

Australia and New Zealand Micromineral News



Issue 11 – September 2015

Editor: Steve Sorrell – steve@crocoite.com



Cover photo:

Pseudomalachite

Burra, South Australia

7 images stacked using Zerene Stacker

Taken with Canon 600D with reversed 18-55mm lens

Photo width 6mm across

Photo and Specimen: Steve Sorrell

In This Issue

Introduction

Apologies for the delay in getting this issue out. I hadn't realised how quickly time has gone this year! However, to make up, this is a bumper issue. Once again, thanks to John Haupt, and to Noel Kennon and the New South Wales micro group. They have been very busy and the results are here to see.

Contributions – We Still Need Your Input!

Articles should be submitted to the editor in Word format, and any photos should be of a sufficient quality for publication. If you believe that you can provide a suitable article for the next issue, please advise the editor as soon as possible. Planning for the next issue begins as soon as the current one is published!

Contacts

If you want to find out what's happening with micromounting or microminerals in your region, get in touch with one of the following:

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Forward Diary

Please send details of micromounting or micromineral upcoming events (up to six months ahead would be good) for inclusion in the next issue of the Australian and New Zealand Micromineral News.

- The New Zealand Symposium is on again in October. Contact Jocelyn for details (sodalite@paradise.net.nz)
- The Joint Mineralogical Societies' Seminar is in Tasmania this year in November. Contact Ralph for details (rbottrill@mrt.tas.gov.au) or go here <http://tasmanianlapidarymineral.weebly.com/joint-australian-mineralogical-societies-seminar-tasmania-2015.html>

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Notes and Queries

It seems that the Notes and Queries idea has been a bit of a flop, so will be discontinued.

Woodlawn Minerals

The Micromineral Group, Mineralogical Society of New South Wales Inc.

The ANZ Micromineral News No 10, January 2015 included a contribution entitled “Minerals of the Woodlawn Mine in the Southern Tablelands of NSW” by The Micromineral Group of the Mineralogical Society of NSW Inc. Reference was made in that paper to the probability that a Woodlawn specimen containing silver may become available to the Group for examination.

That specimen has now been provided and seen to contain not only silver but a single globule of chlorargyrite and so we add two more minerals to the Woodlawn list. Additionally, a collection of single crystals of pyrite has been deemed worthy of inclusion in this note.

The Minerals

Fifteen mineral species, not listed in Mindat were described in the original paper, together with six listed minerals. The two additional new minerals described here were identified in a single specimen loaned to the Group by Society member Doug Austin.

Silver Ag

Silver occurred as irregularly shaped small clumps including the globular-dendritic spray shown in Fig. 1. This mineral was non-existent in the original material examined by the Group although, as reported earlier, in the late 1970's, Ross Pogson had seen considerable silver associated with yellow ochrous corkite in the gossan.



Fig. 1 Silver, spray ~ 3mm across, field of view (fov) 6mm, depth of field enhanced with Combine ZM stacking software (CZM), specimen Doug Austin, photograph Dieter Mylius.

Chlorargyrite AgCl

A single globule of chlorargyrite (Fig. 2) was identified in the specimen containing the several clumps of silver. Whether this species occurs in association with silver in other specimens is not known. However it is expected to be rare as there is no other mineral containing chlorine either listed in Mindat for the site or listed in the original paper. Only fluorite, muscovite and phlogopite from those lists contain a halide (fluorine).

Pyrite FeS₂

During a private visit by several members of the NSW. Min. Soc. to the mine in about 2000, isolated crystals of pyrite (Fig. 3), were collected from a mullock heap that had been dumped near the edge of the open cut pit. The crystals had probably weathered from foliated host rock.



Fig. 2 Chlorargyrite, 1 mm globule, depth of field enhanced with CZM, specimen Doug Austin, photograph Dieter Mylius.



Fig. 3 Pyrite, fov 25mm, depth of field enhanced with CZM, specimen David Colchester, photograph Dieter Mylius.

Conclusion

Although we know from Ross Pogson that silver occurred in the gossan of the Woodlawn ore body, we can now add it, together with chlorargyrite, to the list of photographed species that have been identified in the Woodlawn deposit.

Meetings of the Micro Group of Victoria, March and April 2015

By Jo Price, Photographs by John Haupt

The March meeting was held on the 29th, with the topic being minerals from South Australia, excluding Puttapa, Reaphook Hill, and Spring Creek.

Some of the many Iron Monarch minerals tabled were meta-switzerite, turquoise, clear wardite crystals and one specimen coated with crandallite. Then connellite, beyerite, yellow cubes of alunite, berrmanite, gibbsite, triploidite, nissonite, and francisite for which this is the type locality and honours Glyn Francis.



Pale blue turquoise crystals with crandallite, from Iron Monarch, 2mm FOV.



Lustrous crystals of gibbsite from Iron Monarch, 4mm FOV.

From the Sir Dominic Mine we saw azurite, cornwallite, and olivenite. There was atacamite, cuprite and dendritic copper from Moonta; anglesite, minium with fluorite, phosgenite, pyromorphite, and wulfenite from the Avondale mine; lovely cuprite crystals on dolomite with malachite. Tabular malachite, pink calcite and rhodochrosite from Mutooroo; and sphaerocobaltite from O'Donoghue's Castle.

There was pharmacosiderite and lavendulan from Preamimma, pumpellyite from Roopena Station, opal from Coober Pedy; quartz from Ashton's Quarry; arseniosiderite, orthoserpierite, and olivenite from Mt Malvern; digenite, emplectite and wittichenite from Mt. Gunson; glauberite from Lochiel, good crystals of rutile from Strathalbyn; while from Paratoo we saw paratooite-(La), decrespignyite-(Y), donnayite-(Y), basnäsite-(La), and tenerite-(Y).

We particularly liked the fine turquoise from Iron Monarch and the malachite and cuprite from Mutooroo, and were reminded of many field trips we had there.



Wulfenite crystal 3mm across, from the Avondale mine, Lyndhurst.



From Mutooroo: A lustrous cuprite crystal, 0.4mm across.





From Mutooroo: Malachite crystals, 3mm FOV.

The topic for the April meeting was minerals from their Type Locality.

Type locality minerals from Australia included cloncurryite, the Great Australia Mine, Cloncurry; sieleckiite, Mt Oxide Mine, Queensland; miersite and raspite, Proprietary Mine, birchite, Block 14, kintoreite and segnitite, Broken Hill N.S.W; selwynite, Wycheproof; pittongite, Pittong; ulrichite and lakebogaite, Lake Boga Quarry, Vic.; ashburtonite; Ashburton Downs Station, W.A.; carrboydite, Carr Boyd Rocks, Gindalbie Station W.A; hellyerite, Lord Brassey Mine, dundasite, Adelaide Mine, stichtite, near the Adelaide Mine and luinaite, Mt. Cleveland Mine, Tas.; kapundaite, Tom's Quarry, decrespignyite, Paratoo Mine, and kleemanite, Iron Monarch Quarry, South Australia.

There were many other minerals from overseas type localities, such as libethenite from Libethen, Slovakia; bentorite, Negev Desert, Israel; senegalite, Senegal; imiterite, Imiter mine, Anti-Atlas Mts., Morocco; scholzite, Hagendorf-Sud, Germany; khaidarkanite, Altai Range, Kyrgystan; shuiskite on uvarovite, Urals, Russia; rimkoralgite, Kovdor Massif, Russia, callaghanite, Gabbs, Nevada, gilalite, Christmas Mine, Arizona, U.S.A; and tualite, Mayor Island, N.Z.

The U.K was well represented with alstonite, Brownley Hill, Cumbria; arthurite, Hingston Down Consols, Cornwall; chalcocyanite; Wheal Phoenix, Cornwall; brewsterite, Strontian, Scotland and many more.

