Development of exploration tools for granite-breccia-hosted mineral deposits

Supervisors

Main supervisor: Doctor Ben Williamson (University of Exeter)
Co-supervisor: Professor Tom Blenkinsop (Cardiff University)
Co-supervisor: Doctor José Piquer (

Universidad Austral de Chile, Chile

)
Co-supervisor: Professor Axel Müller (

Natural History Museum, Oslo, Norway

)

Project enquiries - Email: b.j.williamson@exeter.ac.uk **Contact number:** +44 (0) 01326 371856

Host Institution: University of Exeter

Project description

Tourmaline breccias are a major host of Cu mineralisation in porphyry-type deposits including El Teniente, the World's largest single Cu deposit, and the Río Blanco-Los Bronces district in Chile, the most highly endowed porphyry Cu cluster in the world. However, many aspects of the link between tourmaline breccias, their parent magmas and related mineralisation are poorly understood. Of most interest to minerals exploration companies are: a) why some breccias are heavily mineralised whilst others are 'barren'; and 2) whether any aspects (chemical or textural) of outcropping porphyry rocks can be used to predict the presence of underlying or adjacent breccia-type mineralisation.

These knowledge gaps will be addressed through detailed mapping and sampling of 'barren' and mineralised breccias, and their parent intrusions, in Sn- and Cu-dominated systems at Wheal Remfry, Cornwall, and El Teniente, Chile, respectively. Collected materials will be characterised and a comparison made of textural properties, feldspar, quartz and tourmaline compositions and fluid inclusion populations. Analyses will be undertaken using state-of-the-art facilities including electron microprobe, SEM, ICP-MS, cathodoluminescence and fluid inclusion microthermometry at UoE, and IXRF Xb micro-XRF and EBSD at UoC.

The effectiveness of mineral-chemical investigations was demonstrated in studies of breccias at Roche, Cornwall (Williamson et al., 2000). Tourmaline hydrothermal overgrowths show strong chemical variations in which four distinct zones have been identified (Fig. 1). These variations were interpreted as being due to episodic mixing between magmatic fluids (dominant in zone 1) and an increasing component of more oxidising Fe-rich connate waters, which resulted in the precipitation of

Sn as Sn^{4+} in zones 2 and 4. In another example (unpublished, Fig. 2), from the Los Sulfatos Cu porphyry-breccia, Chile, Cu concentrations (and Mg) increase from the base to the tip of the tourmaline crystal towards the point of chalcopyrite precipitation. Such trends in tourmaline from in-situ breccias or stream sediments could be used as an exploration indicator.

To determine the relationship between breccias and their associated porphyries, samples will be studied which show direct spatial and temporal associations, to ensure a genetic link (see example in Fig. 3).

The student will undertake full paragenetic and mineral-chemical studies, including for trace and ore-forming elements, to determine the nature of the interaction between the porphyry melt and breccia, including viscosity contrasts and formation of apparent back-reaction products (see 'pink reaction rim' in Fig. 3).

Reference

Williamson B. J., Spratt J., Adams J. T., Tindle A. G. and Stanley C. J., 2000. Geochemical constraints from tourmaline hydrothermal overgrowths on the evolution of mineralising fluids in southwest England. Journal of Petrology, 41: 1439-1453.

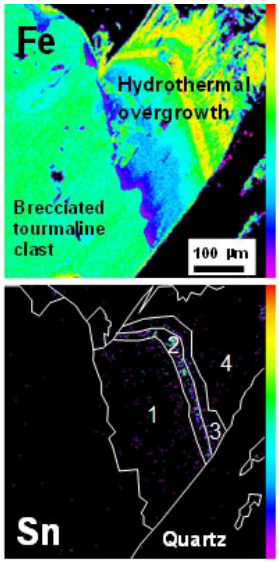

Fig. 1 X-ray maps for Fe and Sn in tourmaline from Roche, Cornwall.

