

The Applied Mineralogist

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Mineralogical Society



From the AMG committee

Hello and welcome to the September edition of *The Applied Mineralogist*! We present a special feature on brand new research on **carbonate-derived fluorapatite** and how it can enhance the size of your marrows. Read about what happened at the first **Virtual Goldschmidt** conference, and about the other recent **online talks and workshops**. Finally, test your mineralogical vocabulary on this edition's **mineralogy crossword**.

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Goldschmidt: Virtual 2020, 21st-26th June

Summary by Daisy Jennings-Gray, Imperial College London

This year's Goldschmidt conference, hosted by the Geochemical Society and the European Association of Geochemistry, was scheduled to be held in Hawaii in late June. However, due to the Covid-19 pandemic, the whole conference was virtualised into a week-long event for a global audience. As a 4th year integrated Masters student at Imperial College London, the virtual conference still offered me plenty of opportunities to attend presentations on topics of interest, network and present my own work to a Q&A panel.

The conference was split into themes, spanning from Planetary Geochemistry to Mineral, Melt and Fluid Chemistry. Each theme had subcategories with timetabled slots for live Q&A sessions, so there were plenty of presentations to attend outside of your own group. Amongst others, I attended talks from Session 6a, 'Cross-Scale Investigation of Geochemical Processes: Experimental and Modelling Approaches', where one of the conveners of the group was Dr Cedric John from Imperial's own Earth Science department, and also the keynote presentation from the 'Processes of hydrothermal ore formation for base, precious and critical metals' which discussed the importance of fluid-melt interaction for Nb-Ta mineralisation.

As well as the research talks, I was able – as a young presenter – to sign up to an array of Early Career events that looked at networking and personal development. Early on in the week there was a session on 'Clear, Concise and Confident: Overcoming Stage




Fright And Creating Impact In Your Virtual Goldschmidt Presentation', which addressed how to respond in your live Q&A session and tips on overcoming nervousness when speaking to experienced academics. I also tuned into a session on Non-Academic Career Paths and there were talks available on Funding Opportunities and a mentoring scheme in which young academics could enrol in for guidance throughout the course of the conference.

On the Thursday, I was lucky enough to be able to present my MSci work, supervised by Dr Samuel Krevor, on Machine Learning for Mineral Segmentation Using Dual-Energy Micro-CT scans, which had been accepted into the 'Novel Analytical and Computational Methods Connecting Molecular-Scale to Pore-Scale Geochemical Processes' session.

Prior to the session, I was asked to upload a 5-minute presentation of my work, which I then presented again live (at 11:30pm due to the time difference with Hawaii!) and answered questions put to me by other speakers in the group and attendees of the session. It was a brilliant opportunity to showcase my research and, apart from there being no beach 50 yards from the back door, I felt like I still had all the opportunities to network and attend all the presentations I was interested in as if I had been to the real thing.

Staying Virtual

Compiled by Adam Eskdale, Royal Holloway, University of London

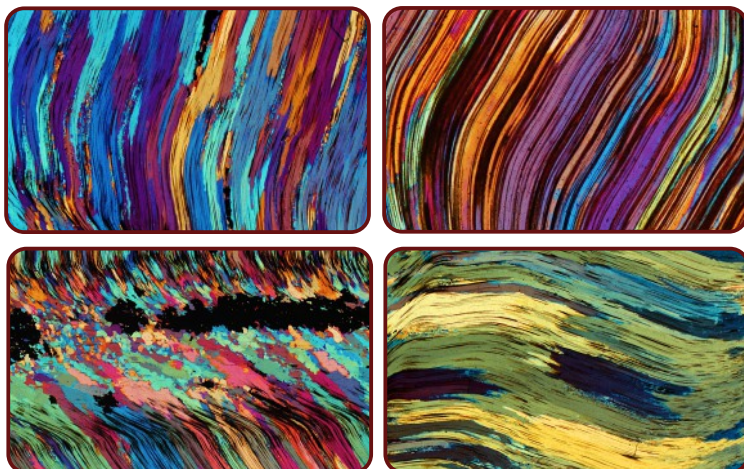
The **Ore Deposits Hub**  is an open talks platform providing researchers, academics and industry representatives a way to continue to present exciting work that has been going on in the past few months, without the need for in-person presentations. Online lectures cover a whole host of subjects across the economic geology spectrum and deposits across the globe.



