Evolution of ureilites by ^{26}Al heating of the parent body

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DaG-319 polymict ureilite contains a variety of plagioclase-bearing clasts (An_0-An_{100}) with ureilitic oxygen isotopic compositions, indicating that they correspond to the "missing basaltic" component from the ureilite parent body (UPB). Our trace element study indicates that the plagioclase was derived from low degree partial melts repeatedly segregated from a chondritic precursor. Recently, we determined the ^{26}Al-ages of the plagioclase in these clasts to be ~5.2 m.y. after CAI formation (Kita et al., 2003). A similar Mn-Cr age was obtained from the glass in another polymict ureilite, DaG-165 (Goodrich et al., 2002). The early formation of ureilitic basalts favors ^{26}Al heating as a major heat source for the parent body.

We applied a simple ^{26}Al heating model for the UPB without considering heat loss from the surface of the body. Heating of the parent body to the temperature range of 1120-1180˚C (10-20% partial melting of the chondiritc precursor) at 5.2±0.2 m.y. requires the accretion time of the UPB to be 2.5-2.8 m.y. (i.e., $^{26}Al/^{27}Al \sim 4\times10^{-6}$). This is near the end of the chondrule formation period (e.g., 0.7-2.4 m.y. after CAIs by Mostefaoui et al. 2002), implying that planetesimal formation might have occurred when the chondrule forming events ended in the proto-planetary disk. The model predicts that the temperature of the UPB increased at the rate of ~10˚C per 0.1 m.y. when the precursor started to undergo partial melting. This gradual temperature increase might have allowed repeated segregation and melting of the precursors, and resulted in producing the final ultra-mafic residue known as the monomict ureilites.

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Archaeal tetraether lipid as a new geothermometer

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Introduction

The number of cyclopentane rings of isoprenoids derived from archaeal tetraether lipids increases with increasing their growth temperature, in the case of thermoacidophiles. Using the data of *Sulfolobus acidocaldarius* given by DeRosa et al. (1980), growth temperature was plotted as a function of average cyclization, and the plot was found to be linear; $y=24x+29$ (y: growth temperature, x: average cyclization of total lipids), indicating that this relationship can be useful as a geothermometer. In the beginning, we have searched for archaeal isoprenoids in surface sediments of hot springs in Beppu (Murae et al., 1998), and here report the estimation of palaeo-temperatures of three hot springs in Kirishima (present-day hot water; Yunono; 76.5^{o}C pH5.09, Yahata; 75.0^{o}C pH 2.00, and Gin'yu; 44.0^{o}C pH 3.55) .

Experimental

Isoprenoids were prepared from tetraethers according to essentially the procedure of DeLong et al. (1998).

Direct counting of population density of living microbes was performed by fluorescent microscopy and the amounts of ether lipids contained in the living cells in the sediments were estimated.

Results and Discussion

Direct counting of microbial population density reveals that the contribution of lipids from living cells is negligible, because the amounts of ether lipids extracted from sediments are two or three orders of magnitude greater than those of estimated values for living cells.

Estimated temperatures from total tetraether lipids are as follows; Yunono; 76.0^{o}C, Yahata; 73.9^{o}C, and Gin'yu; 51.9^{o}C. The values of Yunono and Yahata are very close to those of present-day hot waters. The value of Gin'yu suggests that the temperature was much higher in the past than that at present, it is in accordance with the geological literature (Kimbara 1992).

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