Mineralogical Society of Western Australia Inc.

To encourage mineralogical study by amateur and professional alike and, in so doing, discover, document and preserve the Earth's, and in particular Western Australia's, natural history.

NEWSLETTER 107
June 2024

CONTENTS

EDITORIAL

Welcome to the 107th issue newsletter for the second quarter 2024.

Since the last Newsletter, we had an interesting talk in March on rubies in Greenland. This was followed in May with a talk on that fascinating place south of us – Antarctica.

Some members attended the National Gem and Mineral Show Gemboree in April.

A number of us stretched our brains at the quiz night in June.

It's a bumper Newsletter this quarter with excellent extra interesting bits and pieces. Enjoy the read.

Wendy H
Newsletter Editor

THE GONIOMETER

EARLY MINERALOGICAL TECHNIQUES and SOME BACKGROUND

By Susan Stocklmayer

If you research "*goniometer*" on the web, many of the sites may surprise you by referring to a gadget used by physiotherapists to measure joint angles of the human body. However, goniometry and the instruments originally developed for use in crystallography have an otherwise history of over two hundred years.

Goniometers were developed originally to measure the angles between crystal faces and surfaces to assess the geometry of their forms.

By the late seventeenth century it was realized that crystals had consistent geometric development; Nicolaus Steno (né Niels Steensen, Danish scientist) who was studying quartz crystals, described measurements he made by tracing their outline on paper (transverse sections of the prismatic zone) and demonstrated that analogous angles of the different sections of quartz, although varying in size and shape, were always the same. The quote "*non mutates angulis*" [1] attributed to Steno references this study and its conclusions. More than a hundred years later, in the late eighteenth century, Steno's work was confirmed by French mineralogist, Jean-Baptiste Louis Romé de I'Isle. The *'law of constancy of angle'*, as it is known, states that in all crystals of the same substance, the angles between corresponding faces have a constant value [1].

Arnould Carangeot, who worked as an assistant to Romé de I'Isle, is credited as the inventor of the earliest type of crystal measuring device, termed a "contact goniometer".

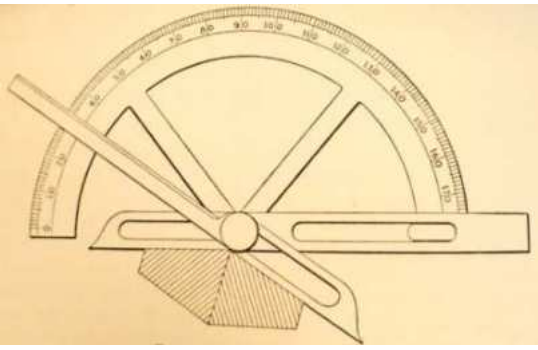


Diagram of a contact goniometer. Shown with two faces of a crystal between and contacting two moveable arms of the protractor device. The degrees shown on the protractor are those of the supplement of the solid angle – termed the interfacial angle.
Diagram from F.C. Phillips [2].

Geology students at university may recall using a contact goniometer. This simple protractor device is compact and inexpensive and continues to be used by amateur mineralogy enthusiasts, the advantages being its simplicity to produce approximate angular measurements.

In 1809, William Hyde Wollaston, (1766 to 1828, English scientist) produced the first description of a "reflecting goniometer" [3]; this instrument as shown below and many models of similar designs, are all eponymously named- Wollaston-type goniometers.

Table model Vertical one-circle Wollaston reflecting goniometer, manufactured by Troughton and Simms, London, about 1890. Dimensions: 25 × 14.5 × 19.5 cm. Images - S. Stocklmayer.

Reflecting goniometers have a greater accuracy than contact models. They return a target image (signal) from successive crystal faces rotating in the light beam and the angular readings between these on the crystal faces in a zone are measured.

The instrument shown above is a one circle vertical reflecting goniometer and has the following working parts: a horizontal bar forms a stand with levelling screw feet and mounted with an adjustable rectangular black glass mirror, a raised adjustable stirrup or cradle on which a crystal can be mounted which has several screws to adjust the position of the crystal under test and, a pair of vertically positioned brass and blackened brass circular plates, of which one is rotatable and graduated to 360 degrees in arc minutes, and one is non-rotatable and marked with a Vernier scale. Readings can be made to minutes and half minutes. The crystal under test is affixed by any cementing material, formally beeswax or pitch, on the moveable spindle and adjusted so that the common edge of a pair of faces is set into a position horizontal to the axis of the rotatable graduated circle.

A notable disadvantage of the one-circle instrument is that only the angles of one crystal zone can be measured, after which the crystal has to be dismounted and reset in another zone position, thus requiring a repeat of all the fine adjustments to position it in a new axial position.

In use, the Wollaston goniometer would have been placed opposite to a distant (about 4 m) light source, such as a window, with the viewer's eye positioned quite close to the mounted crystal. Readings of the image signal are taken on the degree circle and the crystal then rotated so that the signal images between a pair of adjacent faces with a common edge are measured. The difference between the pair of readings of the signal image gives the interfacial angle.

This model of goniometer and the method of operation [4] is demonstrated at: https://physicsmuseum.uq.edu.au/wollaston-goniometer This site shows the same model of the Wollaston-type goniometer as the images above.

