

Formation process and metamorphism on R chondrite parent body based on distribution of rare earth elements, Th and U.

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Introduction: Mineralogical and chemical compositions of R chondrites are similar to those of ordinary chondrites (OCs) [1]. In the previous study [2], abundances of rare earth elements (REEs), Th and U in bulk R chondrites were reported to be almost equal to those of OCs. In equilibrated OCs, major host phases for REEs, Th and U are known as Ca-phosphates [3, 4]. Therefore, considering similar mineralogical and chemical compositions, it can be expected that those elements in R chondrites are distributed in the same way as OCs, but major host phases of these elements in R chondrite are not known yet. In this study, we investigated the distribution of REEs, Th and U in R chondrite by using a chemical leaching technique for discussing formation processes of and/or metamorphism on R chondrite parent body.

Experimental: Fifteen R chondrites were subjected to chemical leaching experiment. A powder sample of each R chondrite was successively leached with 0.1 M HNO₃ and 5 M HNO₃. Then, the residual fraction was recovered. Abundances of major elements and trace elements including REEs, Th and U in each fraction were determined by using ICP-AES and ICP-MS [5]. In addition, thick sections were prepared from eight R chondrites. Modal abundances of constituent minerals were estimated by using EPMA and FE-SEM equipped with EDS, and then abundances of REEs, Th and U in selected minerals were determined by using LA-ICP-MS.

Results and Discussion: We found that REEs, Th and U in R chondrites are hosted into Ca-phosphates to a certain extent (Figure. 1). However, distributional budgets of REEs in Ca-phosphates for R chondrites are different from those for OCs, where REE distributions are related to petrologic types. In R chondrites, their distributions are variable regardless of the petrologic type. Moreover, CI-normalized light REE (LREE) abundances in Ca-phosphates reach up to 600, assuming that the P, REE, Th and U recovered by the first leaching of 0.1M HNO₃ is entirely due to the dissolution of Ca-phosphates. Apparently, REEs in R chondrites were distributed into Ca-phosphates in a different way from that of OCs.

In OCs, REE abundances in acid residues of OCs are related to petrologic types [6], while elemental abundances are related to petrologic types for LREEs but not for heavy REEs (HREEs) in R chondrites. CI-normalized REE abundance patterns for acid residues are convex with a positive Eu anomaly, changing upward from LREEs to HREEs even for R3, whereas unequilibrated OCs show rather flat patterns with no Eu anomaly.

The results from the 2nd leachates indicate the presence of acid-soluble mineral(s) which is abundant in HREEs compared with LREEs in R chondrites. EPMA and FE-SEM observations, however, could not identify any candidate of such a mineral(s) so far. Again, it is suggested that the distribution of REEs in R chondrite is quite different from that in OC.

Based on the results of leaching experiments and EPMA/FE-SEM observations, we are performing the *in-situ* measurement of REEs, Th and U contents in some minerals (including Ca-phosphates) of R chondrite using LA-ICP-MS.

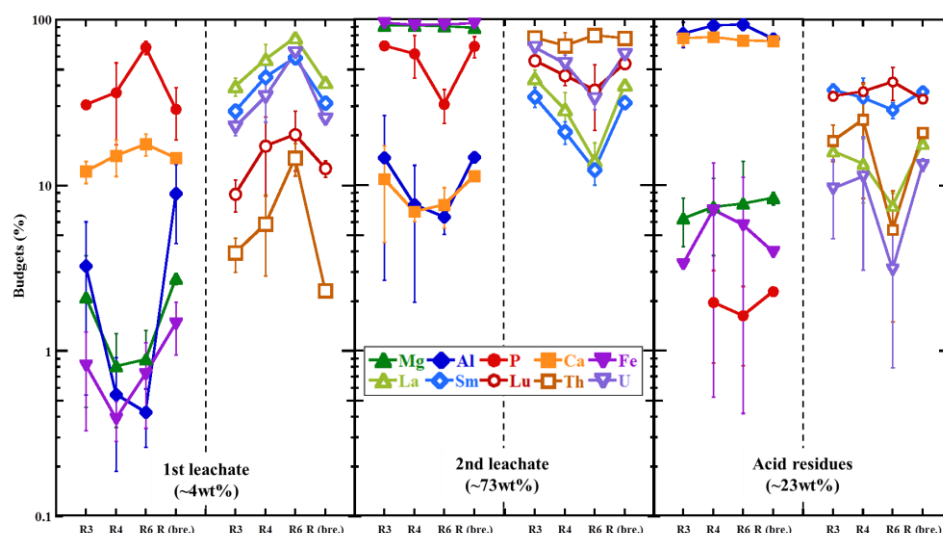


Figure 1. Average budgets for several major elements (Mg, Al, P, Ca and Fe) and trace elements (La, Sm, Lu, Th and U) for dissolution fractions and petrologic types. Phosphorous in the residues of R3 couldn't be detected. The values below name of each fraction are weight ratio obtained from each fraction. The error bars are for 1s for R3 - R6. Bars for brecciated R chondrites represent range of maximum and minimum.

References

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