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OF THE MINERALOGICAL SOCIETY

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From our editors...

Hello and welcome to the December issue of the Applied Mineralogist!

In this issue we present a bursary report funded by the AMG to help with analytical studies. For the special feature we present a report by Millie Dobson into work by Golden Star Resources. Tim Webster provides insights into his placement with Cornish Lithium, and test your skils with a festive wordsearch. Don't miss the winner of ThinSectionThursday!

Figure 1. Group photo of the participants to the International Diamond School 2023 in the lounge of the Hotel Elephant

AMG BURSARY REPORT

Andrea Pezzera, Edmonton, 13/03/23

International Diamond School 2023, Brixen, Italy

The International Diamond School is held approximately every three years, with the aim of discussing the latest achievements in all the disciplines related to diamond geology. The 2023 edition was hosted by the University of Padua, from the 20th to 25th of February, in its branch office in Brixen. The high peaks of the Dolomites accompanied the short walk that every day the participants made from the historical Hotel Elephant to the conference room. More than 80 scientists from every level of academic and industry backgrounds participated. The school started with lectures from senior scientists, covering fields from cratonic geology to petrology and isotopic studies. The lecture week was broken in half by one day of practical sessions. Diamond crystals had been observed optically and analyzed in real time by Raman and FTIR spectrometers assembled specifically for the event. Another practical session showed how to calculate the reciprocal orientations of diamond and its inclusions by ESBD and X-ray diffraction data. A Further two days of talks followed, starting with the young academics, and finishing with the Ph.D. students. This was the occasion to give my first conference talk, entitled "Mesoarchean diamonds from Manitoba: mineralogical insights on early geodynamics and unconventional diamond deposits". Like rolling apples, typical products of the high Adige Valley, students and scientists met for informal discussions during the breaks at the end of every session; this was the real 'juice' of the conference. The talk that intrigued me the most was entitled "Dynamical properties of diamond from ab initio simulations", by Razvan Caracas, CNRS, about the behavior of hydrogen defects in the diamond lattice. A unique talk by John Armstrong, Lucara Diamonds, showed how the biggest diamonds in the world are mined; the participants had the occasion to handle a real pair of them (plastic replicas!). The great success of the school must be addressed to the fabulous organization committee, starting from the tireless Prof. Fabrizio Nestola and Professors Suzette Timmerman, Karen Smit, Thomas Stachel, Martha Pamato, Steve Shirley, Graham Pearson. It was a highly inclusive, multigenerational, and international event that was able to create a sense of family and will surely boost the scientific achievements in diamond geology for the next three years.

Highlights

Edited by:
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Tim Webster
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SPECIAL FEATURE

Millie Dobson1, Christina Larkin1, Golden Star Resources, a member of Chifeng Gold Group

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Usually, the interest of most economic mineralogists may dwindle long before the production of mine tailings or other wastes. After all, tailings are just the crushed waste rock that remains after all of the interesting ore minerals have been thoroughly extracted, so where would be the interest in that?

Although I'm not a mineralogist myself, and this topic is almost definitely adjacent to what most applied mineralogists study on a day-to-day basis, I believe that placing our research within a broader context can never be a bad thing; so, I would like to keep your attention to talk about how we can use mine tailings to remove carbon dioxide from the atmosphere.

The IPCC has now stated that in order to limit global warming to ≤2°C above pre-industrial levels, we must now actively remove carbon dioxide from the atmosphere, as well as reducing global emissions(1). One emerging carbon dioxide removal technique is called Enhanced Weathering, which aims to artificially speed up the rate of silicate weathering(2). When silicate minerals naturally weather with carbonic acid in rainwater, the reaction draws down CO2 from the atmosphere:

$$2H_2CO_{3(aq)} + CaSiO_{3(s)} \rightarrow Ca^{2+}_{(aq)} + 2HCO^{-}_{3(aq)} + SiO_{2(aq)} + H_2O_{(l)}$$

