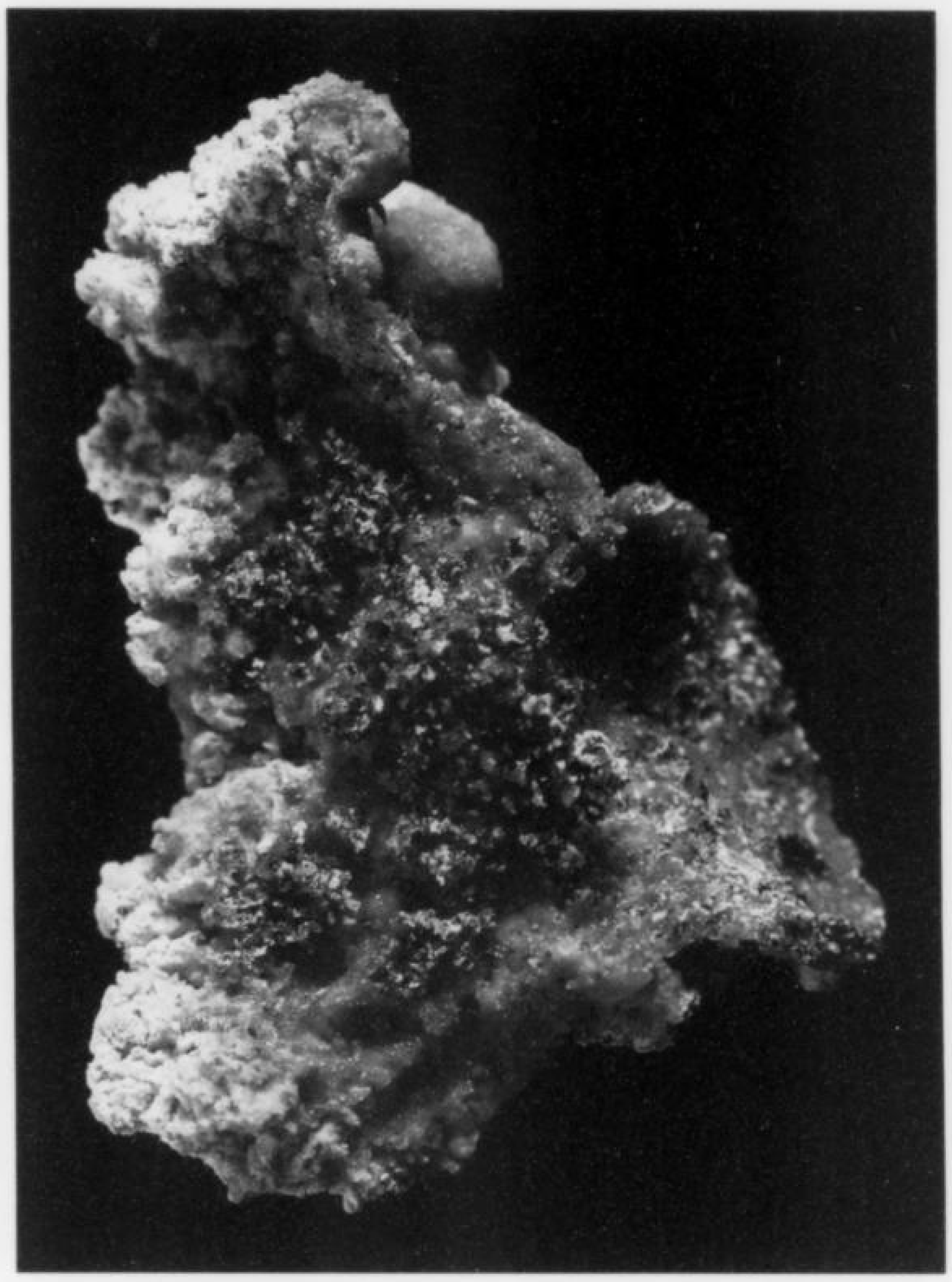


Figure 33. **Chalcanthite, 3.8 cm, collected from present-day surficial sands at the Jubilee mine. Bruce Cairncross specimen and photograph.**

Figure 34. **Group of twinned chalcocite crystals, 7 cm, from the Nababeep West mine; believed to be the best from the Okiep copper district, and one of the finest South African chalcocites. Nababeep Mining Museum specimen; Bruce Cairncross photograph.**

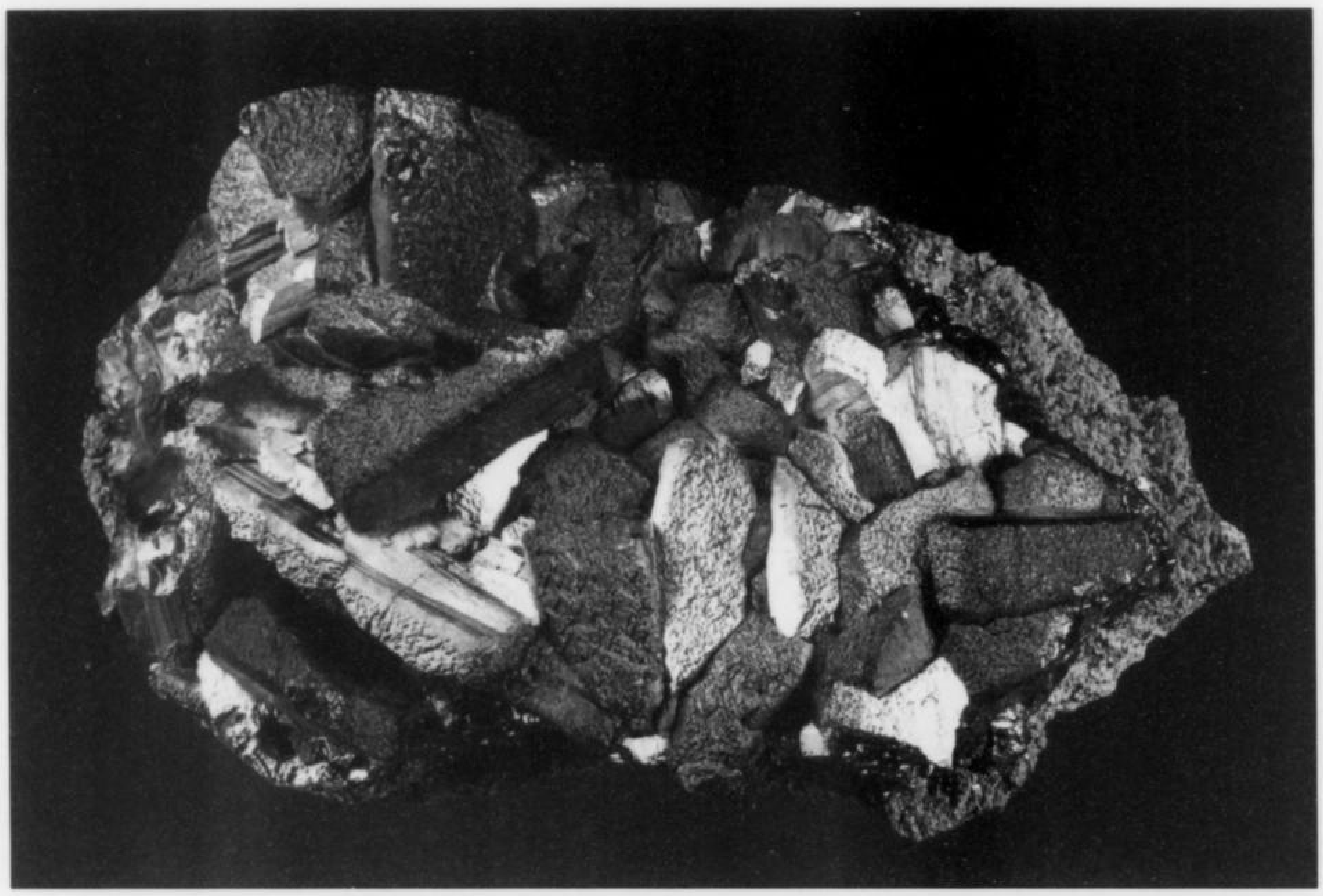


Figure 35. A group of intergrown chalcopyrite crystals on a matrix of granular, chlorite-stained quartz, 12.2 cm, from the Okiep mine. Bruce Cairncross specimen and photograph.

Figure 36. Euhedral calcite crystals on a large chalcopyrite crystal (with small, dark-green epidote crystals on the back), 7.5 cm, from the Jan Coetzee mine. Desmond Sacco collection; Bruce Cairncross photograph.

Figure 37. A 12 x 13-cm dolomite epimorph of calcite, associated with chlorite and quartz, from the Jan Coetzee mine. Desmond Sacco collection; Bruce Cairncross photograph.

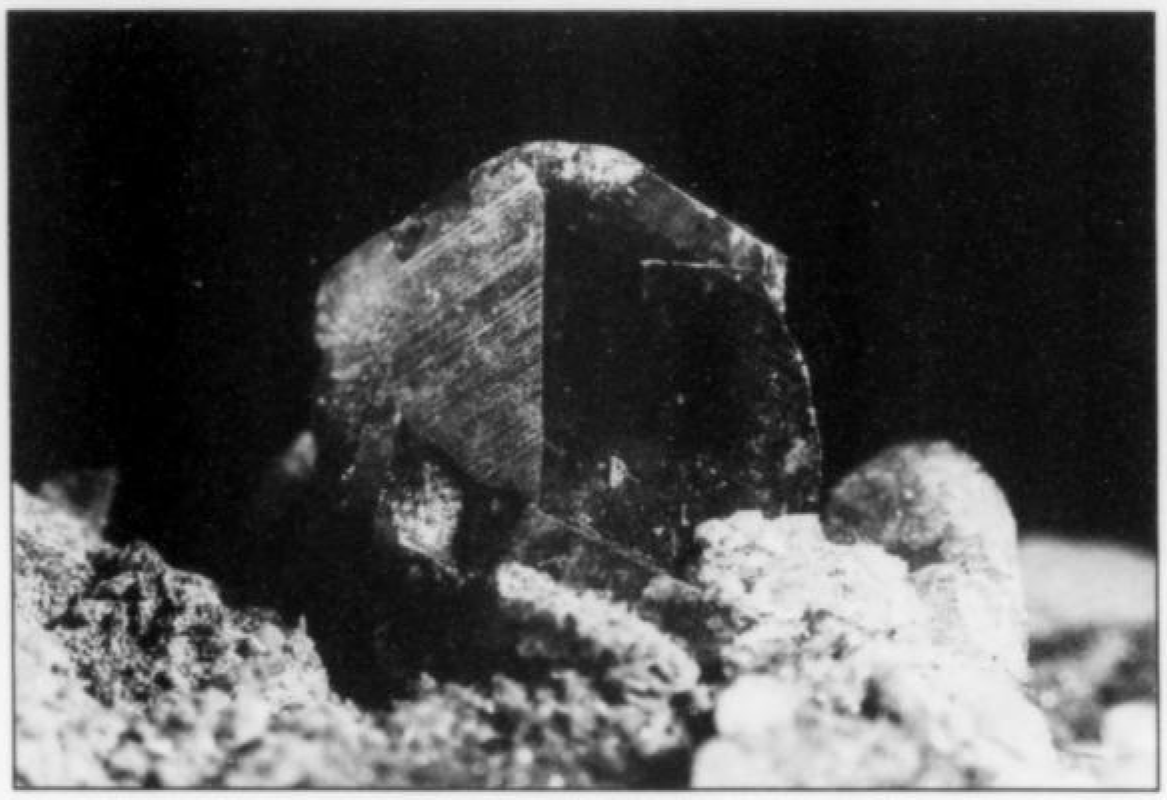


Figure 38. Ferro-axinite crystal, 8 mm, on a matrix of euhedral quartz, purple fluorite microcrystals, and chlorite from the Nababeep West mine. Museum of the Council for Geoscience (Pretoria) specimen #MGS 20405; Bruce Cairncross photograph.

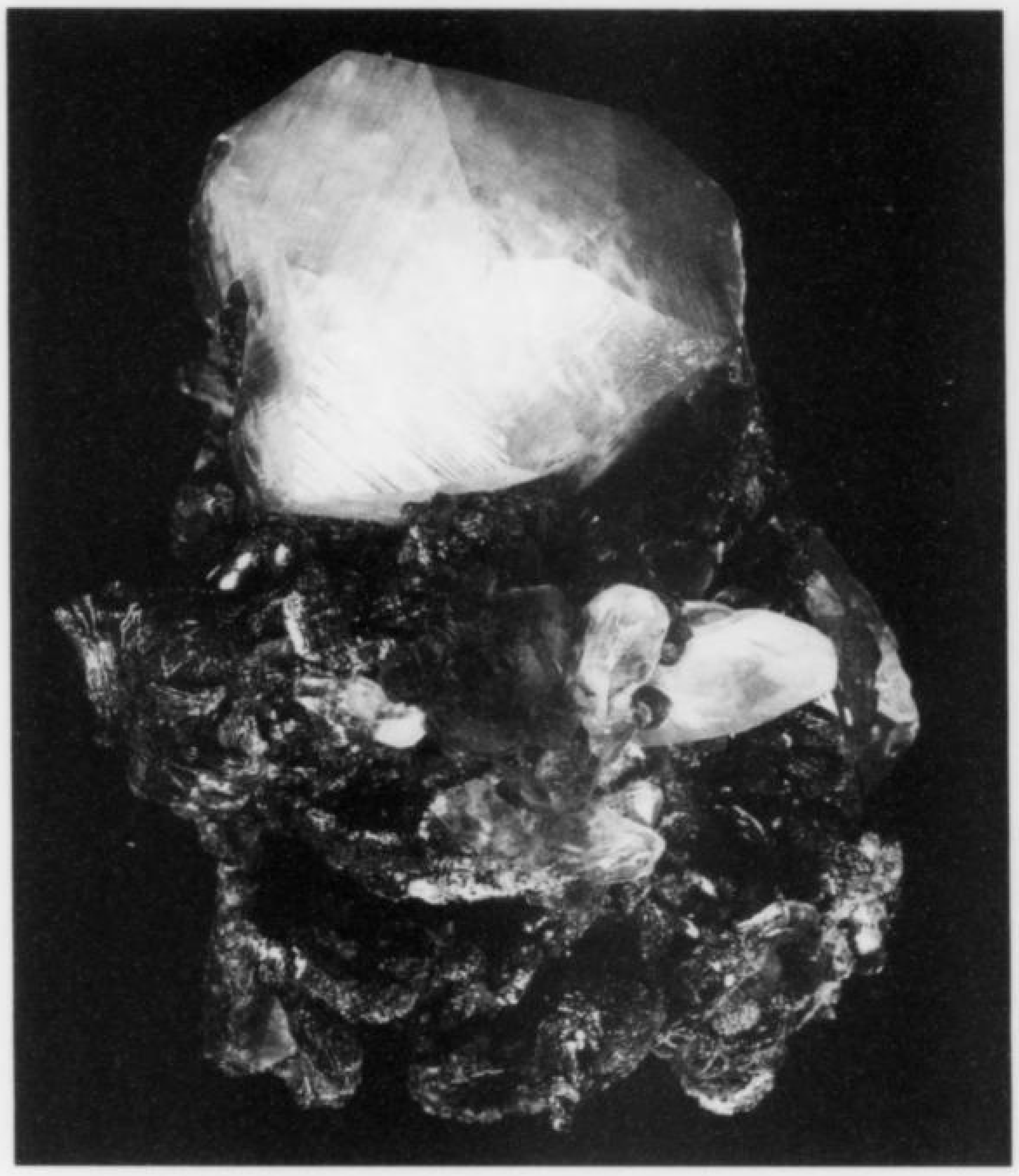


Figure 39. **Calcite, purple fluorite and pyrite on many clusters of hematite rosettes, 7.4 cm, from the Jan Coetzee mine. Bruce Cairncross specimen and photograph.**

Figure 40. **Acicular pumpellyite crystals up to 3 mm, associated with quartz, epidote, hematite and chlorite, from the Nababeep West mine. Museum of the Council for Geoscience (Pretoria) specimen #MGS 14762; Bruce Cairncross photograph.**

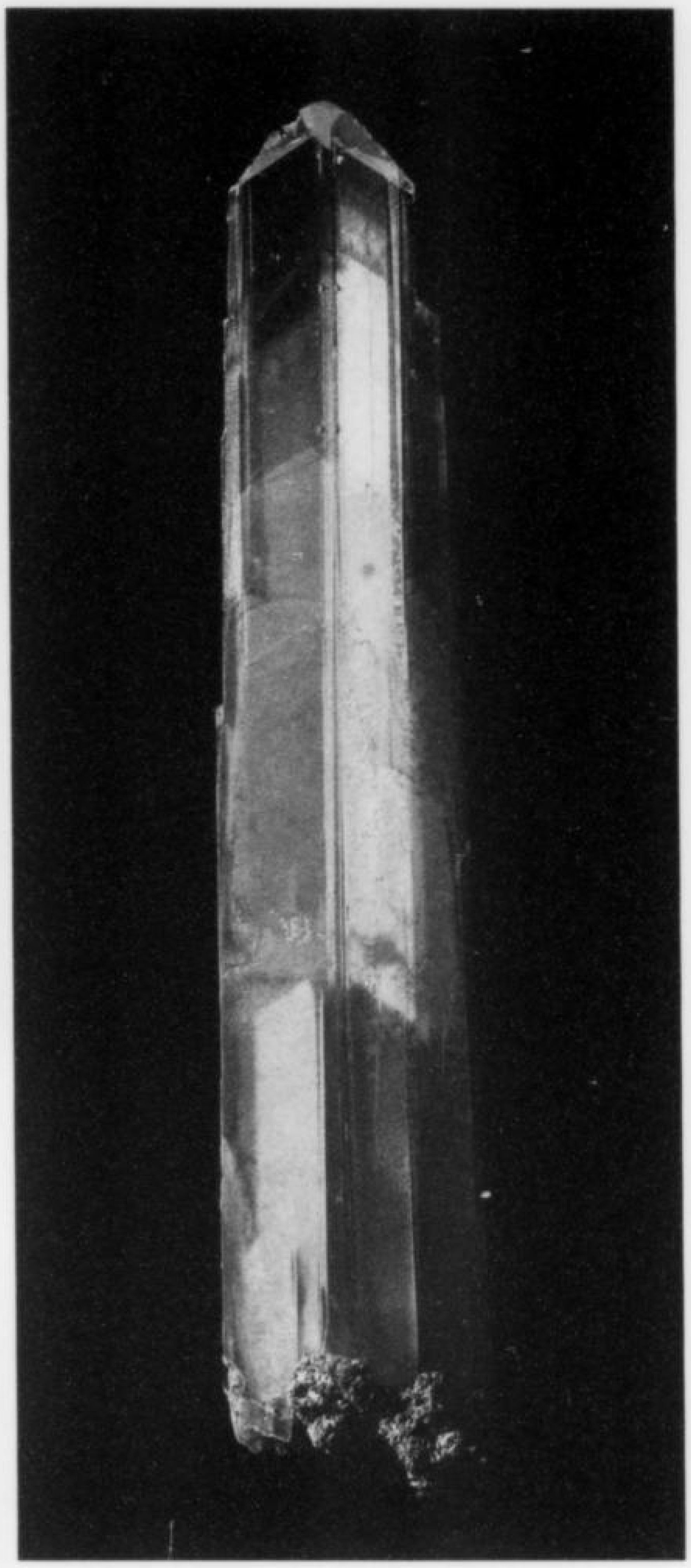


Figure 41. **Gypsum crystal enclosing several phantoms, 30 cm, from the Nababeep West mine. A single terminated gypsum crystal measuring 82 cm, from the same mine, is in the collection of the Geology Department, Rand Afrikaans University. Two large crystals are on display in the Museum of the Geological Survey, Pretoria and a similar specimen to the one pictured is in the Museum Africa collection in Johannesburg. University of the Witwatersrand (Bleloch Museum) specimen.**

specimens, notably the Nababeep West, Spektakel, Okiep and Jan Coetzee mines. What may be one of the best chalcocite specimens in South Africa, rivaled only by a few specimens from the Messina mine, was found at the Nababeep West Mine many years ago. This fine specimen consisting of multiply twinned crystals, is housed in the Nababeep Mining Museum.

Unusual botryoidal and stalactitic chalcopyrite was found at the old Wheal Julia mine (Cornelissen, 1958). A horizontal system of fractures several centimeters wide contained cavities up to 60 cm long and 5 to 15 cm wide; botryoidal and finger-like chalcopyrite lined the cavities and projected into them. Another fault zone (on the 620-foot level) at Wheal Julia contained crystals of chalcocite. At the Nababeep West mine, a zone of vuggy alteration was commonly encountered in the mineralized diorite (Cornelissen, 1958). Cavities were generally small but reached up to 1 meter in length. Spongiform, decomposed minerals usually filled these cavities, together with **anhydrite**. The walls of the cavities were lined with drusy quartz and agate-like layers of **chlorite, fluorapa-**

Figure 42. Six quartz crystals from the discovery made in 1966 at the Jan Coetzee mine. The largest crystal (right foreground) measures 30 x 83 cm and weighs 75 kg. The doubly terminated one behind measures 17 x 88 cm and weighs 35 kg. Karl Messner collection; Bruce Cairncross photograph, 1993.

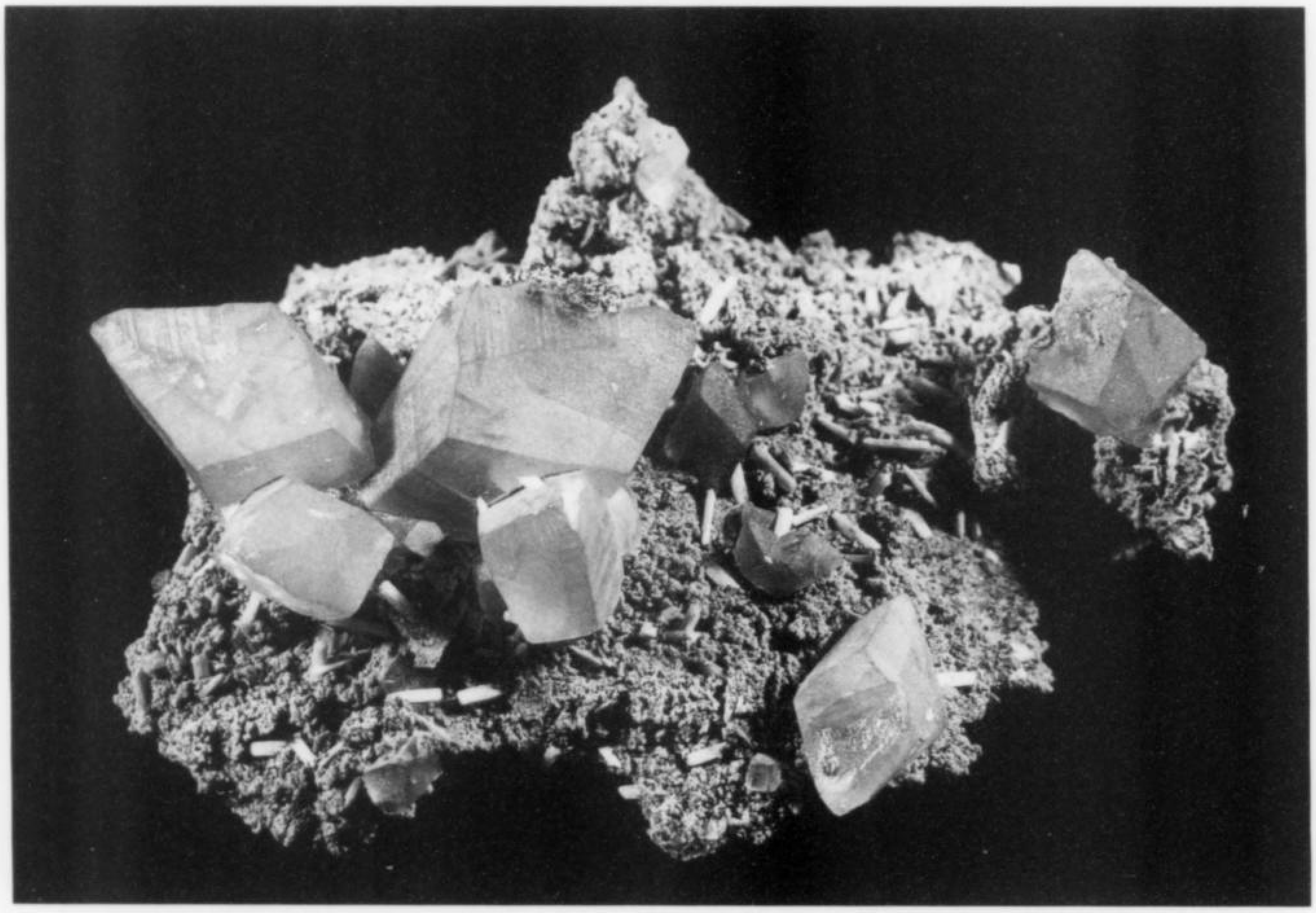


Figure 43. Prismatic, cream-colored stilbite crystals on matrix with scalenohedral calcite, chalcopyrite, orthoclase and chlorite from the Nababeep West mine. The largest calcite crystal measures 4.1 cm. Museum of the Council for Geoscience (Pretoria) specimen #MGS 14895; Bruce Cairncross photograph.

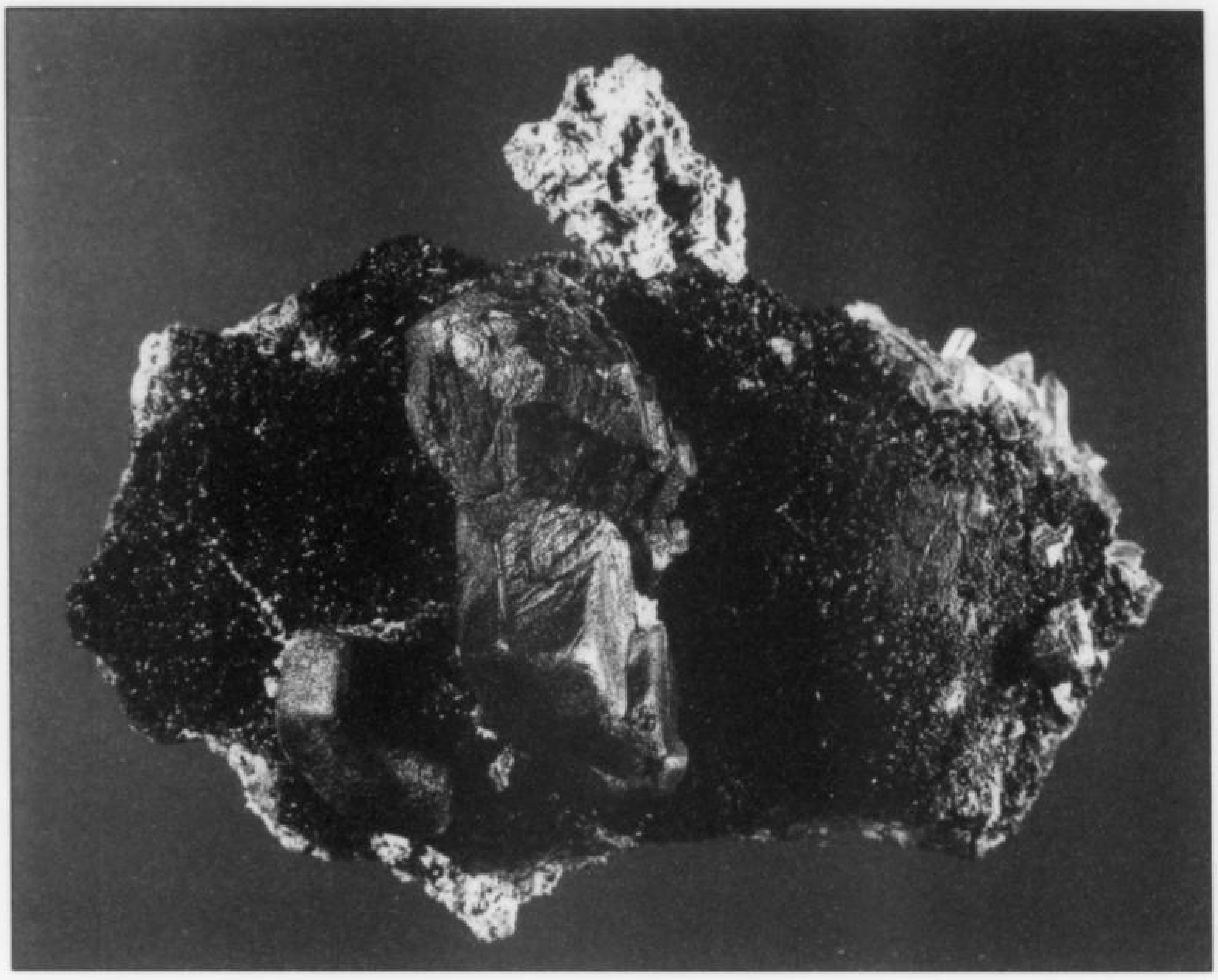


Figure 44. **Three sphalerite crystals coated by a layer of partially resorbed, iridescent chalcopyrite on a matrix of euhedral epidote, orthoclase, quartz, calcite and minor pyrite, 10.1 cm, from the Jan Coetzee mine. This specimen was originally owned by Gerry Rossouw, then was sold to the Swiss collector Hans Thöni during the early 1970's and recently repatriated to South Africa. Bruce Cairncross specimen and photograph.**

tite, prehnite and **calcite**. Cockscomb chalcopyrite often projected into the inner voids.

Several other interesting collectable minerals were found in the East Okiep orebody. A fault zone on the 480-foot level contained drusy cavities lined with euhedral **quartz**, cubes of **galena**, and **sphalerite**. Museums in South Africa such as the Transvaal Museum in Pretoria, Museum Africa in Johannesburg, the Nababeep Mining Museum and the SA Museum in Cape Town, possess extensive suites of aesthetic, well-crystallized specimens of minerals including **chalcopyrite, chalcocite**, **barite, calcite, epidote, fluorite, gypsum, quartz** and **stilbite**.

Private collectors also have specimens from these mines. Jopie Kotze, owner of the Springbok Café in Springbok, has a comprehensive permanent public display of specimens from the copper mines at his premises. For many years, George Swanson, a well-known resident of Springbok, had the largest private collection of Jan Coetzee mine specimens (mainly quartz), but this collection was recently acquired by the Johannesburg collector Uli Bahmann. Gold Fields of South Africa Ltd, the previous mine owners, had ore samples and excellent specimens in their corporate head office in Johannesburg. Furthermore, when the local Federation of South African Gem and Mineralogical Societies held their annual "Gemboree" at Springbok in 1969, the local "Copper-Nama News" ran an article, with photographs, on several local collectors who had major Okiep collections (Anonymous, 1969).

PRESENT STATUS

At present, the copper mines that were owned by Gold Fields of South Africa Ltd. have been taken over by Metorex (Pty) Ltd. All of the Okiep copper mines are closed, with the Carolusberg mine being the last to close in 1998 (Viljoen and Reimold, 1999).

ACKNOWLEDGEMENTS

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REFERENCES

(NOTE: There is abundant literature published on the early historical and social life in Namaqualand; the best references are those by Dowdle (1955), Robertson (1968) and Smalberger (1975). There are also numerous scientific publications dealing with the geology of the region, and Boer (1991) and Gibson and Kisters (1996) provide many useful references.)

AFRICA (undated) *On maps from the Twelfth to the Eighteenth Century (auf Karten des 12. Bis. Jahrhundrets).* (Rand Afrikaans University Rare Books Collection). Edition Leipzig, 77 pages.

ALEXANDER, J. E. (1838) *An expedition of discovery into the interior of Africa, through the hitherto undescribed Countries of the Great Namaquas, Boschmans, and Hill Damaras, performed*

Under the Auspices of Her Majesty's Government, and the Royal Geographical Society. Henry Colburn Publisher, London. Two volumes, 302 and 306 pages.

ANONYMOUS (undated) *Pictorial history of South Africa*. Odhams Press Ltd. Long Acre, London, W.C.2. 512 pages.

ANONYMOUS (1968) Jan Coetzee mine. *Copper-Nama News*, Springbok. **5**, No. 1, August, 1968, 1–2.

ANONYMOUS (1969) Local Rockhounds. *Copper-Nama News*, Springbok. **5**, No. 10, May, 1969, page 2.

BAIN, A. G. (1854) *Cape of Good Hope Parliamentary Report A39-1854, correspondence on the subject of the discovery of Metals in Namaqualand*. Presented to both Houses of Parliament by order of Lt. Governor C. H. Darling, July 25th, Cape Town. [Note: This is the first geological report published in South Africa.]

BARROW, J. (1801) *An account of Travels into the Interior of Southern Africa*. London. Two volumes, 419 and 452 pages.

BELL, C. D. (1855) On the Copper Fields of little Namaqualand, and of Commander M. S. Nolloth, of H.M.S. "Frolic," on the bays and harbours of that coast. *Reports of the Surveyor-General, Charles D. Bell*. Council for Geoscience Archives, Pretoria, 45 pages.

BOER, R. H. (1991) Bibliography on the geology of the Okiep copper district, Namaqualand, South Africa, 1685–1990. *Economic Geology Research Unit Information Circular No. 241*. University of the Witwatersrand, Johannesburg, 15 pages.

