In situ chronometry and its application to determining rates of tectonic processes

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While petrographic and chemical techniques are well-established in providing valuable insight into the mineral equilibria and structure of metamorphic rocks, the quantification of rates of metamorphic and deformational processes using *in situ* geochronometry is still evolving but shows considerable promise in constraining quantitative tectonic models of orogenic belts. In recent years there have been major advances of *in situ* chronology using primarily the (K)-Ar-Ar and U-Th-Pb decay schemes, with laser spot fusion Ar-Ar, SIMS, EMPA, and LA-ICP(MC)MS methods all playing important roles. In the higher temperature realm above the closure temperature of Ar in micas, the dating of U+Th-bearing accessory minerals is proving of real value in quantifying the high temperature part of the P-T path, even though the P-T significance of growth of such phases is often difficult to dicipher and highly dependent on textural, chemical and zoning information. There are relatively few published studies that combine detailed metamorphic P-T path determination, accessory mineral thermometry (i.e. Ti-in zircon), chemical zoning of accessory minerals and other relevant phases (i.e. garnet), and high spatial resolution *in situ* age determination to construct a reasonably constrained tectonic story, all in a well-founded tectonic context. Challenges still to be overcome relate to the wider usein dating of minerals like allanite (& epidote), apatite, titanite and rutile (especially difficult in young orogens) and the challenge of producing high precision ages in their petrographic context in older rocks by *in situ* methods in order to resolve events with less than 5-10 Ma duration. ID-TIMS methods will be needed to anchor some interpretations using less precise dating methods. Increasingly, the documentation of age gradients (using depth profiling in part related to diffusion and/or very thin younger growth rims) will complement *in situ* data. Instrumental advances in isotope dating relevant to these methods will be discussed along side summaries of a few case studies to illustrate how rates of exhumation and direct dating of shearing can be accomplished.

Turning rock into soil – Variations in soil mineral reactivity, surface area, and porosity through the critical zone

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The breaking down of massive rock into smaller grains and the resultant increase in mineral surface area, is potentially the most critical step in soil formation. The aim of this study is to investigate how mineral surface area and porosity varies during pedogenesis, and how these variations in conjunction with mineralogical changes influence soil mineral reactivity.

Soil profiles directly overlying granitic bedrock were systematically sampled from sites in Dartmoor and the Cairngorms. The contrast in glacial histories of Eastern Scotland and South-West England provide profiles of varying age, and thus soils at different stages of pedogenesis. The differing evolutionary histories of the profiles was quantified through the dating of individual soil horizons using a combination of carbon-14 and uranium-series techniques. Surface area, porosity, mineralogy, and chemistry of mono- and multi-mineralic samples derived from bulk and individual particle size fractions were determined using multipoint nitrogen adsorption (B.E.T isotherm), X-ray Diffraction, and X-ray Fluorescence respectively. The dissolution rates of bulk samples and isolated individual mineral species were determined under far from equilibrium conditions using batch and mixed flow-through reactors. The results yield a systematic understanding of how granitic rock reactivity, mineralogy and surface area vary with age during soil formation.