Australia and New Zealand Micromineral News

Issue 9 – June 2014

Editor: Steve Sorrell – steve@crocoite.com

Cover photo:

Hydroxyapophyllite-(K) and Phillipsite
West Ridgley Quarry, Ridgley, Tasmania
15 images stacked using Zerene Stacker
Photo width 5mm across

Photo and Specimen: Steve Sorrell

In This Issue

Introduction

A good response to Noel Kennon's open letter seeking support for this publication (reprinted below). But we need to keep it up! This issue contains a wide range of articles, on localities, techniques, and activities. Enjoy!

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! I have one for the next issue just waiting on photographs.

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:

- ⚒ New South Wales: George Laking – bglaking@tech2u.com.au
- ⚒ New Zealand: Jocelyn Thornton – sodalite@paradise.net.nz
- ⚒ Queensland: Russell Kanowski – kanowfam@icr.com.au
- ⚒ South Australia: Peter Keller – gondwanaminerals@yahoo.com.au
- ⚒ Tasmania: Ralph Bottrill – rbottrill@mrt.tas.gov.au
- ⚒ Victoria: John Haupt – john.haupt@bigpond.com
- ⚒ Western Australia: Susan Koepke – minsocwa@hotmail.com

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.

October 2014

October 24th to 28th - New Zealand Micromount Symposium, Te Rau Aroha, Waihi Beach on the NZ's North Island.

October 31st to November 1st - 37th Combined Mineralogical Societies of Australasia Seminar at the same venue.

Table of Contents

An Open Letter

Noel F. Kennon

annoelk@gmail.com

This letter is directed to all members of the micro-Groups associated with the Mineralogical Societies in each state of Australia and the Group in New Zealand. It is also directed to all recipients and readers of the Australia and New Zealand Micromineral News. There are about 100 direct recipients and possibly over a 1000 readers. Please read on.

Many of you will recall that at the 2011 Bathurst Gemboree, a meeting of people concerned with micro-minerals was held to assess the level of interest in some kind of joint venture for collectors in Australia and New Zealand. Strong support was expressed for such a venture with a regular newsletter being strongly favoured. Participants were asked to refer back to members of the various Groups to solicit their views. A subsequent meeting held during the Joint Societies Symposium in Melbourne later in 2011 strongly reaffirmed the support and agreed that, to succeed, a regular newsletter would be dependent upon two necessary factors.

First we needed an editor and secondly the editor would need a regular supply of suitable articles. Just about everybody at that second meeting was enthusiastic and declared intent to provide those articles because we agreed that the function of the editor would be to edit – not to write. John Haupt was asked to see whether Steve Sorrell might be interested in taking on the electronic publishing job. You all know that Steve agreed and in 2½ years he has delivered eight issues, beginning in September 2011, thereby maintaining his declared intention publishing four issues each year.

However, should any reader look carefully at the authorship of the articles in those eight issues it will be evident that ANZ Micromineral News is not being supported by those enthusiastic collectors who attended the meeting in Melbourne but by relatively few contributors. Indeed, in issue No 8 Steve says “but still not enough contributors!”.

In two previous issues he pleaded:

………LACK OF CONTRIBUTIONS! There is little point in publishing something that is only a few pages in length. When this concept was first mooted, there were promises of articles and information. If you want this venture to continue, CONTRIBUTE! Otherwise, it is doomed to fail.

And in several issues you will have read -

Contributions – We Need Your Input

Have a careful look through those eight issues and you will see that Steve Sorrell has contributed about 30% of the material. That’s 30% from the person who was to just edit our contributions.

John Haupt, as author and joint reporter for the Victorian Group has contributed another 20%. So between them, those two have supported over half the publications. I ask whether those who said “yes, of course I’ll do my bit” are comfortable with that. Nobody should be. I certainly am not!

So where is this support we all pledged at the Melbourne meeting? Where are all the promised contributions?

The Victorian Group has certainly given strong support with contributions in every issue. Other multiple contributors have been the Queensland Group (Suzie E), Ted Fowler, David Colchester, and the Kennons. Single contributions have come from eight sources. Where is the support from the Tasmanian, NSW, SA and WA Micro Groups?? We know these Groups are active – surely somebody can take on the reporting job – or share it around.

So far there have been about 50 articles in those eight issues. Some have been substantial with information that is both interesting and valuable for micro-mounters. Others have been quite short but nevertheless valuable in their own right. Length is important; number is very important. And it is not as if there was nothing to write about.

Just one example. I believe that several of the Groups are keen to acquire the wherewithal to take half way decent photographs of micros. So, where are the articles about the basic requirements and available technology at reasonable cost. Lively discussions of pros and cons, of what each Group is doing, of how we muddle through at the moment, and so on through the News would help all Groups.

And surely therein lies the value of the News. The several Groups are remote from one another and consequently interaction is limited. But by using the News we can learn what others are doing and how they are going about solving their problems. Everybody would benefit. It only needs goodwill and intent to help. An hour or two of your time to prepare a contribution is all that is asked. Should each Group nominate a correspondent?

As I was involved in initiating this venture I feel a sense of responsibility for doing all that I can to see that it continues even if it means cajoling my colleagues to put pen to paper – or more likely, fingers to keyboard. A single contribution from each subscriber over the next couple of years and the venture is sustained for up to five years. If you as a reader are too busy (or lazy) then the venture cannot continue and we will be back to where we were prior to the Bathurst meeting. At the time of writing this letter in early April 2014, Steve does not have a single contribution on hand for Issue No 9!!

Noel Kennon
NSW Group

Notes and Queries

According to Wikipedia, *Notes and Queries* was first published in 1849 as a weekly periodical edited by W.J. Thoms. It was founded as an academic correspondence magazine, in which scholars and interested amateurs could exchange knowledge on folklore, literature and history. The format consisted of "Notes" (miscellaneous findings of correspondents that they and the editors considered of interest to the readership), and "Queries" (and responses to queries), which formed the bulk of the publication.

During discussions about how to make it easier for people to contribute, Noel Kennon suggested a similar concept for this publication. So, it is now included! The idea is that Notes can be published to disseminate information that may not be readily available through other channels, and Queries where someone is trying to get an answer or opinion on something. Respond to Queries if you think you can help the requestor.

Notes and Queries should be limited to a short paragraph or two (otherwise it is an article in its own right!). So that responses can be matched to previous queries, I will number them using the issue plus a sequential number. I have started the process below.

Notes

9.01 – Rutley's Mineralogy was probably my first mineralogy book. Great content and easy reading. You can still find copies of it for not too many $$$. But if you can't, there is now an online scanned version. https://archive.org/details/elementsofminera00rutlrich - Contributed by Steve Sorrell

Queries

9.02 – In a Canadian Museum of Nature blog: Mineral Exchange Collections: The “Trading Cards” of the Mineral World, Paula Piilonen outlines one method of how museums acquire specimens. The article itself is interesting, but also highlights an issue for us as collectors. Paula acquired mrazekite and hechtsbergite from Morass Creek, Benambra, Victoria. All good. Except I could not find a reference to hechtsbergite. At some point, this species has been identified (presumably at Museum Victoria) but not communicated to collectors. It would be nice to hear a bit more about it. Dermot, Bill, Stuart? Article can be read here: http://canadianmuseumofnature.wordpress.com/2013/08/15/mineral-exchange-collections-the-trading-cards-of-the-mineral-world/ - Contributed by Steve Sorrell

9.03 – I recently acquired an “elestial” quartz from Baluchistan, Pakistan, and in looking closely at it through the microscope, noticed that there are cavities at the base of the crystal where another species once was (see photo below). Barite and diopside have been suggested. I would be interested to hear what species others might think it is. - Contributed by Steve Sorrell

Epimorph of unknown mineral in quartz, Baluchistan, Pakistan. Photo width 11mm. Steve Sorrell specimen and photo.

Pseudomorphs in Microspecimens

Noel F. Kennon
annoelk@gmail.com

Collectors of microspecimens might specialise in one or many groups of minerals. Alternatively, collectors might take whatever comes their way. In any case it is likely that all collectors have in their collections, at least one specimen on which there is a form that can be properly classified as a pseudomorph. It is also likely that many of these collectors are unsure about such a form and it is to help them that these notes have been prepared.

At the 36th Annual Joint Seminar of the Mineralogical Societies of Australia held in 2013 on June 8 and 9 in Sydney, Professor Paul Carr from the University of Wollongong, gave an excellent talk entitled Pseudomorphs – misfits of the mineral world. The following notes build on the ideas that Paul presented there. Specifically he spoke about cabinet size specimens but the principles apply equally well to specimens of all sizes, including micros.

The word pseudomorph is derived from two Greek words - PSEUDO meaning false and MORPH meaning form. So the word means ‘false form’ and is used specifically in mineralogy to refer to one mineral which occurs in the form or shape of a crystal of another mineral.

Pseudomorphs may form in four ways.

1 – A crystal of one mineral changes to another mineral without changing composition or shape. The parent and product minerals necessarily have the same composition and are called polymorphs (see the Note below). Sometimes the product is called a paramorph and the result of the change is a mass of many crystals of the product polymorph having the shape of the crystal of the parent polymorph.

Note – in mineralogy, a polymorph is one of two or more minerals having the same chemical composition but different crystal structures. For example, silica, SiO_2, occurs as five polymorphs – quartz (rhombohedral), cristobolite (tetragonal), tridymite (monoclinic), coesite (monoclinic but different from tridymite) and stishovite (hexagonal). Another example is calcium carbonate, $CaCO_3$, which occurs as calcite, aragonite and vaterite. There are many others.

Examples of this kind of pseudomorphism are:

- aragonite (orthorhombic $CaCO_3$) changed to calcite (rhombohedral $CaCO_3$),
- marcasite (orthorhombic FeS_2) changed to pyrite (cubic FeS_2).

2 – A crystal of one mineral is replaced by another mineral while maintaining the original shape. The result of the change is a mass of crystals of the product mineral in the shape of the crystal of the parent mineral.

