Heading towards the most precise, accurate and reproducible U-Pb age of least material

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U-Pb geochronology has seen unprecedented developments during the last few years. The run for always higher precision of dates from ever lower volumes of material has required a series of innovations: chemical pre-conditioning of sample material, micosampling, highly precise and reproducible micro-chemical procedures, and innovations in low-level mass spectrometry. These developments rendered analyzed volumes from isotope-dilution TIMS dating equivalent to those sampled by laser-ablation ICP-MS, and closer to the ones analyzed by secondary ion beam mass spectrometry techniques.

This talk will give an outline of the main developments that were necessary to achieve our presently best precision of 0.01-0.02% for an ID-TIMS $^{206}Pb/^{238}U$ age of a geological sample: (i) lowest procedural chemistry blanks for Pb; (ii) isotope fractionation correction of Pb, U and O during analysis using an EARTHTIME double-lead, double-uranium isotope tracer solution; (iii) optimizing chemical abrasion for zircon using Raman spectroscopy; (iv) optimizing measurement conditions for Pb isotope analysis using secondary-electron as well as Daly-based ion counting systems; (v) shifting U as well as Pb isotope analysis from ion counters to high-sensitivity, low-noise Faraday collectors.

Achieving long-term, intra-sample, and intra-laboratory reproducibility at the same 0.01-0.02% level is by far more challenging than it is for precision. In my talk I will document (i) our continuous efforts to assess accuracy using the synthetic EARTHTIME standard solutions; (ii) our tests of system reproducibility with natural reference materials or unknowns; and (iii) our results of intercalibratig our two TIMS platforms (Triton from Thermo Scientific vs. Phoenix from IsotopX) at the same level of precision.

Our improved temporal resolution offers new insights into fundamental questions of planetary dynamics, including the synchrony of large igneous provices and mass extinctions, or the role of large-scale continental glaciations for major evolutionary discontinuities in the biosphere recorded in the geological past.

These achievements are the result of the joint efforts of the EARTHTIME community over the last 10 years. I especially acknowledge the help and support of the Isotope Geochemistry Group at University of Geneva.