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The Silica Cycle on a continental Shelf during the Upper Cretaceous: Reconstructions of Silicon Isotopes of Sponges, Radiolaria and Diatoms

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The oceanic Silica Cycle, driven by weathering and biosilicification, is important due to its strong link to carbon drawdown, other marine key nutrients and the global climate state. Chemical weathering of silicates is the main source of dissolved silica (DSi) to the ocean via rivers, groundwater and meltwater, while biosilicification, driven by the availability of DSi, is a major sink of silica via primary productivity. In today's ocean, the global DSi concentrations are comparatively low, especially in the surface Ocean, in contrast to estimates of high concentrations during the Precambrian and Paleozoic Oceans[1,2]. This change to low DSi availability is attributed to the high turnover of DSi by Diatoms. Previously it was assumed that this change occurred during the Cenozoic [1] peak diversification of diatoms[3]. However, it was recently suggested that the drawdown in surface DSi concentrations occurred already in the Mesozoic[2] after the first appearance of diatoms [4]. Unfortunately, the latest record of DSi concentrations based on isotope data only goes back as far as 60 Ma[5].

To bridge the gap in the reconstruction of the past silica cycle, we studied a section from the Kanguk formation on Devon Island, recording Upper Cretaceous shelf sediments covering about 94 Ma to 86 Ma years [6,7]. The section provides a unique opportunity as samples contain sponge spicules, radiolaria, diatoms and silicoflagellates. Analyses of silicon (Si) isotope ratios (expressed as δ^{30}Si) record changes in DSi concentrations[8] (sponges and radiolaria) and DSi utilization[9] (diatoms). Our preliminary data indicate that δ^{30}Si of sponges range from -2.3‰ to -0.35‰, with lower values observed close to OAE2 and OAE3. In contrast, the δ^{30}Si of radiolaria is on average 0.89±0.2‰ throughout the record. Overall, the δ^{30}Si-sponge values indicate DSi concentrations only slightly higher than found in the Canadian Arctic today, with DSi concentrations of less than 40 µM. Additionally, higher concentrations of DSi in the bottom waters of the shelf before and after the anoxic events likely reflect either a stronger stratification or a change in water mass circulation, as no change is observed in the δ^{30}Si-radiolaria, representing subsurface to surface water concentrations.