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Nature and timing of Sn mineralization in southern Hunan, South China: Constraints from LA-ICP-MS cassiterite U-Pb geochronology and trace element composition

Tao Ren[1], Huan Li[1,*], Thomas J. Algeo[2,3,4], Musa Bala Girei[5], Jinghua Wu[1], and Biao Liu[1]

[1]Key Laboratory of Metallogenic Prediction of Nonferrous Metals and Geological Environment Monitoring, Ministry of Education, School of Geosciences and Info-Physics, Central South University, Changsha 410083, China
[2]State Key Laboratory of Geological Processes and Mineral Resources, School of Earth Resources, China University of Geosciences, Wuhan 430074, China
[3]State Key Laboratory of Biogeology and Environmental Geology, School of Earth Sciences, China University of Geosciences, Wuhan 430074, China
[4]Department of Geosciences, University of Cincinnati, Cincinnati, Ohio 42221-0013 U.S.A.
[5]Department of Geology, Bayero University Kano, Kano State, Nigeria

Abstract

Accurately determining the timing and mechanism of metallogenesis of ore deposits is essential for developing a robust genetic model for their exploration. In this paper, we analyze the formation conditions of cassiterite in five major deposits of southern Hunan Province, one of the most important tungsten-tin (W-Sn) provinces in South China, using a combination of cathodoluminescence imaging, in situ U-Pb geochronology, and trace-element concentration data. In situ cassiterite U-Pb geochronology constrains the main period of Sn mineralization to between 155.4 and 142.0 Ma, demonstrating a temporal and genetic relationship to silicic intrusive magmatism in the same area. Three stages of magmatic activity and metallogenic evolution are recognized: (1) Early Paleozoic and Triassic: the initial enrichment stage of tungsten and tin; (2) Jurassic: the metasomatic mineralization stage; and (3) Cretaceous: the magmatic-hydrothermal superposition stage. The cassiterite in these deposits takes four forms, i.e., quartz vein-type, greisen-skarn-type, greisen-type, and granite-type, representing a progression characterized by the increasing content and decreasing range of variation of high field strength elements (HFSEs), and reflecting a general increase in the degree of evolution of the associated granites. Rare earth element (REE) concentrations suggest that precipitation of cassiterite was insensitive to the redox state of the fluid and that precipitation of cassiterite in the southern Hunan Sn deposits did not require a high-f_{O_2} environment. These findings provide new insights into tin mineralization processes and exploration strategies.

Keywords: Tin, tungsten, U-Pb dating, geochemistry, metallogenesis, Nanling