Through the following century, goniometers were produced as more complicated models with horizontal and vertical degree circles and many additional refinements including collimator lighting (in which lenses concentrate the beam), and telescope magnification. Adaptations to make it easier to perform multiple readings on a crystal in different directions require a "two-circle theodolite goniometer". The workings of this handsome device are demonstrated by Ross Pogson, Collections Manager at the Australian Museum, on an informative YouTube™ short film at https://www.youtube.com/watch?v=OBx-9UPOnmc [5]

Of mineralogical interest is that both Steno and Wollaston have minerals named in their honour; Stenonite ($Sr_2 Al (CO_3) F_5$) is a white carbonate-fluoride, discovered in Greenland and named for Nicolaus Steno, discoverer of the law of constancy of interfacial angles [6]. Wollastonite, a white calcium silicate ($Ca_3(Si_3O_9)$) was named in 1818 by J. Léman in honour of William Hyde Wollaston, English chemist and mineralogist who discovered palladium (1804) and rhodium (1809), and invented the reflecting goniometer (1809) and the camera lucida (1812) [7]. William Phillips, author of a self-published mineralogical textbook published in 1823, who proved the accuracy of Wollaston's designed goniometer, considered the mineral attribution as 'unworthy' of the scientist. Wollastonite at its type locality at Capo de Bove, near Rome, was "too yielding, and that the attribution to Wollaston should be abandoned [8]. In spite of Phillips' opinion, the mineral attribution to Wollaston has remained in the records.

Precision goniometers, the two and three-circle models, were used routinely and had a major role in mineralogy and crystallography studies in the later 19th and early 20th centuries and continue to have a role in some specialized studies.

Many of the mineral identification scientific papers in which goniometers were used make interesting reading. For example, a paper authored by Dr Herbert Smith, working in the early 20th century, at the British Museum, describes his identification of small crystals of paratacamite ($Cu_3(Cu, Zn)\ Cl_2(OH)_6$) an unknown copper mineral from Chile stored in the collection. The crystallography data recorded the measurements of 43 small crystals (some about 2 mm in size) of this unknown mineral which were compared with those of atacamite, using a three-circle model goniometer which Smith himself invented [9]. Smith was recognised during his working life for his prodigious mineral studies. He received the honour of having two minerals named in attribution: smithite ($AgAsS_2$), a red coloured silver arsenical sulphide mineral, first described from Switzerland [10] and herbertsmithite, ($Cu_3Zn(OH)_6\,Cl_2$) a green copper mineral from Chile [11].

In a 2012 gemmological study, the inter-facet angles of fashioned unmounted diamonds were measured using a two-circle classic goniometer, made in about 1920, to produce a standard master set of diamonds. The results demonstrated greater precision of this instrument compared to a non-contact optical scanner generally used for this task [12].

Modern manufactured goniometer instruments are used for the precision positioning of crystals for optical and X-ray diffraction techniques.

The techniques of mineral determination that had relied on manual methods of studying the geometry of crystals and determining refractive indices of grains are now rarely taught at university. However, there is an enthusiastic following of those who continue to use these time-honoured and time-consuming techniques. Antique and archaic instruments are appreciated by collectors for their workmanship, their ingenuity of design and value.

References:

1. Menchetti S, 2021. How do Crystals Grow? Steno's Approach, *Dipartimento di Scienze della Terra, Università di Firenze, Italy. (http://www.fupress.com/substantia)*
2. Phillips FC 1962. An introduction to crystallography. Longmans printed by Robert Maclehose and Co., The University Press, Glasgow, 324p.
3. Wollaston WH, 1809. Description of a Reflective Goniometer Source: Philosophical Transactions of the Royal Society of London, 1809, v. 99 (1809), p. 253–258 Published by: Royal Society Stable URL: https://www.jstor.org/stable/107265 (accessed January 2024).
4. How a goniometer is used https://physicsmuseum.uq.edu.au/wollaston-goniometer
5. Australian Museum, Sydney. Ross Pogson demonstrating a two-circle goniometer https://www.youtube.com/watch?v=OBx-9UPOnmc
6. stenonite - https://www.mindat.org/min-3762.htmlnoite
7. wollastonite - https://www.mindat.org/min-4323.html
8. Phillips, W 1823. An elementary introduction to the knowledge of Mineralogy. 3rd Ed. Privately printed by W. Phillips, George Yard, Lombard Street, London. 406pp [extract -page 211]
9. Smith H, 1906. Paratacamite, a new oxychloride of copper*.: Mineralogical Magazine*, v. 14(65), p. 170–177.
10. Solly RH, 1905. Some new minerals from the Binnenthal, Switzerland: *Mineralogical Magazine*, v. 14, p. 72–82.
11. https://www.mindat.org/min-26600.html. Herbertsmithite. Accessed March 2024
12. Shen AH, Bassett WA, Skalwold EA, Fan NJ and Tao, Y 2012. Precision measurement of inter-faces angles on faceted gems, using a goniometer: *Gems and Gemology*, v. 48(1), p. 32–44.

MARCH 2024 TALK

The Aappaluttoq Ruby Deposit, Southwest Greenland
Reviewed by Neils Dahl

At our March meeting we enjoyed hearing about the Aappaluttoq Ruby Deposit in Southwest Greenland by a virtual meeting with Léonard Cornuz from Switzerland. Léonard is a friend of our Nicholas Hébert, and thank you to Nic for organising this opportunity to hear about a rare mining venture, the only ruby mining in Greenland.