Upcoming talks:

- 23rd September, 07:00 GMT - **Jesse Clarke and Kathy Ehrig:** Unravelling the Geology of Olympic Dam.
- 23rd September, 16:00 GMT - **Monica Ospina and OTrade:** Environment, Social and Governance (ESG) for Geoscientists.
- 30th September, 07:00 GMT - **Walid Salama:** Mineral Exploration Techniques in Weathered and Covered Terrains
- 30th September, 16:00 GMT - **Richard Goldfarb:** Geologic Evolution and Gold Metallogeny of China

Find out more information and sign up at: <https://oredepositshub.com/>



#Applied Mineralogy @ micROCKScopica

From your #ThinSectionThursdays, #FieldworkFridays & #MineralMondays, our #AppliedMineralogy winner is...

@micROCKScopica

...with a series of sensational images showcasing intergrowths of quartz and crocidolite needles in Tiger's Eye from South Africa.

Mineral Cup 2020

It's back! The 2020 edition of the Mineral Cup kicked off on Twitter on the 1st September and rounds will take place daily throughout September. Some new rules have been implemented by the organisers this time, including the potentially controversial decision to only include specific mineral species (as recognised by the IMA) and not mineral groups. Previously included mineral groups have been replaced by representative minerals delegated by the organisers, for example this year fluorapatite takes the weighty responsibility of representing the entire apatite group.

For more information on the 2019 edition including a fact file on the reigning champion #IceMin, check out June's edition of Applied Mineralogist. Stay tuned @MineralCup on Twitter #MinCup2020

The origin and composition of carbonatite-derived carbonate-bearing fluorapatite deposits

Sam Broom-Fendley, Camborne School of Mines, University of Exeter

If you are fortunate enough to have a garden then you've probably turned your hand to growing vegetables this summer and I'd wager that, by now, you're a little disappointed with the size of your marrows. It turns out, as well as water, sunlight and some attention, plants also need nutrients in order to live. One of these is phosphorus— it's one of the three main macronutrients in fertilizer (along with K and N), it's particularly important for fruit and seed development, and it's almost entirely dug out of the ground.

Phosphorus extraction is big business, with over 200 Mt of phosphate rock extracted annually (Pufahl and Groat, 2016). Gone are the days of scraping bird poo from Pacific Islands (sorry Nauru). Today >90% of mined phosphorus is extracted from phosphorites (marine biochemical sedimentary rocks with >18 wt % P_2O_5). The remainder is obtained from alkaline igneous rocks and carbonatites. Carbonatites are igneous rocks with >50% carbonate minerals, and those which we're going to delve into today.

There are two different phosphate deposit types related to carbonatites: 'magmatic' apatite deposits and 'secondary' carbonate-bearing fluorapatite deposits. Magmatic apatite deposits are relatively straightforward. Fluorapatite ($Ca_5(PO_4)_3F$) is commonly an abundant accessory mineral in carbonatites and, as such, many carbonatites have a P_2O_5 concentrations of between 3 and 6% P_2O_5 . This is not significant when compared with other phosphate deposit types, but carbonatites can be relatively easy to process and so, where intrusions are large enough, they can be mined.

'Secondary' carbonate-bearing fluorapatite deposits are almost entirely composed of a variety of fluorapatite which accommodates a small amount of carbonate in its structure. In contrast to magmatic apatite deposits from carbonatites, 'secondary' deposits can reach very high grades— almost reaching a pure apatite rock. The deposits can also be pretty big, and are actively mined at Catalão I in Brazil, with mineral reserves mined out at Cargill (Canada) and Glenover (South Africa).

How these 'secondary' carbonate-bearing fluorapatite deposits form is something of a mystery. At some deposits geological evidence, such as brecciated cone-structures, points towards a hydrothermal origin. Other deposits are located in modern tropical weathering horizons, clearly demonstrating formation through a supergene process. Part of the problem is that each study, to-date, has focussed on individual localities with little comparison between sites, and few studies describe the mineralogy of the deposit in detail. Our recent study did just this. Mineralogy to the rescue!

By comparing the composition and texture of apatite from five, globally-distributed, carbonate-bearing fluorapatite deposits we found that, with a few minor exceptions, the composition and textural evolution of each locality is broadly the same. Apatite forms distinct textures at different stages, which correspond to a trend of decreasing overall trace element contents, with minor increases in U and Cd. Some of these apatite textures are spectacular (see pictures).



A. View from the sauna at the Sokli carbonatite, Finland, one of the sites studied in this work. Up to ~100 m of carbonate-bearing fluorapatite underneath your feet. Sauna not tested by author (unfortunately).