BOWLES, M. (1988) Tungsten mineralisation in the Namaqualand-Bushmanland region, Northwestern Cape, South Africa. *Memoir 74*, Geological Survey, Pretoria, South Africa, 75 pages.

CAIRNCROSS, B. and DIXON, R. (1995) *Minerals of South Africa*. Geological Society of South Africa, Johannesburg, 290 pages.

CAMERON, T. and SPIES, S. B. (1986) *Nuwe geskiedenis van Suid-Afrika in woord en Beeld*. Human & Rosseau, Pretoria, South Africa, 320 pages.

CORNELISSEN, A. K. (1958) Note on botryoidal and stalactitic copper ores from Namaqualand. *Transactions of the Geological Society of South Africa*, **69**, 367–376.

DAPPER, O. (1676) Naukeurige Befchrijvinge der Afrikaensche Gewesten van Egypten, Barbaryen, Lybien, Biledulgerid, Negroslant, Guina, Ethiopiën, Abyffinie: *Vertoont* in de Benamingen, Grenspalen, Revieren, Steden, Gewaffen, Dieren, Zeeden, Drachten, Talen, Rijkdommen, Godsdienften en Heerfchappyen. Met Lantkaerten en afbeeldingen van Steden, Drachten &c. na't Leven getekent, en in Kooper gefneden. Amsterdam By van Meurs, op de Keyfers-gracht, in de Stadt Meurs, Anno. M.DC.LXXVI.

DOWDLE, K. (1955) *A bibliography of Namaqualand*. University School of Librarianship, Cape Town.

DUNN, E. J. (1872) Report on the country traversed by the "Gold Prospecting Expedition" in Namaqualand, &c. *Cape of Good Hope Parliamentary Report G21 '72*. Cape Town, 11 pages.

FORBES, V. S. (1965) *Pioneer travellers of South Africa: a geographical commentary upon routes, records, observations and opinions of travellers at the Cape 1750–1800*. A. A. Balkema, Cape Town, 177 pages.

GIBSON, R. L. and KISTERS, A. F. M. (1996) Special Issue on the geology of the Okiep Copper District. *South African Journal of Geology*, **99**, 220 pages.

KISTERS, A. F. M., CHARLESWORTH, E. G., ANHAEUSSER, C. R. and GIBSON, R. L. (1994) Mechanisms of steep structure formation in the Okiep copper district, Namaqualand, South Africa. *Economic Geology Research Unit Information Circular No. 280*. University of the Witwatersrand, Johannesburg, 28 pages.

KOLBE, P. (1727) Naukerige en uitvoerige Beschryving van De Kaap de Goede Hoop; behelzende Een zeer omftandig Verhaal van den tegenwoordigen toeftalnt van dat vermaarde Gewelt, deszelfs Gelegenheit, Haven, Sterkte, Regerings-vorm, Uitgeftrektheit, en onlangs ontdete aanleggende Landen; NEVENS *Een geleerde Befchryving van het Klimaat en Aart van dat Landfchap; van deszelfs DIEREN, VISSCHEN, VOGELEN, PLANTEN, KRUIDEN; mitsgaders verfcheide WONDEREN der NATUUR, daar te Lande ontdekt*; Waar by nog komt, een zeer nette en uit eige ondervinding opgemaakte Befchryving van den oorfprong der HOTTENTOTTEN. Amsterdam. Volume I, 529 pages, Volume II, 449 pages.

LE VALIANT, F. (1791) *Reize in de binnenlanden van Afrika, langs de Kaap de Goede Hoop, in den jaaren MDCCLXXX tot MDCCLXXXV gedaan door den Heer le Valiant, uit het Fransch door J. D. Pasteur*. Leyden, 5 volumes, 352, 360, 332, 374 and 392 pages.

LEVIN, G. (1997) Andrew Geddes Bain. In: Anhaeusser, C. R. (Editor*). A Century of Geological Endeavour in Southern Africa 1895–1995*. The Geological Society of South Africa, Johannesburg, 587 pages.

LOMBAARD, A. F. and the EXPLORATION STAFF OF THE O'OKIEP COPPER COMPANY LIMITED (1986) The copper deposits of the Okiep district, Namaqualand. In: Anhaeusser, C. R. and Maske, S. (Editors). *Mineral Deposits of Southern Africa*, Volume II, 1421–1445.

MARAIS, J. (1987) *O'okiep Copper Company Ltd 1937–1987*. Commemorative brochure published by O'okiep Copper Company Ltd, Springbok, 44 pages.

MASON, R. (1982) Prehistoric mining in South Africa and Iron Age copper mines in the Dwarsberg, Transvaal. *Journal of the South African Institute of Mining and Metallurgy*, **82**, 134–144.

MILLER, D. (1995) 2000 years of indigenous mining and metallurgy in southern Africa—a review. *South African Journal of Geology*, **98**, 232–238.

MOSSOP, E. E. (1931) *Journals of the Expeditions of the Honourable Ensign Olof Bergh (1682 and 1683) and Isaq Schrijver (1689)*. Transcribed and translated into English and edited with a foreword and footnote. The Van Riebeck Society, Cape Town, 270 pages.

POTGIETER, J. E. (1996) Exploration in the Okiep Copper District, Northern Cape Province, South Africa: An overview. *South African Journal of Geology*, **99**, 209–220.

ROBERTSON, J. K. (1968) *The history of narrow gauge railways in South Africa*. Department of Librarianship, University of South Africa (UNISA), Pretoria.

ROGERS, A. W. (1917) An old report on the Copper Field of Namaqualand. *South African Journal of Science*, October 1917, 146–152.

ROGERS, A. W. (1937) The pioneers in South African geology and their work. *Annexure to volume 29 of the Transactions of the Geological Society of South Africa*, Johannesburg, 139 pages.

SIMONS, P. B. (1998) *The life and work of Charles Bell (including: The art of Charles Bell: an appraisal by M. Godby)*. Fernwood Press, Vlaeberg, South Africa, 176 pages.

SMALBERGER, J. M. (1975) *Aspects of the history of copper* *mining in Namaqualand 1846–1931.* Struik Publishers, Cape Town, South Africa, 152 pages.

STEENKAMP, W. (1975) *Land of the Thirst King (2nd edition).* Howard Timmins, Cape Town, 192 pages.

THEAL, G. M. (1909) *History and Ethnography of Africa south of the Zambezi, from the settlement of the Portuguese at Sofala in September 1505 to the conquest of the Cape Colony by the British in September 1795.* Vol. II. Swan Sonnenschein & Co. Limited. London, 523 pages.

THOMPSON, G. (1827) *Travel and Adventures in Southern Africa, by George Thompson Esq., eight years a resident at the Cape, compromising a view of the Present State of the Cape Colony, with observations on the progress and prospects of the British emigrants.* London, 493 pages.

TROTTER, A. P. (1903) *Old Cape Colony: a Chronicle of Her Men and Houses from 1652 to 1806.* Archibald Constable & Co. Ltd, London, 320 pages.

VAN ZYL, D. (1967) The geology of the O'okiep copper mine, Namaqualand. *Annals of the University of Stellenbosch,* **42**, series A No. 1, Stellenbosch, South Africa, 68 pages.

VILJOEN, M. J. and REIMOLD, W. U. (1999) *An introduction to South Africa's geological and mining heritage.* MINTEK publication, Randburg, Johannesburg, South Africa, 193 pages.

VON BEZING, K. L. and KOTZE, J. (1993) The Jan Coetzee copper mine, Namaqualand, South Africa. *Mineralogical Record,* **24**, 39–40.

WATERHOUSE, G. (1932) *Simon van der Stel's journal of his expedition to Namaqualand 1685–6.* (Edited and translated from the manuscript in the Library of Trinity College, Dublin). Hodges, Figgis and Co., Dublin, 179 pages.

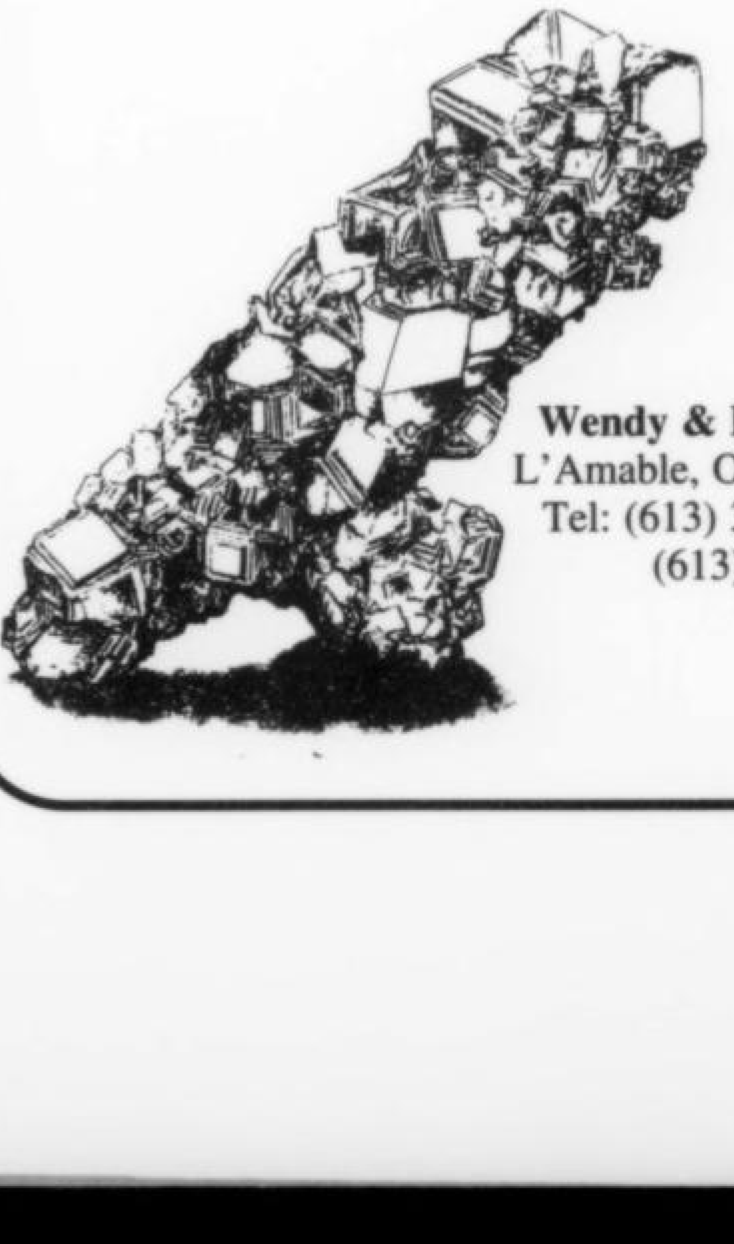
WATERHOUSE, G. (1953) *Simon van der Stel's journal of his expedition to Namaqualand 1685–6.* Supplement: Addenda et corrigenda. Hodges, Figgis and Co., Dublin, 19 pages.

WILLIAMS, A. F. (1948) *Some dreams come true.* Howard B. Timmins, Cape Town. 590 pages.

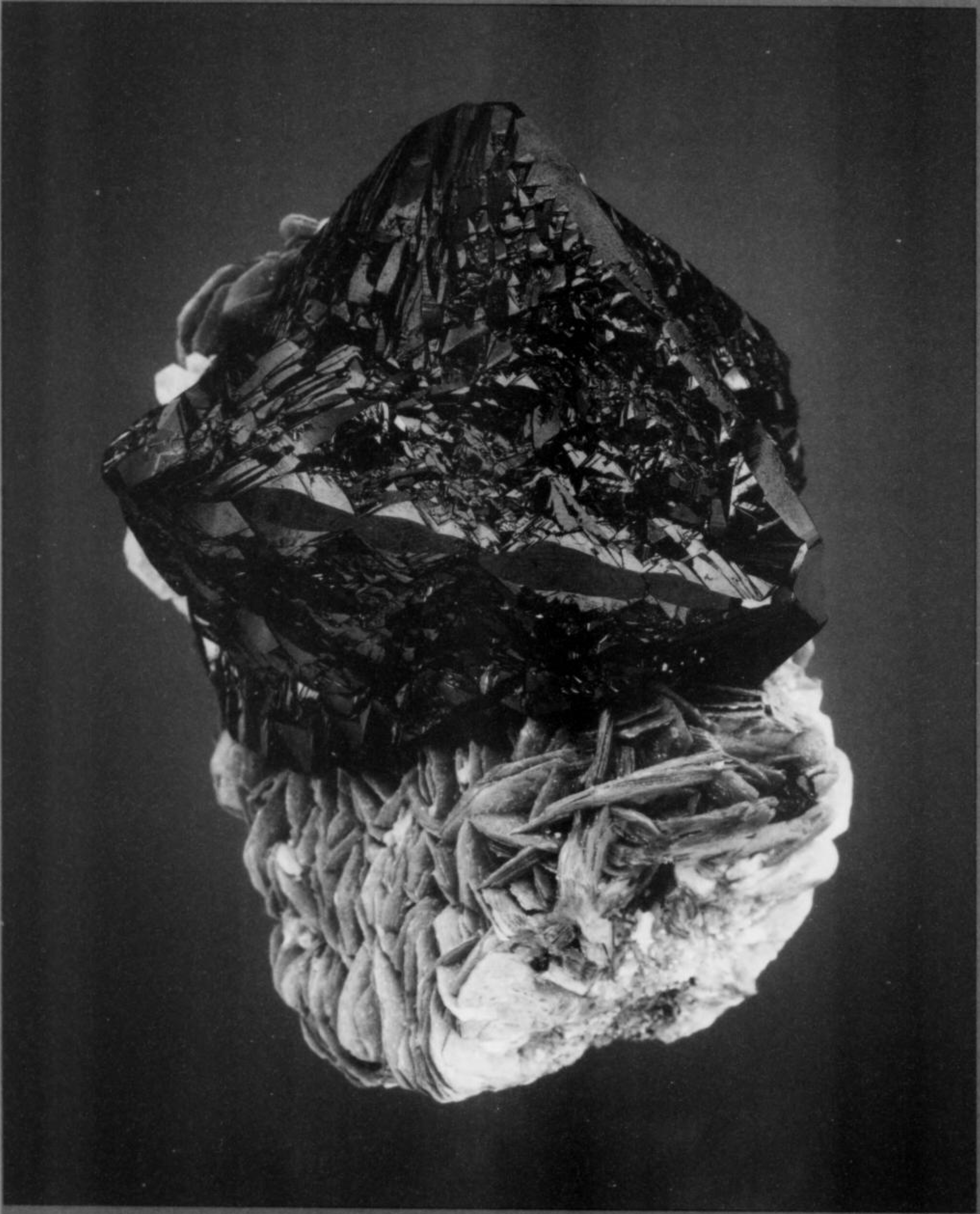
WILSON, M. G. C. (1998). Copper. In: Wilson, M. G. C. and Anhaeusser, C. R. (Editors). *The Mineral Resources of South Africa* (6th Edition). Handbook **16**, Council for Geoscience, Pretoria, South Africa, 209–227.

WYLEY, A. (1856) Provisional report upon the nature and general character of the copper districts of South Namaqualand. *Cape of Good Hope Parliamentary Report No. G.36-'56*, Cape Town, 6 pages.

WYLEY, A. (1857) Report upon the mineral and geological structure of South Namaqualand and the adjoining districts. *Cape of Good Hope Parliamentary Report G.36-'57*, Cape Town, 55 pages.

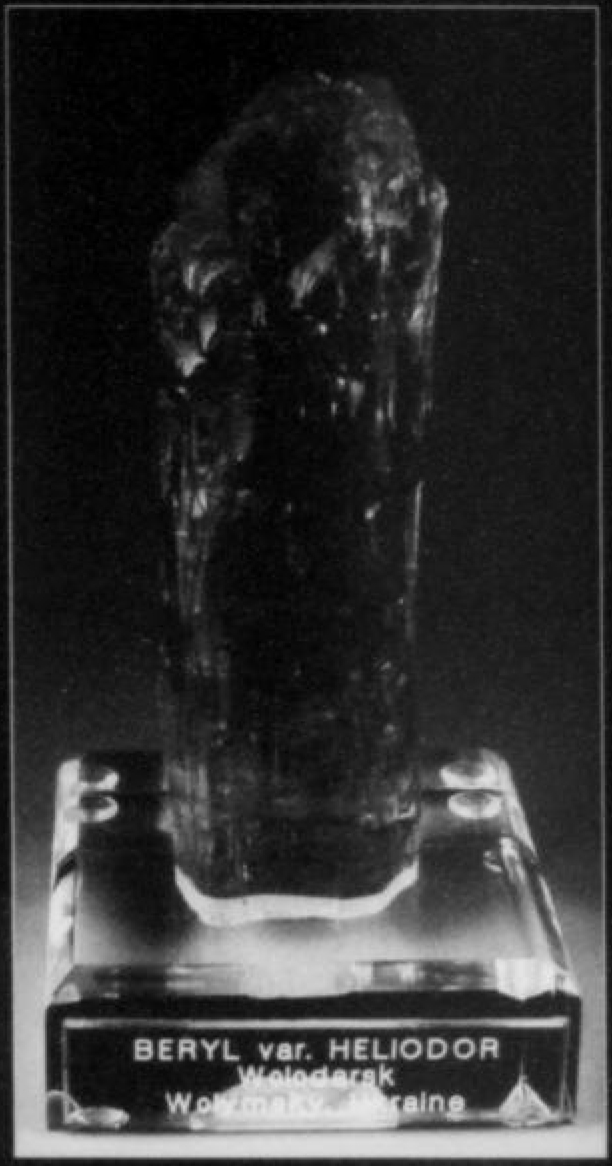


From the Steve Neely Collection

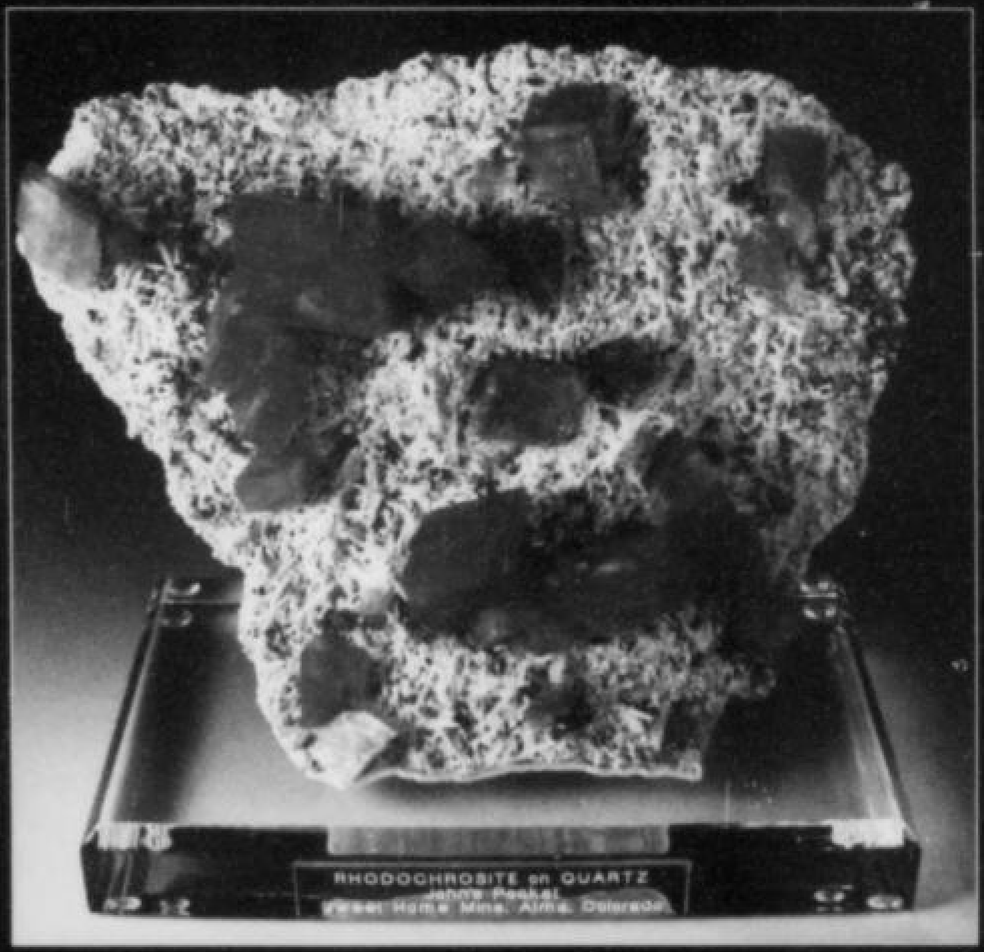


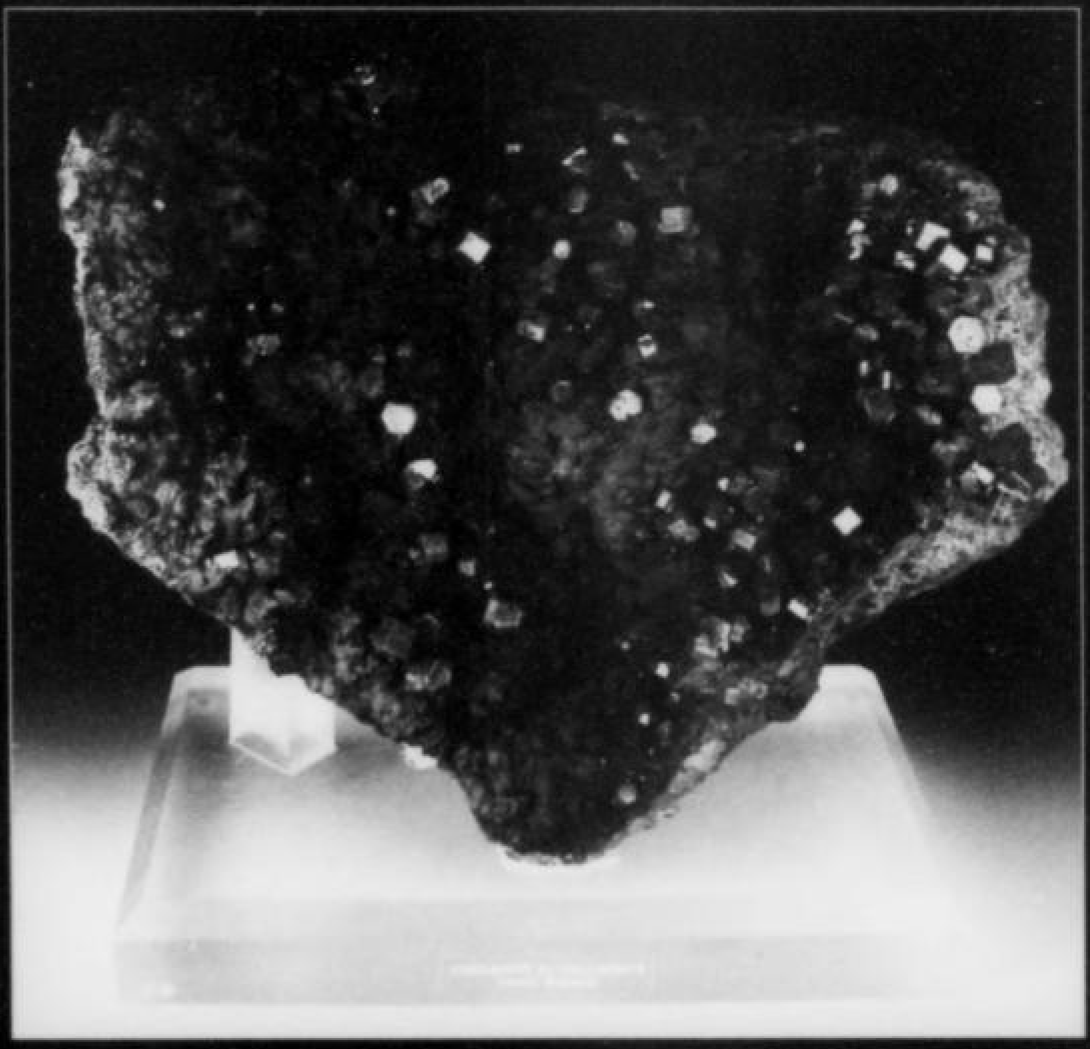
CASSITERITE with Muscovite and Calcite, 5 x 3.25 x 4 inches, from the Huya mine, Ping-wu, Sichuan, China. Acquired at the 2001 Denver Show from Ian Bruce, *Crystal Classics.*

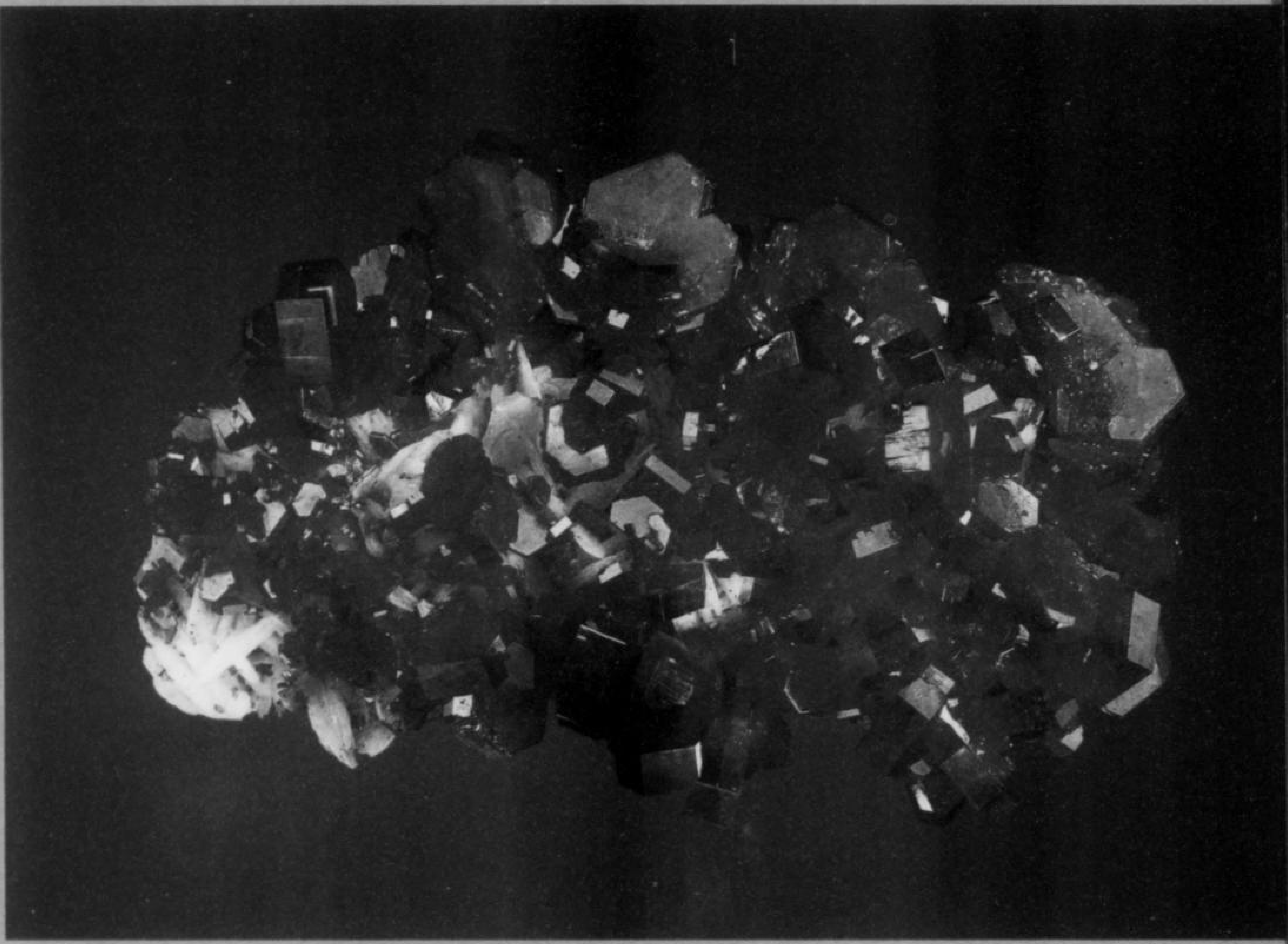
Jeff Scovil Photo


BERYL var. HELIODOR
Wolodarsk


STELLERITE GEODE

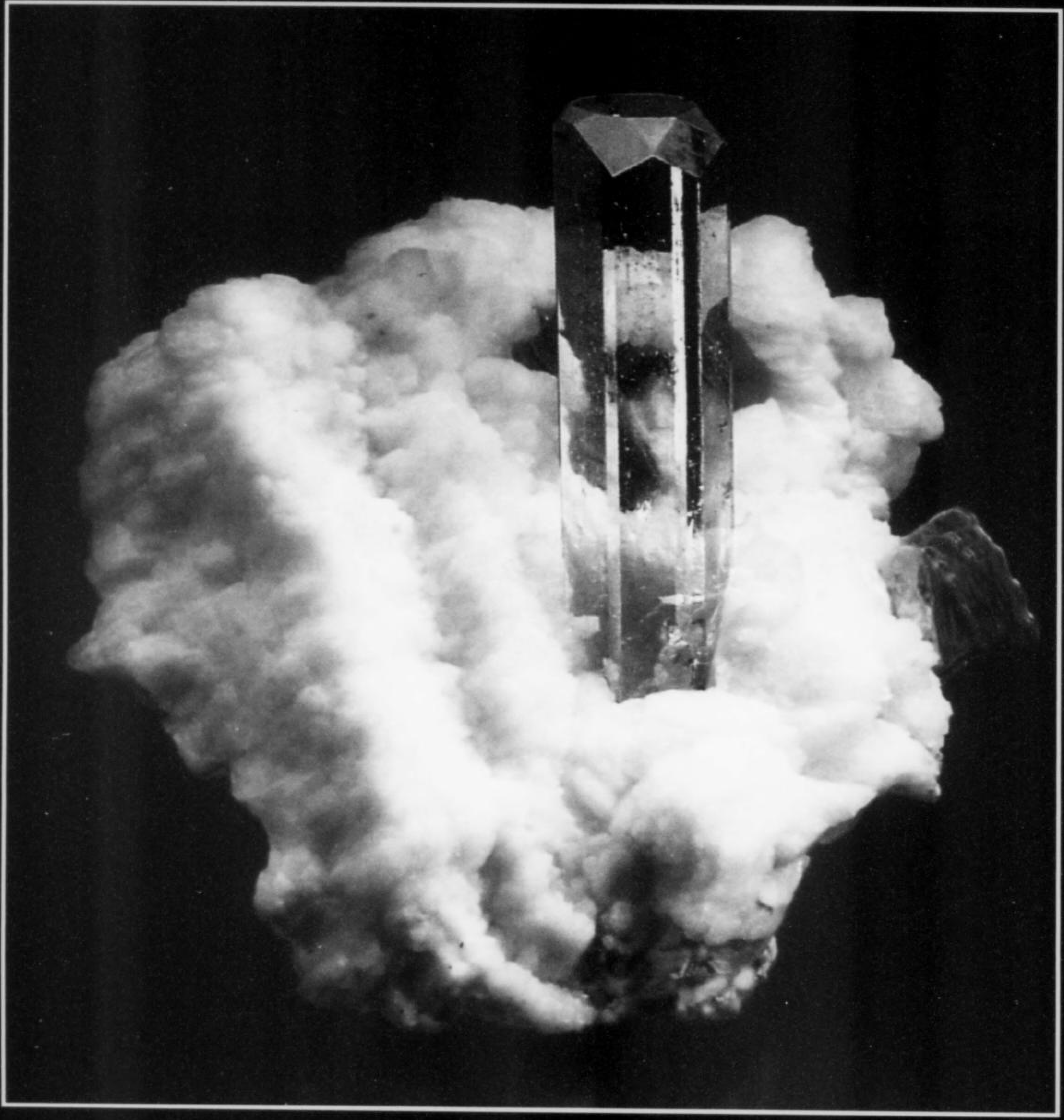

RHODOCHROSITE on QUARTZ
Sweet Home Mine, Alma, Colorado





VANADINITE, 10 cm, Mibladen, Morocco. Jeff Scovil photo.

Inesite on Quartz, 6 inches tall, Daye mine, Hubei Prov., China. Jeff Scovil photo.



LARGE CLINTONITE CRYSTALS

from the Crestmore Quarry
Riverside, California

Curt Forrester
Technical Services
TXI Riverside Cement at Crestmore
1500 Rubidoux Blvd.
Riverside, California 92502
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The famous Crestmore quarries at Riverside, California have yielded over 200 contact-metamorphic and skarn mineral species since 1909 and are the type locality for ten of them. Large crystals of clintonite have been found there since 1916, but in 2001 some extraordinary crystals up to 4.2 cm across were recovered.

INTRODUCTION

Riverside, California is home to the famous Crestmore quarry, a locality that has produced 200 mineral species, including clintonite, over a period of nearly 100 years. Actually, the Crestmore quarry consists of several quarries that include the Wet Weather, Chino, Commercial and Lone Star quarries. Since the beginning of the 20th century, mineralogists, geologists and collectors from around the world have been attracted to Crestmore's intriguing mineralogy. Crestmore is currently the type locality for ten mineral species, and is still yielding additional new species as research continues. The large number of species found here ranks Crestmore among the most mineralogically interesting and complex deposits in the world. Not only are the minerals fascinating, but Crestmore's unique contact metamorphism and skarn geology are particularly well-exposed for study.

