

Editorial

Editorial for Special Issue “Polymetallic Metallogenic System”

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Received: 5 July 2019; Accepted: 10 July 2019; Published: 15 July 2019



In the last century, following the development of Earth System Science, the metallogenic system has become an important topic in the study of mineral deposits. The term “metallogenic system” firstly presented in 1970s, connotes a natural system with ore-forming functions [1]. The metallogenic system includes geological factors controlling ore-formation and preservation, and ore-forming processes and their products—ore deposit series and anomaly series [1]. It emphasizes the integration of tectonic settings, controlling factors, metallogenic mechanisms, and conditions and mechanisms of post-mineralization transformation and preservation (i.e., the source, transport, trap, transformation, and preservation). On the basis of the theory of the metallogenic system, Deng et al. [2–4] defined the composite metallogenic system and summarized the distribution and characteristics of composite metallogenic systems in China.

While economic geology typically focuses on the differences between individual deposits, the metallogenic system looks for broad similarities in each system [5]. The metallogenic system model allows for multiple mineralization styles to be identified within a single system [5]. For example, a porphyry copper system may develop associated high and low sulfidation epithermal gold mineralization, and skarn-type or hydrothermal vein-type Cu-Pb-Zn-Ag mineralization [6–8]. By integrating all geological ingredients and processes that are necessary for the formation of mineral deposits, the investigation of the metallogenic system is more useful for revealing the geodynamic evolution of a region, and more effective for regional prospecting exploration [9–11]

From the perspective of regional metallogeny, the study by Niu et al. [12] relates deep dynamic processes in the Earth to gold deposits at the crustal surface (core → mantle → crust) in Jiaodong Province. Zircon Hf and whole-rock Nd isotopic mapping presented in Zhang et al. [13] precisely illustrate the controls of lithospheric architecture on the distribution of regional polymetallic mineralization. Liu et al. [14] and Wei et al. [15] propose the main gold deposition mechanisms by studying the fluid inclusions and corresponding H–O–S isotopic compositions of different ore-forming stages in the Sanshandao and Sizhuang gold deposits, respectively. Zhao et al. [16] classifies the Koka gold deposit in NE Africa as an orogenic gold deposit based on the similar features of geology and ore-forming fluids.

The study by Chen et al. [17] describes the occurrence of texturally heterogeneous gold-hosting quartz types and variations in trace element geochemistry, offering a more multi-generational perspective on precipitation mechanisms that fluid inclusion studies may not be able to offer. Guo et al. [18] investigates the rare earth element geochemistry and C–O isotope characteristics of hydrothermal calcites to provide new insights into the fluid–rock interactions and ore-forming processes. Li N. et al. [19] present a textural and trace-element analysis of sulfides, and investigate the controls on the distribution of invisible and visible gold in the ores to further improve our genetic understanding of the deposits in the Yangshan gold belt. The arsenopyrite and chlorite mineral thermometers are applied in Sun et al. [20] to constrain the process and mechanism of gold mineralization in the Zhengchong gold deposit–Jiangnan orogenic belt.

For the strategies of mineral exploration, Li et al. [21] recognize the negligible wall-rock alteration of high-grade auriferous quartz vein-type ores and increase the target mineralized zone and the volume of potential ore for gold deposits that are hosted in Archean metamorphic rocks. A geostatistical analysis of data is presented in Wang et al. [22] to determine the geometry of mineralized zones and the structural control of ore shoot plunge in the Sizhuang Au ore deposit, exemplifying an effective exploration strategy for studying the structural control of the geometry, orientation, and grade distribution of orebodies via the integration of geostatistical tools and structural analysis.

The studies by Yu et al. [23], Wang et al. [24], Yang Q. et al. [25], and Yang F. et al. [26] provide geological, geochronological, and geochemical insights into the formation of polymetallic deposits, including the timing of mineralization and ore genetic types. In addition, garnet Sm–Nd dating is conducted on the Hongshan skarn deposits to further constrain the timing of skarn formation in Zu et al. [27]. The emplacement ages and geochemical and isotopic signatures of ore-related intrusions are also proved to be genetically linked with the formation of mineral deposits [28–34].

In order to reveal the importance of water content and the oxidation state for the formation of porphyry Au mineralization, Bao et al. [35] analyze the compositions of amphiboles and zircons to evaluate the physicochemical conditions (e.g., pressure, temperature, fO_2 , and water content) of the ore-fertile porphyries and ore-barren porphyries identified in the Beiya Au deposit. To evaluate the relative contribution of ore-forming elements from granites and from the surrounding strata, Jiang et al. [36] compare the whole-rock geochemistry of ore-related skarns to the composition of associated granites and strata and suggest that the strata played an important role in the formation of W–Sn polymetallic deposits in South China.

Overall, we hope this Special Issue will contribute further to the development of metallogenic system theory, enhance scientific thinking, and suggest ways forward to investigate polymetallic mineral deposits.

Funding: This research is funded by the National Key Research Program of China (Grant No. 2016YFC0600107-4), the National Natural Science Foundation of China (Grant No. 41572069), the National Science Foundation of China (Grant No. 2015CB2605 and 2009CB421008), and the 111 Project under the Ministry of Education and the State Administration of Foreign Experts Affairs, China (Grant No. B07011).

Acknowledgments: L.Y. is a professor at the China University of Geosciences, Beijing (CUGB). I would like to thank my research group at CUGB, especially for Yu-Sheng Zhai and Jun Deng.

Conflicts of Interest: The author declares no conflict of interest.

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