

Carbonate chemistry evolution in the deep South Pacific and the deglacial release of CO₂

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Upwelling of CO₂- and nutrient-rich waters across the modern Southern Ocean results in the release of CO₂ to the atmosphere. Inverse modelling suggests that during the pre-industrial period more than 75% of the CO₂ degassed from the global ocean was upwelled across the Southern Ocean and either released directly from the Southern Ocean surface or transported to the equatorial Pacific as intermediate water and subsequently released. Spanning around half of the total volume of the ocean, the Pacific Ocean is a large potential reservoir of carbon on glacial-interglacial timescales. The South Pacific is therefore a key region for understanding the transfer of CO₂ from the ocean to the atmosphere, however very little is known about the evolution of the carbonate system in this region. Here we present the first high-resolution records of carbonate chemistry evolution in the deep South Pacific and surface ocean using deglacial benthic and planktonic boron isotopes, B/Ca and radiocarbon. Whilst we find evidence for the expected increase in carbon storage in the glacial ocean in comparison to the modern, by far the oldest and most carbon-rich waters are found during the onset of the last deglaciation (18-16 ka). This contrasts the records of radiocarbon in the Atlantic, where strongest radiocarbon depletions are observed during this time period. We argue that this represents a transient pulse of radiocarbon 'dead' CO₂ (e.g. from hydrothermal or porewater sources) in the deep South Pacific. We show evidence that this old CO₂-rich water upwelled to intermediate and surface waters in the South Pacific, likely contributed to the early deglacial increase in atmospheric pCO₂.