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Editorial: Critical Metals in Northwest China: Characters, Genesis and Tectonic Settings

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Editorial on the Research Topic

Critical Metals in Northwest China: Characters, Genesis and Tectonic Settings

Critical metals are strategic mineral resources that are indispensable to our global high-tech industry. Having a robust understanding of how critical metal deposits form and the criteria that can be used for their exploration is, therefore, of great importance to the international mineral resources industry. Northwest China is one of the most important mineral exploration and mining regions in China. It formed by the multi-phase accretion of variably mineralized Paleozoic–Mesozoic terranes caused by the closure of the Paleo-Asian and Paleo-Tethys oceans. Recently, a number of important breakthroughs have been made in the petrogenesis, metallogenesis, and exploration for critical metal deposits in Northwest China, including rare metal, precious-metal, and rare-earth element deposits.

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DIVERSE TECTONIC SETTINGS

Critical-metal mineralization occurs in diverse tectonic settings and in different geologic units throughout Northwest China. Chromite and platinum-group element (PGE) mineralization of the Hongshishan Alaskan-type complex in the Beishan area is characterized by cumulate and layering textures, with mineral, petrological, and geochemical characteristics that differ from typical ophiolites, and resemble Alaskan-type complexes related to subduction or arc magmatism in the Late Devonian (Z. Wang et al., this issue). During the Permian, extensive mafic dyke swarms and Ni–Cu–Co-mineralized mafic–ultramafic intrusions formed in the Beishan area, all of which are related to the extensional tectonics that dominated this area at this time (G. Xu et al., this issue; P. Li et al., this issue). In the Late Permian to Middle Triassic, the Chaqianbeishan area of the Quanji Massif was affected by the southward subduction of the Zongwulong oceanic plate (T. Pan et al., this issue), while the tectonic setting of the Eastern Tianshan transferred from a subduction to an intraplate environment (J. Zhi et al., this issue).

TYPICAL DEPOSITS AND THEIR GENESIS

Four different types of deposits located in the Chinese Altay Orogen were characterized in detail in this issue. Y. Tang et al. (this issue) combined zircon U–Pb and molybdenite Re–Os dating methods to constrain the mineralization age of the Askartor Be–Mo deposit to the Triassic. This mineralized two-mica granite exhibits highly fractionated geochemical characteristics, suggesting that it is the product of multistage fractional crystallization of an initially Be-enriched magma, and that fluid exsolution occurred late in the evolution of this magma. S.D. Li et al. (this issue) conducted a systematic fluid inclusion and H–O–C–S–Pb isotope study of the Jinba Au deposit, constraining it as an orogenic deposit and establishing its genetic model. Z. Hu et al. (this issue) characterized the textures and major–trace element chemistry of six garnet grains from the Tiemurt Cu–Pb–Zn(–Au) deposit. They found that the fluids related to the formation of this base-metal mineralization are CO_2-rich, mesothermal, mildly acidic, and reduced, analogous to metamorphic fluids generated during orogensis. X. Wei et al. (this issue) conducted a geochronologic and geochemical study of volcanic rocks related to Fe–Cu–Mo mineralization in the Xilekuduk area. The magnetite-related mineralization was divided into Devonian magmatic stratiform-type and Carboniferous hydrothermal vein-type, with the latter being closely related to porphyry Mo mineralization.

Four deposits in the Chinese Eastern Tianshan and one in the Kyrgyz North Tianshan have been well documented in this issue. D. Xue et al. (this issue) characterized the mineralogy, fluid inclusions, H–O isotopes, and age of a newly discovered skarn W deposit. The Heiyanshan W deposit is hosted at the contact between a Carboniferous biotite monzogranite pluton, and Mesoproterozoic metamorphosed clastic and carbonate rocks, and formed from hydrothermal fluids characterized by moderate to low temperatures and salinities. Using the trace-element composition of pyrite and chlorite in the Tuwu porphyry Cu deposit, W. Tan et al. (this issue) identified three stages of mineralization related to magmatic, hydrothermal, and metamorphic processes. P. Li et al. (this issue) conducted a systematic petrological, geochronological, and geochemical analysis of the Lubei Ni–Cu–Co deposit, and demonstrated that it formed from a magma that experienced fractional crystallization, crustal contamination, and sulfide segregation in a post-collisional extensional geodynamic setting. Using magmatic and hydrothermal zircons, J. Zhi et al. (this issue) determined the ages of five lithological zones in the Baishitouquan pluton, which hosts the large, newly discovered Zhangbaoshan Rb deposit. The ages of the magmatic and mineralization events that formed this deposit are Triassic, which is a critical period for granitic magmatism and rare-metal mineralization in the Eastern Tianshan. Based on zircon U–Pb and Lu–Hf isotopes, W. Xi et al. (this issue) constrained the ages of the auriferous monzogranite porphyry of the Taldybulak Levoberezhny gold deposit and the host Kemin Complex in Kyrgyztan. The deposit is demonstrated to have formed in the Silurian and derived from the Precambrian basement rocks back to the Archean.

Apart from deposits in the Tianshan and Altay, four deposits from the West and East Kunlun Orogenic Belts, the Quanji Massif, and the Southwest Yangtze Block were described in this issue. Using Zircon U-Pb and muscovite Ar-Ar isotope dating methods, Y. Gao et al. (this issue) determined the age of Li mineralization in the Bayankala Fold Belt, West Kunlun. Y. Han et al. (this issue) characterized the mineralogy of nickel and cobalt minerals, and established a mineralization model for the Xiarihamu deposit in East Kunlun, the second largest Ni–Co deposit in China. T. Pan et al. (this issue) characterized the U–Pb isotope and trace-element composition of columbite–tantalite group minerals to determine the ages of emplacement and hydrothermal metasomatisim of a typical Li-rich pegmatite in the Chaqianbeishan area of the Quanji Massif. Y. Fu et al. (this issue) described two outcrop sections of lower Cambrian black shales in Southwest Yangtze that contain thin polymetallic layers with elevated Ni, Mo, V, PGEs, and rare Earth elements. They proposed that these polymetallic layers formed in a hypoxic oceanic environment during the Sinian–Cambrian transition, and that metal enrichment was enhanced during diagenesis.

MINERAL EXPLORATION AND PROSPECTING

Y. Gao et al. (this issue) used a combination of geologic mapping, geochemical methods, and high-resolution remotely sensed multispectral imagery to pinpoint potential locations of pegmatite-hosted Li occurrences in areas adjacent to the recently discovered Li deposits in the Dahongliutan area, West Kunlun Orogen. This contribution led to the discovery of several large Li-mineralized occurrences in the Bayankala Fold Belt, with a combined resource of over 1.7 million tonnes (Mt).

ELEMENT PARTITIONING

C. Ye et al. (this issue) characterized the major- and trace-element composition of amphiboles from the Huangyangshan alkalic granite and associated enclaves to estimate the crystallization temperature and pressure of these amphibole, and the partition coefficients of trace elements between these amphiboles and the granitic magma. They found that the high field strength elements and rare Earth elements are more compatible in sodic amphiboles than in calcic amphiboles.

Summary

This special Topic focuses on the most common types of deposits in Northwest China, as well as newly discovered deposits in this region, with the aim of understanding their characteristics, mineralization ages, mineralization mechanisms, and metallogenesis. We believe that these articles will provide a wealth of knowledge to a broad readership that has been fundamental to the enhancement of our understanding of critical-metal mineralization in Northwest China.

AUTHOR CONTRIBUTIONS

C-ZW worte the primary paper, MB revised the paper, all authors had reviewed the paper.

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