The product mineral may be related to the parent mineral as in:

- azurite ($Cu_3(CO_3)_2(OH)_2$) replaced by malachite ($Cu_2(CO_3)(OH)_2$), (Fig. 1)
- cuprite (Cu_2O) replaced by malachite ($Cu_2(CO_3)(OH)_2$), (Fig. 2)
- pyrite (FeS_2)cubes replaced by cubes of goethite ($FeO(OH)$) – called ‘devil’s dice’
- olivenite ($Cu_2(AsO_4)(OH)$) replaced by conichalcite ($CaCu(AsO_4)(OH)$), (Fig. 3)

- linarite ($PbCu(SO_4)(OH)_2$) replaced by brochantite ($Cu_4(SO_4)(OH)_6$), (Fig. 4)

Alternatively, the product mineral may be unrelated to the parent mineral as in:

- 'garnet' replaced by hematite (Fe_2O_3), (Fig. 5)

3 – A crystal of a parent mineral becomes coated with a thin layer of a second mineral. This combination has been called an endomorph. Should the parent mineral then dissolve, the shell of the second mineral remains and has been called a negative pseudomorph. The cavity may be filled later with an unrelated third mineral. The result of the changes is a mass of crystals of the third mineral covered by a layer of crystals of the second mineral all in the shape of the crystal of parent mineral.

Examples of this kind of pseudomorph are:

- crystals of anglesite ($Pb(SO_4)$) covered with a thin layer of goethite ($FeO(OH)$); the anglesite dissolves and later may be replaced by a third mineral, (Fig. 6),
- fluorite covered by a thin layer of quartz; followed by dissolution of the fluorite and later filling of the resultant cavity with a mass of crystals of calcite or pyrite or something else.

4 – A crystal of an easily soluble mineral, such as halite or gypsum, becomes embedded in mud which dries. The soluble mineral dissolves leaving a mould of the crystal shape. Alternatively, a mineral crystal originally embedded in rock or another mineral is dissolved or otherwise removed leaving a cavity in the shape of the mineral crystal. In either case, the cavity, called a perimorph or an epimorph in older terminology, may be later filled with sediment or another mineral to form the pseudomorph.

These four processes can lead to pseudomorphs in cabinet size, thumbnail size, miniature size and micro size. It is the latter of course, that microspecimen collectors seek for their collections. The accepted terminology for referring to a pseudomorph, regardless of size, is pseudomorph of calcite after aragonite and so on.

In some instances, it is possible to recognise a pseudomorph in a specimen because the edges lack sharpness and the faces are dull and uneven - as is evident in all the Figures shown in this article. In these cases, the shape is usually due to two factors. The first is the change in density associated with the change from one mineral species to another, and the second is the replacement of one crystal with a mass of many crystals (see Fig. 2). On the other hand, some polymorphs have the sharp edges and flat faces commonly associated with a true crystal. In these cases, identification of the form as a polymorph can be tricky.

Steve Sorrell made a significant contribution to this article by taking all the photographs, and additionally, the specimen shown in Fig. 2 is from his collection. The other specimens are from the collection of Ann and Noel Kennon.

Fig. 1 Pseudomorph of malachite after azurite; Sir Dominic Mine, Arkaroola, South Australia. The pseudomorphs are up to 4mm long.

Fig. 2 Pseudomorph of malachite after cuprite; Mineral Hill, New South Wales. Photo width 2.5mm.

Fig. 3 Pseudomorph of conichalcite after olivinite; Dome Rock, South Australia. The long pseudomorphs are about 0.2mm wide.

Fig. 4 Pseudomorph of brochantite after linarite; New Mexico, USA. The pseudomorphs are 0.05 to 0.1mm wide

Fig. 5 Pseudomorph of hematite after ‘garnet; Utah, USA. The pseudomorphs are 3 - 4mm across.

Fig. 6 Pseudomorph of goethite after anglesite. The large pseudomorph is 3.5mm on edge.

29th Annual Micromineral Symposium, Wellington, New Zealand

October 21 – 25 2011-12-10

Sue Wearden

Thursday morning saw Mathew, Errol and myself load one Nissan Safari to the hilt with microscopes, sleeping bags, etc, plus all that I had collected in the States and head off from Tangiteroria to Wellington via Taranaki. Mt Egmont put on a beautiful display for Errol. Our first view of the mountain was it rising up out of the sea. It was a bit misty and a long way off and reminded me of Bali Hai from South Pacific. When next it appeared, the mountain was bathed in sunshine with the snow glistening. Errol was told how lucky he was to get this view. I somehow do not think he believed us until next morning when the mountain had disappeared, completely covered in cloud.

We arrived at Silverstream Retreat late Friday afternoon. The venue was excellent. A large room in which we set up microscopes also had tea and coffee making facilities. Sleeping quarters were great. Bunk beds (full size) with single beds also in some rooms. Top bunks not needed.

Our meals were fully catered for and were good. Breakfast toast, cereal and fruit, more than adequate. Lunch was the best meal volume-wise with things like lasagne and salads. Morning tea with muffins, afternoon tea and supper biscuits - all very nice.

Friday night started with the usual wine and cheese and welcome, especially to the three first-time attendees, Vivienne Carruthers, Graham Milestone and Nigel Savage. Jocelyn announced that Rod Martin had been elected into the Micromounters Hall of Fame, and presented Rod and Jill with a quilt to mark the occasion. On a sad note, we remembered Fergus Stott who lost his battle on 3rd October. He was at the first symposium that Ted and I came to in 1997. We had many great times with him both in Australia and New Zealand.

Saturday was heads down and tails up at microscopes from very early. A trip to GNS (Institute of Geological and Nuclear Sciences) was a highlight. Rod, who knew where to go, did not look at the map provided and did not realise that GNS had moved since he was last there, so Errol got an unscheduled tour of Lower Hutt. Thank goodness for modern technology and mobile phones.

Hamish Campbell and Tony Christie were most kind in giving up a couple of their holiday hours in order to accommodate us and take us to the inner sanctum where there were cupboards after cupboards of minerals and fossils used for research and referencing. The amount of material there was mind-boggling – our first stop was a section of a black smoker from an ocean sea-mount, complete with microcrystals. Cameras at the ready.

The afternoon saw the competitions. The Tetrahedron Trophy for the best New Zealand specimen was won by Mathew Singleton, for an autunite from the Buller Gorge. Yvonne Mackenzie and Phil Andrews were joint runners-up. Mathew also won the Stan Rowe Trophy for the best overseas specimen with a barite on orpiment from Quiruvilca Mine, Peru. David Macdonald won the Ruth Jacobson Trophy for the best specimen from last year’s field trips, with a langite from the Champion Mine. Dick Dufton won the prize for the best photograph with his titanites epitaxial on edenite, from Hendersons Quarry, Mt Ngongotaha.

The trophies were given out after a dinner which Margaret Graham was able to attend, her enthusiasm not lessened by her impaired mobility and eyesight troubles. These led to her donation of microscope, breaker and ultrasonic cleaner to the Monday auction. She was fair bubbling. I met Margaret for the first time in 1997 and the thing I remember most of her was going to Kerosene Creek at night and us all wallowing in the warm water when the air temperature was probably zero. A great time.

A box of material from Maharahara near Woodville kept many busy at the line-up of breakers. On Sunday morning two speakers came – Denise Kulhanek from GNS spoke about the different kinds of microfossils that are studied by the large group of palaeontologists there. Then Terry Seward, now back at Victoria University, showed us the collecting of sublimate minerals in active calderas on Volcano in Italy and also in the Russian islands off Kamchatka, north of Japan. Scary stuff. He also had some of the minerals to put under the microscope.

The rest of the day passed quickly with giveaway tables full and the breakers in use. After dinner there was a crossword to do with minerals to add to the cryptic clues – Phil Andrews won the blue and pink smithsonite from Mexico as the prize.

On Monday the auction this year was extremely good. Mat once again did an excellent job as auctioneer. It gets a bit hard when the bids come from behind as well as in front, but all adds to the occasion. Dick was kept on his toes recording the results. There was a great response to Jocelyn’s request to make the auction bigger and better due to the added expense of this particular venue. Wellington Club was invited to the big event and some members took up the offer which was good to see. We had quite a few items from past members of the group. As well as Margaret’s contributions, there were books from Ian Campbell and Graham Robertson, and minerals from all of us, as well as some from Fergus which Ron Keen had brought up. There was some very spirited bidding at times. $1,700 was raised, which enabled us to cover the costs and add another $100 to the bank account. Well done everyone.

Then it was time for the photography session, before we returned to the microscopes and more socialising.

After cleanup on Tuesday morning it was time to say goodbye to everybody. Although we were small in number, 24 and only two from across the ditch it was a really great symposium.

Hopefully we will all get together next year west of Christchurch.

Errol and I arrived in Brisbane on the Friday evening to be greeted by Suzie and Phil Eriksson saying you aren’t going home just yet, are you? It was Toowoombah Annual Gem Show on the Saturday and a Minsoc fossicking trip to Storrs Quarry at Oakey (not too far from Toowoombah). I decided to go to the show, etc. What was another couple of days seeing I had not been home since middle of July when I visited family in Townsville before I went travelling overseas.

Errol decided to do the right thing by Lois and went home to Coffs Harbour on the Saturday.

GNS visit, introductory talk in the foyer, waiting for the lost ones.

Micro Group Meetings, Victoria

John Bosworth and Jo Price

The February meeting of the Micro Group was on the subject of “Minerals containing Ag”. Both ‘ruby’ silvers were seen with small delicate deep red crystals, striated on the C axis, of proustite (a specimen from Imiter, Morocco being a stand out) while pyrargyrite specimens from Peru and Broken Hill, NSW were on display. The silver bromides and iodides were represented by iodargyrite, marshite and miersite from Broken Hill, NSW as well as iodargyrite from Les Montmins, France.

Silver as an element was represented by many specimens, with a spectacular arborescent example from Pohla, Erzgebirge in Saxony. Several examples from the classic locality of Kongsberg, Norway were on display as well as pieces from the Alva mine, Clackmannan, Scotland and Elura, NSW.

Other than the ‘ruby’ silvers, the sulphosalts were represented by stephanite from Broken Hill, NSW, dyscrasite from Pribram, Czech Republic, legenbachite from Legenbach quarry, Binn, Switzerland and perroudite from Cap Garonne, France.

