The Mineralogical Society of Queensland Inc.
NEWSLETTER

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No. 61 **December 2010**

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The Management Committee of the Mineralogical Society of Queensland wishes each and every one of you a Merry Christmas, Joyous Festive Season, and a Happy and Prosperous 2011

UPCOMING MINSOCQ MEETINGS 2011

MinSocQ meetings are usually held on the last Wednesday of each month, excepting December, at the Mt Gravatt Lapidary Society **(MGLS)** clubrooms, formally starting at 7.30pm or 1930 hours. Anyone interested in minerals and mineral collecting is most welcome, at any meeting. The clubrooms are located at the bottom end of Carson Lane, which is off Logan Road, Upper Mt Gravatt, on the left as you are heading north towards the city, directly opposite McDonald's. There is plenty of free off-street parking available, immediately adjacent to the MGLS clubrooms.

- *January:* ***There will be no January meeting.*** *As the 26th falls on Australia Day, the general meeting has been moved back one week, to February 2; likewise for the Management Committee meeting*

February 2: **What makes a great mineral specimen?** by Tony Forsyth, who is now also the Curator of the Minerals Heritage Museum. Do bring in what you think are some of your best specimens, so we can look, learn and compare.

February 23: **The geology and the minerals of the Iramafimpa Mine, Eastern Highlands Province, PNG** by Larry Queen. This presentation last February was cancelled, so we will try again in 2011, and hope Larry will not be called away at the last moment. Larry may well have PNG specimens for sale, but please do bring your own for a look-see.

March 30: **Inclusions in crystals and gems,** by Don Everingham, who is a jeweller, and stalwart member of MGLS, our sister society. Some microscopes will be set up, so you will be able to see firsthand what Don is on about, rather than the customary *Death by PowerPoint*. If you have particular inclusions of interest, or have not been able to identify same, bring 'em in.

- *April:* ***There will be no April meeting****, as decided at last November's general meeting, as this date is contiguous with those of Gemboree at Bathurst, and many members will still be away.*

May 25: **Buying minerals in China -** first-hand experiences and tribulations, by our very own Trevor Kitto. We've all seen some of the superb Chinese specimens that Trevor has brought to our meetings, and for sale at various shows, so this presentation promises to be something different! Bring your Chinese specimens so we can all look!

MINSOCQ MANAGEMENT COMMITTEE MEETINGS: Commencing at 6.00pm, prior to the monthly MinSocQ general meetings: *2 February, 30 March, 25 May, 27 July*

2011 MICROMOB MEETINGS starting 10am

January 8: At the Gold Coast Lapidary Club, 80 Pacific Av. Miami (Pizzey Park) - and what's more, it's air-conditioned! The topic will be **Minerals of the fossicking areas to be included in our first book,** and will be followed by the customary problem, brag and swap sessions.

February 12: At MGLS clubrooms; the meeting will commence with the obligatory cuppa, and the topic will be **Feldspars, micas, pyroxenes and amphiboles,** to be followed by the customary problem, brag and swap sessions

March 12**:** Chez Tom Taylor in Toowoomba. The topic will be **Calcite, aragonite and zeolites from the greater Toowoomba area;** and will be followed by the customary problem, brag and swap sessions.

April 9: At MGLS clubrooms; the meeting will commence with the obligatory cuppa and the topic will be **Native elements,** to be followed by the customary problem, brag and swap sessions.

May 7: Chez Glenys and Lloyd Sinclair, in Casino NSW; the topic will be the **Fossicking areas of Northern Rivers NSW, open and closed**, and will be followed by the customary problem, brag and swap sessions. *Note that this meeting has been brought forward by a week to avoid clashes with the Lismore show and other club meetings.*

- *June: There will be no 'Mob meeting, since the date coincides with the Annual Joint Seminar, Mineralogical Societies of Australasia, in Melbourne.*

WELCOME NEW MEMBERS OF MINSOCQ

We are very pleased to welcome three new members of the Society: Brendan Gay of Carrara, John Sandifort of Caloundra West, and Willem Slykhuis of Sippy Downs. Although you live outside the Brisbane metropolitan area, we hope to see you at Mt Gravatt whenever the opportunity permits, else at one or more of our Micro-Mob meetings. We'd love to see you at our social functions too!

2011 DATES and SHOW CALENDAR

Dates below are from the latest QLACCA calendar, accurate at time of publishing, but may be subject to change before the event. Any known changes will be reflected in upcoming newsletters, but if any doubt remains, visit the websites of individual clubs or organisations before you go.

March 5 & 6: North Brisbane Gem & Jewellery Festival, Aviation High School, Widdop St, Hendra, starting 0830

March 11-13: **Minerama**, at the Combined Services Club, Lang & Grey Sts, Glen Innes, NSW**,** formally starts at 1000 hours, but tailgaters are accessible earlier; *note that it's still Eastern Daylight Savings Time in NSW.*

March 19: Gatton Lapidary Club, Gem, Wood & Pottery Show, Gatton Sports Grounds, 0800-1600

March 19: New England Lapidary and Fossicking Club Annual Gem & Craft Show, at Armidale Showground, NSW, free entry, commencing 0900. *Note: it's still daylight savings time in Armidale (daylight savings ends 3rd April).*

April 22-24: *It used to be the Warwick Easter Rock Swap***,** *but is now advertised as the Darling Downs Bottle and Collectables Club Rock Swap, at Warwick Showground, Warwick;* If you're not going to the Gemboree, go to Warwick!

April 22-25: **47th Gemboree,** National Gem & Mineral Show, Showground at Bathurst, NSW **-** *if you plan to go, book accommodation as soon as possible - it's alreafy very tight!*

April 30 & May 1: Redcliffe Gem, Mineral & Jewellery Craft Show, *location to be announced*

May 14 & 15: 21st Annual Lismore Gemfest, Showground at Lismore, NSW

May 21: Mt Gravatt Gem Show, MGLS club rooms - do come, support our sister society, and enjoy!

June 11-13: 34th Annual Joint Seminar, Mineralogical Societies of Australasia, Melbourne, Vic. Hosted by The Mineralogical Society of Victoria, the theme will be: *Mineralogy into the Future.* If you do go, bear in mind that *Tutankhamun and the Golden Age of the Pharaohs* will be on at the Melbourne Museum; so if you want to see the unique King Tut relics, reserve or book your tickets *Tut-de-suite!*

WHAT'S BEEN HAPPENING

MinSocQ Meeting October 27: **Metamorphism and metamorphic minerals in aluminous metasediments** presented by Steve Dobos. Members were introduced to geothermal gradients (the rates at which temperatures rise with increasing depths in the crust), lithostatic pressure (brought about by the weight of overlying rocks at various depths in the crust), shear pressure (resulting from directional stresses within the crust), and water vapour pressure. These are the controlling parameters that dictate what mineral assemblages, and rock textures, will be formed when clay-dominated sediments or sedimentary rocks (shales and mudstones) are buried deep within the crust, to give rise to newly crystallized minerals such as micas, chlorite, garnet, staurolite, andalusite, kyanite, sillimanite and cordierite. The particular mineral assemblage is also controlled by the composition of the original rocks ('protoliths'). This talk set the stage for future presentations on metamorphic minerals from different suites of protoliths, such as from pure and impure calcite, dolomite and magnesite-rich sediments (limestones and other carbonate-rich sedimentary rocks).

MinSocQ Meeting November 24: Very well attended, and we welcomed new faces and guests for Fred Bruvel's presentation: **Madagascar - minerals, gems, people, scenery and wildlife.** Fred started with the location of Madagascar in the breakup of Gondwanaland, pointing out the similarity of Madagascan rocks to those of India and Eastern Africa. The island is dominated by high-grade metamorphic rocks intruded with granites and syenites, and their attendant pegmatites, which are the sources of the many minerals and gems for which Madagascar is known. Fred moved on to wildlife (lemurs in particular) and scenery, the loss of trees over much of the island, the resulting erosion of topsoil, the inhabitants, their religions and customs, and the demands on resources by the growing population. Madagascar has a population similar to that of Australia, with a land area of 587,041 km^2, about a third the size of Queensland, or 2.5x the size of Victoria. After questions, the meeting broke for tea, coffee and munchies, and much socializing. Thanks heaps Fred! It was gratifying to See Doug Rumsey from Longreach, who was in Brisbane for medical reasons - all the very best with the medicos, Doug!