HISTORY

Limestone, silica and alumina (usually processed from clay) are the essential ingredients for the manufacture of cement. In 1909 the quarrying of limestone and of silicate rock began at Crestmore, and a cement plant was constructed. Unfortunately, clay was not available in commercial quantities in the quarries and had to be "imported."

By 1927 the lower Chino quarries had been cut down to the general level of the surrounding countryside or somewhat deeper, and an underground mine was initiated in 1930 (Woodford, 1943). Continued underground mining furnished most of the plant's requirements until 1939. During the mining of limestone by the block-caving method, 8 miles of drifts and 5 miles of raises were developed. From 1939 half the production came from the Wet Weather and Lone Star quarries and half from the underground workings. From 1940 until 1954 the Wet Weather quarry was deepened and extended, and the upper part of the Commercial quarry was cut to the 910-foot level. During the forties hundreds of thousands of tons of rock were removed from the Crestmore operations. Block-caving was stopped in 1954, and room-and pillar mining was practiced until 1986.

Mining of limestone ceased at Crestmore over 17 years ago when aquifers which the workings had intersected released huge amounts of water so quickly that pumping costs became prohibitive. The underground mine is now completely flooded, and two lakes have formed, the larger one just above the underground workings and the smaller one just east of the Commercial quarry. Since 1986, raw materials and cement clinker have been trucked into the plant.

TXI Riverside Cement is the owner of the Crestmore quarries, and mineral collecting is prohibited without this company's permission. Collecting is now confined to the Commercial quarry, but is sometimes suspended because of hazardous conditions.

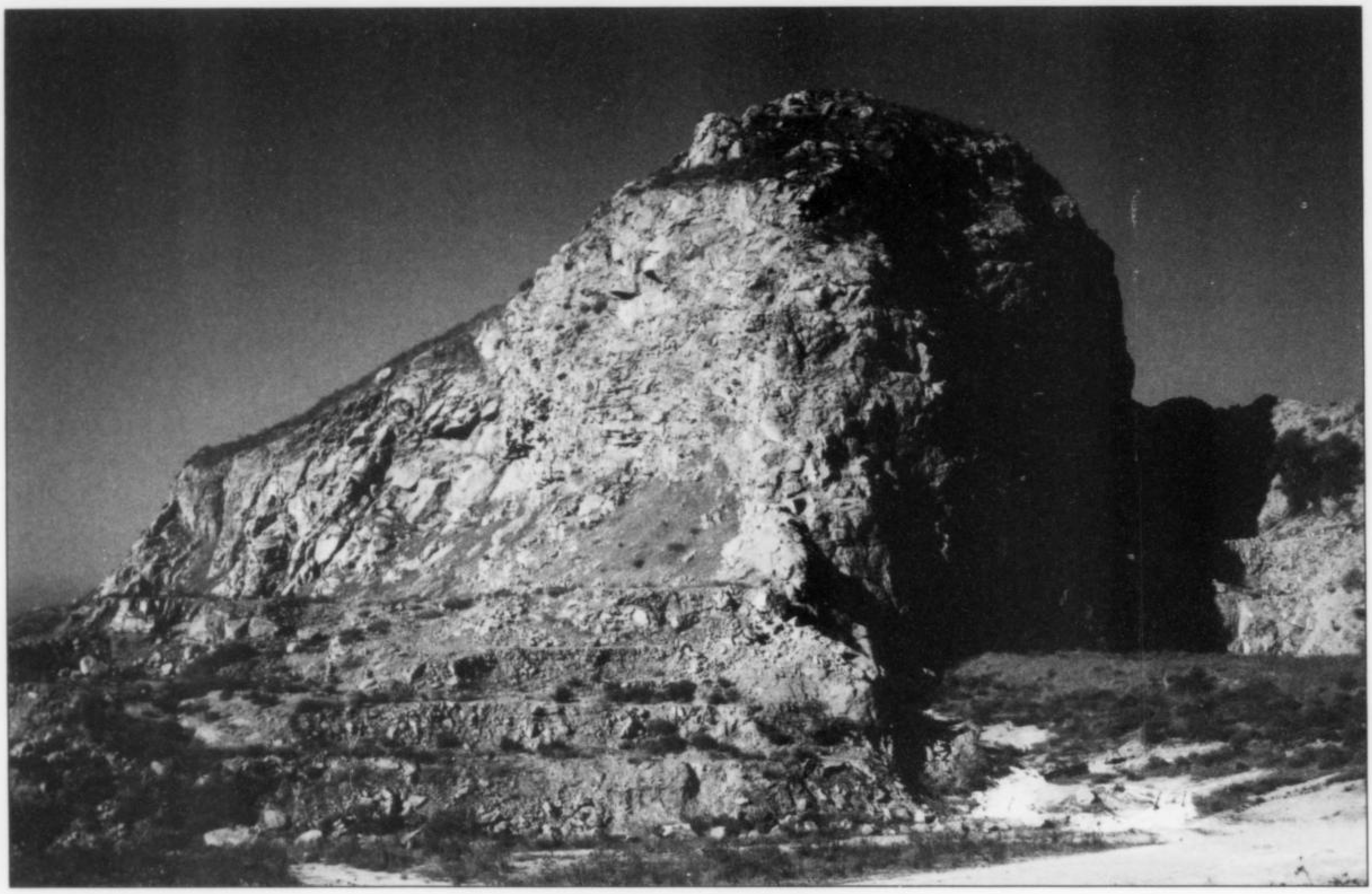

Figure 1. **Northeast face of the Commercial quarry, Crestmore.**

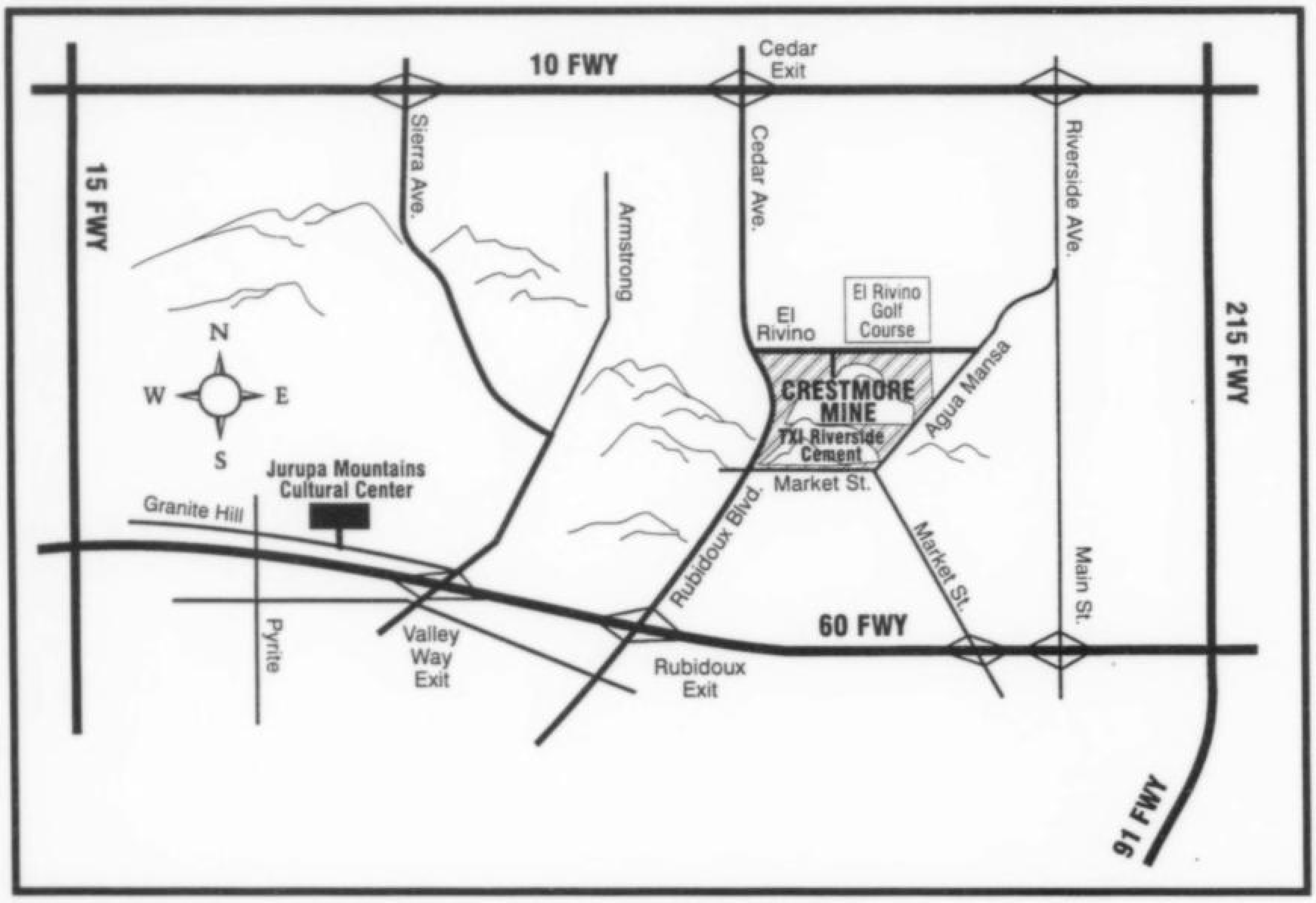

Figure 2. **Location map.**

GEOLOGY

Two beds of magnesium-rich limestone were deposited at Crestmore during the Mississippian, each approximately 400 feet thick. The lower bed is known as the Chino Limestone and the upper bed as the Sky Blue Limestone. The Chino Limestone has been exploited primarily by underground mining. Gneissic hornfelses, schists, and diorite separate the two limestone beds.

Metamorphism took place in several cycles, recrystallizing the limestone into marble during the early Triassic. Later there were several magmatic intrusions into the marble that produced the complex suite of contact metamorphic minerals for which Crestmore is famous.

The first intrusion was a quartz diorite that had little effect on overall mineral formation. Textural evidence indicates that the quartz diorite magma was highly viscous and had a high proportion of crystals to liquid (Burnham, 1954). Magmatic water was tied up in biotite and hornblende which had formed earlier. The magma was also in the lower part of its temperature range for crystallization and thus produced a minimal contact effect on the marbles which it intruded. The highly siliceous diorite penetrated the Chino

Figure 3. **The clintonite ledge in the Commercial quarry, Crestmore; the main occurrence is in the center of the photo.**

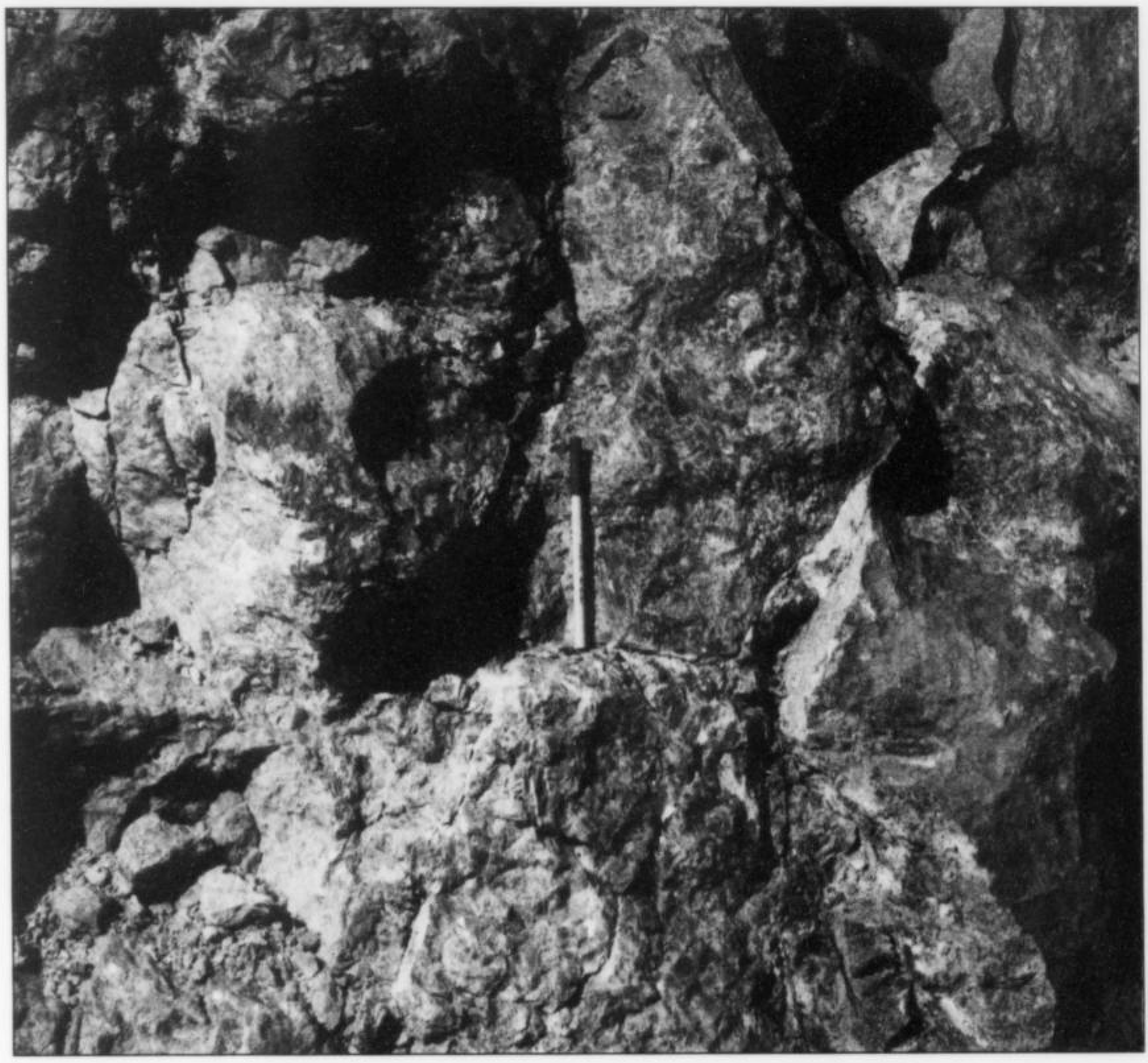

Figure 4. **Contact zone in the Commercial quarry where the large clintonite crystals were found in 2001.**

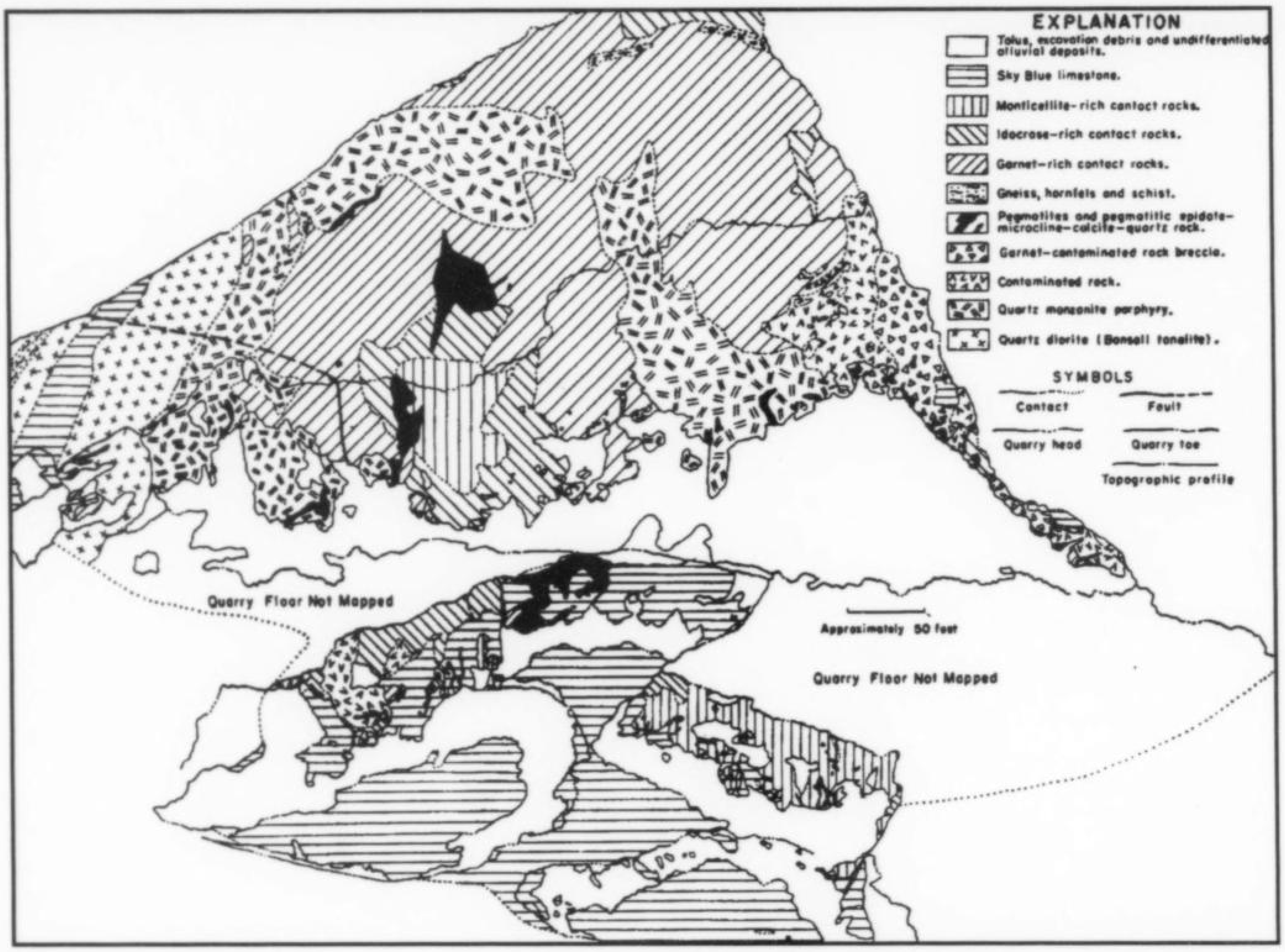

Figure 5. **Generalized geologic map of faces of the Commercial quarry, Crestmore (Burnham, 1954).**

Limestone and deposited pyrrhotite, sphalerite and other sulfides along its perimeter.

The second magmatic intrusion, a quartz monzonite porphyry, was much more active in mineralizing the surrounding rocks. This intrusive body is responsible for the classic contact metamorphism and skarn mineralogy that exists at Crestmore. The intrusion took the form of two pipe-like masses ranging from 200 to 300 feet in diameter. The first pipe intruded the quartz diorite and Sky Blue limestone. The second pipe pushed up through the metasedimentary rocks and terminated in the Sky Blue Limestone. Textural evidence indicates that less than 15% of the quartz monzonite porphyry magma was crystalline at the time of intrusion (Burnham, 1954). Water had therefore not been fixed in early phases, so large quantities of water, free silica and alumina were available for metasomatism of the marble units (Burnham, 1954). There is also evidence of large-scale metasomatism before the quartz monzonite porphyry magma was completely crystallized, suggesting that the metasomatizing fluids were not all from the residuum of crystallization (Burnham, 1954).

Burnham (1954) suggests that the release of pressure on the magma resulting from intrusion into the reactive and deformable marble units caused the volatiles to separate from the magma and become available for metasomatism of the marble. The fluids conveyed heat, silica, alumina and water to the marble and removed CO_2 from carbonates, producing the contact aureole. Temperatures during these reactions exceeded 700° C, and pressures reached 2000 bars. Metasomatic aureoles that were formed during this volatile activity are up to 50 feet wide.

CLINTONITE

Sizeable crystals of clintonite—$CaMg_2AlAl_3SiO_{10}(OH)_2$—were first discovered at Crestmore around 1916. At that time the accepted mineral name was "xanthophyllite, variety waluewite." Both of those names were subsequently discredited in favor of clintonite (named

Figure 6. **DeWitt Clinton (1769–1828), Governor of New York and a patron of science, after whom clintonite was named by W. Mather in 1828. (Oil painting by Rembrandt Peale in the Historical Society of Pennsylvania.)**

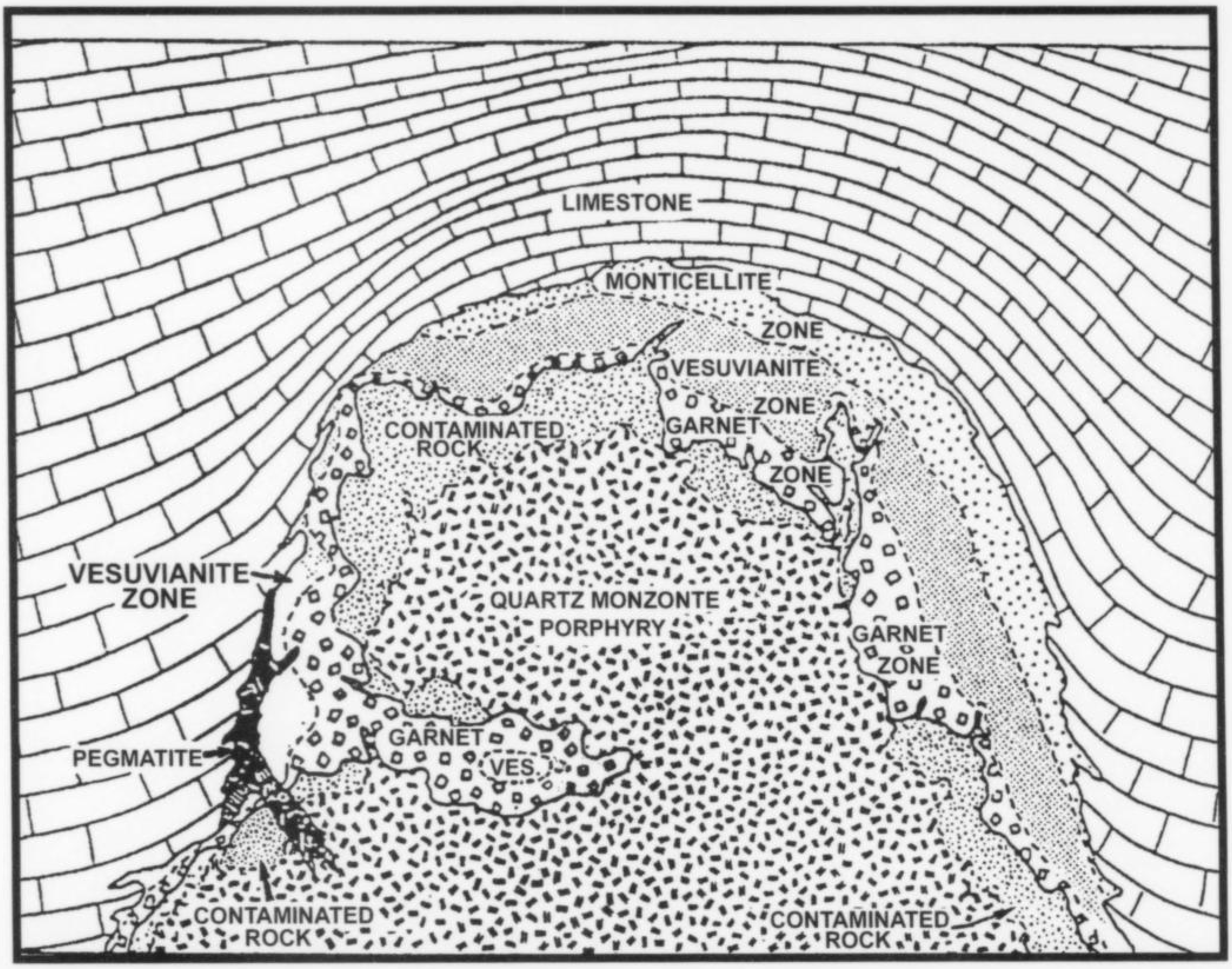

Figure 7. **Idealized north-south cross section (not to scale) through the quartz monzonite porphyry instrusion at Crestmore (after Burnham, 1954).**

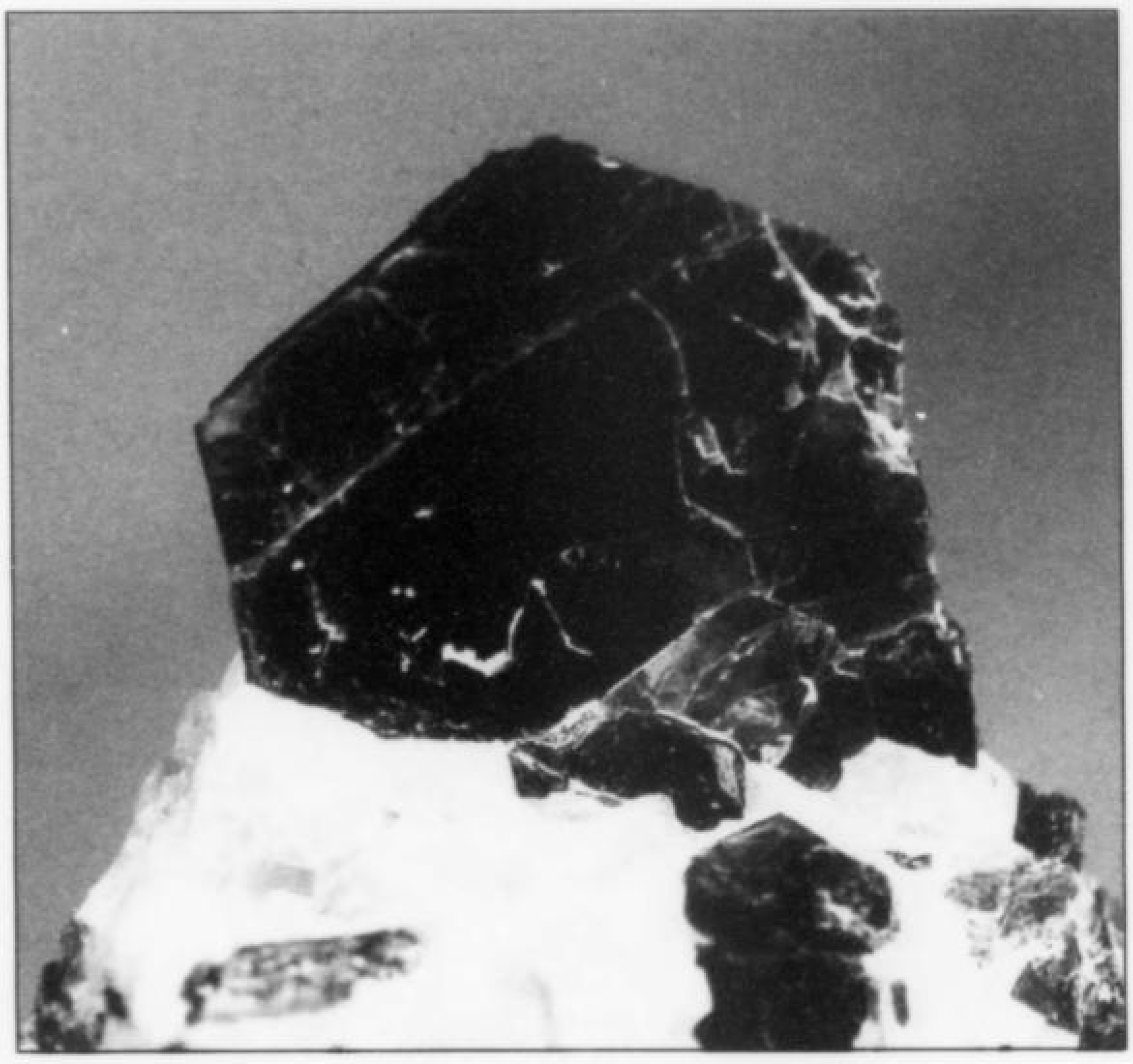

Figure 8. **Large clintonite crystal, 2.7 cm, on marble from the Commercial quarry, Crestmore. Unique Mineral Collection; Paul Ostrinski photo,**

after New York Governor DeWitt Clinton in 1828). The dimensions of those crystals varied greatly, but the largest were said to be 3 to 4 cm wide (across the basal face) and 4 mm thick.

Three years ago Anne Seminaris began finding clintonite crystals in sizes up to 1 cm at the far eastern end of the Commercial quarry, on a ledge about 15 feet above the smaller lake. In early June of 2001, Paul Ostrinski and I were fortunate enough to locate

Figure 9. **Large clintonite crystal, 2.1 cm, on marble from the Commercial quarry, Crestmore. C. and C. Forrester collection; Curt Forrester photo.**

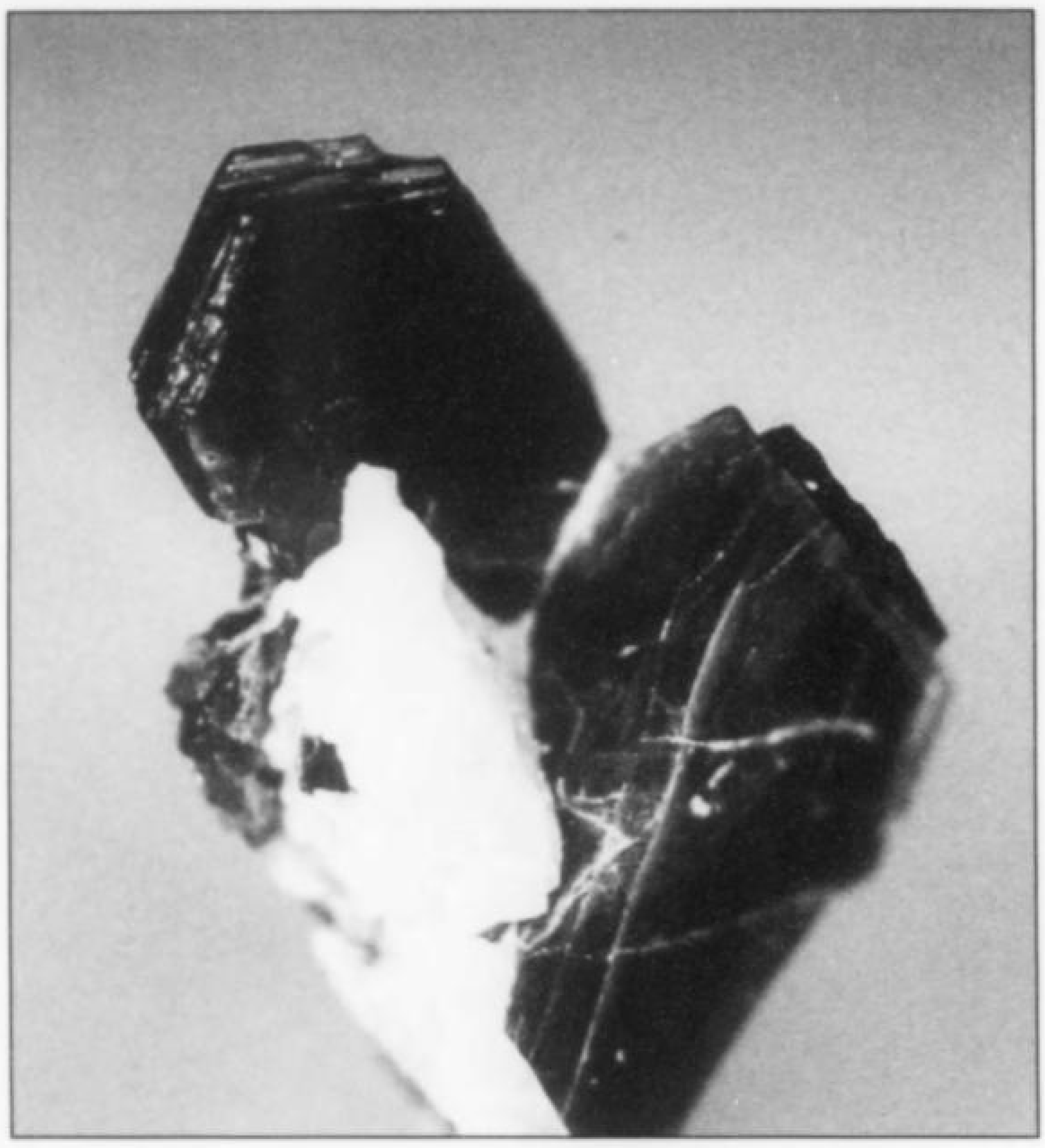

Figure 10. **Fine crystals of clintonite to 1.6 cm on marble from the Commercial quarry. Private collection; Paul Ostrinski photo.**

some very large crystals of clintonite at the same site. Much of the clintonite is included in lenticular masses of blue calcite from 7 to 20 cm long, the masses surrounded by loose fill and varying greatly in hardness; granular yellowish green vesuvianite sparingly accompanies the clintonite. Physical weathering was evident, and a few streaks and surface coatings of hematite appeared on both the clintonite and calcite.

The clintonite was buried just inches below the ground and did not appear to have formed *in situ*. Perhaps a bulldozer had moved this "deposit" to its current location during the mining of limestone in past years. However, the occurrence was situated about 15 feet from an intact blue calcite outcrop. The outcrop contains a metasomatic vesuvianite aureole that yields clintonite crystals to 3 mm wide. Collectors have extracted blue calcite from this location for years.