The subject produced an array of specimens showing a wide variation of habits, colour and interest.

The March meeting was "Minerals from Africa" and we shouldn't have been surprised that that large continent provided such a large number of mineral species.

From the Democratic Republic of Congo there was gallite in germanite, from Gabon, francevillite; and chervetite, a rich yellow vanadate. Malawi minerals included aegirine with parisite-(Ce), and monazite. There was a dark red corundum from Madagascar.

The largest variety was from Morocco, and some that we noted included cobaltaustinite; bladed crystals of spherocobaltite; lustrous skutterudite groups; karibibite; roselite and roselite-beta; red vanadinite; wendwilsonite and xanthoconite with proustite.

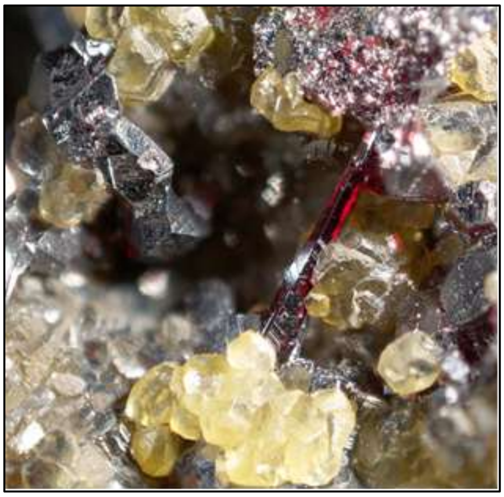
Namibian minerals included plancheite; sphalerite with eudialite; phenakite; beyerite; lustrous descloisite; and topaz. Some Aris Quarry minerals seen were mauve crystals of villiaumite; labuntsovite; tuperssuatsiaite; and new species sazhinite (T.L); and arisite (T.L.)

Minerals from the Republic of South Africa included rhodochrosite; inesite; bultfonteinite with poldervaartite; sturmanite; gaudefroyite; yellow ettringite and sugilite in a rich violet colour.

Then there was a specimen of senegalite from Senegal, and hopeite from Zambia.

We agreed that this was a very good topic with many interesting minerals.

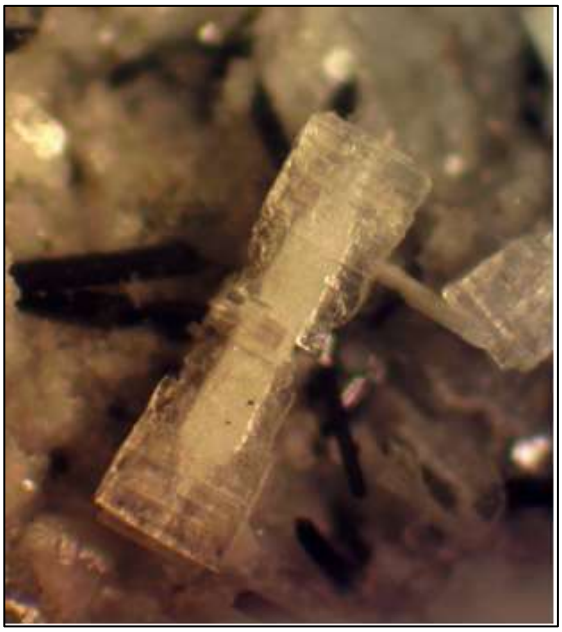

Perroudite from Cap Garonne, France


Pyrargyrite from Broken Hill, NSW


Arisite, Aris Quarry. Photo and Specimen: V. Hoppe


Labuntsovite-Mn, Aris Quarry. Photo and Specimen: V. Hoppe

Tuperssuatsiaite, Aris Quarry. Photo and Specimen: V. Hoppe



Sazhinite-(La), Aris Quarry. Photo and Specimen: V. Hoppe

Iridescent Andradite from Queensland

Jocelyn Thornton

Over the years I have acquired several specimens of Queensland andradite garnet. The first was a 6cm chunk of dark oily green garnets just labelled “Queensland”, from a deceased estate. The next two were thumbnail-sized pieces, one identified as andradite from between Herberton and Mt Garnet, and the second given as being from Mt Garnet. Two years ago I bought another 6cm specimen labelled from Mt Garnet, because I liked its trail of doubly-terminated quartz crystals. It had been owned by the late Ray Kilsby and was being sold by Rosalie as she was down-sizing their collection.

I happened to unwrap it along with some micro-minerals acquired at the same show, and put it under the microscope just for a look. As I turned the garnets, I was surprised to see a band of colour appearing along one of the edges of the rhombic faces. Generally there was one colour in a crystal, but it could be crimson, blue, emerald green, yellow-green or golden, in a band that was parallel to one edge of the face, and definitely below the surface of the crystals.

Wondering if this was a one-off, or usual for the locality, I got out all the other specimens, and found that every one of them showed the same iridescence in at least one crystal, under the scope and after carefully turning them around. I had read in *The Mineralogical Record* about iridescent garnets from Mexico, and wondered how common this is and what makes the play of colour.

Being a vandal, I broke off a piece from the first large specimen and sent it to Willow Wight, the Canadian gemmologist in Ottawa, with a plea for information. She responded with photocopies of several articles on iridescent garnets. The best summary came from a 1997 paper by Badar and Akizuki. I am quoting and paraphrasing from that paper.

Iridescent garnets are extremely rare and are reported from only a few localities in the world. The first reported example of the iridescent sheen observed in garnet was described by Ingerson and Barkdale in 1943, when they examined garnets from Adelaide Mining District, Nevada and found the fine lamellae (layers). Then Akizuki *et al* (1984) studied iridescent grandite garnets from Kamihogi, Yamaguchi Prefecture, Japan and compared them with the Nevada garnets. They explained that the iridescence in the garnets was due to the presence of two chemically distinct growth layers, parallel to the (110) face (this is the vertical diamond-shaped face of the dodecahedron crystal, in the simplest form of garnets).

In 1997 Badar and Akizuki described the iridescent garnets from Sonora, Mexico, elsewhere described as byproducts of a calcite mine located about 145km northeast of Hermoncillo. They noted that the Mexican garnets were translucent, with striated surfaces. “On the {110} natural faces, behind the striations, unclear images of iridescent lamellae were noticed. The colourful lamellae became more clear…after focussing on the lamellae inside a (110) natural face.”

The source of the iridescence lies in regularly stratified growth layers with distinct high chemical contrast. The studied Mexican garnet was composed of micron-sized layers with varying amounts of iron and aluminium. There was less variation in the core, but the outer layers regularly alternated between a composition of higher Al ($Gros_{21}And_{79}$) and higher Fe ($Gros_{6}And_{94}$), with respective refractive indices of about 1.855 and 1.878. The difference in refractive index produces the iridescence, just as the difference in the refractive indices of oil and water produces rainbow colours. I am guessing that this is the reason for the iridescence in the andradite garnet from the Mt Garnet region.

Now we can add Queensland to the localities for iridescent garnet.

Seeking more information about the locality and the geology I asked Steve Dobos in Brisbane for help. Although he owned some of the garnet, purchased from a dealer, he had not noticed the iridescence and not investigated the locality. Prompted by my enquiry, he spoke with a friend, Con Constantinides, at Mt Isa, who had been to the garnet locality some years ago, and gave this information.

“The name of the ‘mine’ is the Mt Noble Garnet Mine, originally opened up with the intention of mining the garnet for profit. The original lease lapsed, and Helmut Elbing snapped it up. He is a bit of a recluse, in his 60s or older, and lives on the site under rather primitive conditions, making occasional forays into Mt Garnet for supplies and mail, etc. No phone, PO Box 15 Mt Garnet, Queensland 4872, but apparently he does not always reply to letters.”

Steve attached to his email a Google Earth screen shot of the site and environs: the original latitudes and longitudes of the site (at end of green arrow) are at the bottom of the image. The large operation northeast of the site is the Kagara Mine (polymetallic Zn Pb Cu); mineralisation is hosted by skarns which include garnet.

The Noble Garnet Mine site is in a small creek adjacent to the end of the arrow. It comprises a skarn dominated by quartz, calcite and garnet. Most of the garnet is greenish, of one hue or another, and occasionally more translucent, or even transparent, crystals can be found. Rarely, yellow to red/orange to colourless crystals are encountered, and all of these are sought by lapidaries for faceting. Helmut sells crystals and specimens and also fashions necklaces, etc. for sale.

Not all the green(ish) garnets will show the iridescence, and it is only visible as you carefully turn the garnets under magnification of at least 10x, in handlens or microscope, with a good strong light.

References:

Akizuki, M., Nakai, H. and Suzuki, T. (1984) Origin of iridescence in grandite garnet. *American Mineralogist*. 69: 896 901.

