Hello and welcome to the September edition of Applied Mineralogist! In this issue, we bring you a special feature from Dr. Rob Chapman, University of Leeds, on tracing Au back to its source, together with a round-up from the SGA biennial meeting. We also have the winner of our #AppliedMineralogy competition and a calendar for all upcoming events so you don’t miss out!

**Round-up: SGA Biennial Meeting, Glasgow, 27th to 30th August 2019**

William Smith, Cardiff University

Academics, industry professionals, and students gathered in Glasgow’s striking Gilbert Scott Building for the 15th biennial meeting of the Society of Geology Applied to Mineral Deposits. The conference was preceded by a number of short courses and field trips, including a trip to the Scottish Highlands, to visit sites of classic geology and mineral deposits and another to Ireland, to visit base metal deposits, such as the famous Navan Pb-Zn mine.

Of the many short courses on offer, my personal bias was toward the exploration targeting for magmatic Ni-Cu-PGE mineral systems course, organised by Dr. Dave Holwell and Prof. Marco Fiorentini. Over the two-day course, we saw fantastic magmatic sulphide ores from world-class ore deposits, including Voiysey’s Bay and the Bushveld, together with a number of talks on the mineralising system, sulphide textures, and case studies. The course was a great precursor, and got participants excited for the magmatic sulphide and oxide system session occurring later on in the conference programme.

Conference delegates were welcomed to the Hunterian Museum for the pre-conference ice breaker event, allowing participants to browse the museum’s collection, whilst catching up with old friends and colleagues. The conference programme began with plenary speakers Cam McCuaig (BHP), Sarah Gordon (Satarla), and Mike Russell (CalTech), who set the tone of the conference, with insightful talks regarding mineral systems, mining evaluation, and the relationship between life and ore deposits. From the afternoon onwards, the cohort was divided into different sessions, where I was able to attend talks outside of my subject area. I particularly enjoyed talks from Cyril Chelle-Michou on the role of chlorine in porphyry systems and from David Mole on the crustal architecture of the Superior Craton, as seen through isotope mapping. Later that evening was the Student-Industry networking event, which allowed myself and my fellow student attendees to talk to those working in the mining and metals industry. Throughout this evening, there was a lot of opportunity to get advice and perspectives from those in the early and later stages in their career, and on behalf of the student attendees, I thank the organisers of this event.

Wednesday gave me another opportunity to attend talks outside of my ‘comfort zone’, where I enjoyed the ‘fertility assessment’ morning in the porphyry to epithermal session. This session gave a nice insight into ongoing research regarding ways to assess mineral fertility of large-scale regions, using geochemistry, minerals, and mineral inclusions. After the break, SGA-Newmont Gold Metal awardee Richard Sillitoe spoke about the role of breccias in porphyry copper formation, imparting many years of fieldwork experience. Two poster sessions were held over the course of Wednesday and Thursday afternoons, allowing presenters to talk about their research over a drink or two.

Most of my time over Thursday and Friday was dedicated to the magmatic sulphide and oxide session, where I was particularly interested in talks on the Grasset Ultramafic Complex (Michael Tucker) and the Nova-Bollinger Ni-Cu ore deposits in Western Australia (Valentina Taranovic). Following the magmatic sulphide and oxide session, was the session on the Co-evolution of Life and Ore deposits, were I was fascinated by John Parnell’s presentation on the importance of carbon in ore deposits.

Following on from the conference are field trips to visit the mineral deposits of Milos Island (Greece) and the Skellefte Belt (Sweden), and we hope that participants enjoy these trips. From all SGA participants from the AMG, we thank the organising committee, session conveners, course and field trip hosts, and sponsors for putting together a wonderful conference, and we congratulate the deserving award winners; thank you Glasgow!
There is a cultural stereotype for prospectors: they tend to be sartorially challenged, bearded and generally ancient. They have inherited the alchemist's obsession with obtaining gold, and pursue it to the exclusion of most other things in life. The methodology is simple - detrital gold forms a dispersion trail from its source, so when the gold cuts off upstream it's time to look for the motherlode.

