From the AMG committee
Dear Applied Mineralogist readers, welcome to the fifth bulletin from the AMG. It is our pleasure to share with you reports from our PhD student reps and bursary awardees. It’s also our privilege to include a special feature about diffusion in diamonds, courtesy of Ben Harte and John Craven at the University of Edinburgh. We hope you enjoy this issue—until Christmas, adieu.

#AppliedMineralogy @ArcheanGeo

"The Blue Picasso". Zoned #diamond in CL for #ThinSectionThursday. Coesite/omphacite inclusions in black. 

Tim Ivanic (@ArcheanGeo)

To see more of the “blue picasso”, see our special feature, written by Ben Harte & John Craven.

AMG bursary report: European Rare Earth Resources Conference 2017  Eva Marquis

Thanks to the AMG student bursary, I attended the 2nd European Rare Earth Resources conference. The conference took place in May on Santorini and was organised by the EURARE and EREAN projects. The conference covered a range of REE-related topics, from policy to production as well as magnet recycling and, of course, geology and mineralogy. My presentation was in the “REE resources beyond Europe” session and introduced the Ambohimirahavavy alkaline complex (NW Madagascar) that has an associated ion adsorption-type REE deposit. The talk introduced the geology of the complex, before discussing the potential effects of hydrothermal alteration on developing mineral assemblages amenable to breaking down and releasing REE during chemical weathering. The presentation went well, with a good discussion at the end of the session. I am one of a number of students and researchers working on the SoSRARE project, and it was the first conference where all the strands of this project have been in attendance—it was great to see how the work on this project is fitting onto the wider topic of sustainable REE supply in Europe and globally.

The conference finished with a fantastic fieldtrip to the Akrotiri ruins, a settlement buried in ash and pumice from the 1672 BC eruption, followed by a boat trip to Nea Kameni to investigate the lava flows of this newest volcanic edifice. It was a great day for all the geologists on board, finding beautiful yellow sulphate minerals deposited around old fumaroles (see picture), as well as spotting the various lava tubes and flows of the old shield volcano in the cliffs.

Sulphate mineral around fumaroles, Nea Kameni.

Green Energy - Opportunities and Challenges to Applied Mineral Research  Andrew Dobrzanski

Solar power, once derided as expensive and unreliable, has received a boost in recent years due to improved photovoltaic (PV) technology and a drop in the price per PV unit cost. This price drop has been due to increased Chinese PV manufacturing with units allegedly being sold at a loss to dominate the market. The influx of cheap PV has reduced costs and increased installed PV capacity by 76 Gw in 2016 (article continues on page 3)
**Background and Objectives**

The carbon isotope composition of natural diamonds is widely used as an indicator of their conditions of formation and the source of the fluid/melt from which they precipitated in the Earth’s mantle [1, 2]. Given that estimates of the ages of natural diamonds are commonly more than 1000 million years [3], and that mantle residence temperatures are widely expected to be between 1200-1400°C, the possibility arises that the initial carbon isotope composition of the diamond may be modified by diffusion while at depth in the mantle [4].

Previously, ion microprobe determinations of carbon isotope ratio in diamonds have been done by a few analyses at selected points across the crystals [4, 5]. These point analyses are then compared with the growth zones in the diamond revealed by cathodoluminescence (CL). Studies of different diamonds show both the absence and presence of variations in carbon isotopes in conjunction with growth zones [4, 6], but the detail of isotope ratio variation in relation to growth zone structure has not been determined. Clearly, the extent of detailed correspondence of carbon isotope compositions with the original growth zone structure across a whole crystal would provide a test of whether extensive diffusive modification had occurred subsequent to crystal growth. The purpose of the measurements reported here was to map carbon isotope compositions in sufficient detail to examine this correspondence.

**Method**

The Cameca ims 1270 ion microprobe enables rapid, high precision analyses to be performed automatically over long periods of time, meaning that it is now possible to map minerals for minor variations in isotopic ratios. The diamond crystal selected for measurement was mounted in indium between two standards of known isotopic composition. An array of ion probe pits were used to create the contour plots of δ13C.

Point determinations on the sample were made at 100µm intervals along line transects, which were themselves 100 µm apart. This made a grid of 26 lines with up to 24 points per line. Five measurements were made on the standard crystals at the start and end of each line – thus enabling calibration of the sample measurements for each line against 10 standard measurements.

**Results**

The diamond selected for study is part of the collection from Guaniamo, Venezuela, investigated by Schulze et al. [7], and is notable for its complex CL pattern, which has led to it being referred to as the ‘Picasso’ diamond (Fig. 1). It figured in Nature (volume 423, page 24) and on the cover of the 8th International Kimberlite Conference Hawthorne volume (2004). The CL image is shown opposite.

