中国イオン吸着型鉱床における希土類元素についての微視的研究
Microscopic study on rare earth elements in ion-adsorption type ore of China

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At present, China constitutes more than 80 % of the rare earth elements (REE) production in the world. Among REE ores, ion-adsorption type ones existing mainly in southern China are a major supply source of heavy REE (HREE) which are especially valuable. The ion-adsorption type ore is formed under weathering of the underlying parent granite rocks. This ore typically contains more than 50 % of ion-exchangeable REE that can be extractable with electrolyte solution such as ammonium sulfate $(NH_4)_2SO_4$ solution. It has been estimated that permanent negative charge on clay minerals, such as kaolinite, leads to surface adsorption of REE in the ore. However, the direct observations or analyses for the individual minerals have been rarely conducted due to the relatively low concentrations of REE (<2000 ppm). In the present study, we analyzed weathered granite collected from an ion-adsorption ore in Dingnan County, Jiangxi Province, China on a submicroscopic scale by using various experimental apparatuses.
XRD measurements indicated that the weathered granite is mainly composed of quartz, K-feldspar and kaolinite. The results of SEM-EDS and LA-ICP-MS measurements showed that “kaolinitic particle” is abundant with REE compared to the other minerals. These results suggest that the kaolinitic particles are major reservoir of REE in the ore. The elemental mapping for a kaolinitic particle by LA-ICP-MS showed that each element is distributed heterogeneously in the particle. The SEM-EDS analyses also suggested that the kaolinitic particle is composed of several minerals. For further micro-analyses, cross sections were processed from the kaolinitic particles by FIB. XAFS study on the cross sections suggested that REE are basically hydrated in the particle. STEM-EDS analyses revealed that the kaolinitic particle contains illite and hematite in addition to kaolinite. Considering general weathering process, it can be assumed that K-feldspar was altered into illite and further into kaolinite during chemical weathering. Elemental mapping with high spatial resolution by NanoSIMS clarified that REE are distributed in kaolinite and illite.

キーワード：イオン吸着型希土類鉱床、レーザアブレーション誘導結合プラズマ質量分析法、集束イオンビーム／透過型電子顕微鏡法、X線吸収微細構造解析法、超高空間分解能二次イオン質量分析法
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