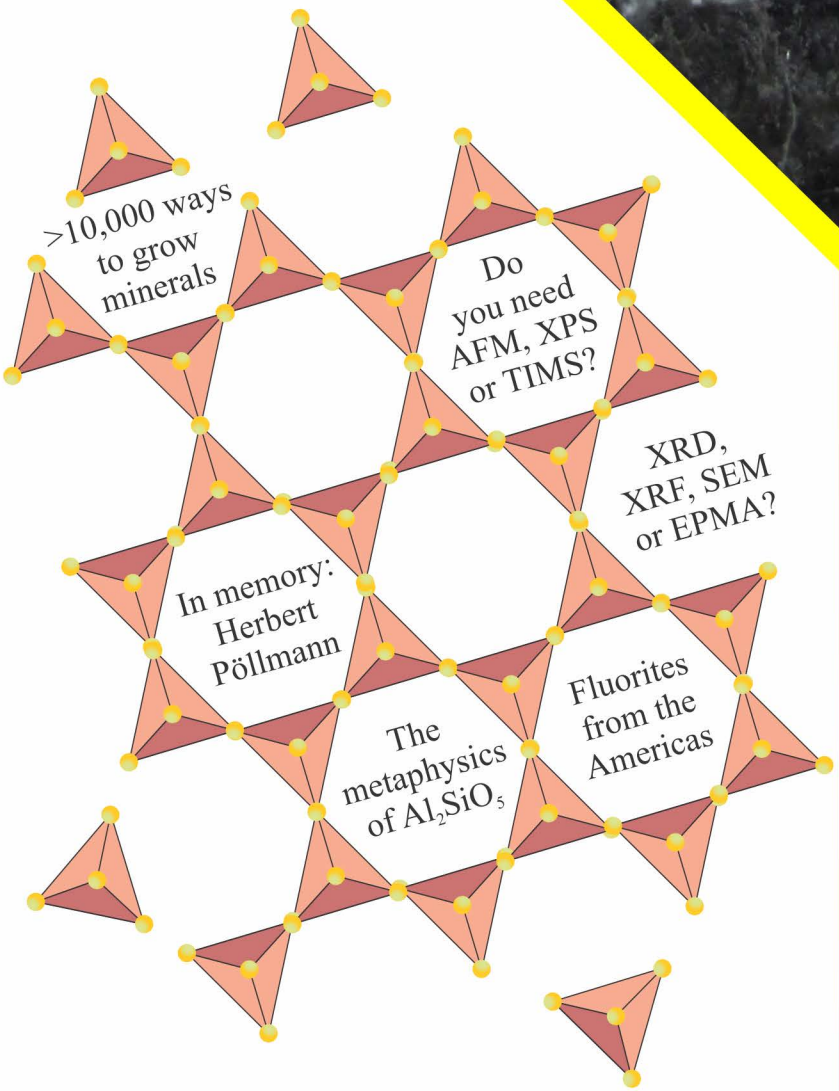
the Geode

the Geode

MINSA
Mineralogical Association of South Africa
A division of the GSSA

A catalogue of South African analytical resources for research materials



The GEODE

Minsa Newsletter
Volume 9
No. 2
June
2022

MINSA
Mineralogical Association of South Africa
A division of the GSSA

website: www.gssa.org.za/Minsa
e-mail: Minsa@gssa.org.za

the Geode
the Geode
NEWSLETTER
Volume 9 No. 2
June 2022

2022: IMA's Year of Mineralogy

Contents

Next issue theme:

Glass: what's it good for, and how do we analyse it?
(see also pg. 15)

Forthcoming Events & Attractions

Some events are still missing specific dates: Minsa will let you know! Watch for e-mailed announcements. All dates are 2022 unless otherwise stated.

- GSSA AGM (online) July 14.
- MEI (Minerals Engineering International):
  - Sustainable Minerals '22 – online conference, July 11-14.
  - Process Mineralogy – November 2-4 in Sitjes, Spain (online and in- person conference).
- Bulk Commodities talk (26 July)
- SAIMM current president Isabel Geldenhuys will present a talk on slag glass (date to be announced)
- **Minsa AGM (18th August)**
- R512 Dolomite Pub Crawl (19 Nov., Lesedi Cultural Village, Lazy Lizard Brewhouse, L'Atmosphere Bistro, Nikita Restaurant Motel, Blue Night Revue Bar, Gem of the Bushveld Sportsbar).
- Minsa Night at the Museum, last weekend in November.
- Microscopy Society of South Africa (MSSA) annual meeting, Gold Reef City (JHB), December. For details, and membership info, see https://www.microscopy.co.za/.
- GSSA/IMSG combined meeting, January 2023 in Stellenbosch. See also their website at https://allevents.eventsair.com/geocongress/.

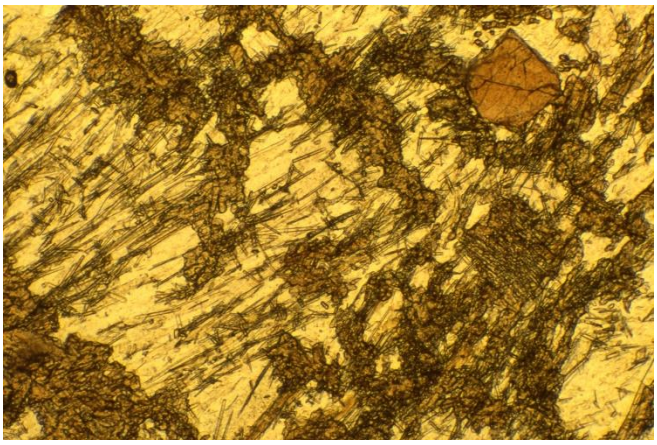
The Editor's Site

Welcome to the second issue of the Minsa Geode for 2022. 2022 is still the International Mineralogical Association's official "Year of Mineralogy". I trust you are all doing your part. In this issue, we are being very consumer-focussed, with the special theme of analytical services offered in South African institutions, and my, there are a lot of them, many using methods I've never heard of, and presumably for purposes I am unaware of. Our thanks must go in particular to Axel Hofmann (UJ) who initiated this exercise in data collection on the various labs, and allowed us to purloin his data for sharing, and to Petra Dinham who worked hard at getting the list updated over the past month or so.

An (the) Editor

In order to make this issue not strictly an analytical encyclopedia and as readable as a catalogue, we also are soliciting nominations for the 2022-2023 Minsa Committee (see pg. 4-5), we note with sadness and fondness the recent passing of Herbert Pöllmann, and a Wirsam XRF workshop is acknowledged. In addition, two new papers in American Mineralogist highlight the myriad ways in which minerals can form (nine of the near 5000 recognised minerals form in more than fifteen different ways!), and I explore the metaphysical implications of the Al_2SiO_5 polymorphs, because we just hosted the National Arts Festival, and to illustrate our societal breadth.

Our crossword puzzle this issue features the theme of retrograde metamorphism, one of the top choices of metamorphism in reader polls. Just to get you in the mood, here is one of my personal favourites; the breakdown of osumilite (it's a high temperature cyclosilicate, often found with sapphirine, which is both high temperature and pressure) in paragneisses, into a complex pseudomorphic assemblage of quartz, orthoclase, cordierite and hypersthene*, along with associated sillimanite and biotite (*yes, I know this is no longer IMA-approved). This example is from the Grenville geological province in eastern Labrador (from my M.Sc.).



And that's the perspective from the Editor's site.

Steve Prevec

From the Chair

Welcome to the June 2022 Geode! A Geode released just in time as things appear to be returning to "normal", with COVID measures lifted and the lights going off and on again. This will be my last chair column for this 2021-22 term because Igor Tonžetić, as the current vice-chair, will take over as chair after Minsa's Annual General Meeting. Although I won't be the chair for the next term, I will still be active in Minsa. With this year sneaking closer to its end, I would also like to remind and encourage our members to renew their membership, or to join Minsa if you are reading this and haven't done so yet.

This quarter's Geode presents a comprehensive list of the analytical facilities available in South Africa that might be useful to mineralogists. I would like to extend a special thanks to Prof. Axel Hofmann from the University of Johannesburg for compiling the original working list, as well as all other contributors who added to this list. This Geode will therefore hopefully serve as a handy (indispensable!) guide for mineralogists (and others) looking for research analytical resources.

