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Geochronology, Geochemistry, and Hf Isotope of the Granite Porphyry at Shimensi in the Dahutang Tungsten District, Northern Jiangxi Province

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The Dahutang tungsten deposit is located in the northern part of the Jiuling Mountain in the center of the Jiangnan Orogen, which approximates to the Jiurui region of Middle-Lower Yangtze Valley Mineralization Belt to the north and the Xiangshan district of Gan-Hang Belt to the south. The Dahutang deposit, including three main orebodies of Shimensi, Yihaomai (or Dalingshang), and Shiweidong, is the world's largest tungsten deposit which contains ~>1 million tons (Mt) tungsten reserves. The mineralization and associated alteration of the deposit mainly occur between the late Mesozoic granite stocks and Neoproterozoic biotite granodiorite intrusion (Mao et al., 2013, 2014). Geological features show that the granite porphyry is associated with the Shimensi orebody. However, the genesis of the granite porphyry is still unclear. Therefore, here we present new geochronological, geochemical, and isotopic data, with the aim to constrain genesis of the Shimensi granite porphyry.

Zircon U-Pb LA-ICP-MS dating yielded an age of 154.4 ± 0.8 Ma for the Shimensi granite porphyry, which is older than that for the Shiweidong granite porphyry and muscovite granite (134.6 ± 1.3 Ma; ~144.2 ± 1.3 Ma; Huang and Jiang, 2012, 2013). Geochemical data show that the Shimensi granite porphyry has SiO_2 of 71.90 to 76.53 wt %, TiO_2 of 0.12 to 0.23 wt %, Al_2O_3 of 12.76 to 14.76 wt %, CaO of 0.38 to 1.06 wt %, MgO of 0.26 to 0.59 wt %, FeO of 0.65 to 1.00 wt %, Na_2O/K_2O of 0.45 to 1.30, A/CNK [molar $Al_2O_3/(CaO + Na_2O + K_2O)$] of 1.70 to 1.90, A/NK [molar $Al_2O_3/(Na_2O + K_2O)$] of 1.87 to 2.23, σ of 1.06 to 2.05 and AR of 2.42 to 3.02. They are geochemically high-K calc-alkaline, peraluminous rocks and belong to S-type granite. These rocks are characterized by enrichment of LILEs, depletion of HFSEs, moderate total REE contents (49.38–72.36 ppm) and LREE-enrichment (LREE/HREE = 9.83–16.76; La_N/Yb_N = 16.43–39.45), with negative Eu anomalies (Eu/Eu* =0. 27–0.65). In the primitive mantle-normalized trace element diagram, they show depletion in Ba, Nb, Sr, P, and Ti, and enrichment in Rb, U, and Hf. Zircon Hf isotopic compositions indicate that the granite porphyry has two-stage Hf model ages ranging from 1.4 to 2.7 Ga, with εHf(t) values of –23.6 to –2.9, indicating that these rocks were originated from partial melting of Mesoproterozoic and Paleoproterozoic crust material with the involvement of variable amounts of mantle components. The geological, geochronological, and mineralogical evidence indicates that Mesozoic tungsten mineralization in Jiuling Mountains can be divided into two distinct episodes: (1) ~150 Ma tungsten mineralization associated with the subduction of the Paleo-Pacific plate; and (2) ~135 Ma tungsten mineralization related to lithosphere thinning induced by asthenosphere upwelling.