The balance between silica production and silica dissolution in the sea: Insights from Monterey Bay, California applied to the global data set

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ABSTRACT: Silicon isotope tracers were used to examine the relative magnitude of silica dissolution and silica production in the Monterey Bay, California, upwelling system. A diatom bloom dominated by *Skeletonema costatum* and *Chaetoceros* spp. was encountered under conditions of moderate upwelling. Profiles of silica production and dissolution rates were obtained at seven stations that sampled both inside and outside the bloom. Integrated silica production rates ranged from 5.4 to 108 mmol Si m^{-2} d^{-1}, averaging 42.8 mmol Si m^{-2} d^{-1}. Integrated silica dissolution rates were considerably lower than production rates with values between 0.63 and 6.5 mmol Si m^{-2} d^{-1} (mean = 2.90 mmol Si m^{-2} d^{-1}). The mean ratio of integrated silica dissolution to integrated silica production ($\int$ D:$\int$ P) between the surface and the 0.1% light depth was 0.075, omitting one station with an unusually high $\int$ D:$\int$ P of 0.61, indicating that, on average, 93% of silica production was supported by new silicic acid. The f-ratio for diatom nitrogen use estimated from silicic acid and nitrate depletion curves and the mean $\int$ D:$\int$ P ratio was found to be 0.83, indicating that silica was being regenerated at a rate that was only slightly slower than that for particulate organic nitrogen. These data provide direct evidence confirming earlier hypotheses that the silica pump is weak in Monterey Bay. Analysis of the global data set on $\int$ D:$\int$ P in the surface ocean leads to the hypothesis that low $\int$ D:$\int$ P (~0.10 or less) are typical of diatom bloom events, with $\int$ D:$\int$ P rising to values in excess of 0.50 during nonbloom periods. This pattern is shown to be consistent with previous estimates that the annual mean $\int$ D:$\int$ P ratio in the upper 200 m of the global ocean is 0.5-0.6. A regional analysis reveals that the fraction of silica production supported by new silicic acid varies as a hyperbolic function of the level of gross silica production similar to the variation in the f-ratio for N use with primary productivity. These trends suggest that diatom blooms, especially those occurring in more productive waters, are the main vectors of silica export in the sea, with the majority of the silica produced during nonbloom periods being recycled in the euphotic zone.