Reliable LA-ICPMS U-Pb Dating of Cassiterite without an Independent Age Standard

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Precise and accurate dating of cassiterite (SnO_2) is needed for direct age determinations of this main ore mineral in tin deposits. Traditional approaches in LA-ICPMS U-Pb dating utilize matrix-matched standards that have been previously precisely dated by a reliable technique (e.g., ID-TIMS). Because cassiterite is extremely difficult to digest completely (necessary for obtaining accurate ID-TIMS U-Pb ages) the traditional approach cannot be easily implemented.

We propose a new approach for LA-ICPMS dating of cassiterite, which is based on its unusual, extremely low Th content. Accordingly, ^{208}Pb measured in cassiterite is mostly of non-radiogenic origin and can be used as a proxy for common Pb. Our method is as follows: (1) calculate a $^{208}Pb/^{206}Pb$ vs $^{207}Pb/^{206}Pb$ isochron date for a ~1.54 Ga cassiterite with closed U-Pb system (this age is in good agreement with its ID-TIMS Pb-Pb age) and (2) calculate a $^{208}Pb/^{206}Pb$ vs $^{238}U/^{206}Pb$ isochron date for the same spot analyses. The difference between these two dates (in this case, ~10%) is used to calculate a correction factor for instrumental U-Pb fractionation. The correction factor is then applied to younger cassiterites analyzed in the same analytical session and allows U-Pb dating of cassiterite of any age with no need for independently dated matrix-matched standard nor assumptions about the isotopic composition of common Pb.

Our USGS LA-ICPMS system (Photon Machines Excite-Analyte™ 193 nm excimer laser + NU Instruments SC-ICPMS Attom™, 135 µm spot diameter) was used to acquire U-Th-Pb data using NIST 612 glass as a primary non-matrix-matched standard and Iolite™ for data reduction. Preliminary results for cassiterite from tin deposits in Russian Karelia, Siberia, Spain, Saudi Arabia, and Brazil, with ages ranging from ~300 to ~1,900 Ma, demonstrate the applicability of this approach. These ages are in good agreement with published geochronology for rocks associated with the tin deposits. Thus, our LA-ICPMS methodology verifies the use of cassiterite as a reliable U-Pb mineral-geochronometer for direct dating of tin deposits.