Léonard (M.Sc.) graduated from Lausanne University, Switzerland, and later added two diplomas in gemmology after some time working at Malmberget Iron Ore Mine in Northern Sweden. After Malmberget he joined a mining venture in Greenland for two years, which mined and explored for rubies. Léonard worked as an exploration geologist, only Greenlanders are allowed to undertake the mining.

Rubies (red) and sapphires (blue) are corundum minerals which may also be colourless or have yellow or green hues. Corundum, number 9 in Mohs' hardness scale, has the formula Al_2O_3, it is trigonal, prismatic with short prisms and are commonly barrel-shaped in nature. Lamellar twinning is common and it may show parting along twin planes. Rubies owe their colour to traces of chromium, sapphires have traces of iron and titanium +/- vanadium. Vanadium gives the mineral a greenish hue. At Aappaluttoq the rubies may have inclusions of rutile and pargasite.

Corundum crystal rotating on the fabric (block 208-8).

Corundum, fuchsite, kyanite, tschermakite (?) (block 193-1).

Corundum with colorless core in a massive feldspar vein (block 193-1).

Photos by Léonard Cornuz

Rubies form from fluids that develop silica deficiency, so minerals other than silicates can develop when the fluids solidify. The rubies at Aappaluttoq formed by pegmatitic fluids intruding a more than 200km long shear zone which extends from the Greenland ice cap to Labrador in Canada. Rubies have been located in pods formed by metasomatic reactions with the host rocks along its known entirety. At Aappaluttoq, two parallel subzones carrying rubies have been recognised, Ruby Island Line and Ruby Island Line East. Aappaluttoq Ruby Deposit lies on the Ruby Island Line. In the mine, pinch and swell structures are exposed carrying the mineralization in two shear structures 15 m apart. The mineralization can reach a depth of 200 m but has been mined to only 36 m depth (December 2022). Planned maximum size of the pit is at the moment 70 m (depth) x 215 m (length) x 145 m (width).

At right: Mineralised phlogopite ore with feldspar veins. Photo Léonard Cornuz

Aappaluttoq Ruby Deposit was first recognized in 1966 by the Greenland Geological Survey based in Copenhagen. It was explored intermittently through the following years but was first mined in 2017. Mining stopped in December 2022, perhaps due to Covid. Annual production was 35,000 t ore and 300,000 t waste. About 17,000 t ore was processed per year by heavy medium separation and manual sorting. Some processing is still being done. Tailings were checked four times a day.

The concentrate is sent to Nuuk (formerly Godthåb), the capital of Greenland, for acid treatment and then to Bangkok for heat treatment for clarity, sorting, cutting and polishing before being released to the market by Sales Greenland Ruby A/S (Ltd).

At Aappaluttoq, the shear zone intersects a folded and metamorphosed (up to granulite facies), Archaean, anorthosite complex at Qeqertarsuatsiaat, which has been dated to 2.97 Ga. The anorthosite complex is layered and three horizons towards the centre of the intrusion are of particular interest for the exploration for rubies; a lower leucogabbro, a central gabbro and an upper leucograbbro; because they host the mineralisation. The rubies have been dated to 2.71 Ga making it the oldest known ruby deposit in the world. The rubies formed from a fluid, which in the metagabbro unit at Aappaluttoq, developed phlogopite envelopes to the ruby-bearing paragenesis. The phlogopite-ruby zone is bordered by mica-bearing rocks (biotite?) to the west and sapphirine-gedrite bearing rocks to the east, both of which are barren of rubies. Rubies have also been recognised to be associated with garnet (pyrope-almandine) and amphibole (tschermakite) in the district, and fuchsite, kyanite, calcite and possibly kornerupine were also mentioned to be present. The rubies were developed while the shear zone was still active which is shown by the development of snowball textures in some, and by rubies developing along the refolded foliation of the shear zone.

A link to a video on YouTube with the best part at about 2 minutes onwards:
Rubies from Aappaluttoq, Greenland.
See also:
Cleaning and studying the ruby rich contact zone in block 208-8 at Aappaluttoq in Greenland

MAY 2024 TALK

A Deep Adventure in Antarctica

Reviewed by Neils Dahl

Dr Bruce Groenewald entertained us at our May meeting with recounting his five tours to Dronning (Queen) Maud Land in Antarctica in the 1980s, which he completed for his PhD thesis and further academic work to study the Sverdrupfjella, a line of nunataks trending N-S. Sverdrupfjella means Sverdrup Mountains in Norwegian. This presentation was not about beautiful specimens of minerals for collectors, but about rocks which have undergone extreme pressure and temperature conditions in the crust of our Earth resulting in interesting features and, here and there, also extraordinary mineral parageneses.