Bertus Smith
Chair, 2021-22
Minsa Executive Committee

Exciting news from Minsa is that we are planning to rename our Minsa Book Prize, which is awarded annually to a South African University-based post-graduate dissertation focusing on applied mineralogy. After a call for nominations of prestigious South African mineralogists or geoscientists, a shortlist was compiled of possible candidates (*Minsa is in the process of checking with the living ones that they are willing to be publicly nominated; Ed.*). When the call to vote is made, please vote for who you think this award should be named after.

With regards to recent Minsa activities, there was a visit to Wirsam Scientific on 23rd June 2022 where an introductory course to X-Ray fluorescence analysis was presented. This event was attended by 20 people. I would like to thank Sarah Glynn and everyone from Wirsam Scientific for making this event possible (see also short article below).

I am also very happy to announce that we will have our first in-person Minsa talk in more than two years! On 26th July 2022 at 18:00 we will be hosting Tricia Scott from Anglo American for a talk on bulk commodities processing. Be on the lookout for the official invitation and please RSVP! Also be on the lookout for other Minsa activities planned for the remainder of 2022.

Minsa's Annual General Meeting will take place on 18 August, 2022. Prof. Bruce Cairncross from the University of Johannesburg will be our speaker. Please diarize this event. The official announcement will follow soon, and also be on the lookout for the call for nominations to the Minsa executive.

Thank you as always to Steve Prevec for all the effort he puts into editing the Geode and also thanks to our contributors and to our readers! Until we meet again!

Kind regards,

Bertus Smith

Minsa News

5th Annual Southern African Joint Minsa – SAMS (South African Micromount Society) Mineral Symposium

Please note that the 5th Annual Southern African Mineral Symposium, originally scheduled for November 2021, is now tentatively planned for 2023. For more information, please contact Igor Tonžetić at the Minsa address.

Wirsam XRF course and site visit

On the 23rd of June Minsa and Wirsam collaborated to organise a site visit combined with a "Basics of XRF" course at Wirsam Scientific's Johannesburg office, after a long hiatus of in-person events. Maggi Loubser from UP was the invited speaker and presented the course to 20 participants from industry, academia and the Council for Geoscience. The participants were also treated to lunch and a tour of the equipment on the premises, and it was great to see instrument novices and professionals networking together!

contributed by Sarah Glynn

NOMINATIONS FOR EXECUTIVE COMMITTEE:

2022-2023

Nominations are hereby invited for the Minsa executive committee to hold office for 2022-2023. A nomination form is attached. All nominations must be sent to:

minsa@gssa.org.za

The closing date for nominations is **Friday 15th July 2022**. Each nominee must have a proposer (to be completed in attached nomination table). The proposer must be a Minsa member. The proposer must ensure that the nominee is willing to serve, is able to attend at least 50% of committee meetings (as per GSSA Council guidelines), whether in person or through a conference call facility (such as Skype/Zoom). Executive members must be BOTH a Minsa and a GSSA member.

Please list as many nominees as you wish, bearing the nominee criteria in mind. Outgoing members of the executive are listed below for your information. Please mark (tick/cross) which portfolios the nominated member is willing to run for (they may run for all the portfolios).

Outgoing members of the Executive Committee are:-

Dr Bertus Smith (Chair)	bertuss@uj.ac.za
Dr Sabine Verryn (Treasurer)	sabine.verryn@xrd.co.za
Ms Sara Turnbull (Communications)	sara.sjt.turnbull@gmail.com
Dr Sarah Glynn (Youth & Development)	sarahglynn22@gmail.com
Mrs Petra Dinham (Secretary)	pea.dinham@gmail.com

As Vice Chair for 2021 – 2022, Igor Tonžetić automatically becomes the Minsa Chair for 2022-2023 (as per Constitution).

MINSA
Mineralogical Association of South Africa
A division of the GSSA

MINERALOGICAL ASSOCIATION OF SOUTH AFRICA

NOMINATIONS FOR THE EXECUTIVE COMMITTEE 2022-2023

Proposer:

Nominee	Vice Chair	Treasurer	Secretary	Communications	Youth & Development

Please complete the form and email (or hand in person) to Igor Tonžetić at:

minsa@gssa.org.za

by Friday 15th July, 2022

Obituary: Prof. Dr Dr Herbert Pöllmann (1956 - 2022)

This short note is offered in memory of Prof. Dr Dr Herbert Pöllmann, who was taken from our midst completely unexpectedly.

Herbert Pöllmann had been a professor at Martin Luther University, Halle-Wittenberg, Germany since 1994, in the department of mineralogy and geochemistry. He was a passionate researcher and university lecturer, a committed colleague who rendered great service to his students, colleagues, and fellow scientists. He had been a member of Minsa for a long time and contributed to our short courses.

We have lost a highly esteemed, fun-loving and humorous member.

Our deepest compassion goes to his family.

Contributed by Sabine Verryn

Articles

The June issue theme: Analytical resources in South Africa (*OR* Where, oh where, can I get analytical work done on research materials, and still pay in ZAR?)

Facilities available for microscopy and microanalysis at South African universities and research institutes

This document , originally compiled for reference for geological sciences research by Axel Hofmann (ahofmann@uj.ac.za), University of Johannesburg earlier in 2022, kindly agreed to share his document and allow it to be updated by Minsa through communication with as many national analytical facilities as we can find. Many of the services listed are relevant well beyond geology and into Material Sciences, Life Sciences, and beyond. This document is by necessity a "living document", inasmuch as the availability and quality of any specific service may vary with time, as may the specific responsible staff members. This is the best we've got as of June 2022. If you keep us posted, we'll keep a version of this updated.

University departments/labs

NMU – Nelson Mandela University, Centre for HRTEM (https://chrtem.mandela.ac.za/)

RU - Rhodes University (www.ru.ac.za/geology)

SU - Stellenbosch University (www.sun.ac.za/english/faculty/science/earthsciences ; www.sun.ac.za/english/faculty/science/CAF)

UCT - University of Cape Town (www.geology.uct.ac.za; http://www.geology.uct.ac.za/facilities-10)

UFS – University of the Free State (https://www.ufs.ac.za/natagri/departments-and-divisions/geology-home/research-and-publications/analytical-facilities)

UJ - University of Johannesburg (www.uj.ac.za/faculties/science/geology; www.uj.ac.za/faculties/science/research/spectrum)

UKZN - University of KwaZulu-Natal (https://saees.ukzn.ac.za/category/geology)

UP - University of Pretoria (http://www.up.ac.za/en/geology)

UP – University of Pretoria Laboratory for Microscopy and Microanalysis (www.up.ac.za/laboratory-for-microscopy-and-microanalysis)

Wits – University of the Witwatersrand (www.wits.ac.za/geosciences)

Wits – University of the Witwatersrand, Microscopy and Microanalysis Unit (MMU) (www.wits.ac.za/mmu)

Research institutes

iThemba LABS - Somerset West, Johannesburg (https://tlabs.ac.za)

MINTEK - Johannesburg (https://www.mintek.co.za)

NECSA – Pelindaba (www.necsa.co.za)

NMISA – National Metrology Institute of South Africa (https://www.nmisa.org)

CSIR – Council for Scientific and Industrial Research (https:www-csirnano.co.za/ncnsm-characterisation-facility/)

CGS – Council for Geosciences (https://www.geoscience.org.za/index.php/cgs-services/laboratory-services)

Specific analytical services

1. Mineral separation (e.g., zircon)
2. XRD (crystallography, mineral identification)
3. XRF, ICP-MS, ICP-OES (major/trace element analysis)
4. Elemental analysis (C,H,N,S) *(those are elements, not an acronym)*.
5. Electron microprobe (in-situ major/trace element analysis)
6. LA-ICP-MS (in-situ trace element analysis, dating)
7. MC-LA-ICP-MS (radiogenic isotope geochemistry, geochronology)
8. Noble gas MS (Ar-Ar dating, (U,Th)-He dating)