This produces cations, and alkalinity in the form of a bicarbonate ion. Enhanced Weathering usually operates via the spreading of crushed magnesium and calcium rich rocks onto agricultural fields, where their dissolution not only contributes to CO2 removal, but also releases nutrients and contributes to reducing soil acidity(3). Sourcing the feedstock rocks for Enhanced Weathering is a key challenge; quarrying and crushing of rocks leads to further CO2 emissions, of course. This is where the global metal and diamond mining industry may come in; over 13Gt of silicate-hosted tailings are produced by the industry each year(4). Furthermore, tailings are already crushed, and they are expensive to store safely long-term and if stored improperly can be the source of fatal disasters(5)- for these reasons therefore, they are a promising potential material to use as a feedstock for Enhanced Weathering.

We have been working with an established mining company from Ghana called Golden Star Resources, Member of Chifeng Gold Group. Golden Star Resources operate a mine in the Wassa region of Ghana, which exploits the Ashanti Greenstone Belt. When one of their Tailings Storage Facilities (TSFs) was due for closure, in lieu of traditional capping methods, Golden Star Resources decided to revegetate the TSF by planting oil palms directly on top of the surface of the tailings (Fig. 1). Tailings storage facilities cannot be left uncovered due to the risk of aeolian erosion, but usual capping methods would prevent them from being in contact with the atmosphere.
This soilless revegetation was initially carried out as it was a cheap way to rehabilitate the TSF, however this is interesting from the perspective of those of us working in Enhanced Weathering for a few reasons:

1. Are the tailings weathering under the oil palms? Can we quantify the atmospheric CO2 removed during this?
2. How well do plants grow on mine tailings? Can they be safe to use as a feedstock for enhanced weathering?

Myself and my colleague Christina Larkin, visited the mine site in Ghana in December 2021 in order to investigate these questions. We flew into the bustling hub of Accra before a five hour drive west along the beautiful Ghanaian coastline to Wassa. At the mine site we were given a thorough tour around the operations; seeing every aspect from the exploration drills and core logging, the entrance to the underground operations, through to the ore processing plant and construction of tailings storage facilities. I think seeing the scale of the operations and resources used in mining first hand also confirmed to me why increasing sustainability and efficiency at every step of the process is so important, particularly as demand for metals will continue to increase throughout the 21st century.

We sampled soils, soil waters and surface waters from two main areas on site; the revegetated TSF and an adjacent oil palm plantation that was also managed by Golden Star Resources, but is grown on normal soils (Fig. 2).

The team on site at Golden Star were fantastic in supporting us in the field- working on active mine sites means that you are always accompanied by members of the team, owing to well-respected health and safety protocols. We have quantified CO2 removed by both alkalinity production in the waters, and also in the accumulation of organic carbon in the revegetated tailings. We also analysed the leaf samples to rule out heavy metal accumulation in the oil palms, and took samples of fresh tailings so we could characterise the initial material. Our results combining both alkalinity generation from chemical weathering, and organic matter generation give us a CO2 removal value of ~ 1100 t CO2 yr-1 between the beginning of the trial and 2021, in which we sampled (in prep). We have also found no evidence of heavy metal accumulation in the leaves of oil palms planted on the tailings versus on local soils- furthermore, the oil palms planted on the tailings had fruit yields over twice those of the palms on 'normal' soils for the same year! Full details of analyses and results will be available to read on publication. The site will be monitored in the future for heavy metals, but overall, the revegetation trial represents a successful rehabilitation of a TSF. Our fieldwork and subsequent analyses acts as a simple 'snapshot' proof-of-concept study, demonstrating the potential applicability of mine waste to enhanced weathering systems.

The results of this revegetation are promising; they demonstrate that we may be able to repurpose waste from the mining industry for use in carbon dioxide removal schemes, as well as demonstrating that revegetation may be a cheap and effective way to close tailings storage facilities, whilst enhancing the weathering of the minerals within the tailings. Of course, there is still a long way to go from a regulatory standpoint before using mine tailings for enhanced weathering can become commonplace, and all tailings will have to be assessed on a case-by-case basis in order to monitor long term safety and efficacy of such schemes. Overall however, it is encouraging as a whole to see continuing efforts from the mining community in how best to improve sustainability within the industry, as well as producing novel solutions to waste management and circularity of resources.