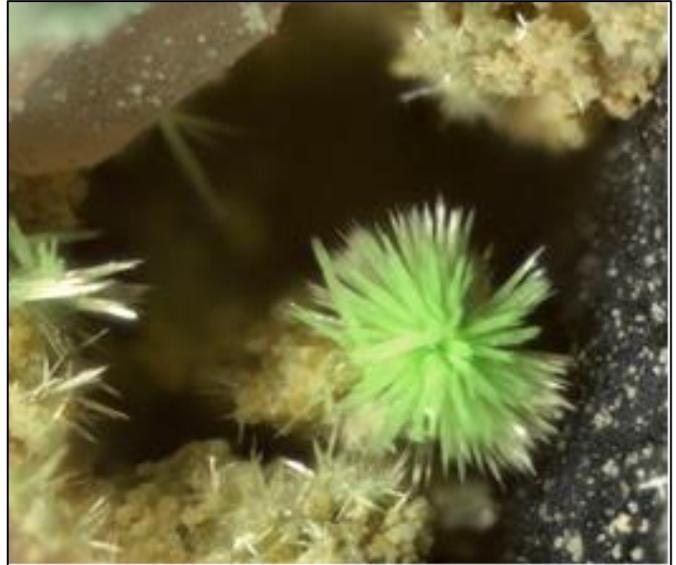
Some Mont St Hilaire minerals shown were tetranatrolite, caresite, chamerrite, hilairite, donnayite-(Y), monteregionite, gaidonnayite, horvathite, dresserite, adamsite-(Y), petarasite-(Ce), thomasclarkite-(Y), normandite, and griceite.

There were several species from the Aris Quarry in Namibia that we don't usually see, such as arisite (brown), suzhinite (white), ellinsite (white sprays) and taperssuatsiaite (golden sprays).

There is a similar volcanic rock at three localities: Aris Quarry, Mont St Hilaire and Mayor Island, N.Z. The rock from Aris and Mont St Hilaire is very hard and has been quarried for road works.



Pale blue cloncurryite, 2mm FOV.



Ulrichite spray, 1mm across.



Chalcosiderite from Wheal Phoenix 2mm FOV.



Arthurite from Hingston Down Consols, 2mm FOV.

Our next meeting is 31st May with the topic being minerals containing chromium, molybdenum or tungsten (the same group on the Periodic Table).

Mercury

Noel Kennon

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Some micromineral collectors have specimens of mercury in their collections. The specimens undoubtedly comprise small globules of the species loosely attached to matrix (Fig. 1) and may have crystals of cinnabar (Fig. 2 - HgS) as well. Such specimens are quite rare and of course must be treated with considerable care as mercury is a toxic substance.

Micro- and other collectors might be interested in some information about one of the most significant mercury mines in the mining history of the world and perhaps the source of many micro-, miniature, thumbnail and cabinet sized collectables. This is the Indira Mercury Mine located in town of Idrija, on the southeastern edge of the Alps in northwest Slovenia. During five centuries of operation, the mine has produced about 325,000 tonnes of mercury which is close to 13% of world production during that period.

Mining of the deposit commenced in 1490 when, according to legend, a local cooper saw a silvery liquid collecting in a tub lying in a nearby stream. The liquid was identified as mercury by a goldsmith, and as a consequence, the long and illustrious mining operations commenced.

Initially, mining of the low grade ore in schist was slow and small scale. However, by the end of the 1500's, the workings had reached a depth of 170 metres and the mine was one of the deepest in Europe. Around that time, high grade cinnabar (mercury sulphide HgS) was found in abundance and the low grade ore was abandoned. The bright red cinnabar, easily located in the gloom of the mine, was hauled to the surface, packed in earthenware vessels and heated over a charcoal fire to produce mercury metal.

Idrija rapidly became the technological centre of the day and was visited by leading scientists who were greatly impressed by the quality of the work being carried out. However, there was a downside to the operations as production of mercury was a highly dangerous process. Despite their best efforts, operators could not totally contain the mercury vapours and many workers died from mercury poisoning. Poisoned workers suffered chronic lethargy with associated mental deterioration and became known as kimpahs, a term still used locally to describe lazy people.

During the five centuries of active mining, some 700 km of mine roadway was built and the mine eventually reached a depth of 400 metres. The mine closed in about 1980 and in 2012 UNESCO added it to the World Heritage List. Today, it is possible to enter the mine by way of the original road built around 1500.

(Extracted from Down to Earth Issue No 34, March 2001, published by Geo Supplies Ltd, Sheffield, England; original material provided by Niko Jereb, Idrija.)

Figures 1 and 2 obtained from the internet.



Figure 1: Mercury globules

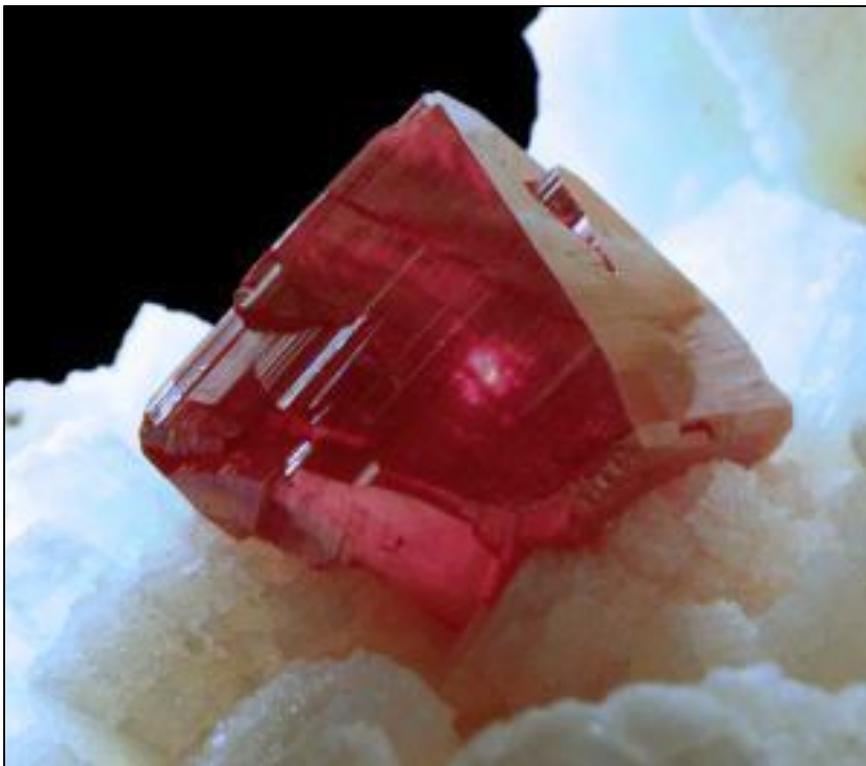


Figure 2: Cinnabar crystal



Minerals from Portland, Victoria

By John Haupt

In the 1970's, the Portland Harbour Trust opened a quarry at Cape Sir William Grant, 6 km south of Portland to obtain rock for the extension of Portland harbour. This quarry produced a number of interesting minerals which occurred in vesicles in the basalt. Members of the Mineralogical Society of Victoria visited the quarry in 1984 and many of the minerals described in this article were collected at this time. The locality is listed as Portland for brevity. The quarry was located adjacent to the sea and was flooded after the quarrying was finished.



The Portland Harbour Trust quarry, March 1984.



Collecting in the quarry on the Min Soc Vic. field trip, March 1984.

The Minerals

The following is a short description of the minerals found at Portland. Additional information on the minerals from this locality is contained in Bosworth (1989, 1990). No detailed chemical analysis appears to have been conducted on the zeolites from Portland, so only the generalised species name has been used.

