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Sedimentary Phosphorus Variability in Deep Subarctic Pacific during Termination I

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The subarctic Pacific represents a sensitive region to investigate variations in sedimentary redox conditions as a consequence of climate change. This region represents the end of the global deep ocean circulation pathway, where subsurface waters upwelling into the euphotic zone are depleted in oxygen and enriched in dissolved carbon dioxide and macronutrients as a result of constant respiration and remineralization of organic carbon along the routes of abyssal circulation.

Although phosphorus is not redox sensitive, it shows a strong affinity for Fe-oxides. Moreover, alkalinity and oxygen levels do affect its redistribution to several sedimentary phases. Here, we present sedimentary P phases along with redox-sensitive trace metal (Mn, Mo, U) accumulation from ODP Site 882 (50˚21'N, 167˚35'E; water depth 3244 m) to pinpoint changes in deep North Pacific ventilation across termination I, and make inferences on possible implications on nutrients cycling. We couple these observations with submillennial-scale biogenic barium measurements as a proxy for carbon export to separate the influences of deep-water oxygen concentration and sedimentary organic carbon respiration on the redox state of the sediment.

Our results suggest that the deep subarctic Pacific water column was close to suboxic conditions during glacial intervals, with oxygen concentrations as low as 20-40 μM. Molybdenum concentrations in the sediment are not significantly higher than average crustal values, indicating that the sediment never reached anoxic (i.e. sulfidic) conditions. Authigenic uranium concentrations are significantly higher during cold periods, and enriched during termination I. Fe, Fe-bound P and authigenic P decreased from glacial periods to termination I, possibly enhancing phosphate concentrations in deep waters. However, primary productivity was significantly lower during glacial intervals

possibly due to more severe water-column stratification.

Ventilation resumed rapidly during deglacials and remained efficient throughout warm intervals, promoting the “upwelling” of nutrient-rich deep waters to the surface as indicated by the occurrence of lower authigenic uranium concentrations in the face of higher productivity, carbon, and phosphorus flux to the sediment.

We propose that the glacial decrease in deep Pacific ventilation originated in the Southern Ocean as a result of increased water-column stratification and possibly extended sea-ice cover hindering ocean-atmosphere gas exchange. Oxygen-poor water masses filling the glacial deep Pacific positively affected redox sensitive elements cycling in sediments, with important consequences on macronutrients, like phosphorus, and, possibly, on primary productivity.