

Magmatic Activities Directly Contributed to the Formation of Giant Jiaodong Gold Province: Evidence from the Xiejia Diorite

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Gold deposits in Precambrian cratons were mostly generated during the formation and stabilization of the cratons, but the North China Craton (NCC) is unusual in that its gold deposits were mainly formed ca. 1.7 billion years after its stabilization. A magmatic-hydrothermal origin or mantle-derived fluid source has been proposed for the giant gold deposits of the Jiaodong district in the eastern NCC, but direct evidence is sparse and the mineralization processes remain controversial. Here, we present the results of a comprehensive study of the Xiejia diorite beneath the Linglong ore field at Jiaodong to link the gold mineralization to underlying magmatism. Magmatic zircon and titanite grains from the Xiejia diorite have U-Pb ages of 121.3 ± 0.9 Ma to 120.8 ± 1.1 Ma and 121.7 ± 3.9 Ma, respectively. The geochemical characteristics (REEs, Sr-Nd-Hf-Pb isotopes) of the Xiejia diorite are akin to those of contemporaneous mafic dikes in most gold mines at Jiaodong, indicating that it was most likely derived from an enriched lithospheric mantle source. The upper part of the diorite intrusion is pervasively altered and mineralized. Gold-bearing pyrite has a Re-Os isochron age of 122.5 ± 6.7 Ma, which is consistent with the ore-related sericite $40\text{Ar}/39\text{Ar}$ plateau age of 122.6 ± 1.3 Ma. Pyrite from the mineralized diorite yielded $\delta^{34}\text{SCDT}$ values of 2.1 to 9.7 ‰, which are comparable with those of pyrite from gold ores of Dongfeng. Pyrite grains from both groups also have similar Pb isotope compositions. The sulfur and lead isotope data are consistent with values of mafic dikes which are spatially and temporally associated with gold veins. The xiejia diorite is thus supposed to link the shallow gold mineralization to deep-seated mantle-derived magmatism generated during the extensive destruction of the NCC, which was induced by the rollback of the subducted Paleo-Pacific plate.