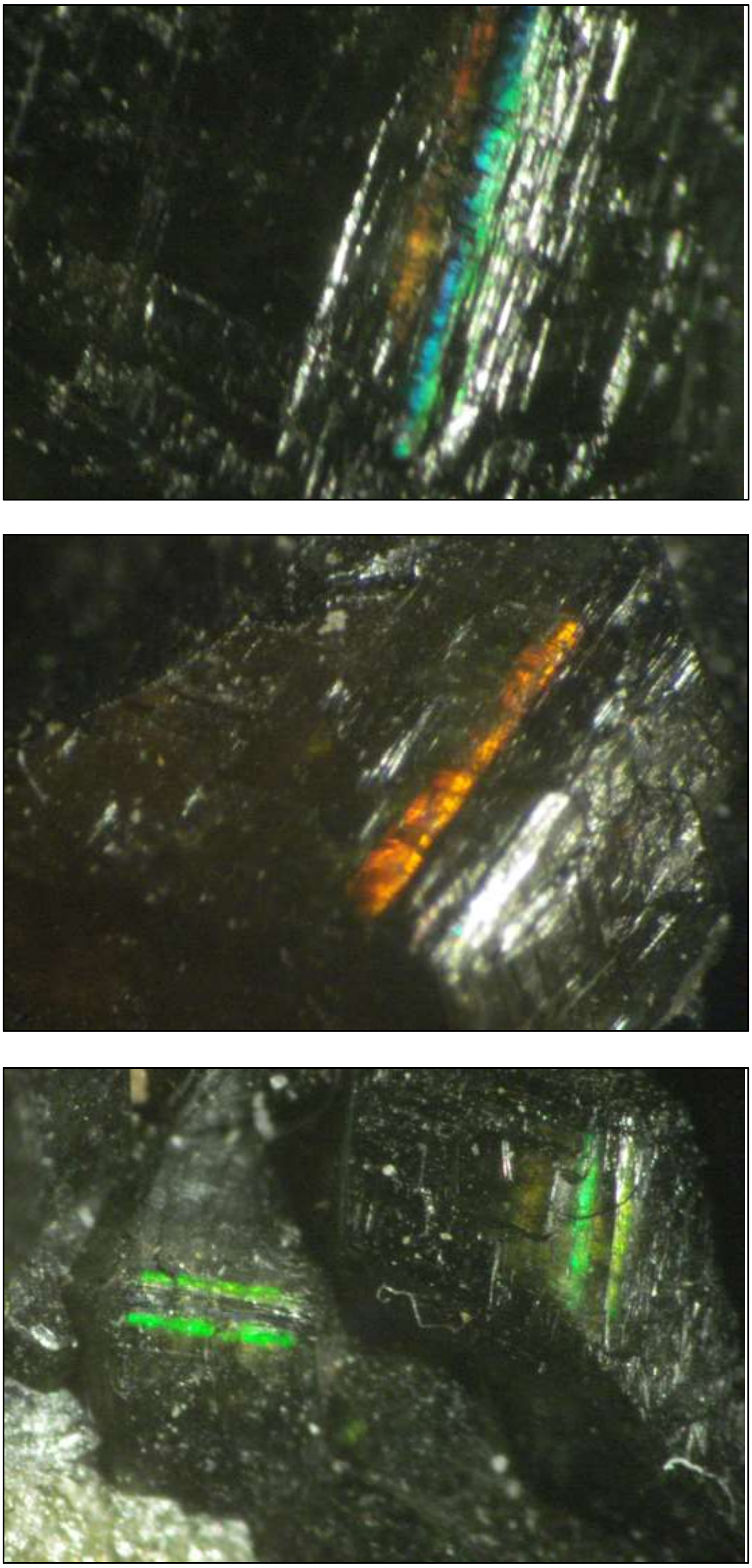
Badar, M.A. and Akizuki, M. (1997) Iridescent andradite garnet from the Sierra Madre Mountains, Sonora, Mexico. *Neues Jahrbuch fur Mineralogie, Monatshefte*. Pp 529 – 539.

Ingerson, E. and Barkdale, J. D. (1943) Iridescent garnet from the Adelaide mining district, Nevada. *American Mineralogist* 28: 303 – 312.

Quartz on andradite, Mt Garnet area, Queensland

Mt Garnet site in relation to Mount Garnet, the place (Google Maps)

Mt Garnet site closeup (Google Maps)



Iridescence in Mt Garnet andradites, photographed by Jocelyn Thornton

Minerals from the Narre Warren & Harkaway quarries

John Haupt

These two quarries on the outskirts of Melbourne's eastern suburbs have produced some interesting micro mineral specimens. Both were basalt quarries operated by Pioneer Quarries (later Hanson quarries). They have been encroached by Melbourne's urban sprawl and have closed and their sites rehabilitated.

The Narre Warren quarry was located in A'Beckett Road Narre Warren North. The minerals occur in small cavities in the basalt, which is commonly lined with blue to cream montmorillonite.

Siderite occurs as lustrous golden brown to dark brown hemispheres, up to 1cm across. The occurrence of 'basketweave' siderite is of particular interest, with the contrast of the golden siderite on a blue background of montmorillonite making striking micro specimens.

Phillipsite occurs as clear glassy individual crystals to 4mm long and in crystal clusters, commonly associated with siderite. The most attractive specimens are of phillipsite with or on irregular spheres of siderite. Noted American micromounter, Bill Henderson says "the material would be very nice were it to contain either of the two minerals alone, but the combination is especially striking" (Henderson, 1981).

Henderson later examined the growth of 'basketweave' siderite and found that the siderite 'weave' was a secondary growth through shrinkage cracks in the montmorillonite. (Henderson, 1987). He also noted the selective growth of montmorillonite on phillipsite crystals at Narre Warren.

Chabazite, calcite and aragonite also occurred in the quarry, but were less common and specimens were less attractive. A few specimens of pyrite were also collected, some with right angle bends.

The Harkaway quarry was located in Noack road, Harkaway and was noted for the specimens of fluorapophyllite, now known as fluorapophyllite-(K), the only occurrence found in the Victorian basalts. It occurred as a druse of small equant crystals lining cavities up to 15cm across in the basalt. Natrolite, phillipsite and calcite occur with the apophyllite. The apophyllite was found in a small zone in fragmented basalt, 5 metres across and 10 metres high in the quarry and was quickly quarried out (Birch *et al* 1984). Calcite crystallised later than natrolite, forming attractive micros of calcite 'teardrops' on natrolite crystals.

Members of photographic group of the Mineralogical Society of Victoria, led by Frank Robinson, photographed many specimens from these quarries and some of these are included.

References:

Birch, W.D., Johnston, A & J., 1979: Zoned siderite and zeolites from Narre Warren, Victoria. *Australian Mineralogist*, 20, 97-100.

Birch, W.D., & Johnston, A., 1984: Fluorapophyllite from Harkaway, Victoria. *Australian Mineralogist*, 45, 264-5.

Haupt, J., 1989 : South Gippsland - In Zeolites of Victoria, *Mineralogical Society of Victoria*. Special Publication 2, 59-65.

Henderson, W., 1981: Microminerals, *The Mineralogical Record*. 12(2), 108-9.

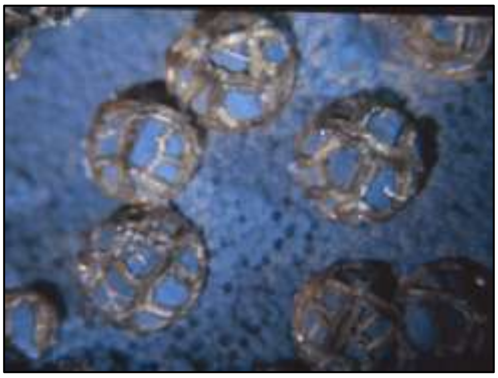
Henderson, W., 1987: Microminerals, *The Mineralogical Record*, 18(6), 435-438.

Robinson, F 1994: Narre Warren North & Harkaway Quarries. The Mineralogical Society of Victoria. Album of Minerals, Volume 8. Unpublished.

Narre Warren Quarry in 1985. Photograph: F. Robinson

Narre Warren Quarry showing columnar jointing. Photograph: J. Leach.

Min Soc Victoria field trip at the Narre Warren Quarry jn1985. Photograph: F. Robinson.



Basketweave siderite on blue montmorillonite. FOV ~6mm. Photograph: B. Day.

Phillipsite and basketweave siderite from Narre Warren. 4mm tall. Photo: J. Haupt

Calcite from Narre Warren. An unusual form, 4mm tall; Photograph: F. Robinson.

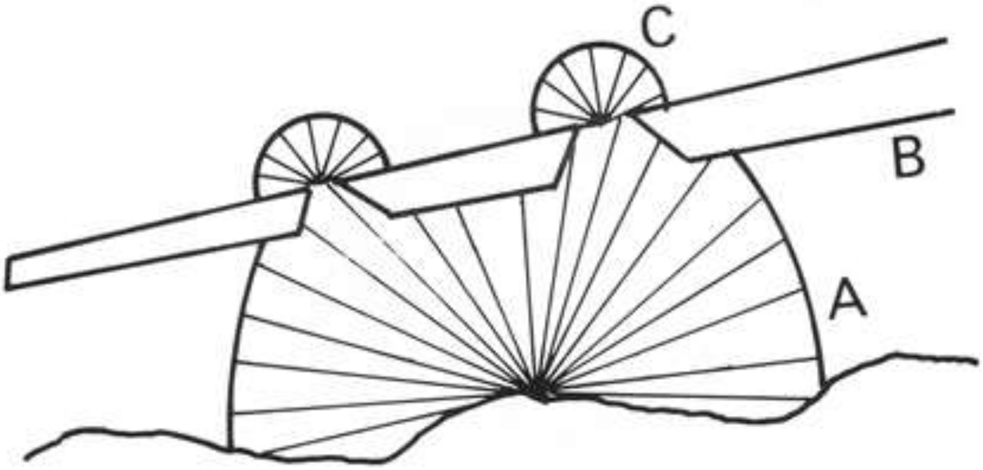
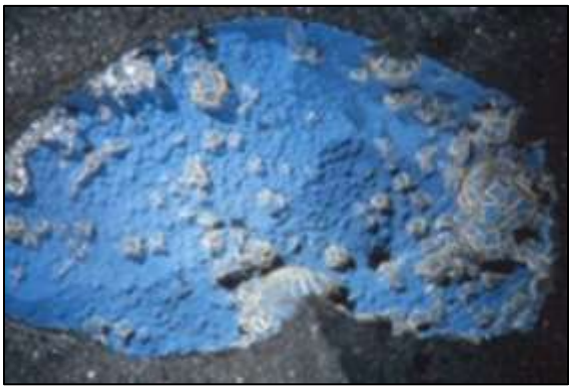


Figure 5. **Mechanism of growth of a second generation of radiating crystals. A large, primary sphere of radiating crystals, A, on reaching a barrier, B, grows through small pinholes or cracks in the barrier and continues growing as radiating crystals to form secondary spherules or ridges, C.**

Sketch showing the growth mechanism of siderite (from Henderson 1987).

