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Apatite Mineralogy and Chemistry of the Taocun Magnetite-Apatite Deposit in Ningwu Volcanic Basin: Implications for Ore Genesis of IOA Deposits

ZENG Liping[1] and ZHAO Xinfu[1,2]

1 Faculty of Earth Resources, China University of Geosciences
2 State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences

1 Introduction

Apatite is a common gangue mineral in Iron-Oxide Apatite (IOA) deposits (Williams et al., 2005). The crystal structure of apatite-group minerals may contain significant amount of trace elements, including REE, halogens and Sr (Pan and Fleet, 2002). The concentrations of these elements, and the variations between them, can be used to decipher the nature of ore-forming fluids and ore genesis. In this study, apatites from the Taocun iron deposit, Lower Yangtze River Valley metallogenic belt (LYRVMB), were chosen for detailed textural and geochemical analyses. Apatites are closely associated with magnetite in the deposit, and are considered to be slightly older than and/or synchronous with magnetite precipitation. Therefore, mineralogy and chemistry of apatite will provide tight constraint on the genesis of magnetite.

2 Study Area

The Cretaceous NingWu volcanic basin, located in the LYRVMB, contains numerous IOA deposits (Chang et al., 1991). The genesis of these deposits has been attributed to either immiscible Fe-P melts (Chen et al., 1981; Chang et al., 1991; Hou et al., 2011), or to high temperature hydrothermal metasomation (Institute Of Geochemistry, 1987; Lu et al., 1990).

The Taocun iron deposit, located in the central part of the Ningwu basin, is one of the typical magnetite-apatite deposit. Ore mineralization is genetically related to Early Crataceous augite diorite porphyry which was considered as subvolcanic intrusions of overlying volcanic rocks of the Dawangshan Formation (Group, 1978). Orebodies are mainly hosted within top part of the diorite porphyry and at the contact zone of the intrusion and the volcanic rocks.

The Taocun deposit comprises a large body of disseminated magnetite, which has been crosscut by late stage apatite-actinolite-magnetite veins. The deposit displays extensive hydrothermal alteration which is characterized by earlier scapolite and albite, overprinted by assemblages comprising apatite, actinolite and epidote, and by silification. Albitization shows an intimate spatial association with the iron orebody.

3 Results

Apatite grains from the ore-related diorite porphyry pluton (I-Ap) and magnetite-apatite ores, including disseminated magnetite ores (D-Ap) and vein magnetite ores (V-Ap), were examined using optical microscopy, cathodoluminescence (CL) imaging, scanning electron microscopy and electron microprobe analysis to evaluate texture and major and trace element composition. I-Ap grains are hexagonal in cross-section; some display growth zones. D-Ap grains typically have embayed shapes; whereas V-Ap grains are automorphic- hypautomorphic. Three types apatite are fluorapatites (from 3.54 to 5.44 wt.% for F, from 0.12 to 1.05 wt.% for Cl, repectively). I-Ap grains contain high Cl (between 0.58 and 1.05 wt.%), Fe(0.31~0.72 wt.%), Mn (0.04~0.14 wt.%) and Mg (0.002~0.012 wt.%), whereas V-Aps have high content of S (0.03~0.80 wt.%) and Na (0.16~0.030 wt.%).

Compositional variation among these different groups suggests that I-Ap, D-Ap and V-Ap are controlled by different exchange balance during formation, including the coupled exchanges: Na++REE3+=2Ca2+; Si4++REE3+=Ca2++P5+; and S6++Na+=Ca2++P5+ (Pan and Fleet, 2002). CL images of I-Ap and hydrothermal apatite grains are light yellow and green in colour, respectively, confirming different compositions between them (Zhang et al., 2010). We hence suggest that apatites from the intrusions (I-Ap) and ores (D-Ap and V-AP) were formed in different ways (igneous vs hydrothermal).

* Corresponding author. E-mail: 539865837@qq.com

Hydrothermal fluids responsible for D-Ap and V-Ap are also compositionally different, as indicated by their different element contents.

4 Discussion

Field and microscopic observations, in combination, allow two episodes of ore formation to be recognized. These are: (1) a stage of disseminated magnetite mineralization; and (2) a later phase of vein magnetite mineralization. The former is characterized by formation of fine-grained disseminated magnetite ores via extensive metasomatism. A transitional boundary between the orebody and wall rock implies a hydrothermal metasomatism origin of the orebody. In contrast, vein-type mineralization is marked by infill of coarse-grained to pegmatitic magnetite-actinolite-apatite veins along fractures and joints in the intrusion and pre-existing disseminated magnetite ores. The ore veins commonly displays sharp boundaries with the host rocks.

5 Conclusions

Our study clearly supports a hydrothermal metasomatic origin for the Taocun iron deposit and likely also for other IOA deposits in the Ningwu Basin. This study provides convincing evidence for the hydrothermal origin of IOA deposits. The existence of two separate mineralization events in the Taocun deposit imply that IOA deposits may have multiple episodes of ore-formation events, analogous to those commonly identified in porphyry copper deposits (e.g., Piccoli and Candela, 2002).

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References

Chang, Y.F., Liu, X.P. Wu, Y.C., 1991. The copper–iron belt of the lower and middle reaches of the Changjiang River. Beijing: Geological Publishing House. (in Chinese with English abstract).

Chen, Y.C., Sheng, J.F. Ai, Y.D., 1981. Meishan iron deposit—an ore magma-hydrothermal. Bulletin of the Institute of Mineral Deposits, Chinese Academy of Geological Sciences, 2: 26-48. (in Chinese with English abstract).

Ningwu Research Group, 1978. Ningwu Porphyry Iron Ores. Beijing: Geological Publishing House,Beijing. (in Chinese with English abstract).

Hou, T., Zhang, Z., Kusky, T., 2011. Gushan magnetite–apatite deposit in the Ningwu basin, Lower Yangtze River Valley, SE China: hydrothermal or Kiruna-type?. Ore Geology Reviews, 43(1): 333-346.

Institute of Geochemistry, Chinses Academy of Sciences, 1987. Ore-forming Mechanism of Ningwu Type Iron Deposits. Beijing: Sciences Press. (in Chinese with English abstract).

Lu, B., Hu, S. X., Lin, Y. S., et al., 1990. A study on origin and ore-forming model of Ningwu type iron deposits. Miner Deposit, 9(01):13-25. (in Chinese with English abstract).

Pan, Y. and Fleet, M.E., 2002. Compositions of the apatite-group minerals: substitution mechanisms and controlling factors. Reviews in Mineralogy and Geochemistry, 48(1): 13-49.

Piccoli, P.M. and Candela, P.A., 2002. Apatite in igneous systems. Reviews in Mineralogy and Geochemistry, 48(1): 255-292.

Williams, P.J., Barton, M.D., Johnson, D.A. et al., 2005. Iron oxide copper-gold deposits: Geology, space-time distribution, and possible modes of origin. Economic Geology 100th Anniversary Volume: 371-405.

Zhang, C., Huang, S., Yang, D., et al., 2010. Tunable luminescence in Ce3+, Mn2+-codoped calcium fluorapatite through combining emissions and modulation of excitation: a novel strategy to white light emission. Journal of Materials Chemistry, 20(32): 6674-6680.