Analcime was uncommon at Portland. It occurred sparingly as small glassy trapezohedron crystals up to 1mm.

Andesine This intermediate member of the albite-anorthite plagioclase series is probably the most abundant crystallised mineral at Portland. It forms thin tabular white, cream and tan coloured crystals up to 2mm, lining and infilling many of the vesicles.

Apatite has been found sparingly as thin prismatic crystals to 2mm.

Augite is commonly associated with andesine. It forms glassy deep green to black prismatic crystals up to 2cm long. Analysis has shown it to be better known as diopsidic augite (Birch 1982).

Calcite mainly occurs as individual transparent scalenohedral crystals up to 2mm long. An occasional cluster of these crystals make attractive specimens, as shown in the accompanying photographs.

Chabazite occurs as small glassy crystals to 4mm across, most commonly as complex twins with a hexagonal outline known as phacolite.

Copper Thin wires of native copper to 2mm have been found in chabazite lined vesicles.

Ilmenite is commonly associated with andesine and augite. It forms as tabular crystals up to 5mm across.

Natrolite appeared to be rare at Portland. It has been found as spherical sprays of white crystals to 1mm across.

Phillipsite occurred sparingly at Portland and is usually found as complex penetration twins or 'fourlings', up to 2mm across.

Thomsonite appears to have been the rarest of the zeolite species from Portland. Several specimens were collected of both a globular form and as individual sprays of tabular crystals up to 1.5mm across.

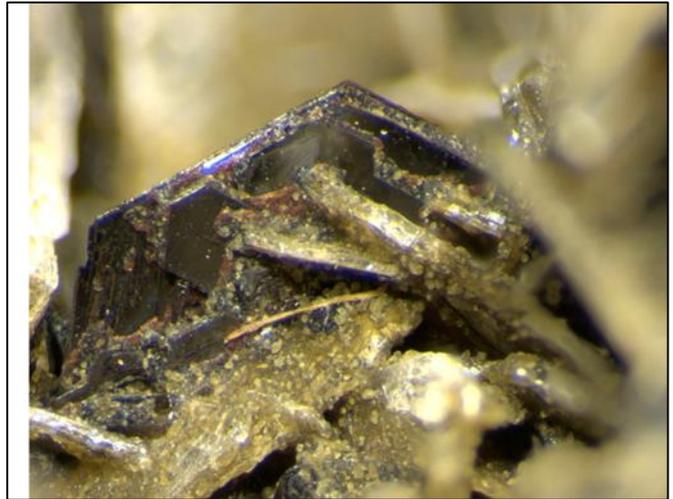
Accompanying photographs: Unless otherwise noted, the photographs have been taken by John Haupt. The ones marked * have been taken as multiple images and combined using the Helicon stacking program.

References:

- Birch, W.D., Smith, N., & Hatley, J., 1982: Andesine, augite and ilmenite in vesicles in an alkali olivine basalt from Portland, Victoria. *The Australian Mineralogist*, 37, 195-198.
- Bosworth, J.D., 1990: Cape Sir William Grant Quarry Portland. *The Mineralogical Society of Victoria. Album of Minerals, Volume 3, Unpublished.*
- Bosworth, J.D., 1989: Western Victoria. Chapter 8, *Zeolites of Victoria, Special Publication 2, 85-89.*



Tabular andesine crystals, 40mm across. Specimen & Photograph: J. Bosworth.



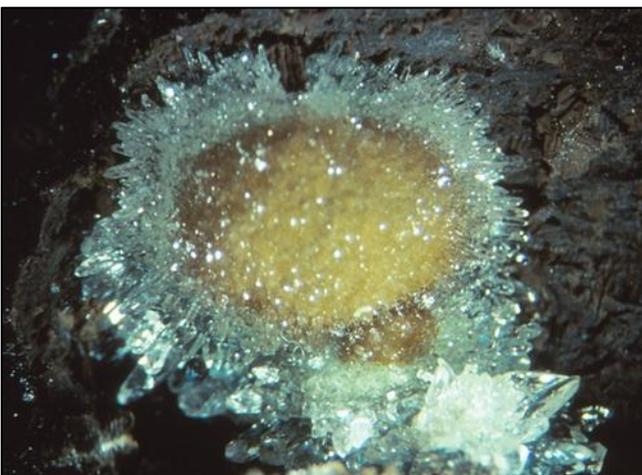
Ilmenite crystal 3mm across*.



Augite, 1mm crystal with andesine and chabazite*.



Radiating group of calcite crystals, 15mm across.



Cluster of calcite crystals, 19mm FOV.
Specimen & photograph: J. Bosworth.



A 4mm chabazite crystal of the phacolite habit, on andesine*.



A 2mm tall cluster of chabazite crystals of the phacolic habit*.



A 2mm tall copper wire in chabazite. Specimen and photograph: F. Robinson.



Chabazite crystal on augite, 8mm tall. Specimen and photograph: F. Robinson.



Chabazite crystals on calcite, 10mm tall. Specimen & photograph: F. Robinson.



A 1mm phillipsite crystal*.



Phillipsite crystals exhibiting typical cruciform 'fourling' twinning. 4mm FOV*.

Hoelite

Neil Smith

(Neil contacted me about hoelite. His emails are reproduced here – Ed.)

Hello Steve,

I've just caught up reading the latest issue of Micronews (Issue 10) and read with interest Noel Kennons' Mercury verses Ice verses liquid verses solid.

This made me think about an organic mineral I came across recently whilst surfing the Internet. The organic mineral is "Hoelite" which is found in the Czech Republic. I was under the impression (being a novice) that "things", my geological term, were either a mineral or organic.

Anyway here is a write up from the eBay site:

HOELITE

* yellow micro-needles on matrix - very nice under magnification *

* rare thumbnail specimen from famous burning coal dumps *

Size: 16 X 10 X 5mm

Weight: 1g

3B5

Origin: Kladno Mine (Schöller Mine), Libušín, Kladno, Central Bohemia, Czech Republic

A coal mine which started in 1899 as Schoeller mine (after Gustav Schoeller, Austrian mining entrepreneur). From 1946, it was named Zdeněk Nejedlý Mine (historian, musicologist and minister of culture in communist government), from 1951 Nejedlý I Mine. After 1990 again renamed: Kladno Mine in Libušín. Terminated 2002 after 2001 methane explosion with four casualties.

The mine was active exactly 100 years and total of 45,768,396 tons of coal was mined. Depth of mine pit 533 m, shaft bottom 518 m. The famous burning dumps of Schoeller mine are now fully recultivated.

Hoelite - a very rare organic mineral which occurs in coal fire environments in association with sal ammoniac and native sulfur. Chemical formula is $(C_6H_4)_2(CO)_2$ or $C_{14}H_8O_2$ (9,10-anthraquinone).

You can see images of hoelite on Mindat here - <http://www.mindat.org/gm/1915>

Hello Steve,

My hoelite specimen has finally arrived from the Czech Republic, here are a couple of photos.

The photos were taken with a Kaiser baas Digital Microscope and are the best I could do with my limited machinery.

Hoelite - 1 is about 2mm whilst Hoelite - 2 is only 1mm.

The actual rock that these hoelites are on is about 3cm x 2cm and has many other specimens too small for me to photograph.

Regards neil Smith



Crystallography for Micromounters - Part II –CRYSTALS

Noel Kennon

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In Part I of this series, we saw that (nearly) every mineral species is uniquely identified by two properties. One of these is the composition of the mineral and the other is the crystal structure. If we are to understand what is meant by *crystal structure*, we need to have an understanding of what is meant by *composition* and that was dealt with in Part I.

