

REE contents of ore and apatite from Nolans Bore REE-P-U deposit, Australia: Implication for REE mineralization

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Nolans Bore REE-P-U deposit, Northern Territory, Australia, is one of the most promising REE resources in the world. High grade REE ore derived from Nolans Bore deposit consists mainly of apatite with various amounts of acid-resistant minerals such as monazite-group mineral. Here we report that REE content of ore and apatite was analyzed by ICP-MS and LA-ICP-MS, respectively. In the analysis for ore by ICP-MS, we applied two different preparation methods before the analysis; Li-borate-fusion in a commercial laboratory and multi-acid digestion. Result derived from multi-acid digestion method is likely to be a true value relative to the other method. The high-grade REE ore is enriched in light-REE, especially Ce and Nd, with a maximum value of around 7 wt % total REE. The quantitative analysis by multi-acid digestion is highly precise and reliable for a wide range of REE concentration when using suitable dilution ratio and digestion sequence with several types of acids which could totally dissolve acid-resistant minerals such as monazite. On the other hand, analysis by Li-borate-fusion potentially gives lower trace element values than that of multi-acid digestion, when a sample is extremely concentrated in trace elements including REE. Apatite occurs as veins varying its width up to several tens meters wide. Petrographic studies indicate that there are two major types of apatite. Type 1 apatite occurs as euhedral grains containing fine-grained inclusions (hematite or multiple-oxide?) which exhibits an amoeba-like texture. Type 1 apatite is dominant in the ore. Type 2 apatite is sporadically present and occurs as anhedral and along grain-boundary. Fragments of type 1 apatite grains are sporadically present in the type 2; suggesting that type 1 was formed earlier than type 2, which is considered supergene in origin. Type 1 apatite has a bright CL-image, but type 2 has no luminescence. LA-ICP-MS analysis reveals that type 1 apatite is extremely enriched in REE together with Th and U contents. On the contrary, type 2 apatite is almost pure fluoro-apatite and is free of REE, Th and U. The type 1 apatite has high content of Ce and Nd, with a maximum value around 6 wt % total REE. The REE composition in type 1 apatite resembles that of ore; implying the type 1 apatite, relative to acid-resistant minerals, principally contributes the REE grade of the ore deposit.

Keywords: REE, apatite, Nolans Bore deposit, LA-ICP-MS