Mineralization and metal deportment in the Redmoor deposit, Cornwall

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Project Highlights:

- Development of new mineralization model for the Redmoor sheeted vein deposit.
- Mineral mapping and deportment of minor and trace metals.
- Establishment of predictive geometallurgy framework for the deposit.

Overview:

The Redmoor deposit is a large, unexploited resource of tungsten, tin and copper located in Cornwall, UK. It is a newly discovered resource that is situated below the historical workings of the Redmoor mine. It has the structure of a sheeted vein system and is assumed to have formed as granite-related hydrothermal fluids escaped from the underlying granite into the surrounding metasedimentary host.

The deposit is traditionally considered to be equivalent to that at Hemerdon. However, while Hemerdon and other greisen-bordered sheeted vein systems (at Cligga Head and St Michael's Mount) formed at granite cupolas, the Redmoor deposit occupies a saddle in the underlying granite. The traditional model with fluid escape from a volatile saturated carapace therefore doesn't make geological sense. Furthermore, the Redmoor deposit is entirely hosted within metapelites and metabasites, whereas Hemerdon (as well as Cligga Head and St Michael's Mount) straddles the boundaries between the granite and metapelites.

While the nature and genesis of the Redmoor deposit leads itself to the broad classification as a sheeted vein deposit, it is more complex and includes elements of skarns, greisen-bordered sheeted veins (with and without tourmaline), quartz-tourmaline breccias, polymetallic chlorite-sulphide lodes, as well as cross-course Pb-Zn-Ag veins. Redmoor is unusually rich in tungsten and tin and carries surprisingly high copper and indium concentrations.

We wish to test that:

1. The mineralisation evolved from magmatic fluids and their host rocks. Differential equilibration with metabasite and metapelite caused variability in the depositional environments. Fluid mixing and cooling led to selective precipitation in the veins in response to their immediate host.
2. Veins display signs of repeated mineral deposition indicating that the mineralised system was rejuvenated several times during evolution. We suggest that the Redmoor deposit evolved from fluids that escaped from more than one type of underlying granite source.
3. Critical metals precipitated primarily at the stage of the chlorite-sulphide assemblage. Trace elements within the ore minerals reflect granite sources and pathways.
4. Metabasaltic host rocks introduced systematic changes in the fluid and contributed Ca, Co and Cu to the system and acted as semi-impermeable barriers in the host.

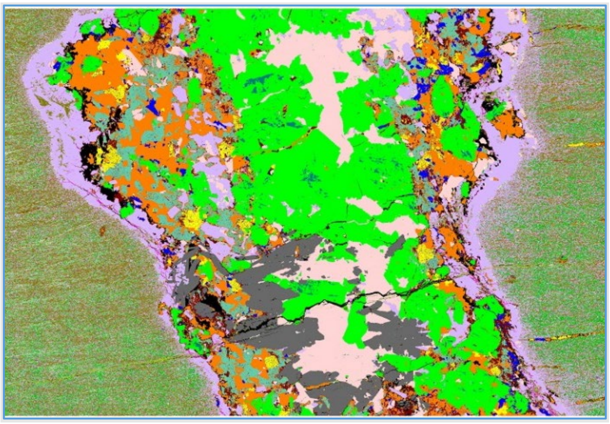

Figure 1: QEMSCAN mineral map of greisen-bordered quartz (light pink) vein at Redmoor. The vein was mineralized in wolframite(grey), chalcopyrite (orange), arsenopyrite (green) and stannite (olive). A thin muscovite (purple) border developed against the host slate. Thin, cleavage-parallel veins of pyrite (yellow), chalcopyrite and sphalerite (blue) invaded the host rock and greisen bordered vein.

Methodology:

1. Drill core logging and establishment of the different mineralisation styles and paragenetic successions that developed in the different host lithologies.
2. Sampling for petrographic and geochemical study.
3. Reflected and transmitted light optical microscopy to identify minerals and establish the relationships of minerals in and around different types of veins.
4. Cathodoluminescence to examine growth patterns in vein minerals such as quartz.
5. Automated mineralogy (QEMSCAN) to determine mineral abundances, relative proportions, and relationships.
6. Electron-probe microanalysis and LA-ICP-MS to determine mineral compositions and the distribution of minor and trace metals.
7. Numerical mass balance modelling of metal deportment in different types of ores.
8. Establishment of a predictive geometallurgical framework for the deposit.

Possible Timeline

Year 1: Background reading and drill core logging at Cornwall Resources. Optical microscopy and petrography. Establishment of paragenetic assemblages and successions in contrasting host lithologies.

Year 2: Electron-probe microanalysis and LA-ICP-MS of minerals

Year 3: Continued analytical work on EPMA and LA-ICP-MS. Data synthesis and deportment calculations. Determination of predictive metallurgy.

Training and skills:

TARGET researchers will participate in a minimum of 40 days training over the 3.5 years of study composed of:

- an annual one-week workshop dedicated to their year group, and tailored to that cohort's needs in terms of skills development – *for the first three years of their study*;
- an annual all-TARGET workshop with cross-year interactions, advanced training and opportunities to specialise in particular areas – *all years of study*;
- a number of one-day workshops;

- additional online events and in-person workshops attached to relevant conferences.

Partners and collaboration (including CASE):

The student will be based at Camborne School of Mines on the Penryn Campus of University of Exeter. It is expected that the student will spend at least eight weeks with Cornwall Resources to carry out core logging, sampling and learn from the insights of the company. At least two weeks are expected to be spent at Cardiff University to work on aspects of paragenesis.

It is our hope that the studentship will run in parallel to another Redmoor project at Cardiff (with a focus on isotopes and fluid inclusions). The projects are stand-alone but will benefit from close collaboration on aspects relating to paragenesis and evolution. We expect to spend at least two weeks at Cardiff University to cross-fertilise findings and develop ideas.

Further reading:

Andersen, J.C., Stickland, R.J., Rollinson, G.K. and Shail, R.K., 2016. Indium mineralisation in SW England: host parageneses and mineralogical relations. Ore Geology Reviews, 78, pp.213-238.

Simons, B., Shail, R.K. and Andersen, J.C., 2016. The petrogenesis of the Early Permian Variscan granites of the Cornubian Batholith: Lower plate post-collisional peraluminous magmatism in the Rhenohercynian Zone of SW England. Lithos, 260, pp.76-94.

Simons, B., Andersen, J.C., Shail, R.K. and Jenner, F.E., 2017. Fractionation of Li, Be, Ga, Nb, Ta, In, Sn, Sb, W and Bi in the peraluminous early permian Variscan granites of the Cornubian Batholith: Precursor processes to magmatic-hydrothermal mineralisation. Lithos, 278, pp.491-512.

Further details:

Please contact Jens Andersen (J.C.Andersen@exeter.ac.uk) for further information about the project. Information about the department and facilities can be found at https://dees.exeter.ac.uk/csm. Please visit https://target.le.ac.uk/ for additional details on how to apply.