Turning now to crystal structure, we need to appreciate that, in essence, there are two kinds of solid materials. In one, the atoms are bonded together in an array that is not orderly and not regular. These materials are called amorphous and there are several minerals of this kind. We will look at them in Part VI. In the other kind of solid, the atoms comprising the material are bonded together in an orderly, regular, three dimensional array and because of that order, these materials are called crystalline.

It is the crystalline state that we are concerned with here, and the first question that must be answered is this: what is meant by “orderly regular three dimensional array”? This is best answered by first considering an orderly regular two dimensional array.

Look at Figure 1 that shows an orderly regular array of three intersecting circles in two dimensions. This is part of a plane pattern that could be used for dress material or carpet or wall paper or gift wrapping paper or a multitude of other applications. There are two parts to this pattern. One part is the group of three intersecting circles that is repeated over and over to make the pattern. This part can be called the *motif* of the pattern. The other part is the way the motif is repeated over and over in the two dimensions of the plane to generate the pattern. The way the motif is repeated is called the *scheme of repetition*. It must be appreciated that there are many different motifs that can be used to make a plane pattern but only several different schemes of repetition. The motif can be defined easily by a simple drawing perhaps, but how can the scheme of repetition be defined and why are there only several of them? We will tackle these questions in Part III. First however, we need to look at Figure 2 which shows part of another plane pattern but with a point (labelled P) in exactly the same position at the top right corner of each of the square motifs. Remove the motifs, as in Figure 3, and the array of points is left. This is the scheme of repetition for it shows the locations of the motifs in the pattern. It is important to note that the scheme is identical everywhere on the plane and mathematically extends to infinity in both directions. This array of points is called a *plane lattice* and the points are called *lattice points*.

It is instructive to see how a plane pattern can be constructed from a motif and a plane lattice. Simply place a motif in exactly the same way at each lattice point and the pattern is made. This requirement that each motif is related to its' lattice point in exactly the same way is a fundamental characteristic of patterns of all kinds.

And so it is for crystals which are nothing more nor less than patterns in the three dimensions. In general, the motif is one or more atoms or a molecules and the scheme of repetition is a regular orderly array of points in space. That array is identical everywhere and extends to infinity in three dimensions. It is called a *space lattice* and the points are also

called *lattice points*. Because the lattice is the same everywhere, the array of motifs of atoms or molecules (located in the same way at every one of the lattice points) must also be the same everywhere. It is this regularity and sameness of the array that defines the meaning of crystallinity. Of course even though the space lattice for a crystal is infinite, the crystal itself is not, and most crystals are very small.

It is essential to note that, like everything else in nature, nothing is perfect and the array of motifs at the lattice points does contain misfits. A misfit may be a lattice point with no motif, a lattice point with a different motif, an additional motif squeezed in between motifs in a regular array, a motif not exactly at the lattice point and so on for others. These misfits are called defects and even though they are quite rare, they are extremely important to the property values and behavioural characteristics of a solid of any kind.

A few examples of the motif in mineral crystals are:

- single atom copper (copper), silver (silver), gold (gold),
- group of atoms sulphur (sulphur), carbon (diamond), carbon (graphite),
- single molecule sodium chloride (halite), lead sulphide (galena),
- group of molecules titanium dioxide (rutile), zirconium silicate (zircon).

A crystalline solid which consists of only one crystal is called a *single crystal*. If that crystal is completely bounded by flat surfaces (planes) it is called *euhedral*; if it is partly bounded by flat surfaces and partly by irregular surfaces it is called *subhedral*; if it is fully bounded by irregular surfaces it is called *anhedral*. A crystalline solid consisting of several crystals (which might be the same or different) is called a *polycrystal*. Figure 4 shows a euhedral single crystal of calcite, Figure 5 shows subhedral crystals of calcite, Figure 6 shows a polycrystal of barite, and Figure 7 shows a polycrystal of prehnite and feldspar.

Finally, it is instructive to consider the size of (mineral) crystals. Huge natural crystals of quartz, feldspar and other minerals weighing several tonnes have been found from time to time but these are very rare. More usually, 'large' mineral crystals might weigh a few kilograms but the majority of crystals are less than a gram, perhaps even a milligram – about the size of the head of a pin and less. It is mineral specimens in this size range that interest micromounters who might be surprised to learn that such a crystal contains about one hundred million million million atoms (that is 10^{20} or 100 000000 000000 000000) ! So, compared with the size of an atom or a few atoms that comprise the motif, all crystals are immensely large.

In the next Part III of this series we will examine some important concepts concerning space lattices and see how these will lead to an understanding of 'crystal structure'.

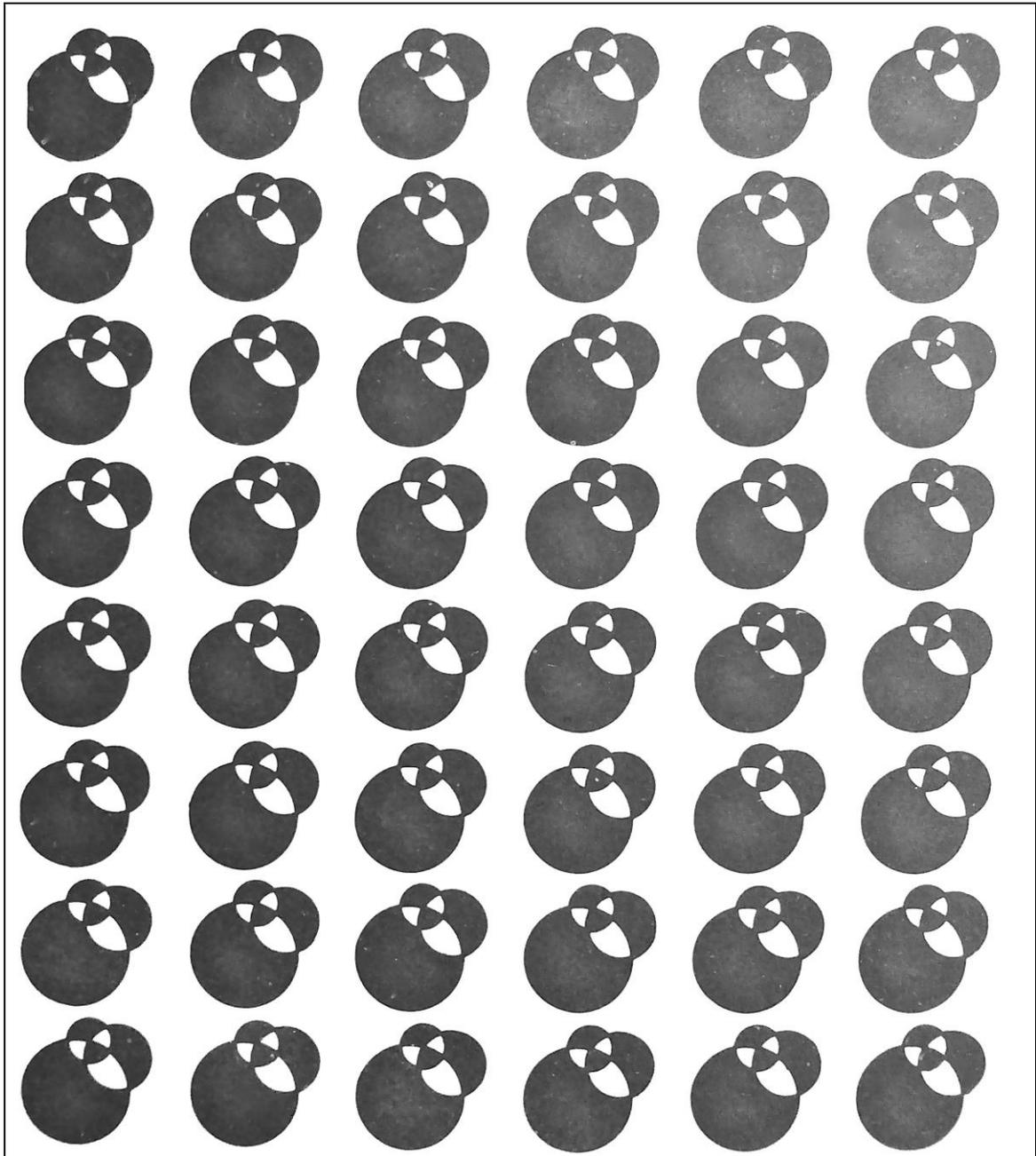


Figure 1: Part of a plane pattern.



