American Mineralogist, Volume 108, pages 178–191, 2023

Textural and chemical evolution of magnetite from the Paleozoic Shuanglong Fe-Cu deposit: Implications for tracing ore-forming fluids

Shuanliang Zhang[1,2], Huayong Chen[1,2,3,4,*], Bing Xiao[1], Liandang Zhao[5], Xia Hu[6], Jianping Li[1], and Lin Gong[1,2]

[1]Key Laboratory of Mineralogy and Metallogeny, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China
[2]University of Chinese Academy of Sciences, Beijing 100049, China
[3]CAS Center for Excellence in Deep Earth Science, Guangzhou, 510640, China
[4]Guangdong Provincial Key Laboratory of Mineral Physics and Materials, 511 Kehua Street, Guangzhou 510640, China
[5]School of Earth Science and Resources, Chang'an University, Xi'an 710054, China
[6]CAS Key Laboratory of Crust-Mantle Materials and Environments, School of Earth and Space Sciences, University of Science and Technology of China, Anhui, 230026, China

Abstract

The Aqishan-Yamansu belt in Eastern Tianshan (NW China) hosts several important Fe and Fe-Cu deposits, the origin of which is the subject of considerable debate. The coexistence of various types of ore-forming fluids makes it difficult to distinguish the genesis of the Fe-Cu deposits. We present detailed textural and compositional data on magnetite from the Paleozoic Shuanglong Fe-Cu deposit to constrain the formation of iron oxides and the evolution of the ore-forming fluids and thus define the genesis of the Fe-Cu ores.

Based on the mineral assemblages and crosscutting relationships of veins, two mineralization stages were established, including the early Fe mineralization and late Cu mineralization stage. Three types of magnetite, i.e., platy (MA), massive (MB), and granular (MC) magnetite occur in the Fe mineralization. Backscattered electron (BSE) images identified display oscillatory zoning in an early hematite and transformational mushketovite phase (MA-I), characterized by abundant porosity and inclusions, as well as two later generations, including an early dark (MA-II, MB-I, and MC-I) and later light magnetite (MA-III, MB-II, and MC-II). The MA-I has extremely high W contents and mostly displays as micro- and invisible scheelite inclusions, which were probably caused by the W expulsion during mushketovitization. The texture and composition of magnetite suggest that the later light magnetite formed via dissolution and reprecipitation of the precursor dark magnetite, and the temperature and oxygen fugacity of fluids decreased over time. Our study also shows the MB-II magnetite and coexisting chlorite display synchronous oscillatory zoning, with the calculated temperature from 444 to 212 °C. Such variations could indicate the incursion of external low-temperature fluids with high salinity, which can dissolve the primary dark magnetite. This study provides a good example of using magnetite to trace the complex evolution and multiple sources of ore-forming fluids.

Keywords: Magnetite, texture and chemistry, ore-forming fluid, Fe-Cu deposit, Eastern Tianshan