In-situ Pb isotope analysis of detrital tourmaline: a new technique for sand provenance

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The goal of many sedimentary provenance studies is to characterize and identify the sedimentary source. This information can contribute to paleogeographic reconstructions, correlation between sedimentary rock units, and the determination of maximum depositional ages. Detrital minerals are divided into 3 broad categories: (1) multi-cycle refractory, grains that are easily recycled and long-lived in the sedimentary system (e.g. zircon); (2) multi-cycle, yet affected by diagenetic changes (e.g. rutile); and (3) first-cycle, grains that are easily broken down by chemical weathering (e.g. feldspars). Often, multiple in-situ techniques (EPMA, LA-ICPMS, SIMS) are applied to the same detrital mineral and the results combined to maximize the information for provenance analysis.

Tourmaline is an excellent mineral for sedimentary provenance investigations. It is present in most rock types and is known for both its chemical and physical stability. Along with rutile and zircon, tourmaline is considered one of the most stable multi-cycle detrital minerals. We present a new method for measuring Pb isotopes in tourmaline by laser ablation (193 nm, excimer) multi-collector ICPMS (ThermoScientific Neptune). The method employs the use of Channeltron ion counters for detection of ^{202}Hg, ^{204,206,207,208}Pb and ^{235,238}U ion signals. A standard-sample-standard bracketing approach is used to correct for instrumental mass bias using BCR2G as the external standard. Stationary laser ablation conditions were 5 J/cm^2, 10 Hz with a laser spot size from 20 to 129 um, depending on the total Pb concentration of the tourmaline grain of interest. Accuracy and precision of the method was evaluated by within-run analyses of an in-house tourmaline standard with homogeneous Pb isotope composition characterized by ID-TIMS. Using example data collected from detrital tourmalines found in reservoir sandstones of offshore Newfoundland and potential source rocks from on-land Newfoundland stream deposits, we will demonstrate how in-situ Pb isotope geochemistry of detrital tourmalines can be combined with in-situ elemental and Boron isotopic data from the same tourmaline grain to further characterize the source rock. We will also demonstrate how this information can be integrated with geochemical data from other in-situ provenance techniques (e.g. Pb in feldspar, U-Pb and Hf in zircon) to constrain sedimentary sources.