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Editorial

Editorial for Special Issue "Geochemistry and Mineralogy of Hydrothermal Metallic Mineral Deposits"

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The Special Issue of *Minerals* on Geochemistry and Mineralogy of Hydrothermal Metallic Mineral Deposits presents the results of diverse geochemical and mineralogical research from across the globe. It is aimed to demonstrate that geochemical and mineralogical variation, both within and among hydrothermal ore deposits can be applied to genetic models, to exploration and drilling programs, and more. The eight contributions reflect a wide range of deposits, as well as different types of geochemical and mineralogical research applied to them. While most of these studies are focused on gaining a better understanding of deposit genesis, the results have a far greater application, as highlighted below.

Isotopic analyses of ore and gangue minerals have been applied to research on hydrothermal metallic mineral deposits for a little more than a century. Advances in analytical methods over the past few decades have lowered detection limits and allowed determination of ages and isotopic compositions that were previously not possible. Molnar et al. [1] use isotopic analyses of uraninite and molybdenite to assist in unraveling hydrothermal events related to Rompas gold–uranium mineralization in northern Finland. The mineralization is hosted by Paleoproterozoic rocks with a complex magmatic, metamorphic, and structural history, and the detailed isotopic analyses provide insight into the relation between mineralization and orogenic events [1]. This study also illustrates the importance of detailed field and mineralogical studies as the basis for isotopic analyses.

The study of platinum-group elements (PGE) mineralization in the Great Dyke of Zimbabwe at the Unki mine, by Chalumba [2] shows how detailed mineralogical relations can separate distinct processes. The concentration of PGE, nickel, and base metals in ultramafic to mafic rocks has often been attributed to magmatic processes. Yet, in this study, mineralogical relations indicate that the magmatic ore has been overprinted by a secondary phase of hydrothermal alteration. These results demonstrate the importance of basic descriptive mineralogical data in distinguishing hydrothermal and magmatic processes.

For a little more than half a century, the study of fluid inclusions in minerals have been a routine part of many studies of hydrothermal metallic mineral deposits. Kowalski and Kissin [3] have used this well-tested method to investigate the Archean Brookbank-Cherbourg gold deposit in northwestern Ontario, Canada. Hydrothermal gold deposits form over a wide range of deep Earth conditions, with mesothermal deposits hosted in more ductile shear zones and formed at higher temperature and pressure conditions, compared to epithermal deposits that are hosted by fissures and breccias (relatively brittle) and formed at generally lower temperature and pressure conditions. The fluid inclusion data at Brookbank-Cherbourg are consistent with field observations indicating a transitional character for the deposit with gold, hosted both in a shear zone and a fissure vein. This study provides further confirmation of the important role that fluid inclusion studies play in determining the conditions of formation for hydrothermal metallic mineral deposits.

Use of multiple types of geochemical data is an effective way to solve problems involving ore genesis. In a study of the Shimensi deposit in south China, Wie et al. [4] merged isotopic data to determine the age of hydrothermal muscovite in the deposit, as well as the source of sulfur in the ore minerals, and water in fluid inclusions. These results showed that formation of the deposit was synchronous with intrusion of host granites and that metals were precipitated by mixing of magmatic and meteoric waters. This study illustrates how helpful it is to have a wide range of geochemical and mineralogical data in building a genetic model.

Although quantitative modeling facilitated by complex computer codes is becoming the standard for testing hypotheses for the formation of mineral deposits, qualitative conceptual modeling is also useful. Brown [5] used generic descriptive characteristics of sediment-hosted stratiform copper deposits combined with Eh-pH diagrams to estimate the processes leading to mineralization in this important deposit type. He compares these inferences to specifics of several deposits to constrain the evolution of ore-forming fluids. Conceptual modeling has and will continue to play an important role in advancing our understanding of hydrothermal metallic mineral deposits.

Until about 20 years ago, analytical methods were not sufficient to determine natural stable isotopic variation of metals, such as copper, for which relatively high atomic weights result in limited mass-dependent fractionation. Bornhorst and Mathur [6] have documented the stable copper isotopic composition of native copper from the large native copper deposits of the Keweenaw Peninsula, Michigan, USA. A model of the history of copper is proposed through interpretation of the copper isotopic data in light of existing experimental data on copper isotope fractionation and other geological, mineralogical, and geochemical data. This study provides important insights into the likely source of copper in these deposits, and gives an indication of the potential that stable isotopic studies of metals have to refine our understanding of the origin of metallic mineral deposits.

Advances in analytical methods have made it possible to look for clues to the origin of metallic mineral deposits by study of the nano-scale surfaces of minerals. Tauson et al. [7] present a study of the surfaces of native gold grains from two different styles of gold deposits in Eastern Russia. Their results document that the surfaces of native gold grains from a mesothermal deposit lack oxidized gold minerals, whereas native gold grains from an epithermal deposit have oxidized gold minerals on their surfaces. This study demonstrates that detailed study of mineral surfaces and their coatings can provide additional insights about the conditions under which they were deposited.

Textures of minerals in metallic deposits are key indicators of paragenesis and formation conditions. Saunders and Burke [8] have synthesized textural and experimental evidence to demonstrate that nanoparticles and colloids are important in the formation of epithermal gold deposits. Nanoparticles involve a “far-from-equilibrium” process that must be considered when doing geochemical modeling of precipitation from hydrothermal fluids. Tauson et al. [7], introduced above, independently conclude that nanoparticles were probably important in an epithermal deposit, providing support for the suggestion by Saunders and Burke that nanoparticles play a much wider role in metallic hydrothermal ore deposits than previously recognized.

This Special Issue demonstrates how geochemical and mineralogical data from macro-to-nano scale, and from descriptive to advanced, are key attributes which, when integrated with other geological data, can lead to new insights into the processes of formation of hydrothermal metallic mineral deposits. I hope this Special Issue will prove useful long into the future.

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