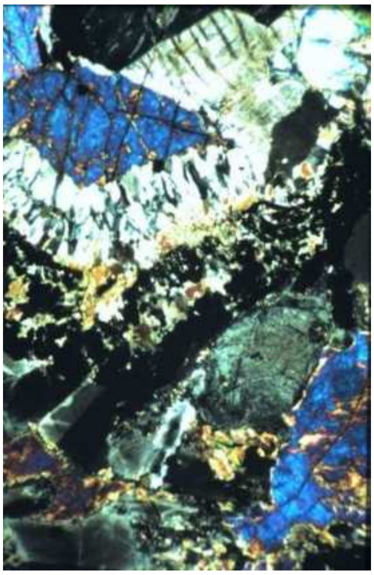
The district of interest in this presentation has mostly Norwegian names due to history. Everybody remembers the race to the South Pole which Amundsen (Norwegian polar explorer) won, but the young Norwegian nation was seriously exploring both Polar Regions at the same time. Due to their efforts in Antarctica, Norway is laying claim to a sizable proportion of this continent. Queen Maud became queen of Norway when Norway obtained independence from Sweden in 1905, and the Sverdrupfjella are named after Harald Ulrik Sverdrup, Norwegian meteorologist, oceanographer and polar explorer. He was born in 1888 and died in 1957. The geographical names were given by a Norwegian-British-Swedish expedition in 1950.

Bruce, being South African, used South Africa's base in Queen Maud Land as a staging post for his work there. He was the first to map Sverdrupfjella. Sverdrupfjella lies approximately 200 km inland from the coast, so he and his field assistant were airlifted by helicopter to the work area and camped there for the duration of the field seasons (6 to 8 weeks) with their skidoo and sledge and supplies of dehydrated foods. We saw wonderful photos of how they managed life there, even some photos of bird life that far from the coast.

Images courtesy of PB Groenewald

Similarly to other continents, the rocks in Antarctica span much of the time of the life of Earth. Annansdagtoppane (Norwegian for the nunataks discovered the second day) has granitic rocks dating back to 3020 Ma. Nunatak means summit peeping through the ice cover in Inuit language. In Bruce's work area, two prominent dates of formation of the lithology are shown by zoned zircons (SHRIMP-dating), 1000-1100 Ma and 500 Ma.

The oldest rocks in Bruce's area are highly metamorphic, migmatitic (mixed), gneisses which are partially remelted rocks that reached granulite facies conditions. Their precursor rocks were sedimentary, volcanic and granitic rocks. Quartz and feldspar constitute almost entirely the new melt, which is called the leucosome (light-coloured phase). Quartz and feldspar are the first minerals to melt in a rock that undergoes pressure and temperature conditions favourable for remelting. This phase veins the gneisses, and Bruce recognised 17 generations of such veining. The darker parts of the gneisses are not considered to be a remelt and contain almost all the Fe-Mg-silicates in the migmatites and these phases are called the melanosome (dark-coloured phase). Commonly, migmatites have undergone more than one deformation phase which is also the case at Sverdrupfjella. At the depths under which crustal rock remelts the pressure is too high for cavities to form in which crystals can develop. Quartz never develops crystal habits in solid rock, and in migmatites other minerals generally do not either.

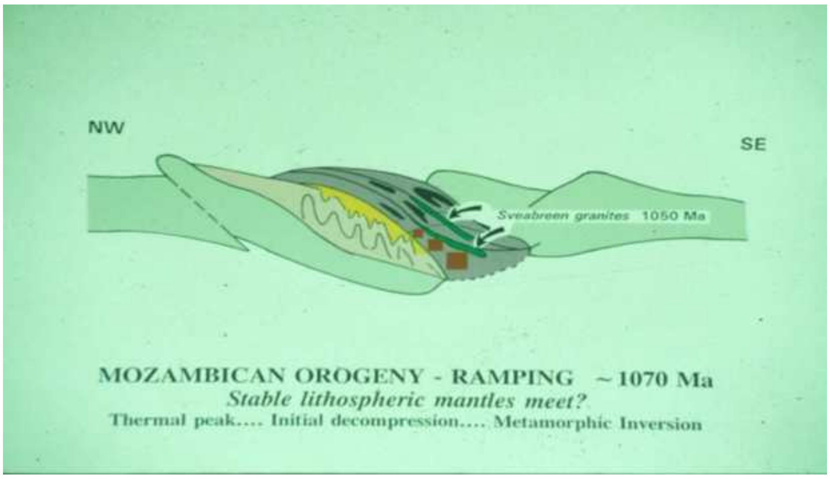


The migmatites locally have remnant inclusions of mafic/ultramafic rocks, witnessing this part of the crust was intruded by basic rocks (metadolerites) at some stage, and in Bruce's area more than one generation of metadolerites were recognised. At Sverdrupfjella, these intrusions have themselves undergone strong deformation. In a few ultramafic samples, quartz and olivine were found to coexist. This shows that this part of the lithology had once been under extreme pressure, because olivine is generally unstable in the presence of quartz. Together olivine and quartz will form diopside. This writer refers to his presentation on Mary Kathleen Uranium Mine two years ago in which he postulated a garnet–olivine eclogite was silicified and is now a garnet–diopside rock.

Garnet is a common mineral in the mafic remnants in Sverdrupfjells. At times it developed symplectic textures with clinopyroxene, i.e. grains with solid cores of garnet rimmed by vermicular (worm-like) textures of alternating garnet and clinopyroxene forming coronas around relics of the original orthopyroxene or olivine grains (shown in the image to the right).

Based on the recognised mineral parageneses, Bruce concluded that the 1100 Ma old gneisses at Sverdrupfjella once had been at a depth of 30–40 km. This was followed by a stable stage at 15-20 km depth during which the lithology was strongly deformed 580 Ma to 550 Ma ago. In Sverdrupfjella, the presence of the mafic/ultramafic remnants show they are pre- to synkinematic, i.e. they intruded their hosts before and during the strong deformation event.