B. Carbonate-bearing fluorapatite rocks from Kovdor, Russia. Finger— author's own.



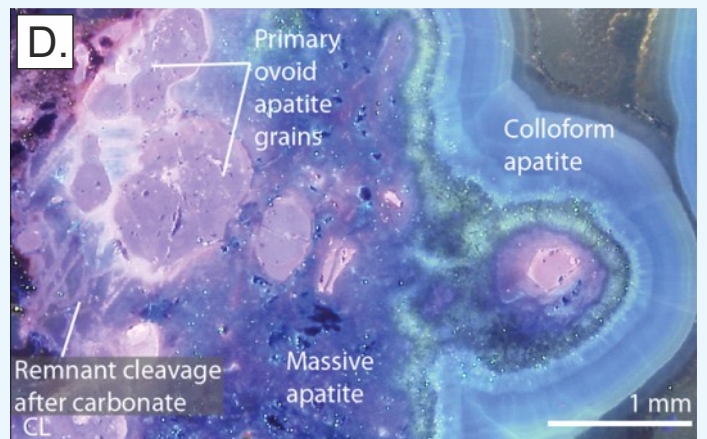
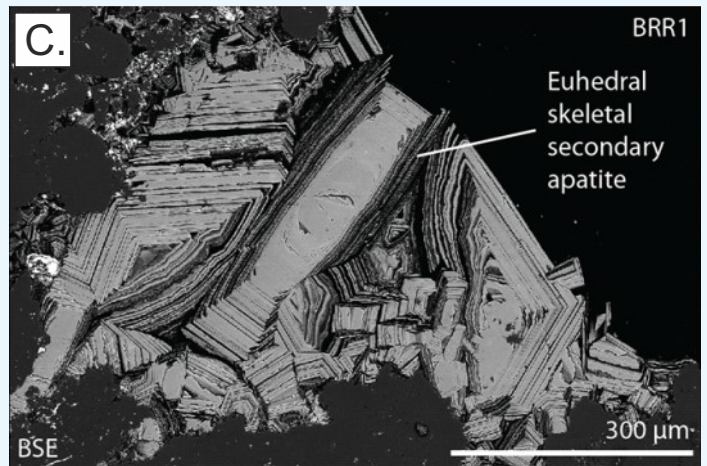
In addition, the REE distributions of each apatite generation remain roughly the same, but develop a distinct Ce anomaly, typically attributed to weathering processes.

So there you have it – carbonate-bearing fluorapatite deposits probably form through weathering. Pretty cool considering some of the examples studied occur in arctic climates. Have a read of the paper if you want to find out more! Or go outside and grind some carbonatite on your garden to ready it for next year.

Broom-Fendley S, Siegfried PR, Wall F, O'Neill M, Brooker RA, Fallon EK, Pickles JR, Banks DA (2020). The origin and composition of carbonate-derived carbonate-bearing fluorapatite deposits. Accepted- in press, Mineralium Deposita. <https://doi.org/10.1007/s00126-020-01010-7>

References:

Pufahl PK, Groat LA (2017) *Sedimentary and Igneous Phosphate Deposits: Formation and Exploration*. *Econ Geol* 112:483–516



C. Skeletal carbonate-bearing fluorapatite from Catalão I. **D.** Cathodoluminescence image of colloform carbonate-bearing fluorapatite, Kovdor, Russia.

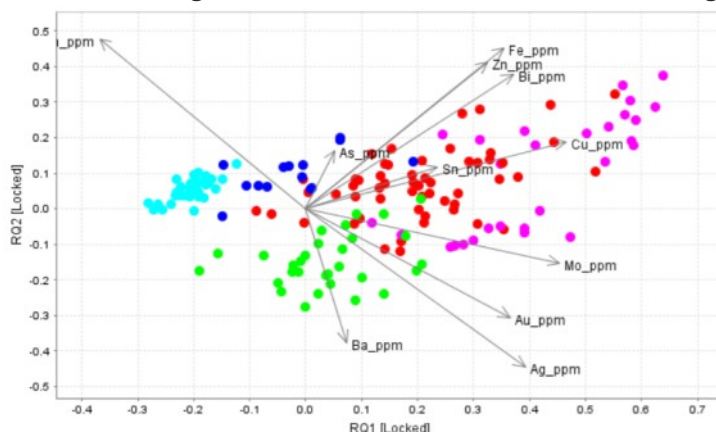
Geological Society ioGAS Webinar

Katie McCann, Imperial College London



IoGAS is a software that was previously unfamiliar to me, but going into my MSci project it'll be a large component of extracting value from data I've compiled and produced. IoGAS is primarily a geoscience workflow tool to aid in the visualisation and interpretation of geochemical data. The start of the workshop focussed on the philosophy and techniques we need to consider when analysing data, with some incredible book recommendations to aid the link between the process of analysis and utilising that in science.

