The Daye Iron Deposit, East China: a Possible Missing Link between Kiruna-type and Iron Skarn Ores

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Kiruna-type deposits, often referred to iron oxide–apatite (IOA) deposits, typically contain abundant F-apatite and V- and/or Ti-rich magnetite. Despite having been described as an independent style of mineralization, origin of many Kiruna-type deposits remains hotly debated. Two contrasting models have been proposed to explain their formation: (1) they crystallized from immiscible iron melts, and (2) they formed as a result of hydrothermal metasomatism as is the case of iron skarn systems. The Daye iron deposit provides an opportunity to reconcile these contrasting models. This deposit is localized within the contact zone between an early Cretaceous dioritic intrusion and Triassic marine carbonate rocks. Magnetite and hematite from the iron ore bodies have close paragenetic relationships with skarn assemblages mainly consisting of diopside and garnet. As such, the Daye deposit has long been considered as a typical iron skarn system. In a recent study, we have recognized apatite-rich diopside skarns and theire associated iron ores (up to 20 vol. % apatite) in the Daye deposit, with mineral assemblages and geochemistry resembling Kiruna-type ores. Apatite has two types of occurrences: (1) it forms mass of aggregates coexisting with magnetite or prograde skarn minerals such as diopside and garnet, and (2) it occurs as veinlets crosscutting the magnetite. Many magnetite grains are characterized by orientated ulvospinel exsolutions. The diopside and garnet have chemical compositions typical of iron skarn deposits. However, apatite contains high F (up to 2.9 wt. %), LREE (8694 ppm), and magnetite with ulvospinel inclusion have up to 2.14 wt. % Ti and 0.36 wt. % V, characters similar to the Kiruna-type deposits. We suggest that the IOA ores from the Daye deposit have a similar origin to the Kiruna deposits and possibly represent a missing link between Kiruna-type and iron skarn mineralization. Our findings also indicate that the Kiruna-type iron deposit may have formed from high temperature magmatic-hydrothermal fluids.