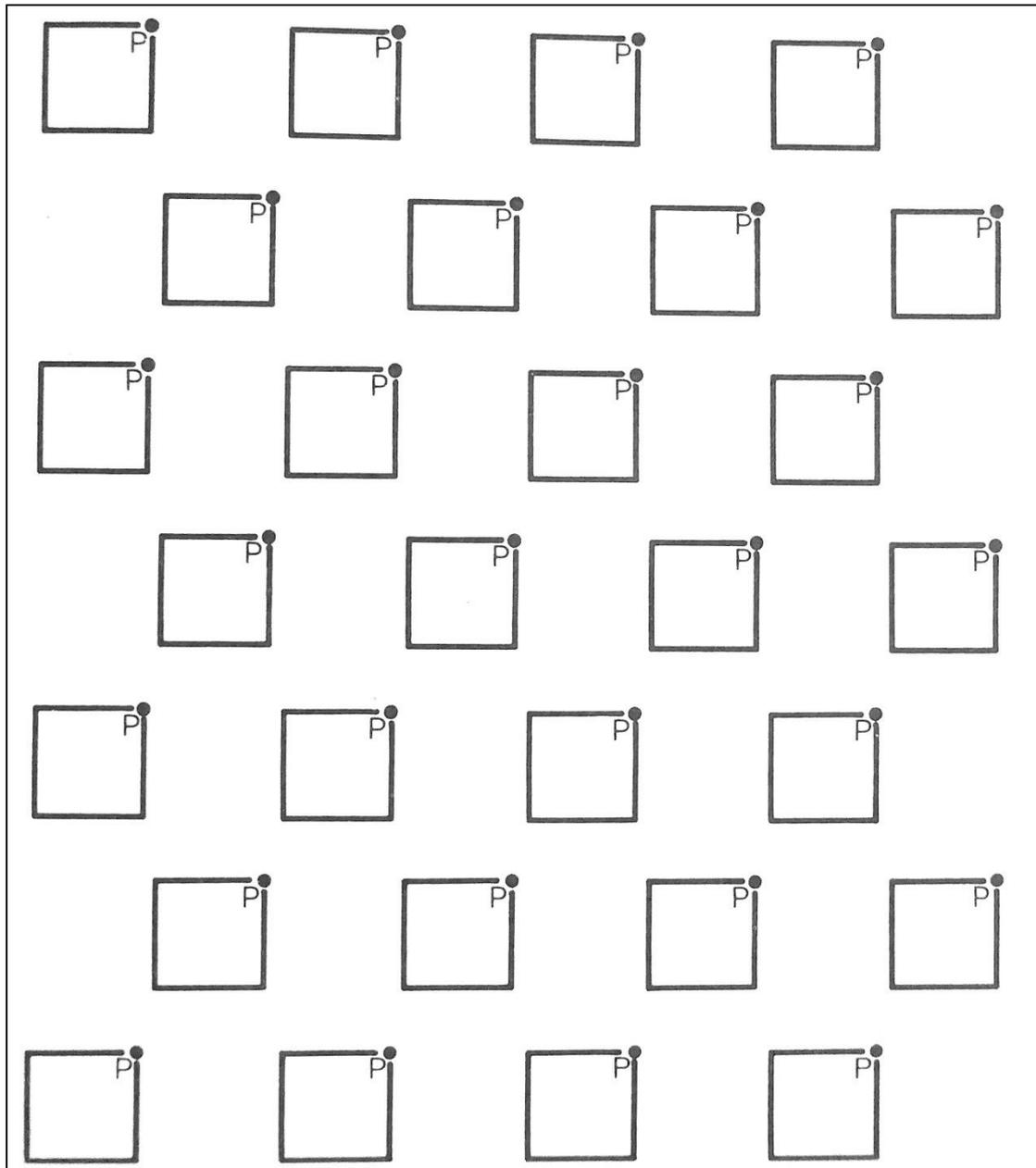


Figure 2: Part of a plane pattern showing a point P at the same place in every square motif.

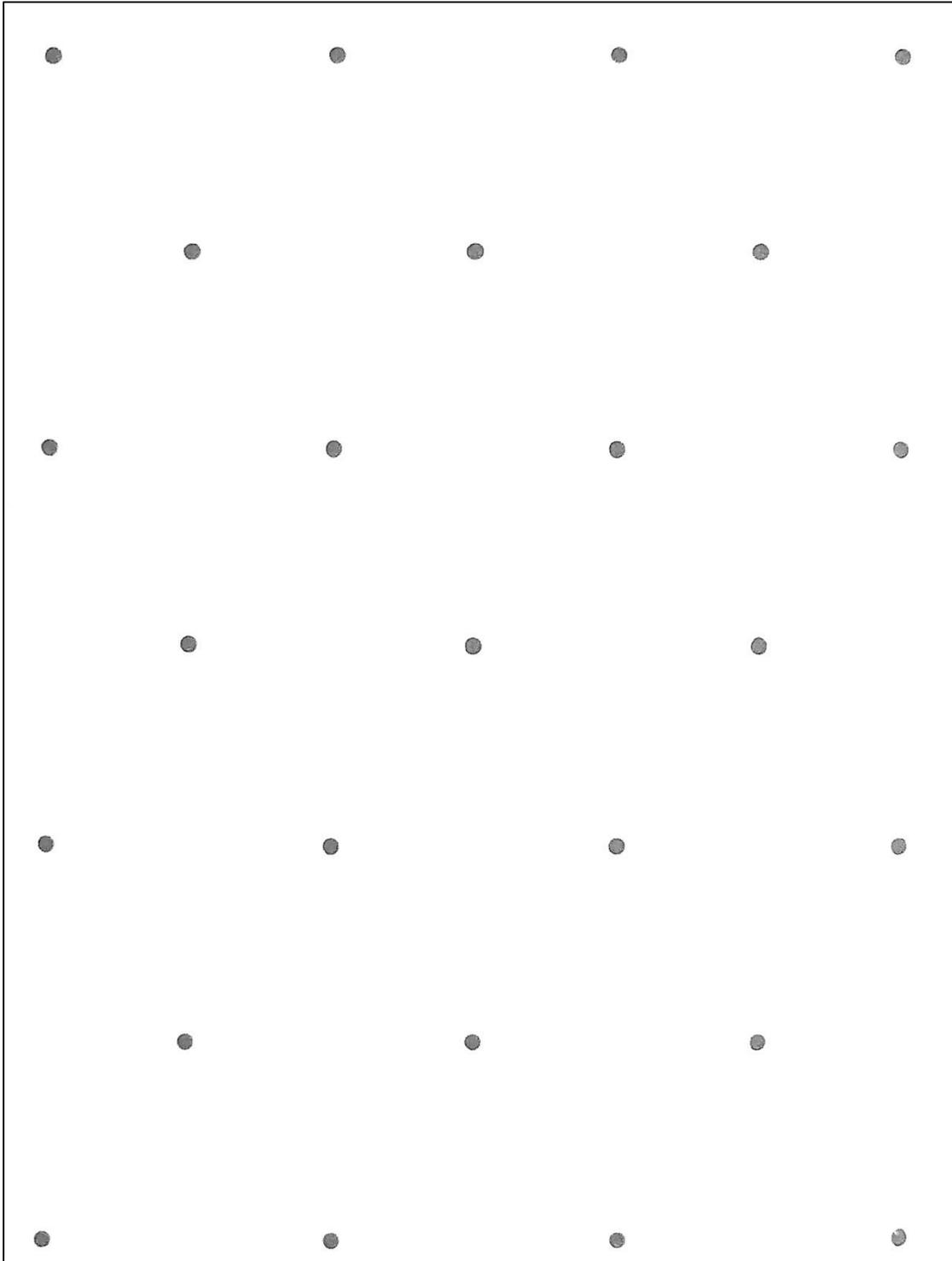


Figure 3: The array of points remaining after removal of the motifs from Figure 2.