To this author's knowledge, no other zones in the Commercial quarry are currently producing clintonite. The largest crystals that we recovered are from 3 to 4.2 cm wide across the basal face, dark green in color, and pseudohexagonal in habit. These are quite remarkably large: generally, any crystals of clintonite exceeding 1 cm across the pinacoid face are rare. Many of the Crestmore crystals are formed in "books," i.e. are layered perpendicular to the optic axis, as is typical for mica-group species. These "books" are often 6 mm thick on the larger specimens of Crestmore clintonite.

The contrast of dark green clintonite against the sky-blue calcite is quite attractive, and the occasional association with yellowish green vesuvianite is an aesthetic bonus.

There was only one minor incident while we were digging. Paul was using a 4-foot-long pry bar to overturn a small boulder, and during one of his attempts the bar decided to "jump" out of his hands and into the lake below us. This lake is at least 15 feet deep and very murky, so we figured that we had lost the crowbar. On the other hand, the outdoor temperature was soaring to 105° F or better: we could have had a refreshing swim to recover the bar, but we left that for another time.

***Table 1.* Chemical composition of Crestmore clintonite**

SiO_2	14.78	MgO	19.05
TiO_2	0.01	CaO	13.15
Al_2O_3	46.27	Na_2O	n.d.
Cr_2O_3	0.03	K_2O	0.01
FeO	1.16	F	n.d.
MnO	0.03	H_2O	[4.20]
		Total	98.69

Analysis by electron microprobe; average of 15 spot analyses (all Fe reported as FeO; water calculated to fill the OH sites). This composition yields the formula $(Ca_{1.007}K_{0.007})_{\Sigma 1.014}(Mg_{2.030}Mn_{0.002}$-$Al_{0.991}Cr_{0.002}Ti_{0.001})_{\Sigma 3.025}(Al_{2.944}Si_{1.056})_{\Sigma 4.00}O_{10}(OH)_2$.

ASSOCIATED MINERALS

At Crestmore much of the **calcite** has been recrystallized, particularly near contact zones. The typical calcite crystal size at this occurrence is from 1 to 5 cm, but embedded cleavage faces can be larger. The most common crystal habit is rhombohedral.

Vesuvianite at Crestmore usually occurs in a granular habit, although in certain locations in the Commercial quarry, vesuvianite has been found in prismatic crystals exceeding 10 cm.

ACKNOWLEDGMENTS

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REFERENCES

BARTHELMY, D. (2001) Clintonite, calcite and vesuvianite. *webmineral.com*.

BURNHAM, C. W. (1954) Contact metamorphism at Crestmore, California. *California Division of Mines Bulletin* **170**, 61–70.

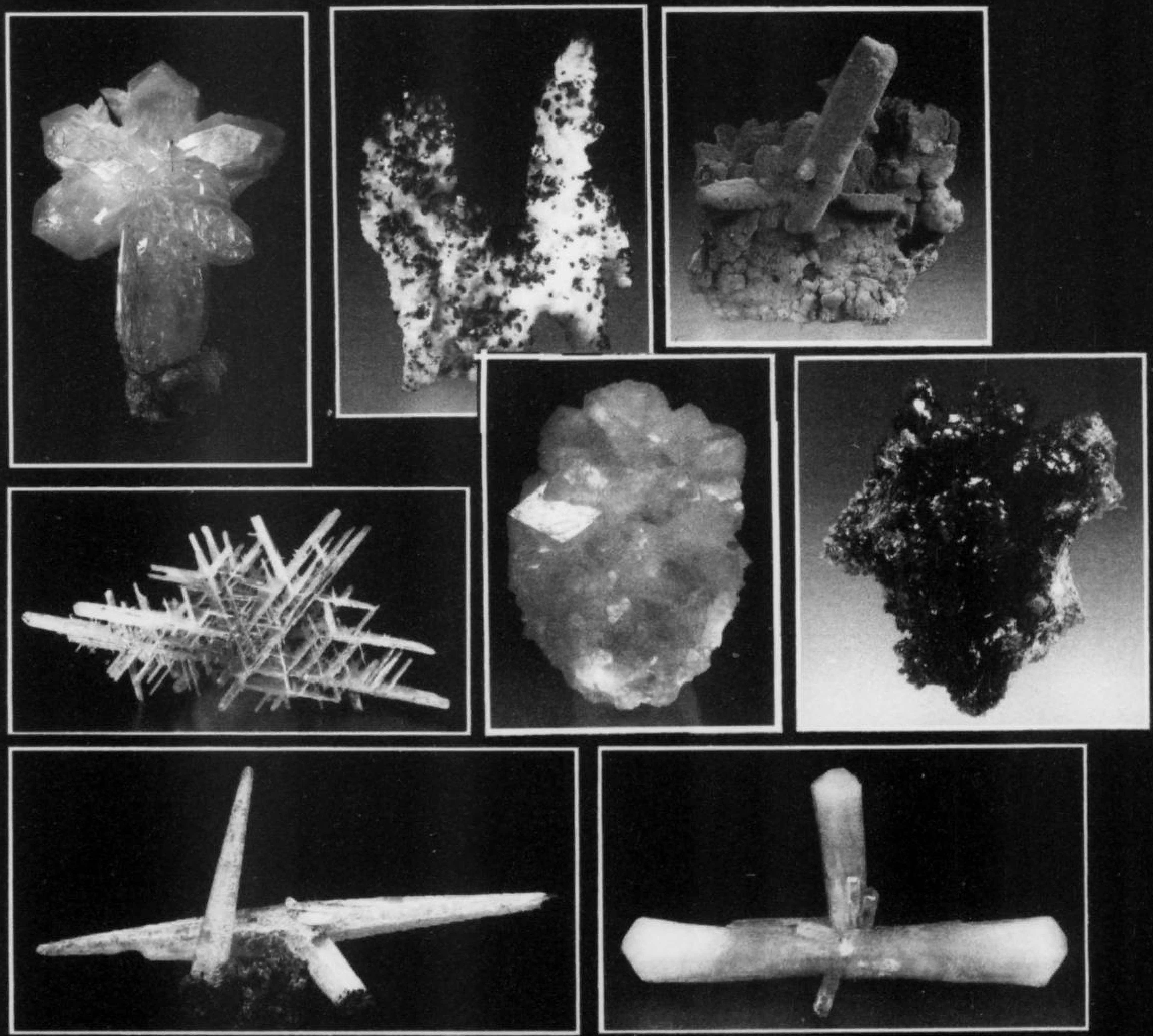
De VITO, F., PARCEL, R. T., and JEFFERSON, G. T. (1971) Contact metamorphic minerals at Crestmore quarry, Riverside, California. *Department of Geological Sciences, University of California, Geological Excursions in Southern California, Riverside Campus Museum Contributions,* **1**, Field Trip No. 5, 94–124.

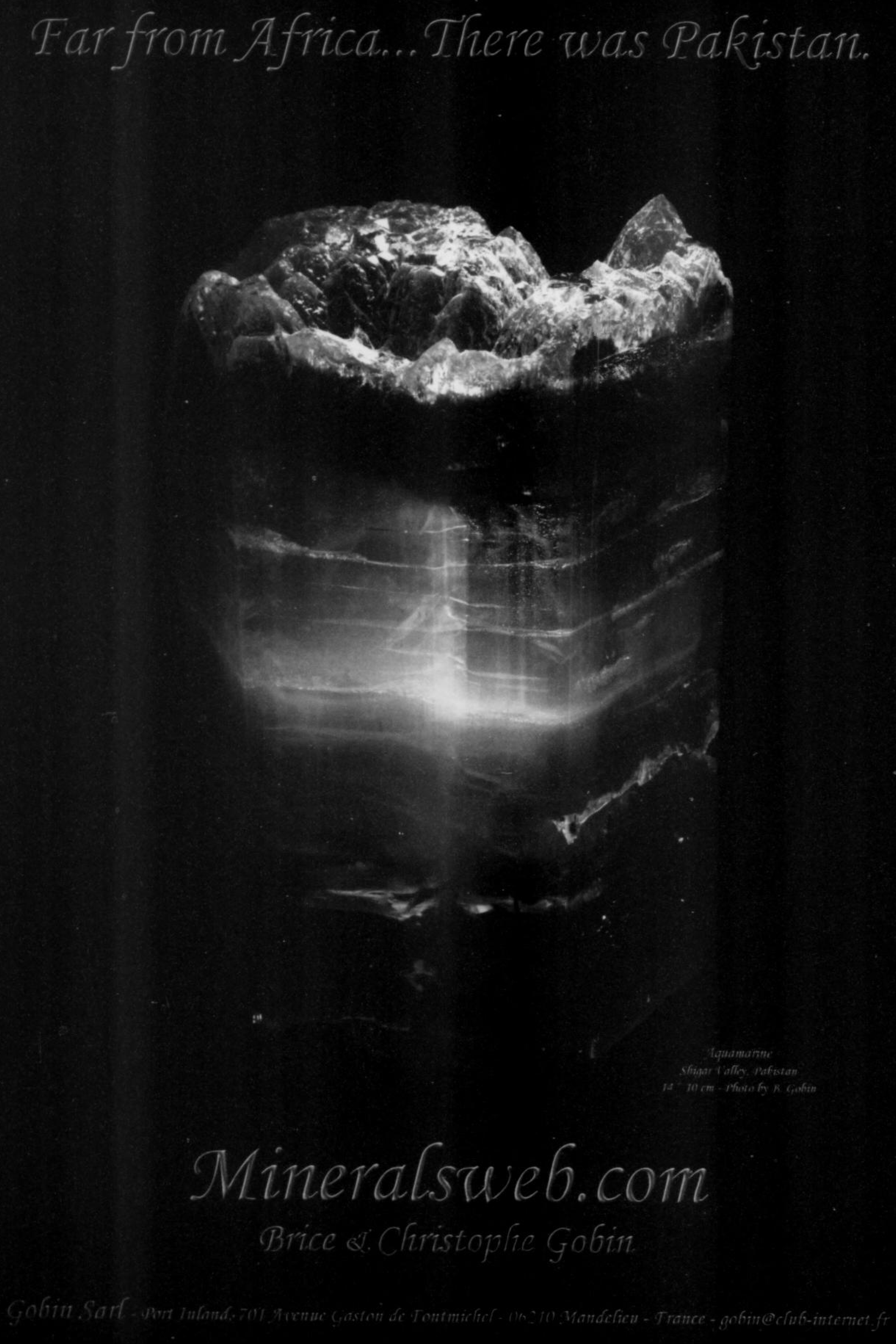
EAKLE, A. S. (1916) Xanthophyllite in limestone. *Washington Academy of Science Journal,* **6**, 332–335.

MANDARINO, J. A., and BACK, M. (2004) *Fleischer's Glossary of Mineral Species.* The Mineralogical Record Inc., p. 31, 43 and 224.

MURDOCH, J. (1961) Crestmore—past and present. *American Mineralogist,* **46**, 245–257.

WOODFORD, A. O. (1943) Crestmore minerals. *California State Mineralogist Report,* **XXXIX,** Chapter 3, 334–335. ☒

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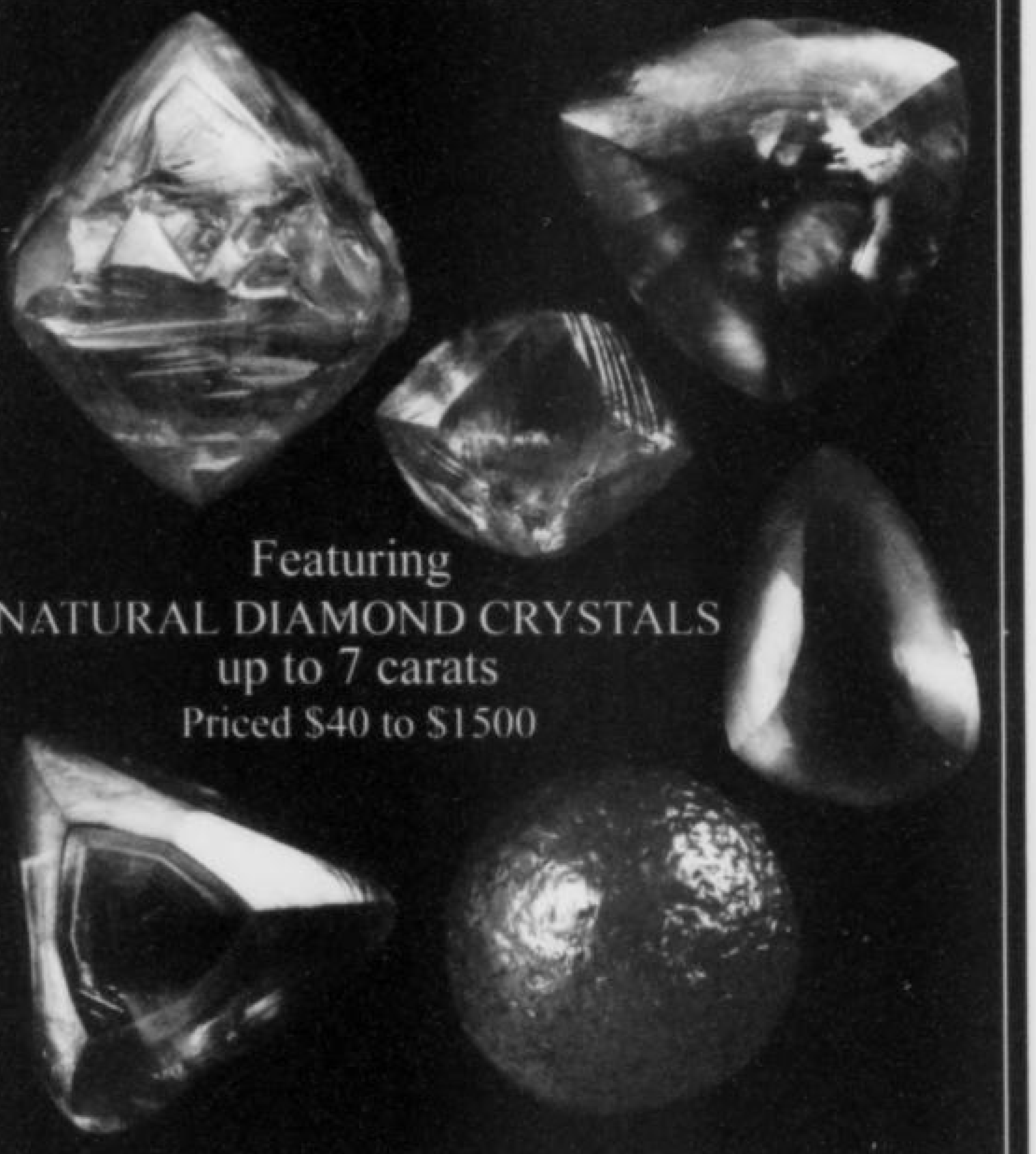

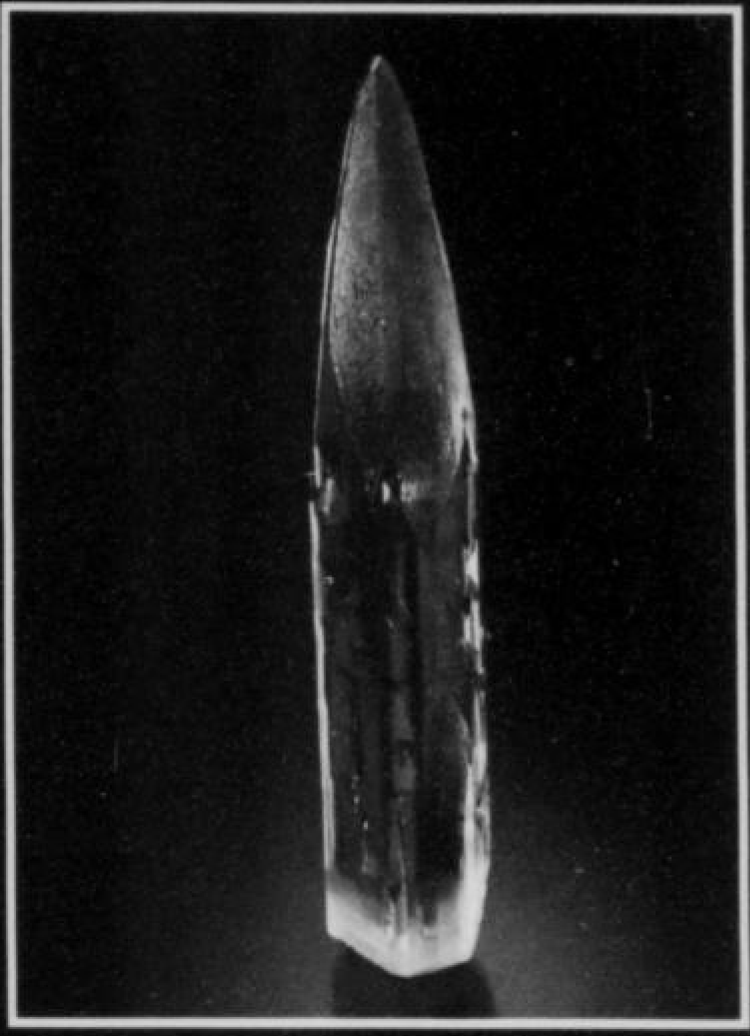


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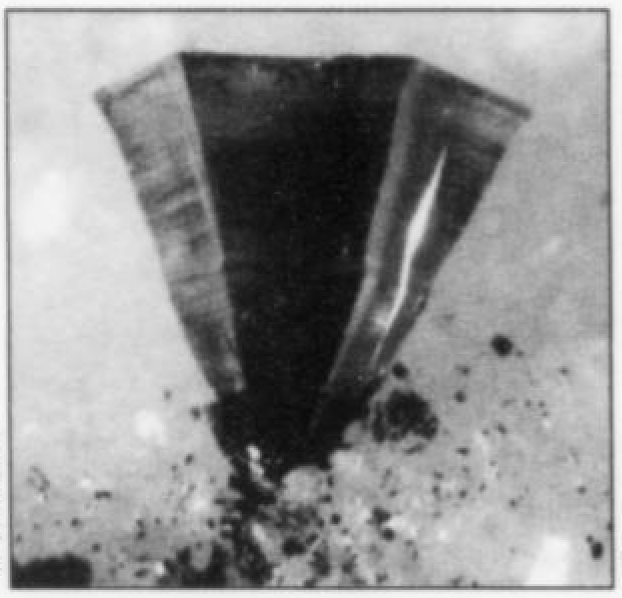
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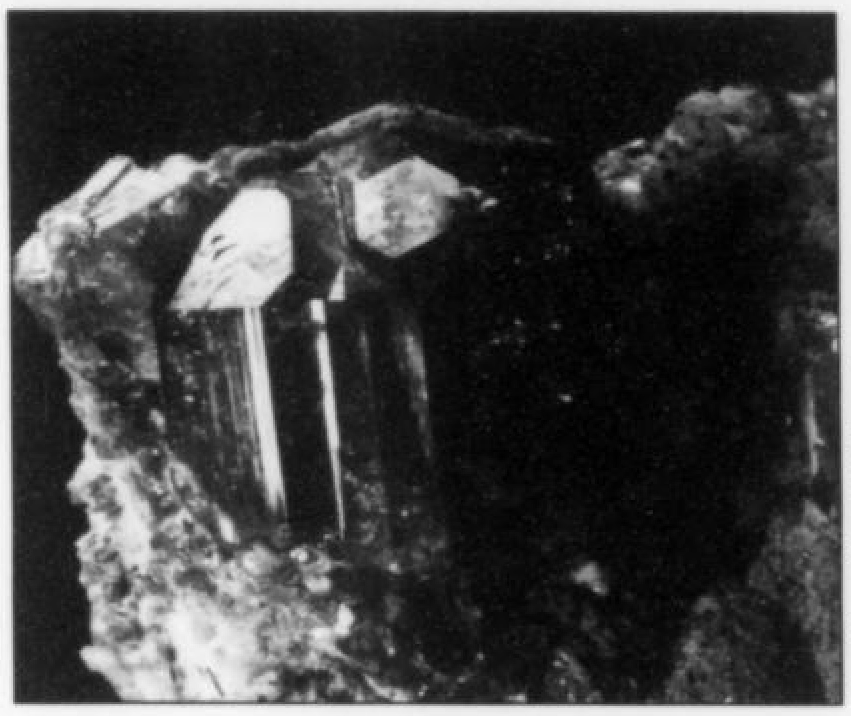

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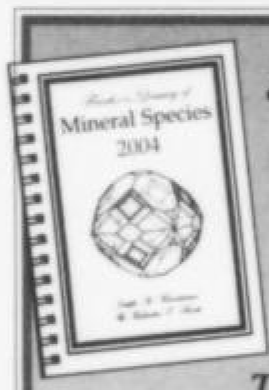

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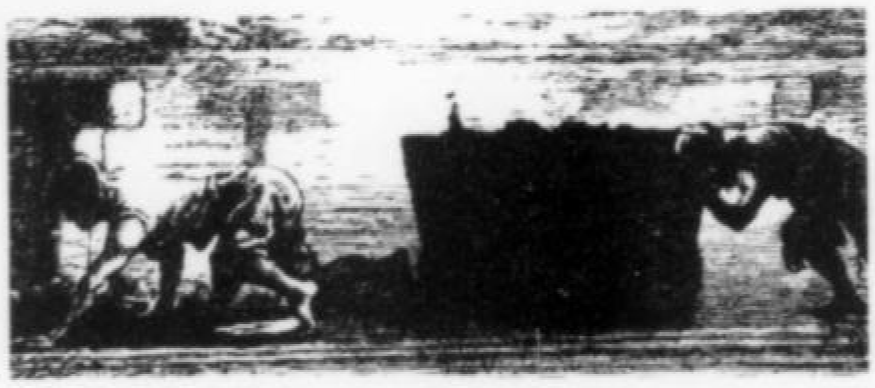

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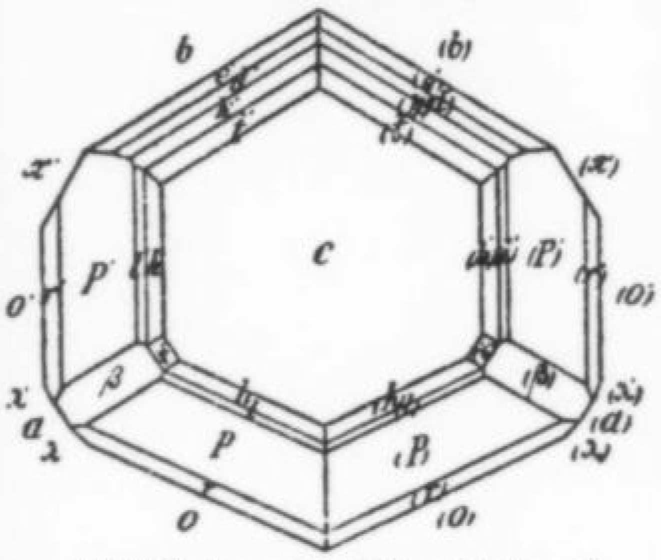

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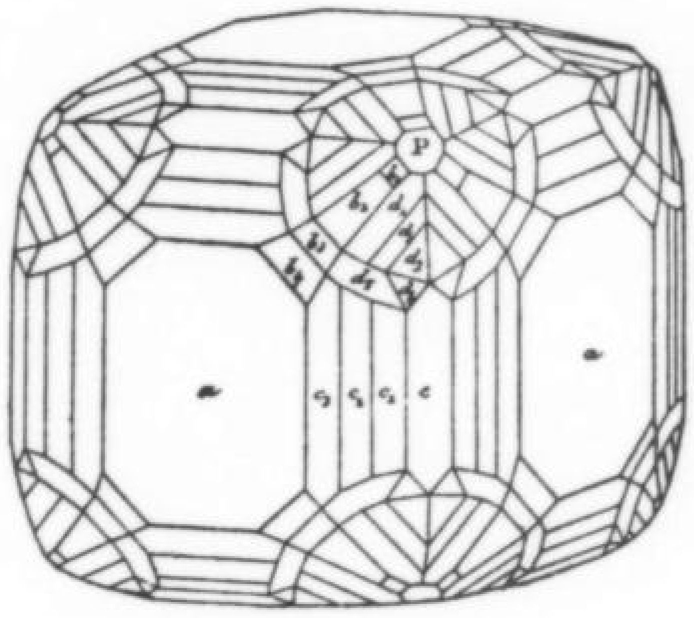

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Alsakharovite-Zn Monoclinic

$NaSrKZn(Ti,Nb)_4[Si_4O_{12}]_2(O,OH)_4 \cdot 7H_2O$

Locality: Lepkhe-Nelm Mt., Lovozero alkaline massif, Kola Peninsula, Russia.

Occurrence: A hydrothermal mineral in cavities of a eudialyte-aegirine-feldspar pegmatite. Associated minerals are: lamprophyllite, natrolite, halloysite, rancéite. kuzmenkoite-Zn, tsepinite-Na, vinogradovite, etc.

General appearance: Coarse, flattened prismatic crystals (up to 8 x 20 x 0.5 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent to transparent. *Color:* white, pale brown, colorless. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* ~5. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* uneven. *Density:* 2.90 g/cm^3 (meas.), 2.94 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *Cm*, *a* 14.495, *b* 13.945, *c* 7.838 Å, β 117.75°, *V* 1402 Å^3, Z 2, *a:b:c* = 1.0394:1:0.5621. Morphology: probably {100} and {001}; elongated along [010]. Twinning: micro-twinning on (001) and ($\bar{4}01$). ***X-ray powder diffraction data:*** 6.96 (100) (020, 001), 3.21 (80) ($40\bar{2}$, $42\bar{1}$, 400), 3.11 (90) (041, 022, 240), 2.60 (35) ($15\bar{1}$, 241, 202), 2.50 (40) ($44\bar{1}$, $40\bar{3}$), 1.74 (30) (080, 004), 1.70 (40) ($46\bar{3}$, $44\bar{4}$, 461, 442). ***Optical data:*** Biaxial (+), α 1.680, β 1.687, γ 1.787, 2V(meas.) 25°, 2V(calc.) 31°; dispersion not observed; nonpleochroic; Y = *b*. ***Chemical analytical data:*** Means of eight sets of electron microprobe data (with H_2O by TGA): Na_2O 2.04, K_2O 2.43, MgO 0.04, CaO 1.48, MnO 0.11, FeO 0.22, ZnO 5.02,SrO 4.49, BaO 3.65, Al_2O_3 0.15, SiO_2 39.23, TiO_2 18.89, Nb_2O_5 12.57, H_2O 11.10, Total 101.42 wt.%. Empirical formula: $(Na_{0.68}Ca_{0.32})_{\Sigma 1.00}(Sr_{0.53}Na_{0.13})_{\Sigma 0.66}(K_{0.63}Ba_{0.29})_{\Sigma 0.92}(Zn_{0.76}Fe_{0.04}Mn_{0.02}$-$Mg_{0.01})_{\Sigma 0.83}(Ti_{2.90}Nb_{1.16})_{\Sigma 4.06}(Si_{8.00}Al_{0.04})_{\Sigma 8.04}O_{24.00}[O_{2.90}(OH)_{1.10}]_{\Sigma 4.00} \cdot 7.00H_2O$. ***Relationship to other species:*** It is a member of the gutkovaite subgroup of the labuntsovite group.

Name: For *Al*eksey S. *Sakharov* (1910–1996), Russian geologist who actively studied the Lovozero alkaline massif. ***Comments:*** IMA No. 2002-003.

PEKOV, I. V., CHUKANOV, N. V., ZADOV, A. E., ROZENBERG, K. A., and RASTSVETAEVA, R. K. (2003) Alsakharovite-Zn, $NaSrKZn(Ti,Nb)_4[Si_4O_{12}]_2(O,OH)_4 \cdot 7H_2O$, a new mineral of the labuntsovite group from Lovozero massif, Kola Peninsula. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132**, 52–58.

Anorthominasragrite Triclinic

$V^{4+}O(SO_4) \cdot 5H_2O$

Locality: North Mesa mine group (west ½, southwest ¼ of section 35, Township 224 South, Range 11 East), Temple Mountain mining district, Emery County, Utah, USA.

Occurrence: In a silicified tree approximately 46 cm wide by 30 cm high surrounded by a rim of coal 6 to 25 mm thick. Associated minerals are: orthominasragrite and bobjonesite.

General appearance: Crusts and spherical granular aggregates (<1 mm across) of irregular grains (<0.1 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* not stated but probably transparent. *Color:* pale blue. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* approximately 1. *Tenacity:* not given. *Cleavage:* none. *Fracture:* not given. *Density:* could not be measured, 2.12 g/cm^3 (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 7.548, *b* 7.805, *c* 7.821 Å, α 79.03°, β 71.94°, γ 65.31°, *V* 397.1 Å^3, Z 2, *a:b:c* = 0.9671:1:1.0020. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.053 (80) (010), 6.617 (100) (100), 5.314 (30) (011), 4.116 (80) ($\bar{1}10$), 3.712 (80) (121, 002, 211), 3.206 (70) (221), 2.934 (50) ($1\bar{1}2$, $\bar{1}02$), 2.555 (30) (131). ***Optical data:*** Biaxial (+), α 1.548, β 1.555, γ 1.574, 2V(meas.) 86°, 2V(calc.) 63°; dispersion not mentioned; nonpleochroic; $X \wedge c \approx 18°$ in obtuse angle β, $Y \approx a$, $Z \wedge b \approx 19°$ in obtuse angle γ. ***Chemical analytical data:*** electron microprobe data: VO_2 33.93, SO_3 30.78, H_2O (35.52), Total (100.23) wt.%. Empirical formula: $V_{1.04}O_{1.08}(SO_4)_{0.98} \cdot 5.00H_2O$. ***Relationship to other species:*** It is the triclinic polymorph of minasragrite (monoclinic) and orthominasragrite (orthorhombic).

Name: For the relationship to minasragrite and orthominasragrite. ***Comments:*** IMA No. 2001-040.

COOPER, M. A., HAWTHORNE, F. C., GRICE, J. D., and HAYNES, P. (2003) Anorthominasragrite, $V^{4+}O(SO_4(H_2O)_5$, a new mineral species from Temple Mountain, Emery County, Utah, U.S.A.: description, crystal structure and hydrogen bonding. *Canadian Mineralogist* **41**, 959–980.

Artsmithite

Monoclinic

$Hg_4^{1+}Al(PO_4)_{2-x}(OH)_{1+3x}$ (x = 0.26)

Locality: The Funderburk prospect (Lat. 34.177° N, Long. 93.659° W) north of Cowhide Cove road, Cowhide Cove Recreation area, on Lake Greeson, approximately 13 km north of Murfeesboro, Pike County, Arkansas, USA.

Occurrence: In fractures in the Jackfork sandstone with cinnabar, quartz and dickite and other mercury minerals (calomel, eglestonite, mercury, metacinnabar, montroydite, terlinguaite).

General appearance: A matted nest (approximately 3 x 1 mm) of randomly scattered fibrous to acicular crystals.

Physical, chemical and crystallographic properties: *Luster:* stated to be vitreous but the optical data indicate adamantine. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* off-white to cream. *Luminescence:* nonfluorescent. *Hardness:* could not be determined. *Tenacity:* needles are flexible. *Cleavage:* none. *Fracture:* irregular. *Density:* could not be measured, 6.37 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *C2/c*, *a* 17.022, *b* 9.074, *c* 7.015 Å, β 101.20°, *V* 1062.9 Å^3, Z 4, *a:b:c* = 1.8759:1:0.7731. Morphology: no forms could be identified. Twinning: none mentioned. ***X-ray powder diffraction data:*** 8.326 (100) (200), 4.739 (50) (310), 2.979 (80) (202), 2.952 (50) $(\bar{4}02)$, 2.784 (80) (600), 2.660 (75) (330), 1.755 (50) $(640, \bar{2}04)$. ***Optical data:*** Biaxial (+), indices of refraction could not be measured but the mean value calculated from the Gladstone-Dale relationship is 1.94 to 1.99, 2V(meas.) approximately 60°, dispersion $r < v$, distinct; parallel extinction and length slow with $Z < c$. ***Chemical analytical data:*** One set of electron microprobe data (with H_2O calculated by stoichiometry): Hg_2O 78.28, Al_2O_3 5.02, P_2O_5 11.39, H_2O (1.63), Total (96.32) wt.%. Empirical formula: $Hg_{3.97}Al_{1.04}(PO_4)_{1.70}(OH)_{1.91}$. ***Relationship to other species:*** None apparent.

Name: For Arthur ("Art") E. Smith (1935–) who collected the mineral. ***Comments:*** IMA No. 2002-039.

ROBERTS, A. C., COOPER, M. A., HAWTHORNE, F. C., GAULT, R. A., GRICE, J. D., and NIKISCHER, A. J. (2003) Artsmithite, a new Hg^{1+}-Al phosphate-hydroxide from the Funderburk prospect, Pike County, Arkansas, U.S.A. *Canadian Mineralogist* **41**, 721–725.

Bobjonesite

Monoclinic

$V^{4+}O(SO_4)(H_2O)_3$

Locality: The North Mesa 5 mine, SW ¼ of section 35, and the adjacent eastern edge of section 34, Township 24 South, Range 11 East, Emery County, Utah, USA.