Acknowledgement to the team at Golden Star Resources, member of Chifeng Gold Group for their help on and off site in carrying out this work.

I. IPCC, J. S. Shukla, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, "Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change," (2022).

2. D. J. Beerling et al., Potential for large-scale CO(2) removal via enhanced rock weathering with croplands. Nature 583, 242-248 (2020).

3. A. L. Lewis et al., Effects of mineralogy, chemistry and physical properties of basalts on carbon capture potential and plant-nutrient element release via enhanced weathering. Applied Geochemistry 132, (2021).

4. L. A. Bullock, R. H. James, J. Matter, P. Renforth, D. A. H. Teagle, Global Carbon Dioxide Removal Potential of Waste Materials From Metal and Diamond Mining. Frontiers in Climate 3, (2021).

5. L. H. Silva Rotta et al., The 2019 Brumadinho tailings dam collapse: Possible cause and impacts of the worst human and environmental disaster in Brazil. International Journal of Applied Earth Observation and Geoinformation 90, (2020).

FIGURE 1: LEFT HAND SIDE; THE ACTIVE TAILINGS STORAGE FACILITY AT THE MINE SITE, DEMONSTRATING WHAT THE TRIAL WOULD HAVE LOOKED LIKE PRIOR TO REVEGETATION. RIGHT HAND SIDE: THE TAILINGS STORAGE FACILITY FOUR YEARS AFTER REVEGETATION WITH OIL PALMS.

FIGURE 2: SOIL AND SOIL WATER SAMPLE COLLECTION IN THE FIELD.

FIGURE 3:TERRESTRIAL CRABS THAT LIVE IN HOLES IN THE GROUND.

CORNISH LITHIUM, TRELAVOUR DOWNS PLACEMENT

By Tim Webster

I recently completed a three-month secondment at Cornish Lithium at their Trelavour Site from August to November 2023. During this period, I took a three month break from my PhD. I started the placement during the height of their third drilling campaign. My role during the first two months of the placement was to support the geologist team, where I helped with core logging, acquiring structural data, and core sampling. This allowed me to see 100s of metres of Li-rich Topaz granite. There were also numerous examples of Stockscheider pegmatites and layered aplites.

FIG. 1: LEFT: RC PILES SHOWING EXTENT OF SAMPLING FOR ONE DRILL SITE. RIGHT: IMAGE SHOWING THE VARIATION IN COLOUR OWING TO THE CHANGES IN MINERALOGY OF THE GRANITE

Rotary core (RC) drilling was used as a quick and easy way to acquire information on the mineralogy, as opposed to diamond drilling, which takes longer (Fig. 1). This involved sampling after a specific distance, seizing, and washing the sample before placing in a chip tray. When the tray is full it is very easy to see the colour changes that may reflect changes in granite type and/or alteration, such as kaolinization or phengitization. Kaolinization is the breakdown of feldspars to clay minerals such as kaolinite, and phengitization is the alteration of Li-mica to muscovite which is identified by greening of feldspars and mica. While kaolinization does not impact Li-grade, phengitization drastically reduces Li concentrations in mica and thus lowers the grade considerably.

