SEG 2017 Conference

Thermochronologic constraints on the formation and exhumation of the Mesozoic lode gold deposits, northwestern Jiaodong Peninsula, eastern China

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The Jiaodong gold province is mainly composed of Precambrian basement and ultrahigh pressure metamorphic rocks with the intrusion of large-scale Mesozoic granites, the concentration of a large amount of hydrothermal gold deposits, and accumulation of a huge gold resource of as much as 4500 t. It has undergone continental collision between North China and Yangtze Cratons, subduction of the paleo-Pacific plate, and the related complex transformation of the tectonic regime. More than 90% of the proven gold resources are located in the northwestern part of the province. Based on our research on the distribution of the ores, alteration assemblages, mineral association, deformation, and low- and medium-temperature thermochronology (such as $^{40}Ar/^{39}Ar$ dating of muscovite, zircon and apatite fission track dating, zircon (U-Th)/He dating), we have better constrained the evolution of the regional tectonics, and formation, preservation, and exhumation of the gold deposits in the northwestern Jiaodong Peninsula. With the formation of the Linglong Metamorphic Core Complex (MCC), the Linglong granite intruded into the Precambrian basement rocks at ~163-155 Ma on the footwall of the Linglong detachment fault (LDF). Subsequently, rapid cooling and exhumation occurred along the LDF at 155-134 Ma forming the ultramylonite-mylonite zones. The exhumation and uplift rate of the Linglong MCC decreased beginning ~134 Ma. Simultaneously, the area underwent a significant ductile-brittle transition. The syntectonic Guojialing-type granitoid, which had undergone obvious ductile deformation, was emplaced at 132-123 Ma. Thereafter, the ductile deformation ceased with the overprint of further intense brittle deformation at 123-120 Ma. Corresponding to the rapid cooling and exhumation of the footwall along the LDF, as well as to the intrusion of the Guojialing granitoid, hydrothermal alteration was controlled by the brittle-ductile deformation, initiated at ~130 Ma with insignificant deposition of gold in the detachment fault zone. Major gold mineralization and related intense brittle deformation overprinted at ca. 120 Ma. The disseminated and veinlet pyrite-sericite-quartz altered ores formed just on the footwall of the ore-controlling faults near the major fault plane, whereas the auriferous quartz-sulfide veins filled in the high angle brittle faults far away from the major faults. Although tectonic activities were less significant after the Early Cretaceous mineralization, several post-mineralization faults crosscut the orebodies. The post-mineralization normal movements of the Linglong detachment and Jiaojia faults resulted in the different uplift and exhumation between their footwall and hangingwall. The post-mineralization exhumation of the orebodies is estimated at 3-7 km for deposits located in the block between the two major faults. Given that the ore-forming depth wasf 5-10 km, the orebodies have been partly eroded. However, the major orebodies have been well preserved, which is a favorable scenario for further exploration.