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Silicon isotopic fractionation by modern polycystine radiolarians

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During the Earth's geological history, evolutionary competition for dissolved silicon (Si) by silicifiers in the ocean directly influenced changes in the global cycles of silicon, carbon, and other nutrients that regulate ocean productivity and ultimately the Earth's climate. Polycystine radiolarians are key players in this evolution and have provided rich palaeontological records for palaeoceanographic study. These marine micro-organisms produce intricate skeletons made of silica, which is particularly useful when studying climate change where carbonate-based archives are poorly preserved. In addition, polycystine radiolarians are found in the mid-depth zone (30 to 1000 m) of the marine environment, a depth range that is crucial for the detection of glacial–interglacial changes in water column stratification, which plays a critical role during periods of abrupt climate change. To date, a small number of studies have attempted to use the silicon stable isotope composition of polycystine radiolarians ($\delta^{30}Si_{RAD}$) to study past changes in the marine silicon cycle. Core-top samples show that the fractionation of silicon isotopes between dissolved silicon and the polycystine radiolarians ($\Delta^{30}Si_{RAD}$) should range between -0.54 and -1.31 ‰ and some suggest that there is a species-specific fractionation of the silicon stable isotopes. Here, we present the first $\delta^{30}Si_{RAD}$ and $\Delta^{30}Si_{RAD}$ data for modern radiolarians collected from the water column from several different oceanic basins (i.e. different sectors of the Southern Ocean and the Mediterranean Sea). These data are presented alongside new core-top $\delta^{30}Si_{RAD}$ data from the Southern Ocean and are compared with existing $\delta^{30}Si$ data for modern diatom and sponge spicules. In contrast to other silicifying organisms found in the palaeo-record, such as deep-water sponges and surface-dwelling diatoms, the use of polycystine radiolarian geochemistry is very much in its infancy. This gap is due to the challenges associated with their growth under laboratory-controlled conditions and limited knowledge regarding the factors that govern radiolarian contemporary biogeographic distributions. This study provides new data regarding the variability and magnitude of $\delta^{30}Si_{RAD}$ and $\Delta^{30}Si_{RAD}$ in the modern ocean while evaluating the potential link between biogenic silica production, environmental context, and species-specific silicon isotope fractionation by polycystine radiolarians.