Unveiling hidden Archean processes through petrochronology

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Archean geodynamic interpretations can be a controversial topic, often exacerbated by complex, highly deformed field relationships. This problem can be compounded by confusing and prolonged geochronological records, in which multiple episodes of intrusive and metamorphic events are justaposed. The Lewisian Gneiss Complex (LGC) is a classic example in this regard, recording a billion years of Archean zircon ages, followed by significant retrogression and U–Pb disturbance through the Proterozoic. As a result there are many interpretations as to the nature of the geodynamic processes at work in the LGC, often with the same field evidence being used to substantiate apparently disparate models. The Archean rocks of the LGC comprise tonalite-trondhjemite-granodiorite (TTG) gneiss, interspersed with mafic-ultramafic bodies and felsic sheets. The smear of U-Pb ages through these rocks has compromised detailed interpretations of the igneous and metamorphic history.

The recent advent of Laser Ablation Split Stream (LASS) petrochronology is key to deciphering the processes at work in the Archean. Zircon from TTG gneisses and associated felsic sheets display a marked contrast in trace element signatures, defining discrete processes within the smear of Archean U–Pb ages. Emplacement and/or metamorphism of the TTG suites between *c*. 2800–2700 Ma is followed by a distinct suite of felsic sheets intruded at *c*. 2600 Ma. The trace elements associated with these felsic intrusions suggest melting of a distinctive source that could be the associated, grt-bearing mafic rocks. This highlights discrete melting processes occurring in the LGC crust between the traditionally interpreted “events”. This supports, and provides evidence for, how the LGC may have remained at elevated temperatures for a considerable period of time during the late Archean.