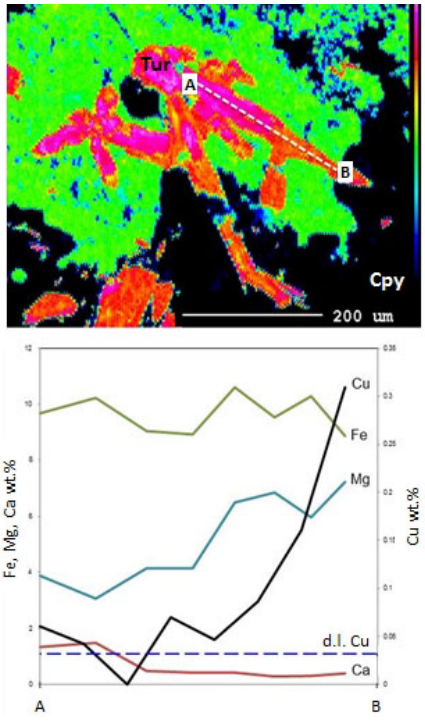

Fig. 2 X-ray element map for Al in a breccia sample from Los Sulfatos Cu porphyry-breccia, Chile; and (below) geochemical point traverse (line A-B) within a single tourmaline crystal.

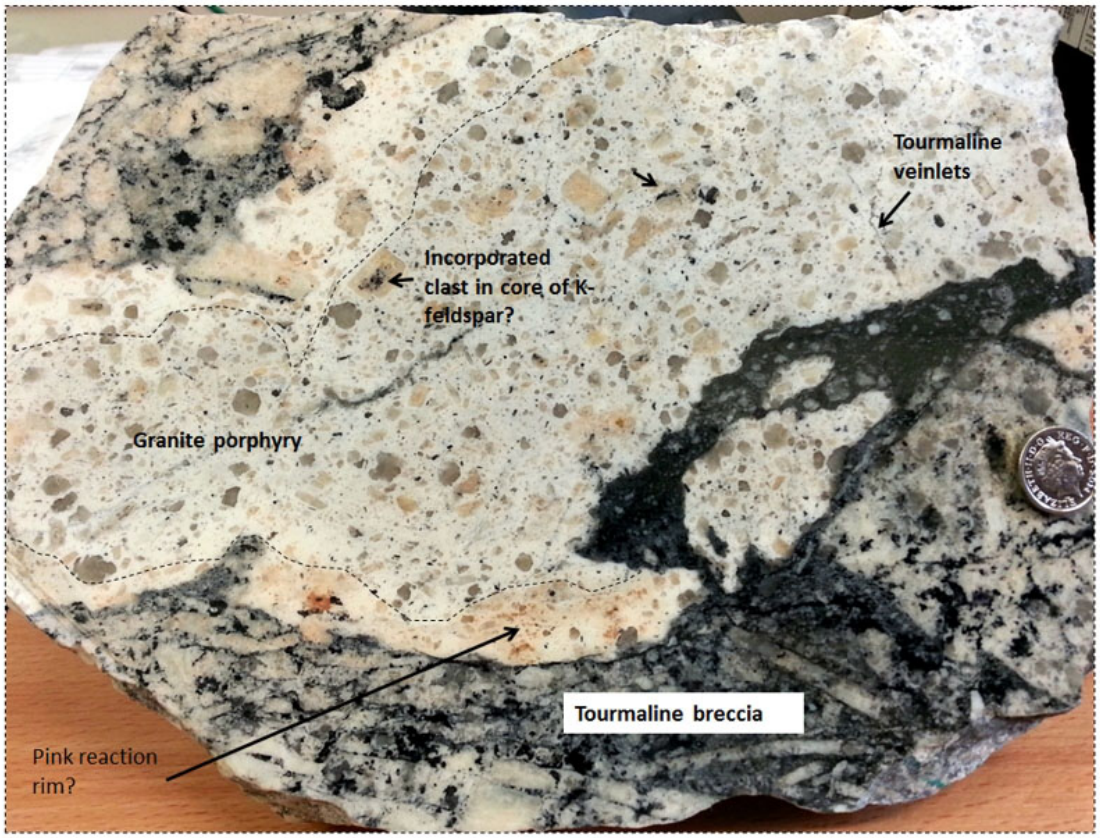

Fig. 3 Photograph of tourmaline breccia from Wheal Remfry, Cornwall, containing 'tongues' of granite porphyry which were emplaced as a melt into the unconsolidated breccia. The porphyry is cross-cut by tourmaline veinlets.