Unfortunately this method has some limitations, which have become amplified as the 'search for the motherlode' has evolved to the point where exploration companies may seek a specific style of gold mineralisation in areas where outcrop is non-existent. The increasing challenges facing explorationists are well documented. New discoveries demand techniques which can identify the presence of a relatively small target, often obscured by surficial deposits. An array of geophysical and geochemical approaches has been developed, enabling us to predict the presence of prospective bedrock geology. Indicator minerals have enjoyed much publicity in the literature as specific erosional products of mineralisation may either clearly indicate the presence or direction of a target. Gold has chemical and physical attributes required by indicators, in that it is inert and relatively easy to isolate on account of its high density. However, there are drawbacks too: chemical stability permits recycling into generations of surficial sediments removed from the original erosional context, and particulate gold may be generated in a range of geological environments, such that the presence of gold in a panned concentrate is not indicative of a specific style of mineralisation. In many parts of the world, exploration is focussed in geologically complex areas, where different sources of gold are possible. Exploration campaigns rely on deposit models but the source of most/all detrital gold is often unclear.

Various localities (in the UK at least) proudly proclaim that their local gold is the 'purest in the world', despite all natural gold being predominantly an alloy of gold and silver. It has long been recognised that the silver content varies with location; data describing placer gold compositions from different localities may represent bulk compositions, which can mask contributions from different sub-populations.

The advent of the electron microprobe (EMP) facilitated screening of large numbers of individual gold particles and the identification of component populations. These studies (e.g., Knight et al. 1999) sought to match compositions of detrital gold with that of known sources and to speculate on whether there may be other sources yet to be discovered.

The approach met with success on an empirical 'same or different' basis but it proved difficult to link alloy composition to a style of mineralisation. The silver content of gold alloy is a function of fluid composition (Au/Ag, S, Cl and pH) and temperature (Gammons & Williams-Jones 1995). The net effect of these controls is that silver content is only potentially diagnostic where it is very high, or very low because the majority of gold particles exhibit a silver content between 5 and 30% Ag irrespective of source.

In the early 1990s the British Geological Survey (BGS) began to record systematically the presence of opaque inclusions of other minerals within detrital gold particles. Mineral inclusions (Figure 1) have been shown to represent the mineralogy coeval with the phase of gold precipitation (Chapman et al., 2000). Consequently an inclusion suite derived from a detrital gold population can be used to reconstruct the source vein mineralogy.
A combination of inclusion and alloy data on a grain-by-grain basis permits 'microchemical characterisation' of a population, where the two datasets provide independent parameters to identify any sub-populations. This approach has found application both in refining the 'same or different' approach for use in establishing placer-lode relationships, but also in establishing compositional templates for gold derived from different styles of mineralisation. Distinctive inclusion signatures have been established for gold derived from alkalic porphyries, (Pd-Hg signature) calc-alkalic porphyries (Bi-Te-Pb-S signature) and their associated epithermal expressions through study of samples of vein gold and detrital gold from adjacent placers (Chapman et al., 2018).

Gold from orogenic settings usually yields a simpler signature comprising base metal sulphides and sulpharsenides (e.g., Chapman & Mortensen 2016). Gold particle studies have the potential to be extremely helpful in various exploration scenarios. In areas of complex geology, characterisation of detrital gold may indicate the styles of mineralisation present within the catchment. At brownfield sites, the signature of local detrital gold can be compared with that derived from the resource already exploited to evaluate whether further reserves are present. Finally, ascribing a style of source to detrital gold can avoid fruitless pursuits pinned to an incorrect deposit model.

Further analytical techniques are being applied to natural gold to establish the relationship between gold crystallography and compositional heterogeneity, and the heterogeneity of gold alloy with respect to trace elements. Such studies will both contribute to our understanding of gold mineralisation processes and facilitate more sophisticated approaches to designing indicator methodologies based on gold.

References

#AppliedMineralogy

@freyargeorge

Check out this awesome #ThinSectionThursday entry of garnet-mica schist from the Sikkim Himalaya (40 mm) curtesy of metamorphic petrologist Dr. Freya George.