Occurrence: In a silicified tree in the Shinarump conglomerate. The tree has a rim of coal 6 to 25 mm thick. Associated minerals are: ferricopiapite, kornelite, rozenite, szomolnokite, sulfur, montroseite, anorthominasragrite, orthominasragrite, minasragrite and an unidentified yellow-green hydrated Fe-V sulfate.

General appearance: Crusts and efflorescences with individual grains $\ll$ 1 mm.

Physical, chemical and crystallographic properties: The mineral is unstable in all but the driest air and hydrates easily. Consequently, some of the following properties were determined from synthetic material. *Luster:* vitreous. *Diaphaneity:* Not given but probably transparent to translucent. *Color:* pale blue. *Streak:* pale blue. *Luminescence:* nonfluorescent in ultraviolet light. *Hardness:* approximately 1. *Tenacity:* not given. *Cleavage:* not observed. *Fracture:* not given. *Density:* could not be measured because of the instability of the mineral, 2.28 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, $P2_1/n$, *a* 7.394, *b* 7.411, *c* 12.0597 Å, β 106.55°, *V* 633.5 Å^3, Z 4, *a:b:c* = 0.9977:1:1.6272. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.962 (11) $(\bar{1}01)$, 6.255 (11) (011), 5.795 (100) (002), 5.408 (37) (101), 4.571 (20) (012), 3.881 (48) $(\bar{1}03)$, 3.498 (90) (112), 3.423 (10) (013). ***Optical data:*** Biaxial (+), α 1.555, β 1.561, γ 1.574, 2V(meas.) 72°, 2V(calc.) 69°; dispersion not mentioned; nompleochroic; $X = b$, $Y < a$, $Z \wedge c < 19°$ in obtuse angle β. ***Chemical analytical data:*** Because of the instability of the mineral an electron microprobe analysis could not be carried out. The ideal formula requires: VO_2 38.21, SO_3 36.88, H_2O 24.91, Total 100.00 wt.%. ***Relationship to other species:*** Anorthominasragrite (triclinic), orthominasragrite (orthorhombic) and minasragrite (monoclinic) are polymorphs of the higher hydrate $V^{4+}O(SO_4)(H_2O)_5$.

Name: For Robert (Bob) Jones (1926–) of Cave Creek, Arizona, USA, in recognition of his enormous contribution to the mineralogical community. ***Comments:*** IMA No. 2000-045A. The crystal structure has been determined.

SCHINDLER, M., HAWTHORNE, F. C., HUMINICKI, D. M. C., HAYNES, P., GRICE, J. D., and EVANS, H. T. Jr. (2003) Bobjonesite, $V^{4+}O(SO_4)(H_2O)_3$, a new mineral species from Temple Mountain, Emery County, Utah, U.S.A. *Canadian Mineralogist* **41**, 83–90.

Borocookeite

Monoclinic

$Li_{1+3x}Al_{4-x}(BSi_3)O_{10}(OH,F)_8$

Locality: The Sosedka and Mokhovaya pegmatite veins, Malkhan pegmatite field, Krasny Chikoy area, Chita region, Russia.

Occurrence: In pockets of pegmatites. Associated minerals are: elbaite, lepidolite, danburite, boron-rich muscovite, laumontite, quartz and albite.

General appearance: Massive nearly monomineralic aggregates or thin (0.5 to 2 mm) crusts and snow-like coatings on other minerals.

Physical, chemical and crystallographic properties: *Luster:* greasy. *Diaphaneity:* given as "not transparent," so presumably translucent. *Color:* light gray with a pinkish or yellowish hue. *Streak:* light pinkish gray. *Luminescence:* not given. *Hardness:* 3. *Tenacity:* given as "not elastic." *Cleavage:* {001} perfect. *Fracture:* not observed. *Density:* 2.62 g/cm^3 (meas.), 2.68 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, space group not given but probably *Cc* by analogy with cookeite, *a* 5.110, *b* 8.856, *c* 14.080 Å, β 96.93°, *V* 632.2 Å^3, Z 2, *a:b:c* = 0.5768:1:1.5881. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.05 (50) (002), 4.71 (70) (003), 3.512 (100) (004), 2.807 (20) (005), 2.332 (14) (006), 2.304 (16) (202), 1.946 (17) (204). ***Optical data:*** Biaxial (+), α 1.574, β 1.580, γ 1.591, 2V could not be measured, 2V(calc.) 73°; dispersion not determined; nonpleochroic; Z = elongation. ***Chemical analytical data:*** Analysis by wet chemistry (B_2O_3, BeO, H_2O, F), flame photometry (Li_2O, Rb_2O, Cs_2O) and electron microprobe (SiO_2, TiO_2, Al_2O_3, FeO, MnO, MgO, CaO, K_2O, Na_2O) gave (after deduction of about 2 wt.% quartz and recalculation to 100 wt.%): Li_2O 4.65, Na_2O 0.01, K_2O n.d., Rb_2O 0.004, Cs_2O 0.005, BeO 0.05, MgO 0.04, CaO 0.08, MnO 0.07, FeO 0.06, B_2O_3 4.06, Al_2O_3 41.77, SiO_2 34.19, TiO_2 0.02, H_2O 14.28, F 1.22, sum 100.51, less O=F 0.51, Total 100.51

wt.%. Empirical formula: $(Li_{1.59}Ca_{0.08}Mg_{0.01}Mn_{0.01})_{\Sigma 1.69}Al_{3.68}$-$(Si_{2.90}Al_{0.50}B_{0.59}Be_{0.01})_{\Sigma 4.00}O_{9.59}[(OH)_{8.08}F_{0.33}]_{\Sigma 8.41}$. ***Relationship to other species:*** It is the boron-dominant analogue of cookeite.

Name: For the relationship to cookeite. ***Comments:*** IMA No. 2000-013.

ZAGORSKY, V. Y., PERETYAZHKO, I. S., SAPOZHNIKOV, A. N., ZHUKHLISTOV, A. P., and ZVYAGIN, B. B. (2003) Borocookeite, a new member of the chlorite group from the Malkhan gem tourmaline deposit, Central Transbaikalia, Russia. *American Mineralogist* **88**, 830–836.

Brinrobertsite

Monoclinic

An ordered, mixed layer, dioctahedral pyrophyllite/smectite

Locality: 750 m NE of Penrhyn castle, near Bangor, North Wales, UK.

Occurrence: In a metabentonite within a sequence of dark gray mudstones. Associated minerals are: quartz and a chlorite group mineral.

General appearance: Anhedral grains in aggregates up to 0.02 mm across. Individual grains are less than 1 µm.

Physical, chemical and crystallographic properties: *Luster:* dull to vitreous. *Diaphaneity:* translucent. *Color:* gray to yellowish gray. *Streak:* gray. *Luminescence:* not mentioned. *Hardness:* close to 1. *Tenacity:* not given. *Cleavage:* {001} as observed by TEM. *Fracture:* not given. *Density:* could not be measured or calculated. ***Crystallography:*** Monoclinic or pseudo-monoclinic, d_{100} 5.2, *b* 9.1, d_{001} 24 to 25 Å. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** Air dried: 22.29 (48) (001), 10.99 (100) (002), 7.32 (2) (003), 5.48 (7) (004), 4.47 (3) (005), 3.17 (33) (007), 2.22 (<1) (00.10), 2.01 (4) (00.11), 1.84 (1) (00.12). Glycol-solvated: 26.80 (100) (001), 13.21 (33) (002), 9.02 (9) (003), 6.66 (2) (004), 5.30 (7) (005), 4.48 (3) (006), 3.82 (1) (007), 3.33 (20) (008), 2.97 (3) (009), 2.66 (1) (00.10), 2.46 (<1) (00.11), 2.22 (<1) (00.12), 2.04 (1) (00.13), 1.91 (2) (00.14). ***Optical data:*** none available. ***Chemical analytical data:*** Five sets of XRF data are given. One of these consists of: SiO_2 74.82, Al_2O_3 12.01, TiO_2 0.17, Fe_2O_3 7.66, MgO 1.03, CaO 0.17, Na_2O 1.03, K_2O 0.31, MnO 0.06, P_2O_5 0.02, LOI 3.01, Total 100.30 wt.%. ***Relationship to other species:*** It is made up of pyrophyllite-like and smectite-like units.

Name: For Dr. Brin Roberts, Birkbeck College, University of London, UK. ***Comments:*** IMA No. 1997-040B. Descriptions of interstratified minerals lack many of the usual mineralogical data but the minerals are considered valid species. The designation "RI" in the reference stands for "Reichweite Illite."

DONG, H., PEACOR, D. R., MERRIMAN, R. J., and KEMP, S. J. (2002) Brinrobertsite, a new RI interstratified pyrophyllite/smectite-like clay mineral: characterization and geological origin. *Mineralogical Magazine* **66**, 605–617.

Calderonite

Monoclinic

$Pb_2Fe^{3+}(VO_4)_2(OH)$

Localities: Las Colmenitas and Los Llanos mine, 2 km NW of Santa Marta village (Lat. 38°37′ N, Long. 6°36′ E), Badajoz province, Spain. It also occurs at the La Muda mine, in Azuaga (Lat. 38°20′20″ N, Long. 5°47′30″ E), Badajoz province, Spain; Venus mine, Sierra Gorda, Argentina; Nepomucene mine, Annaberg, Austria.

Occurrence: In the upper oxidation zone of the two Pb-Zn hydrothermal deposits. Associated minerals are: vanadinite and descloizite. Other minerals not directly associated with calderonite are: wulfenite, mimetite, cerussite, beudantite, adamite, hemimorphite, smithsonite, chalcophanite, silver, quartz and Ca-Fe carbonates.

General appearance: Scattered clusters of idiomorphic prismatic crystals up to 1 mm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous to resinous. *Diaphaneity:* semitransparent to translucent. *Color:* deep orange to red brown. *Streak:* red orange. *Luminescence:* nonfluorescent. *Hardness:* between 3 and 4. *Tenacity:* not given. *Cleavage:* not given. *Fracture:* splintery. *Density:* not given, 6.08 g/cm³ (calc.) by the abstractor. ***Crystallography:*** Monoclinic, $P2_1/m$, *a* 7.647, *b* 6.094, *c* 8.900 Å, β 112.0°, *V* 384.5 Å³, Z 2, *a:b:c* = 1.2548:1:1.4605. Morphology: no forms were listed, but the SEM photograph shows several forms. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.893 (43) (011), 4.166 (34) (002), 3.401 (21) $(\bar{2}02)$, 3.242 (100) $(\bar{2}11)$, 3.058 (25) (020), 2.980 (48) $(\bar{1}03)$, 2.746 (48) (003), 2.449 (20) (022). ***Optical data:*** Biaxial (+), indices of refraction not given (the mean index of refraction calculated by the abstractor from the Gladstone-Dale relationship is 2.25), 2V(meas.) 86° given as $2V_x$ which indicates biaxial (−), dispersion strong; pleochroism X = light greenish yellow, Y = brown, Z = reddish brown; orientation not given. ***Chemical analytical data:*** Means of twenty-one sets of electron microprobe data (H_2O by TGA): PbO 61.80, CaO 0.03, BaO 0.32, CuO 0.67, ZnO 0.09, Al_2O_3 0.11, Fe_2O_3 10.12, Mn_2O_3 <0.01, SiO_2 0.33, V_2O_5 23.86, As_2O_5 0.13, P_2O_5 0.57, H_2O 1.91, Total 99.94 wt.%. Empirical formula: $(Pb_{1.95}Ba_{0.01})_{\Sigma 1.96}(Fe^{3+}_{0.89}Cu_{0.06}$-$Al_{0.02}Zn_{0.01})_{\Sigma 0.98}(V_{1.85}P_{0.06}Si_{0.01}As_{0.01})_{\Sigma 1.96}O_{7.51}(OH)_{1.49}$. Ideally, $Pb_2Fe^{3+}(VO_4)_2(OH)$. ***Relationship to other species:*** It is the Pb-, Fe^{3+}-, VO_4- dominant member of the brackebuschite group and, therefore, the Fe^{3+}-dominant analogue of brackebuschite and the Pb-dominant analogue of gamagarite.

Name: For Professor Salvador Calderón (1852–1911). ***Comments:*** IMA No. 2001-022.

DEL TANAGO, J. G., LA IGLESIA, A., RIUS, J., and SANTÍN, S. F. (2003) Calderonite, a new lead-iron-vanadate of the brackebuschite group. *American Mineralogist* **88**, 1703–1708.

Carbokentbrooksite

Trigonal

$(Na,\square)_{12}(Na,Ce)_3Ca_6Mn_3Zr_3Nb(Si_{25}O_{73})(OH)_3(CO_3)\cdot H_2O$

Locality: Dara-i-Pioz alkaline massif, Tajikistan.

Occurrence: In the quartz core of a zoned pegmatite. Associated minerals are: zirsilite-(Ce), quartz, microcline, aegirine, stillwellite-(Ce), ekanite, polylithionite, pyrochlore, fluorite, calcite and galena.

General appearance: As zoned rhombohedral crystals up to 2 cm across, with a carbokentbrooksite core and a zirsilite-(Ce) rim.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* yellow. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* conchoidal. *Density:* 3.14 g/cm³ (meas.), 3.10 g/cm³ (calc.). ***Crystallography:*** Trigonal, *R*3*m*, *a* 14.239, *c* 30.039 Å, *V* 5274 Å³, Z 3, *c:a* = 2.1096. Morphology: {101}, {102}, {010}, {001}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.39 (25) (014), 4.30 (24) (025), 3.394 (23) (035), 3.204 (38) (028), 3.155 (35) (127), 3.019 (34) (042), 2.970 (83) (135), 2.849 (100) (044), 2.590 (30) (039). ***Optical data:*** Uniaxial (−), ω 1.645, ε 1.635, nonpleochroic. ***Chemical analytical data:*** Electron microprobe data: Na_2O 10.17, K_2O 0.51, CaO 10.61, SrO 1.42, MnO 5.41, FeO 2.22, La_2O_3 1.79, Ce_2O_3 2.97, Pr_2O_3 0.24, Nd_2O_3 0.76, Y_2O_3 0.43, SiO_2 45.55, TiO_2 0.41, ZrO_2 11.07, Nb_2O_5 3.55, H_2O 1.18, Cl 0.29, CO_2 0.29, sum 99.36, less O = Cl 0.06, Total 99.30 wt.%. Empirical formula: $(Na_{9.48}Ca_{0.94}K_{0.36})_{\Sigma 10.78}(Na_{1.39}Sr_{0.45}Ce_{0.60}La_{0.36}Nd_{0.15}Pr_{0.05})_{\Sigma 3.00}(Ca_{5.32}Mn_{0.55}Y_{0.13})_{\Sigma 6.00}(Zr_{2.97}Ti_{0.03})_{\Sigma 3.00}(Nb_{0.88}Ti_{0.14})_{\Sigma 1.02}Si_{25.11}O_{73.62}[(OH)_{4.34}Cl_{0.27}]_{\Sigma 4.61}(CO_3)_{0.59}$. ***Relationship to other species:*** It is a member of the eudialyte group.

Name: For the relationship with kentbrooksite. ***Comments:*** IMA No. 2002-056. The indexing of the powder pattern in the paper is somewhat different from that given here.

KHOMYAKOV, A. P., DUSMATOV, V. D., FERRARIS, G., GULA, A., IVALDI, G., and NECHELYUSTOV, G. N. (2003) Zirsilite-(Ce), $(Na,\square)_{12}(Ce,Na)_3Ca_6Mn_3Zr_3Nb(Si_{25}O_{73})(OH)_3(CO_3)\cdot H_2O$ and Carbokentbrooksite, $(Na,\square)_{12}(Na,Ce)_3Ca_6Mn_3Zr_3Nb(Si_{25}O_{73})(OH)_3(CO_3)\cdot H_2O$, two new eudialyte group minerals from Dara-i-Pioz alkaline massif, Tajikistan. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132(5)**, 40–51.

Cattiite Triclinic

$Mg_3(PO_4)_2\cdot 22H_2O$

Locality: Zhelezny Mine, Kovdor Massif, Kola Peninsula, Russia.

Occurrence: In cavities in dolomite carbonatite. Associated minerals are: dolomite, bakhchisaraitsevite, nastrophite, magnetite, sjögrenite and carbonate-fluorapatite.

General appearance: Crystalline masses up to 1.5 cm.

Physical, chemical and crystallographic properties: *Luster:* vitreous, pearly on cleavages. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* not observed. *Hardness:* 2. *Tenacity:* not mentioned. *Cleavage:* {001} perfect. *Fracture:* uneven. *Density:* 1.65 g/cm³ (meas.), 1.64 g/cm³ (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 6.932, *b* 6.925, *c* 16.154 Å, α 82.21°, β 89.70°, γ 119.51°, *V* 666.3 Å³, Z 1, *a*:*b*:*c* = 1.0010:1:2.3327. Morphology: {001}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.98 (100) (002), 5.32 (63) (003), 3.19 (45) ($1\bar{1}4$), 2.896 (33) (202), 2.867 (30) ($\bar{2}22$), 2.728 (32) ($1\bar{1}5$), 2.658 (37) (006). ***Optical data:*** Biaxial (−), α 1.459, β 1.470, γ 1.470, 2V(meas.) 25°, 2V(calc.) 0°; dispersion $r < v$, weak; nonpleochroic; $X \wedge c = 80°$, $Y \wedge a = 10°$, $Z \wedge c = 90°$, optic axial plane close to (001). ***Chemical analytical data:*** A wet chemical analysis of a 243.5 mg sample (H_2O by weight loss at 1000°C) gave: MgO 18.0, FeO 0.1, P_2O_5 21.8, H_2O 60.8, Total 100.7 wt.%. Empirical formula: $(Mg_{2.92}Fe_{0.01})_{\Sigma 2.93}(PO_4)_{2.01}\cdot 22.05H_2O$. ***Relationship to other species:*** It is the natural -1*A*2 polytype of synthetic $Mg_3(PO_4)_2\cdot 22H_2O$.

Name: For Michele Catti (1945–), Professor of Physical Chemistry, University of Milano Bicocca, Italy, for his contributions to the crystal chemistry of hydrated oxysalts. ***Comments:*** IMA No. 2000-032.

BRITVIN, S. N., FERRARIS, G., IVALDI, G., BOGDANOVA, A. N., and CHUKANOV, N. V (2002) Cattiite, $Mg_3(PO_4)_2\cdot 22H_2O$, a new mineral from Zhelezny Mine (Kovdor Massif, Kola Peninsula, Russia). *Neues Jahrbuch für Mineralogie, Monatshefte* **2002**, 160–168.

Cavoite Orthorhombic

CaV_3O_7

Locality: Gambatesa mine, near Reppia, northern Appenines, Val Graveglia, Liguria, Italy.

Occurrence: In micro-cavities in massive bands of caryopilite + calcian rhodochrosite ± quartz. Another associated mineral is an unidentified silicate.

General appearance: Very rare radiated aggregates of strongly elongated prismatic to acicular crystals up to about 0.28 mm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous to adamantine. *Diaphaneity:* transparent. *Color:* colorless to olive green-brown. *Streak:* near white. *Luminescence:* nonfluorescent. *Hardness:* could not be determined. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* not mentioned. *Density:* could not be determined, 3.51 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, *Pnam*, *a* 10.42, *b* 5.28, *c* 10.34 Å, *V* 568.2 Å³, Z 4, *a*:*b*:*c* = 1.9735:1:1.9583. Morphology: no forms were mentioned. Twinning: none observed. ***X-ray powder diffraction data:*** 5.16 (M) (200), 3.45 (W) (211, 112), 3.00 (S) (212), 2.88 (W) (013, 203), 1.85 (M) (024), 1.56 (W) (612, 033, 216). ***Optical data:*** could not be determined but a value of about 2 was measured roughly for the index of refraction. ***Chemical analytical data:*** Means of ten sets of electron microprobe data: K_2O 0.35, CaO 17.76, MnO 0.70, SiO_2 4.31, VO_2 76.80, Total 99.92 wt.%. Empirical formula: $(Ca_{0.95}Mn_{0.03}K_{0.02})_{\Sigma 1.00}(V_{2.79}Si_{0.22})_{\Sigma 3.01}O_{7.00}$. ***Relationship to other species:*** It is the natural analogue of synthetic CaV_3O_7.

Name: For the chemical composition, *ca*lcium, *v*anadium, *o*xygen. ***Comments:*** IMA No. 2001-024.

BASSO, R., LUCCHETTI, G., MARTINELLI, A., and PALENZONA, A. (2003) Cavoite, Ca_3O_7, a new mineral from the Gambatesa mine, northern Appenines, Italy. *European Journal of Mineralogy* **15**, 181–184.

Čejkaite Triclinic

$Na_4(UO_2)(CO_3)_3$

Locality: The Geschieber vein, Svornost mine, Jáchymov, NW Bohemia, Czech Republic.

Occurrence: An efflorescence on a calcite vein with disintegrated uraninite in a single specimen. Secondary associated minerals are andersonite and schröckingerite but they are not in direct contact with čejkaite.

General appearance: An earthy efflorescence consisting of crystals from 0.2 to 0.6 µm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* not observed. *Color:* pale yellow to beige. *Streak:* light yellow. *Luminescence:* fluoresces weak yellow to yellow-green in short- and long-wave ultraviolet light. *Hardness:* could not be determined. *Tenacity:* could not be determined. *Cleavage:* could not be determined. *Fracture:* could not be determined. *Density:* 3.67 g/cm³ (meas.), 3.77 g/cm³ (calc.). ***Crystallography:*** Triclinic, *P*1 or $P\bar{1}$, *a* 9.291, *b* 9.292, *c* 12.895 Å, α 90.73°, β 90.82°, γ 120.00°, *V* 963.7 Å³, Z 4, *a*:*b*:*c* = 0.9999:1:1.3878. Morphology: no forms were identified, but individual crystallites display indistinct hexagonal morphology in TEM images. Twinning: none mentioned. ***X-ray powder diffraction data:*** 8.022 (92) ($1\bar{1}0$, 010, 100), 5.080 (57) ($\bar{1}02$, $0\bar{1}2$), 5.024 (60) ($\bar{1}12$, $1\bar{1}2$), 4.967 (68) (012, 102), 4.639 (100) ($1\bar{2}0$, $2\bar{1}0$, 110), 3.221 (63) (004), 2.681 (60) ($3\bar{3}0$, $\bar{1}\bar{1}4$, 030, 300). ***Optical data:*** could not be determined due to the extremely small grain size. The mean index of refraction derived from Gladstone-Dale calculations is 1.5825 which is consistent with the mean index of refraction measured for the trigonal polymorph of čejkaite. ***Chemical analytical data:*** A combination of ICP MS and thermal analysis (with CO_2 by difference) gave: Na_2O 21.39, MgO 0.15, FeO 0.53, UO_3 53.93, CO_2 (24.00), Total (100.00) wt.%. Empirical formula: $(Na_{3.77}Fe_{0.04}Mg_{0.02})_{\Sigma 3.83}(UO_2)_{1.03}(CO_3)_{2.98}$. ***Relationship to other species:*** It is structurally similar to synthetic trigonal $Na_4(UO_2)(CO_3)_3$.

Name: For Dr. Jiří Čejka (1929–), former Director of the Museum of Natural History of the National Museum in Prague, in recognition of his numerous contributions to the crystal chemistry of uranium minerals. ***Comments:*** IMA No. 1999-045.

ONDRUŠ, P., SKÁLA, R. VESELOVSKÝ, F., SEJKORA, J., and VITTI, C. (2003) Čejkaite, the triclinic polymorph of $Na_4(UO_2)(CO_3)_3$—a new mineral from Jáchymov, Czech Republic. *American Mineralogist* **88**, 686–693.

Clinobarylite

Monoclinic

$BaBe_2Si_2O_7$

Locality: Yukspor Mt., Khibiny massif, Kola Peninsula, Russia.

Occurrence: In four alkaline pegmatite veins. Associated minerals are: natrolite, aegirine, microcline, catapleiite, fluorapatite, titanite, fluorite, galena, sphalerite, strontianite, annite, astrophyllite, lorenzenite, labuntsovite-Mn, kuzmenkoite-Mn, cerite-(Ce), edingtonite, ilmenite and calcite.

General appearance: Platy to prismatic crystals (up to 20 x 4 x 1 mm) and radiated aggregates.

Physical, chemical and crystallographic properties: *Luster:* strong vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 6½. *Tenacity:* brittle. *Cleavage:* {100} perfect, {001} and {101} less perfect. *Fracture:* uneven. *Density:* 3.97 g/cm³ (meas.), 4.10 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *Pm*, *a* 11.618, *b* 4.904, *c* 4.655 Å, β 89.94°, *V* 265.2 Å³, Z 2, *a:b:c* = 2.3691:1:0.9492. Morphology: {100}, {010}, {201}, {$\bar{2}01$}; less common forms are {610}, {101}, {$\bar{1}01$}. Twinning: micro-twinning about [010]. ***X-ray powder diffraction data:*** 3.389 (84) (011), 3.249 (45) (111, $11\bar{1}$), 3.043 (40) (310), 2.926 (55) (211, $21\bar{1}$), 2.458 (100) (020), 2.335 (48) (002). ***Optical data:*** Biaxial (+), α 1.698, β 1.700, γ 1.705, 2V(meas.) 70°, 2V(calc.) 65°; dispersion not observed; nonpleochroic; X ∧ *a* = 6°, Y ∧ *c* 5.5°, Z = *b*. ***Chemical analytical data:*** Means of four sets of electron microprobe data (BeO by atomic emission): BaO 47.66, BeO 14.90, SiO_2 36.38, Total 98.94 wt.%. Empirical formula: $Ba_{1.03}Be_{1.97}Si_{2.00}O_{7.00}$. ***Relationship to other species:*** It is the monoclinic dimorph of barylite (orthorhombic).

Name: For the relationship to barylite. ***Comments:*** IMA No. 2002-015.

CHUKANOV, N. V., PEKOV, I. V., RASTSVETAEVA, R. K., CHILOV, G. V., and ZADOV, A. E. (2003) Clinobarylite, $BaBe_2Si_2O_7$, a new mineral from Khibiny massif, Kola Peninsula. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132**, 29–37.

Diversilite-(Ce)

Trigonal

$Na_2(Ba,K)_6Ce_2Fe^{2+}Ti_3[Si_3O_9]_3[SiO_3OH]_3(OH,H_2O)_9$

Locality: Mt. Yukspor, Khibiny alkaline massif, Kola Peninsula, Russia.

Occurrence: In a strongly mineralized rischorrite-ijolite-urtite pegmatite. Associated minerals are: nepheline, sodalite, potassium feldspar, natrolite, pectolite, aegirine, shcherbakovite, lamprophyllite, magnesium astrophyllite, delindeite, wadeite, umbite and kostylevite.

General appearance: A fan-shaped intergrowth (2 to 3 mm) of subhedral platy crystals (1 to 2 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* yellowish orange. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* conchoidal. *Density:* 3.68 g/cm³ (meas.), 3.75 g/cm³ (calc.). ***Crystallography:*** Trigonal, $R\bar{3}$, *a* 10.713, *c* 60.67 Å, *V* 6030 Å³, Z 6, *c:a* = 5.6632. Morphology: {001}. Twinning: none observed. ***X-ray powder diffraction data:*** 10.12 (27) (006), 3.236 (100) (1.1.15), 3.094 (21) (300), 2.654 (38) (223), 2.642 (44) (3.0.12), 2.234 (19) (2.2.15), 2.026 (61) (0.0.30). ***Optical data:*** Uniaxial (+), ω 1.705, ε 1.708, pleochroism strong, O = pale yellow, E = yellowish orange. ***Chemical analytical data:*** Means of three sets of electron microprobe data: Na_2O 2.76, K_2O 5.81, CaO 0.10, MnO 1.09, FeO 3.10, SrO 0.42, BaO 24.85, La_2O_3 4.84, Ce_2O_3 6.72, Pr_2O_3 0.74, Nd_2O_3 1.21, Sm_2O_3 0.16, SiO_2 32.46, TiO_2 9.17, Nb_2O_5 1.62, H_2O 6.15, Total 101.20 wt.%. Empirical formula: $Na_{2.00}(Ba_{3.64}K_{2.77})_{\Sigma 6.41}(Ce_{0.92}La_{0.67}Nd_{0.16}Pr_{0.10}Sm_{0.02}Mn_{0.16}Sr_{0.09}Ca_{0.04})_{\Sigma 2.16}(Fe_{0.97}Mn_{0.03})_{\Sigma 1.00}(Ti_{2.58}Nb_{0.27}Mn_{0.15})_{\Sigma 3.00}Si_{12.12}O_{36.36}[(OH)_{7.97}(H_2O)_{3.67})_{\Sigma 11.64}$. The crystallochemical formula is $Na_2(Ba,K)_6Ce_2FeTi_3[Si_3O_9]_3[SiO_3OH]_3(OH,H_2O)_9$. ***Relationship to other species:*** It is chemically similar to ilímaussite-(Ce) and joaquinite-(Ce).

Name: From the Latin *diver*sus (heterogeneous) and *sil*icate reflecting its main structural features and its composition. ***Comments:*** IMA No. 2002-043.

KHOMYAKOV, A. P., NECHELYUSTOV, G. N., RASTSVETAEVA, R. K., and MA ZHESHENG (2003) Diversilite-(Ce), $Na_2(Ba,K)_6Ce_2Fe^{2+}Ti_3[Si_3O_9]_3[SiO_3OH]_3(OH,H_2O)_9$, a new silicate with heterogeneous tetrahedral complexes from the Khibina alkaline massif, Kola Peninsula, Russia. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132(5)**, 34–39.

Eveslogite

Monoclinic

$(Ca,K,Na,Sr,Ba)_{48}[(Ti,Nb,Fe,Mn)_{12}(OH)_{12}Si_{48}O_{144}](F,OH,Cl)_{14}$

Locality: Mt. Eveslogchorr, Khibiny alkaline massif, Kola Peninsula, Russia.

Occurrence: As a monomineralic veinlet cross-cutting poikilitic nepheline syenite. Associated minerals are: nepheline, potassium feldspar, biotite, shcherbakovite, astrophyllite, fluorapatite.

General appearance: Subparallel intergrowths of fine-fibrous crystals (up to 0.005 mm thick and 5 cm long); aggregates 10 to 15 cm across.

Physical, chemical and crystallographic properties: *Luster:* silky. *Diaphaneity:* translucent. *Color:* light brown, yellow. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* {001} perfect (mica-like), {010} good. *Fracture:* splintery or fibrous. *Density:* 2.85 g/cm³ (meas.), 2.91 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *P2/m* (?), *a* 14.069, *b* 24.937, *c* 44.31 Å, γ 95.02°, *V* 15,486 Å³, Z 4, *a:b:c* = 0.5642:1:1.7769. Morphology: {001}, flattened on {001} and elongated along [100]. Twinning: none observed. ***X-ray powder diffraction data:*** 12.33 (51) (020), 6.199 (42) (040), 3.127 (65) ($\bar{4}26$), 3.110 (52) ($\bar{3}64$), 2.990 (59) (2.3.12), 2.940 (45) ($\bar{2}$.4.12), 2.835 (100) (428). ***Optical data:*** Biaxial (−), α 1.631, β 1.641, γ 1.647, 2V(meas.) 82°, 2V(calc.) 75°; dispersion not observed; pleochroism marked, X colorless, Y and Z yellow, Z < Y > X; X < *a*, Y ∧ *c* = 5° in obtuse angle β, Z = *b* (the authors give X < *a*, Y = *c*, Z ∧ *b* = 5° in obtuse angle γ, but this is not possible in a monoclinic crystal). ***Chemical analytical data:*** Wet chemical analysis gave: Na_2O 4.59, K_2O 8.53, Rb_2O 0.20, CaO 18.60, SrO 2.75, BaO 2.84, MnO 1.00, FeO 0.88, Al_2O_3 0.32, Fe_2O_3 0.23, TiO_2 6.52, ZrO_2 0.35, Nb_2O_5 6.56, Ta_2O_5 0.25,

SiO_2 41.96, H_2O 2.85, F 2.72, Cl 0.42, sum 101.57, less O=F+Cl 1.24, Total 100.33 wt.%. Empirical formula: $(Ca_{22.46}K_{12.27}Na_{10.03}Sr_{1.80}Ba_{1.25})_{\Sigma 47.81}(Ti_{5.53}Nb_{3.34}Mn_{0.95}Fe^{2+}_{0.83}Fe^{3+}_{0.20}Zr_{0.19}Rb_{0.14}Ta_{0.08})_{\Sigma 11.26}(OH)_{12.00}(Si_{47.30}Al_{0.43})_{\Sigma 47.73}[O_{138.08}(OH)_{9.42}F_{9.70}Cl_{0.80}]_{\Sigma 158.00}$. ***Relationship to other species:*** It is a mixed-layered titanosilicate with an astrophyllite-like structure.

Name: For the locality. ***Comments:*** IMA No. 2001-023A.

MENSHIKOV, Yu. P., KHOMYAKOV, A. P., FERRARIS, G., BELLUSO, E., GULA, A., and KULCHITSKAYA, E. A. (2003) Eveslogite, $(Ca,K,Na,Sr,Ba)_{48}[(Ti,Nb,Fe,Mn)_{12}(OH)_{12}Si_{48}O_{144}](F,OH,Cl)_{14}$, a new mineral from the Khibiny alkaline massif, Kola Peninsula, Russia. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132**, 59–67.