Management Committee Meeting, 24 November: Preceding the general meeting, with an apology from Sue Wearden (who had not yet returned from New Zealand). The usual 'busy' items (previous minutes and correspondence) were discussed and passed, and were followed by the treasurer's report, which indicated we're in fairly good shape financially. Steve has lodged our revised constitution to the Office of Fair Trading, as a step towards the submission for another grant from the Gambling Community Benefits Fund, as foreshadowed at the last AGM. (It was subsequently accepted without changes, and has been registered). The speaker lineup for 2011 meetings was discussed, and the issue of the April meeting immediately following Gemboree in Bathurst was raised; it was resolved to put the probable cancellation of this meeting to the members at the general meeting, (where it was resolved that there will be no April meeting).

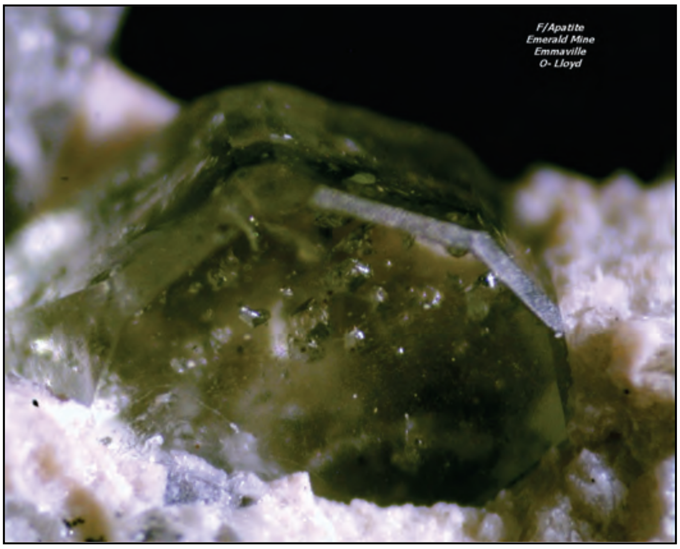
Tony sought operating funds for the Minerals Heritage Museum, and a sum of $300 was approved; in lieu, the proceeds from the December auction will go to consolidated Society funds. A sum of $500 was also voted to the Australian Journal of Mineralogy, as the Society has not usually been in a position to do so. A sum of $420 was passed to Theo, to underwrite the purchase of micromount boxes from Germany, to be on-sold on their arrival to members, at cost. Bev Mortensen had made good headway towards the setting up of a Scout's Badge for mineral identification. After discussion, Bev was tasked with taking this further, to lead to the formulation of a 'syllabus' for this badge, which the Society will prepare when required. A good move Bev, reaching out to the younger generation! Hopefully, we will be doing more of this along other lines as well.

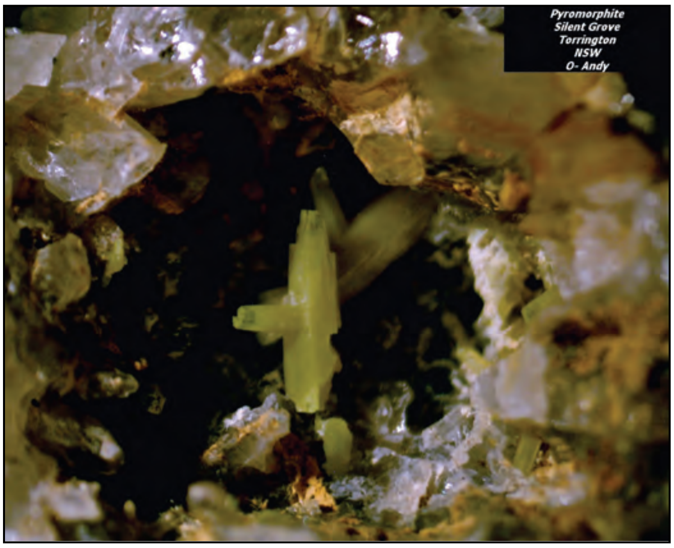
Tony is intending to organize a mineral display at the Queensland Museum sometime in 2011, to run over several months. To do our bit for mineralogy in Queensland, we will be soliciting help from members to 'man' the display, especially over weekends. We intend to have several 'scopes set up at various times, since this opens a new world to the younger generation, and viewing minerals through microscopes has always been at great hit, most recently at the Caloundra show last September. (We have gained several new Society members from such displays, and it helps to put the beauty and heritage value of minerals in the public eye).

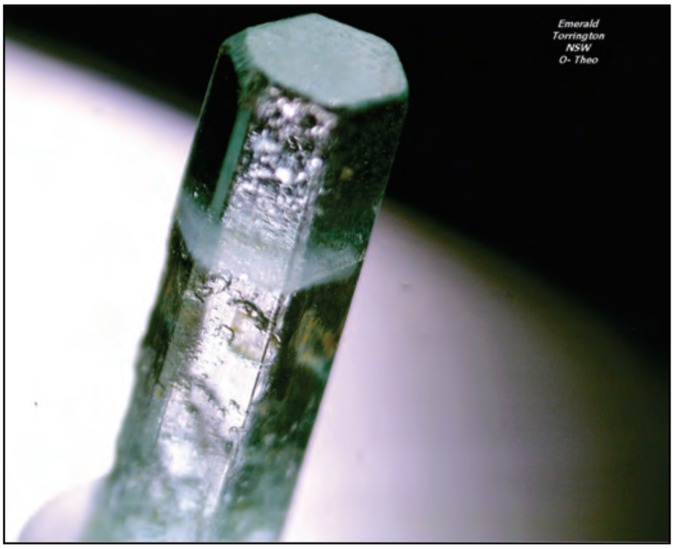
MicroMob Meeting November 13, at MGLS: November signified the end of our current calendar so as we enjoyed our early cuppa, we discussed the calendar for 2011 which is finally complete and ready for distribution. Our gathering numbered eleven this time and lead to a many and varied discussion time. Bev Mortensen sent her apologies, but advised that she was offering a bed for the travellers coming to the MinSocQ December BBQ. This includes those snails who drag their homes, however, Bev asked for prior notification of such caravan travellers. Vic Cloete also sent his apologies.

It was also mentioned that we will need an auctioneer for the BBQ; our auction is our main fund raiser each year and further donations would be gratefully received. The contacts list was also updated ready for distribution - mainly via email, with a couple of exceptions. The latest edition of the International Micromounters Journal (V17, No.2) had arrived and was copied and distributed. As we have joined the International Micromounters, I am receiving the Canadian Micromounters' newsletter which will now be emailed to all. It contains interesting articles for us all to read.

Steve has been in contact with two of the MinSocQ 'sickies'. He told us of Doug Rumsey's ongoing cardiac problems, but he is slowly improving. Doug feels somewhat isolated out there at Longreach so we are all encouraged to keep in contact with him to help him stay positive. Doug Ball who is battling cancer was at RNS in Sydney undergoing treatment. Theo stated that the micro boxes are at an all time low price so he will be putting in a bulk order on behalf of members. Theo also tabled the latest edition of the Lapis magazine for our perusal.







Clockwise from top left: Apatite - field-of-view 3mm; pyromorphite crystal is 3mm; quartz needles FOV 8mm; beryl or 'emerald' crystal is 3mm - all photomicrographs by Sue Ericksson

Finally we got to the theme - the Emmaville-Torrington district. Steve lead us through the geology of the area and I read an article printed some time ago by Hylda Bracewell on fossicking around Torrington. There was much discussion about various field trips, fossicking areas and the finds that were made. Steve is at present pursuing an offer to take the 'Mob around the Torrington area. Show and tell began after lunch which began slightly early in consideration of the Southerners and daylight savings! There was also an opportunity to have another fossick across the spares table one more time.

