

Geochemical mapping of $^{87}\text{Sr}/^{86}\text{Sr}$ ratios using stream sediments in Japan

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A series of nationwide geochemical maps of element concentrations using catchment outlet stream sediments (<180 μm) have been created by Geological Survey of Japan, AIST, in Japan [1]. The original purpose of this project was environmental assessment. Recently, the geochemical database is also applied to determinate producing area of food and tracking of human migration in archaeology. For such purposes, we have started to determine $^{87}\text{Sr}/^{86}\text{Sr}$ ratios in stream sediments of whole Japan because isotope fractionation is much smaller than concentration variation.

As a first step, we investigated appropriate grain sizes of stream sediments for the $^{87}\text{Sr}/^{86}\text{Sr}$ mapping project because it is unknown whether the fine sediments (<180 μm) are also suitable for the above purposes or not. The stream sediments were collected from two river systems. They were sieved into 6 fractions (1000–500 μm , 500–300 μm , 300–180 μm , 180–125 μm , 125–75 μm , and <75 μm), and each size fraction was measured for $^{87}\text{Sr}/^{86}\text{Sr}$ ratios by thermal ionization mass spectrometry (TIMS; VG Sector 54). The results indicate that $^{87}\text{Sr}/^{86}\text{Sr}$ ratio in <180 μm fraction shows the most representative value of bedrocks in the catchment area.

Secondly, we created the $^{87}\text{Sr}/^{86}\text{Sr}$ geochemical map using stream sediments (<180 μm) in Shikoku Island and the Kii Peninsula in Japan, to investigate the factors controlling spatial distribution of the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios [2]. The $^{87}\text{Sr}/^{86}\text{Sr}$ ratios range from 0.705 to 0.719. The variation corresponds to the distributions of geological units. For example, underlying Neogene-Cretaceous accretionary complexes in the southern part of this area show the highest values (0.718–0.719), while the other regions covered by the older accretionary complexes have the lower isotope ratios. The fact suggests that detrital materials derived from the Asian continent having high $^{87}\text{Sr}/^{86}\text{Sr}$ ratio were supplied to the fore-arc basin during the Neogene and Cretaceous ages. From the results, we concluded that newly created $^{87}\text{Sr}/^{86}\text{Sr}$ maps reflect geochemical features of source rocks faithfully.

[1] Imai *et al.*. (2010) Available at <http://riodb02.aist.go.jp/geochemmap/index.htm>. [2] Jomori *et al.*. (in press) *Geochemical Journal*

Grain boundaries and transient porosity as fluid pathways for reaction front propagation

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We used the pseudomorphic replacement of Carrara marble by calcium phosphates as a model system to study the influence of different fluid pathways for reaction front propagation induced by fluid-rock interaction. Grain boundaries present in the rock as well as the transient porosity structures developing throughout the replacement reaction enable the reaction front to progress further into the rock as well as to the center of each single grain until transformation is complete. Hydrothermal treatment of the marble using phosphate bearing solutions led to the formation of OH-apatite and β -TCP; the formation of the latter phase was probably promoted by ~0.6 wt.% Mg in the parent carbonate phase. Completely transformed single grains show a distinctive zoning, both in composition and texture. Whereas areas next to the grain boundary consist of nearly pure OH-apatite with a coarse porosity, areas close to the center of the single grains have a high amount of β -TCP and a very fine porous microstructure. The use of the isotope ^{18}O as a chronometer for the replacement reaction makes it possible to reconstruct the chronological development of the calcium phosphate reaction front. Raman analysis revealed that the incorporation of ^{18}O in the PO_4 tetrahedron of OH-apatite results in the development of distinct profiles in the calcium phosphate reaction front perpendicular to the grain boundaries of the marble. Through the use of the ^{18}O chronometer, it is possible to estimate and compare the time effectiveness of the different fluid pathways in this model system. The results demonstrate that the grain boundaries are an effective pathway enabling the fluid to penetrate the rock more than one order of magnitude faster compared to the newly developing channel-like porosity structures, which act as pathways towards the center of single mineral grains. Thus, after only short reaction durations, it may be possible for the fluid to progress relatively large distances along the grain boundaries without developing broad reaction fronts along the path.