The conclusion was that Sverdrupfjella represents a collision zone between two continents during which one was slipping underneath the other to great depth. After collision, the crust underwent uplift and heating, resulting in much remelting and extreme deformation. In his original work, Bruce proposed that this occurred during the formation of the 1100 Ma old supercontinent of Rodinia. This stimulated more international research on these rocks, which has shown that the collision event occurred during the creation of the supercontinent of Gondwana, about 550 Ma, and involved up to 500 km of continental crustal overlap.



60th NATIONAL GEM & MINERAL SHOW - Gemboree

Easter Weekend 29th March - 1st April

Willunga South Australia

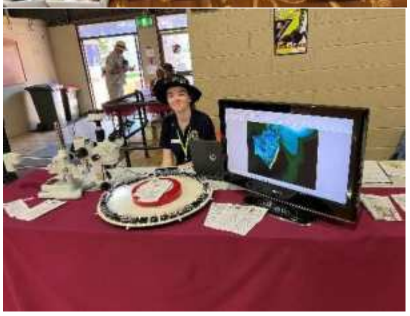
Attended by Allan Hart

It was well worth a visit for Allan Hart who has provided the following photos to drawl over.

Opalised belemnite 24ct $1000/ct

Azurite from Minerals of Eyre stand

Chiastolite from T.J Minerals stand



QUIZ NIGHT at the HERDSMAN LAKE TAVERN

11 June 2024

With compère and quiz designer – **Craig Bosel**

Photos by Allan Hart

With eight tables planned and seven full on the night (due to sickness one table pulled out), it was a close battle to the top prize of $300 per table as the points tally swung towards different tables. But in the end, it was the Stone-Cold Trivial bunch who pipped the other tables to the post by only one point.

At the start of the night, Stuart Jeffries gave Craig a tiny trophy cup for the winner on the night. Did he know his table was destined to take that trophy home?


A full room of contestant tables



1. Craig being quizzed on the number of wives of Henry VIII. 2. Stuart claiming his tiny trophy for his table, and 3. The winning table crew

MInSoc Quiz Night Scores June 11th 2024	General Knowledge 1	Sport 2	Minerals & Gems 3	True or False 4	Movies 5	Australiana 6	Perth & WA Trivia 7	Geography 8	Rocks & Geology 9	History 10	Total	Rank
STONE COLD TRIVIAL	4.0	7.5	6.0	6.0	9.0	6.0	9.0	10.0	11.0	10.0	79	1st
THE HOT SPOTS	6.0	8.5	6.5	6.0	9.0	7.0	10.0	10.0	7.0	7.5	78	2nd
THE HADEANS	2.0	5.0	8.0	7.0	4.0	5.0	7.0	8.0	10.0	3.5	60	
THE DARK HORSES	2.0	8.0	9.0	6.0	3.0	6.5	8.0	9.0	8.0	5.0	65	
THE BLACK DIAMONDS	6.0	7.5	10.0	5.0	6.0	3.0	9.0	9.0	8.0	7.0	71	
THE CARBUNCLES	2.0	5.5	6.5	5.0	9.0	4.0	7.0	7.0	8.5	3.0	58	Last
HOWZAT !	4.0	7.0	9.0	6.0	5.0	7.0	9.0	10.0	9.0	8.0	74	

Table Quiz	out of 25 possible	
18	STONE COLD TRIVIAL	
20	THE HOT SPOTS	1st equal
13	THE HADEANS	
20	THE DARK HORSES	1st equal
18	THE BLACK DIAMONDS	
19	THE CARBUNCLES	
18	HOWZAT !	

The final scores – a very close battle, and the one-off table quiz winners

A great night for all participants involved. We hope to see you next year …

SIMPSON MINERAL NOTES

By Vernon Stocklmayer

In July 2020, a new collaborative project was introduced at a general meeting Mineralogical Society of WA as a stimulating mineralogical exercise to which all MinSocWA members and others could contribute.

Numerous minerals new to Western Australia have been discovered since the publication of the three volumes of Dr. Edward Simpson's "Minerals of Western Australia" in the early 1950s.

The *Simpson WA update* project was to focus on the write up of all the minerals that were NOT included in Simpson's earlier work and to publish this in some form or other by the 25th anniversary of the founding of MinSocWA in 2025.

However, to date (April, 2024) first drafts for only slightly over 100 minerals have been completed by various members of MinSocWA. This represents less than 25% of the over 400 minerals that have currently been identified and it is apparent that the original target will not be achieved.

Nevertheless, a considerable amount of data has been acquired to date and this represents a valuable resource that should not be wasted. One possibility is that the data be made available to any MinSocWA member to utilize in the production of a mineralogical article for publication such as was done recently in *Australian Journal of Mineralogy* 24(2).

Another suggestion was that this data be used in some form or other in the MinSocWA newsletters, possibly as short articles on some interesting aspect of Western Australian minerals.

This is the first of these:

Some Western Australian "moon" minerals

Three new minerals were identified from material collected from the surface of the Moon during the Apollo 11 mission in 1969. Two of these, armalcolite and tranquillityite have subsequently been recorded from lithological units in Western Australia while the third, pyroxferroite, has been found at the Cannington silver mine in Queensland. The two Western Australia occurrences are briefly described.