Ferrohögbomite-2*N*2*S*

Hexagonal

$(Fe^{2+}_3ZnMgAl)_{\Sigma 6}(Al_{14}Fe^{3+}Ti^{4+})_{\Sigma 16}O_{30}(OH)_2$

Locality: Aïn Taïba, at the northwestern edge of Grand Erg Oriental, Sahara Desert, Algeria (Lat. 30°16.44′ N, Long. 5°48.94′ E. 227 m above sea level). The mineral also has been found at the following localities: Lusaka, Zambia; Strangways Range, central Australia; Benson mine, Adirondack Mountains, New York, USA; Prince Olav Coast, east Antarctica.

Occurrence: At the type locality (Aïn Taïba) the mineral was found in an isolated rock. Associated minerals are: hematite, ilmenite, pseudorutile, magnetite and hercynite.

General appearance: Euhedral grains up to 0.3 mm along grain boundaries and in fissures within ilmenite, pseudorutile and hematite. Some grains are closely associated with hercynite.

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* translucent. *Color:* reddish brown. *Streak:* brownish. *Luminescence:* nonfluorescent. *Hardness:* 6 to 7. *Tenacity:* brittle. *Cleavage:* {001} pronounced. *Fracture:* conchoidal. *Density:* could not be measured because the mineral is intergrown with other minerals, 4.04 g/cm³ (calc.). ***Crystallography:*** Hexagonal, $P6_3mc$, *a* 5.712, *c* 18.317 Å, *V* 517.6 Å³, Z 1, *c:a* = 3.2068. Morphology: no forms were observed. Twinning: By merohedry with the inversion center as the twinning operation. ***X-ray powder diffraction data:*** 2.867 (38) (110), 2.608 (66) (016), 2.433 (91) (114), 2.058 (34) (025), 1.601 (60) (126, 003), 1.557 (35) (034), 1.478 (78) (0.2.10), 1.434 (100) (220). See COMMENTS. ***Optical data:*** Uniaxial (−), indices of refraction could not be measured (material of similar composition has ω 1.852, ε 1.827), pleochroic from orange-brown to yellow. ***Chemical analytical data:*** Means of 32 sets of electron microprobe data (Fe_2O_3 and FeO calculated from total FeO to give charge balance; H_2O calculated to give 2H): MgO 3.27, CaO 0.02, MnO 0.25, FeO 16.35, NiO 0.05, ZnO 5.88, Al_2O_3 59.28, Cr_2O_3 0.09, Fe_2O_3 8.05, Ga_2O_3 0.25, SiO_2 0.04, TiO_2 5.04, SnO_2 0.38, H_2O (1.42), Total (100.37) wt.%. Empirical formula: $(Fe^{2+}_{2.91}Zn_{0.93}Mg_{1.04}Mn_{0.05}Ni_{0.01}Al_{1.06})_{\Sigma 6.00}(Al_{13.84}Fe^{3+}_{1.29}Ti_{0.81}Ga_{0.03}Sn_{0.03}Cr^{3+}_{0.02}Si_{0.01})_{\Sigma 16.03}O_{28.98}(OH)_{2.02}$. ***Relationship to other species:*** It is the Fe^{2+}-dominant, -2*N*2*S* polysome of the högbomite group.

Name: Given in compliance with the approved nomenclature of the högbomite group. This mineral formerly was known as "högbomite-8*H*." ***Comments:*** IMA No. 2001-048. The X-ray powder diffraction data were calculated and compare very well with data measured for material of similar composition.

HEJNIY, C., GNOS, E., GROBETY, B., and ARMBRUSTER, T. (2002) Crystal chemistry of the polysome ferrohögbomite-2*N*2*S*, a long-known but newly defined mineral species. *European Journal of Mineralogy* **14**, 957–967.

Ferrokentbrooksite

Trigonal

$Na_{15}Ca_6(Fe,Mn)_3Zr_3NbSi_{25}O_{73}(O,OH,H_2O)_3(Cl,F,OH)_2$

Locality: Poudrette Quarry, Mont Saint-Hilaire, Rouville County, Quebec, Canada. The mineral also has been found at the following localities: Narssârssuk Pegmatite, Igaliko alkaline complex, southwestern Greenland; Langesundfjord area, Norway (at Brønnebukta, Siktesøya; Barkevik Strand; and the Bjørndalen quarry, Tvedalen); Kariåsen, Sandefjord area, Norway; the Burpala alkaline complex, Baikal area, Russia.

Occurrence: It is a primary but late-stage phase found in a small pegmatite dike in nepheline syenite. Associated minerals are: microcline, nepheline (partially altered to natrolite), fluorite, natrolite, gonnardite, rhodochrosite, aegirine, albite, calcite, sérandite, ancylite-(Ce) and catapleiite.

General appearance: Pseudo-octahedral crystals up to 1 cm in diameter, but much larger crystals and masses have been found in other dikes.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* reddish brown to red. *Streak:* white. *Luminescence:* nonfluorescent in ultraviolet light. *Hardness:* 5 to 6. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* uneven to conchoidal. *Density:* 3.06 g/cm³ (meas.), 3.06 g/cm³ (calc.). ***Crystallography:*** Trigonal, *R*3*m*, *a* 14.2099, *c* 30.067 Å, *V* 5257.7 Å³, Z 3, *c:a* = 2.1159. Morphology: {001}, {101} and {012} are dominant; {021} and {110} are minor. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.104 (38) (110), 5.694 (50) (202), 4.300 (43) (205), 3.955 (31) (214), 3.391 (51) (131), 3.207 (31) (208), 3.155 (31) (217), 2.968 (100) (315), 2.847 (98) (404), 1.776 (31) (440). ***Optical data:*** Uniaxial (−), ω 1.6221, ε 1.6186, nonpleochroic. ***Chemical analytical data:*** Means of two sets of electron microprobe data: Na_2O 11.96, K_2O 0.44, CaO 7.99, MnO 3.88, FeO 5.08, SrO 0.45, Al_2O_3 0.11, Y_2O_3 0.58, La_2O_3 1.51, Ce_2O_3 2.51, Nd_2O_3 0.53, Sm_2O_3 0.11, Gd_2O_3 0.17, SiO_2 44.70, TiO_2 0.09, ZrO_2 11.20, HfO_2 0.17, Nb_2O_5 2.51, Ta_2O_5 0.16, H_2O 0.35, F 0.40, Cl 0.93, sum 95.83, less O = F + Cl 0.38, Total 95.45 wt.%. Empirical formula (based on 77.47 anions determined in the crystal structure with H_2O calculated by stoichiometry): $(Ma_{13.05}\mathit{REE}_{0.99}K_{0.32}Ca_{0.23}Sr_{0.15})_{\Sigma 14.74}(Ca_{4.59}Mn_{1.24}Y_{0.17})_{\Sigma 6.00}(Fe_{2.39}Mn_{0.61})_{\Sigma 3.00}(Zr_{3.00}Ti_{0.04}Hf_{0.03})_{\Sigma 3.07}(Nb_{0.64}Si_{0.23}Zr_{0.07}Ta_{0.02})_{\Sigma 0.96}(Si_{24.93}Al_{0.07})_{\Sigma 25.00}O_{73.00}(O,OH,H_2O)_{\Sigma 2.47}[Cl_{0.89}F_{0.71}(OH)_{0.40}]_{\Sigma 2.00}$. ***Relationship to other species:*** It is a member of the eudialyte group, specifically the Fe^{2+}-dominant analogue of kentbrooksite, $Na_{15}Ca_6Mn_3Zr_3NbSi_{25}O_{74}F_2$.

Name: For the relationship to kentbrooksite. ***Comments:*** IMA No. 1999-046. The crystal structure has been solved.

JOHNSEN, O., GRICE, J. D., and GAULT, R. A. (2003) Ferrokentbrooksite, a new member of the eudialyte group from Mont Saint-Hilaire, Quebec, Canada. *Canadian Mineralogist* **41**, 55–60.

Ferrosaponite

Monoclinic

$Ca_{0.3}(Fe^{2+},Mg,Fe^{3+})_3(Si,Al)_4O_{10}(OH)_2\cdot 4H_2O$

Locality: Levoberezhye Iceland spar deposit, Nizhnyaya Tunguska River, Evenkiya, Siberia, Russia.

Occurrence: A hydrothermal mineral related to basalt pillow lavas. Associated minerals are: calcite, pyrite, chalcedony, mordenite, heulandite-Ca and stilbite-Ca.

General appearance: Spherulites up to 2 mm in diameter in transparent calcite.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* dark green. *Streak:* green. *Luminescence:* nonfluorescent. *Hardness:* 2. *Tenacity:* sectile. *Cleavage:* {001} perfect. *Fracture:* uneven. *Density:* 2.49 g/cm³ (meas.), 2.39 g/cm³ (calc.) see COMMENTS. ***Crystallography:*** Monoclinic, space group unknown but probably a *C*-cell see COMMENTS, *a* 5.365, *b* 9.337, *c* 14.65 Å, β 94.9°, *V* 731 Å³, Z 2, *a:b:c* = 0.5746:1:1.5690. Morphology: no forms were mentioned. Twinning: none observed. ***X-ray powder diffraction data:*** 7.37 (90) (002), 4.72 (90) (020), 3.80 (80) (112), 3.03 (100) (031), 2.585 (90) (201), 2.429 (90) (006), 1.549 (90) (060). ***Optical data:*** Biaxial (−), α 1.282 see COMMENTS, β 1.641, γ 1.642, 2V(meas.) 5°, dispersion not observed; pleochroic brown, Z > Y; X < *c*. ***Chemical analytical data:*** Means of five sets of electron microprobe data (with H_2O by TGA): Na_2O 0.21, K_2O 0.07, MgO 6.62, CaO 3.31, FeO 21.23, Al_2O_3 9.95, Fe_2O_3 8.78, SiO_2 33.15, H_2O 17.92, Total 101.24 wt.%. Empirical formula: $(Ca_{0.31}Na_{0.04}K_{0.01})_{\Sigma 0.36}(Fe^{2+}_{1.54}M_{0.85}Fe^{3+}_{0.45})_{\Sigma 2.84}$-$(Si_{2.87}Al_{1.01}Fe^{3+}_{0.12})_{\Sigma 4.00}O_{9.67}(OH)_{2.33}\cdot 4.00H_2O$. ***Relationship to other species:*** It is a member of the smectite group, specifically the Fe^{2+}-dominant analogue of saponite.

Name: For the relationship to saponite. ***Comments:*** IMA No. 2002-028. There are some inconsistencies in this description: (1) the authors give the calculated density as 2.435 g/cm³, using the given unit cell and chemical data a value of 2.39 g/cm³ is calculated; (2) The authors state that the unit cell probably is *P*-centered but by analogy with saponite it should be *C*-centered; (3) the α index of refraction is given as 1.448 and stated to have been calculated by the Gladstone-Dale relationship but no explanation of how this was done is given, the value α 1.282 was calculated here from β, γ and 2V.

CHUKANOV, N. V., PEKOV, I. V., ZADOV, A. E., CHUKANOVA, V. N., and MÖKKEL, S. (2003) Ferrosaponite $Ca_{0.3}(Fe^{2+},Mg,$-$Fe^{3+})_3(Si,Al)_4O_{10}(OH)_2\cdot 4H_2O$, the new trioctahedral smectite. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132**, 68–74.

Galgenbergite-(Ce)

Triclinic

$Ca(REE)_2(CO_3)_4\cdot H_2O$

Locality: The railroad tunnel Galgenberg, Jassing, between Leoben and St. Michael, Styria, Austria (Lat. 47°20′48″ N, Long. 15°2′19″ E, altitude 570 m above sea level).

Occurrence: In small fissures of an albite-chlorite schist. Associated minerals are: calcite, siderite, pyrite and kaolinite.

General appearance: Rosette aggregates about 1 mm in diameter composed of idiomorphic crystals about 0.6 mm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* colorless to white. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* not determined due to small size of crystals. *Tenacity:* brittle. *Cleavage:* {001} perfect. *Fracture:* splintery. *Density:* could not be measured, 3.99 g/cm³ (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 6.388, *b* 6.386, *c* 12.388 Å, α 96.54°, β 100.85°, γ 100.51°, *V* 482.2 Å³, Z 2, *a:b:c* = 1.0003:1:1.9399. Morphology: {001}, {101}, {010}, tabular on {001}. Twinning: none observed. ***X-ray powder diffraction data:*** 5.901 (59) $(0\bar{1}1)$, 5.049 (100) (101), 4.695 (38) $(0\bar{1}2)$, 4.468 (38) $(1\bar{1}1)$, 3.899 (49) $(\bar{1}12)$, 3.229 (33) $(\bar{1}\bar{1}3)$, 3.125 (45) $(0\bar{2}1)$, 3.0051 (65) (004). ***Optical data:*** Biaxial (−), α 1.635, β 1.725, γ 1.750, 2V(calc.) 53°; dispersion not measurable; nonpleochroic; X ∧ *a* = 119°, Y ∧ *a* = 46°, Z ∧ *a* = 121°; X ∧ *b* = 62°, Y ∧ *b* = 120°, Z ∧ *b* = 137°; X ∧ *c* = 37°, Y ∧ *c* = 59°, Z ∧ *c* = 73°. ***Chemical analytical data:*** Means of six sets of electron microprobe data (H_2O and CO_2 calculated here to give $1H_2O$ and $4CO_3$ as indicated by the crystal structure determination): CaO 9.22, Ce_2O_3 28.11, La_2O_3 11.36, Nd_2O_3 11.52, Pr_2O_3 3.38, CO_2 (29.13), H_2O (2.98), Total (95.70) wt.%. Empirical formula: $Ca_{0.99}(Ce_{1.04}La_{0.42}Nd_{0.41}Pr_{0.12})_{\Sigma 1.99}(CO_3)_{4.00}\cdot 1.00H_2O$. ***Relationship to other species:*** It is chemically similar to various Ca-REE-carbonates, but the structure is different.

Name: For the locality. ***Comments:*** IMA No. 1997-036. Only an extended abstract of this description has been published (see below), but Prof. Dr. Franz Walter (Universität Graz) kindly supplied additional information. The crystal structure has been solved.

HOLLERER, C. E. (1998) $Ca(REE)_2(CO_3)_4\cdot H_2O$, ein neues Mineral aus der Steiermark, Österreich. *Mitteilungen der Österreichische Mineralogischen Gessellschaft* **143**, 200–201. WALTER, F. (2003) personal communication.

Ganterite

Monoclinic

$[Ba_{0.5}(Na,K)_{0.5}]Al_2(Si_{2.5}Al_{1.5}O_{10})(OH)_2$

Locality: The Berisal Complex, Wasenhorn, Simplon Region, Switzerland.

Occurrence: In schists associated with muscovite, quartz, epidote group minerals, zircon and apatite. Also in zoisite-celsian gneiss associated with margarite and quartz.

General appearance: Average grain size 0.5 x 0.15 x 0.01 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* presumably transparent. *Color:* light grey to silver. *Streak:* white. *Luminescence:* nonfluorescent, but shows very strong general fluorescence under a green argon laser (514.5 nm). *Hardness:* VHN_{100} 260 kg/mm², corresponding to Mohs 4 to 4½. *Tenacity:* flexible. *Cleavage:* {001} perfect. *Fracture:* laminated. *Density:* 3.11 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/c*, *a* 5.212, *b* 9.046, *c* 19.978 Å, β 95° 48′, *V* 937.6 Å³, Z 4, *a:b:c* = 0.5762:1:2.2085. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.481 (71) (110), 3.887 (76) $(\bar{1}13)$, 3.737 (77) (023), 3.495 (71) $(\bar{1}14)$, 2.602 (95) $(130, \bar{1}31)$, 2.571 (100) $(\bar{2}02, 131)$, 1.5054 (91) (060, 2.0.10). ***Optical data:*** Biaxial (−), α 1.600 (calc.), β 1.619, γ 1.622, 2V(meas.) 42.5°, dispersion not given; nonpleochroic; orientation not given. ***Chemical analytical data:*** Means of 32 sets of electron microprobe data gave: Na_2O 1.91, K_2O 3.02, MgO 0.86, CaO 0.03, MnO 0.03, FeO 0.69, BaO 15.54, Al_2O_3 36.5, SiO_2 37.47, TiO_2 0.73, H_2O 3.90, Total 100.68 wt.%. Empirical formula: $(Ba_{0.44}K_{0.28}Na_{0.27})_{\Sigma 0.99}(Al_{1.84}Mg_{0.09}Fe_{0.04}Ti_{0.04})_{\Sigma 2.01}[(Si_{2.72}Al_{1.28})_{\Sigma 4.00}O_{10.11}](OH)_{1.89}$. ***Relationship to other species:*** It is the Ba- and Al-dominant member of the mica group.

Name: For the Gantertal, a famous valley in the region in which the mineral was found. ***Comments:*** IMA No. 2000-033.

GRAESER, S., HETHERINGTON, C. J., and GIERÉ, R. (2003) Ganterite, a new barium-dominant analogue of muscovite from the Berisal Complex, Simplon Region, Switzerland. *Canadian Mineralogist* **41**, 1271–1280.

Gjerdingenite-Fe

Monoclinic

$K_2[(H_2O)_2(Fe,Mn)][(Nb,Ti)_4(Si_4O_{12})_2(OH,O)_4]\cdot 4H_2O$

Locality: Gjerdingselva, Lunner, Oppland, Norway.

Occurrence: In miarolitic cavities in ekerite, a sodic granite. Associated minerals are: quartz, orthoclase, albite, aegirine, kupletskite, elpidite, lorenzenite, pyrochlore, monazite-(Ce), gagarinite-(Y), ralstonite, gearksutite and molybdenite.

General appearance: Prismatic to lath-shaped crystals up to 1 mm long and subparallel or irregular aggregates to 3 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous to waxy. *Diaphaneity:* translucent to rarely transparent. *Color:* pale yellow to orange yellow to brownish yellow. *Streak:* white to faint yellow. *Luminescence:* nonfluorescent. *Hardness:* about 5. *Tenacity:* very brittle. *Cleavage:* none observed. *Fracture:* uneven. *Density:* 2.82 g/cm³ (meas.), 2.83 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 14.529, *b* 13.943, *c* 7.837 Å, β 117.61°, *V* 1406.8 Å³, Z 2, *a:b:c* = 1.0420:1:0.5621. Morphology: {100}, {010}, {001}, $\{20\bar{1}\}$, {021}; flattened on {001} and elongate along [010], {010} is subordinate or may be lacking. Twinning: present and was used to solve the crystal structure. ***X-ray powder diffraction data:*** 6.92 (80) (020, 001), 6.42 (50) (200, $\bar{2}01$), 4.94 (70) (021), 3.225 (100) ($\bar{4}21$, 400, $\bar{4}02$), 3.114 (67) (041, 022), 2.512 (50) ($\bar{4}41$, 401, $\bar{4}03$). ***Optical data:*** Biaxial (+), α 1.6676, β 1.7001, γ 1.794, 2V(meas.) 58.5°, 2V(calc.) 63.7°; dispersion not observed; nonpleochroic; Y = *b*. ***Chemical analytical data:*** Thirty-nine analyses were carried out by electron microprobe. One such set of data is given here: Na_2O 0.68, K_2O 6.76, CaO 0.08, MnO 2.97, FeO 3.44, Al_2O_3 0.20, SiO_2 36.35, TiO_2 10.14, ZrO_2 0.71, Nb_2O_5 23.24, H_2O not determined, Total 84.57 wt.%. Crystal-chemical formula (with Si + Al = 16) derived from the structure determination: $\{[K_{1.20}Na_{0.72}(H_2O)_{2.08}]_{\Sigma4.00}[K_{2.08}(H_2O)_{1.92}]_{\Sigma4.00}\}[(H_2O)_{3.40}K_{0.56}Ca_{0.04}]_{\Sigma4.00}(Fe_{0.95}Mn_{0.75}\square_{0.30})_{\Sigma2.00}Nb_{4.30}Ti_{3.45}Fe_{0.20}Zr_{0.05})_{\Sigma8.00}(Si_{15.90}Al_{0.10})_{\Sigma16.00}O_{48.00}[(OH)_{4.16}O_{3.84})_{\Sigma8.00}\cdot 4.00H_2O$. ***Relationship to other species:*** It is a member of the labuntsovite group.

Name: Assigned according to the IMA approved nomenclature for the labuntsovite group. In terms of root names, gjerdingenite is an analogue of kuzmenkoite and has Nb > Ti in the *M* site whereas kuzmenkoite has Ti > Nb. The dominant cation in the *D* site is Fe for gjerdingenite so the name is gjerdingenite-Fe. ***Comments:*** IMA No. 2001-009.

RAADE, G., FERRARIS, G., GULA, A., and IVALDA, G. (2002) Gjerdingenite-Fe from Norway, a new mineral species in the labuntsovite group: description, crystal structure and twinning. *Canadian Mineralogist* **40**, 1629–1639. CHUKANOV, N. V., PEKOV, I. V., and KHOMYAKOV, A. P. (2002) Recommended nomenclature for labuntsovite-group minerals. *European Journal of Mineralogy* **14**, 165–173.

Glagolevite

Triclinic

$NaMg_6[Si_3AlO_{10}](OH,O)_8\cdot H_2O$

Locality: Kovdor phlogopite quarry, Kovdor massif, Kola Peninsula, Russia.

Occurrence: Associated minerals are: vesuvianite, pectolite, monticellite, diopside, phlogopite, andradite, apatite, magnetite, olivine, calcite.

General appearance: Massive aggregates (up to several cm); platy grains 1 to 15 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 3 to 5. *Tenacity:* sectile. *Cleavage:* {001} perfect. *Fracture:* uneven. *Density:* 2.66 g/cm³ (meas.), 2.73 g/cm³ (calc.). ***Crystallography:*** Triclinic, *C*1, *a* 5.354, *b* 9.263, *c* 14.653 Å, α 89.86°, β 96.844°, γ 90.03°, *V* 721.5 Å³, Z 2, *a:b:c* = 0.5780:1:1.5819. Morphology: {001}, habit tabular on {001}. Twinning: none observed. ***X-ray powder diffraction data:*** 7.266 (50) (002), 4.629 (30) (020, $1\bar{1}0$, 110), 2.992 (40) ($11\bar{4}$), 2.597 (60) (131, $20\bar{2}$, $1\bar{3}1$), 2.556 (100) (201, $1\bar{3}\bar{2}$, $13\bar{2}$), 2.457 (50) (132, $1\bar{3}2$, $20\bar{3}$), 1.544 (100) ($3\bar{3}\bar{1}$, $33\bar{1}$, 060). ***Optical data:*** Biaxial (+), α 1.569, β(calc.) 1.569, γ 1.571, 2V(meas.) 17°; dispersion not observed; nonpleochroic; Z < *c*. ***Chemical analytical data:*** Means of four sets of electron microprobe data (H_2O by TGA): Na_2O 3.94, MgO 37.23, MnO 0.11, FeO 0.38, Al_2O_3 13.36, SiO_2 29.24, H_2O 14.5, Total 98.76 wt.%. Empirical formula: $Na_{0.76}(Mg_{5.55}Al_{0.49}Fe_{0.03}Mn_{0.01})_{\Sigma6.08}[(Si_{2.92}Al_{1.08})_{\Sigma4.00}O_{10.00}][(OH)_{7.67}O_{0.33}]_{\Sigma8.00}\cdot 1.00H_2O$. ***Relationship to other species:*** It is chemically related to clinochlore, but is a new structure type.

Name: For A. A. Glagolev (1927–1993), Russian petrographer who worked at Kovdor for many years. ***Comments:*** IMA No. 2001-064.

SEREDKIN, M. V., ORGANOVA, N. I., KRIVOVICHEV, S. V., ARMBRUSTER, T., MOISEEV, M. M., CHUKANOV, N. V., CHUKANOVA, V. N., BURNS, P. C., MARSIY, I. M., ZVYAGIN, B. B., KONONKOVA, N. N., and SIVTSOV, A. V. (2003) Glagolevite, $NaMg_6[Si_3Al_{10}](OH,O)_8\cdot H_2O$, a new mineral. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132**, 67–75.

Gmelinite-K

Hexagonal

$(K,Na,Ca)_6[Al_7Si_{17}O_{48}]\cdot 22H_2O$

Locality: Mount Alluaiv, Lovozero alkaline massif, Kola Peninsula, Russia.

Occurrence: In cavities within brecciated pegmatite. Associated minerals are: K-feldspar, nepheline, sodalite, cancrinite, amphibole, pyroxene and other minerals.

General appearance: Granular and radial aggregates of columnar to acicular crystals (up to 0.1 x 3 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless to brownish. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* VHN_{30} 258 kg/mm², Mohs 4. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* conchoidal. *Density:* 2.00 g/cm³ (meas.), 2.04 g/cm³ (calc.). ***Crystallography:*** Hexagonal, *P6₃/mmc*, *a* 13.696, *c* 10.203 Å, *V* 1657.5 Å³, Z 1, *c:a* = 0.7450. Morphology: {100}, {101} and {001}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 11.9 (80) (010), 5.16 (70) (021, 002), 4.11 (100) (121, 112), 3.27 (70) (130, 013), 2.971 (80) (040), 2.852 (80) (041, 222), 2.719 (100) (123). ***Optical data:*** Uniaxial (−), ω 1.477, ε 1.471, nonpleochroic. ***Chemical analytical data:*** Means of four sets of electron microprobe data (recalculated to 100.00 wt.%): Na_2O 2.63, K_2O 7.54, CaO 1.56, Al_2O_3 18.53, SiO_2 50.54, H_2O 19.20, Total 100.00 wt.%. Empirical formula: $(K_{3.25}Na_{1.73}Ca_{0.57})_{\Sigma5.55}[(Al_{7.39}Si_{17.10})_{\Sigma24.49}O_{48.34}]\cdot 21.66H_2O$. ***Relationship to other species:*** It is a member of the zeolite group and the K-dominant member of the gmelinite series.

Name: For the relationship to the other members of the gmelinite series. ***Comments:*** IMA No. 1999-039.

KHOMYAKOV, A. P., POLEZHAEVA, L. I., and MALINOVSKY, Yu. A. (2001) Gmelinite-K, $(K,Na,Ca)_6[Al_7Si_{17}O_{48}]\cdot 22H_2O$, a new zeolite mineral from the Lovozero alkaline massif, Kola Peninsula, Russia. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **130(3)**, 65–71.

Goldquarryite

Triclinic

$CuCd_2Al_3(PO_4)_4F_2(H_2O)_{10}(H_2O)_2$

Locality: Gold Quarry mine, 11 km northwest of Carlin, Eureka County, Nevada, USA.

Occurrence: In brecciated and hydrothermally rounded jasperoid fragments lightly cemented by late-stage silicification. Associated minerals are: opal, carbonate-fluorapatite and hewettite.

General appearance: Isolated clusters of radiating crystals and compact parallel aggregates of crystals. Maximum crystal size is 1.5 mm long by 0.1 mm in diameter.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent but aggregates are translucent. *Color:* very pale blue to blue-gray, masses are blue. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 3 to 4. *Tenacity:* brittle. *Cleavage:* none observed. *Fracture:* irregular. *Density:* 2.78 g/cm^3 (meas.), 2.88 g/cm^3 (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 6.787, *b* 9.082, *c* 10.113 Å, α 101.40°, β 104.27°, γ 102.51°, *V* 568.7 Å^3, Z 1, *a*:*b*:*c* = 0.7473:1:1.1135. Morphology: {010} and {001} dominant, {100} very minor. Twinning: multiple on {001}. ***X-ray powder diffraction data:*** 9.433 (100) (001), 4.726 (30) (002), 3.700 (30) $(0\bar{2}2)$, 3.173 (30b) $(\bar{1}\bar{2}2$, $\bar{1}\bar{1}3$, 120, 003), 3.010 (30) $(\bar{1}22$, $\bar{2}12)$, 2.896 (30) $(\bar{2}\bar{1}1)$, 2.820 (50) (022). ***Optical data:*** Biaxial (+), α 1.570, β 1.573, γ 1.578, 2V(meas.) 30°, 2V(calc.) 76°; dispersion $r < v$, strong; pleochroic, deep blue parallel to the elongation and very pale blue normal to the elongation; orientation not given. ***Chemical analytical data:*** Means of five sets of electron microprobe data (with H_2O calculated to give 26 H + F): K_2O 0.17, CaO 1.25, NiO 0.23, CuO 5.33, ZnO 0.05, CdO 26.24, Al_2O_3 15.22, V_2O_3 0.05, P_2O_5 28.04, H_2O (22.19), F 3.63, sum (102.40), less O = F 1.53, Total (100.87) wt.%. Empirical formula: $(Cu_{0.66}Ni_{0.03}Zn_{0.01})_{\Sigma 0.70}\square_{0.30}]_{\Sigma 1.00}(Cd_{2.00}Ca_{0.22}K_{0.04})_{\Sigma 2.26}$-$(Al_{2.92}V_{0.01})_{\Sigma 2.93}(PO_4)_{3.87}F_{1.89}(H_2O)_{12.06}$. ***Relationship to other species:*** None apparent.

Name: For the locality. ***Comments:*** IMA No. 2001-058.

ROBERTS, A. C., COOPER, M. A., HAWTHORNE, F. C., GAULT, R. A., JENSEN, M. C., and FOORD, E. E. (2003) Goldquarryite, a new Cd-bearing phosphate mineral from the Gold Quarry mine, Eureka County, Nevada. *Mineralogical Record* **34**, 237–240.

Graulichite-(Ce)

Graulichite-(Ce) Trigonal

$CeFe^{3+}_3(AsO_4)_2(OH)_6$

Locality: Hourt, 2 km north of Vielsalm, in the southeastern border region of the Stavelot Massif, Ardennes, Belgium.

Occurrence: In quartzites associated minerals with: arsenopyrite, scorodite, mimetite, pharmacosiderite, barium-pharmacosiderite and goethite.

General appearance: Spherical aggregates 80 to 150 μm in diameter made up of rhombohedral crystals 50 to 80 μm across.

Physical, chemical and crystallographic properties: *Luster:* resinous. *Diaphaneity:* transparent. *Color:* light green to brownish. *Streak:* not given. *Luminescence:* nonfluorescent. *Hardness:* not given. *Tenacity:* not given. *Cleavage:* none. *Fracture:* irregular. *Density:* greater than 3.9 g/cm^3, 4.40 g/cm^3 (calc.). ***Crystallography:*** Trigonal, $R\bar{3}m$, *a* 7.260, *c* 16.77 Å, *V* 765.5 Å^3, Z 3, *c*:*a* = 2.3099. Morphology: {102}, {101}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.906 (25) (101), 3.636 (40) (110), 3.052 (100) (113), 2.792 (30) (006), 2.239 (35) (107), 1.968 (25) (303), 1.817 (35) (220). ***Optical data:*** Uniaxial (−), mean n close to 1.97, pleochroism light green to yellowish. ***Chemical analytical data:*** Means of 33 sets of electron microprobe data (with H_2O calculated to give OH + H_2O = 6): CaO 0.03, SrO 0.24, BaO 3.95, PbO 0.07, Al_2O_3 3.09, Fe_2O_3 30.65, La_2O_3 2.26, Ce_2O_3 15.73, Nd_2O_3 2.08, SiO_2 0.03, P_2O_5 0.03, As_2O_5 31.20, H_2O (8.37), Total (97.79) wt.%. Empirical formula: $(Ce_{0.66}Ba_{0.18}La_{0.10}Nd_{0.09}Sr_{0.02})_{\Sigma 1.05}(Fe^{3+}_{2.65}$-$Al_{0.42})_{\Sigma 3.07}[(As_{1.88}S_{0.01}\square_{0.11})_{\Sigma 2.00}O_{8.00}][(OH)_{5.62}(H_2O)_{0.40}]_{\Sigma 6.02}$. ***Relationship to other species:*** It is a member of the crandallite group and the Fe^{3+}-dominant analogue of arsenoflorencite-(Ce), $CeAl_3(AsO_4)_2(OH)_6$.

Name: For Jean-Marie Graulich (1920–2001), mining engineer and honorary director of the Geological Survey of Belgium, in recognition of his contribution to the knowledge of the geology of the Stavelot Massif. ***Comments:*** IMA No. 2002-001.

HATERT, F., LEFÈVRE, P., PASERO, M., and FRANSOLET, A.-M. (2003) Graulichite-(Ce), a new arsenate mineral from the Stavelot Massif, Belgium. *European Journal of Mineralogy* **15**, 733–739.

Greifensteinite Monoclinic

$Ca_2Be_4(Fe^{2+},Mn)_5(PO_4)_6(OH)_4\cdot 6H_2O$

Locality: Greifenstein, Saxony, Germany.

Occurrence: In a Li-rich granite pegmatite. Associated minerals are: albite, potassic feldspar, roscherite, viitaniemiite, childrenite, quartz, apatite, herderite, elbaite and montmorillonite.