9. Gas source IR-MS (stable isotope geochemistry, conventional C, O, H isotopes)
10. Ultra-clean lab (elemental separation for solution isotope analysis by mass spectrometry)
11. SEM-EDS, -WDS, -EBSD,-TKD, -CL (backscatter and secondary electron imaging, element mapping, mineral analysis, CL-imaging)
12. FIB-SEM (FIB-SEM, TEM sample prep)
13. TEM
14. TEM-tomography
15. Cryo and Low-Dose TEM
16. ETEM (Environmental TEM)
17. Mineral Liberation Analyser (automated quantitative mineral analysis)
18. Micro-XRF (element and mineral imaging)
19. Raman spectroscopy (mineral identification, mapping, fluid inclusions)
20. X-ray tomography (3D scanning and image analysis)
21. Fluid inclusion lab
22. Palaeomag lab
23. Organic Petrology lab
24. Nuclear microprobe and PIXE (Particle Induced X-ray Emission)
25. Secondary Ion Mass Spectrometry (SIMS) via virtual SIMS facility
26. Time-of-Flight Secondary Ion Mass Spectroscopy (ToF-SIMS)
27. Thermal Ionisation Mass Spectrometry (TIMS)
28. AFM (Contact, taping, MFM, EFM, Liquid-AFM
29. Fluorescent Light Optical (DIC, Z-Stack, LCSM)
30. X-ray Photoelectron Spectroscopy (XPS)
31. Particle Size Distribution (PSD) (Laser diffraction and optical microscopy)
32. Metallographic sample preparation
33. Confocal laser scanning microscopy

Points to note

- Most of the above departments have sample preparation facilities that include the preparation of thin sections and epoxy mounts as well as rock crushing, milling, sawing etc. and have reflected light and stereo microscope facilities.
- Most labs have different prices depending on internal vs external users. Some labs also offer collaborative rates. Analysis on a collaborative basis expects the submission of a proposal of the work to be undertaken and the publication of the results with the collaborator as a co-author.
- MINTEK has a host of equipment for mineralogical studies available to academia, at a cost and not for self-use.
- Wits MMU has a host of characterization instruments, free of charge to any Wits student/staff, conducts user training to all users registered.
- The CGS do analyses for student researchers; those who want to use the instruments need to consult with the Council for Geoscience and a Memorandum of Understanding/Collaboration needs to be in place for them to use/train on the instruments.
- CSIR rates and analytical facilities, as well as contact numbers, are listed on their website.

A brief review of the preceding acronyms:	
AFM	Atomic force microscopy EFM = Electrostatic force microscopy MFM = Magnetic force microscopy
ICP-MS	Inductively-coupled plasma mass spectrometry LA-ICP-MS = laser ablation ICP-MS MC-ICP-MS = multi-collector ICP-MS
SEM	Scanning electron microscopy +CL = cathodiluminescence detector +EBSD = electron backscatter spectrometer +EDS = with energy dispersive spectrometer +WDS = wavelength dispersive spectrometer
SIMS	Secondary ion mass spectrometry ToF-SIMS = Time of Flight SIMS
TEM	Transmission Electron Microscopy ETEM = Environmental TEM
TIMS	Thermal ionisation mass spectrometry (solid source)
XPS	X-ray photoelectron spectroscopy
XRD	X-ray diffraction spectroscopy
XRF	X-ray fluorescence spectroscopy

The following list consists of the heading by analytical service (following the preceding numbered list), and includes the name or location of the lab, the name of the instrument, the contact person and their contact information, listed alphabetically by institute.

1. Mineral separation (e.g. zircon, apatite)

SU (Frantz magnetic and heavy liquid separation: Mareli Grobbelaar, mgrobbelaar@sun.ac.za)

UCT (2 Frantz magnetic separators and heavy liquid separation; Philip Janney, phil.janney@uct.ac.za)

UJ (Frantz magnetic and heavy liquid separation; Clarisa Vorster, clarisav@uj.ac.za)

UP (SelFrag, Frantz magnetic separator; Jaco Delport, delportexploration@gmail.com)

Wits (Wilfley table, Frantz magnetic and heavy liquid separation: Louis Mudalahothe; louis.mudalahothe@wits.ac.za)

2. XRD (crystallography, mineral identification)

Mintek (Bruker D8 Advance; Desh Chetty, deshc@mintek.co.za)

NMISA (PANalytical Empyrean XRD with GIXRD & XRR; Clive Oliphant, coliphant@nmisa.org)

RU Physics (Bruker D2 Phaser 2nd Gen. XRD; Vincent Smith, v.smith@ru.ac.za)

UFS (Panalytical Empyrean XRD; Megan Purchase, purchasemd@ufs.ac.za)

UJ (Panalytical XRD; Willie Oldewage, willieho@uj.ac.za)

UP (Panalytical XRD; Wiebke Grote, wiebke.grote@up.ac.za)

Wits-MMU (Bruker D2 XRD; alexander.ziegler@wits.ac.za)

Some facilities at the Department of Geology, UP.

And some more of their facilities…

3. XRF, ICP-MS, ICP-OES (major/trace element analysis)

SU (PANalytical Axios XRF: Mareli Grobbelaar, mgrobbelaar@sun.ac.za; Thermo iCAP 6200 ICP-OES; Agilent 7900 ICP-MS: Charney Anderson, charney@sun.ac.za; Agilent 8800 QQQ ICP-MS: Riana Rossouw, rrossouw@sun.ac.za)

UCT (PANalytical Axios XRF; Thermo iCAP-RQ with NewWave UP213 and Applied Spectra RESOlution excimer laser ablation system; Phil Janney, phil.janney@uct.ac.za)

UFS (Rigaku Primus IV WD XRF; Megan Purchase, purchasemd@ufs.ac.za)

UJ (PANalytical XRF, Christian Reinke, christianr@fastmail.com; Perkin Elmer NexION 300; Spectro ARCOS; Willie Oldewage, willieho@uj.ac.za)

UP (Thermo Fisher XRF; Jeanette Dykstra, jeanette.dykstra@up.ac.za)

Wits (PANalytical XRF; Perkin Elmer Elan DRC-e, Thermo iCapQ; Allan Wilson, Grant Bybee, Allan.Wilson@wits.ac.za, grant.bybee@wits.ac.za)

Perkin Elmer Elan DRC-e ICP-MS (previous page) and Thermo Element XR (above) at the Earth Lab, Wits University.

4. Elemental analysis (C H N S)

SU (Elementar Vario EL Cube Elemental Analyzer: Charney Anderson, charney@sun.ac.za)

5. Electron probe microanalysis (EPMA), or electron microprobe (in-situ major/trace element analysis)

Mintek (JEOL JXA-8230; Yash Thakurdin, YashT@mintek.co.za)

RU (JEOL JXA-8230; Deon van Niekerk, epma@ru.ac.za)

UCT (JEOL JXA 8100; Nicholas Laidler, nicholas.laidler@uct.ac.za)

UJ (Cameca SX-100; Christian Reinke, christianr@fastmail.com)

Wits-MMU (Cameca SX5-FE, alexander.ziegler@wits.ac.za)

6. LA-ICP-MS (in-situ trace element analysis, geochronology)

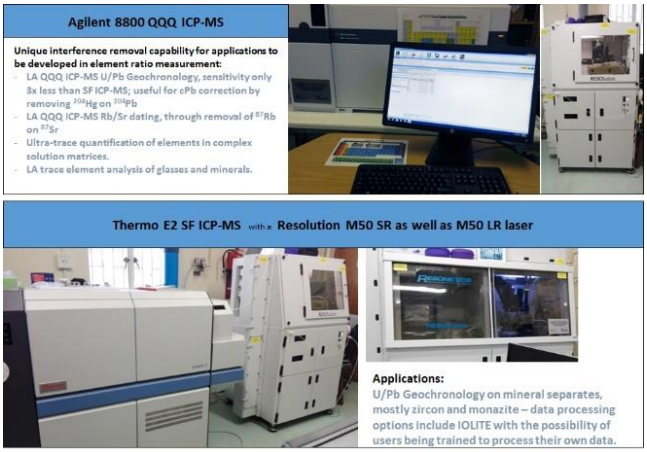
SU (RESOlution LR-M50 and SE-S155 excimer lasers; Agilent 7700 ICP-MS, Agilent 8800 QQQ ICP-MS; Thermo Element 2 SF SC ICP-MS Scientific E2 SF; Resonetics SE excimer laser; trace element analysis: Riana Rossouw, rrossouw@sun.ac.za; U-(Th)-Pb dating: Riana Rossouw, rrossouw@sun.ac.za)

UCT (Thermo iCAP-RQ with NewWave UP213 and Applied Spectra RESOlution excimer laser ablation system; Phil Janney, phil.janney@uct.ac.za)

UJ (Thermo-Fischer iCap ICP-MS; ASI RESOLUTION laser; New Wave UP213 laser; Clarisa Vorster, clarisav@uj.ac.za or Marlina Elburg, marlinae@uj.ac.za)

Wits (Thermo Scientific Element XR single collector ICPMS coupled with ASI Resolution SE-155 excimer laser; Robert Bolhar, robert.bolhar@wits.ac.za)

Mintek (Thermo Scientific Element XR magnetic sector ICPMS coupled with New Wave 193nm excimer laser; trace element analysis; Candice Carelse, candicec@mintek.co.za)



LA-ICP-MS lab at SU

7. MC-LA-ICP-MS (radiogenic isotope geochemistry, dating)

UJ (NuPlasma HR MS with ASI RESOlution excimer laser with S155 sample cell; Marlina Elburg, marlinae@uj.ac.za)

UCT (Two NuPlasma HR MS instruments, one with ASI RESOlution excimer laser with S155 sample cell; Petrus le Roux, petrus.leroux@uct.ac.za)

Wits (NuSapphire with ASI RESOlution SE-155 excimer laser or solution mode; Robert Bolhar, robert.bolhar@wits.ac.za; Karen Smit, karen.smit@wits.ac.za)

MC-LA-ICP-MS faciliies at UJ (above) and UCT (preceding page).

