



## Changes in silicate utilization and upwelling intensity off Peru since the LGM – insights from silicon isotopes

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The Peruvian coastal upwelling area is characterized by one of the most pronounced Oxygen Minimum Zones (OMZs) in the world's Ocean. Oxygen concentrations in the water column are controlled by consumption through decomposition of organic matter versus ventilation via ocean circulation. Surface bioproductivity, which is dominated by diatoms building their frustules from dissolved silicic acid,  $(\text{Si(OH})_4)$ , is a function of both nutrient supply and upwelling intensity. The utilization of silicic acid is reflected by its stable Si isotope composition ( $\delta^{28}\text{Si}$ ) and directly mirrors nutrient availability and thus the amount of newly supplied nutrients with upwelled waters because Si isotopes are fractionated during utilization in a way that the lighter Si isotopes are preferentially incorporated into the diatom frustules, leaving ambient seawater enriched in the heavier isotopes. This results in the highest fraction and thus heaviest Si isotope values in the most depleted surface waters.

Here we present the first surface sediment silicon isotope data obtained from diatom samples distributed along the Peruvian shelf. These data directly reflect upwelling intensity and nutrient (silicic acid) availability. In the area between  $10^\circ\text{S}$  to  $15^\circ\text{S}$ , where upwelling is strongest today, the fractionation in water and diatoms ( $\delta^{28}\text{Si} = +1\text{ ‰}$ ) is lowest because the permanent re-supply of nutrients prevents a high degree of fractionation. With the given fractionation between diatoms and surface waters of  $-1.1\text{ ‰}$  surface seawater  $\delta^{28}\text{Si}$  values near  $+2\text{ ‰}$  are calculated, which is in very good agreement with seawater measurements (see contribution by Grasse et al.). Further north and south of this zone, however, the silicon isotope ratios in the diatoms differ from present day surface waters at the same locations in that they are much lighter than expected ( $\delta^{28}\text{Si}$  between  $-0.3$  and  $+0.7\text{ ‰}$ ). These data will be discussed in terms of a much lower degree of silicic acid utilisation in surface waters over the past few 100 years but also potential influences of remineralization processes as a consequence of diatom or clay mineral dissolution in the sediments and subsequent release of isotopically light silicon to the shelf bottom waters. In addition, the possibility of contributions from non-diatom biogenic opal (such as sponge spicules) will be evaluated.

The surface sediment calibration of the silicon isotope distribution is then applied for the interpretation of downcore silicon isotope data covering the past 20,000 years. Today, the investigated core is located in the center of the strongest coastal upwelling. Since the last glacial maximum the Peruvian shelf area experienced changes between periods of strong upwelling, indicated by low fractionation of silicon isotopes in the diatoms, and phases of weak upwelling, where the availability of nutrients was lower and the degree of silicate utilization was higher.