Chemical analysis of individual fluid inclusion by synchrotron X-ray fluorescence microprobe

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Chemical composition of ore-forming fluid has fundamental importance to discuss the origin and evolution of ore-forming fluid, transport of ore-forming metals, and mechanism of ore mineral precipitation. Several substantial efforts have been made to develop the analytical techniques of individual fluid inclusions. In this study, we present a preliminary result of SXRF (synchrotron X-ray fluorescence microanalysis) analysis on fluid inclusion.

Doubly-polished thin section of quartz from a prospect of porphyry copper deposit at Mocha, northern Chile was used as a test sample. Quartz specimen contains large amount of polyphase inclusions with large NaCl daughter crystal. The XRF spectrum obtained from a polyphase fluid inclusion that locates ~20 μm depth beneath the surface of quartz reveals the presence of Si, Ca, Ti, Mn, Fe, Ni, Cu, Zn, As, and Br. The background of XRF spectrum was obtained from quartz of fluid inclusion free portion just beside the fluid inclusion analyzed. In addition to silicon, Ti and Ni were detected from host quartz crystal. The fluid inclusion contains elements such as Mn, Fe, Cu, Zn, As and Br. However, many other elements such as Na and Cl are also likely to be present, but were not detected owing to limitations in detector sensitivities coupled with signal loss by absorption of X-rays in the host quartz crystal. SXRF analysis is not an adequate method to analyze light elements especially mass number <Ca. In contrast with this, heavy elements are very sensitive to SXRF. Although bromine content in fluid inclusion is usually much less than that of Cl, it is clearly detected from hypersaline inclusion.

We have succeeded to map the distribution of several elements in single fluid inclusion. The map suggests elements except As distribute homogeneously in liquid phase of fluid inclusion. Although this fluid inclusion contains daughter crystal of NaCl, concentrations of Br, Fe, Mn and Zn are not obviously high in solid phase. However, concentration of arsenic in daughter crystal probably in opaque mineral is higher than that in liquid phase. Since effect of absorption of X-ray by host quartz was not known in this stage, quantitative concentrations of elements in the fluid inclusion are unclear. We are continuing effort to obtain quantitative relationship among concentration of metals, depth from surface, and intensity of X-ray by use of synthetic fluid inclusion that contains known amount of base metals.

Ce and Nd isotopic geochemistry of Barberton Greenstone Belt, South Africa: Constraint on early Archean mantle and origin of Ce anomaly

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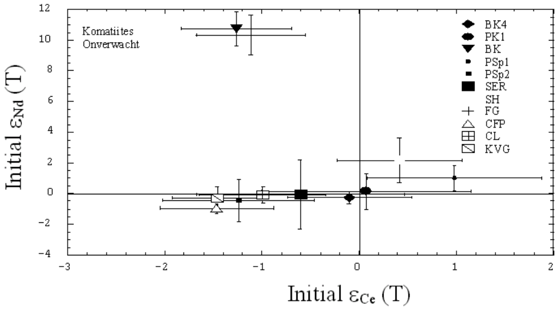
Cerium and Neodymium isotopic compositions were determined on rocks from Barberton Greenstone Belt, South Africa, using the dynamic multi-collection technique (ref. 1), together with light rare earth elements (LREEs) abundances. A variety of rocks was examined; komatiites from Onverwacht Group, sedimentary rocks, cherts and felsic igneous rocks from FigTree Group, Moodies Group and Kaap Valley Pluton. Negative Ce anomalies were recognized in banded ferruginous chert and shale samples from FigTree Group, while the other rocks have no Ce anomalies. Leedey chondrite-normalized LREE patterns of their sources were estimated by their $^{138}Ce/^{142}Ce$ and $^{143}Nd/^{144}Nd$, $^{138}La/^{142}Ce$ and $^{147}Sm/^{144}Nd$ isotope ratios and the decay constants. It is plausible that these negative Ce anomalies arose at around 0.6 Ga from a comparision of initial isotopic composiions between rocks with and without Ce anomalies.

Initial ε values of the komatiites range $-1.3 < \varepsilon_{Ce} < +1$ and $-0.3 < \varepsilon_{Nd} < +10.7$ (figure). This result suggests that early Archean mantle, which was source material of komatiites, was heterogeneous isotopically. Initial Ce and Nd isotopic data indicate first mantle fractionation was occurred as early as 4.2 Ga at least. Although the most of the komatiitic rocks has "chondritic" initial ε_{Nd} and ε_{Ce} values, one basaltic komatiite has an extremely high initial ε_{Nd} value, (+10.7), with low ε_{Ce} values, (–1.3). LREE pattern of the mantle corresponding to this special initial ε values is calculated to be $(La/Ce)_N = 0.6 \pm 0.2$ and $(Sm/Nd)_N = 1.49 \pm 0.05$, respectively. It would suggest that extremely depleted mantle like lunar mare basalts had remained until 3.45 Ga, without assimilation by crustal or recycled mantle component.



Reference

[1] Tanimizu, M. (2000) Geopysical determination of the ^{138}La β^{-} decay constant. Phys. Rev. C, vol. 62, 017601