8. Noble gas MS

UJ (MAP 215-50 with Nd:YAG lasers for Ar-Ar dating; Jan Kramers, jkramers@uj.ac.za or Georgy Belyanin, gabelyanin@uj.ac.za; also MKS E-VISION2 quadrupole gas MS with extraction furnace for (U,Th)-He dating; Tebogo Makhubela, tvmakhubela@uj.ac.za)

9. Gas source IR-MS (stable isotope geochemistry, conventional C, O, H isotopes)

iThemba LABS, Johannesburg (Thermo Delta V; Mike Butler, butler@tlabs.ac.za)

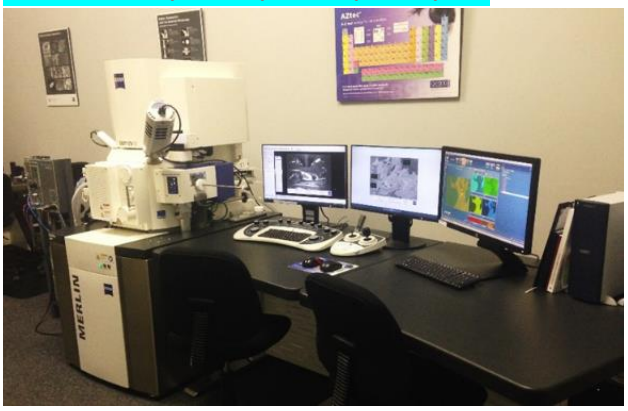
UCT (O-isotopes in silicates by laser and conventional fluorination; H and O by Picarro and IRMS, C and O in carbonates, H in silicates; Access to DeltaXP and Velta dual-inlet mass spectrometers; Chris Harris, chris.harris@uct.ac.za)

10. Ultra-clean lab (elemental separation for solution isotope analysis by mass spectrometry)

UCT (Radiogenic Isotope Facility, routine chemical separation of Rb-Sr, Sm-Nd, Lu-Hf, U-Th-Pb, some non-traditional isotope systems (Li, B, Mg) in development; Petrus le Roux, petrus.leroux@uct.ac.za)

Wits (Wits Isotope Geoscience Lab; capabilities include isotope dilution and chemical separation of Rb-Sr, Sm-Nd, Lu-Hf, U-Pb, Fe-Cu-Zn, Ca-Sr, Al-Be; Grant Bybee, grant.bybee@wits.ac.za; Kimberley Beaton, kimberley.beaton@wits.ac.za)

11. SEM-EDS, -WDS, -EBSD, -TKD, -CL



MERLIN nano-FEG SEM with EDS at SU

NMU (JEOL 7001F SEM + Oxford (Aztec) EDS and WDS + Oxford HKL EBSD and TKD; Arno Janse van Vuuren, arno.jansevanvuuren@mandela.ac.za)

RU (Tescan VEGA SEM with Oxford INCA Penta-FET-X3 EDS; Deon van Niekerk, epma@ru.ac.za)

SU (Zeiss MERLIN FESEM, Zeiss EVO SEM, Zeiss LEO VP-SEM; Madelaine Frazenburg mrfsem@sun.ac.za)

UCT (FEI NovaNano SEM with Oxford INCA EDS (UCT Electron Microscope Unit); Miranda Waldron, miranda.waldron@uct.ac.za)

UFS (JEOL JSM-6610 SEM + EDS/WDS; Megan Purchase, purchasemd@ufs.ac.za)

UJ (Tescan SEM; Willie Oldewage, willieho@uj.ac.za)

Wits-MMU (FEI Nova NanoLab 600 FEG-SEM+Oxford INCA EDS, alexander.ziegler@wits.ac.za)

Wits-MMU (FEI Quanta 400 FEG-SEM+Oxford INCA EDS, MLA, alexander.ziegler@wits.ac.za)

Wits-MMU (Tescan Vega+Bruker EDS+Bruker EBSD, alexander.ziegler@wits.ac.za)

Wits-MMU (Leo 1550 FEG-SEM+uXRF EDS+EDAX EBSD, alexander.ziegler@wits.ac.za)

Mintek (Zeiss EVO MA 15; Bruker EDS; deshc@mintek.co.za)

UP Laboratory for Microscopy and Microanalysis (Zeiss Gemini Ultra Plus FEG SEM with BS, EDS & EBSD detectors; (microscopylab@up.ac.za)

UP Laboratory for Microscopy and Microanalysis (Zeiss Gemini 2 Crossbeam 540 FEG SEM with EDS & BS detectors, Leica EM ACE 600 Freeze fracture/Cryo/Coater system and VCT 100 transfer system; (microscopylab@up.ac.za)

NMISA (Zeiss LEO 1525, Loukie Adlem ladlem@nmisa.org)

12. FIB-SEM

NMU (FEI Helios Nanolab 650 FIBSEM, site specific sampling applications for TEM nanoanalysis; Arno Janse van Vuuren, arno.jansevanvuuren@mandela.ac.za)

Wits-MMU (FEI Nova NanoLab 600 (FEG) FIB-SEM+Oxford INCA EDS+Omicron manipulator, TEM sample prep, alexander.ziegler@wits.ac.za)

NMISA (FIB-SEM with EBSD Zeiss Cross-Beam 540, Clive Oliphant, coliphant@nmisa.org)

13. TEM

NMU (JEOL JEM 2100 + Gatan EELS + Oxford EDS and JEOL ARM200F + Gatan EELS + Oxford EDS; Arno Janse van Vuuren, arno.jansevanvuuren@mandela.ac.za)

UCT (FEI F20 Cryo TEM and FEI T20 TEM with EELS (Electron Microscope Unit) Mohamed Jaffer, mohamed.jaffer@uct.ac.za)

UJ (JEM-2100; Willie Oldewage, willieho@uj.ac.za)

Wits-MMU (FEI T12+Oxford SSD-EDS, FEI T12+Oxford LN-EDS, FEI F30 TEM/STEM, alexander.ziegler@wits.ac.za)

UP Laboratory for Microscopy and Microanalysis (Jeol 2100F FEG TEM with EDS detector, microscopylab@up.ac.za)

14. TEM- tomography

Wits-MMU (FEI T12+Oxford SSD-EDS, FEI T12+Oxford LN-EDS, FEI F30 TEM/STEM, alexander.ziegler@wits.ac.za)

15. Cryo- and Low-Dose TEM

Wits-MMU (FEI T12+Oxford SSD-EDS, FEI T12+Oxford LN-EDS, FEI F30 TEM/STEM, alexander.ziegler@wits.ac.za)

16. ETEM (Environmental TEM)

Wits-MMU (FEI T12+Oxford SSD-EDS, FEI T12+Oxford LN-EDS, FEI F30 TEM/STEM, alexander.ziegler@wits.ac.za)

17. Mineral Liberation Analyser (automated quantitative mineral analysis)

UCT (FEI QEMSCAN 650F (UCT Centre for Image Analysis, Chemical Engineering Dept), Megan Becker, megan.becker@uct.ac.za)

UJ (FEI XL40 ESEM; Fanus Viljoen, fanusv@uj.ac.za)

Wits (Automated Mineralogy Lab; TESCAN TIMA; Nonkusela Madlakana, nonkuselo.madlakana@wits.ac.za)

Wits-MMU (FEI Quanta 400 FEG-SEM+Oxford AZTec MLA, alexander.ziegler@wits.ac.za)

Mintek (FEI FEG-QEMSCAN, Desh Chetty, deshc@mintek.co.za)

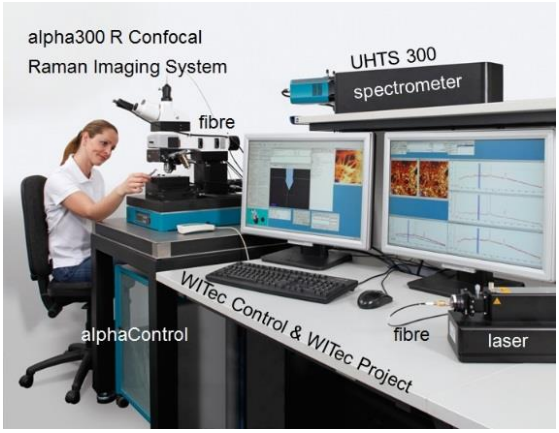
Mintek (FEI FEG-MLA, Desh Chetty, deshc@mintek.co.za)

Mintek (FEI Quanta-MLA, Desh Chetty, deshc@mintek.co.za)

18. Micro-XRF (element and mineral imaging)

Mintek (Bruker M4 Tornado, Desh Chetty, deshc@mintek.co.za)

19. Raman spectroscopy (mineral identification, mapping, fluid inclusions)



WITec alpha300 R confocal Raman imaging system.

