

SR/CA in symbiotic corals is linked to light enhanced calcification

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The strontium-calcium ratio (Sr/Ca) of reef coral skeleton is an important ocean temperature proxy that has been used to address some particularly controversial climate change issues. However, the paleothermometer has sometimes proven unreliable and there are indications that biological processes may influence the incorporation of Sr into the growing aragonitic skeleton. We examined the effect of algal symbiosis on skeletal chemistry using *Astrangia poculata*, a small colonial temperate scleractinian that occurs naturally with and without zooxanthellae. Live symbiotic (deep brown) and asymbiotic (white) colonies of similar size were collected in Woods Hole where water temperatures fluctuate seasonally between -2°C and 23°C. We used a microbeam technique (Secondary Ion Mass Spectrometry) and a 20 µm diameter sampling beam to construct high-resolution Sr/Ca profiles, 2500µm long, down the growth axes of the outer calical (thecal) walls. Profiles generated from co-occurring symbiotic and asymbiotic colonies are remarkably different despite their exposure to identical water temperatures. Sr/Ca of both symbiotic and asymbiotic corals display clear annual cycles with high values in the winter and low values in the summer. However, the temperature dependence of Sr/Ca in the symbiotic coral increases with size and age of the corallite, from that equivalent to inorganic aragonite at the base of the calyx (-0.038 mmol/mol/°C) to that equivalent to tropical reef corals at the tip (-0.080 mmol/mol/°C). The small temperature sensitivity of Sr/Ca in the skeleton of the asymbiotic coral (-0.038 mmol/mol/°C) is maintained throughout its life and the Sr/Ca profile from this coral tracks the recorded *in situ* temperature variability. We used Computed Tomography (CAT Scan) to quantify changes in skeletal density along the narrow corallite wall. The density of the symbiotic corallite increases from 750 Hounsfield Units (HU) at the base to 1500 HU at the tip, while skeletal extension rates remain the same. By comparison, the density of the asymbiotic corallite remains low throughout its life (~750 HU). We propose that the temperature dependence of Sr/Ca in the symbiotic corallite differs from inorganic aragonite and asymbiotic skeleton due to the presence of algal symbionts in the host tissue and the enhancement of skeletal calcification rates by algal photosynthesis. Our model provides a framework for understanding the role of biology in determining coral skeletal chemistry and an explanation for anomalous Sr/Ca-based paleotemperature derivations..

Unradiogenic W in Kimberlites: Direct Evidence for Core-Mantle Interaction

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Introduction

Syngenetic lower mantle (LM) mineral inclusions in diamond from different cratons suggest that the kimberlites, which transported these diamonds must have formed in LM. The close spatial relationship between kimberlite pipes and the locus of former mantle plume tracks suggests that both are related to the same LM upwelling (Crough et al., 1989). Collerson and Kamber (2000) proposed that kimberlites might be valid isotopic proxies for LM since they are the only known rocks with physical evidence for a LM origin. Their geochemistry will add information about the character of the primitive LM reservoir and extent of LM-core interaction.

Results

We report W isotopic data for Gp 1 and Gp 2 kimberlites, mainly from the Kaapvaal Craton, obtained by Isoprobe MC-ICPMS following the technique outlined in Schoenberg et al. (in press). Kimberlites were bracketed with measurement of the ACQUIRE W standard; mean composition (n=53) $^{182}\text{W}/^{183}\text{W} = 1.852507$ (6 ppm $2\sigma_{-}$) equivalent to a terrestrial $\epsilon^{182}\text{W} = 0$. The kimberlites exhibit a wide range in W (58 to 16200 ppb) and other siderophile element abundances. Samples yield unradiogenic $\epsilon^{182}\text{W}$ similar to values obtained for metal in meteorites (e.g. Horan et al., 1998).

Discussion

W in kimberlites originated from the core suggesting that kimberlites form by melting of a metal+silicate-bearing layer at the base of the LM. Such a layer, and its role in stabilizing mantle convection cells was suggested by Manga and Jeanloz (1996). Its existence is supported by superchondritic $^{186}\text{Os}/^{188}\text{Os}$ ratios in Hawaiian basalts (Brandon et al. 1998), and by Ag isotope anomalies in OIB (Hauri et al. 2000). Meteoritic metal that accumulated to form the core preserves $^{182}\text{W}/^{183}\text{W}$ ratios from a time before significant decay of ^{182}Hf ($T_{1/2} = 9$ Ma) in the solar nebula. Results have implications for planetary accretion models and processes of metal-silicate differentiation. The constant W isotopic composition of the silicate Earth since 3.8 Ga implies limited core-mantle exchange and suggests isolated geochemical evolution of the base of the LM.

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