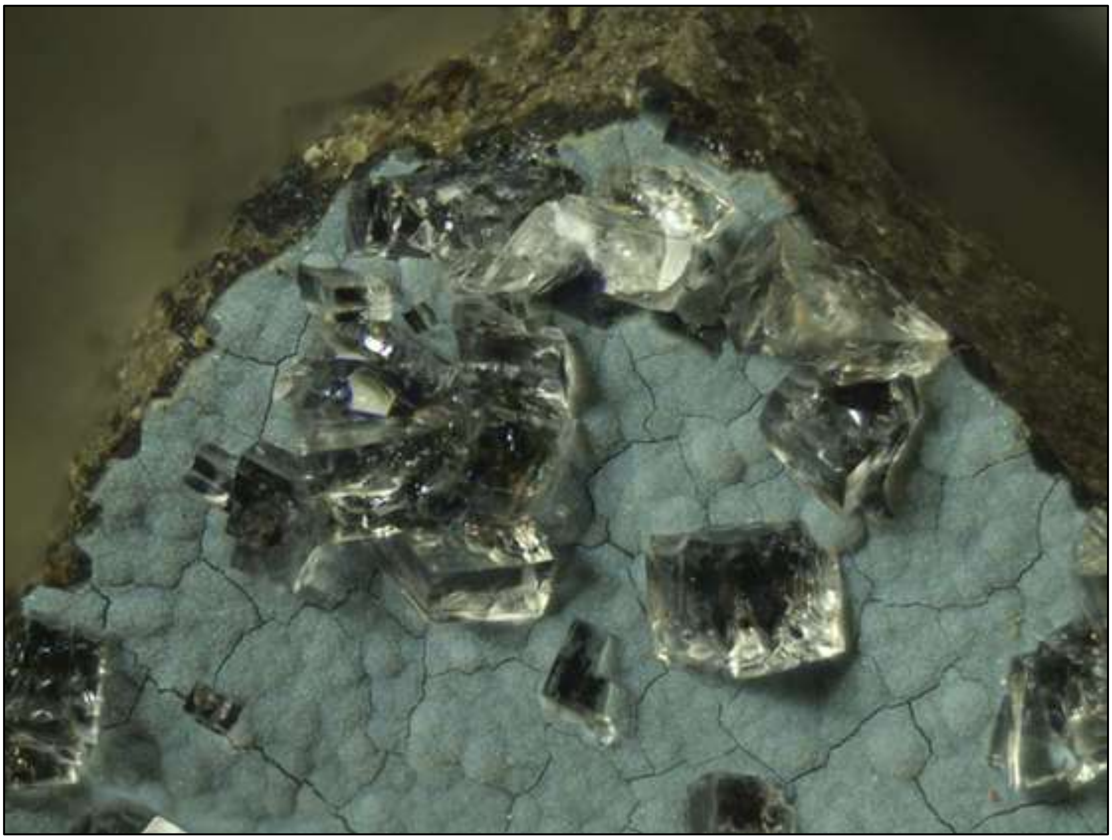


A cavity with basketweave siderite on montmorillonite, 18 mm across. Photograph: F. Robinson.

Siderite growing through cracks in montmorillonite, with phillipsite. 4mm FV. Photograph: J. Haupt

Pyrite and phillipsite from Narre Warren. FV ~2mm. Photograph: F. Coffa. Specimen: Museum Victoria.

Calcite from Narre Warren. Glassy 'balls' in cavity, 18mm across. Photograph: F. Robinson.



Clear chabazite rhombs to 1 mm, from Narre Warren. Photograph: J. Haupt

Golden siderite and phillipsite from Narre Warren. 6mm FV. Photograph: J. Haupt

The Harkaway quarry c 1985. Photograph: F. Robinson

Glassy crystals of fluorapophyllite with natrolite from Harkaway, 4mm FV. Photograph: J. Haupt.

Calcite ‘teardrops’ on natrolite, 4mm across. Photograph: F. Robinson

Natrolite and calcite from Harkaway, 7mm tall. Photograph: F. Robinson.

Broken cavity lined with fluorapophyllite from Harkaway. Specimen 70 mm tall. Photograph: J. Haupt.

Calcite crystal from Harkaway, 10mm tall. Photograph: F. Robinson.

Natrolite crystal, 2mm tall. Photograph: F. Robinson.

Calcite on natrolite from Harkaway, ~4mm tall. Photograph: J. Leach.

Forum on the Photography of Microminerals

Part 1 – Contributed by members of the micromineral group of the Mineralogical Society of NSW.

Recently Noel Kennon distributed an open letter to many readers of the *Australia and New Zealand Micromineral News* (ANZMN) encouraging them to be more forthcoming in presenting articles for publication. Several responses have been received indicating that although they have “an article which they would like to publish in the ANZMN, it needs photographs of publishable quality which unfortunately they are unable to provide”. This is a situation confronted by nearly all micromounters – ‘how can I take reasonable quality photographs with equipment that is not too expensive?’ So, at a recent gathering of the micromineral group of the Mineralogical Society of NSW it was suggested that the ANZMN consider hosting a forum of an ongoing discussion on the photography of small minerals and mineral specimens and invite readers to contribute accounts of their attempts including some examples of their work to help readers decide on how they should proceed. To start this discussion here is the first installment outlining some of the physics and technology involved in micromineral photography.

Some definitions and terminology

There are two types of photography of small objects. Firstly there is photomicrography which is photography using a compound microscope. This term is not the same as microphotography which is the production of miniature photographs. Photomicrography can involve magnifications from about 1X to 1000X. Secondly there is photomacrography which is photography using a camera adapted to take photographs of objects that appear approximately full size or larger on the image plane of the camera. The magnification may range from 1X to approximately 5X. For this type of photography the camera is fitted with a special macro lens and bellows while the camera sits on a stand. Thus in terms of magnification there is a certain amount of overlap between these two techniques. Micromineral specimens generally span a size range applicable for either photomicrography or photomacrography.

The photomicrography of microminerals usually involves a compound microscope called a dissecting microscope which is a low power microscope with a large object to objective lens distance, called the working distance. Typically this ranges from about 50-100 mm and the object is viewed in reflected light. This large working distance allows the object to be manipulated (dissected, hence the name) while being viewed through the microscope at the same time. Most of these dissecting microscopes are also stereo microscopes and hence are binocular microscopes, having two eye pieces, and enabling the object to be seen in 3D. Some simple (and cheap) dissecting microscopes are monocular, having only one light path and so do not give a stereo image. Microscopes with a zoom lens have an objective lens in which the focal length can be varied continuously. This causes the field of view to vary in size continuously from a low magnification to a higher magnification. In older microscopes this change in magnification was achieved in steps by having several objective lenses each with a different magnifying power. If the object stays in focus while ‘zooming’ the system is said to be par-focal.

Most stereo microscopes are really two monocular microscopes, one for each eye, each having its own objective lens and combined into one instrument. The optical path of the two component microscopes are usually inclined at an angle of 120 to each other with each being tilted 60 to the vertical. This set up is called the Greenough system, named after its inventor. To check if a microscope is of the Greenough type microscope look closely underneath at the objective lens (use a small mirror) and see if there are two objective lenses. Note in some cases a Greenough microscope may have a single large supplementary lens attached in front of the two objective lenses giving it the superficial appearance of having a single objective lens. If the pupils in a person's eyes are 64 mm apart (a fair average) then an object when viewed through such a microscope would appear as if it were 304 mm in front of the eyes [32/tan60].

There are other binocular microscopes which have a single objective lens. These are high powered mainly transmitted light microscopes where the objective lens is a few millimetres or less from the object. The single image may be shared by two eyepieces using a beam splitter and the microscope does not provide stereo vision, only 2D views. Many microscopes are also trinocular, with this third ocular used to connect a camera or other image capturing device. This eliminates the need to appropriate one of the binocular eyepieces for this purpose. In all stereo microscopes inspected, this third ocular uses one or other of the two optical paths of a stereo microscope and does not have its own, third, separate, vertical optical path.

Image capture

Since the capturing an image on film may now be considered obsolete, this discussion will concentrate on digital photography. There seems to be two ways of capturing an image using a compound microscope (1) replacing an eyepiece of the microscope with a digital camera or digital image sensor connected to a computer and (2) photographing the image formed through the eyepiece of the microscope. In both cases the quality of the subsequent photograph will depend on both the quality of optics involved and the quality of the image sensors and their resolution (often defined in megapixel size).

Taking photographs through the eyepiece of a microscope is controlled by the exit pupil. Focus the microscope on an object and look at the eyepiece from about 30 cm away. You will see a bright circular patch near the centre of the eyepiece. This is the exit pupil. If the microscope is focussed correctly the diameter of this exit pupil will not change when your eye is moved to and from the eyepiece because the light rays exiting the eyepiece are parallel and the microscope is said to be focussed at infinity. Measure its diameter of the exit pupil using a ruler held near the eyepiece. In the microscopes tested this exit pupil has a diameter approximately 2mm for 10X magnification and it decreases for higher magnifications. A 2mm diameter exit pupil is approximately equivalent to f22 for a 50mm SLR lens [50/2]. So the lens of the camera having a diameter larger than, say, 3-5mm is unnecessary.

The problem of object relief and depth of field

Most micromineral specimens display considerable relief. A 10mm square field may have a relief just as large, such as when viewing crystals protruding into a mariolitic cavity. Even in relatively ‘flat’ specimens crystals may protrude several mm above a surface which is itself fairly rough. Viewing such a field through a microscope means that much of it will be out of focus. The width of the ‘slice’ that is in focus, termed the depth of field, depends on several factors, the main ones being (1) the distance the object is from the objective lens of the microscope and (2) diameter of the objective lens. Depth of field can be increased by increasing the object- objective lens distance (working distance) or by making the diameter of the objective lens smaller. In microscopy both these variables are restricted. In many stereo, zoom, par-focal, microscopes the object- objective lens distance averages about 50mm and the objective lens diameter is 12mm (1/2 inch). Note that the ‘slice’ of the object that is in focus is parallel to the image plane of the camera in which sits the image sensor. This affects the stacking of images using Greenough (stereo) type microscopes which is discussed in the next section.

Perspective distortion may also be an issue and is most noticeable when viewing flat-sided geometric shapes such as crystals close up. It can be reduced by increasing the object to objective lens distance.

Computer image stacking and Greenough optics

To increase the depth of field of digital photographs, computer programs have been developed that combine a stack of multiple images taken at different focus distances to give a resulting image which has a greater depth of field. A series of images are taken with the microscope first focussed on the lowest point in the field to the highest point in small steps of up to about 35 images. These are then sequentially combined with the software selecting the parts of each image that are in focus to form a combined image.