Armalcolite $(Mg,Fe^{2+})Ti_2O_5$

In 1970, a new magnesium-rich oxide mineral was identified from samples of lunar material collected from *Mare Tranquillitatis* on the moon. The name was derived from the first letters of the three astronauts **Arm**strong, **Al**drin and **Col**lins who collected the samples during the Apollo 11 mission (Anderson et al., 1970).

The lunar material contained tiny (100-300 µm), generally rectangular grains of opaque, pale grey and distinctly pleochroic armalcolite that are usually mantled by a well-defined overgrowth of ilmenite. Armalcolite has a Mohs hardness of 5 and a theoretical specific gravity of 4.64.

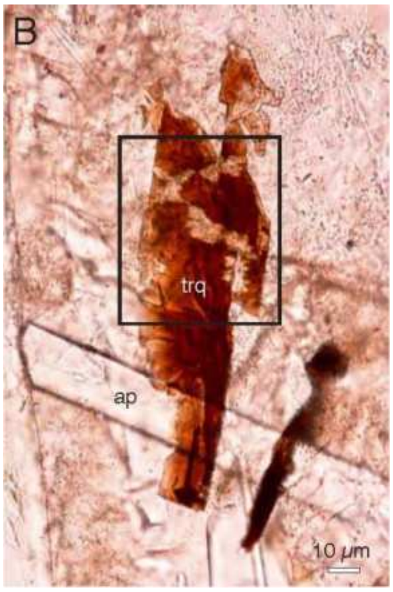
A later comprehensive electron microprobe study of lunar armalcolite samples showed that it occurred as three distinct compositional types classified as armalcolite, Cr-Zn-Ca armalcolite and Zr-armalcolite (Haggerty, 1973).

The type material is stored at the Lunar Science Institute in Houston, Texas, USA. Armalcolite was also found in lunar meteorites and later identified from several terrestrial locations. One of these is in the Kimberley region of Western Australia.

A heavy mineral concentrate from the Argyle lamproite, located in the Kimberley region, was found to contain a grain of Cr-armalcolite rimmed by K-Cr-priderite (Jaques et al., 1989). Cr-armalcolite of similar composition was also found in a peridotite xenolith from the Argyle lamproite (Jaques et al., 1990; Downes et al., 2023) where it occurs in association with Ti-rich chromite.

Tranquillityite $Fe^{2+}_8Ti_3Zr_2Si_3O_{24}$

Tranquillityite was first discovered in basalts collected during the Apollo 11 mission to the Sea of Tranquillity (*Mare Tranquillitatis*) on the moon in July 1969. It was formerly recognized as a new mineral in 1971 and named after the Apollo 11 landing site.



Tranquillity from the about 1070Ma Warakurna LIP intruding the Eel Creek Formation, North Pilbara. Photo by Birger Rasmussen

Tranquillityite from the crystalline basaltic lunar rocks characteristically occurs as thin laths that are generally less than 100 microns long with the coarsest individual laths found in samples of cristobolite basalt. It is optically homogeneous and free of exsolution or alteration products (Lovering et al., 1971).

It is semi opaque and grey in reflected light with a submetallic lustre, but thin crystals in strong transmitted light show a deep reddish-brown colour with an RI of between 2.11 and 2.13. It has been reported to be isotropic to weakly anisotropic and is non-pleochroic. A single report states that it is biaxial with a 2V of about 40^o.

Type material is deposited at the Lunar Science Institute, Houston, Texas, USA.

Currently tranquillityite has been identified in six dolerite dykes and sills from Western Australia and possibly has a more widespread occurrence. In most samples it occurs as thin, straight to slightly curved laths or sheaves of laths up to 150 µm in length and 40 µm in width. It is reddish-brown in transmitted light and non-pleochroic.

It is concentrated in late-stage interstices comprising myrmekitic intergrowths of quartz and K-feldspar which form between plagioclase laths, pyroxene, olivine and ilmenite. It is commonly associated with other accessory minerals such as baddeleyite, zirconolite, apatite and ilmenite (Rasmussen et al., 2012) The six sample sites are recorded as:

(1) coarse-grained dolerite sills intruding the Eel Creek Formation along the northern margin of the Pilbara Craton
(2) an olivine gabbro dike from the 755 Ma Mundine Well swarm in the Gascoyne province
(3) late-stage dolerite from the ca. 500 Ma Table Hill Volcanics
(4) ca. 525 Ma quartz dolerite sills intruding the Manganese Group from the south-eastern Pilbara Craton
(5) late-stage quartz dolerite from the ca. 1790 Ma Hart Dolerite suite in the Kimberley Complex
(6) an undated dolerite sill intersected in drillhole Billy Goat Bore in the eastern Pilbara Craton

References.

Anderson AT, Bunch TE, Cameron EN, Haggerty SE, Boyd FR, Finger LW, James OB, Keil K, Prinz M, Ramdohr P and El Goresy A, 1970. Armalcolite: A new mineral from Apollo 11 samples. *Proceedings of the Apollo 11 Lunar Science Conference,* vol. 1, p. 55–63.

Downes PJ, Stocklmayer V and Stocklmayer S, 2023. Rare mineral species from the Kimberley region, Western Australia. *Australian Journal of Mineralogy,* v. 24 (2), p. 5–26.

