Direct dating of shear zone operation and sulphide mineralisation using titanite

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Ductile shear zones nucleate during the tectonic deformation of the lithosphere, facilitating km-scale translation of crystalline rocks, subduction and exhumation of (U)HP terranes, and localisation of orogenic-style high-grade mineralisation. The difficulty of texturally linking U-Th-Pb-bearing accessory phases and deformation fabrics makes strain chronometry a daunting task. In this regard, the potential of titanite is tested on an greenschist-amphibolite facies ore-controlling ductile thrust from the South Range of the Sudbury impact structure.

Quantitative microstructural analysis (EBSD) of metasomatic titanites from the shear shows (a) a strong shape preferred orientation, (b) strongly developed texture (CPO), and (c) both dislocation and diffusion creep microstructures. These three independent lines of microstructural evidence support the interpretation of the metasomatic titanite growth as syndeformational. Quantitative microstructural analysis of the shear-hosted sulphides (Po-Pn-Cpy) shows cumulative misorientation angles up to 50˚ in pyrrhotite and pole figures with strongly developed point maxima that are distributed along a great circle. The microstructural record of crystal-plastic flow in sulphides provides further corroborating evidence for the presence of sulphide meso and micro-scale textures produced by means of mechanical or mixed-state remobilization in the examined structure.

Preliminary U-Pb isochron age dating, using laser-ablation-inductively-coupled-mass-spectrometry (LA-ICP-MS), of the fabric-forming titanite grains yields a lower intercept date of 1692 ± 54 Ma. Taking in consideration the aforementioned micro-textural evidence we attribute this date as the timing of shear zone operation and sulphide remobilization, in the South Range of the Sudbury impact structure, during the Mazatzalian-Labradorian orogenic episode (1.7-1.6 Ga).