

Editorial

Editorial for Special Issue “Rare Metal Ore Formations and Rare Metal Metallogeny”

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Rare metals (usually defined as including elements such as Li, Rb, Cs, Be, Sn, Nb, Ta, Zr, Y, U, and rare-earth elements) are included in the list of “critical mineral resources” by major economies around the world. Recently, global research into rare-metal resources has experienced renewed intensity, with 14 important achievements being published in this Special Issue of *Minerals*. This Special Issue publishes research on the genesis, geological setting, and characteristics of several rare-metal deposits.

Zhou et al. [1] demonstrated that volatile components such as CO₂ play an essential role in the migration and enrichment of rare metals. They proposed that the immiscibility of melt-fluid is likely a necessary enrichment mechanism for rare metals in the Dakalasu No. 1 pegmatite dyke.

Zhou et al. [2] discussed the substitution mechanism of rare-metal elements in muscovite in the pegmatite of Altay, China, along with the evolution and metallogenic processes of rare metal-rich magma. They proposed a set of discriminative indicators of rare-metal mineralization potential in pegmatites based on muscovite geochemistry.

Through the study of the mineral geochemistry of beryl, Wang et al. [3] discussed the magmatic-hydrothermal mineralization process of Cuonadong pegmatite in southern Tibet, China. They proposed that beryl primarily precipitates due to the emplacement of highly fractionated Be-containing magma in the overlying or surrounding country rock, followed by undercooling of the melt-fluid, and crystallization of volatile-bearing minerals.

Wang et al. [4] used systematic mineral geochemical to discuss the magmatic-hydrothermal mineralization process of Jiajika pegmatite in western Sichuan, China, and the controlling factors for large-scale lithium mineralization. Based on the pegmatite mineral equilibria and fluid inclusions, a constrained P–T path was proposed for the process of magmatic-hydrothermal crystallization of the Jiajika No. 134 pegmatite. The limited activity of hydrothermal fluids and the high cooling rate during magma crystallization minimized the diffusion of Li into the surrounding rock from the pegmatite. This is a key factor in producing high-quality lithium resources in the Jiajika deposit.

Jiang et al. [5] conducted geochemical and spectroscopic analyses to identify cation substitution and the genesis of beryl in the Renli deposit from the Mufushan area in central China. Further, they proposed that the concentration of Cs and Na/Li value in the Renli beryl grains suggests a relation to relative less-evolved granite intrusion of the Mufushan batholith. This provides new insights into the multi-stage rare-metal mineralization in the region.

Zheng et al. [6] compared the major and trace elements of apatite and zircon and the isotopic compositions of zircon from fertile and barren porphyries of the Yao'an deposit in southwestern China. They proposed that high oxygen fugacity and exsolution of Cl-bearing fluids facilitated the migration and enrichment of metal elements. High oxygen fugacity inhibits metal precipitation as sulfide minerals, thereby enhances rare-metal mineralization potential.



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Yakut wodginite, an intermediate mineral between wodginite and wolframowodginite, was discovered by Alekseev et al. [7] at the Kester deposit in the Russian Far East. The finding of wodginite with a high WO_3 content, along with the discovery of similar minerals from China, Spain, Canada, and India, supported identification of a new mineral. They proposed that Yakut wodginite is an example of rare heterovalent isomorphism and an indicator of rare-metal granites and pegmatites bearing tin and tantalum.

Based on the geochemical composition and Pb–O isotopes of scheelite, Wang et al. [8] concluded that the ore-forming fluid of Shimensi was mainly sourced from magmatic water, which possibly mixed with meteoric water in the late stage of ore formation. Both the early- and late-stage ore-forming fluids may have been relatively rich in F^- and HCO_3^{3-} , respectively, and evolved from reducing to oxidizing fluids.

Using combined evidence from geochronology, rare-earth elements, and fluid geochemistry, Li et al. [9] estimated that the Shuanghuajiang fluorite deposit in South China was F-mineralized at 185 ± 18 Ma. The ore-forming fluids belong to a NaCl– H_2O system with low temperature and low salinity, typical of meteoric water, and are not derived from magmatic-hydrothermal activity. The metallogenic model proposed by Li et al. [9] is that faults developed in the granite pluton provided pathways for meteoric water to reach deep into the crust, where it evolved into hydrothermal fluids that circled back with enhanced dissolution and leaching capacities. Ore-forming ingredients Ca and F were leached out from the Xiangcaoping granite and Ca-bearing strata, picked up by the hydrothermal fluids, and later migrated and precipitated in the faults at shallower levels due to changes in temperature, pressure, and pH conditions.

Gao et al. [10] recognized the three periods of celestine deposit formation in the Huayingshan strontium ore district in China; these include the evaporation period, hydrothermal period, and supergene period. They concluded that the ore-forming fluids of Huayingshan ore district were derived from basinal brines, with the addition of a large amount of meteoric water. Strontium was predominantly derived from the Jialingjiang Formation.

Yuan et al. [11] estimated the ore-forming age of the Daping tungsten deposit in central China as 133.5 ± 1.3 Ma. They proposed that the deposit underwent the following complex magmatic-hydrothermal ore-forming process: the magmatic greisen stage, hydrothermal sulfide stage, and calcite stage. The W content in greisen veins in the Daping deposit is proportional to the intensity of greisenization and muscovite, which were closely associated with scheelite.

Dai et al. [12] demonstrated two stages of magmatic and mineralization occurred in the Xuebaoding W–Sn–Be deposit in west China, during the late Indosinian at 219.0 ± 1.12 Ma and at 213.5 ± 1.7 Ma. The W–Sn–Be mineralization is closely related to the highly fractionated Indosinian granites of the Xuebaoding deposit, which are formed by the partial melting of Mesoproterozoic basement.

Wang et al. [13] determined the mineralization ages of hydrothermal rutile and monazite from the Tongmugou and Laobaotan deposits in north China as 1858 ± 27 Ma and 1876 ± 30 Ma, respectively. These ages are consistent with those of peak and retrograde metamorphism caused by a collision of the Trans-North China Orogen at ca. 1850 Ma. They suggested that the Hubi copper (cobalt) ore district is the oldest sediment-hosted stratiform copper–cobalt deposit in China and is possibly the oldest such deposit in the world.

Qin et al. [14] proposed four main magmatic stages, namely 230.8 ± 1.6 , 222.1 ± 0.56 , 203.1 ± 1.6 , and 135.5 ± 2.4 Ma, of the Chuankou tungsten ore field in South China. Tungsten mineralization occurred under a post-collisional setting of South China in the late Paleozoic to early Mesozoic. Widespread W mineralization reflects crust–mantle interactions, which resulted from the multistage extension of the South China Block caused by the westward subduction of the paleo-Pacific plate.

We hope that this Special Issue will promote further research of rare-metal deposits and facilitate exploration for and discovery of new rare-metal deposits.

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