General appearance: Radiated aggregates up to 5 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* dark olive green. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 4½. *Tenacity:* brittle. *Cleavage:* {100} good. *Fracture:* uneven. *Density:* 2.93 g/cm^3 (meas.), 2.93 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *C2/c*, *a* 15.903, *b* 11.885, *c* 6.677 Å, β 94.68°, *V* 1257.8 Å^3, Z 2, *a*:*b*:*c* = 1.3381:1:0.5618. Morphology: {100} and {110}, habit prismatic. Twinning: none observed. ***X-ray powder diffraction data:*** 9.48 (10) (110), 5.94 (8) (020), 4.82 (6) (310), 3.96 (9) (400), 3.068 (6) (510), 2.982 (7) (202), 2.783 (8) (240), 2.638 (7) (600). ***Optical data:*** Biaxial (−), α 1.624, β 1.634, γ 1.638, 2V(meas.) 80°, 2V(calc.) 64°; dispersion not observed; pleochroic, X light blue-green, Y light-green, Z brown to green; X = *b*. ***Chemical analytical data:*** Means of five sets of electron microprobe data (H_2O by TGA): BeO 9.24, MgO 0.34, CaO 9.98, MnO 5.56, FeO 22.42, Al_2O_3 1.05, P_2O_5 38.36, H_2O 13.6, Total 100.55 wt.%. Empirical formula: $Ca_{1.96}Be_{4.07}(Fe^{2+}_{3.44}Mn_{0.86}$-$Al_{0.23}Mg_{0.09})_{\Sigma 4.62}(PO_4)_{5.96}(OH)_{3.65}\cdot 6.50H_2O$. ***Relationship to other species:*** It is the Fe^{2+}-dominant member of the roscherite group.

Name: For the type locality. ***Comments:*** IMA No. 2001-044.

CHUKANOV, N. V., MÖCKEL, S., RASTSVETAEVA, R. K., and ZADOV, A. E. (2002) Greifensteinite $Ca_2Be_4(Fe^{2+},Mn)_5(PO_4)_6$-$(OH)_4\cdot 6H_2O$—a new mineral from Greifenstein, Saxony. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **131**, 47–52.

Gutkovaite-Mn

Monoclinic

$CaK_2Mn(Ti,Nb)_4(Si_4O_{12})_2(O,OH)_4\cdot 5H_2O$

Locality: Maly Mannepakhk, Mt. Khibiny alkaline massif, Kola Peninsula, Russia.

Occurrence: In a pegmatite in nepheline syenite. Associated minerals are: microcline, aegirine, arfvedsonite, nepheline, eudialyte, albite, lorenzenite, loparite, aenigmatite, manganneptunite, murmanite, analcime, natrolite, stilbite, chabazite, kuzmenkoite-Mn, nontronite, and others.

General appearance: Coarse prismatic crystals up to 0.8 mm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent to transparent. *Color:* pale yellowish pink. *Streak:* white. *Luminescence:* not mentioned. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* uneven. *Density:* 2.83 g/cm^3 (meas.), 2.80 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *Cm*, *a* 14.30, *b* 13.889, *c* 7.760 Å, β 117.51°, *V* 1367 Å^3, Z 2, *a:b:c* = 1.0296:1:0.5587. Morphology: no forms were mentioned. Twinning: micro twinning on (001) and ($\bar{4}$01). ***X-ray powder diffraction data:*** 7.0 (7) (020, 001), 6.33 (5) (20$\bar{1}$, 200), 4.90 (4) (021), 3.22 (9) (42$\bar{1}$, 40$\bar{2}$, 400), 3.05 (10) (022, 24$\bar{1}$, 240), 2.57 (5) (24$\bar{2}$, 241), 2.48 (6) (44$\bar{1}$, 40$\bar{3}$, 401). ***Optical data:*** Biaxial (+), α 1.688, β 1.700, γ 1.805, 2V(meas.) 35°, 2V(calc.) 39°; dispersion not observed; nonpleochroic; orientation not given. ***Chemical analytical data:*** Means of six sets of electron microprobe data: Na_2O 0.18, K_2O 6.54, MgO 0.17, CaO 4.81, MnO 4.96, FeO 0.61, ZnO 0.13, SrO 0.54, BaO 1.03, Al_2O_3 0.17, SiO_2 41.03, TiO_2 24.47, ZrO_2 0.08, Nb_2O_5 5.14, H_2O 8.67, Total 98.53 wt.%. Empirical formula: $(Ca_{1.00}Na_{0.07})_{\Sigma 1.07}(K_{1.63}Ba_{0.08}Sr_{1.06})_{\Sigma 1.77}(Mn_{0.82}Fe_{0.10}Mg_{0.05}Zn_{0.02})_{\Sigma 0.99}(Ti_{3.59}Nb_{0.45}Zr_{0.01})_{\Sigma 4.05}[(Si_{4.00}Al_{0.02})_{\Sigma 4.02}O_{12.07}]_{2.00}[O_{2.47}(OH)_{1.53}]_{\Sigma 4.00}\cdot 4.87H_2O$. ***Relationship to other species:*** It is a member of the labuntsovite group with Mn dominant in the D-site. The A-site in this species is divided into two sites: A(I)-site is occupied by Ca and the A(II)-site is vacant; this results in lowering the symmetry from *C2/m* to *Cm*.

Name: For N. N. Gutkova (1896–1960?) who intensively studied the Khibiny-Lovozero alkaline complex; the suffix denotes the dominance of Mn in the D-site. ***Comments:*** IMA No. 2001-038.

PEKOV, I. V., CHUKANOV, N. V., RASTSVETAEVA, R. K., ZADOV, A. E., and KONONKOVA, N. N. (2002) Gutkovaite-Mn $CaK_2Mn(Ti,Nb)_4(Si_4O_{12})_2(O,OH)_4\cdot 5H_2O$, a new mineral of the labuntsovite group from the Khibiny massif, Kola Peninsula. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **131(2)**, 51–57. CHUKANOV, N. V., PEKOV, I. V., and KHOMYAKOV, A. P. (2002) Recommended nomenclature for labuntsovite-group minerals. *European Journal of Mineralogy* **14**, 165–173.

Hillite

Triclinic

$Ca_2(Zn,Mg)(PO_4)_2\cdot 2H_2O$

Locality: Reaphook Hill, South Australia, Australia.

Occurrence: In a gossan-like mass covering unmetamorphosed, poorly sorted argillaceous siltstones of the Lower Cambrian Parachilna Formation. Associated minerals are: scholzite, tarbuttite, parahopeite, zincian collinsite, switzerite and phosphophyllite.

General appearance: Euhedral, doubly terminated crystals and clusters (up to 50 µm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* colorless or grey with a greenish or bluish tint. *Streak:* not given, probably white. *Luminescence:* greenish-yellow fluorescence in shortwave UV. *Hardness:* 3½. *Tenacity:* not given. *Cleavage:* {010} and {001} perfect. *Fracture:* not given. *Density:* 3.16 g/cm^3 (meas.), 3.16 g/cm^3 (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 5.736, *b* 6.767, *c* 5.462 Å, α 97.41°, β 108.59°, γ 107.19°, *V* 186.05 Å^3, Z 1, *a:b:c* = 0.8476:1:0.8072. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.24 (34) (010), 3.512 (16) (011, $\bar{1}\bar{1}$1), 3.230 (22) (1$\bar{2}$0), 3.130 (37) (020), 3.038 (40) (101), 2.690 (100) ($\bar{1}$21, $\bar{1}$02), 1.668 (22) ($\bar{2}\bar{1}$3). ***Optical data:*** Biaxial (+), α 1.635, β 1.650, γ 1.667, 2V(calc.) 83°; dispersion not given; nonpleochroic; orientation not given. ***Chemical analytical data:*** Means of fifteen sets of electron microprobe data (with H_2O calculated to give $2H_2O$): Na_2O 0.11, MgO 4.34, CaO 30.36, FeO 0.04, ZnO 14.79, P_2O_5 40.85, H_2O (10.23), Total (100.72) wt.%. Empirical formula: $(Ca_{1.91}Na_{0.01})_{\Sigma 1.92}(Zn_{0.64}Mg_{0.38})_{\Sigma 1.02}(PO_4)_{2.03}\cdot 2.00H_2O$. ***Relationship to other species:*** It is the Ca- and Zn-dominant member of the fairfieldite group.

Name: For Dr. Roderick Hill (1949–), Chief of the Mineral Research Division, CSIRO, Melbourne, Australia, who first described the mineral and recognized it as a potentially new species. ***Comments:*** IMA No. 2003-005.

YAKUBOVICH, O. V., MASSA, W., LIFEROVICH, R. P., GAVRILENKO, P. G., BOGDANOVA, A. N., and TUISKU, P. (2003) Hillite, a new member of the fairfieldite group: description and crystal structure. *Canadian Mineralogist* **41**, 981–988.

Hoganite

Monoclinic

$Cu(CH_3COO)_2\cdot H_2O$

Locality: The Potosi silver-lead-zinc deposit, 2 km northeast of Broken Hill, New South Wales, Australia (Lat. 31°56′ S, Long. 141°30′ E).

Occurrence: In gossan. Associated minerals are: goethite, hematite, quartz, linarite, malachite, azurite, cuprian smithsonite, cerussite and paceite.

General appearance: Isolated prisms (up to 0.6 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* dark bluish green. *Streak:* pale blue. *Luminescence:* nonfluorescent. *Hardness:* 1½. *Tenacity:* brittle. *Cleavage:* could not be observed but {001} perfect and {110} distinct are reported on synthetic material. *Fracture:* conchoidal. *Density:* 1.93 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *C2/c*, *a* 13.162, *b* 8.555, *c* 13.850 Å, β 117.08°, *V* 1388.6 Å^3, Z 8, *a:b:c* = 1.5385:1:1.6189. Morphology: forms observed are similar to those reported for synthetic crystals {10$\bar{1}$}, {01$\bar{1}$}, {2$\bar{1}\bar{1}$}, {110} and {1$\bar{1}\bar{2}$}; also reported are synthetic {110} tablets with {001}, {100} and {20$\bar{1}$}. Twinning: none observed, but butterfly twins have been reported for synthetic crystals. ***X-ray powder diffraction data:*** 6.921 (100) (110), 6.176 (14) (002), 5.872 (9) (200), 5.382 (10) (11$\bar{2}$), 3.592 (11) (22$\bar{1}$), 3.532 (28) (202), 2.291 (9) (33$\bar{3}$), 2.278 (10) (402). The data in the paper are indexed on the alternate setting in space group *A2/a* to compare with the data in PDF 27-145, but have been changed here for the given cell in space group *C2/c*. ***Optical data:*** Biaxial (+), α 1.533, β 1.541, γ 1.554, 2V(meas.) 85°, 2V(calc.) 77°; dispersion r < v, medium; pleochroism strong X = blue, Y = pale bluish, Z = pale bluish green, X > Y > Z; orientation unknown. See Comments. ***Chemical analytical data:*** Wet chemical analysis by AAS (Ca, Cu, Mg, Zn, Pb and Fe), CHN analyzer (C and H) and O by difference gave: C 23.85, H 3.95, Cu 31.6, Fe 0.4, O (40.2), Total (100.00) wt.%.

Empirical formula: $C_{4.01}H_{7.90}O_{5.07}Cu_{1.00}Fe_{0.01}$ or $Cu_{1.00}(CH_3$-$COO)_{2.00}\cdot 0.95H_2O$. ***Relationship to other species:*** It is an acetate.

Name: For Graham P. Hogan (1957–) of Broken Hill, New South Wales, Australia, a miner and well-known collector of Broken Hill minerals, who originally recovered the material. ***Comments:*** IMA No. 2001-029. Due to the very small amount of natural material, the optical properties were determined from ssynthetic crystals grown from aqueous solutions.

HIBBS, D. E., KOLITSCH, U., LEVERETT, P., SHARPE, J. L., and WILLIAMS, P. A. (2002) Hoganite and paceite, two new acetate minerals from the Potosi mine, Broken Hill, Australia. *Mineralogical Magazine* **66**, 459–464.

Ikranite

Trigonal

$(Na,H_3O)_{15}(Ca,Mn,REE)_6Fe^{3+}_2Zr_3(\square,Zr)(\square Si)$-$Si_{24}O_{66}(O,OH,Cl)\cdot nH_2O$

Locality: Karnasurt Mt., Lovozero alkaline massif, Kola Peninsula, Russia.

Occurrence: In peralkaline pegmatites. Associated minerals are: aegirine, microcline, lorenzenite, nepheline, lamprophyllite, murmanite and arfvedsonite.

General appearance: Grains up to 3 cm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* brownish yellow. *Streak:* yellowish white. *Luminescence:* nonfluorescent. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* conchoidal. *Density:* 2.82 g/cm³ (meas.), 2.63 g/cm³ (calc.). ***Crystallography:*** Trigonal, *R3m*, *a* 14.167, *c* 30.081 Å, *V* 5228.5 Å³, Z 3, *c:a* = 2.1233. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.41 (41) (104), 4.30 (91) (205), 4.09 (36) (116), 3.521 (57) (027), 3.205 (44) (208), 2.963 (92) (315), 2.841 (100) (404), 2.588 (37) (039). ***Optical data:*** Uniaxial (+), ω 1.612, ε 1.615, pleochroism colorless to yellow, weak. ***Chemical analytical data:*** Means of three sets of electron microprobe data: Na_2O 7.95, K_2O 0.44, CaO 6.29, MnO 3.40, FeO 0.38, SrO 1.61, Fe_2O_3 4.80, La_2O_3 0.62, Ce_2O_3 1.53, Nd_2O_3 0.19, SiO_2 48.91, TiO_2 0.37, ZrO_2 13.94, HfO_2 0.28, Nb_2O_5 0.28, H_2O 7.70, F 0.10, Cl 0.89, sum 99.68, less O = F + Cl 0.24, Total 99.44 wt.%. Empirical formula: $Na_{7.12}K_{0.26}Ca_{3.11}Sr_{0.43}Ce_{0.26}La_{0.11}Nd_{0.03}Mn_{1.33}$-$Fe^{2+}_{0.15}Fe^{3+}_{1.67}Zr_{3.14}Ti_{0.13}Hf_{0.04}Nb_{0.06}Cl_{0.70}F_{0.15}Si_{22.58}H_{23.71}O_{75.15}$. ***Relationship to other species:*** It is a member of the eudialyte group.

Name: For the Russian acronym IKRAN (*Institut Kristallgrafii Rossiskoy Akadameii Nauky*). ***Comments:*** IMA No. 2000-010.

CHUKANOV, N. V., PEKOV, I. V., ZADOV, A. E., KOROVUSHKIN, V. V., EKIMENKOVA, I. A., and RASTSVETAEVA, R. K. (2003) Ikranite, $(Na,H_3O)_{15}(Ca,Mn,REE)_6Fe^{3+}_2Zr_3(\square,Zr)(\square Si)$-$Si_{24}O_{66}(O,OH,Cl)\cdot nH_2O$ and raslakite, $Na_{15}Ca_3Fe_3(Na,Zr)_3$-$Zr_3(Si,Nb)(Si_{25}O_{73})(OH,H_2O)_3(Cl,OH)$, the new eudialyte group minerals from Lovozero massif, Kola Peninsula. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132(5)**, 22–33.

Karupmøllerite-Ca

Monoclinic

$(Na,Ca,K)_2Ca(Nb,Ti)_4(Si_4O_{12})_2(O,OH)_4\cdot 7H_2O$

Locality: In the Mellemelv stream valley, Kangerluarsuk area, Ilímaussaq alkaline complex, South Greenland.

Occurrence: In a naujaite pegmatite. Associated minerals are: aegirine, arfvedsonite, eudialyte, potassic feldspar, sodalite, albite, carbonate-fluorapatite, lueshite, natrolite, and tuperssuatsiaite.

General appearance: Pseudomorphs after rectangular lamellae (up to 2 x 1.5 x 0.1 cm) of epistolite replacing vuonnemite. The pseudomorphs are fine-grained aggregates with minor relics of epistolite.

Physical, chemical and crystallographic properties: *Luster:* vitreous to dull. *Diaphaneity:* translucent. *Color:* white with grayish and pinkish tints. *Streak:* not given but probably white. *Luminescence:* not mentioned. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* parting along the perfect {001} cleavage of the original vuonnemite/epistilite crystals. *Fracture:* not given. *Density:* 2.71 g/cm³ (meas.), 2.75 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 14.641, *b* 14.214, *c* 7.9148 Å, β 117.36°, *V* 1463 Å³, Z 2, *a:b:c* = 1.0300:1:0.5568. Morphology: no forms were observed; particles about 0.01 mm are irregular, platy. Twinning: none observed. ***X-ray powder diffraction data:*** 7.104 (73) (020), 7.026 (100) (001), 6.482 (45) ($20\bar{1}$), 4.996 (74) (021), 3.253 (38) ($42\bar{1}$), 3.250 (36) (400), 3.242 (34) ($40\bar{2}$), 3.171 (56) (041), 3.150 (38) (022). ***Optical data:*** Biaxial (+), α 1.656, β 1.662, γ 1.755, 2V(meas.) 30°, 2V(calc.) 30°; dispersion not observed; nonpleochroic; orientation not given. ***Chemical analytical data:*** Means of twelve sets of electron microprobe data (H_2O by TGA): Na_2O 2.17, K_2O 1.74, CaO 6.00, MnO 0.31, ZnO 0.06, SrO 0.08, BaO 0.28, Al_2O_3 0.25, Fe_2O_3 0.47, SiO_2 39.85, TiO_2 8.51, Nb_2O_5 29.92, H_2O 11.31, Total 100.95 wt.%. Empirical formula: $(Na_{0.84}Ca_{0.64}K_{0.44}$-$Ba_{0.02}Sr_{0.01})_{\Sigma 1.95}(Ca_{0.64}Mn_{0.05}Zn_{0.01})_{\Sigma 0.70}(Nb_{2.70}Ti_{1.28}Fe^{3+}_{0.07})_{\Sigma 4.05}(Si_{7.97}$-$Al_{0.06})_{\Sigma 8.03}O_{24.09}[O_{2.75}(OH)_{1.25}]_{\Sigma 4.00}\cdot 6.92H_2O$. ***Relationship to other species:*** It is a member of the labuntsovite group with Ca dominant in the D-site.

Name: For Svend Karup-Møller (1936–), Associate Professor at the Technical University of Denmark; the suffix denotes the dominance of Ca in the D-site. ***Comments:*** IMA No. 2001-028. In the table giving the X-ray powder diffraction data, twelve entries have redundant indices; all those with 0*kl* (where *l* is negative) are equivalent to 0*kl*.

PEKOV, I. V., CHUKANOV, N. V., PETERSEN, O. V., ZADOV, A. E., YAMNOVA, N. A., KABALOV, Y. K., and SCHNEIDER, J. (2002) Karupmøllerite-Ca, $(Na,Ca,K)_2Ca(Nb,Ti)_4(Si_4$-$O_{12})_2(O,OH)_4\cdot 7H_2O$, a new mineral of the labuntsovite group from the Ilímaussaq alkaline complex, South Greenland. *Neues Jahrbuch für Mineralogie, Monatshefte* **2002**, 433–444.

CHUKANOV, N. V., PEKOV, I. V., and KHOMYAKOV, A. P. (2002) Recommended nomenclature for labuntsovite-group minerals. *European Journal of Mineralogy* **14**, 165–173.

Keilite

Cubic

$(Fe,Mg)S$

Localities: The Abee enstatite chondrite meteorite found near Abee, Alberta, Canada (Lat. 53°50′ N, Long. 113°15′ W). The mineral also is present in the following meteorites: Adhi-Kot, Saint-Sauveur, LEW 88180, RKP A80259, LEW 87119, LEW 88714, Y-791790, Y-791811, Y-86760 and Y8404.

Occurrence: Associated minerals are: niningerite, enstatite, kamacite and troilite.

General appearance: Small grains up to several hundred µm across.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* not observed. *Streak:* not observed. *Hardness:* could not be measured. *Tenacity:* not determined. *Cleavage:* not observed. *Fracture:* not observed. *Density:* could not be measured, 3.59 to 3.67 g/cm³ (calc.). ***Crystallography:*** Cubic, *Fm*3*m*, *a* 5.20 Å, *V* 140.6 Å³, Z 4.

Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** Only two spacings were measured: 2.584 and 1.829 (indexed as 200 and 220, respectively). Calculated spacings and indices are: 2.985 (111), 2.585 (200), 1.828 (220), 1.492 (222), 1.292 (400), 1.156 (420), 1.055 (422), 0.914 (440), 0.862 (600), 0.817 (620), 0.779 (622). ***Optical data:*** In reflected light: gray, isotropic. R: (27.2 %) 470nm, (26.7 %) 546nm, (26.4 %) 589nm, (26.3 %) 650nm. ***Chemical analytical data:*** Six sets of electron microprobe data are given. The data for the grain which gave the reflectance data above are: Fe 39.57, Mg 10.36, Mn 3.43, Ca 1.86, Cr 1.98, Zn 0.30, Ti 0.09, Ni —, Cu 0.01, S 41.46, Total 99.06 wt.%. Empirical formula: $(Fe_{0.55}Mg_{0.33}Mn_{0.05}Ca_{0.04}Cr_{0.03})_{\Sigma 1.00}S_{1.00}$. ***Relationship to other species:*** It is the Fe-dominant analogue of niningerite, (Mg,Fe)S.

Name: For Dr. Klaus Keil (1934–), Hawaii Institute of Geophysics and Planetology, University of Hawaii, Honolulu, Hawaii, USA. ***Comments:*** IMA No. 2001-053. Because of the small grain size, many of the usual physical properties could not be determined.

SHIMIZU, M., YOSHIDA, H., and MANDARINO, J. A. (2002) The new mineral species keilite, (Fe,Mg)S, the iron-dominant analogue of niningerite. *Canadian Mineralogist* **40**, 1687–1692.

Kochite — Triclinic

$Na_2(Na,Ca)_4Ca_4(Mn,Ca)_2Zr_2(Si_2O_7)_4(O,F)_4F_4$

Locality: The northern side of Hvide Ryg in the mountain range of Werner Bjerge on the eastern coast of Greenland (Lat. 72° N, Long. 24° W).

Occurrence: In a loose block of nepheline syenite between the Sirius Glacier and Hvide Ryg. Associated minerals are: nepheline, alkali-feldspar and låvenite.

General appearance: Lath-shaped to acicular grains in parallel to subparallel aggregates up to 0.3 x 1.0 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* pale brown. *Streak:* not given. *Luminescence:* not given. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* {100} perfect. *Fracture:* uneven. Density: 3.32 g/cm³ (meas.), 3.35 g/cm³ (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 10.032, *b* 11.333, *c* 7.202 Å, α 90.192°, β 100.334°, γ 111.551°, *V* 747.1 Å³, Z 1, *a:b:c* = 0.8852:1:0.6355. Morphology: no forms were observed, crystals are elongated along [010]. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.951 (3) $(120, 2\bar{2}1)$, 3.028 (6) (211), 2.908 (10) $(1\bar{2}2, 2\bar{2}\bar{2})$, 2.600 (8) (040), 2.462 (2) $(3\bar{4}0, 22\bar{2}, 122, 4\bar{2}0)$, 1.868 (6) $(4\bar{2}2, 5\bar{2}\bar{2}, 420)$, 1.670 (5) (340), 1.554 (2) $(5\bar{4}2, 6\bar{4}\bar{2})$. ***Optical data:*** Biaxial (+), α 1.684, β 1.695, γ 1.718, 2V(meas.) 73°, 2V(calc.) 70°; dispersion not given; pleochroism weak with X = colorless and Z = pale yellow; X = *c*, Z ∧ [100] ~ 20°. ***Chemical analytical data:*** Means of four sets of electron microprobe data: Na_2O 10.33, MgO 0.01, CaO 21.39, MnO 4.92, FeO 1.08, SrO 0.12, Al_2O_3 0.05, V_2O_3 0.03, Y_2O_3 0.39, La_2O_3 0.25, Ce_2O_3 0.57, SiO_2 31.55, TiO_2 8.44, ZrO_2 12.12, HfO_2 0.09, Nb_2O_5 1.86, Ta_2O_5 0.02, F 6.83, sum 100.05, less O = F 2.88, Total 97.17 wt.%. Empirical formula: $(Na_{1.92}Sr_{0.02})_{\Sigma 1.94}(Na_{2.77}Ca_{1.23})_{\Sigma 4.00}(Ca_{3.52}Na_{0.48})_{\Sigma 4.00}(Mn_{1.07}Ca_{0.81}Y_{0.05}Ce_{0.05}La_{0.02})_{\Sigma 2.00}(Zr_{1.41}Fe_{0.23}Ca_{0.35}Hf_{0.01})_{\Sigma 2.00}(Ti_{1.64}Nb_{0.22}Zr_{0.11}Al_{0.02}V_{0.01})_{\Sigma 2.00}(Si_2O_7)_{4.07}F_{4.00}(O_{1.94}F_{1.57})_{\Sigma 3.51}$. ***Relationship to other species:*** It is a member of the rosenbuschite group.

Name: For Lauge Koch (1892–1964), Danish geologist who made significant contributions to the knowledge of the geology of Greenland and mapped the geology of the type locality of this mineral. ***Comments:*** IMA No. 2002-012.

CHRISTIANSEN, C. C., GAULT, R. A., GRICE, J. D., and JOHNSEN, O. (2003) Kochite, a new member of the rosenbuschite group from Werner Bjerge alkaline complex, East Greenland. *European Journal of Mineralogy* **15**, 551–554.

Kozoite-(La) — Orthorhombic

$La(CO_3)(OH)$

Locality: Mitsukoshi, Hizen-cho, Saga Prefecture, Japan.

Occurrence: In cavities of alkali olivine basalt. Associated minerals are: kozoite-(Nd), lanthanite-(Nd), kimuraite-(Y), lokkaite-(Y), calcite, aragonite and opal (variety, hyalite).

General appearance: Spherical aggregates less than 1 mm in diameter.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* presumably transparent. *Color:* extremely pale purple to white. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* could not be determined. *Tenacity:* could not be determined. *Cleavage:* could not be determined. *Fracture:* not given. *Density:* could not be determined, 4.16 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, *Pmcn*, *a* 4.986, *b* 8.513, *c* 7.227 Å, *V* 306.7 Å³, Z 2, *a:b:c* = 0.5857:1:0.8489. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.54 (32) (011), 4.31 (100) (110, 020), 3.69 (72) (111, 021), 2.93 (57) (121, 102), 2.33 (50) (131), 2.06 (48) (221), 1.994 (35) (212). ***Optical data:*** could not be determined, but the abstractor calculated the mean index of refraction from the Gladstone-Dale relationship as 1.730. ***Chemical analytical data:*** Means of four sets of electron microprobe data with (CO_2 and H_2O calculated): CaO 6.30, SrO 1.36, La_2O_3 35.55, Ce_2O_3 0.00, Pr_2O_3 4.68, Nd_2O_3 17.60, Sm_2O_3 1.15, Eu_2O_3 0.00, Gd_2O_3 1.49, Tb_2O_3 0.00, Dy_2O_3 0.09, Er_2O_3 0.04, Y_2O_3 3.88, CO_2 (23.17), H_2O (5.87), Total (101.19) wt.%. Empirical formula: $(La_{0.41}Ca_{0.21}Nd_{0.20}Y_{0.07}Pr_{0.05}Sr_{0.02}Gd_{0.02}Sm_{0.01})_{\Sigma 0.99}(CO_3)_{1.00}[(OH)_{0.74}(H_2O)_{0.25}]_{0.99}$. ***Relationship to other species:*** It is a member of the ancylite group, specifically the La-dominant analogue of kozoite-(Nd).

Name: For the relationship with kozoite-(Nd). ***Comments:*** IMA No. 2002-054.

MIYAWAKI, R., MATSUBARA, S., YOKOYAMA, K., IWANO, S., HAMASAKI, K., and YUKINORI, I. (2003) Kozoite-(La), $La(CO_3)(OH)$, a new mineral from Mitsukoshi, Hizen-cho, Saga Prefecture, Japan. *Journal of Mineralogical and Petrological Sciences* **98**, 137–141.

Kristiansenite — Triclinic

$Ca_2ScSn(Si_2O_7)(Si_2O_6OH)$

Locality: The Heftetjern pegmatite, Tørdal area, Telemark, Norway.

Occurrence: In a granite pegmatite. Closely associated minerals are: quartz, albite, apatite and stilpnomelane. Other associated minerals are: scandiobabingtonite, scandian ixiolite, hingganite-(Y), cerian epidote, titanite, plumbomicrolite and other microlite minerals, bazzite, milarite cassiterite and two unidentified tantalum minerals (rynersonite? and tantite?).

General appearance: Tapering crystals rarely up to 2 mm long and a massive aggregate nearly 2 mm across.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent to transparent. *Color:* colorless, white or slightly yellowish. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 5½ to 6. *Tenacity:* brittle. *Cleavage:* {001} inferred from preferred orientation in the X-ray powder diffraction pattern. *Fracture:* uneven. *Density:* could not be measured but sinks in di-iodmethane (3.3 g/cm³ (meas.), 3.64 g/cm³ (calc.). ***Crystallography:*** Triclinic, *C*1, *a* 10.028, *b* 8.408, *c* 13.339 Å, α 90.01°, β 109.10°, γ 90.00°, *V* 1062.7 Å³, Z 4, *a:b:c* = 1.1927:1:1.5865. Morphology: no forms could be measured but {010} is present. Twinning: polysynthetic on {010} with twin striations. ***X-ray powder diffraction data:*** 5.18 (53) $(1\bar{1}1)$, 3.898 (12) $(\bar{1}\bar{1}3)$, 3.146 (100) (004), 3.089 (63) $(\bar{2}22)$, 2.901 (19) (221), 2.595 (34) (222), 2.142 (17) $(\bar{3}\bar{3}1)$, 1.433 (12) (137). ***Optical data:*** Because of intensive twinning no optical data could be determined except for a mean index of refraction of 1.74. ***Chemical analytical data:*** Forty-nine sets of electron microprobe data were measured from several grains in three laboratories. The means of eleven sets of electron microprobe data (H_2O by difference) for the grain used for the crystal structure study are: Na_2O 0.41, K_2O 0.06, CaO 18.45, Al_2O_3 0.35, Sc_2O_3 8.11, Fe_2O_3 1.98, SiO_2 40.76, TiO_2 0.08, ZrO_2 0.43, SnO_2 27.33, H_2O (2.04), Total (100.00) wt.%. Empirical formula: $(Ca_{0.96}Na_{0.04})_{\Sigma 1.00}(Sn_{0.53}Sc_{0.34}Fe_{0.07}Al_{0.02}Zr_{0.01})_{\Sigma 0.97}Si_{1.98}$-$[O_{6.34}(OH)_{0.66}]_{\Sigma 7.00}$. Taking into consideration the crystal structure data, the ideal formula is $Ca_2ScSn(Si_2O_7)(Si_2O_6OH)$. ***Relationship to other species:*** None apparent.

Name: For Mr. Roy Kristiansen (1943–), a well-known amateur mineralogist from Norway who first noticed the new mineral and (with K. Eldjarn, A. Haugen and H. V. Ellingsen) provided samples for the study. ***Comments:*** IMA No. 2000-051. Note that the crystal structure has been solved.

RAADE, G., FERRARIS, G., GULA, A., IVALDI, G., and BERNHARD, F. (2002) Kristiansenite, a new calcium-scandium-tin sorosilicate from granite pegmatite in Tørdal, Telemark, Norway. *Mineralogy and Petrology* **75**, 89–99.

Kukharenkoite-(La)

Monoclinic

$Ba_2(La,Ce)(CO_3)_3F$

Locality: Kirovsky mine, Kukisvumchorr Mt., Khibiny massif, Kola Peninsula, Russia.

Occurrence: In late hydrothermal assemblages in cavities of two pegmatites. In the Hilairitovoye pegmatite, holotype material is associated with: microcline, albite, calcite, nenadkevichite, hilairite, catapleiite, strontianite, donnayite-(Y), synchysite-(Ce), pyrite, etc.; in a pectolite-aegirine-microcline vein other associated minerals are: natrolite, calcite, neodymian ewaldite, etc.

General appearance: Flattened prismatic to needle-like crystals up to 0.5 mm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless, white, pale green. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* about 4. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* uneven. *Density:* could not be measured, 4.60 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *P*2₁/*m*, *a* 13.396, *b* 5.111, *c* 6.672 Å, β 106.628°, *V* 437.7 Å³, Z 2, *a:b:c* = 2.6210:1:1.3054. Morphology: {010}, $\{\bar{2}01\}$, {100} and {001}. Twinning: rotation about [100] forming trillings. ***X-ray powder diffraction data:*** 4.01 (100) $(11\bar{1}, 201)$, 3.27 (100) $(310, 40\bar{1}, 20\bar{2})$, 2.54 (50) (020, 112), 2.14 (80) $(221, 51\bar{2}, 600)$, 1.998 (80) $(42\bar{1}, 22\bar{2}, 511, 31\bar{3})$, 1.370 (20) $(910, 42\bar{4}, 712, 71\bar{4})$. ***Optical data:*** Biaxial (−), α 1.581, β 1.715, γ 1.715, 2V(meas.) 5°, 2V(calc.) 0°; dispersion not observed; nonpleochroic; X ∧ *a* = 9° in acute angle β, Y = *b*, Z ∧ *c* = 26° in obtuse angle β; the drawing of the optical orientation given in the paper does not appear to be correct. ***Chemical analytical data:*** Means of nine sets of electron microprobe data (with CO_2 calculated to give $3CO_3$ (actually, 2.97): Na_2O 0.23, K_2O 0.27, CaO 0.99, SrO 2.38, BaO 44.10, La_2O_3 11.18, Ce_2O_3 5.36, Pr_2O_3 0.87, Nd_2O_3 0.76, CO_2 (21.30), ThO_2 9.41, F 3.38, sum (100.23), less O = F 1.42, Total (98.81) wt.%. Empirical formula: $(Ba_{1.76}Sr_{0.14}K_{0.04})_{\Sigma 1.94}$-$(La_{0.42}Th_{0.22}Ce_{0.20}Ca_{0.11}Na_{0.05}Pr_{0.03}Nd_{0.03})_{\Sigma 1.06}(CO_3)_{2.97}F_{1.09}$. ***Relationship to other species:*** It is the La-dominant analogue of kukharenkoite-(Ce).

