Multi-mineral, multi-isotopic approach for the provenance, weathering and transport history of sedimentary systems

PAUL J. SYLVESTER[1] AND A. KATE SOUDERS[1]

[1]Department of Earth Sciences, Alexander Murray Building, Memorial University, St John's NL A1B 3X5 Canada (psylvester@mun.ca; kate.souders@mun.ca)

In situ isotopic and geochemical compositions of detrital and authigenic mineral constituents of clastic sediments and sedimentary rocks are rich archives of information about present and past surface processes. We exploit this archive by focusing on six key detrital minerals: zircon, tourmaline, rutile, monazite, apatite and feldspar. Monazite, apatite, rutile (titania polymorphs) and feldspar may also be present as authigenic minerals. Systematic and quantitative analysis of the abundances, sizes and shapes of the minerals in sampled sedimentary units are made by automated scanning electron microscopy using the Mineral Liberation Analyzer (MLA), followed by backscattered electron (BSE) and/or cathodoluminescence (CL) imaging of representative grains. In situ analysis of U-(Th)-Pb radiometric age (zircon, rutile, monazite, apatite); Hf (zircon), Nd (monazite, apatite) and common Pb (tourmaline, feldspar) isotopic compositions; and geochemistry (all minerals) of discrete, inclusion-free domains in the grains is made by laser ablation – (multicollector) – inductively coupled plasma mass spectrometry (LA-MC-ICPMS).

A critical aspect of this approach is the complementary use of the mineral analyses. Zircon, tourmaline, and rutile are highly resistant to weathering and thus document the provenance of the long-lived, polycyclic clastic component of samples. Monazite, apatite and feldspar break down more readily during weathering and thus largely reflect only the most recent, single-cycle clastic component delivered to a sampled unit: their abundances, textures and compositions may also be used to infer particular conditions of weathering and transport, e.g., monazite and apatite are highly unstable in acidic solutions; feldspar is dissolved most strongly in hot, humid environments. Chemical compositions of each of the six minerals may be linked to particular magmatic and high-grade metamorphic source terrains, e.g., the trace element chemistry of rutile distinguishes meta-mafic and meta-pelite sources; Ca-Na-K proportions of feldspar distinguish basaltic and granitic sources. The isotopic compositions of authigenic monazite, apatite, rutile and feldspar can constrain the sources of diagenetic basinal fluids.