Sue Ericksson

MinSocQ BBQ December 11: Saturday the 11th of December started overcast with high humidity - most members arrived at the home of Bev and Geof Mortensen, in the wilds of Jimboomba, by boat. There was a good turnout, with a total of 24 warm bodies. We were especially glad to see Doug Rumsey who's recently emerged from Prince Charles hospital (and was recovering chez Ericksson), and Sue Wearden, who'd arrived from a protracted stay in NZ, just in time to attend the BBQ. We were also pleased to see Vic Tarhanoff, and thank Michael for the 'taxi service'. The southern contingent was very well represented, with the Danbys, Sinclairs and Bob Myer-Gleaves, as well as Val and Lindsay Armstrong, whom some of us had not met before. It was good to see Jacki, and Bev's friend Rota Bishop, even though they had to leave early; we hope to make Rota one of us soon.

Bev's *Room of the Rocks* was greatly admired, stuffed to the rafters with an eclectic collection, mainly from diverse parts of Australia, and including many faceted stones, some of which are the fruits of Bev's own labours. Some of us will be back later to do the display justice. Plates of fruit made their rounds, with local pineapple being a hit; the mood was upbeat and spirits high despite the steamy weather - after all, it could have been much worse had the sun come out.

Above: The pre-barbie nibbles, clockwise from front left: Vic Tarhanoff, Glenys Sinclair, Phil Ericksson, Bob Meyer-Gleaves, Jan Lippold, Cheryl Kanowski, Rota Bishop, back of Russell's head, Val Armstrong and Les Danby; SD photo

The BBQ was fired up, and the real men gathered round it, as they are wont to do. Bob produced a T-bone that was the immediate envy of all carnivores - it would have provided the daily protein allowance for the inhabitants of a small island! A large selection of desserts was in abundance, with Cathy's banana cake and Cheryl's cumquat tarts getting blue ribbons. There was dessert left over, so at least some stomachs were fully distended! Light showers and a breeze provided immediate relief, and made the rest of the proceedings even more pleasant.
After a short interval to facilitate digestion, the auction geared up. The number of items was relatively small, but the overall quality was high. Steve took on the role of auctioneer, ably assisted by Tony as the keeper of records (and subsequently, as the collector of cash). Items ranged from specimens, through brain food (mineral related books and periodicals), plants, a calendar, a handsome mineral poster, a framed set of mineral stamps and an old beam balance, complete with a set of counterweights. These latter items brought back memories to those of us that actually used such balances at school.

The bidding wars were punctuated with pithy comments from the auctioneer, some returned in spades. Further entertainment was provided by Bob, who sat in a semi-comatose state, no doubt focusing all his energies to

digesting said gargantuan T-bone. From time to time, in response to barbed comments from the auctioneer, he would rouse himself to bid and win, only to ink back into his torpor; but it was fun, and in good spirit!

It must be said that many of the specimens were real bargains; all the plants fetched good prices, as did the three volume set of Dana's *System of Mineralogy*. Many thanks to those that donated items, especially to Andy and Eric, who sent items even though they could not attend. (In the highly unlikely event that those who did not donate items were feeling a little guilt, well, you'll know what to do next time).

Only three items did not meet reserve prices, and these have been retained for subsequent sale or placement in the Society's library.

Top picture: Men round the barbie - clockwise from front left: Lloyd Sinclair, back of George Brabon, Tony Forsyth, Michael, Hobbit (pretending to be one of the men), Lindsay Armstrong, and back of Geof Mortensen; SD photo. Above: Auctioneer at work - at left, out of the field of view, were Bev and SueW, as well as Tony and Geof; the table behind Steve has all the items, including bromeliads on pavers; Judy Forsyth photo.

The auction raised $460 for the Society's coffers, the second highest amount in recent memory; it certainly brought a gleam to the eyes of treasurer Phil. Thank you all; we're a relatively small group, and with this fresh infusion of funds, we're managing all right financially. The auction was concluded with a vote of thanks from president Russell to Bev and Geoff.

By now it was 3.40pm, and people continued to socialize, but inevitably had start packing up to leave in dribs and drabs. Once again, out heartfelt thanks to Bev and Geof Mortensen for hosting this thoroughly enjoyable and relaxed end-of-year event, and for all the time and effort it took to set up, and then pack up, especially as the they had to leave early on Sunday morning to southern parts.

Whilst on the subject of BBQs, June 2011 will be the 25th anniversary of the founding of MinSocQ. One option to mark the occasion is to have a formal organized dinner, but these are a pain to organize, are not very flexible, and for a decent feed, cost may be a factor. Another option is a mid-year festive BBQ, possibly in July, since June is a busy month (Joint Seminar in Melbourne etc).

A mid-year BBQ is great in terms of weather, and more conducive to digestion; it would also be more convivial, allowing better mixing and mingling, and would cost much less. It's also been suggested that there might be a modest entry fee, offset with a range of donated prizes to be drawn by our hosts. If we do opt for a BBQ with door prizes, we'll need a venue, and a range of donated prizes; proceeds of course will go to the Society. The management committee, however, is open to alternative suggestions, so put on your thinking caps, and if you have any bright ideas for festivities, please let's hear them early in 2011.

SPECIMEN DONATED TO THE MINERALS HERITAGE MUSEUM

Recently, Tony Forsyth, who is also the honorary curator of the Minerals Heritage Museum, was pleased to receive an email from Craig Bosel in Western Australia. Craig is the Geological Superintendent at Magellan Metals which is near Wiluna on the far north of the Western Australia goldfields region. The Magellan Mine extracts fine grained ore containing cerussite (lead carbonate) for its lead content.

The ore generally doesn't have much in the way of discrete or free-standing crystals, however, recently Craig discovered a small vugh that contained some quite interesting crystallised cerussite. Knowing that this was a discovery worthy of preservation, Craig contacted Tony and offered to donate a 2.2 kg specimen (measuring some 12x10cm) to our Heritage Museum - photo by Tony at right.

The specimen has duly arrived and is a fine example of crystallised cerussite. It has an inclusion or coating that has rendered the colour a charcoal grey, which doesn't detract for the specimen at all. Tony will place the specimen with acknowledgements on display at 61 Mary Street in the near future. We would like to acknowledge the generosity of Magellan Metals and hope that other companies are as enlightened and generous in future.

BITS, PIECES AND TOPICAL ISSUES

Newsletter compatibility Computers are getting faster and more capable, with storage capacities beyond all pervious dreams; at the same time, software is getting progressively more bloated, crammed with features that most of us will never use. However, Adobe Acrobat, the program that makes portable document files, or *.pfd* files, has evolved to version 9.3, and has become more powerful and versatile. In order to utilise these newer capabilities, please upgrade your Adobe Acrobat Reader to at least version 9.1; versions 7.x or older may no longer open future newsletters. Note that Adobe Acrobat Reader is a free download or upgrade.

Doug Ball Many of you may not know that Doug has been at RNS Sydney for a number of weeks; he's had his right shoulder pinned, and has had subsequent radiation therapy. On Saturday 11th December, Doug was flown to Glen Innes, and is now at home in Deepwater for the Christmas-New Year break. He is doing as well as can be expected, and pain is more or less under control. Doug sends his regards to us all, and we in return wish Doug and Lesley all the very best, and Season's Greetings.

Miners in the news 33 men were trapped by a cave-in of the San José copper-gold mine near Copiapó in Chile, on 5th August this year; thankfully, they were all rescued safely by the 14th of October. Did you know that there is a mineral named *copiapite,* named after the locality? It's triclinic, in shades of pearly yellow through yellow to greenish yellow, more commonly various shades of orange to brown; it's a sulfate that forms encrustations and coatings, rarely in minute crystals, with a hardness of around 2.7; formula $Fe^{2+}(Fe^{3+})_4(SO_4)_6(OH)_2 \bullet 20H_2O$.

