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Geological and geochemical characteristics of the Donggushan skarn deposit: The first discovery of a tungsten deposit in the North Luzong orefield, Middle-Lower Yangtze River Valley metallogenic belt

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The Donggushan tungsten skarn deposit was the first discovery of its kind in the northern part of the Middle-Lower Yangtze Metallogenic Belt. Its geological characteristics and ore-forming magmatic rocks differ greatly from other deposits in the Luzong orefield, such as the magnetite-apatite and porphyry copper deposits. As the age of host rocks and mineralization had not previously been determined, we carried out detailed geological field work as the basis for a systematic geochronological study, and a systematic petrography study of the Donggushan deposit. Scheelite is the primary ore mineral in the Donggushan deposit; it was analyzed for major, trace, and rare earth element (REE) abundance and Sr-Nd isotopes. The dominant disseminated tungsten mineralization occurs along the contract zone between biotite granite and Ordovician dolomite limestone or marble. The scheelite occurs in the metamorphosed dolomitic limestone with Mo-Cu-Pb-Zn and skarn minerals. The scheelite precipitated in two stages, a skarn stage (Type 1) and an oxide stage (Type 2). The Mo content in scheelite decreases from Type 1 to Type 2, and negative Eu anomalies decrease. This shows that the ore fluid was becoming more reduced. The two types of scheelite both show strong HREE depletion and the decoupling of LREEs and HREEs. The substitution mechanisms $3Ca^{2+}=2REE^{3+}+\square Ca$ (where $\square Ca$ is a Ca-site vacancy) is preferred for the substitution of REE^{3+} for Ca^{2+} in the Donggushan deposit. The WO_3 vs. CaO and WO_3 vs. MoO_3 relations in Donggushan scheelite are in the normal range for skarn deposits. Compared to other skarn scheelite deposits, calcium and tungsten content are high, and the Mo content is low. Rare earth elements in Donggushan scheelite show enrichment of LREE, and REE patterns are similar to those of other skarn scheelite deposits. The Sr-Nd isotopic characteristics of scheelite in the Donggushan deposit are different from those in the south sub-belt of the Middle-Lower Yangtze Metallogenic Belt, and in Dahutang deposit, which may be due to differences in the intrusive rocks of the three areas. The Nd (t) of scheelite in Donggushan is in the range -16.4 to -17.7, higher than that of the ore-forming intrusive rock, indicating the tungsten was derived from the crust, and with a probable contribution from the Dongling basement. Closely related biotite granite yielded LA ICP-MS U-Pb zircon ages ranging from 99.7±1.5 to 99.9±1.7 Ma. Molybdenite in the ore yielded Re-Os isotopic model ages of 97.22±0.77 Ma, indicating the age of the deposit. Geological field evidence indicates that the deposit formed after the biotite granite, consistent with the dating result. The Early Cretaceous age of the Donggushan deposit at about 100 Ma is different from the age of magnetite-apatite deposits in the basin (~130 Ma) and indicates a previously unrecognized age and type of mineralization in the Middle-Lower Yangtze River Valley Metallogenic Belt.