Figure 4: A euhedral single crystal of calcite bounded by six cleavage faces.



Figure 5: Multiple subhedral crystals of calcite; these crystals grew onto the matrix and so the bottom crystal faces did not develop.



Figure 6: A polycrystal of subhedral crystals of barite.



Figure 7: A polycrystal of assemblies of green prehnite crystals and light brown orthoclase variety adularia.

Zeolites and Associated Minerals from Bunnan, Hunter Valley, New South Wales.

The Micromineral Group, Mineralogical Society of New South Wales

Introduction

The so-called Bunnan locality comprises several adjacent road cuttings on the Scone to Merriwa road in the Hunter Valley, NSW. The principal cutting is 24.5 kilometres northeast of Merriwa, 5.7 kilometres southwest of Bunnan Bridge over Wybong Creek and 39.8 kilometres southwest of the railway crossing in Scone. The cuttings have exposed a highly vesicular zone in Paleogene basalt which has been hydrothermally altered and strongly weathered after exposure. Members of the Mineralogical Society of NSW have collected zeolites there on several occasions, Fig. 1.



Fig. 1 Members of the NSW Mineralogical Society collecting in the principal Bunnan road cutting.

The zeolite occurrence is similar to that at Borambil, 5 kilometres southeast of Cassilis on the Golden Highway (England, 1996), but differs in the apparent absence of analcime, phillipsite, and lévyne-Ca coated with erionite (or offretite) but with a greater abundance of thomsonite. Other zeolite localities in the area include Krui Valley 25 kilometres north-northwest of Merriwa on the Golden Highway and Willy Wally Gully, also on the Golden Highway 29 kilometres north-northwest of Merriwa. At the Krui Valley locality, thomsonite is abundant in many morphologies while at Willy Wally Gully, lévyne-Ca is the most abundant species. Both these localities have been described in the Australian Journal of Mineralogy (England, 2002 and England, 2012 respectively).

Geology

The Bunnan locality occurs in the vesicular top of an Early Oligocene alkali olivine basalt flow which is one of several forming the southwestern part of the Liverpool Range volcanic province. That province covers the southern part of the Oxley Basin, 200 kilometres northwest of Sydney (Schon, 1985).

Mineralogy

Members of the NSW Micromineral Group know of no papers or other documents concerning the mineralogy of the Bunnan locality. It is not mentioned in Mindat. However, one member, Brian England, has been studying the deposit for many years and has examined specimens from most of the road cuttings. He provided the Group with a draft report on his observations and this constituted the only guidance the Group had when seven members met at the home of Ann and Noel Kennon on Saturday 14 June 2014 to study specimens from most of the road cuttings. Several subsequent meetings were also devoted to examination of specimens from these localities

It became evident that the mineralogy of the Bunnan material is relatively simple being decomposing basalt with profuse vesicles having a smectite selvage and containing aragonite, calcite, three zeolites and todorokite. Examination of several thousand Bunnan specimens by Brian England enabled him to determine the paragenesis as:

smectite – chabazite-Ca – thomsonite – todorokite – mesolite – calcite

Aragonite was also observed in several specimens but the position in the paragenetic sequence could not be determined.

The following minerals have been identified in the specimens examined.

Aragonite **CaCO₃**

Aragonite seems to be rare at Bunnan but has been observed as assemblies in small vughs (Fig. 2) and typical groups of elongated crystals (Fig. 3) which may have originated in small vughs.



Fig. 2 Aragonite in a liberated vugh 15 mm across, specimen Ann & Noel Kennon, photograph Dieter Mylius.



Fig.3 Cluster of aragonite crystals 7 mm high, depth of field enhanced with Combine ZM stacking software (CZM), specimen Ann & Noel Kennon, photograph Dieter Mylius.

Calcite **CaCO₃**

Well-formed rhombohedra (Fig. 4) and scalenohedra, (Figs. 5, 6, 7) of colourless to amber calcite up to several centimetres occur commonly in some larger vesicles and fracture-filling veins. Single crystals and clusters may have originated in vughs and been liberated during weathering processes. In some specimens the calcite is covered or partly covered with thomsonite (Fig. 8) while in others it occurs as rounded elongated crystals (Fig. 9). Calcite also commonly occurs in a habit that appears to be the “spherulites”, (Fig. 10), reported Lebedev, 1967, and which are typically pearly white and up to 0.5 cm in diameter. These spherulites may cover or partly cover rhombohedral crystals (Fig. 11).



Fig. 4 Rhombohedral crystals of calcite, field of view (fov) 20 mm, specimen and photograph Ann & Noel Kennon.



Fig. 5 Scalenohedral calcite crystal cluster, 140 x 90 mm, specimen and photograph Dieter Mylius.



Fig. 6 Scalenohedral crystal of calcite, 70 mm high, specimen and photograph Dieter Mylius.



Fig. 7 Scalenohedral crystals of calcite, 90 mm high, specimen and photograph Dieter Mylius.

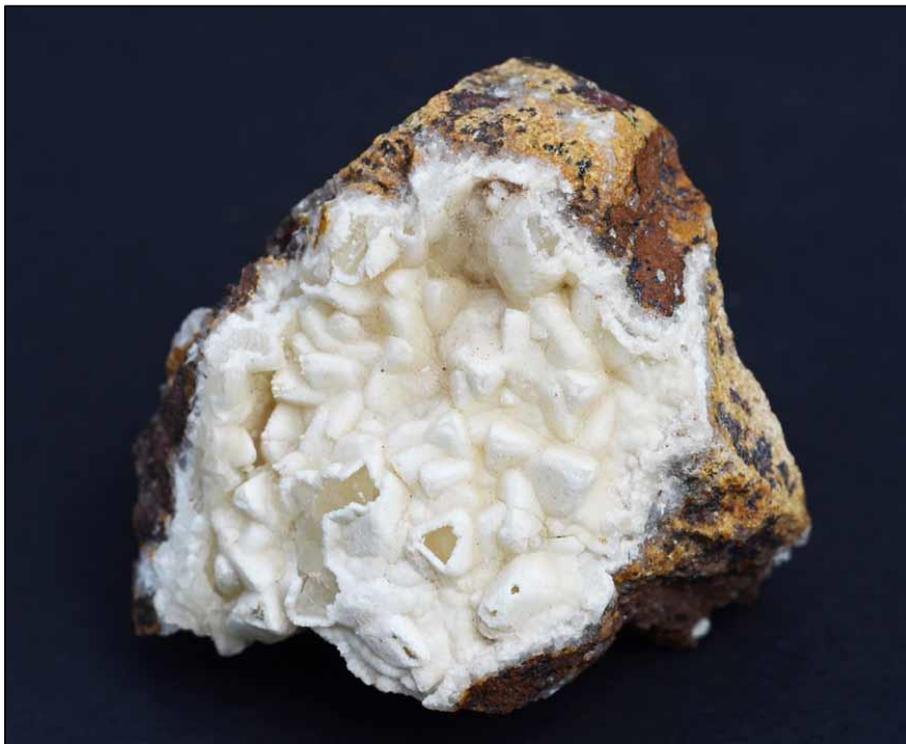


Fig. 8 Thomsonite on calcite, specimen is 30 mm across, depth of field enhanced with CDM, specimen Ann & Noel Kennon, Photograph Dieter Mylius.