The collected carbon isotope data, forming a grid of points at 100 µm intervals, have been contoured to yield a map of carbon isotope variation across the whole crystal (Fig. 2; Fig. 3).

**Discussion**

As may be seen the growth pattern of the CL image is matched exceptionally closely by the carbon isotope map. This matching includes details of the four corners of the inner areas as well as the overall growth patterns. There is no evidence of disturbance of carbon isotope compositions subsequent to growth by diffusive equilibration across the growth zones.

**References**

alone. Globally, total PV capacity installed is 305 Gw (up from 50 Gw in 2010). The growth of solar is changing the energy market. In 2016, 2% of new jobs in the US were due to the solar industry. India aims to produce 175 Gw from renewables by 2022, while solar panels are used by communities around artisanal mines, reducing the need for state installed power infrastructure in remote areas. A desire for improved PV materials is increasing research opportunities into engineered synthetic minerals, such as perovskites.

As PV demand grows, so does the demand for raw materials to manufacture them. PV panels incorporate Nb, Cd, Mo and Ga along with critical elements Li, In and Te. The challenge of the six-fold increase in global PV capacity is managing the pressure on the supply of these elements to the market. There is a secure supply for some of these elements. For example, Mo is currently in oversupply and Nb sources in Brazil are stable, but projections suggest that Li and In will remain ‘fairly balanced’, depending on new supplies coming online. However, elements such as Cd and Ga, which are produced as co-products of metal refining, may experience a supply shortage if there is a downturn in primary metal mining (i.e. Zn, Al).

The boom in renewable energy has also created other mineral supply issues. April 2017 saw the first time since the industrial revolution that British power generation achieved a ‘coal free’ day. While this is a significant achievement, the move away from coal has begun a separate critical resource issue. The UK Quality Ash Association (QAA) has for some time been warning that the UK supply of Pulverised Fuel Ash (PFA) has for some time been significant achievement, the move away from coal has begun a separate critical resource issue. The UK Quality Ash Association (QAA) has for some time been warning that the UK supply of Pulverised Fuel Ash (PFA) has for some time been

**Green Energy Case Study: Te and Se  Katie McFall**

As mentioned in the above article, elements mined as co-products, such as Te and Se, present both challenges and opportunities. If extracted efficiently, producing critical metals as co-products is potentially a more environmentally friendly and sustainable way of ensuring supply. However, they are subject to fluctuations in base metal markets, which may not reflect the needs of specialist technologies. Moreover, extracting these co-products can be expensive and technically challenging. Te and Se, for example, are produced as by-products of Cu mining and are currently extracted from anode slimes at copper refineries after the processing of ore from porphyry copper deposits and volcanogenic massive sulphide (VMS) deposits. Although whole-rock assay data reveals that Te and Se are present in Cu deposits, little is known about the mineralogical and spatial controls within deposits. This inhibits efficient processing, meaning that some of the resource is being lost. Te minerals are also found in many gold deposits, such as Cripple Creek (USA) and Perama Hill (Greece). These are not, however, currently being mined for Te due to a lack of efficient extraction techniques. Research into new processing methods is ongoing, but it requires a clearer understanding of the mineralogy and enrichment mechanisms of these elements.

**Calendar**

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Details</th>
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<tr>
<td>AMG bursary deadline</td>
<td>SEP '17 30</td>
<td><a href="http://www.minersoc.org/amg.html">http://www.minersoc.org/amg.html</a></td>
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<td>Brian Lovell Meeting: Mining for the future</td>
<td>NOV '17 23 - 24</td>
<td><a href="https://www.geolsoc.org.uk/Lovell17">https://www.geolsoc.org.uk/Lovell17</a></td>
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<td>MDSG (Mineral Deposit Studies Group) conference, Brighton, UK</td>
<td>JAN '18 3 - 5</td>
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<td>Platinum Symposium, Mokopane, South Africa</td>
<td>JUL '18 30 - 6</td>
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<td>Granulites &amp; granulites, Ullapool, UK</td>
<td>JUL '18 10 - 13</td>
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**Coffee break small-talk: mineral application facts**

- 18 g of diamond has the same combustion energy as a Mars bar (other chocolate bars are available).
- Deerite, howeite and zussmanite can all be found in blueschist-facies meta-ironstone in Laytonville, California.
- Your smartphone contains roughly 75% of the elements in the periodic table. For example:
  - Screen: In O Cr Ni Sn Al Si Cl Na K Y Eu Gd Tb Pr
  - Electronics: Cu O Pb Sn Al Si Cl Na K Y Eu Gd Tb Pr
  - screen: In O Cr Ni Sn Al Si Cl Na K Y Eu Gd Tb Pr
  - Electronics: Cu Sn Pb Al Si Cl Na K Y Eu Gd Tb Pr

**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.