On a much sadder note, we all know of the tragic death of 29 miners in the Pike River Mine on the South Island of NZ. To their families and friends, we express our heartfelt sorrow and sympathies.

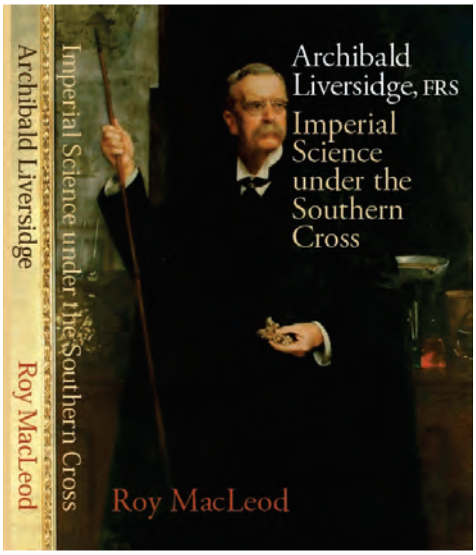
Theo has submitted another of his sublime literary snippets, this time from *Ariel's Song* in *The Tempest* by Wm. Shakespeare, and your editor offers this bit of doggerel in counterpoint:

Full fathom five thy father lies;
Of his bones are coral made;
Those are pearls that were his eyes;
Nothing of him that doth fade
But doth suffer a sea-change
Into something rich and strange

A collector we all know as Hobbit
Has a quaint and puzzling habit;
In the field .. near a crystal of phillippsite fine,
She'll exclaim .. 'A zeolite, it's simply divine!'
... And the Hobbit will reach out and grab it.

BRAIN FOOD

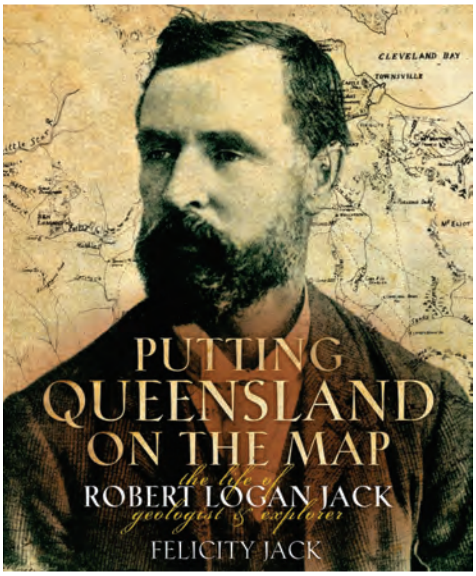
Eric Stevens has previously submitted articles on Archibald Liversidge (v53) and Robert Logan Jack, (v54) and to follow, Eric has prepared two book reviews focused on these mineralogical and geological 'greats'.



Archibald Liversidge FRS: Imperial Science under the Southern Cross MacLeod, R; Royal Soc. NSW, Sydney, 2009, 637pp., 170x 240mm, soft cover, illustrated b&w, plus CD ROM; Price $50 (approx.)

It has taken almost a century for this biography of one of Australia's greatest mineralogical chemists to be published. It is a rather large volume and well illustrated covering his initial mining and chemistry studies in England through to his work in Australia and final return to his homeland. He set up the School of Chemistry at Sydney University and was heavily involved in education and the Royal Society, both in London and Sydney. In all he produced 120 papers in multi disciplines plus 22 Government Reports.

His early analyses and reports on Australian mineralogy were pioneering and outstanding. I highly recommend it to those mineralogy followers who wish to scratch beneath the surface of their interest – after all mineralogy is another form of chemistry in its natural state.



Putting Queensland on the Map - The life of geologist & explorer Robert Logan Jack Jack, Felicity; Uni. New South Wales Press Ltd, Sydney, 2008, 275pp., 230x280mm, illustrated b&w, plus CD ROM, Price $59.95.

This long overdue book contains fascinating reading about the life of Queensland's and arguably Australia's greatest colonial geologist. It depicts his full life from childhood and English studies to his Australian operations through to Korea and China and his return to England and his ultimate return to this country.

This man was the vanguard for most of the development of Queensland in the 1900's that included railways, base metal and coal mining, the Great Artesian Bore and much exploration and surveying amongst the many facets of his outstanding career. The book details the magnitude of his contributions to Queensland and Australia over a quarter of a century.

I would suggest that this biography should be read by anyone interested in the economic mineralogy and general beginnings of this State. If I may be so bold, maybe I could suggest that the Society give consideration to purchasing the book, not only as a statement but also for the use by members.

Theo Kloprogge has been busy compiling articles for our newsletter. The first article below is longer than usual, but is fascinating nonetheless. Reading it will prevent brain death over the Christmas - New Year festivities. Well worth the effort, especially if you are a systematic collector, or are interested in the evolution of mineralogy; *Ed.*

92 ELEMENTS - BUILDING BLOCKS FOR 4,500 MINERALS

A mineral is a crystalline array of one or more elements, formed as the result of a variety of geological and geochemical processes. There are 92 'natural' elements to choose from. (In this article, % means percentage by mass or weight, and crust refers to the earth's crust).

Of the elements, some, for example gold, silver, copper and iron, have been known for more than 2,000 years. But most elements were discovered fairly recently. The element phosphorus was discovered in 1669 by a German alchemist Hennig Brand. It would take until around 1735 before another element, platinum, was added to the list. From then on new elements were discovered in the crust on a regular basis. The last-found natural element was protactinium, discovered in 1913, number 91 in the periodic table of the elements,.

Historically, many scientists have tried to create some form of order amongst the then-known compounds. Avicenna, a Persian doctor in the 11th century, divided all known minerals into 4 groups: stones and earths, flammable and sulphur-containing minerals, salts and metals. In 1863 John Alexander Reina Newlands, a British chemist, established the first periodic system. He placed 56 elements in 11 groups. In 1865 Newlands published his table as *'The law of the octaves'* because he had discovered that, after ordering the elements with increasing atomic mass, certain properties were repeated every 8 elements, hence *periodic* system.

The Russian chemist Professor Dmitri Ivanovich Mendeleev ordered the 63 then-known elements into a table in 1869, and progressively refined it till 1871, on the basis of atomic masses and similar chemical behaviour. Mendeleev left open places in his table for elements that were not then known, but that should exist. Later discoveries of new elements confirmed his predictions. The new elements did indeed fit into the open places in his table, which we now know as the periodic table. (See image at left)

So many elements, not enough minerals?

The 92 elements occur in very different quantities or concentrations on earth, from very large, such as oxygen (almost half of the mass of the crust) to extremely small, such as astatine (estimated at 44 milligrams in the entire crust). A limited number of minerals consist essentially of only one element (for example diamond, and some gold, silver, copper and platinum - but of course alloys of these metals are more common, such as the silver-gold alloy electrum). Most minerals generally comprise a combination of two or more elements.

The number of theoretically possible combinations of these 92 elements can be calculated. Mathematically, there are a few thousand combinations possible for just 2 elements, around a hundred thousand for 3 elements, and several million combinations for 4 or 5 elements. Some minerals even comprise 10 or more elements. Still, there are only about 4,500 minerals. Why are there so few combinations of these 90 odd elements? There are several reasons for this.