Fig. 9 Rounded calcite crystals on chabazite, specimen is 20 mm across, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius.



Fig. 10 Spheroidal calcite with chabazite and thomsonite, fov 17 mm, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius.



Fig. 11 Spheroidal calcite on calcite rhombs, fov 27 mm, depth of field enhanced with CZM, specimen and photograph Ann & Noel Kennon.

Chabazite-Ca $\text{Ca}_2(\text{Al}_4\text{Si}_8\text{O}_{24}) \cdot 13\text{H}_2\text{O}$

The chabazite-Ca was identified by morphology only (Fig. 12, 13), with crystals comprising the rhombohedron $r\{10\bar{1}1\}$ showing penetration twinning (Fig. 14) with the c-axis as the twin axis. Crystals are up to 3mm across and are typically colourless. It usually occurs alone in vesicles, coating the smectite selvedge (Fig. 15) and, less commonly, it is partially to fully covered with later thomsonite, (Figs. 16, 17) or with (spherulitic) calcite, (Fig. 10).



Fig. 12 Chabazite, fov 22 mm, specimen and photograph Ann & Noel Kennon.



Fig. 13 Chabazite rhombs, fov 6 mm, depth of field enhanced with CZM, specimen Brian England, photograph Dieter Mylius.

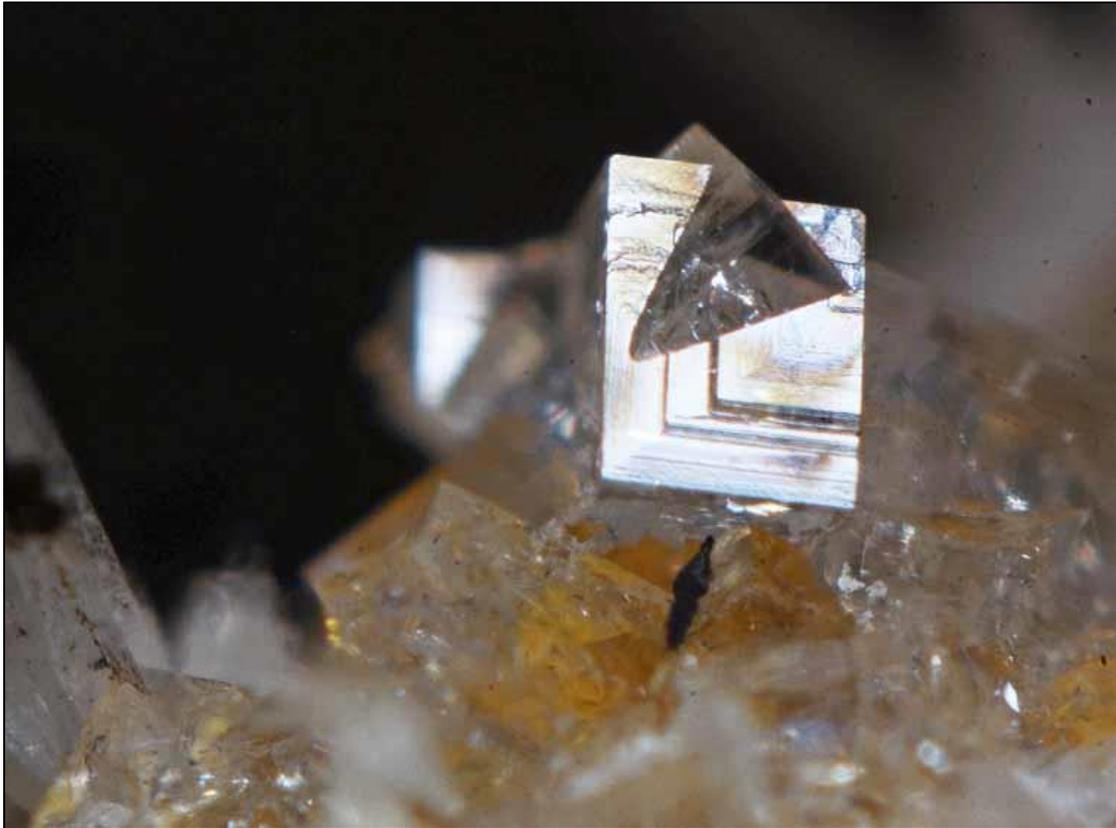


Fig.14 Penetration twinned crystals of chabazite, fov 6 mm, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius.



Fig. 15 Vugh with chabazite crystals on smectite, fov 15 mm, specimen and photograph Ann & Noel Kennon.



Fig. 16 Thomsonite on chabazite, specimen is 25 mm across, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius.



Fig. 17 Thomsonite and chabazite, fov 12 mm, specimen and photograph Ann & Noel Kennon.

Mesolite $\text{Na}_2\text{Ca}_2(\text{Al}_6\text{Si}_9\text{O}_{10})\cdot 8\text{H}_2\text{O}$

The mesolite at Bunnan is similar to that observed at Krui Valley and Borambil where it was first identified in the Liverpool Range volcanics. However at Bunnan it is much more abundant, occurring as white fluffy masses, up to 2 cm across, of ribbon-like crystals, (Fig. 18), which are easily blown out of vesicles on a windy day! The crystals are exceedingly thin and flexible and occur interwoven as concave nests, (Fig. 19), with the flat faces of each individual aligned in the same curved surface forming a reflective web draped over earlier minerals (Fig. 20).



Fig. 18 Mesolite fibres, fov 6 mm, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius. Detail from Fig. 19 specimen.



Fig. 19 Mesolite fibres covering vugh, fov 25 mm, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius.



Fig. 20 Mesolite on thomsonite and chabazite, specimen is 35 mm across, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius.

Smectite

The smectite lining of most vesicles (Fig. 21) is a light brown colour and probably either saponite or nontronite.



Fig. 21 Smectite lining of vugh, fov 15 mm, specimen and photograph Ann & Noel Kennon.

Thomsonite $\text{Ca}_2\text{Na}[\text{Al}_5\text{Si}_5\text{O}_{20}]\cdot 6\text{H}_2\text{O}$

Thomsonite is the most abundant zeolite in the deposits, generally occurring between, or on, scattered chabazite-Ca crystals (Fig. 16) and as tufts of radiating white blades (Fig. 22) or isolated blades (Fig. 23). Much less commonly it occurs in isolated vesicles as mammillary crusts of radiating compact bladed crystals (Fig. 24), in which only the termination faces are visible. It also occurs as crusts on crystals of calcite, (Figs. 6, 7, 8).



Fig. 22 Tufts of thomsonite blades, fov 17 mm, specimen and photograph Ann & Noel Kennon.



Fig. 23 Bladed thomsonite protruding into a vugh, fov 17 mm, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius.



Fig.24 Thomsonite lining of vugh, fov 17 mm, depth of field enhanced with CZM, specimen and photograph Dieter Mylius.

Todorokite $\text{Na}_{1-x}(\text{Mn}^{2+}, \text{Mg}, \text{Al})_6\text{O}_{12} \cdot 3-4\text{H}_2\text{O}$

The presence of todorokite is not unexpected as it has been identified at Borambil and Willy Wally Gully and as a nickeloan form at Krui Valley. At Bunnan it forms small dull black dendritic particles, (Fig. 25, 26), small non-dendritic particles (Fig. 27) and lustrous golden-bronze ribbons, (Fig. 28) all similar to the other occurrences in the Liverpool Range. Where the zeolite species are absent, it forms lustrous black irregular patches on the selvedge of the microglobular smectite vesicles (Fig. 29).