NMU (Bruker FTIR/Raman; Ettienne Minnaar, ettienne.minnaar@mandela.ac.za)

UCT Electron Microscope Unit (WiTec Alpha 300 confocal Raman spectrometer, 532 and 785nm lasers available, Miranda Waldron, miranda.waldron@uct.ac.za)

UJ (WITec alpha300 R; Axel Hofmann, ahofmann@uj.ac.za)

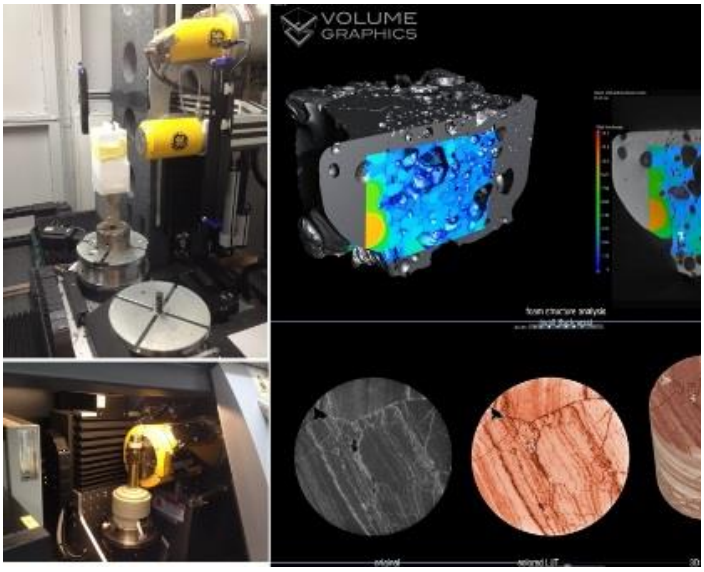
Wits-MMU (Horiba Jobin-Yvon Raman Spectrometer, rudolph.erasmus@wits.ac.za)

20. X-ray tomography (3D scanning and image analysis, reconstruction, modelling & image based simulation)

NECSA (micro-CT, Nikon XTH 225 ST, Lunga Bam, Lunga.Bam@necsa.co.za; www.necsa.co.za/radiography-and-tomography-radtom-group)

SU (micro- and nano-CT, Muofhe Tshibalanganda, muofhe@sun.ac.za; www.sun.ac.za/ctscanner)

Wits (micro-CT with high-energy capability, Jonah Choiniere, Jonah.choiniere@wits.ac.za)

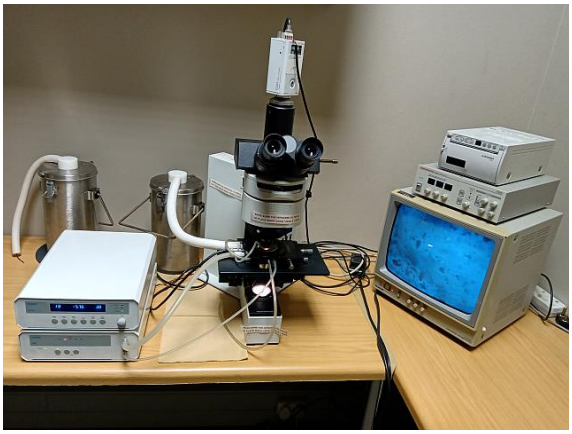


Micro and nano CT facility at SU.

21. Fluid inclusion lab

UCT (Linkam THMSG600; Geoff Howarth, geoffrey.howarth@uct.ac.za)

UJ (Linkam THMSG600; A. Hofmann, ahofmann@uj.ac.za)



Fluid inclusion measurement setup at UJ.

Wits (Linkham THMSG600; Nonkuselo Madlakana, nonkuselo.madlakana@wits.ac.za)

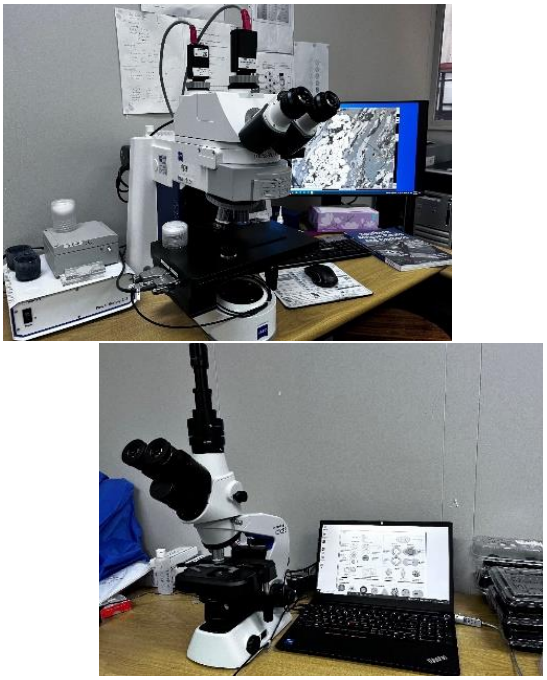
22. Palaeomag lab

UJ (SQUID; Michiel de Kock, mdekock@uj.ac.za)

UKZN (JR6A – spinner magnetometer and LDA-5 AF demagnetizer; Tesfaye Kidane Birke, birket@ukzn.ac.za)

23. Organic Petrology lab

UJ (Zeiss AxioImager M2M reflected light microscope, air and oil immersion lens for reflectance and organic matter; Olympus CX23, transmitted light, air and oil immersion lens) for palynology; Nikki Wagner, nwagner@uj.ac.za)



Organic petrology microscopes at UJ.

24. Nuclear microprobe and PIXE (Particle Induced X-ray Emission)

iThemba LABS (Somerset West; Mlungisi Nkosi, mlungisin@tlabs.ac.za)

Multi-elemental microanalysis and mapping of elements from Na to U using PIXE at iThemba LABS, Somerset West.

25. Secondary Ion Mass Spectrometry (SIMS) (in situ geochemistry)

Wits (via virtual usage of Potsdam CAMECA 1280-HR; Sarah Glynn, Sarah.Glynn@wits.ac.za)

SIMS at GFZ Potsdam.

26. Time-of-Flight Secondary Ion Mass Spectroscopy (ToF-SIMS)

NMISA (ionTOF ToF-SIMS; Werner Jordaan wajordaan@nmisa.org)

27. Thermal Ionisation Mass Spectrometry (isotope geochemistry, dating)

Wits (NuTIMS; Robert Bolhar, robert.bolhar@wits.ac.za; Karen Smit, karen.smit@wits.ac.za)

28. AFM (Contact, tapping, MFM, EFM, Liquid-AFM)

Wits-MMU (Veeco Di3100, Veeco CP2, alexander.ziegler@wits.ac.za)

UP Laboratory for Microscopy and Microanalysis (Bruker Dimension Icon Atomic force microscope with ScanAsyst; microscopylab@up.ac.za)

29. Fluorescent Light Optical (BF, DF, DIC, Z-Stack, 3D, LCSM)

Wits-MMU (Oympus BX63 with DP80, Olympus MVX, Zeiss Axiovert, Zeiss LSM710, alexander.ziegler@wits.ac.za)

30. X-ray Photoelectron Spectroscopy (XPS)

NMISA (Thermo ESCALAB 250Xi XPS; Louise Mostert lmostert@nmisa.org, Werner Jordaan wajordaan@nmisa.org)

31. Particle Size Distribution (PSD)

NMISA (Malvern Mastersizer 3000; Loukie Adlem ladlem@nmisa.org)

NMISA (Zeiss optical microscope; Loukie Adlem ladlem@nmisa.org)

32. Metallographic Sample Preparation

NMISA (ATM Presidion cutter, Struers mounting and polishing equipment; Loukie Adlem ladlem@nmisa.org)

33. Confocal laser scanning microscope

UP Laboratory for Microscopy and Microanalysis (Zeiss Confocal Laser Scanning Microscope 880; microscopylab@up.ac.za)

And that's all folks!

