High temperature Sr isotope fractionation during magmatic differentiation: the role of plagioclase

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A small but significant stable isotopic variation of some major and trace elements has been reported among granites [1-5]. Among those elements, strontium shows the largest range of stable isotopic variation [3, 5]. While fractional crystallization of plagioclase was suggessted to cause the Sr isotopic fractionation [5], the nature of the isotopic fractionation process has not been well documented. In order to link the Sr isotopic variation of granites with the possible isotope fractionation process occurring in high temperature magmatic environment, we have studied Sr stable isotopic composition of suite of samples from a single granitic pluton.

Twenty-one granite and three aplite samples were taken from the late Cretaceous Tadamigawa granite (SiO_2 = 59.6 – 76.1 wt.%). Plagioclase was separated from one of the granite sample (YT11062503: SiO_2 = 71.4 wt.%) using heavy liquid. Samples were measured for there stable Sr isotopes by double spike TIMS technique using Thermo Finigan TRITON at Kochi. Reproducibility of the $\delta^{88}Sr$ analysis was ± 0.02.

The Tadamigawa granites shows large variation of $\delta^{88}Sr$ values from 0.27 to -0.15. The variation is correlated with SiO_2 content were the more evolved samples show low $\delta^{88}Sr$ values. The aplite samples show extremely low $\delta^{88}Sr$ down to -0.74. The $\delta^{88}Sr$ of the granites linearly correlate with the log of Sr concentration indicating that the $\delta^{88}Sr$ variation was controled by Raleigh-type isotope fractionation process with an isotope fractionation factor of $\alpha^{88}Sr_{Raleigh}$ = 1.00018. The plagioclase fraction of YT11062503 has significantly high $\delta^{88}Sr$ of 0.31 compared with its bulk sample ($\delta^{88}Sr$ = 0.21). The plagioclase-bulk isotope fractionation factor calculated from this data is $\alpha^{88}Sr_{plagioclase\text{-}bulk}$ = 1.0001 and agrees quite well with the $\alpha^{88}Sr_{Raleigh}$. These observations show that plagioclase crystallization is the key process causing the stable Sr isotopic variation in granites.

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