Fig. 25 Dendritic todorokite, fov 4 mm, depth of field enhanced with CZM, specimen and photograph Dieter Mylius.



Fig. 26 Todorokite on thomsonite, fov 6 mm, depth of field enhanced with CZM, specimen Ann & Noel Kennon, photograph Dieter Mylius. Detail from Fig. 21 specimen.

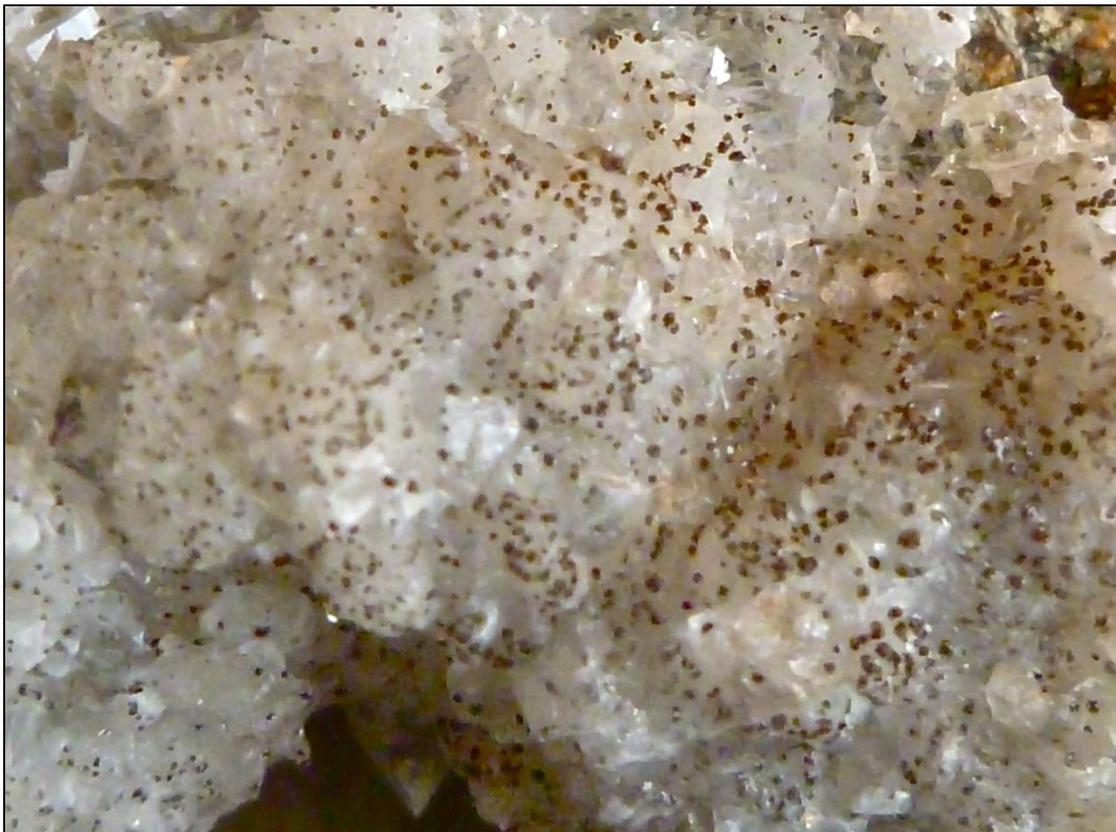


Fig. 27 Todorokite on chabazite, fov 11 mm, specimen and photograph Ann & Noel Kennon.



Fig. 28 Todorokite ribbons on chabazite, group is 0.75 mm across, depth of field enhanced with CZM, specimen Geoff Parsons, photograph Dieter Mylius.



Fig. 29 Todorokite on smectite lining of a vugh, specimen is 10 mm across, specimen Ann & Noel Kennon, photograph Dieter Mylius.



Fig. 30 Spheroidal calcite on mesolite, specimen is 15 mm across, depth of field enhanced with CZM, specimen Brian England, photograph Dieter Mylius.



Fig.31 Spheroidal calcite on mesolite, fov 6 mm, depth of field enhance with CZM. specimen Brian England, photograph Dieter Mylius.

Discussion

The principle means of identifying the minerals in specimens from the Bunnan road cuttings has been crystal morphology observed using stereomicroscopy together with comparison with characterized species from other localities in the Liverpool Range volcanic province. The only Bunnan species to have been confirmed by X-ray diffraction is chabazite-Ca and as no other XRD or micro-chemical analysis have been made, some identifications remain unproven or even speculative.

It is quite clear that many vesicles in the specimens examined are lined with a light brown clay-like (smectic) material. As colour is not a reliable guide for identifying such mineral species it is tentatively proposed that this lining is either saponite or nontronite but differentiation of these two possibilities will require micro-chemical analysis (specifically to determine the $\text{Fe}^{2+}/\text{Mg}^{2+}$ ratio).

Chabazite-Ca was identified by X-ray diffraction and so is distinguished from other chabazite species that could possibly occur at this locality. The thomsonite, identified by morphology and presumed to be the Ca form, will need to be confirmed. By comparison with thomsonite from nearby localities, it is suggested that the typically thin bladed crystals comprise the forms $a\{100\}$, $b\{010\}$, and $c\{001\}$ with the b faces always predominating. The spectacular range of habits observed at Krui Valley is absent at Bunnan.

White fluffy masses of ribbon-like material are very similar to material that occurs at Borambil. That material occurred as very thin ribbons with typical individuals being only a few atomic layers thick as a result of flattening on (010) of the normally square prismatic crystals. Thus, the morphology of the crystals from Bunnan and other localities in the Liverpool Range volcanics may represent an extreme case of morphological variation. In many such cases the ribbons appear to have nucleated on earlier thomsonite and in fact have not been observed in vesicles devoid of thomsonite. Conversely vesicles containing thomsonite always seem to contain the ribbons, even if only a few are present. The morphology of the nests and their late formation in the paragenesis suggest that the ribbons nucleated on the surface of shrinking connate water films in the vesicles as they dried out.

The ribbon-like crystals from the Borambil locality were identified by X-ray diffraction and Raman Spectroscopy as mesolite by Graham and Pogson (2001). This identification was supported by data provided earlier by England (1996). Consequently the similar Bunnan phase has been tentatively identified as mesolite but there is some doubt about both identifications as the ribbon-like morphology is atypical of mesolite. The possibility that the phase is mordenite cannot be discounted.

The description of one form of calcite as “spherulites” is not consistent with accepted vernacular where, in the field of igneous petrology, the terms “spherulites” and “spherulitic” have specific and restricted meaning. An alternative description could be “radiate globular bodies” (England, 1984). Nevertheless, the term “spherulitic” as broadly defined in the Oxford English Dictionary, is preferred for describing the calcite such as shown in Fig. 10. It has been proposed that this spherulitic morphology results from repeated splitting of the rhombohedral planes $r\{10\bar{1}1\}$ along the rhombohedral cleavage directions due to sectorial enrichment in MgCO_3 or FeCO_3 (England, 1984).

These spherulites were formed after the ribbon-like masses of mesolite and result in spectacular micromounts with the globules resting like eggs in concave mesolite nests (Fig. 30, 31).

Conclusion

Seven minerals have been identified in specimens from the Bunnan road cuttings. Chabazite-Ca has been identified by X-ray diffraction and it is probable that the identifications of aragonite, calcite, thomsonite and todorokite are correct although the species of thomsonite remains undetermined. The smectite lining most vughs is probably either nontronite or saponite and the fibrous mineral present in many vughs is most likely mesolite.

Acknowledgement

The Micromineral Group is indebted to one of the members, Brian England, for providing a copy of his unpublished work on the Bunnan zeolites upon which much of the detail in this article is based.

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