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Reconsidering initial Pb in titanite in the context of in situ dating

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Abstract

In situ U-Pb dating of titanite, which can preserve trace-element records of various petrologic processes but also incorporates significant initial Pb, has proliferated in recent years. The widespread use of titanite data to construct tectonic *P-T-t* paths warrants careful assessment of the available dating techniques, as well as attention to the assumptions that underpin the U-Pb data analysis. This contribution provides the first direct comparison of the two major analytical methods [SHRIMP (SIMS) and LA-ICP-MS] for in situ U-Pb titanite dating. A set of well-characterized titanite grains from Harrisville, New York, in the Adirondack Mountains were analyzed for U-Th-Pb isotopes along the same cross-grain traverses by Sensitive High Resolution Ion Microprobe (SHRIMP) and LA-ICP-MS. Both LA-ICP-MS and SHRIMP data sets define approximately linear arrays on the Tera-Wasserburg Concordia (semi-total Pb/U) diagram and would commonly be interpreted as representing a single date population with minor scatter. However, previous studies have suggested that Adirondack titanite actually records two regionally well-defined thermal events, ~50–100 m.y. apart. When titanite data arrays are treated in detail, attempts to determine concordia-intercept ages by robust three-dimensional linear regression produce large uncertainties and/or poor fit statistics that suggest that the data are not, in fact, isochronous. Grain-by-grain analysis of U-Pb titanite data shows that different subsets of titanite (determined by additional geochemical and microstructural data) show different patterns of U-Pb data. By comparing predictions for Pb-ingrowth evolution paths in Tera-Wasserburg diagrams with observed data, it is possible to recognize both a change in initial Pb composition and Pb loss in the Adirondack titanite U-Pb data set. This study provides an example of how greater geochronologic detail can be extracted from large in situ U-Pb titanite data sets. Even when precise dates are not recovered, geological processes and events that cause data scatter can be recognized through analysis of U-Pb data patterns using the Tera-Wasserburg diagram.

Keywords: Titanite, U-Pb geochronology, initial Pb correction, LA-ICP-MS, SHRIMP