1) There are 14 elements that do not participate in the possible combinations: two elements are not stable (Tc and Pm), six elements are extremely rare (Po, Ra, At, Fr, Ac, Pa) and the six noble gases (He, Ne, Ar, Kr, Xe, Rn) do not form any stable bonds with any other element. This reduces the number of possible 'participants' from 92 to 78.
2) Yttrium and the 14 stable lanthanides (the *Rare Earth Elements*, such as lanthanum, cerium and europium) generally behave as a single 'block' of elements; they are always found together in minerals, be it in varying ratios. This means that the number of possible participants has now decreased from 78 to 63.
3) About 10 elements (for example Ga, Hf, Rb) are only found widely dispersed (see text further down). They occur as trace elements in the presence of other elements with similar chemical behaviour that are present in much larger quantities. They are almost never concentrated enough to form their 'own' minerals. This brings the number of possible participants down to 53.
4) A large number of combinations of the 53 elements left over are simply not possible, because two negative or two positive ions cannot bond together, (similar charges repel), or because certain combinations are not stable under natural conditions.

5) Finally there are 8 elements that occur in such large quantities in the crust (together they form 98.5% of its mass), that they strongly limit the number of possible combinations. Quartz and the silicates rule the crust! The other 45 elements do not come to the foreground in specific minerals, unless one or more of the 8 elements are absent in a certain geological or geochemical setting.

In conclusion, we must be happy that there are currently about 4,500 minerals, and every year, despite everything, we find about another 50 new ones.

Dispersed elements

Some elements are not really rare, but they rarely form their 'own' minerals, because their chemical properties too closely resemble those of other elements that occur in much larger quantities in the crust. They are found in a dispersed state in minerals formed from the more abundant elements. For example gallium, or Ga, element 31, comprises 0.002% of the crust. Gallium only forms 4 specific minerals in which it is sufficiently concentrated to be called a 'gallium mineral' (gallite, gallobeudantite, tsumgallite and söhngeite), because the ion size and general chemical properties are almost identical to that of aluminium (Al, element 13, 8.1% of the crust). So gallium is virtually always found as a trace element, taking the place of aluminium in the crystal lattice normally occupied by Al, in aluminous minerals. This is nothing more than an example of limited 'solid-solution'. Gallium can be found as a principal component of a mineral only under conditions where no Al is present.

Other examples of dispersed elements

Rubidium (Rb, element 37, 0.009% of the crust) forms only one mineral (rubicline, the rubidium-rich analogue of microcline). Rubidium is found as a trace element in potassic minerals (K, element 19, 2.6% of the crust). Rubidium is chemically too much like potassium, so rubidium simply 'substitutes' for the more abundant potassium.

Hafnium (Hf, element 72, only 0.0003% of the crust) forms only one mineral (hafnon, the hafnium-rich analogue of zircon). It is otherwise found as a trace element substituting for zirconium in zirconium-rich minerals (Zr, element 40, 0.0165% of the crust). Zirconium itself is also a relatively rare element but is about 50 times more concentrated in the crust than hafnium, and does form several minerals of its 'own', principally zircon.

Rare but still important

The reputation of an element is a reflection of its mineralogy and of its importance in our society. When a particular very rare element is nevertheless found in large quantities in a single mineral in a certain geological setting, for example tin in cassiterite (Sn, element 50, only 0.0002% of the crust), associated with certain granites, it will certainly attract attention. It was used in our early history to produce bronze, a copper-tin alloy, and of course it is in industrial use today.

Gold (Au, element 79) comprises 0.0000004% of the crust (the 75th element of the 92 in order of abundance), but it is found in near-pure metal and alloy forms in sediments; gold forms one of the most important and well known elements in our society.

Mercury (Hg, element 80, only 0.000008% of the crust) forms the striking red mineral cinnabar (HgS), which was known in antiquity (from Almaden, Spain). This liquid metal was then already in use for the extraction of gold (through amalgamation). Mercury is much rarer, but still better known than the 15 elements of the so called lanthanides or rare earth elements (elements 57 to 70 + yttrium, element 39), which together form 0.02% of the crust. A number of these elements do deserve a little better recognition though; they are used, for example, in the production of televisions, fluorescent globes and tubes, and high-strength permanent magnets!

Ytterby is a small town near Resarö, in the Stockholm Archipelago, Sweden. In this town, about 20 km east of Stockholm, a feldspar quarry was worked within a large pegmatite body. Most of the rare earth elements were discovered in minerals from this quarry, and the name of the town itself is reflected in four elements.

Yttrium and terbium, were both discovered in 1843 by the Swedish chemist Carl Gustav Mosander. Ytterbium was discovered in 1878 by the Swiss Jean Charles Galissard de Marignac. The Swedes Per Teodor Cleve and Lars Frederik Nilsson discovered erbium, along with holmium and thulium in 1879. Holmium is derived from Holmia, the Latin name for Stockholm, and thulium, from Thule, an ancient name for Scandinavia. Gadolinium, named after the Finnish chemist Johan Gadolin, was also discovered in a mineral from this quarry, as was scandium (not a rare-earth), named after Scandinavia. So, a total of eight elements were discovered in minerals from the Ytterby pegmatite, setting a record. There is a plaque there, in what is now a rteserve, to commemorate these discoveries, preserving the site as unique chemically and mineralogically.

Element name/mineral name

Sometimes minerals were named after an element that is present in that mineral, for example gallite (gallium), germanite (germanium), indite (indium). But the opposite also occurs. The mineral samarskite was named after a Russian mining engineer W.J. von Samarski, who discovered the mineral in a mine in the Urals. The element samarium was discovered in 1879 by P.E. Lecoq de Boisbaudran in the mineral samarskite, hence the name for the element. (Later on it was discovered that 'samarium oxide' actually consisted of two different oxides. In 1901 E.A. Demarçay succeeded in separating the other oxide from the 'samarium oxide'. He called it europium, named after Europe. The mineral strontianite was named after the town Strontian in Scotland where it was found in the lead mines in 1787, and named *strontites* in 1793. The element strontium was isolated and named by Sir Humphry Davy in 1808, and was named after the mineral (and hence also the town).

Boring earth crust?

The earth consists of a core, mantle and crust. For us, the important geological processes occur in the thin crust, on average only 16 km thick. Also, almost all the minerals we know occur in this crust. Only 8 of the 92 elements found on earth account for about 98.5% of the mass of the crust: the individual percentages are:

Oxygen	O	46.6	Calcium	Ca	3.6	**Total**	**98.5 %**
Silicon	Si	27.7	Sodium	Na	2.8	The other 84 elements	1.5 %
Aluminium	Al	8.1	Potassium	K	2.6		
Iron	Fe	5.0	Magnesium	Mg	2.1		

Based on these numbers it is self evident that about 99% of the mass of minerals in the crust are in the form of oxygen containing compounds, and especially those that contain both silicon and oxygen. The next list gives (a rather boring?) mineralogical composition of the earth crust, again in mass %

Plagioclase (Na-Ca feldspar)	39	Olivine	3
Potassium-rich feldspar	12	Magnetite	1.5
Quartz	12	Calcite + aragonite	1.5
Pyroxenes	11	Dolomite	0.5
Amphiboles	5	**Total**	**95.1%**
Micas (muscovite & biotite)	5	The other ~4,500 minerals:	4.9%
Clay minerals (+ chlorite)	4.6		

Elements and their minerals

The table at the end of this article provides a list of the 92 elements, in order of atomic number **A**, with a selection of well or lesser known minerals that contain that particular element. For each element, the listed minerals are in order of how much of that element is present (in % by mass). In brackets are minerals that contain the name of the element. If an element is named after a mineral, then the mineral is printed in bold. Also listed are the number of minerals known to contain that element, based on www.webmineral.com (as at December 2006).

An example: two minerals that contain lead (A = 82 in the periodic table)

Pyromorphite, also known as green lead ore, has the formula $Pb_5(PO_4)_3Cl$. It contains the elements lead (76.38%), chlorine, phosphorus and oxygen. The name green lead ore does not always suit the mineral as it can also be cream, brown or yellow coloured. Crocoite, also known as red lead ore, has the formula $Pb(CrO_4)$. Crocoite consist of the elements lead (64.11%), chromium and oxygen. Because pyromorphite has a higher lead content than crocoite it is named before crocoite in Table 1. The mineral crocoite is much rarer than pyromorphite in the crust.

