

In situ major and trace element analysis of magnetite from carbonatite-related complexes: implications for petrogenesis and ore genesis

WEI CHEN¹, YUAN-CAN YING¹, TIAN BAI¹,
SHAO-YONG JIANG¹, KUI-DONG ZHAO¹,
DONGBOK SHIN², JINDRICH KYNICKY³

¹ State Key laboratory of Geological Process and Mineral Resources, China University of Geosciences, 430074 Wuhan, China

² Department of Geoenvironmental Sciences, Kongju National University, Gongju 314-701, South Korea

³ Department of Geology and Pedology, Mendel University in Brno, Zemedelska 3 61300 Brno, Czech Republic

Magnetite (Fe₃O₄) is one of the most common accessory minerals in magmatic rocks, and it can accommodate a wide variety of major, minor and trace elements that can be measured by laser ablation ICP-MS. In this study, we investigate the chemical compositions of magnetite from four carbonatite complexes (Oka, Mushgai Khudag, Hongcheon and Bayan Obo).

The minor elements (Mg, Ti, Al, Mn) in magnetite vary significantly both within and between different complexes. High field strength elements (Zr, Hf, Nb, Ta, U, Th) are generally depleted in magnetite from carbonatite complexes, whereas K, Rb, Cs, Ca and P are commonly below detection limits. V and Zn display significant variations from tens to thousands of ppm. Co, Ni and Ga are present in ppm or tens of ppm, whereas Cu, Sr, Y, Ba and Pb are characterized by sub-ppm levels. Mo and Ge are identified at the ppm level, whereas a consistent concentration of 2-5 ppm is observed for Ge. The determined chemical compositions of magnetite from carbonatite complexes are quite distinguishable compared to those formed in silicate and sulfide melts. This is clearly shown using multielement variation diagrams, and the distinct signatures of carbonatite-related magnetite include strong positive anomalies of Mn and Zn and negative anomalies of Cu, Co and Ga.

The discriminant diagrams of Ti vs. Zr+Hf, Ti vs. Nb+Ta and Ni/Cr vs. Ti are applicable for distinguishing magmatic and hydrothermal magnetite in carbonatite-related environments. In addition, the discriminant diagram of Zn/Co vs. Cu/Mo and Cu vs. Zr+Hf can be used to distinguish carbonatite-related magnetite from magnetite that formed in other environments.