TERRANECHRON™: A NEW WAY TO EXPLORE CRUSTAL EVOLUTION

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The TerraneChron™ methodology uses EMP, LAM-ICPMS and LAM-MC-ICPMS analysis of single zircon grains, to provide precise and accurate determinations of U-Pb age, Hf-isotope composition and the concentrations of six key trace elements. Applied to individual magmatic rocks, the technique provides the type of information traditionally derived from combined U-Pb analysis of zircon (conventional or in-situ) and Sm-Nd analysis of whole-rock samples. However, the Lu-Hf system in zircon is more robust than the Sm-Nd system with regard to disturbance by metamorphism or alteration. In addition, variations in Hf-isotope composition within zircon grains or suites give valuable information on magma-generation processes. In polymetamorphic rocks, including lower-crustal xenoliths, the Hf isotope composition provides key information to distinguish between the recrystallisation of older zircons and the growth of new zircon, and improves the interpretation of in situ age data.

The speed of in situ analysis allows the rapid collection of large datasets from suites of zircons derived from ancient sediments or modern drainages. The combination of techniques provides an overview of the ages of magmatic events, the compositions of the magmas, and their sources (juvenile vs reworked crustal material) within the drainage area. The use of detrital zircons leads to an inevitable loss of petrographic context; this is offset by the recovery of zircons from the entire spectrum of rocks in the drainage. The corresponding reduction in geological sampling bias can reveal magmatic events not recognised, or not well-dated, by conventional techniques.

TerraneChron™ has proved to be a powerful exploration tool in mapping the tectonic history of poorly-known, difficult terrains. A series of studies in Archaean, Proterozoic and Phanerozoic terranes has provided useful insights into fundamental problems relevant to crustal evolution. Examples will be presented to illustrate: (1) the earliest appearance of the Depleted Mantle source in different cratonic areas; (2) the development of isolated volumes of highly depleted mantle beneath some cratons during Proterozoic time; (3) the presence of unexposed Archaean crust beneath many Proterozoic terrains; (4) an apparent change in tectonic style between Archaean and younger time. Several Proterozoic and Phanerozoic orogens studied thus far show a characteristic pattern of juvenile additions to the crust over periods of 100-400 Ma, followed by extensive reworking of the earlier crust over similar periods. This pattern is not apparent in Archaean areas so far examined.