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Dating young (100-350 ka) Gen Z zircons: Development of a dual ID-TIMS and ID-MC-ICPMS U-^{230}Th-Pb zircon analytical technique and data reduction

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Zircon geochronology has been an important tool for reconstructing thermal histories of silicic volcanoes. Typical SIMS U-^{230}Th zircon age uncertainties for < 100 ka grains are 1-2%, while ID-TIMS U-Pb zircon age uncertainties for > 1 Ma grains are ≤ 0.1%. However, it is extremely difficult to produce high-precision zircon ages for 100 ka to 350 ka grains using either chronometer. Despite the large SIMS U-^{230}Th zircon age uncertainties for this age range, some U-^{230}Th datasets have been used to support the hypothesis of protracted (≥ 10^5 years) thermal histories.

We developed an analysis and data reduction protocol, which measures radiogenic Pb by ID-TIMS and U and Th in that same crystal by ID-MC-ICPMS. This protocol effectively bridges the gap in precision between SIMS U-^{230}Th dates < 100 ka and ID-TIMS U-Pb dates > 1 Ma. Our technique overcomes the major shortcomings of each dating technique, namely overcoming (1) low radiogenic Pb to common Pb ratio that characterizes young (< 1 Ma) zircon, (2) large uncertainties associated with initial ^{230}Th disequilibrium corrections in the U-Pb chronometer, and (3) inability of in-situ U-^{230}Th techniques to resolve isotopic disequilibrium in grains very near secular equilibrium. We combine the TIMS Pb and MC-ICPMS U-Th data into an algorithm that we built, which describes intermediate daughter disequilibrium and incorporates appropriate common Pb corrections resulting in a single, higher-precision zircon age (< 1% age uncertainties versus 10-20% age uncertainty for SIMS U-^{230}Th) and thus improves temporal resolution of geologic events in this difficult to date age range (100-350 ka).

We present results of our new dual ID-TIMS and ID-MC-ICPMS protocol and data reduction technique. To corroborate the accuracy of our algorithm and the dates it yields, we date high-U (≥ 500 ppm) zircons from ca. 111 ka Sierra La Primavera (Mexico), which have U-^{230}Th rim and interior ages that are indistinguishable at the age resolution possible with SHRIMP-RG. Therefore, integrated ID-TIMS and ID-MC-ICPMS whole-grain zircon dates should match the SHRIMP-RG zircon dates. Ultimately, our dual-instrument protocol technique can be applied to magmatic systems with complex zircon crystallization histories to understand pre-eruptive magma storage conditions.