Which minerals can we still expect? In 1970 the then president of the Commission on New Minerals and Mineral Names, Michael Fleischer, wrote an article on which minerals were not yet discovered, but which, based on well known atomic or ionic substitution ranges, could be expected. Many of his predictions have since been proven to be true. Below are a couple of examples of this 'looking in a crystal bowl' but with enough mineralogical knowledge!

Mineral known in 1970		**substitution**	**expected and found in:**	
Cassiterite	SnO_2	Sn-Ge	argutite	GeO_2 (1980)
Pseudobrookite	Fe_2TiO_5	Fe-Mg	armalcolite	Mg_2TiO_5 (1970)
Avogadrite	KBF_4	K-NH_4	barberiite	NH_4BF_4 (1993)
Stibnite	Sb_2S_3	S-Se	antimonselite	Sb_2Se_3 (1992)
Molybdenite	MoS_2	S-Se	drysdallite	$MoSe_2$ (1973)
Chlorargyrite	AgCl	Ag-Tl	lafossite	TlCl (2003)

But even Fleischer could not control his urge to discover or predict new minerals. Here are some examples of minerals which have not yet been found. There is still a lot to find, fortunately!

Mineral known in 1970		substitution	expected and not yet found
Gillespite	$BaFeSi_4O_{10}$	Fe-Al	$BaAlSi_4O_{10}$
Trevorite	$NiFe_2O_4$	Fe-Al	$NiAl_2O_4$
Larsenite	$PbZnSiO_4$	Zn-Cu	$PbCuSiO_4$
Bromargyrite	AgBr	Ag-Cu	CuBr
Spodumene	$LiAlSi_2O_6$	Al-Fe	$LiFeSi_2O_6$
Bornite	$CuFeS_4$	S-Se	$CuFeSe_4$
Nordenskioldine	$CaSnB_2O_6$	Sn-Ti	$CaTiB_2O6$
Dioptase	$CuSiO_2(OH)_2$	Cu-Zn	$ZnSiO_2(OH)_2$

Is there a limit to the number of minerals?

Earlier in this article I explained why there are only about 4,500 minerals formed from the 92 elements. Still, each year about 50 new minerals are discovered and described. In 1980 Brian and Catherine Skinner asked the question whether this could continue forever or whether there would be an end to it. Almost thirty years later we can conclude that it still continues. What is happening? When James Dwight Dana published his first edition of the *System of Mineralogy* in 1850 there were about 600 known minerals. Michael Fleischer, previously mentioned, claimed that there were about 1950 minerals in 1969 and the Skinners mentioned the existence of 2900 minerals. In the years between 1969 and 1980 there were therefore about 950 new minerals added to the list.

It is difficult to figure out exactly how many minerals there are at any time now. For many minerals named prior to 1959 (the start of the Commission on New Minerals and Mineral Names) the exact status is not always clear. In 2007, it was presumed that there were about 4,200 minerals, in other words an increase of about 1,300 minerals in 27 years, or about 50 per year on average. Will this continue? Probably yes, but nobody knows for certain. In many countries mineralogy has a strongly minimised role in the earth sciences; fewer and fewer institutions are working on systematic mineralogy. However, there are new analytical techniques available that make it possible to characterise smaller and smaller grains. The number of new micro- or even sub-microscopic minerals increases each year. Also research on old museum collections of localities that no longer exist continue to provide new minerals every year.

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Skinner, B.J. and Skinner, C.W. (1980) *Is there a limit to the number of minerals?* Min. Record, 11, 333-335
Fleischer, M. (1970) *Some possible new minerals not yet found.* Min. Record, 1, 121-123
www.mineratlas.com www.webmineral.com www.mindat.org

Table of the 92 elements with a selection of more common or lesser known minerals containing the listed element

A	Symbl.	Name	No. of minerals	Mineral example
1	H	Hydrogen	2578	evenkite, opal, goethite, analcime, (hydroxyl apatite)
2	He	Helium	0	xxxxxx
3	Li	Lithium	111	Griceite, (lithiophyllite), cookeite, spodumene, lepidolite
4	Be	Beryllium	102	Phenakite, chrysoberyl, euclase, (**beryl**)
5	B	Boron	231	Borax, colemanite, (**borax**), datolite, dravite
6	C	Carbon	384	Diamond, graphite, amber, whewellite
7	N	Nitrogen	76	Sal-ammoniac, (niter), boussingaultite, likasite
8	O	Oxygen	3608	Borax, quartz, hubeite, charoite, hematite
9	F	Fluorine	367	Cryolite, (**fluorite**), herderite, topaz
10	Ne	Neon	0	xxxxxx
11	Na	Sodium	903	Halite, sodalite, (natron), natrolite, jadeite, albite
12	Mg	Magnesium	791	Brucite, olivine, spinel, dolomite, (**magnesite**)
13	Al	Aluminium	1035	Corundum, andalusite, kyanite, wavellite, (alunite), grossular
14	Si	Silicon	1323	Quartz, sugilite, orthoclase, barrerite
15	P	Phosphorus	535	Variscite, apatite, turquoise, pyromorphite
16	S	Sulfur	941	(**Sulfur**), pyrrhotite, sphalerite, celestine

A	Symbl.	Name	No. of minerals	Mineral example
17	Cl	Chlorine	315	Halite, sylvite, (chlorargyrite), atacamite, sodalite
18	Ar	Argon	0	xxxxxx
19	K	Potassium	490	Alunite, adularia (orthoclase), biotite, neptunite
20	Ca	Calcium	1251	Fluorite, (calcite), aragonite, anhydrite, pectolite, gypsum
21	Sc	Scandium	11	Kolbeckite, thortveitite, bazzite
22	Ti	Titanium	358	Anatase, brookite, rutile, ilmenite, (titanite)
23	V	Vanadium	189	Mottramite, descloizite, cavansite, (vanadinite)
24	Cr	Chromium	91	(Chromite), uvarovite, crocoite, stichtite
25	Mn	Manganese	646	Hausmannite, (manganite), rhodochrosite, helvite
26	Fe	Iron	1260	Iron (kamacite), magnetite, hematite, goethite, (ferro-axinite)
27	Co	Cobalt	81	Erythrite, skutterudite, siegenite, wendwilsonite
28	Ni	Nickel	176	Nickel (Ni-Fe meteorite), (**Nickeline**), gaspeite
29	Cu	Copper	584	Copper, chalcocite, betekhtenite, malachite, (cuprite)
30	Zn	Zinc	284	Sphalerite, smithsonite, aurichalcite, (zincite)
31	Ga	Gallium	9	Söhngeite, gallite
32	Ge	Germanium	28	Briartite, stottite, schaurteite, (germanite), renierite, argyrodite
33	As	Arsenic	523	Arsenic, skutterudite, realgar, scorodite, conichalcite
34	Se	Selenium	117	Selenium, krutaite, chalcomenite, paraguanajuatite
35	Br	Bromine	17	(Bromargyrite), embolite, murdochite, comancheite
36	Kr	Krypton	0	xxxxxx
37	Rb	Rubidium	6	Rublicline
38	Sr	Strontium	172	(**Strontianite**), celestine, welagonite, kalipyrochlore
39	Y	Yttrium	131	Bastnäsite, xenotime, allanite, goudeyite
40	Zr	Zirconium	113	Baddeleyite, (zircon), catapleiite, eudialyite, welagonite
41	Nb	Niobium	189	Lueshite, ferrocolumbite, kalipyrochlore
42	Mo	Molybdenum	42	(Molybdenite), powellite, wulfenite, ferromolybdite
43	Tc	Technetium	0	xxxxxx
44	Ru	Ruthenium	13	Laurite
45	Rh	Rhodium	19	rhodium, kashinite
46	Pd	Palladium	66	Palladium, potarite, palladium rich gold
47	Ag	Silver	156	Silver, acanthite, dyscrasite, proustite, sylvanite
48	Cd	Cadmium	20	Greenockite, hawleyite, otavite, (cadmoselite)
49	In	Indium	11	Dzhalindite, roquesite, yanomanite, sakuraite
50	Sn	Tin	101	Cassiterite, stannite, cylindrite, asbecasite
51	Sb	Antimony	249	Antimony, (stibnite), stibiconite, kermesite, zinkenite
52	Te	Tellurium	145	Tellurium, (tellurite), sylvanite, calaverite, krennerite, hessite
53	I	Iodine	25	Marshite, miersite, (iodargyrite), moschelite
54	Xe	Xenon	0	xxxxxx
55	Cs	Cesium	20	Pollucite, margaritasite, londonite, rhodizite
56	Ba	Barium	257	Witherite, (barite), barytocalcite, edingtonite, harmotome
57	La	Lanthanum	130	Bastnäsite, (lanthanite), monazite, chevkinite, agardite, davidite
58	Ce	Cerium	206	(Cerite), gasparite, monazite, euxenite, allanite
59	Pr	Praseodymium	50	Calcioburbankite, hellandite
60	Nd	Neodymium	99	Agardite, parisite, florencite-(Nd)
61	Pm	Promethium	0	xxxxxx
62	Sm	Samarium	48	(samarskite), monazite
63	Eu	Europium	30	Hellandite, trimounsite-(Y), agardite
64	Gd	Gadolinium	45	Lepersonnite-(Gd), caysichite
65	Tb	Terbium	31	Calciuburbankite, hellandite, trimounsite-(Y)
66	Dy	Dysprosium	41	Calcioburbankite, trimounsite-(Y), hellandite
67	Ho	Holmium	31	Calciuburbankite, hellandite, trimounsite-(Y)
68	Er	Erbium	34	Calcioburbankite, trimounsite-(Y), hellandite
69	Tm	Thulium	29	Calcioburbankite, trimounsite-(Y), hellandite
70	Yb	Ytterbium	35	Xenotime, keiviite-(Yb), hingganite-(Yb), hellandite
71	Lu	Lutetium	29	Calcioburbankite, trimounsite-(Y), hellandite
72	Hf	Hafnium	6	(Hafnon)
73	Ta	Tantalum	88	Microlite, plumbomicrolite, betafite, euxenite-(Y)
74	W	Tungsten	45	Scheelite, hübnerite, ferberite, stolzite
75	Re	Rhenium	3	Rheniite
76	Os	Osmium	9	(Osmium), osarsite, omeiite, iridium, hexaferrum, anduoite
77	Ir	Iridium	22	Mercury, terlinguaite, cinnabar, calomel, mosesite, amalgam
78	Pt	Platinum	47	(**Platinum**), sperrylite, rustenburgite