The rest of the workshop focussed on an introduction to the software, workflows, and an overview of the various functions and examples to go alongside them. It was made clear how useful the software could be for many different data types and fields of research! I now feel much more confident about using ioGAS software, with a good understanding of the basics as well as an awareness of the huge potential to create more advanced functions.



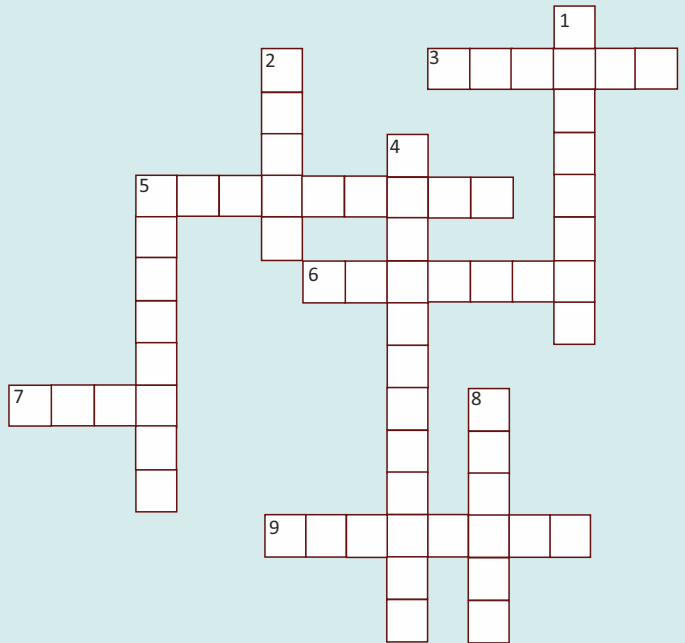
Example of ioGAS principal components analysis (from What's New in ioGAS 6.3)

The ioGAS webinar was held on 29th July 2020 and organised by the Early Career Network of the Geological Society and the Early Career Professionals Committee of the Society of Economic Geologists.

The Introduction to ioGAS webinar can be found here: https://www.youtube.com/watch?v=EEOjkhv8lg0&ab_channel=GeologicalSociety

Mineralogy Crossword

1. The name given to a meteor brighter than Venus
2. The most valuable type of opal
3. The only rock that floats on water
4. The name of the biggest volcano in the Solar System
- 5A. Cenotes used for Mayan sacrifice all aligned to reveal this crater
- 5D. Number 9 on Moh's hardness scale
6. The biggest hole ever dug by man
7. This metal reached a price of \$2000/oz for the first time in history this year
8. Mineral also known as 'Fool's Gold'
9. Officially the world's most colourful mineral (generated by impurities)



Solutions are at the bottom of Page 3

Notices

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 Eimear Deady (Chair).

AMG Postgraduate 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 that there are two bursary application deadlines each year: 1st March and 1st September. Requests for funding must be received well in advance of the proposed 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

About Us

Founded in 1963 by Norman F.M. Henry, the AMG is a special interest group of the Mineralogical Society of Great Britain and Ireland. We encourage and promote the study and research of mineralogy applied to ores and related industrial mineral materials. This encompasses: ore microscopy, fluid inclusions, nuclear minerals, coals, refractories, slags, ceramics, building materials, nuclear waste disposal, carbon capture and storage, down-hole borehole alteration, and mineral-related health hazards.

Black Lives Matter

We, the Applied Mineralogy Group, do not believe there is a place in society for racism. We recognise the significant lack of diversity in the geosciences and know that it is past time for change. We commit to working with Mineralogical Society to make meaningful changes.

Editorial

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 www.minersoc.org/amg-applied-mineralogist

Thanks for reading; our next Applied Mineralogist will be out in January 2021. Keep up on what is happening in the meantime by following us on twitter [@amg_min](https://twitter.com/amg_min).

Calendar

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|-------------------------|---|
| Nov '20
26-27 | Diffusion in Minerals, Rocks and Melts Meeting
<i>London, England</i> |
| Jan '21
TBC | Volcanic and Magmatic Studies Group
<i>University of Manchester, England</i> |
| Jan '21
TBC | Mineral Deposits Studies Group
<i>Location TBC</i> |
| Aug '21
29-2 | European Mineralogical Conference
<i>Krakow, Poland</i> |
| Sept '21
TBC | SEG 2020 Vision Conference
<i>Whistler, Canada</i> |
| TBC | Geochemistry Group 50th An. Symp. & GGRiP
<i>Oxford, England</i> |



Interested in joining the Mineralogical Society and Applied Mineralogy Group? Go to: <http://www.minersoc.org/> for membership details.

