Species dependent fractionation of silicon isotopes by present-day demosponges


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The silicon biogeochemical cycle is a central issue in climate studies since diatoms (phytoplankton with an opal skeleton) transport large quantities of carbon between surface- and deep ocean waters. A relatively new tool has been the deployment of silicon isotopes to study this biogeochemical cycle. The variations of the silicon isotopic composition of seawater through geological time could yield information on the (paleo-)activity of diatoms in removing carbon from surface waters and on the extent of weathering on the continents. So far, only limited data are available for the fractionation factors between dissolved silica and diatom opal. De La Rocha et al. (1997) showed that the fractionation factor between dissolved silica and Si in removing carbon from surface waters and on the extent of weathering on the continents. So far, only limited data are available for the fractionation factors between dissolved silica in seawater and biogenic opal. De La Rocha et al. (1997) showed that the fractionation factor between dissolved silica and diatom opal is not species dependent. However, this has not been shown for other opal incorporating life such as sponges and radiolarians. Here we report the first systematic study of silicon isotope fractionation between opal of three demosponge species (Petrosia hoeksemai, Clathria thalysias basilana and Stylosia carteri) and seawater from the Speramonde Shelf, Sulawesi, East Indonesia.

The demosponges of this study display a range of δ30Si between -2.0 and +0.5‰. This range largely overlaps with previous published data, but extends the range to heavier values. The three species show different δ30Si averages: P. Hoeksemai: -0.02±0.14‰; S. Casteri: -0.20±0.27‰ and C. Basilana -1.28±0.26‰. The results from the studied demosponges suggest that fractionation factors are species dependent, since the sponges display systematic differences at a single locality. We did not observe correlations between δ30Si, opal content and water depth. Sponges are probably dissolved silica limited and not food limited in their growth. Consequently, different biological mechanisms for the uptake of dissolved silica and the conversion to sponge opal could be the reason for the different fractionation factors for each species.

Reference

Calcium isotope variations in Devonian brachiopods

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We investigated 44Ca/40Ca ratios of Devonian brachiopod shells (Lochkovian to Famennian) collected at various locations in Russia (coll. E.A. Yolkin), USA (coll. J. Day), Spain (coll. F. Alvarez), China (coll. X.P. Ma), Morocco, Belgium and Germany. We used samples previously analyzed for δ18O, δ13C, 87Sr/86Sr and trace element contents, and checked for possible diagenetic alteration [1].

Modern brachiopod shells have δ44Ca/40Ca values in good agreement with other modern biogenic calcite shells [2] and show no indication of vital effects. We find the average Devonian brachiopod δ44Ca/40Ca to be about 0.7 ‰ lower than its modern counterpart. This value is well below the Neogene δ44Ca/40Ca minimum [3], which provides further evidence for long-term variations of seawater δ44Ca/40Ca throughout earth history. The δ44Ca/40Ca is relatively stable during most of the Lower to Middle Devonian, shows a possible maximum during the Givetian-Frasnian and a short negative excursion at the Frasnian-Famennian (FF) boundary.

Comparison of our δ44Ca/40Ca and δ18O records excludes temperature as a controlling factor of the calcium isotope variations. We can further exclude any significant influence of radiogenic 40Ca (a daughter product of 40K decay) on the δ44Ca/40Ca record. Fractionation corrected 44Ca/40Ca ratios of Devonian and modern marine carbonates are identical within the observed 44Ca/40Ca excursion with the mass extinction at the FF boundary points to an influence of carbonate production and burial on the marine calcium isotope record. Further possible factors include weathering on the continents and on exposed shelves, possibly related to sea-level variations and/or climatic changes and the spreading of vascular land plants during the Middle and Late Devonian.

References