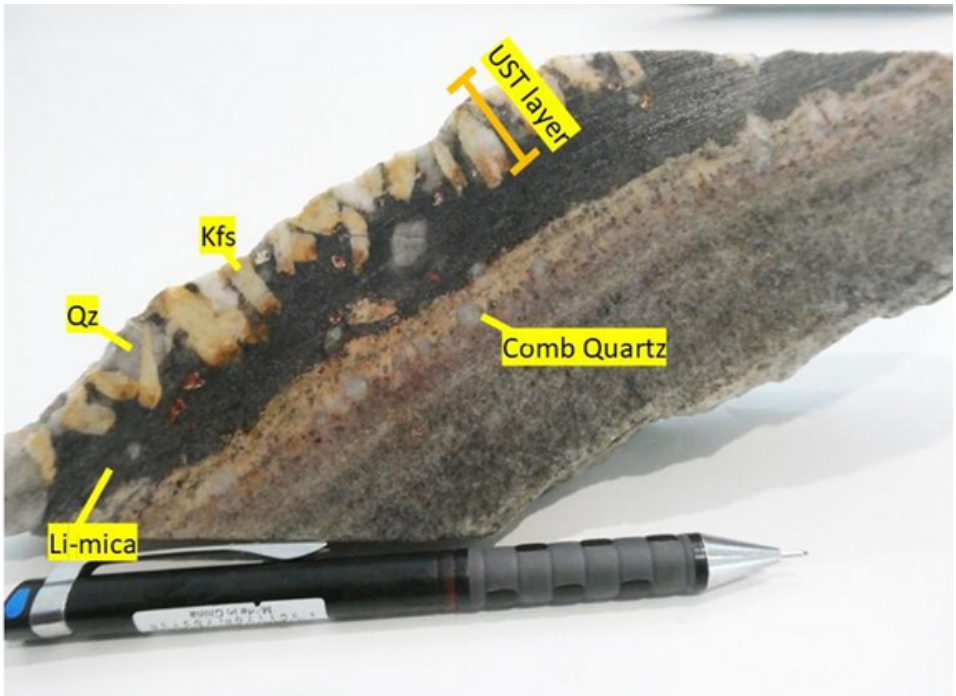

FIG. 2 TEXTBOOK EXAMPLE OF A STOCKSHEIDER PEGMATITE WITH UNIDIRECTIONAL SOLIDIFICATION STRUCTURE (UST)

I also undertook a month of looking at pegmatite types found in the Trelavour Downs Quarry where a wide range of Stockscheider pegmatites are found for examples of these in Cornwall see Yucheng, (1989). Stockscheiders are a marginal pegmatite commonly associated with the roof zone of peraluminous granites and or related to the contact between two granite types such as topaz granite and tourmaline granite (Breiter, 2002). These marginal pegmatites are easily distinguished from other pegmatites due to the presence of large dogtooth K-feldspar and quartz which grow perpendicular to the contact of the pegmatite. Directly below this unidirectional solidification texture (UST), are layered aplites.

Many of the stockscheider pegmatites were textbook examples of marginal pegmatites with stunning unidirectional solidification textures (UST) and layered aplites (Fig. 2). Whilst others were considerably altered, either kaolinized or phengitized. Understanding the spatial distribution within the Topaz granite and Tourmaline granite may help provide insights into the nature of mineralisation within these pegmatites. My recommendation based on the presence of these marginal pegmatites, should be to undertake a detailed petrological and geochemical analysis of the different zones of the pegmatite – with the ultimate aim to better understand the nature and mineralisation of these stockscheider pegmatites.

To conclude this summary of the experience there at Cornish Li. The last three months at Cornish Li were a truly wonderful and insightful where I got a chance to work with an enthusiastic and positive geology team, who showed and taught me all the steps that go from determining a drilling location to sampling core and to lastly monitoring water levels in the quarry (Fig. 3).

FIG. 3: FINAL DAY OF PLACEMENT MEASURING GROUNDWATER LEVELS IN THE TRELAVOUR DOWNS QUARRY USING A WATER LEVEL METER.

