The geological controls and mineral parageneses of the Gunheath Lithium Deposit, St Austell, Cornwall

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Project Highlights

- Integrated field, drillcore and laboratory-based project, working in partnership with Imerys British Lithium, on one of the UK's principal hard rock lithium projects.
- Investigating how magmatic and magmatic-hydrothermal processes, associated with the emplacement of multiple magma batches, control the distribution of lithium and tin and the implications for exploration, development, grade control and mineral processing.
- Defining the timescales of magmatic construction, magmatic-hydrothermal alteration and mineralisation processes, using state-of-the-art high-precision and high spatial resolution U-Pb and Rb-Sr geochronology.

Overview

The UK government's target of Net Zero greenhouse gas emissions by 2050 requires substantial production of critical raw materials, including lithium and tin, and the UK is developing a domestic production capacity for these metals. The focus for the development of hard rock lithium resources is the Cornubian Batholith, in SW England, which has a long history of mining for metal and china clay and hosts one of the largest lithium resources in Europe.

Lithium is principally hosted by micas whose lithium contents are highest within the rare-metal topaz granites (G5) of the Tregonning Granite and the Nanpean and Hensbarrow stocks of the St Austell Granite (Simons et al., 2017). Imerys British Lithium is developing the Gunheath Project in the Hensbarrow Stock at a site of former china clay extraction. It has undertaken over 20,000 m of exploration drilling and has an Inferred Resource of 160 million tonnes at 2500 ppm lithium. Drilling continues as part of moving towards a pre-feasibility stage of technical and economic evaluation.

There geology at the Gunheath Project includes topaz (G5) granite, tourmaline granite (G4) and 'elvan' rhyolite-microgranite dykes. The distribution of lithium and disseminated tin mineralisation in the topaz granite is related to both magmatic and magmatic-hydrothermal processes, not only within the topaz granites, but also within the adjacent tourmaline granite (e.g. Putzolu et al., 2024). The project will evaluate the whole-rock geochemical, mineralogical and mineral chemical expression of these processes, their relative and absolute timing, and their implications for the distribution and recovery of lithium and tin.

The project provides an outstanding opportunity to undertake industrially relevant geological research at Camborne School of Mines and the British Geological Survey, in partnership with Imerys British Lithium, on a UK-based hard rock lithium project. Similar mica-hosted lithium mineralisation, associated within rare-metal granites, occurs in France, Germany, Portugal and Spain, where it is

also the focus of exploration and development activities. The successful candidate will be well-placed for future employment with the mineral resources sector.

Figure 1: (a) Overview of Imerys British Lithium Gunheath Project site, looking NW; (b) geologist inspecting diamond drill core; (c) drill core showing mineralogical and textural variation in granite contact zone; (d) drill core specimen of typical 'G5' topaz granite containing thin pegmatite-aplites.

Methodology

1) *Field and core investigation of magmatic and magmatic-hydrothermal processes: C*onstraining the 3D geometry, character and relative timing of the G5 topaz granite, G4 tourmaline granite, and 'elvan' rhyolite-microgranite dykes, alteration styles and disseminated and vein-hosted lithium and tin mineralisation. Identification of paragenetic zones of similar mineralogical character and grade characteristics.

2) *Mineral parageneses of lithium and tin mineralisation:* Detailed investigation of how the paragenetic and grade zones are manifested in whole-rock geochemical data, and how they relate to mineralogical and mineral chemical variations at thin-section scale. Transmitted-light petrographic analysis will be complemented by automated mineralogy, electron microprobe and laser ablation ICP-MS microanalysis. These data will reveal how zonal variations in lithium and tin grade relate to magmatic and magmatic-hydrothermal enrichment-depletion processes.

3) *Geochronology:* Applying radio-isotopic mineral-geochronometers (U-Pb ID-TIMS on zircon, monazite, xenotime, cassiterite; *in-situ* Rb-Sr on feldspar and mica), and associated techniques, to elucidate the absolute timing and relationships between magmatic, magmatic-hydrothermal and lithium/tin enrichment-depletion processes.

Possible Timeline

Year 1: Working closely within the Imerys geology team. Familiarisation with the Gunheath Project, including geology, deposit model and lithium/tin grade variations. Fieldwork and logging of representative core intervals. Sampling, thin-section petrography, whole-rock geochemical analysis and interrogation, and introduction to mineral chemical analysis methods.

Year 2: Extensive mineralogical and mineral chemical analysis of the samples selected in Year 1, using automated mineralogy, electron microprobe and laser ablation ICP-MS microanalysis, to develop a paragenetic model for lithium and tin mineralisation. Initial visit to the National Environmental Isotope Facility to undertake U-Pb ID-TIMS analyses.

Year 3: Second visit to National Environmental Isotope Facility to undertake *in-situ* Rb-Sr on feldspar and micas. Integration of dating and isotopic studies into paragenetic model. Writing of two papers that will be combined into a thesis for submission.

Training and skills

PhD students at Camborne School of Mines (CSM) have access to a wide range of in-house training courses in mineral deposits, economic geology, mineral processing and mining. Students are encouraged to sit-in on MSc modules to supplement their training needs.

The student will receive analytical training at CSM in the use of automated mineralogy, electron microprobe microanalysis and laser ablation ICP-MS microanalysis.

The student will receive direct training in geochronology data acquisition, results handling and interpretation through the Geochronology and Tracers Facility and the National Environmental Isotope Facility

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)

Imerys British Lithium are the CASE partner in the project and encourage an integrated partnership between their geology team, the prospective student, and supervisors at CSM. The student will spend substantial periods of time embedded with the Imerys British Lithium team at the mine site or local offices in St Austell. Access to all appropriate data such as drill core, maps, internal analyses and reports will be provided once an NDA has been signed between the respective parties.

Further reading

British Lithium | Battery grade lithium produced from Cornish granite

Putzolu, F., Seltmann, R., Dolgopolova, A., Armstrong, R.N., Shail, R.K., Spratt, J., Buret, Y., Broderick, C. and Brownscombe, W., 2024. Influence of magmatic and magmatic-hydrothermal processes on the lithium endowment of micas in the Cornubian Batholith (SW England). *Mineralium Deposita*, *59*, 1067-1088. https://doi.org/10.1007/s00126-024-01248-5

Simons, B.J., Andersen, J., 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*, 278-281, 491-512. https://doi.org/10.1016/j.lithos.2017.02.007

Tapster, S. and Bright, J.W. 2020. High-precision ID-TIMS cassiterite U–Pb systematics using a low-contamination hydrothermal decomposition: implications for LA-ICP-MS and ore deposit geochronology. *Geochronology*, 2, 425-441. https://doi.org/10.5194/gchron-2-425-2020

Further details

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