Amplitude and frequency of Pliocene (~3.2-2.6 Ma) glacio-eustatic, sea-level fluctuations from a new shallow-marine sediment record, Whanganui Basin, New Zealand

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The Mid Pliocene Warm Period (MPWP; 3.3-3 Ma) has long been considered an analogue for future warming scenarios with climate boundary conditions of 400 ppm pCO_2, temperatures 2-3°C higher-than-present and a lack of evidence for large-scale ice sheets in the Northern Hemisphere. Understanding the response of ice sheets to such climates provides constraints on future projections. Sea-level reconstructions based on shallow-marine sedimentary sequences are often discontinuous due to erosion during glacial sea-level low stands, allowing only minimum estimates of sea-level change. Back-stripping of these sea-level records accounts for sediment compaction and tectonic influence, but they are generally not corrected for the regional influence of glacio-isostatic adjustment (GIA), or mantle dynamics. Benthic $\delta^{18}O$ records are better dated than many shallow-marine records and provide a continuous time series, but the $\delta^{18}O$ signal reflects ice volume, temperature and regional hydrographic variability. Attempts to constrain the ice volume component using independently- derived temperature proxies also provides ambiguous results. Additionally, the resulting ice-volume signal, is complicated by differing isotopic signatures of the northern- and southern-hemisphere ice sheets. Consequently, current sea-level estimates are unable to constrain the full amplitude and thus the frequency of sea-level and ice volume cyclicity in the past.

We present a direct and continuous sea-level record, from two cores (~750 m) and an outcrop section in the Whanganui Basin, New Zealand, which describe water depth changes in mid- and outer- continental shelf environments. The sea-level record is derived from a newly developed grainsize water-depth relationship, relating the critical velocity required to transport sand as bed load under specified wave climates. The resulting sea-level record is supported by more traditional methods of lithofacies analysis and depth-sensitive, extant benthic foraminiferal assemblages, quantified using a modern analogue technique. An integrated age model was developed from paleomagnetic analysis of the cores and outcrop, U/Pb dating of a tephra in outcrop and geochemical correlation of the tephra to a proximal offshore core (ODP 1124), combined with biostratigraphy to constrain the interpretation of the paleomagnetic results.

The resulting back-stripped sea-level record describes precession-paced fluctuations with an average amplitude of 20±10 m in the MPWP, transitioning to obliquity-paced fluctuations from ~2.9 Ma through to ~2.6 Ma, corrected for the influence of GIA. Chronological constraints of the high-resolution (1 m kyr^{-1}) sea-level record allows correlation to orbital time series, which displays an in-phase relationship with highsouthern latitude insolation, suggesting Antarctic ice volume is primarily influencing global sea level change during the MPWP. The emergence of obliquity implies an increasing influence of Northern Hemisphere ice sheet volume from ~2.9 Ma.

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