Haggerty SE, 1973. Armalcolite and genetically associated opaque minerals in the lunar samples. *Proceedings of the Fourth Lunar Science Conference,* v. 1, p. 777–797.
Jaques AL, Haggerty SE, Lucas H and Boxer GL, 1989. Mineralogy and petrology of the Argyle (AK1) lamproite pipe, Western Australia: *in* Kimberlites and related rocks, v. 1, *edited by* Ross J et al.: *Geological Society of Australia Special Publication No. 14*, p. 153–169.
Jaques AL, O'Neill HStC, Smith C and Moon J, 1990. Diamondiferous peridotite xenoliths from the Argyle (AK1) pipe: *Contributions to Mineralogy and Petrology*, v. 104, p. 255–276. https://doi.org/10.1007/BF00321484.
Lovering JF, Wark DA, Reid AF, Ware NG, Keil K, Prinz M, Bunch TE, El Goresy A, Ramdohr P, Brown GMPeckett A, Phillips R, Cameron EN, Douglas JAV and Plant AG, 1971, Tranquillityite: A new silicate mineral from Apollo 11 and Apollo 12 basaltic rocks: Proceedings of the 2nd Lunar Science Conference. *Geochimica et Cosmochimica Acta,* v. 1, Supplement 2, p. 39–45
Rasmussen B, Fletcher Ian R, Gregory Courtney J, Muhling Janet R and Suvorova Alexandra A, 2012. Tranquillityite: The last lunar mineral comes down to Earth. *Geology*, v. 40(1), p. 83–86.

OTHER INTERSTING ARTICLES

From Mike Freeman

January 2024 - Titanium dioxide's double life: how rutile helps detect gold, meteorites and forged artworks
https://www.csiro.au/en/news/All/Articles/2024/January/Rutile-titanium-dioxide-mineral?utm_source=newsletter&utm_medium=email&utm_campaign=Snapshot+February+Issue+2024

From Tom Bateman

Green mystery: Plumbian orthoclase reveals hidden resources
https://phys.org/news/2024-04-green-mystery-plumbian-orthoclase-reveals.html

June 2024 New York University - Scientists develop 'X-ray vision' technique to see inside crystals
https://phys.org/news/2024-06-scientists-ray-vision-technique-crystals.html

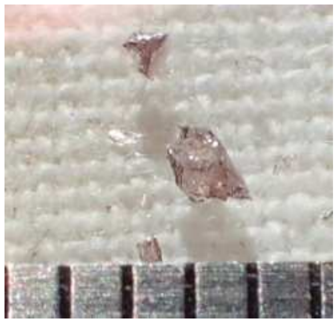
MICROSCOPE CORNER

Submitted by Susan Stocklmayer

Recently I was asked if I could assist with the identification of a brownish-purple mineral that had formed as small (eye-visible) crystals on a specimen of a rock from an unknown location (image 1.). So, there was no background information to set the scene. Both the colour and crystal habit of this mineral were distinctive and my immediate thoughts were– "*have I seen this mineral before?*" and "*where have I seen this mineral before?"*

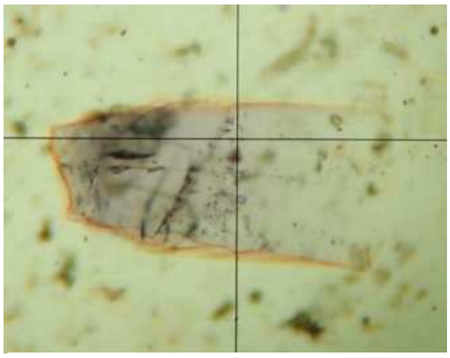
1. Small grey-purple coloured crystals on host rock

Method – taking tiny fragments, each less than a couple of millimeters across (image 2.), crushing the grains onto a microscope slide, adding a refractive index (RI) liquid of n1.69, the grains were then examined using a petrological microscope. Under PPL (plane polarized light) the crystal fragments display strong pleochroism of violet/purple to grey/colourless and dispersion effects at grain boundaries (image 3. Showing orange colour at grain/liquid boundaries). The dispersion effects are indicative of a close match of the refractive index of liquid and mineral. Under crossed polarized light, a biaxial negative optic figure was viewed. On the rock, the crystals have a distinct wedge-shape form, distinctive purple colour and, together with the optic data, the mineral is identified as axinite.



2. Crushed crystal fragments and mm scale

Axinite is a boro-silicate mineral group name ($R^{2}{}_{2}R^{3}{}_{4}B_2(SiO_4)_8$), all members are triclinic. Chemically, R is chiefly Ca, but with varying amounts of other elements; notably iron, manganese and magnesium, four minerals have been recognized to date: namely: axinite-(Fe), axinite-(Mg), axinite- (Mn) and tinzenite (Ca, Mn).



3. PPL view (x200) one grain (0.6 mm) showing violet body colour

Axinite-(Mg), formerly termed magnesio-axinite, when found in the Arusha district of Tanzania as transparent crystals, features commercially as a gemstone mineral. The gem axinite shown is from an unknown location (image 4.).

4. Faceted axinite gemstone 5.2 mm x 3.6 mm GAA collection

There are several locations listed for the occurrences of axinite in Western Australia described on the *mindat.org* web site, but I have been informed that the “unknown” rock specimen was likely to be the material from Colebrook Hill in western Tasmania where axinite formed in a hornfels. If this is the correct location, then the axinite can be identified as axinite-(Fe).

