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Co-Cu Ore Deposit in China Continent: Geological Characteristics, Ore Deposit-Types, and Dynamic Settings

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Based on the principles of host rocks and ore genesis, the Co-Cu ore deposits in China continent mainly include three types, i.e. magmatic rock-hosted Co-Cu sulfide deposits, volcanogenically hydrothermal Co-Cu polymetallic deposits, and sedimentary rock-hosted stratabound Co-Cu deposits. These deposits are mainly distributed in continental margins, rift troughs, east Qinling collisional orogen and Yanshanian intracontinental settings in the Eastern China. However, the Co-Cu ore deposits of different types show large differences from those formed in other countries, in terms of abundance, geodynamic setting, ore-controlling structure, magmatic origin and evolution, and ore-forming age. The magmatic rock-hosted Co-Cu sulfide deposits generally were generated in continental margins and Phanerozoic orogenic settings which were closely related to small-scale ultramafic-mafic intrusions. The resulting deposits tended to be characteristic of that “small-scale intrusions often led to large-scale mineral deposits”, and were hosted largely within mafic-ultramafic intrusions which mainly comprise peridotites and gabbros. The latter, which in return provided ore-forming metals Co and Cu, had been derived from semi-deep or deep mafic-ultramafic magma by the way of multi-stage liquation, injection and hot water leaching. In orogenic belts or rift zones, fine-grained clastic sediments, sedimentary carbonates and marine volcano-clastic sedimentary rocks often hosted volcanogenically hydrothermal Co-Cu polymetallic deposits present as stratiform, stratiform-like or lenticular bodies. This type deposits are widely distributed in China continent and controlled strictly by stratigraphic level, lithological interface and fault. Also, they tend to occur as large- or medium-scale, Cu-dominated or Co-dominated signal-element ore deposits. Moreover, this type deposits contain broad types of host

rocks and wall-rock alterations, and accounted for multiple sources of ore-forming metals. Therefore, the volcanogenically hydrothermal Co-Cu polymetallic deposits had an intimate association with a volcanic-hosted, exhalative and sedimentary process and hydrothermal reworking. By contrast, the sedimentary rock-hosted stratabound Co-Cu deposits formed in marginal rifts or rifting troughs of paleo-continentals in other countries are less developed in China continent. However, one of representative examples in China is the Dahenglu Co-Cu deposit which is Co-dominated Co-Cu deposit of economic significance in Jilin Province, North China. The ore-bearing rocks are mainly sedimentary rocks, as the most typical example, the black shales. Both the ore-bearing formations and the particular strata have shown an apparent control to the distribution and the genesis of orebodies. With the complexity of its genesis, mainly as sedimentation, metamorphism and the late hydrothermal reworking, these are polygenetic and superimposed Co-Cu ore deposits of multiple episodes.

In spite of abundance in cobalt and copper resource in the world, their distribution is more concentrated upon some countries such as Zambia, Zaire, the United States and Canada, which are the main producers of the world's cobalt and copper. Compared with the foreign countries with the abundant, proved resources, the Co-Cu deposits in China continent are dominated low-grade ores with less abundant bonanzas, and often show coexistences of Co and Cu with other metals in associated ores. China thus is scarce in Cu-dominated or Co-dominated signal-element ore deposits. There're obvious differences from similar ore deposits abroad, mainly in following aspects. 1) The foreign countries occupy abundant cobalt metal reserves, but most of the sources are from the weathered lateritic nickel deposits (accounting for 46.8% of total resources). In

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contrast, magmatic rock-hosted Co-Cu sulfide deposits and volcanogenically hydrothermal Co-Cu polymetallic deposits are main, which dominate more than 80% of the total amount of resources, 2) Foreign stratabound cobalt-copper ore deposits mainly occurred in Paleoproterozoic and Mesoproterozoic sedimentary sandstone formations, whereas this type deposits are widely distributed in China, 3) In terms of magmatic origin and evolution, the cobalt-copper ore deposits which are controlled by ophiolites are well developed in foreign countries, such as Cyprus Cu (Co) ore deposits, but this type deposits are scarce in China, and 4) The cobalt-copper ore deposits abroad, which are controlled by geodynamic setting, deep structure and stratigraphic position, often come into being in the form of ore belts, such as the northwestern United States Idaho cobalt-copper ore belt and Zambian copper mineralization belt, etc..

There are also distinct differences among three types of Co-Cu ore deposits in China continent. Except for the magmatic rock-hosted Co-Cu sulfide deposits with an intimate association with magmatic activities, the other ore deposit-types show weak or no relationship to magmatism. Moreover, the latter were characterized by late-stage intense structural deformation and hydrothermal alteration. Nevertheless, all ore deposit-types account for metal

association of Co-Cu-Ni, Cu-Co-Au-Ag, Fe-Co-Cu and/or Co-Pb-Zn-Cu-Sb, and mainly contain ore minerals of pyrite, chalcopyrite, siegenite, cobaltite, cobaltiferous pyrite and cobaltiferous arsenopyrite. Moreover, these ore deposit-types have a broad metallogenic time from Proterozoic to Tertiary.

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