With a Greenough stereo microscope, the optical path and hence the camera is tilted at an angle of 60 to the vertical focussing movement causing the slice of the object in focus to also be tilted at a 60 angle to the vertical focussing movement. Thus when the focus is raised parts of the field that were previously hidden behind some projecting part of the object will now come in to view but will never be in focus. Stacking software will not improve this part of the image. If this factor is considered to be an issue then using a monocular dissecting microscope may be an option. In these microscopes both the optical path and the focussing movement are parallel and vertical. These monocular dissecting microscopes are cheap and provided the quality of the optics is good could be considered an option.

Other factors to be considered

This short introduction has not mentioned some other factors involved in micromineral photography such as lighting, vibration, specimen selection and presentation (under the microscope), and the aesthetic quality of composition. Neither has image processing using Photoshop been considered.

Smart phone photography through a microscope

Many people have either an Apple or android smart phone with a build-in camera. These phones have a fairly small camera lens which can be used to take serviceable photos of micro specimens through a microscope.

As an experiment a series of images were taken through the ocular of a Chinese microscope using a Samsung Galaxy S11 phone, hand held.

When using the phone hand held it is a little tricky to find the exact spot where the camera/phone is correctly aligned with the eyepiece of the microscope. It appears to work best (at least in this combination) if the phone is about 15mm from the eyepiece. To achieve this it was possible to use the rubber eye cup as a steadying mechanism. Then it is a matter of finding where you obtain the maximum round image through the microscope. It can take the camera a few seconds to lock onto the image but then the automatic focus and exposure kick in and the image can be taken. It is worth experimenting with this method to obtain photos of tiny specimens.

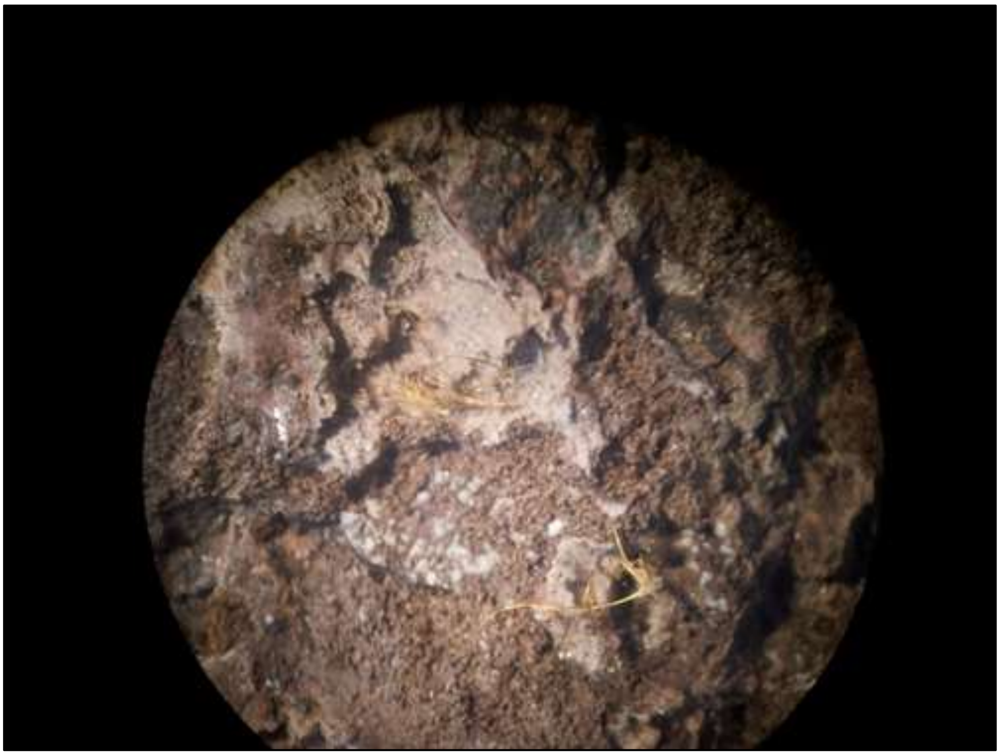
These can then be cropped to eliminate the circular appearance to obtain a "normal" shaped image.

There are some limitations to this in that once you start zooming in on the image, it softens considerably around the edges and will probably not be of publication standard.

As the cameras in the phones are automatic you have little control over exposure and the automatic focus would make stacking images for greater depth of field tricky.

It certainly is not the be all and end all of photographing micro specimens, but you can have fun with it for little extra outlay and little setting up. The system could be improved by making an adapter that will sit on the eyepiece and provide a flat plane for the camera to sit on, so all you need to do is line up the shot.

The following images are of tiny Augite curls, from Kamchatka Peninsula, Brian England specimen.



Original image through microscope

Cropped image - fov 10mm

Cropped image, fov 10mm, with a little sharpening

Queensland Micromob

Sue Ericksson

Queensland Micromob is continuing as a very active group. Our group meets at various members' homes with the remaining meetings being held at the clubrooms of the Mount Gravatt Lapidary Clubrooms (southern suburb of Brisbane). Anyone travelling through is always most welcome to join us. We meet from 10am until about 3pm (or whenever our enthusiasm dies). Just drop an email to ps.ericksson@gmail.com and I can let you know the details of the upcoming meeting. Each month we have a theme and usually we all research the topic and share our findings then have a show and tell time followed by brags, problems and time in the swap box – it seems to grow though, not shrink, despite our good efforts of taking from it each month. So help in this endeavour is most welcome!

Last month we were invited by Minerama to hold our meeting in the board room and have it as a combination meeting and mingling with the public. It worked very well with quite few interested people (including children…how kids love to look down a scope!!). We have been invited to return next year and with a bit more signage around the show it will become busier for us.

Sue Ericksson Group co-ordinator

Forward Diary

- July 12th, Minerals of New England area, New South Wales.
- August 9th, Minerals from Mt Isa area.
- September 13th, The world of Clay minerals according to Theo
- October 11th, Northwest Tasmania minerals
- November 8th, Minerals of Coromandel, Seminar wrap up
- December 13th, Christmas Party

The Zeolite Group of Minerals

Noel Kennon
annoelk@gmail.com

The zeolites are one of the most collectable of all mineral groups, and many museum and private collections contain spectacular specimens of these species. Collectors of microspecimens are also attracted to zeolites and while some can occur as cabinet size specimens many are found as much smaller crystal assemblies and so are most suitable for study and appreciation under the microscope. It is almost certainly safe to say that all micro collectors have several, if not many, zeolites in their collections. It is probably also safe to say that a significant number of these collectors have only a passing knowledge of the zeolite group of minerals. This contribution sets out to provide basic information about zeolites in general and that information may be built on by reference to more detailed publications.

All zeolites are closely related in composition, occurrence and appearance, and although they vary widely in structural symmetry, there are also similarities in the common framework crystal structures. When intensely heated, they froth and boil, and to acknowledge this behaviour, the Swedish mineralogist Axel Fredrik Cronstedt coined the name from the Greek zein, to boil and lithos, stone.

Composition and Structure

As a group, the zeolites are hydrated aluminosilicates in which the ratio of (aluminium + silicon) to oxygen is 1:2 as shown in the six examples below. Zeolites are mostly based on the cations of calcium (Ca) and sodium (Na) but potassium (K), barium (Ba), lithium (Li), magnesium (Mg) and strontium (Sr) also occur. Structurally, the aluminosilicate forms in a framework within which cavities and channels accommodate some cations together with water molecules, which is not water of crystallisation, but an essential part of the crystal structure. It is the liberation of this water that causes the frothing when a zeolite is heated.

The 2008 edition of *Fleischer's Glossary of Mineral Species* lists 89 minerals in the Zeolite Group; 41 of these are subdivided into 15 series with the other 48 listed as the 'Non-series Species". Some authorities have classified zeolites according to whether the crystals occur in fibre, plate or equant form as set out below. However, zeolites such as phillipsite and thomsonite, occur in several shapes and are difficult to classify by this means.

Form	Mineral	Cations	Silicate	Water	(Al + Si):O	Crystal System
fibrous	natrolite	Na_2	$Al_2Si_3O_{10}$	$.2H_2O$	5:10	orthorhombic
	mesolite	Na_2Ca_2	$Al_6Si_9O_{30}$	$.8H_2O$	15:30	monoclinic
platy	stilbite	$NaCa_2$	$Al_5Si_{13}O_{36}$	$.14H_2O$	18:36	monoclinic
	stellerite	Ca	$Al_2Si_7O_{18}$	$.7H_2O$	9:18	orthorhombic
equant	harmotome	$(Ba,K)_{1-2}$	$(SiAl)_8O_{16}$	$.6H_2O$	8:16	monoclinic
	chabazite	Ca	$Al_2Si_4O_{12}$	$.6H_2O$	6:12	rhombohedral

An example of each form is shown in Figures 1, 2 and 3.

Associated Minerals

Apophyllite, calcite, datolite, pectolite, prehnite and quartz often occur in association with one or more zeolite minerals and the associations can form spectacular groups that are eagerly sought by collectors of both large and small specimens.

Properties

Colour	Most zeolites are clear (Fig. 4) or white (Fig. 5), but some may be coloured. For example stellerite, stilbite, heulandite can be orange (Fig. 6), gmelinite can be red (Fig. 7), natrolite can be pink (Fig. 8), and phillipsite can be golden-yellow (Fig. 9).
Streak	Colourless or white
Hardness	mainly 3.5 to 5.5 (similar to other hydrous silicates)
SG	2.1 to 2.3

At the atomic level, zeolites are microporous due to the regular framework structure and, with several other materials having similar structures, are known as molecular sieves. These materials can be used to sort molecules according to size.

Formation

Zeolites are abundant and one of the most widespread of the mineral groups. All zeolites are secondary minerals and form in a range of environments. The most common involves circulating hydrothermal ground waters which dissolve pre-existing minerals (probably from feldspars and feldspathoids) at high temperature, then precipitate zeolites from the solutions below about 300°C. Consequently, in any occurrence, the zeolites are among the last minerals to deposit.

