What is controlling the REE composition of Pacific deep sea sediment?

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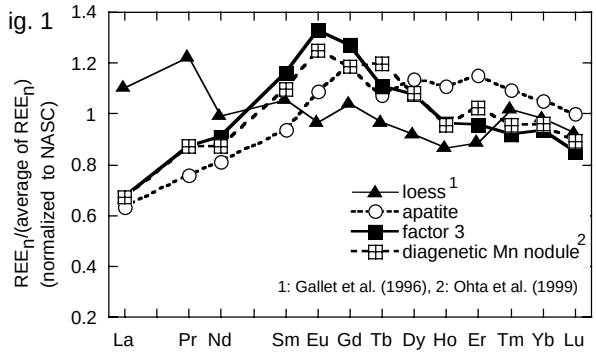
To determine the components affecting the rare earth element (REE) composition of deep sea sediment, Pacific sediments were analyzed for major elements and REEs.

The P and Ca concentrations are positively correlated and the Ca/P ratio is consistent with that of apatite, suggesting a contribution of apatite to the sediments. The P also correlates strongly with REE except for Ce, indicating that the apatite has a high REE content. From the correlations, the REE composition of apatite in the sediment is estimated, and shown in Fig. 1.

Many researchers have reported the important contribution of continental material such as loess to Pacific sediments. On the basis of the REE compositions of "apatite" and "loess", another component controlling the REE composition of the Pacific sediments was estimated by factor analysis. The REE pattern of the calculated additional component (factor 3), normalized to NASC, exhibits a convex shape with a peak near the middle REE, and bears a remarkable resemblance to the pattern shown by a diagenetic Mn nodule (Fig. 1).

To clarify the composition of factor 3, a sequential leaching experiment was performed. This experiment involves 1) leaching by alkaline $Na_2S_2O_4$, 2) subsequent leaching by 0.17 M HCl, and 3) the residue. These fractions contain, in turn: 1) Mn oxide and part of the Fe oxide; 2) part of the Fe oxide and apatite; and 3) detrital materials. Most of the leachates 1) show convex REE patterns similar to that of factor 3, and positive Ce anomalies. Thus, the factor 3 is considered to reflect Mn oxide and Fe oxide components. The leachate 2) from a sample with high P content shows a REE composition identical to that of "apatite" estimated above. Residue 3) is classified into two groups; one has a REE composition identical to that of "loess" and another is characterized by a positive Eu anomaly, suggesting contributions of large amounts of continental materials and basaltic detrital materials, respectively.



1.5-1.7Ga rocks discovered from the Lesser Himalaya and Siwalik belt : ^{40}Ar-^{39}Ar ages and their significances in the evolution of the Himalayan orogen.

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We performed ^{40}Ar-^{39}Ar datings for granite from the Lesser Himalaya and dolerite from the Siwalik belt in Nepal. Both show the Middle Proterozoic age and are attributed to the origin of metamorphic and granitic rocks in the Higher Himalaya.

The Kaberi granite is distributed at 115km SE from Mt. Everest in the Lesser Himalaya. The granite is in the tectonic window of the crystalline nappe, called as Taplejung Window. Although ^{40}Ar-^{39}Ar age spectrum of muscovite from Kaberi granite in the center of the window indicates the pattern of degassing of Ar gas, ages of 960-1300C(about 88% ^{39}K) are 1.5-1.6Ga. This result indicates that the rock has been weakly metamorphosed and the original age is older than 1.6Ga. Moreover, ^{40}Ar-^{39}Ar age at 1200C for muscovite from augen gneiss, to the north of Kaberi granite, is about 1.42Ga. As Ar gas has been degassed, the original age of this muscovite may be older than 1.42Ga.

The Bagmati Group in the Siwalik belt is composed of aeolian and lacustrine beds and dolerite sills. A thin slice of the Siwalik Group is tectonically sandwiched in the thrust sheets of schuppen zone. The ^{40}Ar-^{39}Ar ages of dolerite are 1741±11Ma and 1679±4Ma which are plateau like ages of 800-1100C(about 50-60% ^{39}K). Detrital muscovite separated from shale of the lacustrine beds shows a ^{40}Ar-^{39}Ar plateau age of 1744 ± 9Ma (about 98% ^{39}K). Moreover, U-Pb chime age of the quartzite and Nd-Sm model age for the dolerite show the ages of 1.75-1.8Ga and 1.6 ± 0.2Ga, respectively. These results demonstrate that the dolerite is 1.7Ga.

In India, 400-500km to the south of the Bagmati Group, large Precambrian lavas exist and K-Ar ages of these lavas have been reported to be about 1.6Ga. Then, dolerite at the Bagmati Group and Kaberi granite are considered to have been accreted to the Asia from the supra-continental rocks of India.