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Southwest Pacific deep-water carbonate chemistry during the Mid-Pleistocene Transition

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After more than 40 years of research, there is still wide disagreement in defining when the Mid-Pleistocene Transition (MPT) occurred, with climate reconstructions ranging from an abrupt versus gradual transition that began as early as 1500 ka and ended as late as 600 ka. Our recent work in the Southwest Pacific (Ocean Drilling Program Site 1123) has provided some evidence for a rapid transition, suggesting that the MPT was initiated by an abrupt increase in global ice volume 900 thousand years ago [1]. This study uses shallow-infaunal benthic foraminifera *Uvigerina* spp. to disentangle the contributions of deep-water temperature (using Mg/Ca ratios) and ice volume to the oxygen isotopic composition of foraminiferal calcite over the last 1.5 Ma. The resulting sea-level reconstruction across the MPT shows that the critical step in ice-volume variation was associated with the suppression of melting in Marine Isotope Stage (MIS) 23, followed by renewed ice growth in MIS 22 to yield a very large ice sheet with 120 m of sea level lowering.

Here, we built on this work with the aim to investigate further the abrupt event centered on MIS 24 to 22 (the '900-ka event') and try to shed some light on the processes and mechanisms that caused the MPT. Different hypotheses account for the origin of the MPT as a response to long-term ocean cooling, perhaps because of lowering CO_2. To better quantify the role of the carbon system during the MPT, we reconstruct past changes in bottom water inorganic carbon chemistry from the trace element (B/Ca) and stable isotopic composition of calcite shells of the infaunal benthic foraminifera *Uvigerina* spp. from 1100 ka to 350 ka at ODP Site 1123. This site was retrieved from Chatham Rise, east of New Zealand in the Southwest Pacific Ocean (41°47.2'S, 171° 29.9' W, 3290 m water depth) and lies under the Deep Western Boundary Current (DWBC) that flows into the Pacific Ocean, and is responsible for most of the deep water in that ocean; DWBC strength is directly related to processes occurring around Antarctica. The ratio of boron to calcium (B/Ca) in benthic foraminifer shells has proven to be a reliable indicator of the calcite saturation state of ocean bottom waters. The comparison between benthic foraminifera δ^{18}O and δ^{13}C shows a similar trend at ODP Site 1123, implying a close relationship between these climate and carbon cycle signals, and we use our B/Ca record reconstructed from the same samples to explore the potential processes behind this tight coupling.

These results permit preliminary discussion on the deep-water carbonate saturation state during glacial/interglacial cycles. Deep-water temperatures estimates using Mg/Ca and oxygen isotopic composition of seawater ($\delta^{18}O_{sw}$) are available from Site 1123 for the last 1.5 million years [1] and the phase relationship between the different signals is tentatively assessed for the early/middle Pleistocene, when different patterns of climate variability have been inferred from marine and ice cores records.

[1] Elderfield et al. (2012). Evolution of ocean temperature and ice volume through the Mid Pleistocene Climate Transition. Science, vol. 337, 6095, 704-709