The most attractive and well-crystallised zeolites are usually found in cavities in basaltic rocks (Fig. 10), but may occur in other volcanics. On the other hand, economic deposits occur as microcrystalline accumulations in sediments particularly those having volcanic origins.

Uses

Zeolites are among the most important environmental and industrial compounds known. To fully exploit the characteristics of the group, some 150 synthetic zeolites have been developed to provide uniformity and purity not available in natural material.

One of the earliest applications, based on the capacity of the crystal structure to exchange metallic ions, is for water softening in which ‘hard’ water containing calcium from limestone regions is passed through a bed of zeolite. The zeolite absorbs calcium from the water and replaces it with sodium thereby softening the water and enabling it to lather soap.

Other applications include use as slow release carriers for pesticides and fertilisers, use as an agent for removing ammonia from water and caesium and strontium from nuclear waste material, as catalysts in petroleum and petrochemical processing, in medical and biomedical treatments, in animal husbandry and in agriculture for soil treatment. The biggest use is in the manufacture of laundry detergents.

Collecting

Good quality cabinet sized zeolite specimens can be found at several localities in Australia. However, many sites yield only small specimens which are most appropriately collected as thumbnails, miniatures or particularly, micros. Basalt in quarries, road cuttings and rail cuttings should be examined, when and if possible, for zeolite minerals in cavities in the rock.

In Queensland, Mt Kynoch at Toowoomba, Laidley Creek at Townson and Storeys Quarry at Oakey are currently accessible and worthwhile visiting for micro specimens. Similarly, very collectable zeolites have been found in numerous localities in other states, but sadly, because of issues associated with public liability insurance, many sites are no longer accessible to collectors.

Information about Tasmanian localities is provided in *The Distribution and Occurrence of Zeolites in Tasmania* by Steve Sorrell (April 2003), available at his website www.crocoite.com/zeolites.pdf for reading or downloading. Microspecimens are available from all the localities listed in this compendium.

Zeolites of Victoria, Special Publication No 2 of The Mineralogical Society of Victoria, is a collection of detailed reports about many localities in that state and is available from the Society.

World Class zeolites have been collected for many years from the Garrawilla volcanic deposits in New South Wales and some of the best large specimens are displayed in the Crystal Kingdom museum in Coonabarabran. All localities are on private property but only a few owners permit access. Papers by Brian England in *Australian Journal of Mineralogy*, *Mineralogical Record* and elsewhere provide excellent information about this region and several other localities in the state. Microspecimens are available from all these localities.

As with all collecting in Australia, permission to access any sites for zeolites must be obtained for localities on private or commercial property and the appropriate licences must be obtained for sites on public land.

Overseas, spectacular zeolites from the Poona area in eastern India are well known, and excellent specimens have been recovered from the state of Oregon in USA, the Antrim Plateau in Northern Ireland and many sites in many other countries.

Steve Sorrell contributed significantly to this article by taking the photographs shown in Figures 1 to 4 and 6 to 9. The specimens are from the collection of Ann and Noel Kennon and one of us (NK) took the photographs shown in Figures 5 and 10.

Fig. 1 Crystals of fibrous mesolite from the State Metal Quarry, Cringilla, Wollongong, New South Wales. The crystals in the sprays are about 1mm long.

Fig. 2 Crystals of platy stilbite from Arkaroola Bore, Arkaroola, South Australia. The plates are about 1mm thick.

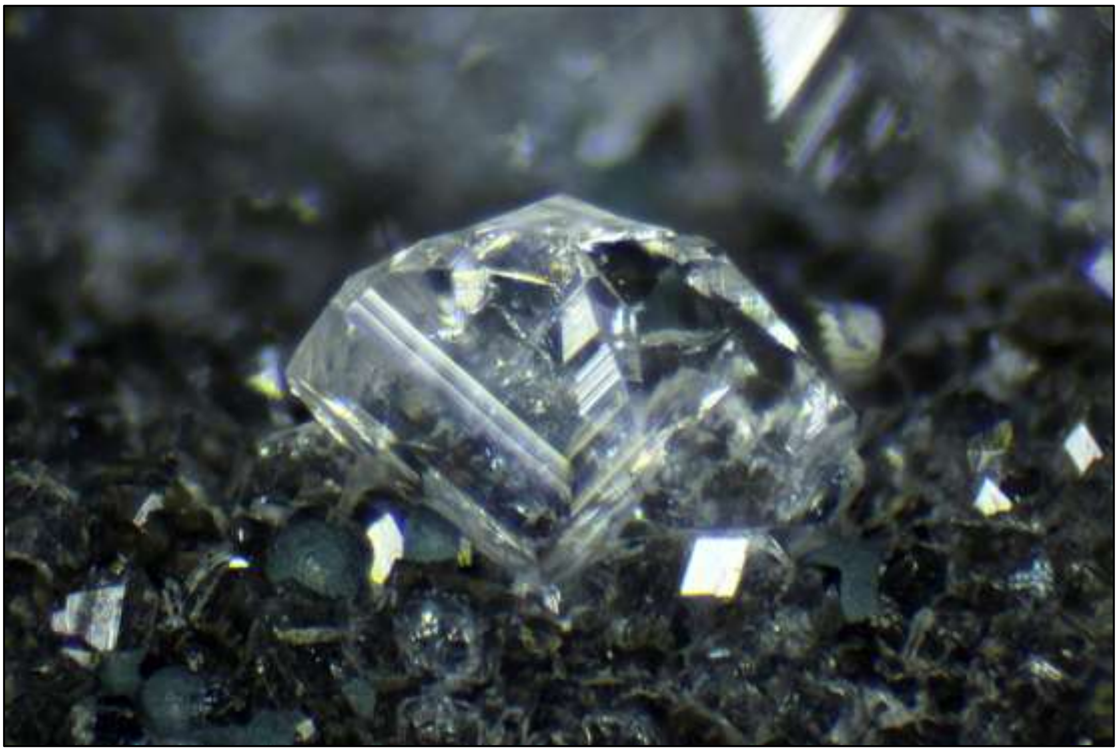


Fig. 3 Crystal of equant chabazite from Ben Lomond roadside quarry, Ben Lomond, New South Wales. The crystal is 1.5mm wide

Fig.4 Crystals of clear analcime from “The Nobbies” on Phillip Island, Victoria. The large crystal is 1.1mm wide.

Fig.5 Crystals of white laumontite from Arkaroola Bore, Arkaroola, South Australia. The length of the longest crystal is 7 mm.

Fig. 6 Crystals of orange heulandite from Portobello property, Garrawilla, New South Wales. The crystals are about 0.3mm wide.

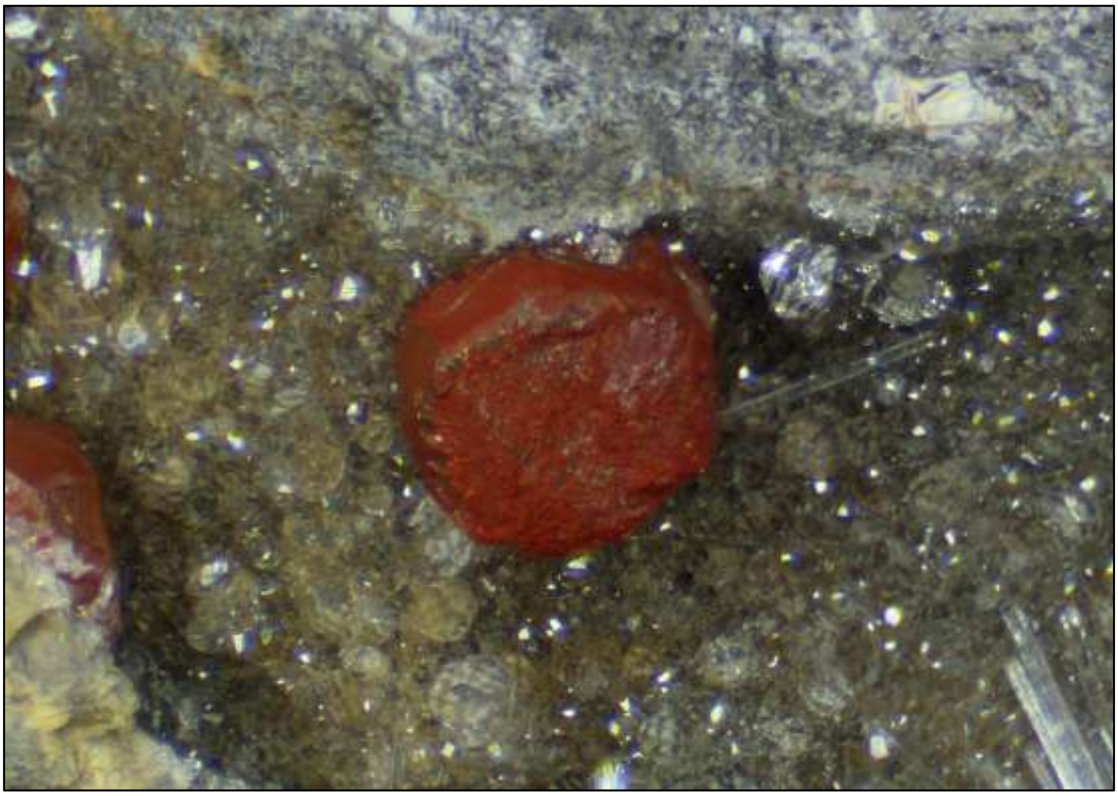


Fig. 7 Crystal of red gmelinite from Fieldwicks Quarry, Weldborough Pass, Tasmania. The crystal is 1.8mm across.

