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Silicon isotope fractionation during nutrient utilization in the North Pacific

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The distribution of silicon in the North Pacific is controlled by the utilization of silicic acid by diatoms, which also fractionate the silicon (Si) isotopes. However, the exact relationship between marine Si distributions and stable isotope variations has not yet been investigated in the surface waters of the open North Pacific Ocean. Silicon isotope variations are presented for six water column profiles from the surface mixed layer down to the deep waters. Although the observed Si isotope composition displays an apparently simple relationship to dissolved nutrient concentrations, it represents a mixture of surface waters with active Si isotope fractionation and deep-waters with more uniform concentrations and isotope compositions. Samples from the surface of the subtropical gyre have the lowest dissolved Si concentrations and heaviest Si isotope composition of marine waters measured. Fractionation in the surface waters follows a typical Rayleigh-type distillation curve for a 'closed' surface water reservoir caused by stratification of the surface layer in the subarctic region, but an 'open' system within the subtropical gyre where there is significant recycling of silicic acid in the upper water column and lateral transport of silicon within surface currents. For deep waters, the Si isotope composition distinguishes the northern North Pacific Deep Water (NPDW) and the southerly-derived bottom water. The relatively low Si isotope compositions measured from waters within the subpolar gyre provides evidence for isolation of the nutrient pool in the North Pacific.