Do you have an analytical service relating to sample preparation, mineral analysis, mineral extraction, or mineral identification?

Do you have capacity to conduct additional services and to get paid for it?

If your answer to any of these questions is "yes, I guess so", then you could be advertising in this space at very reasonable rates, making some revenue, and contributing to the geoscience economy of the nation. What are you waiting for? Right now, someone else is making the profits you could be making, stealing your business! So get busy!

Minsa invites its members to contribute submissions for our next issue of the Geode, on the theme of "*Glass: what's it good for, and how do we analyse it?*" (see below), for Sept. 2022.

Submissions can be sent to minsa@gssa.org.za and should reach us by 31st August 2022.

It is not only the IMA's Year of Mineralogy, but it is also the UN's International Year of Glass. Why is that, do you think; what's so special about glass? From the creation of homogeneous standards and fused discs for element analysis, to understanding polymerisation mechanics, to deciphering parent magma compositions from trapped inclusions in early phenocrysts, glass has a lot to offer. Your take on the uses of glasses, and how we go about measuring properties and compositions of disordered amorphous materials is invited.

Earn CPD points through mentoring!

BridgeTheGap
GeosciencesGuidanceProgram
EMPOWER || INSPIRE

MINSA

Be "the mentor you wish you had" and assist in giving some guidance to geology students by signing up to be a mentor through the Bridge the Gap Geosciences Guidance Program (BTG).

BTG is a student run organisation that focuses primarily on mentorship between undergraduate and postgraduate students. However, all interested individuals are invited to "bridge the gap" between students and industry by joining the BTG program. This could take the form of mentorship, giving a talk, leading an excursion or simply providing sponsorship.

To get involved please complete the Google form via this link: https://forms.gle/Sf5tMciuSStAQuFL8 or email bridgethegap.wits@gmail.com for more information.

SPEAKER

Tricia Scott
Specialist Geometallurgist at Anglo American with a decade of experience in the bulk commodities industry

VENUE

Mandela Mining Precinct: Bottom Shaft
c/o Carlow and Rustenburg road
Melville, Johannesburg

RSVP

by 19 July 2022 at minsa@gssa.org.za

Geometallurgy: unlocking value in bulk commodities

Geometallurgy is traditionally viewed within an extractive metallurgy context – promoting optimal metal recovery and smelting that results in a uniform and exchangeable end state product.

The variable physical and chemical nature of bulk commodity products highlights the importance of not only the extractive metallurgy component of geometallurgical test workflows, but also thorough rock characterisation from the start of the mining value chain, through to the customer use-case.

This presentation describes the application of geometallurgy during bulk commodity mining and marketing processes, highlighting the differences between typical metals versus bulk commodity value chains. The physical and metallurgical variability of bulk products are described, along with the impacts these properties have on environmental sustainability and customer relations.

MINSA
Mineralogical Association of South Africa
A division of the GSSA

26 JULY 2022

18:00

An evening of networking & light refreshments

Unless it ends up going online as well, in which case you may be drinking at home, and networking via the chat function. So get those wine boxes and brie & crackers stocked up, just in case.

Other gems

From pyrite to penguin poop: new papers on mineral parageneses

(alternatively, from the courting mineralogist: How many ways do I love thee? As many ways as pyrite can form. Let me count the ways... yes, of course you can take notes… are you leaving now to go get a pen?)

In July this year, Jonathan Amos of the BBC reported on a new publication by Robert Hazen and Shaunna Morrison from the Carnegie Institute of Geophysical Research (Washington, D.C., U.S.A.), and some of their colleagues, in which they have identified up to fifty seven different "recipes" by which the circa 10,500 different flavours of minerals can be created. About half of these involve some sort of biological agency, and around 80% involve water as a facilitator.

Highlights noted include the production of the mineral spheniscidite as a byproduct of penguin poop. Interestingly, although sphenicscidite, $(NH_4,K)(Fe^{3+},Al)_2(PO_4)_2(OH)\cdot 2H_2O$, is named for its discovery site in British Antarctica, all of the examples of it provided in Mindat.org actually come from the Crimean peninsula in the Black Sea, not normally associated with penguins. Almost 60% of known minerals form by only one (currently) known process, but there are seventeen different ways to form calcite. The winner, with twenty one distinct ways to grow it, is pyrite. Time to update those undergraduate mineralogy course notes!

The BBC article can be found here, at https://www.bbc.com/news/science-environment-62013806. The actual publications in American Mineralogist (available via GeoscienceWorld or a membership in the Mineralogical Society of America) are as follows:

Hazen, R.M. & Morrison, S.M. (2022) On the paragenetic modes of minerals: a mineral evolution perspective. *American Mineralogist* **107**, 1262-1287.

Hazen, R.M., Morrison, S.M., Krivovichev, S.V. & Downs, R.T. (2022) Lumping and splitting: Toward a classification of mineral natural kinds. *American Mineralogist* **107**, 1288-1301.

Contributed by S. Prevec

Considerations on the metaphysics of Al_2SiO_5 in the Earth's crust

The recent passage of the National Arts Festival through my town (Makhanda) in June this year, and my annual pilgrimage to the gem & mineral booth that accompanies it (I bought a tektite and a pallasite), reminded me that a large part (most?) of the commercial appeal of minerals appears to be associated with their more nebulous, less crystallographic properties (I was advised that the tektite is very calming, while the meteorite sample can be very harsh and overstimulating. So far, I haven't noticed, but perhaps this is because they are still in the bag I bought them in, cancelling each other out).

It occurred to me that the ideal case study to assess the metaphysical properties of minerals in a pseudo-scientific way (which is the most appropriate kind of way, in this case) is to examine the polymorphs of Al_2SiO_5, namely kyanite, sillimanite, and andalusite. Mullite, the high temperature low pressure variant, is not technically a polymorph, so we'll ignore that.

Although there has been a lot of fussing about the precise conditions (pressure & temperature, specifically) of the triple point at which andalusite, kyanite, and sillimanite are all stable, we are not concerned with that here, either. The phase diagram in Figure 1 provides us with some critical parameters (crystallography, depth & temperature of formation, and characteristic crystal colour, which is metaphysically significant).

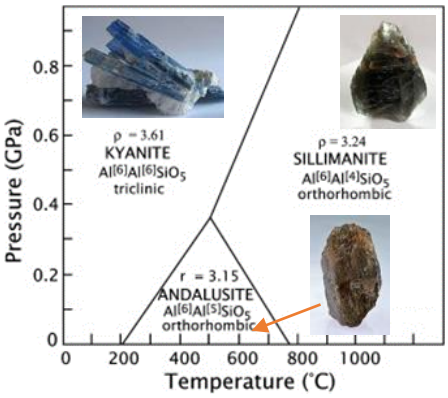


Figure 1. The invariant lines separating our three phases, and the invariant ("triple") point based on Holdaway (1971), modified after Goergen et al. (2008). Mineral images from Wikipedia.

Metaphysics is the branch of philosophy that examines the nature of reality, including the relationships between mind and matter, relevant in our context.

A brief survey of online sources as to the various properties of our minerals of interest can be summarised in the following table.

Health effects

Kyanite

A natural pain reliever, it treats the urogenital system, adrenal glands and parathyroid glands, aids in disorders of the throat, brain and muscular system, and helps to heal infections and lower blood pressure.

Andalusite

An anti-inflammatory, it alleviates arthritis, rheumatism, gout, and joint inflammation, as well as muscles, and nerve paralysis, & twitches.

It can regulate blood flow and reduce edemas, and water retention or eye problems. Finally, it is a boon to breastfeeding mothers, boosting milk production. If you think that's impressive, read on!

Sillimanite

This aids with indigestion, sinus and lung problems, asthma, post-surgery complications, but also has the power to *slow down the aging process*! Who knew! Maybe that's why it's hard to get good dates on sillimanite gneisses.

Relationships and career influence

Kyanite

Kyanite enhances an individual's sense of contentment, so that you are satisfied with what you have instead of what you crave. Also promotes clarity, intuition, and recall of dreams.