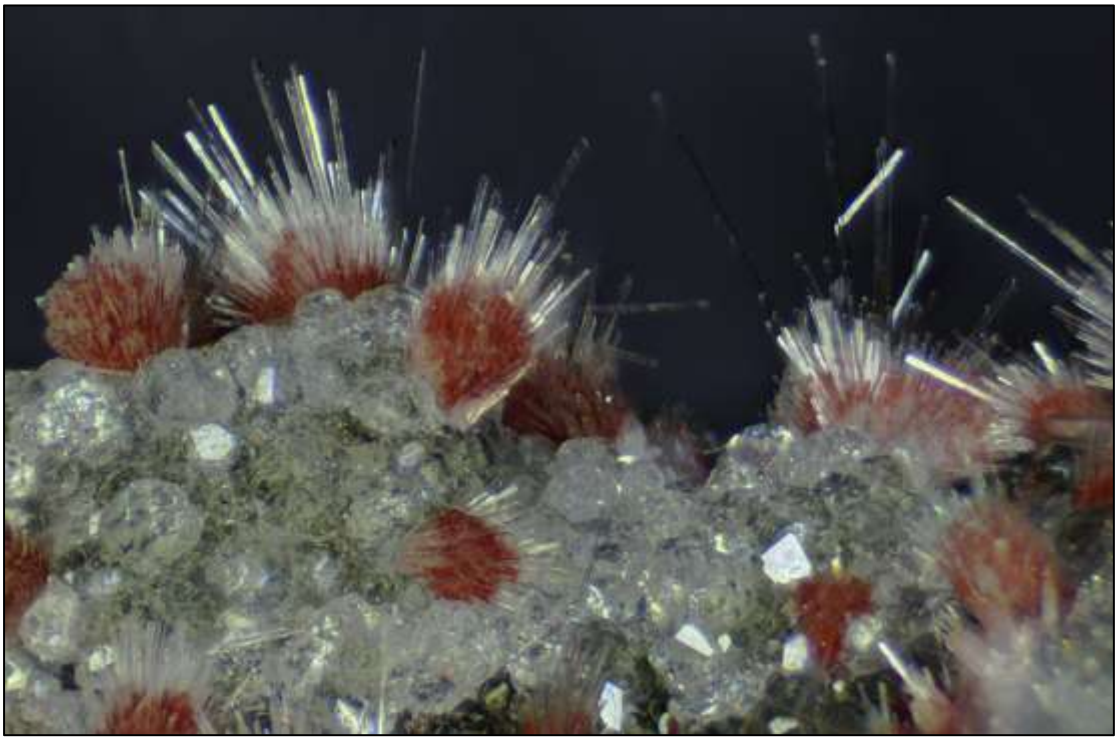


Fig 8 Crystals of pink natrolite from Bundella, New South Wales. The longest crystals are about 5mm in length.

Fig. 9 Crystals of golden-yellow phillipsite from Himix Quarry, Kulnura, New South Wales. The sprays are 2-3mm across.

Fig. 10 Zeolite minerals in a 15cm cavity in basalt, Bunnan, New South Wales.

The Pleochroism of Tuhualite

David M. Colchester, Geoscience, Australian Museum

Introduction

I have long known that the mineral tuhualite displayed remarkable pleochroism so when Neville Berkahn presented me with a specimen containing tuhualite grains I took the opportunity to examine this property for myself. As tuhualite pleochroism was, indeed, quite remarkable and since it is also a very rare mineral, I post two photographs of this phenomenon so that others may also see it for themselves.

A ray of light is a photon of electromagnetic radiation and it vibrates perpendicular to its direction of propagation. It also has a particular wavelength. A beam of white light is composed of a bundle rays having different wavelengths. Different wavelengths stimulate the eye to see different colours. If the vibration direction of the rays in a beam of light are confined to a single plane the light is said to be plane polarized otherwise the beam is unpolarised. When a beam of white light passes through a translucent mineral certain wavelengths may be selectively absorbed. If this happens the transmitted beam will appear coloured. Selective absorption may also depend on the angle the plane of vibration a ray of the light makes with the crystallographic axes of the crystal (mineral). This latter effect is only noticeable if the crystal is illuminated by plane polarized light in which case upon rotating the crystal with respect to the plane of polarization of the incident beam, the transmitted light will change colour. When this happens the crystal (mineral) is said to be pleochroic.

Pleochroism in Tuhualite

Tuhualite is found as small grains in the pantelleritic lavas on Mayor Island (Maori name Tuhua) in the western Bay Of Plenty of New Zealand's North Island. The mineral was first described by Marshall, (1932), (1936) and later by Hutton (1956) who established in detail its crystallographic and optical properties. Briefly, tuhualite, $(Na,K)Fe^{2+}Fe^{3+}Si_6O_{15}$, is an orthorhombic double chain inosilicate occurring as small very dark purplish grains that readily fracture along three pinacoidal cleavage planes.

To examine the pleochroism of tuhualite a tiny grain was prized out of the specimen and crushed between two glass microscope slides using thumb and forefinger. This causes the grains to break along cleavage planes. The resulting cleavage fragments were immersed in a small drop of oil, covered with a coverslip, and examined under plane polarized light (ppl) using a petrographic microscope.

Figures 1 and 2 are photographs of the same field of tuhualite fragments including one large cleavage fragment of tuhualite immersed in a small drop of oil. The field is viewed in plane polarized light with the plane of polarization in both images being E-W. In the second image the field has been rotated 90^0. The length of the left hand edge of the large cleavage fragment in the first photo is 0.095mm. The likely thickness of the large cleavage fragment is about one third of this length. The change in colour of the large cleavage fragment from a pale purple colour to deep violet is caused by pleochroism.

The faces of the large fragment are obviously cleavage faces which according to Hutton (1956) parallel the pinacoidal faces. He also states that light vibrating parallel to the a axis is pale lavender, to the b axis violet – lavender, and the c axis intense purplish blue. So obviously the c axis is E-W in figure 2 but in figure 1 it is difficult to tell whether it is the a or b axis that is E-W.

Figure 1 Tuhualite cleavage fragments viewed under plane polarized light with the plane of polarization E-W. The left hand edge of the large fragment is 0.095mm long.

Figure 2 The same field of view as in figure 1 but rotated 900. The plane of polarization is still E-W.

Observing pleochroism using a stereo microscope

A petrographic microscope is not necessary for observing pleochroism in small mineral fragments as they may be observed readily using a dissecting stereo microscope. Light emitted from iPad screens is plane polarized. In fact this applies to all recent TV and computer screens. In my iPad, the plane of polarization of the emitted light is parallel to the short dimension of the screen. Set the iPad screen to emit white light as when you are writing an email and place it on the stage of your stereo microscope and use the screen to back light a microscope slide on which are placed the mineral grains to be examined. Focus the microscope on them. The slide should be elevated about 10 mm above the computer screen to keep the screen out of focus. Rotate the slide horizontally and note any change in colour of the grains. To minimise surface reflections from the grains immerse them in a tiny drop of glycerine and place a coverslip or another microscope slide on top. I sit a milk bottle top from which the centre has been cut out on the computer screen and rest the microscope slide on top of it.

Many coloured minerals crystallizing in other than the cubic system are pleochroic and best results seem to be obtained when the grains are less than 0.5 mm thick. Many tourmalines, amphiboles and pyroxenes as well as thin flakes of biotite provide good examples of pleochroism.

Polarized light in nature and polaroid

Except for the elusive Haidinger's brush (Können 1985) the human eye is blind to polarized light. However, light polarization in nature is quite common and it can be easily observed by using a polaroid filter present in polaroid sunglasses and polaroid camera filters. Polaroid only transmits light vibrating in a single plane and is opaque to light vibrating at right angles to this plane. Light transmitted through polaroid sheet provides a convenient source of plane polarized and this light can be used in the same way as light emitted from a TV screen.

Iolite pleochroism and medieval Viking navigation

Iolite is a gem variety of cordierite. When a piece of iolite is held up to unpolarised light and rotated around it the transmitted light will display two sets of colours. In one position the colour will be pale grey-brown while in another position the colour will be a deep purple–violet (i.e. the selective absorption of different light wavelengths depends on the path the light beam makes with the crystallographic axes). Now if the crystal is viewed by plane polarized light from a computer screen and rotated parallel to it the transmitted light will be seen to gradually fade to almost zero and on continued rotation again intensify to a maximum. This occurs whether the iolite is held in a position to transmit either the pale grey-brown colour or the deep purple violet. This phenomenon is pleochroism and the maximum absorption occurs at a definite angle to the plane of polarization of the incident light.

This same effect may be seen when a piece of iolite is held up to blue sky and rotated similarly. This is because blue sky is partially plane polarized reaching a maximum in a band of blue sky at right angles to the sun (Können 1985). The plane of polarization is at right angles to the sun. Thus blue sky a natural source of (partially) plane polarized light. Thus when a section of blue sky in this band is viewed through a piece of iolite the position of maximum absorption will always have a constant relationship with the direction of the sun. Legendary accounts suggest that this pleochroic property of iolite was known to the Vikings who realized that it could be used to determine the direction of the sun when it was behind thick cloud or below the horizon. The Vikings supposedly used this fact to help them navigate their ships in the north Atlantic.

References

Hutton, C. O. (1956). Re-examination of the mineral tuhualite. *Mineralogical Magazine* vol. **31** p.96-106

Können G.P. (1985). *Polarized light in Nature*. C.U.P.

Marshall, P (1932). Notes on some volcanic rocks of the North Island of New Zealand. *New Zealand Journal of Science and Technology* vol.**13** p.201-202 [Original description]

Marshall, P. (1936). The mineral tuhualite. *Transactions of the Royal Society of New Zealand* vol. **66** p.330-336

Classifieds

Want to advertise something related to micromounting or microminerals? You can do so here. Willing to trade or sell, want lists, etc. Simply email the editor: steve@crocoite.com to get your listing in the next issue. Please keep ads as short as possible.

Mineral Paradise – Richard Bell

Periodic listings of mainly British micro and thumbnail-sized mineral specimens made available for sale or swap. To view, go to http://www.mineral-paradise.net

Sauktown Sales – Jim Daly

Periodic listings of micro mineral specimens for sale. Jim also sells micromounting supplies. To view, go to http://www.sauktown.com

DarkArtsMinerals – Steve Sorrell, Toby Billing, Ed Johnson and Mathew Latham

Minerals for sale by auction, many micro-material specimens regularly listed. To view, go to http://www.darkartsminerals.com

Facebook Groups for buying and selling minerals

If you are on Facebook, there are a number of options for the buying and selling of minerals. These are some that have interesting items: “Sell Some Rocks!”, “Australian Crystals and Minerals – For Sale”, “Stones to Sell…”. Each have rules, but they are pretty easy to abide by.