Name: For the relationship to kukharenkoite-(Ce). ***Comments:*** IMA No. 2002-019. The empirical formula derived here differs slightly from that given in the paper.

PEKOV, I. V., CHUKANOV, N. V., KONONKOVA, N. N., ZADOV, A. E., and KRIVOVICHEV, S. V. (2003) Kukharenkoite-(La), $Ba_2(La,Ce)(CO_3)_3F$, a new mineral from Khibiny Massif, Kola Peninsula. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132(3)**, 55–64.

Kupčíkite

Monoclinic

$Cu_{3.4}Fe_{0.6}Bi_5S_{10}$

Locality: In orebodies K7 and K8 of the Felbertal scheelite deposit, Tauern Window of the Alps, Austria.

Occurrence: Associated minerals are: quartz, chalcopyrite, pyrrhotite, molybdenite, sphalerite, bismuth, makovickyite, cupromakovickyite, hodrushite, cuprobismutite and derivatives of the bismuthinite-aikinite series.

General appearance: Elongate aggregates up to 0.5 mm.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* grey. *Streak:* not given, but presumably grey. *Hardness:* VHN_{50} 192 kg/mm², corresponding to about 3½ Mohs. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* uneven. *Density:* could not be measured, 6.42 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C*2/*m*, *a* 17.512, *b* 3.9103, *c* 12.869 Å, β 108.56°, *V* 835.4 Å³, Z 2, *a:b:c* = 4.4784:1:3.2911. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.028 (4) (201), 3.596 (7) (401), 3.213 (4) $(\bar{2}04)$, 3.128 (10) (112), 3.071 (7) $(\bar{3}12)$, 2.683 (5) (113). ***Optical data:*** In reflected light: greyish white, anisotropism moderate in air and strong in oil, bireflectance perceptible in air and moderate in oil, pleochroism weak in air white with bluish tints and enhanced in oil. R_1 & R_2 in air: (33.55, 40.56 %) 470nm, (33.92, 41.14 %) 546nm, (34.16, 41.35 %) 589nm, (34.20, 41.32 %) 650nm. ***Chemical analytical data:*** Means of six sets of electron microprobe data: Cu 13.22, Ag 0.04, Cd 0.14, Pb 0.09, Fe 2.09, Sb 0.08, Bi 64.64, S 19.94, Total 100.24 wt.%. Empirical formula: $(Cu_{3.35}Fe_{0.60})_{\Sigma 3.95}$-$(Bi_{4.98}Cd_{0.02}Sb_{0.01}Pb_{0.01}Ag_{0.01})_{\Sigma 5.03}S_{10.02}$. ***Relationship to other species:*** Closely structurally related to cuprobismutite and hodrushite.

Name: For Professor Vladimir Kupčík (1934–1990) of the University of Bratislava and the University of Göttingen for his outstanding contributions to the crystal chemistry of sulfosalts. ***Comments:*** IMA No. 2001-017. The crystal structure has been solved.

TOPA, D., MAKOVICKY, E., BALIĆ-ŽUNIĆ, T., and PAAR, W. H. (2002) Kupčíkite, $Cu_{3.4}Fe_{0.6}Bi_5S_{10}$, a new Cu-Bi sulfosalt from Felbertal, Austria, and its crystal structure. *Canadian Mineralogist* **41**, 1155–1166.

Kurgantaite

Triclinic

$CaSr(B_5O_9)Cl{\cdot}H_2O$

Localities: Inder borate deposit, Kazakhstan. Also from the Chelkar borate deposit, Kazakhstan and the Nepskoe potassium deposit, Siberia, Russia.

Occurrence: Associated minerals are: sylvite, halite, boracite, anhydrite, magnesite and quartz.

General appearance: Fine-grained nodules up to 4 cm across, spherulites up to 0.7 mm in diameter (made up of individual crystals with pyramidal or wedge-shaped terminations) and poorly formed triangular plates up to 0.5 mm..

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless to white. *Streak:* white. *Luminescence:* probably nonfluorescent. *Hardness:* 6 to 6½. *Tenacity:* brittle. *Cleavage:* given as medium for two unspecified directions. *Fracture:* uneven. *Density:* 2.99 g/cm^3 (meas.), 3.04 g/cm^3 (calc.). ***Crystallography:*** Triclinic, *P*1, *a* 6.573, *b* 6.445, *c* 6.369 Å, α 60.995°, β 61.257°, γ 77.191°, *V* 206.9 $Å^3$, Z 1, *a:b:c* = 1.0199:1:0.9882. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.69 (8) (010), 3.22 (9) (112, $1\bar{1}\bar{1}$, 201), 3.13 (7) ($01\bar{1}$, 121), 2.92 (10) (200), 2.84 (9) (020), 2.79 (8) (122), 2.14 (7) (312, $20\bar{1}$), 2.07 (7) (113). ***Optical data:*** Biaxial (+), α 1.637, β 1.638, γ 1.675, 2V(meas.) $< 10°$, 2V(calc.) 19°, dispersion not given; nonpleochroic; orientation not given. ***Chemical analytical data:*** Seven sets of electron microprobe data are given. One set from Inder material consists of the following: CaO 14.69, SrO 26.43, B_2O_3 45.31, H_2O 4.69, Cl 9.58, sum 100.70, less O = Cl 2.17, Total 98.53 wt.%. Empirical formula: $Ca_{1.01}Sr_{0.98}(B_{5.00}O_{8.96})Cl_{1.04}{\cdot}1.00H_2O$. ***Relationship to other species:*** Related to hilgardite, $Ca_2(B_5O_9)Cl{\cdot}H_2O$.

Name: For the type locality. ***Comments:*** The mineral was originally described by Yarzhemskiy in 1952 but was discredited by von Hodenberg and Kühn in 1982 as "strontium hilgardite." Dr. Igor Pekov kindly assisted with this abstract.

PEKOV, I. V., LOVSKAYA, E. V., CHUKANOV, N. V., ZADOV, A. E., APPOLONOV, V. N., PUSHCHAROVSKY, D. YU., FERRO, O., and VINOGRADOVA, S. A. (2001) Kurgantaite $CaSr[B_5O_9]Cl{\cdot}H_2O$: revalidation of the mineral species and new data. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **130(3)**, 71–79.

Kuzmenkoite-Zn

Monoclinic

$K_2Zn(Ti,Nb)_4(SI_4O_{12})_2(OH,O)_4{\cdot}6\text{–}8H_2O$

Localities: (1) Kedykverpakhk Mt., Lovozero massif, Kola Peninsula, Russia. (2) Lepkhe-Nelm Mt., Lovozero massif, Kola Peninsula, Russia. (3) Karnasurt Mt., Lovozero massif, Kola Peninsula, Russia.

Occurrence: In alkaline pegmatites. (1) Associated with natrolite, microcline, albite, aegirine, nepheline, arfvedsonite, sodalite, eudialyte, lorenzenite and others. (2) Associated with microcline, aegirine, nepheline, magnesioarfvedsonite, eudialyte, lorenzenite, lamprophyllite, catapleiite, titanite, vinogradovite, tundrite-(Ce), apatite, neptunite, other labuntsovite group minerals and others. (3) Associated with natrolite, microcline, albite, aegirine, nepheline, arfvedsonite, sodalite, eudialyte, organovaite, beryllite, ranciéite, elpidite, strontiopyrochlore, catapleiite, yofortierite, mangan-neptunite, nontronite and others.

General appearance: (1) Pseudomorphs after murmanite. (2) Coarse prismatic crystals (up to 7 x 0.5 mm). (3) Rough crystals (up to 3 x 0.5 x 0.3 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* pink, pinkish-brown, gray, white. *Streak:* white. *Luminescence:* not mentioned. *Hardness:* ~5. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* rough. *Density:* 2.78 to 2.87 g/cm^3 (meas.), 2.94 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *Cm*, *a* 14.400, *b* 13.851, *c* 7.781 Å, β 117.33°, *V* 1379 $Å^3$, Z 2, *a:b:c* = 1.0396:1:0.5618. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.92 (75) (020, 001), 6.40 (60) ($20\bar{1}$, 200), 4.89 (29) (021), 3.19 (100) ($42\bar{1}$, $40\bar{2}$), 3.09 (91) (041, 022), 2.58 (35) (241), 2.49 (35) ($44\bar{1}$, $40\bar{3}$). ***Optical data:*** Biaxial (+), α 1.680 to 1.683, β 1.686 to 1.688, γ 1.783 to 1.787, 2V(meas.) 25°, 2V(calc.) 28°; dispersion not mentioned; nonpleochroic; Y = *b*. ***Chemical analytical data:*** Three sets of electron microprobe data are given. The set for material from Kedykverpakhk (with H_2O determined by TGA) is: Na_2O 0.49, K_2O 5.69, MgO 0.03, CaO 2.19, MnO 2.07, FeO 0.54, ZnO 3.73, SrO 0.19, BaO 2.00, Al_2O_3 0.10, SiO_2 38.56, TiO_2 17.68, Nb_2O_5 12.54, H_2O 13.80, Total 99.61 wt.%. Empirical formula: $(K_{1.48}Ca_{0.48}Na_{0.19}Ba_{0.16}Sr_{0.02})_{\Sigma 2.33}(Zn_{0.56}Mn_{0.36}Fe_{0.09}\text{-}Mg_{0.01})_{\Sigma 1.02}(Ti_{2.71}Nb_{1.16})_{\Sigma 3.87}[(Si_{3.94}Al_{0.01})_{\Sigma 3.95}O_{11.85}]_{2.00}[(OH)_{2.19}\text{-}O_{1.81}]_{\Sigma 4.00}{\cdot}8.30H_2O$. ***Relationship to other species:*** It is a member of the labuntsovite group with Zn dominant in the D-site.

Name: For Maria V. Kuz'menko (1918–1995). Russian geochemist and mineralogist, a specialist in the geochemistry of rare elements who studied the Lovozero massif; the suffix denotes the dominance of Zn in the D-site. ***Comments:*** IMA No. 2001-037. The subscripts in the empirical formula given here are quite different from those given by the authors.

CHUKANOV, N. V., PEKOV, I. V., ZADOV, A. E., AZAROVA, YU. V., and SEMENOV, E. I. (2002) Kuzmenkoite-Zn $K_2Zn(Ti,Nb)_4(SI_4O_{12})_2(OH,O)_4{\cdot}6\text{–}8H_2O$, a new mineral of the labuntsovite group from the Lovozero massif, Kola Peninsula. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **131(2)**, 45–50. CHUKANOV, N. V., PEKOV, I. V., and KHOMYAKOV, A. P. (2002) Recommended nomenclature for labuntsovite-group minerals. *European Journal of Mineralogy* **14**, 165–173.

Magnesiotantalite

Orthorhombic

$(Mg,Fe)(Ta,Nb)_2O_6$

Locality: Lipovka pegmatite field, Rezh district, Central Urals, Russia.

Occurrence: Intergrowths of magnesiotantalite, ferrotantalite, ferrocolumbite and uranium-bearing microlite form rims on manganotantalite crystals in andesine-calcite nests in a deeply desilicated granite pegmatite which cross-cuts serpentinite near its contact with marble. Other associated minerals are: dravite-uvite series, chrysoberyl, phlogopite, magnesiohornblende-edenite series, cordierite, phenakite, clinochlore, and others.

General appearance: Flattened irregular grains up to 0.4 mm and segregations up to 0.7 mm.

Physical, chemical and crystallographic properties: *Luster:* semimetallic to metallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* brown-red. *Hardness:* VHN_{50} 489 kg/mm^2, Mohs 5½. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* uneven. *Density:* 6.7 g/cm^3 (meas.), 6.79 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, *Pbcn*, *a* 14.335, *b* 5.735, *c* 5.058 Å, *V* 415.8 $Å^3$, Z 4, *a:b:c* = 2.4996:1:0.8820. Morphology: no forms were observed, flattened on {010} ?. Twinning: none observed. ***X-ray powder diffraction data:*** 3.67 (60) (310, 111), 2.96 (100) (311), 1.774

(60) ()330, 1.746 (50) (602), 1.728 (70) (621), 1.545 (50) (910), 1.462 (90) (911, 332). ***Optical data:*** In reflected light: light gray, weak anisotropism, very weak bireflectance, nonpleochroic. $R_{max.}$, $R_{min.}$:

(15.20, 14.02) 400 nm	(15.18, 13.69) 410 nm	(15.05, 13.49) 420 nm
(14.79, 13.27) 430 nm	(14.53, 12.95) 440 nm	(14.28, 12.76) 450 nm
(13.97, 12.82) 460 nm	(13.75, 12.95) **470** nm	(13.58, 13.05) 480 nm
(13.44, 13.13) 490 nm	(13.33, 13.20) 500 nm	(13.25, 13.22) 510 nm
(13.23, 13.19) 520 nm	(13.25, 13.18) 530 nm	(13.32, 13.20) 540 nm
(13.41, 13.19) **546** nm	(13.47, 13.28) 550 nm	(13.67, 13.45) 560 nm
(13.94, 13.67) 570 nm	(14.25, 13.94) 580 nm	(14.57, 14.24) **589** nm
(14.58, 14.25) 590 nm	(14.90, 14.58) 600 nm	(15.18, 14.90) 610 nm
(15.41, 15.16) 620 nm	(15.56, 15.32) 630 nm	(15.61, 15.31) 640 nm
(15.55, 15.15) **650** nm	(15.41, 14.83) 660 nm	(15.22, 14.48) 670 nm
(15.00, 14.12) 680 nm	(14.88, 13.93) 690 nm	(14.76, 13.76) 700 nm

Chemical analytical data: Means of five sets of electron microprobe data: MgO 5.27, MnO 0.82, FeO 6.71, TiO_2 0.38, Nb_2O_5 24.19, Ta_2O_5 61.86, Total 99.23 wt.%. Empirical formula: $(Mg_{0.56}Fe_{0.40}Mn_{0.05})_{\Sigma1.01}(Ta_{1.20}Nb_{0.78})_{\Sigma1.98}O_{6.00}$. ***Relationship to other species:*** It is the Mg- and Ta-dominant member of the columbite group.

Name: For the relationship to ferrotantalite and manganotantalite. ***Comments:*** IMA No. 2002-018.

PEKOV, I. V., YAKUBOVICH, O. V., SHCHERBACHEV, D. K., and KONONKOVA, N. N. (2003) Magnesiotantalite, (Mg,Fe)-$(Ta,Nb)_2O_6$, the new columbite-tantalite group mineral from desilicated granite pegmatites of Lipovka (the central Urals) and its genesis. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132**, 49–59.

Magnesiostaurolite

Monoclinic

$\Box_4Mg_4Al_{16}(Al_2\Box_2)Si_8O_{40}[(OH)_2O_6]$

Locality: The Dor-Maira massif, especially in the Vallone di Gilba, Val Varaita, Italian Western Alps, Italy.

Occurrence: As inclusions in pyrope megablasts from coesite-bearing metamorphic terrane. Associated minerals are: pyrope, talc, clinochlore, kyanite, rutile, magnesiodumortierite, corundum, magnesiochloritoid, ellenbergerite, chlorite.

General appearance: Anhedral isolated grains from a few tens to 250 µm.

Physical, chemical and crystallographic properties: Most of the following properties refer to the mineral in thin-section or are inferred. *Luster:* probably vitreous to resinous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* probably white. *Luminescence:* nonfluorescent. *Hardness:* probably 7 to 7½. *Tenacity:* probably brittle. *Cleavage:* not observed. *Fracture:* not observed. *Density:* could not be measured, 3.54 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 7.8706, *b* 16.5411, *c* 5.6323 Å, β 90.007°, *V* 733.3 Å³, Z 1, *a:b:c* = 0.4758:1:0.3405. Morphology: no forms were mentioned. Twinning: none, but a "tweed" texture was observed between crossed nicols. ***X-ray powder diffraction data:*** 4.139 (23.6) (040), 3.516 (21.6) (131), 3.001 (20.3) (221), 2.678 (38.0) (151), 2.390 (50.4) (132), 2.370 (32.8) (330), 2.356 (24.0) (311), 1.968 (100.0) (062), 1.511 (23.3) (192), 1.407 (23.0) (004), 1.391 (81.8) (246), 1.377 (21.8) (0.12.0). ***Optical data:*** Biaxial (sign unknown), mean n 1.709, 2V(meas.) close to 90°; nonpleochroic; orientation unknown. ***Chemical analytical data:*** Means of three sets of electron microprobe data: Li_2O 0.90, MgO 7.77, FeO 0.72, ZnO 0.10, Al_2O_3 57.45, SiO_2 30.66, TiO_2 0.18, H_2O 2.30, Total 100.08 wt.%. Empirical formula $(\Box_{3.12}Mg_{0.72}Fe_{0.16})_{\Sigma4.00}(Mg_{1.85}$-$Li_{0.94}Zn_{0.02}\Box_{1.19})_{\Sigma4.00}(Al_{15.96}Ti_{0.04})_{\Sigma16.00}(Al_{1.58}Mg_{0.45}\Box_{1.97})_{\Sigma4.00}(Si_{7.96}$-$Al_{0.04})_{\Sigma8.00}O_{40.04}[(OH)_{3.98}O_{4.02}]_{8.00}$. ***Relationship to other species:*** It is the Mg-dominant analogue of staurolite and zincostaurolite.

Name: For the relationship to staurolite. ***Comments:*** IMA No. 1992-035.

CHOPIN, C., GOFFE, B., UNGARETTI, L., and OBERTI, R. (2003) Magnesiostaurolite and zincostaurolite: mineral description with a petrogenetic and crystal-chemical update. *European Journal of Mineralogy* **15**, 167–176.

Mallestigite

Hexagonal

$Pb_3Sb(SO_4)(AsO_4)(OH)_6\cdot3H_2O$

Locality: The dump of a copper-lead-zinc mine, 1 km NW of the Mallestiger Mittagskogel, Westkarawanken, Carinthia, Austria (Lat. 46°31′45″ N, Long. 13°52′24″ E, altitude 1200 m above sea level).

Occurrence: In narrow fractures of limestones where it formed during weathering of primary galena and tetrahedrite. Associated minerals are: anglesite, brochantite, langite, linarite and schultenite.

General appearance: Idiomorphic to hypidiomorphic crystals up to 2 mm long and 0.4 mm thick. Also in radial aggregate up to 3 mm in diameter.

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* transparent to translucent. *Color:* colorless. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* VHN_{10} 176 kg/mm², Mohs 4. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* splintery. *Density:* could not be measured, 4.91 g/cm³ (calc.). ***Crystallography:*** Hexagonal, $P6_3$, *a* 8.938, *c* 11.098 Å, *V* 767.8 Å³, Z 2, *c:a* = 1.2417. Morphology: {100} and {101}; elongated on [001]. Twinning: none observed. ***X-ray powder diffraction data:*** 7.74 (25) (100) 6.35 (44) (101), 3.655 (100) (201), 3.481 (80) (112), 3.175 (31) (202), 2.675 (62) (203), 2.235 (35) (220), 1.741 (24) (224). ***Optical data:*** Uniaxial (+), ω 1.760, ε 1.801, nonpleochroic. ***Chemical analytical data:*** Means of fourteen sets of electron microprobe data (given as elements and converted here to oxides with H_2O calculated to give 12H): PbO 65.67, Sb_2O_5 14.68, As_2O_5 9.71, SO_3 8.64, H_2O (10.38), Total (1009.08) wt.%. Empirical formula: $Pb_{3.06}Sb_{0.95}$-$[(SO_4)_{1.12}(AsO_4)_{0.88}]_{\Sigma2.00}(OH)_{5.99}\cdot3.01H_2O$. ***Relationship to other species:*** It is the Sb-dominant analogue of fleischerite, $Pb_3Ge^{4+}(SO_4)_2(OH)_6\cdot3H_2O$.

Name: For the locality. ***Comments:*** IMA No. 1996-043. Only an extended abstract of this description has been published (see below), but Prof. Dr. Franz Walter (Universität Graz) kindly supplied additional information. The crystal structure has been solved.

SIMA, I. (2002) Mallestigite, $Pb_3Sb(SO_4)(AsO_4)(OH)_6\cdot3H_2O$, ein neues Mineral von einer Halde des ehemaligen Cu-Pb-Zn-Bergbaues NW des Mallestiger Mittagskogels in den Westkarawanken, Kärnten, Österreich. *Mitteilungen der Österreichische Mineralogischen Gessellschaft* **143**, 200–201. WALTER, F. (2003) personal communication.

Manganlotharmeyerite

Monoclinic

$Ca(Mn^{3+},\Box,Mg)_2\{AsO_4,[AsO_2(OH)_2]\}_2(OH,H_2O)_2$

Locality: The Starlera Fe-Mn deposit, Val Ferrera, Eastern Alps, Switzerland.

Occurrence: In carbonate-hosted manganese ore. Associated minerals are: calcite, tilasite and sailaufite (in press).

General appearance: Elongate platy crystals and aggregates up to 1 mm long.

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* transparent to translucent. *Color:* brown-red to dark reddish orange. *Streak:* light brown. *Luminescence:* not given. *Hardness:* about 3. *Tenacity:* brittle. *Cleavage:* {001} distinct. *Fracture:* irregular. *Density:* 3.77 g/cm^3 (meas.), 3.75 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 9.043, *b* 6.2314, *c* 7.3889 Å, β 116.392°, *V* 372.99 Å^3, Z 2, *a:b:c* = 1.4512:1:1.1858. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.93 (80) (110), 3.182 (100) ($\bar{1}12$), 2.927 (70) (201), 2.822 (70) (021), 2.718 (80) ($\bar{3}11$), 2.555 (100) ($\bar{2}21$, $\bar{3}12$), 2.134 (70) (202, 221). ***Optical data:*** Biaxial (+), α 1.785, β 1.814, γ 1.854, 2V(meas.) 85°, 2V(calc.) 82°; dispersion $r < v$, weak; pleochroism not mentioned; orientation unknown. ***Chemical analytical data:*** Means of six sets of electron microprobe data (H_2O calculated to give 10 oxygen atoms): Na_2O 0.08, MgO 3.95, CaO 12.42, ZnO 0.58, SrO 0.20, NiO 1.07, CoO 0.19, Al_2O_3 0.27, Fe_2O_3 0.91, Mn_2O_3 16.70, V_2O_5 0.67, As_2O_5 53.41, H_2O (8.84), Total (99.29) wt.%. Empirical formula: $(Ca_{0.94}Sr_{0.01}Na_{0.01})$-$(Mn^{3+}_{0.45}\square_{0.26}Mg_{0.20}Ni_{0.03}Fe_{0.02}Zn_{0.02}Al_{0.01}Co_{0.01})_2(As_{0.98}V_{0.02})_2O_{10.00}H_{4.16}$. ***Relationship to other species:*** It is the manganese-dominant member of the lotharmeyerite subgroup of the tsumcorite group.

Name: For the relationship to lotharmeyerite. ***Comments:*** IMA No. 2001-026. The crystal structure has been solved and is the basis for the given formula.

BRUGGER, J., KRIVOVICHEV, S. V., KOLITSCH, U., MEISSER, N., ANDRUT, M., ANSERMET, S., and BURNS, P. C. (2002) Description and crystal structure of manganlotharmeyerite, $Ca(Mn^{3+},\square,Mg)_2\{AsO_4,[AsO_2(OH)_2]\}_2(OH,H_2O)_2$, from the Starlera Mn deposit, Swiss Alps, and a redefinition of lotharmeyerite. *Canadian Mineralogist* **40**, 1597–1608.

Marécottite Triclinic

$Mg_3(H_2O)_{18}[(UO_2)_4O_3(OH)(SO_4)_2](H_2O)_{10}$

Locality: La Creusaz uranium prospect near Les Marécottes village, Canton Valais, Western Alps, Switzerland.

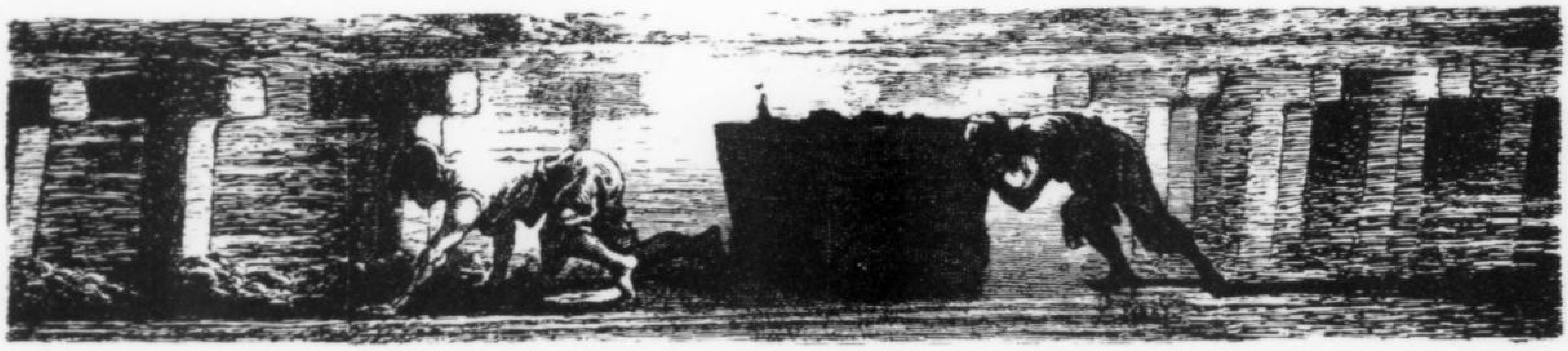
Occurrence: In hydrothermal breccia veins. Associated minerals are: uraninite, gypsum, rabejacite, johannite and some other new uranium species.

General appearance: Diamond-shaped platelets up to 500 μm long grouped into rosettes.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* yellow-orange. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* about 3. *Tenacity:* very brittle. *Cleavage:* {011} perfect. *Fracture:* not given. *Density:* the mineral sinks in Clerici solution with a density of 4.03 g/cm^3, 3.86 g/cm^3 (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 10.815, *b* 11.249, *c* 13.851 Å, α 66.224°, β 72.412°, γ 69.955°, *V* 1422.1 Å^3, Z 1, *a:b:c* = 0.9614:1:1.2313. Morphology: {011} is the prominent form. Twinning: results in two twinned individuals with the composition plane corresponding to the long axis of the crystal and perpendicular to {011}. ***X-ray powder diffraction data:*** 9.46 (100) ($0\bar{1}1$), 8.63 (20) (101), 4.73 (80) (022), 3.44 (80) ($01\bar{3}$, 310), 3.39 (70) (321, $0\bar{2}2$), 2.88 (30) (303) and several other spacings with intensity 20. ***Optical data:*** Biaxial (sign not given), the indices of refraction measured in the (011) face range from 1.735 to 1.750, pleochroism fair from pale-yellow to orange-yellow in the (011) face. ***Chemical analytical data:*** Means of eight sets of electron microprobe data (with H_2O calculated): MgO 2.03, MnO 1.15, SO_3 8.95, UO_3 66.36, H_2O (14.73), Total (93.22) wt.%. Empirical formula: $(Mg_{1.79}Mn_{0.58})_{\Sigma 2.37}(UO_2)_{8.24}(SO_4)_{3.97}$-$(OH)_{2.00}O_{5.64}\cdot 28.02H_2O$. ***Relationship to other species:*** It is related to magnesium-zippeite.

Name: For the locality. ***Comments:*** IMA No. 2001-056. The paper gives the species name without an acute accent on the first "e"; it has been corrected here.

BRUGGER, J., BURNS, P. C., and MEISSER, N. (2003) Contributions to the mineralogy of acid drainage of uranium minerals: marecottite and the zippeite-group. *American Mineralogist* **88**, 676–685.

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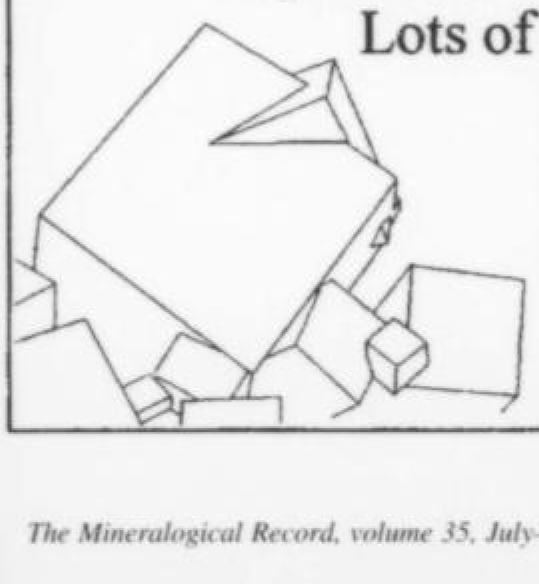

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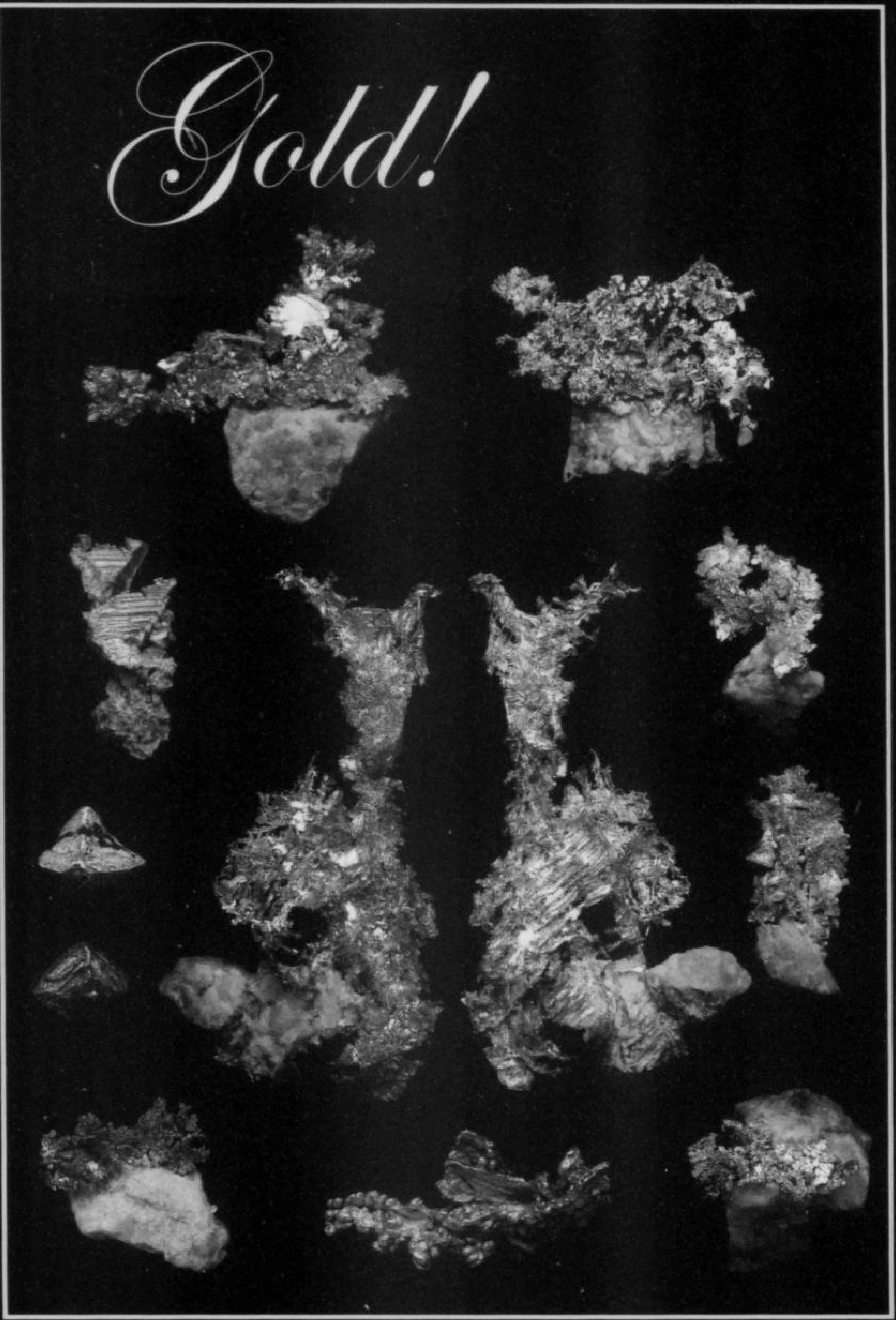
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