Andalusite

Promotes independence, but also, similar to kyanite, aids in balance between desires & ambitions, recognition of what is realistic, less prone to conflict & choosing battles.

Sillimanite

Makes you strong-willed, with enhanced decision-making and analytical skills.

Energy effects

Kyanite

Acts as a shield against negative energies, which it does not absorb.

Andalusite

Facilitates energy flow.

Sillimanite: no data

Chakras

Kyanite: Throat & Third Eye

Andalusite: Navel

Sillimanite: Heart

Overall effects

Kyanite

Calming, soothing

Andalusite

The Seeing Stone; aids to see a person's true character without bias, as well as self-realisation, and seeing how others see you.

Sillimanite

Brings joy, peace & prosperity, with healing powers.

So, what can we make of all that?, you are no doubt asking. And what's a chakra? There are seven Chakras, aligned from the base of the spine to just above the crown of the head, each linked to a specific colour and loosely to the physiological functions relating to their anatomical location (hence the health associations), according to Yogapedia (yes, there is such a thing).

Figure 2. Chakras.

So, kyanite is associated with the throat and third eye (centre of your forehead) Chakras, associated with blue to indigo colours, and with communication (throat) and inspiration (head). Andalusite, being brownish, goes with the navel or solar plexus Chakra, corresponding to self-esteem, and finally sillimanite accesses the heart Chakra (associated with the colour green, not particularly strongly associated with sillimanite, but there we are), and with compassion and love.

We can see that both kyanite and andalusite share the properties of acceptance and balance, which therefore must be linked to their origins as modest temperature polymorphs, compared to sillimanite. We can further extrapolate that this balance is facilitated by having Al in either 6 or 5 fold coordination, rather than 4 (see Fig. 1).

So, in terms of geoscience needs, we can propose the following applications:

Are you participating in job interviews, either as a candidate or on behalf of your employer? Then andalusite, the Seeing Stone, is ideal, to provide insight and true representation of the candidates. If you are being interviewed, you also want andalusite around so that he can see how you are being perceived, maybe bolstered by some kyanite to deflect any negative energies.

Looking for a new ore deposit? Writing a research paper? Dr Prevec recommends the following:

- Kyanite, for inspiration.

In stage two, when you are pushing your ideas through colleagues or management;

- Sillimanite, to enhance the courage of your convictions. A hunk of granulite facies paragneiss is no bad thing to have at hand when trying to be persuasive, either.

When the feedback / reviews come back, and you need to cope with critical analysis, then:

- Some kyanite right at first, to shield those negative energies, followed by andalusite, to facilitate acceptance.

This cycle, from inspiration, to confidence, to acceptance, reflects what we refer to as a clockwise P-T-t path, as illustrated below. Failure to follow these steps in the correct order, such as following an anti-clockwise P-T-t path, could lead to disappointment; if you being with too much balance and acceptance, your proposal will be too conciliatory and lame, followed by stroppy unsubstantiated confidence, and finally, awash with deflected negative energies from your rejected paper or proposal. With great power comes great responsibility, as Spiderman's Uncle Ben once said.

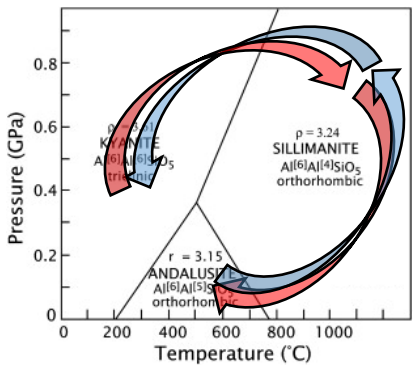


Figure 3. A constructive approach via a clockwise P-T-t path, in red. In blue, a recipe for disaster, probably a future of medication.

Incidentally, in case you are wondering how one goes about using a mineral in this context, it ranges from having it in the room, wearing it as jewellery or about your person, or rubbing it on afflicted body parts.

So to wrap up, just because we can't measure it doesn't mean it's malarkey, unless it is. As a future research question, do the minerals inherit any properties of their polymorph if they form as a result of phase transformation, as opposed to forming from aluminous micas and quartz by prograde processes? A future Honours project in "Human Geology" for your consideration.

References:

Goergen, E.T., Whitney, D.L., Zimmerman, M.E. & Hiraga, T. (2008) Deformation-induced polymorphic transformation: experimental deformation of kyanite, andalusite, and sillimanite. *Tectonophysics* **454**, 23-35.

Holdaway, M.J. (1971) Stability of andalusite and the aluminium silicate phase diagram. *American Journal of Science* **271**, 97-131.

Online Bibliography:

https://meanings.crystalsandjewelry.com/andalusite/

https://meanings.crystalsandjewelry.com/sillimanite/

https://www.charmsoflight.com/kyanite-healing-properties

https://www.firemountaingems.com/resources/encyclobeadia/gem-notes/j145

https://www.mycrystals.com/meaning/kyanite-meaning-healing-properties-and-powers

https://www.thespruce.com/kyanite-can-i-use-it-for-good-feng-shui-1274359

Contributed by Steve
("couldn't you have written a paper in that time?"
No, I could not have)
Prevec

IMA 2022
MINERALOGY AND SPACE
Lyon, 18-22 July

Following the tradition of quadri-annual general meetings of the International Mineralogical Association organized by national societies, the French Society for Mineralogy and Crystallography will host the 23rd general meeting of the IMA in Lyon, France during 18-22 July 2022.

2022 is the year to celebrate mineralogy. It marks the bicentennial of the death of René Just Haüy (born 1743) who is a father of modern mineralogy and crystallography. Two centuries ago is also when Haüy's Traité de mineralogy and Traité de cristallographie were published. Back to our days, in 2022, the last two main Mars exploration programs, Perseverance (Mars2020) and Huoxing 1, will just have had enough time for science return and post-processing. With the return of Hayabusa 2, for the first time, fragments of a primitive carbonaceous asteroid will be analysed.

The 23rd meeting of the IMA will mark these celebrations. In Lyon, we want to paint IMA 2022 with the colours of space exploration. Alongside the more traditional mineralogist we want to inspire the new generation and make a step closer toward the final frontier. The meeting will bring together all the new facets of modern mineralogy; it will be the playground where mineralogy as we know it will meet exploratory planetology, and it will be the place to celebrate two centuries of mineralogy.

The overarching themes of the IMA2022 are:

* Mineral Systematics
* Physics and Chemistry of Minerals
* Ores and Ore Mineralogy
* Mineralogy and Petrology
* Planetary Mineralogy
* Planetary Interiors
* The Dynamical World Of Minerals

To stay updated visit regularly the official conference website: https://ima2022.fr and follow us on Facebook and Twitter. The venue is the Lyon Convention Centre, a state-of-the-art, impressive convention centre featuring 25,000m² of innovative architecture and situated between the Rhône River and the Tête d'Or Park.

On behalf of the French Society for Mineralogy and Crystallography, the leading committee is formed of Razvan Caracas, Herve Cardon, and Cathy Quantin-Nataf.

We are looking forward to seeing you in Lyon later this month!

Bruce's Beauties: Overseas Fluorite

In a previous issue of the Geode, I featured local southern African fluorite specimens. The mineral is repeated here, but this time for examples from outside of Africa. Bruce Cairncross specimens and © photos.

The Tri-State region of the USA is well known for its Pb-Zn deposits and fluorite is often encountered there. This 7 cm specimen consists of cubic fluorite studded by chalcopyrite crystals, some of which are included inside the fluorite. South-End Rosiclare Horizon, Denton mine, Southern Illinois. Collected in 1986.