A	Symbl.	Name	No. of minerals	Mineral example
79	Au	Gold	33	Gold, calaverite, krennerite, petzite, nagyagite
80	Hg	Mercury	92	Mercury, terlinguaite, cinnabar, calomel, mosesite, amalgam
81	Th	Thallium	48	lorandite, imhofite, hutchinsonite, rathite
82	Pb	Lead	476	Lead, galena, cerussite, pyromorphite, descloizite, crocoite
83	Bi	Bismuth	210	(**Bismuth**), bismite, bismuthinite, emplectite, krupkaite
84	Po	Polonium	0	xxxxxx
85	At	Astatine	0	xxxxxx
86	Rn	Radon	0	xxxxxx
87	Fr	Francium	0	xxxxxx
88	Ra	Radium	0	xxxxxx
89	Ac	Actinium	0	xxxxxx
90	Th	Thorium	57	(thorianite), thorite, monazite-(Ce)
91	Pa	Protactinium	0	xxxxxx
92	U	Uranium	234	(uraninite), curite, autunite, torbernite, haiweeite, betafite

MINERALISATION OF SULFIDES THROUGH BACTERIA

Theo Kloprogge

Organisms are sometimes fossilised as sulfides, such as those made up of pyrite or marcasite. How that happens has, at least for certain situations, become a little more clear through the research of Ellsi Maginn and Rachael Mills (University of Southampton) and Crispin Little and Richard Herrington (Natural History Museum, London). They studied the tubes of a polychaete worm (*Alvinella pompejana*) that lives on midoceanic ridges as part of the strange communities that live around undersea volcanoes and hydrothermal vents. The sulfides mineralised tubes of comparable worms, although rare, are known from our geological past.

In the tubes that the studied worm makes to live in, iron sulfides have already formed. This happens through the micro-organisms present on the inside of the tube making a form of coating using very small (10 to 100 micron) particles of iron- and zinc-sulfides from the upwelling hot water. These particles are incapsulated in the tube because the worm sometimes makes new organic layers. Over time a tube is formed with a sequence of organic layers formed by the worm itself and sulfide-rich interlayers formed by the microbes.

This process goes through a number of intermediate phases in which first mackinawite and greigite are formed. Only at the end is pyrite formed. Later, some of the pyritised organic layers can be transformed into marcasite. Throughout all these processes the original structure of the organic layers is preserved, because in the intermediate steps the monosulfides completely encapsulate the cell walls. Because of this the original microscopic details can be studied, which will result in a better understanding how fossilised worms from our geological past built their tubes.

Maginn, E.J., Little, C.T.S., Herrington, R.J. & Mills, R.A., 2002. *Sulphide mineralisation in the deep sea hydrothermal vent polychaete, Alvinella pompejana: implications for fossil preservation.* Marine Geology 181, 337-356.

IS CLAY THE ANSWER FOR HYDROGEN STORAGE?

Theo Kloprogge

A strong new material that is hydrogen leakage free has been developed at the National Institute of Advanced Industrial Science and Technology in Japan in collaboration with the Kyushu Institute of Technology and the Tsuyama National College of Technology.

Thin clay layers were stacked with carbon fibre reinforced polymer sheets and subsequenly treated at high temperature under high pressure. The material is supposed to have a long life span and would be suitable for hydrogen storage tanks not only for cars but also for aviation and space travel.

Source: American Ceramic Society Bulletin, vol. 87 no. 8.

NEW POLYMORPHS OF SiO_2 POSSIBLE ON OTHER PLANETS

Theo Kloprogge

Silicon dioxide (SiO_2) occurs in a number of polymorphs. Under 'normal' conditions this is low- or alpha quartz (alpha), the second most common mineral in the earth's crust. With increasing pressure, however, SiO_2 changes to other polymorphs. It is well known that stishovite, with a crystal structure similar to that of rutile, is formed under extreme conditions (at pressures higher than 10 Gpa), which occur during the impact of meteorites. At a pressure of 70 GPa (gigapascals) and a temperature of about 1325ºC this polymorph changes to another polymorph with a crystal structure similar to $CaCl_2$ (calcium chloride), and this polymorph transforms again to another polymorph with a crystal structure similar to that of alpha-PbO_2 (a form of lead oxide) at 121 GPa and about 2100ºC. Experiments have shown that even more polymorphs of SiO_2 can exist.

Some of these polymorphs can be expected to occur in deeper parts of the earth, in particular the mantle where both temperature and pressure are high. In the core one would not expect any minerals with a composition of SiO_2, since the outer core is molten and the inner core consists almost entirely of metals (mainly iron). Our solar system contains much larger planets, such as Uranus and Neptune, with a surface that consists mainly of ice masses, but for which the core according to theoretical calculations probably consists of igneous rocks. In both planets a pressure of about 800 Gpa (8 million atmospheres) must exist in their cores and under these conditions SiO_2 will not exist in the form of quartz but in another polymorph of SiO_2.

Japanese researchers have conducted experiments showing that a pressure above 268 GPa and a temperature of 1425ºC a stable polymorph of SiO_2 crystallises with a crystal structure similar to that of pyrite (FeS_2). This polymorph has a higher density than any other known silicate, the density is even 5% higher than that of the polymorph with the crystal structure similar to alpha-PbO_2.

