Potential new U–Pb geochronometers applicable to highly fractionated granitic systems

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Placing accurate dates on pulses of magmatic activity in mineral belts is a key component of regional exploration for fertile systems. Low solubility of zircon in typical granitic bulk compositions promotes the preservation of xenocrystic material that can hinder unambiguous assignment of Pb–U ages to magmatic crystallization. To avoid inheritance of this nature, targeting U-bearing minerals that crystallized directly from the magma (or from magmatic-hydrothermal fluids) is critical. To this end, the UNB LA ICP-MS facility has been testing a variety of U-bearing minerals from well-dated, traceable, locations. The goal of this study is to identify potential natural reference materials for in situ (e.g., LA ICPMS) geochronology in peralkaline (miaskitic) igneous suites, greisen vein systems, evolved LCT and NYF pegmatites, kimberlites, uranium deposits, and carbonatites. Geochronometers of interest are from mineral groups such as complex oxides and fluoro-carbonates that can be unambiguously related to crystallization from fractionated late-stage liquids or hydrothermal fluids. Minerals investigated so far include cassiterite, wolframite, bastnaesite, and parasite, the pyrochlore group, uraninite (and uranothorite), fergusonite, euxenite, zirconolite, and columbite-group-minerals. These minerals are normally considered “leaky” to Pb-loss owing to high actinide concentrations and, thus, high amorphous fractions. Our approach has been to empirically test these minerals for isotopic homogeneity and robustness. The time-dependent behavior during ablation at different laser fluence and pulse rate is assessed, as is common-Pb content and optimal crater sizes for intrinsic U and Th concentrations. Once these conditions are established, the material is ‘dated’ using NIST610 glass as an external standard. This step establishes whether the material is isotopically homogeneous. In some Phanerozoic age minerals we have explored (e.g., cassiterite, uraninite, bastnaesite, fergusonite), standardization against NIST610 yields concordant data within error of the assumed age of the material. In other cases (e.g., euxenite), upper intercept ages overlap with known pulses of magmatism. Demonstrating primary external standardization using NIST610 relieves us of finding an additional natural material to act as a secondary standard. Thus, in addition to uncovering a new range of potential reference materials, this study may ultimately allow us to more tightly connect the space-time relationships along the continuum of juvenile through highly fractionated melts and into the magmatic-hydrothermal transition.

Atlantic Geology, 2019, Volume 55
Atlantic Geoscience Society Abstracts – 45th Colloquium & Annual General Meeting 2019
https://doi.org/10.4138/atlgeol.2019.005