Depth-Profile Laser-Ablation-Split-Stream ICP-MS U-Pb And Trace Element Analysis And (U-Th)/He Double Dating of Accessory Minerals

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Accessory minerals are excellent records of the temporal, petrologic, geochemical, and thermal evolution of rocks. Pushing the spatial resolution of geochronological and geochemical information from within single grains enables the more detailed and more finely resolved quantification of timing, rates, and petrologic/geochemical conditions of geological processes. In particular, combined geo- and thermochronometric dating techniques, such as U-Pb and (U-Th)/He dating, have the power to tease more comprehensive timing and geochemical information out of single accessory phases such as zircon or rutile in metamorphic and igneous rocks and promote a more holistic understanding of detrital provenance in basin studies. This study develops new analytical procedures to take advantage of mutli-method geo- and thermochronometry and trace element analyis on single crystals by employing laser-ablation split-stream (LASS)-ICP-MS during progressive depth profiling of unpolished tape-mounted accessory minerals. Time-resolved depth-profiling LASS-ICP-MS analysis of accessory phases has the ability to reveal different growth zones and their corresponding U-Pb age components and trace-element characteristics from a single depth-profile and thus yielding a more complete picture of crystallization and growth and the petrololgical and geochemical environment. Interferometric calibration of abalation rates and post-ablation SEM-CL imaging of grains perpedicular to ablation direction is used to verify spatial gradients and interpretations. Split-streaming of the laser ablated dry aerosol into two HR-ICP-MS instruments permits simultanous measurement of U-Pb age and corresponding trace element and REE concentrations during depth profiling. In addition, spatial variations in U and Th concentrations derived from depth profiles refine alpha-ejection corrections and precision of (U-Th)/He analyses used in U-Pb-He double dating. For both bedrock and detrital studies, detailed depth-profile U-Pb-He and REE/trace ement analyses of accessory minerals open exciting and unprecented new avenues in the reconstruction of their crystallization history, petrological and geochemical environments, crystallization temperatures, and temporal and thermal evolution, and thus elucidating geological, tectonic, and petrological processes recorded by accessory minerals.