

Chlorine isotope variations of apatite in Damiao deposit: Implications for magmatic-hydrothermal process

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There is still some controversy about the genesis of Damiao Fe-Ti-P deposit in the northern North China Craton. After Chen et al. (2013) proposed that formation of a nelsonitic melt is a major ore-forming process in the Damiao deposit, the insights from baddeleyite-zircon relationships indicated that the Fe-Ti oxides being formed at the magmatic stage [1], while apatite precipitated throughout the magmatic-hydrothermal processes (Li et al., 2019)[2]. Apatite chemistry has been widely used in the monitoring of halogen behavior in magmatic-hydrothermal systems, because the ratio of halogen F and Cl in apatite is very sensitive to changes in the composition of evolving silicate melts or aqueous fluids (Palma et al., 2019)[3].

In this study, the backscattered electron (BSE) and thodeluminescence (CL) characterization with major and trace elements of melanorite in Damiao deposit, implies that there are two kinds of apatite, namely magmatic apatite with enrichment of F, while the hydrothermal apatite with enrichment of Cl. The H₂O contents of apatite vary from 0.78 to 1.45 wt%. The chlorine isotopes ($\delta^{37}\text{Cl}$) of apatite in melanorite is $-0.20 \sim +0.57\%$, and that in anorthosite is more positive from $+0.24$ to $+0.59\%$. A positive correlation of $\delta^{37}\text{Cl}$ vs. H₂O content and a weak negative correlation of $\delta^{37}\text{Cl}$ vs. F/Cl molar ratio implies that i) F/Cl gradually decreases and $\delta^{37}\text{Cl}$ increases with the crystallization of fluorapatite, as F is thought to be less volatile than Cl; ii) For melanorite, the $\delta^{37}\text{Cl}$ value in apatite after hydrothermal alteration are generally higher than that in fresh melanorite, which is attributed to the chlorine isotope fractionation with the re-partitioning of chloride between apatite and fluid. Our study provides a further evidence on the two-stage mineralization in Damiao deposit.

[1]Chen, W.T., Zhou, M.F., Zhao, T. P. (2013) Contributions to Mineralogy and Petrology 165, 1341-1362.

[2] Li, L.X., Li, H.M., Zi, J.W., Rasmussen, B., Sheppard, S., Wilde, S.A., Meng, J. (2019) Ore Geology Reviews 115, 103186.

[3] Palama G., Barra F., Reich M., Valencia, V., Simon, A.C., Vervoort, J., Leisen, M., Romero, R. (2019) Geochimica et Cosmochimica Acta 246, 515-540.