Petrochronology and mineral chemistry of mid-crustal shear zones: new tools for tectonics and mineral exploration

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Resolving the timing and rates of crustal deformation is fundamental to the understanding of tectonic, orogenic and ore-forming processes. The direct dating of deformation in greenschist to amphibolite facies shear zones is of particular interest, as these structures can accommodate vast lateral and vertical crustal motions, control the development of tectonic features, and provide important pathways for orogenic and ore-forming fluids. Major advances are being made in this field, via the identification and isotopic analysis of synkinematic mineral phases that belong to the metamorphic assemblages associated with deformation. Certain U-Th bearing accessory minerals (e.g. allanite, monazite, titanite) have great potential in this regard, as they (1) can be linked to specific stages of deformation and physico-chemical conditions (e.g., pressure, temperature and fluid), based upon petrological observations (e.g. Janots et al., 2009; Cenki-Tok et al., 2013); (2) can be dated in-situ, preserving petrographic context (e.g. Storey et al., 2006; Darling et al., 2012); (3) are resilient to retrogression and low-grade alteration.

This industry-focused project will entail a detailed study of accessory mineral growth across well-constrained shear zones within the Sudbury structure, Ontario: one of the world's largest Ni-Cu-PGE sulphide ore deposits. The student will investigate how these phases can be better linked to deformation, metamorphism and ore-formation by combining petrological analysis, mineral chemistry and isotope geochemistry with surface and underground mapping of shear zones that are key to the late stage development of Sudbury's ore deposits. Pilot studies of these shear zones have revealed mineral chemistry trends that have great potential as exploration vectors towards highly valuable ore deposits. Accordingly, the student will work closely with Vale, a leading multinational metals and mining corporation, to develop understanding of the tectonic history (via geochronology), and test the use of mineral chemistry as a guide for future exploration.

The project will combine fieldwork, petrology, electron microscopy and in-situ trace element and isotopic analysis by laser ablation ICP-MS and MC-ICP-MS at the University of Portsmouth. The student will benefit from extensive training in these state-of-the-art techniques, as well as from working closely with exploration geologists from Vale.

References: *Cenki-Tok, B., Darling, J.R., Rolland, Y., Dhuime, B. and Storey, C.D. (2013) Direct dating of mid-crustal shear zones with synkinematic allanite: New in-situ U-Th-Pb geochronological approaches applied to the Mont Blanc massif. Terra Nova*

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