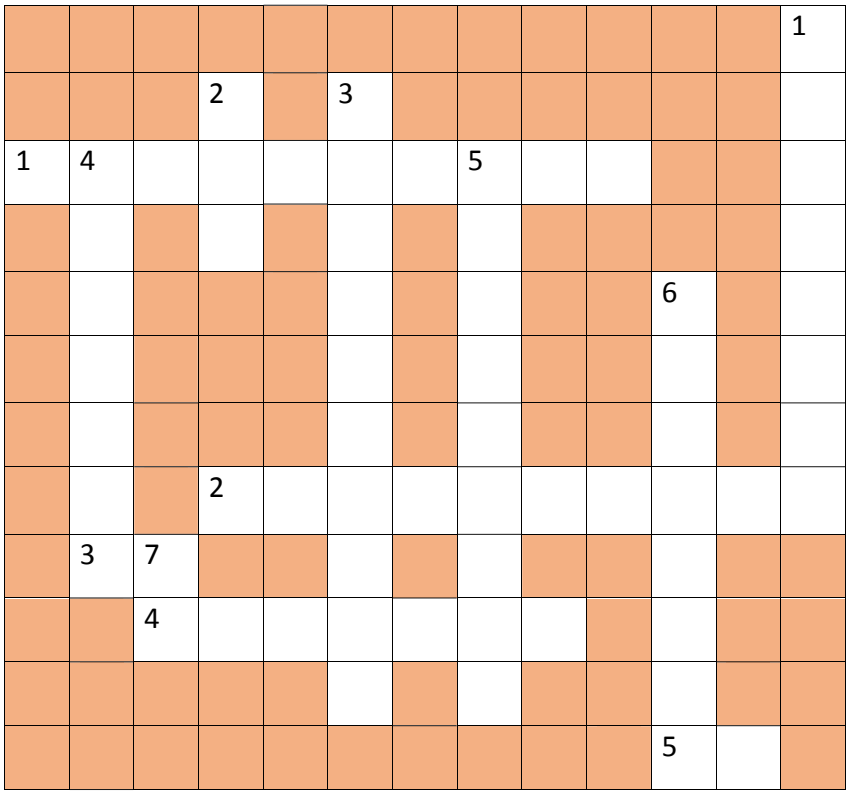
Close-up (field of view is 2.4 cm), of colour-zoned fluorite from Boyle County, Kentucky USA.

Attractive yellow fluorite consisting of intergrown cubic crystals, on white calcite with some drusy pyrite. Field of view is 2.5 cm. Pints Quarry, Black Hawk, Iowa, USA.

Scalenohedral calcite crystals with many small fluorites scattered about on the surfaces. These are colour-zoned. Carmen Mine, West Camp, Santa Eulalia Mining District, Aquiles Serdán Municipality, Chihuahua, Mexico.

Minsa Crossword for June 2022

The theme is retrograde metamorphism; the replacement of one mineral by another, relatively isochemically equivalent one (or ones) as a consequence of decreasing pressure, temperature or both, and typically associated with increasing water content (and associated dissolved ions).



ACROSS:

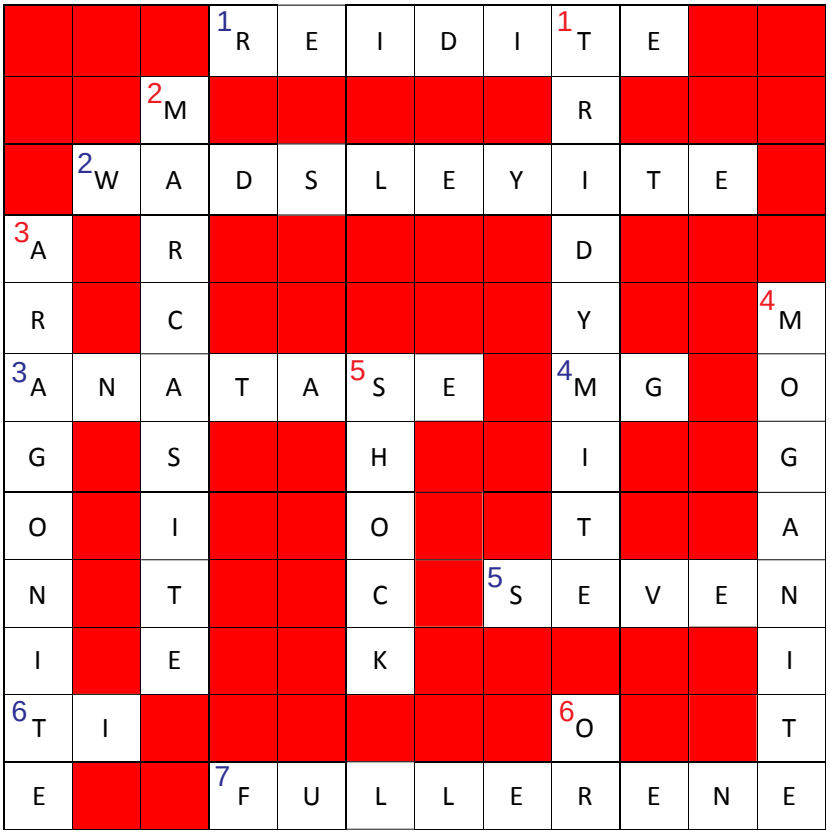
1. A hydrated calcium iron oxide aluminous silicate mineral of the smectite group, now identified as part of the saponite mineral group, formed as part of the breakdown of olivine in the presence of water at low temperatures and pressure.
2. A fibrous serpentine mineral also known as white asbestos which occurs as fibrous crystals replacing the host olivine along fractures.
3. The chemical parameter used to describe the oxidation and reduction potential of a system; the higher the value, the more oxidising the system, as is typically the case in retrograde hydration reaction environments.
4. A K, Fe and Mg sheet silicate mineral group that forms as a result of the hydration and replacement of primary amphiboles and orthopyroxenes during cooling of mafic igneous rocks.
5. The abbreviation for the principal low-Ca pyroxene that forms in mafic igneous rocks at high temperatures, and, similarly to olivine, can alter to serpentine during deuteric alteration.

DOWN:

1. A sheet silicate mineral group that forms as the result of decompression metamorphism of garnets, and by cooling and hydration metamorphism of cordierite.
2. The abbreviation for the common garnet mineral species found in metamorphosed granitoid composition (*s.l.*) crustal rocks, which reverts to the mineral in 1 down with depressurisation.
3. "The other" (along with 2 across) main, non-fibrous structural variant of serpentine that forms from olivine breakdown during late magmatic hydration.
4. The Mg-Fe orthosilicate mineral associated with silica-poor igneous rocks, which readily reacts along its characteristic fractures to form an assortment of sheet silicate minerals, often as pseudomorphic replacements.
5. A microcrystalline rock (no longer considered a mineral) consisting of variably oxidised and hydrated versions of its protolith mineral, from 4 down, found in hypabyssal and extrusive (but not plutonic) rocks.
6. A fine-grained variant of muscovite that characterises the alteration of various tectosilicate minerals such as orthoclase, cordierite, and plagioclase feldspars.
7. The abbreviation for the amphibole mineral group that occurs as a replacement of primary calcic pyroxenes in mafic igneous rocks, either as rims, or eventually as pseudomorphic or wholesale replacements thereof.

Minsa Crossword solution for March 2022

Last issue's crossword theme was polymorphs. Some are common, some obscure. Test your knowledge of the little brothers and sisters of the more well-known minerals. I invited anyone who could suggest other minerals that feature polymorphs, for the chance to win a (used, but a nice one) t-shirt; there were no applicants, so no winners!



ACROSS:

6. A high-pressure (>30 GPa) polymorph of zircon associated with impact craters, named in 2002.

7. A high-pressure form of Mg_2SiO_4 first found in a meteorite. Not as high pressure as Ringwoodite, but similarly able to incorporate H into the structure and potentially hold water.

8. A low-temperature metastable polymorph of brookite and akagoiite.

9. The cation typically present in 3 DOWN whose presence stabilizes this polymorph at low temperatures and pressures.

10. The total number of SiO_2 polymorphs; don't forget the 'new' one in 4 DOWN.

11. The primary cation in the minerals in 3 ACROSS.

12. The informal name for the spherical structural polymorphs of graphite and diamond formed at high temperatures but low pressures, found associated with wildfires.

DOWN:

8. A high temperature polymorph of quartz normally associated with felsic volcanism; the Curiosity Rover unexpectedly found some on Mars in 2015.

9. The polymorph of FeS_2 that forms under particularly acidic conditions. Jewellery made of its polymorph is, confusingly, referred to by this mineral name.

10. The high pressure form of $CaCO_3$ that also, paradoxically, is the preferred polymorph for biomineralization, probably because of the ion in 4 ACROSS.

11. A polymorph of SiO_2 rejected by the IMA in 1994 as being too similar to quartz, accepted 5 years later (it's biaxial!); found in rhyolitic ignimbrite in the Canary Islands.

12. The category of metamorphism in which the mineral found in 1 ACROSS can form.

13. Prograde metamorphism of muscovite and quartz (in the absence of water) produces a polymorph of Al_2SiO_5, melt, and this mineral, whose abbreviation we seek. Yes, I know it's a stretch. As a consequence of this reaction in the Bushveld contact aureole, South Africa has the world's largest ore reserves of andalusite.

Note: The recommended deadline for submissions for the next issue of the Geode is August 31, 2022.