Identification of the variety of axinite is only possible with chemical analysis or microprobe techniques; however simple microscope techniques and observations of the physical attributes of a mineral can provide sufficient results to help establish the initial mineral family.

https://www.mrt.tas.gov.au/prospecting_and_fossicking/fossicking_areas/fossicking_areas_in_tasmania/colebrook_hill_fossicking_area

MEMBERSHIP

The Mineralogical Society of WA has over **100** members. We have welcomed the following new members since April 2024:

Andy Comas | Clive Tolley
Greg Atwell | Ron Noble
Rowena Mitchell

All members are asked to ensure that their contact details are up to date with the Membership Secretary/Secretary. If you change your email address or phone number, please let us know so that you continue to receive all MinSocWA communications – membership@minsocwa.org.au

ADVERTISING

Hunting for a new Treasurer - Found

The Mineralogical Society of WA is please to inform you that we now have an apprentice Vice Treasurer learning the ropes from our Honorary Treasurer John Mill. Vinodaarshini (Vino) Vigneswaran will be inducted officially on to the committee in September at the AGM.

UPCOMING EVENTS

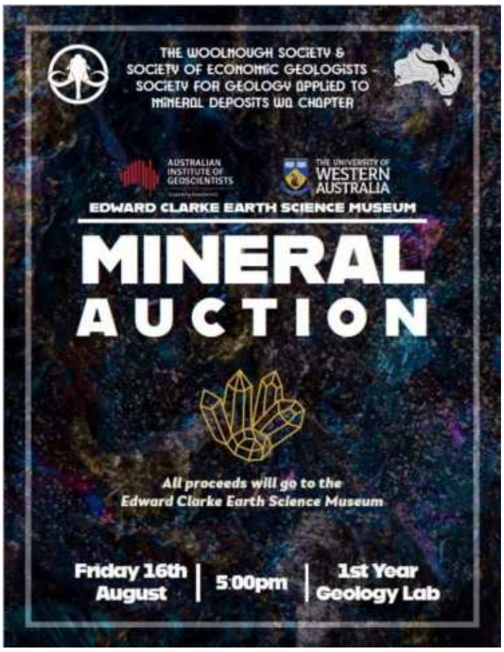
The next MinSocWA Mineral Market will be held on Sunday 21 July 2024, 10 am to 4 pm (bump in for vendors only at 9 am.

Woolnough Society & Society of Economic Geologists –
Society for Geology Applied to Mineral Deposits WA Chapter

A message from the **President of the Woolnough Society** about the upcoming 16 August event:

This year, the committee is dedicated to revitalizing the UWA Woolnough Society to its former prominence. After a successful first semester of events, we are planning a Silent and Live Auction of minerals.

This event will be held in conjunction with the Australian Institute of Geoscientists (AIG), who will deliver a technical talk; UWA, who will announce their winners of the Academic Excellence Awards; and the Society of Economic Geologists (SEG), representing postgraduate UWA students on **August 16th**, we anticipate 60-70 people in attendance.



Our aim for the mineral auction is to foster a strong community spirit while raising essential funds for the UWA Edward de Courcy Clarke Earth Science Museum, which is in urgent need of financial support.

To make this event a success, we need additional samples to auction. We are **looking for a variety of samples**, with more affordable ones for the silent auction and higher-value samples for the live auction.

The Perth Gem and Mineral Show (PGMS)
11 & 13 October 2024
https://www.perthgemmineralshow.com/

PGMS
Perth Gem & Mineral Show
Proudly presented by the Mineralogical Society of Western Australia

The Perth Gem and Mineral Show (PGMS) sub-committee is pleased to report that planning of the inaugural show is going ahead smoothly. The event will showcase many of the wonders that the mineral, gem, fossil and geoscience communities have to offer, with a special focus on Western Australia's mineral heritage.

With 150 tables already sold and more sponsors than last year, it will be an event definitely not to be missed. Add it to your calendar now.

Due to the higher volume of correspondence, more than one email will be operating for the PGMS this year. Please direct your enquiry to the appropriate one:

PGMS_vendors@minsocwa.org.au
PGMS_treasurer@minsocwa.org.au
PGMS_secretary@minsocwa.org.au
PGMS_volunteers@minsocwa.org.au

COMMITTEE MEMBERS FOR 2023/2024

President	Peter Willems	president@minsocwa.org.au
Vice President	James Sherborne	jamessherborne@hotmail.com
Secretary	Angela Riganti	secretary@minsocwa.org.au
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Committee Member	Susan Stocklmayer	baobab46@dodo.com.au
Committee Member	Nicolas Hébert	aminenh3@gmail.com
PGMS Secretary	Peter Willems	pgms_secretary@minsocwa.org.au

Patron - *Mark Creasy*

Meetings

Meetings of the Mineralogical Society of Western Australia Incorporated are usually held at **7.30 pm on the second Wednesday of every odd month** at:

WA Lapidary & Rockhunting Club rooms 31 Gladstone Road,
Rivervale (corner of Newey Street)

The venue will be open from 6.30 pm for refreshments and socialising.

MinSoc WA LINKS

Web http://www.minsocwa.org.au

Facebook Group https://www.facebook.com/groups/minsocwa

Facebook Page https://www.facebook.com/MINSOCWA

Instagram https://www.instagram.com/MINSOCWA

YouTube Channel https://www.youtube.com/channel/UC0S2TFVFIBLU-2zlEzE5VNA

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