Magnetite texture and trace-element geochemistry fingerprint of pulsed mineralization in the Xinqiao Cu-Fe-Au deposit, Eastern China

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ABSTRACT

The origin of stratabound deposits in the Middle-Lower Yangtze River Valley Metallogenic Belt (MLYRB), Eastern China, is the subject of considerable debate. The Xinqiao Cu-Fe-Au deposit in the Tongling ore district is a typical stratabound ore body characterized by multi-stage magnetite. A total of six generations of magnetite have been identified. Mt1 is commonly replaced by porous Mt2, and both are commonly trapped in the core of Mt3, which is characterized by both core-rim textures and oscillatory zoning. Porous Mt4 commonly truncates the oscillatory zoning of Mt3, and Mt5 is characterized by 120° triple junction texture. Mt6 to Mt5 are commonly replaced by pyrite that coexists with quartz, whereas Mt6, with a fine-grained foliated and needle-like texture, commonly cuts the early pyrite as veins and is replaced by pyrite that coexists with calcite. The geochemistry of the magnetite suggests that they are hydrothermal in origin. The microporosity of Mt2 and Mt4 magnetite, their sharp contacts with Mt1 and Mt3, and lower trace-element contents (e.g., Si, Ca, Mg, and Ti) than Mt1 and Mt3 suggest that they formed via coupled dissolution and reprecipitation of the precursor Mt1 and Mt3 magnetite, respectively. This was likely caused by high-salinity fluids derived from intensive water-rock interaction between the magmatic-hydrothermal fluids associated with the Jitou stock and Late Permian metalliferous black shales. The 120° triple junction texture of Mt5 suggests it is the result of fluid-assisted recrystallization, whereas Mt6 formed by replacement of hematite as a result of fracturing. The geochemistry of the magnetite suggests that the temperature increased from Mt2 to Mt3 and implies that there were multiple pulses of fluids from a magmatic-hydrothermal system. Therefore, we propose that the Xinqiao stratiform mineralization was genetically associated with multiple influxes of magmatic hydrothermal fluids derived from the Early Cretaceous Jitou stock. This study demonstrates that detailed texture examination and in situ trace-elements analysis under robust geological and petrographic frameworks can effectively constrain the mineralization processes and ore genesis.

Keywords: Magnetite, stratabound mineralization, Xinqiao Cu-Fe-Au deposit, Middle-Lower Yangtze River Valley Metallogenic Belt

INTRODUCTION

Magnetite is a ubiquitous mineral phase in different geological environments and represents a dominant metallic mineral phase in a wide variety of hydrothermal ore systems (Nadoll et al. 2014, 2015). Octahedral and tetrahedral coordinated positions in the magnetite structure provide host sites for many trace elements (e.g., Al, Mn, Ti, V, Ni, Cr, Zn, Co, Sn, Ga, and Mg) via isovalent and coupled substitutions (Dupuis and Beaudoin 2011; Nadoll et al. 2012; Deditius et al. 2018). The trace-element compositions of hydrothermal magnetite are mainly governed by the composition of the hydrothermal fluids, temperature, oxygen fugacity ($f_\text{O}_2$), sulfur fugacity ($f_\text{S}_2$), co-crystallized mineral phases, and fluid-rock interactions (McIntire 1963; Dare et al. 2012, 2014; Nadoll et al. 2014; Knipping et al. 2015; Huang et al. 2019a, 2019b; Liu et al. 2019; Salazar et al. 2019; Sun et al. 2019a). Therefore, several studies have focused on the trace-element geochemistry of magnetite to constrain mineralization type and ore genesis (Beaudoin et al. 2007; Dupuis and Beaudoin 2011; Dare et al. 2012, 2014; Nadoll et al. 2012, 2014, 2015), fingerprint the temporal and/or spatial evolution of the ore-forming hydrothermal fluids (e.g., Li et al. 2019; Liu et al. 2019), and reconstruct the mineralization processes (e.g., Li et al. 2019; Hu et al. 2020). More importantly, magnetite undergoes dissolution and reprecipitation (DRP), oxy-exsolution, and/or recrystallization to reach chemical and textural re-equilibration, and consequently detailed studies of internal textures are necessary before conducting trace-element analyses (Hu et al. 2014, 2015; Salazar et al. 2019).

The Middle-Lower Yangtze River Valley Metallogenic Belt (MLYRB), Eastern China, is one of the most important mining regions in China and is characterized by abundant large stratabound deposits (e.g., the Dongguashan Cu-Au deposit and the Xinqiao Cu-Fe-Au deposit; Mao et al. 2011). The origin of these stratabound deposits is still a matter of debate with several models proposed including Late Paleozoic submarine exhalative processes (SEDEX, e.g., Gu et al. 2000; Xu and Zhou 2001), Early Cretaceous...