The reason behind all these changes, and in particular the increasing density with increasing temperature and pressure, is related to the ability of silicon atoms forming bonds with other atoms. These covalent bonds comprise pairs of shared electrons, with each atom contributing one electron to each pair. At 'normal' pressure and temperature the electrons of silicon can form 4 bonds with other electrons. The electrons of oxygen atoms can form 2 bonds. Therefore one silicon atom can be bound to 2 oxygen atoms, via four pairs of shared electrons, or four bonds - hence SiO_2.

Under temperature and pressure conditions where stishovite is formed silicon has 2 more electrons available for bonding (so 6 in total) - so in the SiO_2 polymorph with the alpha-PbO_2 structure, the silicon atoms can form 6 bonds. At the high temperatures and pressures where the SiO_2 polymorph with the pyrite structure is formed, the silicon atom has another 2 electrons available for bonding (so now we have a total of 8 electrons available). This results in a crystal structure in which the oxygen atoms form the corners of octahedra with a silicon atom in the centre, with 6 of the silicon electrons forming bonds with the six oxygen atoms at the corners of one octahedron and 2 with those of two oxygen atoms of neighbouring octahedra.

The researchers state that this structure is probably not only stable in the cores of the large planets of our solar system, but also, since silicon dioxide is also one of the most common oxides outside our solar system, exists as a mineral outside our solar system.

Kuwayam, Y., Hirose, K., Sata, N. and Ohisi, Y. 2005) *The pyrite-type high-pressure form of silica.* Science 309, 923-925

Theo has also compiled a topical mineralogical crossword puzzle. Answers range from the simple to sublime, to the arcane - keep the brain active, and have a go!

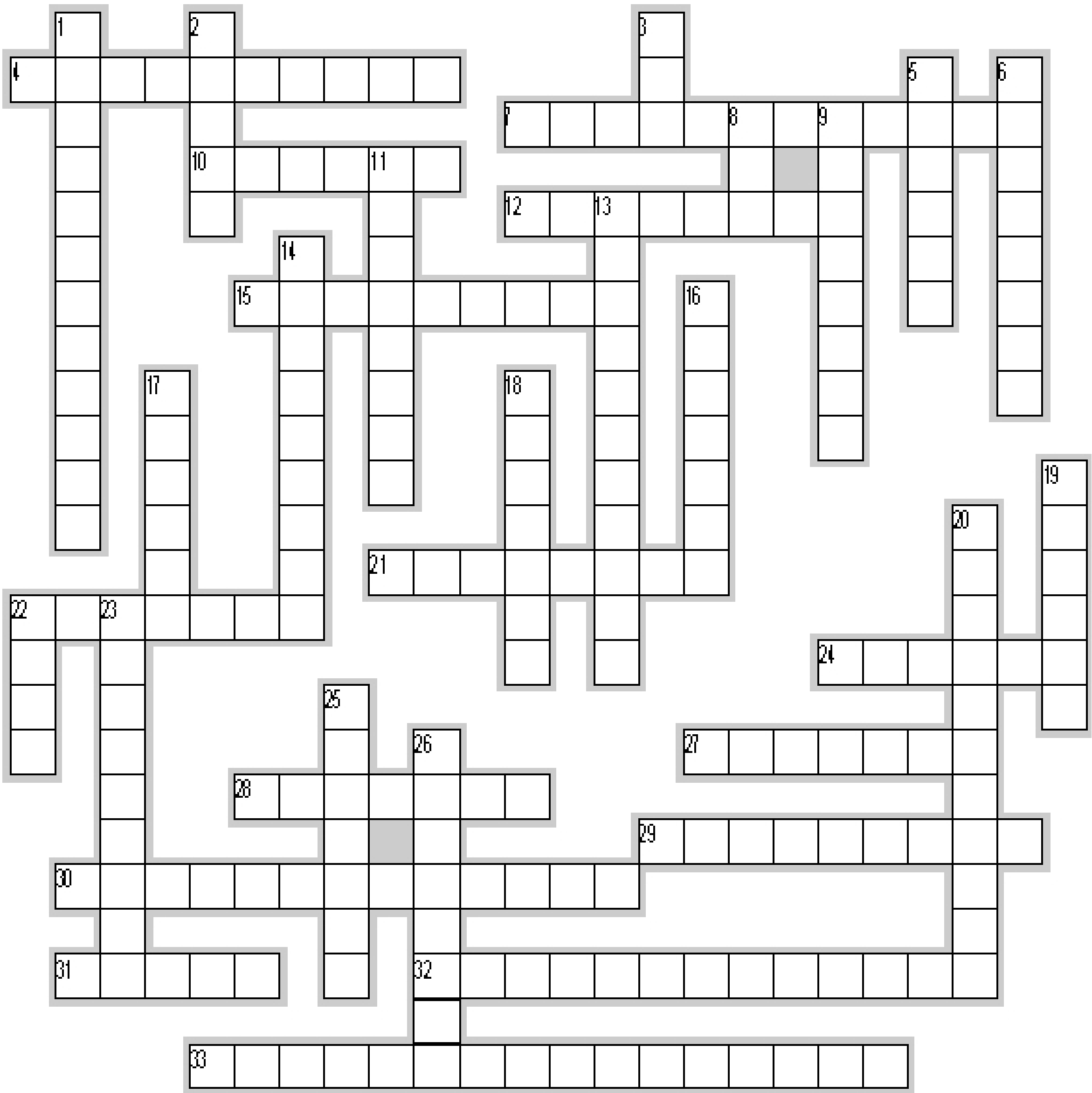
Across

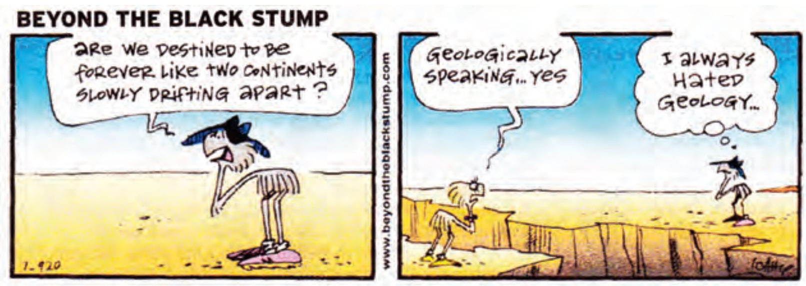
4. monoclinic dimorph of microcline
7. mineral of the cancrinite group, name based on Latin and relation to other mineral in this group
10. an end-member mineral of the plagioclase series
12. old name for kyanite referring to two distinctly different hardnesses
15. blue coloured phyllosilicate, containing vanadium
21. the cubic or isometric calcium difluoride
22. variety name of actinolite pseudomorph after pyroxene
24. nickname for Sue Ericksson
27. old name for stibnite
28. called the 'TV rock' or 'television stone' for its ability to transmit images through natural fibers
29. colourless variety of beryl
30. mineral named after locality Xiangjiang River, Hunan, China
31. an orthorhombic beryllium mineral with hardness of 8.5
32. ammonium feldspar
33. natural alloy, formula Pt_3Fe

Down

1. CrO(OH), member of diaspore group
2. Theo's favorite mineral, orthorhombic, hardness of 8

3. general term for soft, massive, manganese oxides
5. officially accepted mineral name for alabaster
6. group of minerals collected around Brisbane
8. liquid at room temperature, but crystallizes at 0° degrees Celsius, if pure
9. purple variety of quartz
11. sphene
13. Mn end-member of the garnet group
14. common secondary copper mineral
16. variety of spodumene, light pink to mauve
17. black variety of tourmaline
18. hardest mineral
19. Ron Young's favorite mineral
20. hydrated iron oxalate
22. organic mineral containing NH_2 groups
23. the old name is *flos ferri*, present in certain iron ore deposits
25. polymorph of quartz
26. mercury sulphide





To finish for 2010, geology is rarely depicted in cartoons. So here is one whimsical and clever offering from the Courier Mail, with thanks to Sean Leahy for permission to reproduce.