Tin and Zinc Stable Isotope Variations in Cassiterite and Sphalerite from the Bolivian Tin Belt

Evan C. Hirsh[1], Ryan Mathur[2], Adam C. Simon[1], Wayne G. Powell[3]
1. University of Michigan, Ann Arbor, MI, USA, 2. Juniata College, Huntingdon, PA, USA, 3. Brooklyn College, Brooklyn, NY, USA

The Bolivian tin belt is an arcuate northwest-south trending region of Sn-Ag-W-(Sb-Bi-Zn) mineralization that extends for more than 1000 km along the Andean Eastern Cordillera morphotectonic province. Tin mineralization occurs primarily as cassiterite as a result of magmatic-hydrothermal processes associated with reduced ilmenite-series, S-type granitic magmas emplaced within polydeformed pelitic basement rocks. Zinc mineralization occurs primarily as paragenetically later sphalerite and occupies distal positions along proximal-distal thermochemical gradients in many districts and deposits within the tin belt. Previous experimental and field-based work shows that tin and zinc isotopes fractionate as a consequence of the changing physicochemical conditions during the transport and precipitation of cassiterite and sphalerite from saline magmatic-hydrothermal fluid and vapor. In this study, tin and zinc isotopes were measured in ore samples from 10 Bolivian tin districts, which reflect distinct mineralization styles and metal transport-precipitation pathways. The tin isotope compositions reveal that cassiterite precipitated at the shallow porphyry level is isotopically heavier, which may be a consequence of the enhancement of fractionation by redox reactions and vapor phase separation. The residual intrusive-proximal fluids are depleted in heavy tin isotopes, and precipitate isotopically lighter cassiterite at distal positions along district-scale fluid pathways. The zinc isotope compositions reveal that the isotopic behavior of zinc may mirror that of tin during mineralization.