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Preface

Preface to *Metals, minerals, melts and fluids associated with giant mineral deposits: Insights from natural observations, experiments and theoretical models*

1. Introduction

Fluids and magmas rising from the mantle to the crust are the main agents of metals transport and deposition. Magmatic-hydrothermal ore deposits represent localized concentrations of economically valuable elements that have been enriched by orders of magnitude relative to the bulk crust. The genesis of such deposits involves the culmination of a variety of processes, including the generation of metal- and volatile-rich magmas, ore-fluid exsolution, and the efficient transport and precipitation of metals. Thus, geochemical signatures of fluids, melts, minerals and rock alteration are significant to identify rocks that are associated with mineral resources. Field-based studies supported by advanced characterization and innovative high-pressure-temperature laboratory experiments, especially the state-of-the-art *in situ* synchrotron-based high T-P experiments, continue to provide invaluable insights into these processes on a variety of scales, whereas the rapid development of computational capacity supports emerging disciplines such as computational chemistry calculations of metal-complex stabilities and numerical simulation of hydrothermal flow and magma chamber processes.

This special issue of *Ore Geology Reviews* intends to bring together researchers from these various disciplines to highlight the recent progress made towards deciphering the inherent complexity of magmatic-hydrothermal ore formation. We have collected **24** contributions in this special issue, with topics ranging from experimental and theoretical studies of metal transport in ore-forming fluids to field observation and characterisation, including case studies of giant deposits such as Iron Oxide Copper Gold (IOCG), Rare Earth Element and granite-related tungsten deposits. Below are brief highlights of each paper included in this special issue.

2. Highlights of the special issue of the special issue

In this special issue of *Ore Geology Reviews*, several experimental and theoretical studies provide fundamental knowledge of how metal is transported in ore-forming fluids, and how minerals precipitate and form ore deposits. Filimonova et al. (2020) conducted X-ray absorption spectroscopy experiments to reveal the forms of gold and silver occurrence in pyrite and determine the effect of physicochemical-compositional parameters on the concentration and state of "invisible" Au in ore deposits. Liu et al. (2019b) studied the stability of gold nanoparticles in hydrothermal fluids *in-situ* at elevated pressure and temperature using X-ray absorption spectroscopy, revealing that high concentration of gold (~100 ppm) can be transported as gold nanoparticles (colloids) in sulfidic fluids at temperatures up to 300 °C; such fluids are capable of forming giant gold deposits. The *ex-situ* experimental study of Cu-Pb-Ag-Sb-S melts by Govindarao et al. (2020) increases our understanding of the role of melting in altering the mineralogy of massive sulfide deposits. Schmidt et al. (2020) determined experimentally fluid-melt partitioning coefficients of tin and tungsten for a wide range of conditions that represent the magmatic fluids and melts related to Sn and W mineralisation; the new data provide important constraints on the formation of hydrothermal granite-related Sn and W deposits. Liu and Xiao (2020) performed thermodynamic modelling of wolframite solubility and precipitation in hydrothermal fluids, revealing the transport of tungsten as a function of temperature, pressure, pH and salinity.

This special issue includes a number of studies on the ore characterisation and genesis for some important ore deposits. Zhu and Zhu (2020) and Arasada et al. (2020) focused on chromite mineralization, and its geological and geophysical characterization. Alford et al. (2020) and Meng et al. (2020) both conducted detailed mineral paragenesis and sulfide trace element studies in understanding polymetallic Au-Ag mineralization in Central City district, Colorado and Laobashan gold deposit in NE China, respectively. Global interest in rare earth elements and rare metals is rising considerately, leading to rapid advances in our understanding of the diversity of these deposits in the geological record. Liu et al. (2020) describe a new Indosinian Li-Be-Nb-Ta mineralization in East Tianshan orogenic belt in China. Southeast Asia has the world's richest Sn resource. Li et al. (2019a) investigated the geochronology, geochemistry and Sr–Nd–Hf isotopic compositions of Late Cretaceous–Eocene granites in southern Myanmar to resolve outstanding issues with the temporal evolution of Sn deposits. In recent decades, significant efforts have been devoted to indicator mineral to improve exploration. Guo et al. (2020) characterizes field SWIR spectrometry of illite clays in the Sinongduo low sulfidation epithermal deposit, Central Tibet, and Tian et al. (2019) characterize geochemical compositions of garnet in the Hongshan Cu-Mo skarn deposit. In addition to developing indicator minerals, Zhang et al. (2019a) evaluated the fertility of porphyries in the Tulasu basin, Northwest Tianshan for porphyry deposit exploration. Liu et al. (2019a) present new geochronological data to constrain the timing of Fe-(Cu) metallogenesis in Eastern Tianshan, NW. Porphyry deposits are the most important source of copper and molybdenum, and although Cu and Mo in porphyry systems are generally thought to be transported under oxidizing conditions. Zhang et al. (2019b) show that CH_4-rich aqueous fluids are also capable of transporting a certain amount of Cu, Mo, and Au for mineralization, based on a case study of the Seleteguole deposit, NW China. In another case study

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highlighting the role of carbon-rich fluids in ore formation, Crede et al. (2020) show that hydrocarbon-rich and aqueous, silica-rich fluids were present simultaneously, as well as separately in alternating pulses, at the Au-Ag McLaughlin deposit, California. They conclude that a hydrocarbon phase was important in mobilizing Au. Knorsch et al. (2020) conducted a textural and geochemical study of the Artemis Zn-Cu-Au prospect, NW Queensland, Australia, and demonstrated the impact of fluid-driven hydrothermal mineral replacement reactions on the formation and alteration of carbonate-hosted polymetallic sulfide deposits. The nature and origin of fluids in Fe-Ti-P mineralization has been widely debated, and Li et al. (2019b) present new geochronology and fluid inclusion thermometry data from the Damiao Fe-Ti-P deposit, China, and conclude that the Fe-Ti mineralization was formed at the magmatic stage, whereas P-mineralization occurred at the hydrothermal stage.

In addition, a number of geological and geochemical studies related to giant ore deposits are introduced in this special issue. Qin et al. (2020) investigate the origin and recharge model of the Late Cretaceous evaporites in the Khorat Plateau. Lang et al. (2020) studied reduced fluids in porphyry copper–gold systems that reflects the occurrence of thermogenic processes in the wall-rock, and present an example from the No.1 deposit in the Xiongcun district, Tibet, China. Bath et al. (2020) investigated alteration patterns linked to a high-grade Archean gold deposit, the Wattle Dam deposit, Western Australia, indicating that carbonate-undersaturated alkaline fluids played a critical role in mobilizing and concentrating high amounts of gold into veins. Moncada et al. (2019) investigated the relationships between fluid flow rate, metal concentrations of ore-forming fluids, duration of the ore-forming process, and ore grade and tonnage, to explain the formation of giant epithermal precious metal deposits. And finally, Li et al. (2020) studied the interface-coupled dissolution reprecipitation (ICDR) of trace elements (uranium) and shows that in a high-grade Cu-U ore from the super-giant Olympic Dam ore deposit, remobilized U was scavenged during the fluid-driven replacement of chalcopyrite ($CuFeS_2$) by bornite (Cu_5FeS_4), indicating a direct link between sulphide mineralogy and U grade.

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