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WORDSEARCH

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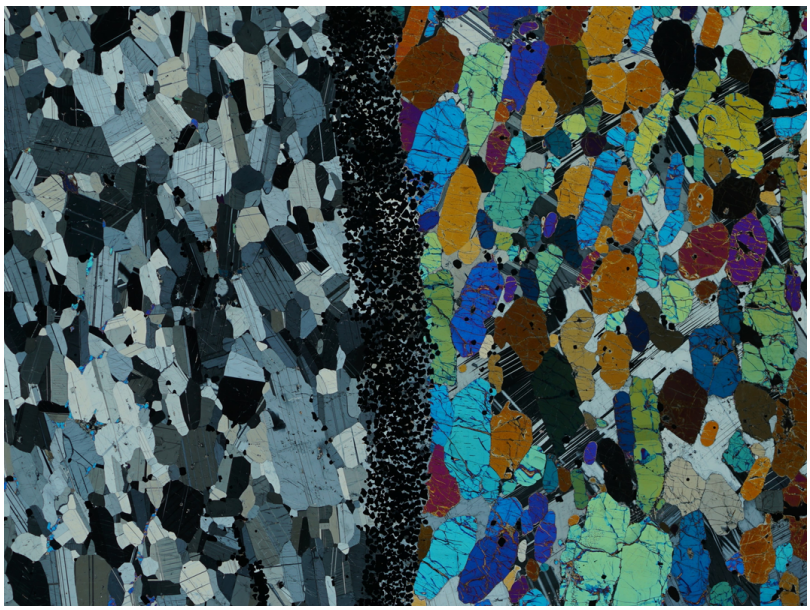
AVENTURINE
CHRISTMAS
CINNABAR
CRYSTALLOGRAPHY
DECEMBER
FIREOPAL
FRANKINCENSE
GOLD
JINGLEBELLROCK
MALACHITE
MICROSCOPE
MINERALOGY
MYRRH
NEPHRITE
NORTH
PETROLOGY
POLE
PRESENTS
PYROMORPHITE
ROCKING
RUBY
SILVER
TANZANITE
TOPAZ
TURQUOISE
ZIRCON

#THINSECTIONTHURSDAY



AND WE HAVE A WINNER....

DR ANOUK BORST
@ANOUKBORST

'Anorthosite-peridotite with chromite seam, from the Rùm mafic layered intrusion, Scotland' - doesn't look real does it?

GET INVOLVED.

If you would like to become more involved in the AMG, elections are held yearly at the AGM. Spaces for Student Representatives come up regularly. If you would like to be considered for a committee spot please email Martin Smith (Chair).

BURSARIES.

The AMG provides bursaries for postgraduate students in the disciplines of Applied Mineralogy, Crystallography, and Petrology and Geochemistry. Bursaries are intended to support conference attendance and associated travel costs, although other activities may be considered. Application guidelines can be found at:

www.minersoc.org/amg-bursaries

Please note there are two bursary application deadlines each year: 15th April and 15th October. Requests for funding must be received well in advance of the event to allow for consideration by the committee.

FUNDING.

We welcome applications from both individuals or organisations for funding in support of events covered in the AMG remit. Further guidelines on how to apply can be found at:

www.minersoc.org/amg-funding

Don't forget to keep posting with ***#ThinsectionThursdays, #FieldworkFridays, #MineralMondays,*** *and* ***#AppliedMineralogy*** *for your chance to be featured.*

A NOTE FROM OUR EDIORS:

Thank you to those who have contributed to this issue of Applied Mineralogist. Please forward any articles, comments or notices of events and conferences to **amgminsoc@gmail.com**. All previous issues of Applied Mineralogist are available at:

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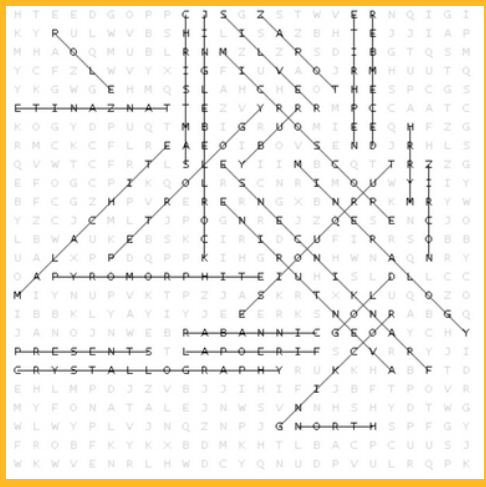
WORDSEARCH ANSWERS



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Upcoming Events:

- MDSG 3-5th Jan 2024
- EGU 14-19th April 2024
- Goldschmidt 18-23rd Aug 2024