LETTER

Abundances of monoisotopic REE, consistent with the Leedeey chondrite values

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Lately the number of papers dealing with REE geochemistry is rapidly increasing, and in most of them, the Masuda-Coryell plot (MASUDA, 1962; CORYELL *et al.*, 1963) is employed, which rests on the abundance ratios between the sample studied and the chondrite. That is, the REE abundances in chondrites serve as normalizing values.

The relative abundances of REE in ordinary chondrites were considered to be constant (SCHMITT *et al.*, 1963, 1964), but the precise determinations (MASUDA *et al.*, 1973; NAKAMURA, 1974) demonstrated that mutually normalized REE patterns even among the ordinary chondrites themselves have fine structures depending on the particular samples. MASUDA *et al.* (1973) advocated that the REE abundances in the Leedeey chondrite analyzed by them be employed as reference values. NAKAMURA (1974) proved that these Leedeey values of REE abundances are about 1.13 times the corresponding ones for the average of ten "normal" ordinary chondrites, but there are little variations in relative abundances between two sets of values. (Specifically, NAKAMURA (1974) suggests that, in a relative sense, the Ce and Yb abundances in "Leedeey" are 1.5 and 0.6% too low, respectively, when compared with his average values.)

Thus the REE abundances obtained for the Leedeey sample are being employed instead of the ones previously presented for chondrites. However, the set of the Leedeey REE abundances has a shortcoming that it is void of abundances for monoisotopic REE, i.e., Pr, Tb, Ho and Tm, because the stable isotope dilution technique as employed by MASUDA *et al.* (1973) can be applied to determination of elements with two or more stable isotopes, not of those comprising single stable isotopes. The purpose of this communication is to fill the void abundances for the above four elements so that their abundances are consistent with those of polyisotopic REE obtained for Leedeey.

There can be two ways of estimation of abundances in question. One of them (method A) is interpolation on a smooth abundance curve for odd-A nuclides (SUESS and UREY, 1956; SCHMITT *et al.*, 1963); the accurate data on REE in Leedeey will be used to secure a smooth curve for span of mass number from 139 through 175. Another one (method B) is estimation based on a linear curve for the chondrite-normalized REE pattern defined by other polyisotopic REE, mostly, with even-Z numbers. Also for the latter method, the Leedeey abundances cited above will serve as a basis, i.e., as a set of normalizing values.

If position of a certain nuclide is unequivocally determined on a smooth odd-A nuclide abundance curve, employment of method A is advantageous in that the abundance to be obtained can be decided without invoking the abundance data by the neutron activation analysis, and, accordingly, free from the experimental errors possibly involved in the activation analysis.

Of the four elements under consideration, only Tb with mass number of 159 can be definitely located on the odd-A curve, because the curve passing through ^{157}Gd , ^{161}Dy and ^{163}Dy is a monotonous one with a gentle slope. According to this smooth segment, ^{159}Tb abundance consistent with the Leedeey set is estimated to be 0.0589 ppm. To our regret, however, it is rather hard for us to estimate the abundances of other three elements in that way, because each of them occupies somewhat critical position. Therefore, let us estimate the abundances of Pr, Ho and Tm by means of method B.

For the purpose of estimation mentioned above, the abundance data by the neutron activation analysis on the following five samples have been taken up: Kilauea Iki-22 basalt, Roberts Victor mine eclogite, and average chondrite (SCHMITT *et al.*, 1963), North American

Table 1. Abundances (ppm) of monoisotopic REE estimated by method B (see text)

	(1)	(2)	(3)	(4)	(5)	Adopted
Pr	0.130	0.176	0.143	0.146	0.129	0.136 $\pm$ 0.006
Tb	0.0606	0.0581	0.0587	0.0680	0.0590	0.0589* $\pm$ 0.0002
Ho	0.0821	0.0900	0.0925	0.0832	0.0875	0.0888 $\pm$ 0.0012
Tm	0.0375	0.0379	0.0400	0.0400	0.0375	0.0385 $\pm$ 0.0010

(1): From Kilauea Iki-22 basalt (SCHMITT *et al.*, 1963).

(2): From Roberts Victor mine eclogite (SCHMITT *et al.*, 1963).

(3): From average chondrite (SCHMITT *et al.*, 1963).

(4): From North American shales (HASKIN and HASKIN, 1966).

(5): From composite chondrite (FREY *et al.*, 1968).

* Value obtained by method A (see text).

shales (HASKIN and HASKIN, 1966) and composite chondrite (FREY *et al.*, 1968). The results of the estimation are shown in Table 1.

As seen in Table 1, the Tb abundance obtained by method A is in good agreement with that by method B. The values presented in the farthest right column are those adopted as consistent with the Leedey REE abundances obtained by MASUDA *et al.* (1973). Of these four adopted values, it is obvious that the Pr abundance is open to a comparatively large uncertainty. Generally, the adopted values well document the data on composite chondrite (FREY *et al.*, 1968).

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Note added in proof: KOLJONEN and ROSENBERG (1974) have presented another similar set.