Large amplitude variations in carbon cycling and terrestrial weathering during the latest Paleocene and earliest Eocene

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Global temperatures rose ~6°C from the late Paleocene ca. 58 Ma to the Early Eocene Climatic Optimum (EECO) ca. 52 – 50 Ma. Superimposed, were certainly two geologically brief (< 200 kyr) intervals of extreme warming, the Paleocene-Eocene thermal maximum (PETM) and Eocene thermal maximum 2 (ETM-2 or H-1); at least four more events, H-2, I-1, I-2 and K/X, probably occurred. Both the long-term rise and short-term "hyperthermals" have been linked to massive injections of ^{13}C-depleted carbon into the ocean-atmosphere system and greater continental weathering. However, relationships remain uncertain, principally because detailed and coupled proxy records do not extend across the entire interval of interest.

Mead Stream, New Zealand, exposes a ~650 m-thick sequence of limestone originally deposited on an upper continental slope from the late Cretaceous to the middle Eocene. Previous work has provided accurate ages for this expanded section, and has shown that the PETM, ETM-2, H-2, I-1 and I-2 hyperthermals are marked by pronounced negative carbon isotope excursions (CIEs) and clay-rich horizons (marls), the latter caused by excess terrigenous dilution. 283 new samples were collected, mostly above the I-2 event; these were analyzed for carbonate content, lithology, and bulk carbonate carbon isotopes. A greatly expanded (100 m-thick) unit represented by a series of marl beds lies above I-2 and correlates to the EECO. Carbonate contents are generally 60 – 90% throughout the studied interval, with lows being marls. The δ^{13}C is generally low but, in detail, represents a series of negative CIEs with magnitudes ranging between 0.2 – 0.6‰. Of these, the K/X/ETM-3 event is the most pronounced (0.6‰).

The late Paleocene-early Eocene δ^{13}C record at Mead Stream is remarkably similar to that generated at Site 1262 at Walvis Ridge (south Atlantic), except that lows in δ^{13}C span intervals of relatively high sedimentation (terrigenous dilution) rather than intervals of relatively low sedimentation (carbonate dissolution). We suggest that over ~6 million years, there was a series of short-term climate perturbations, each characterized by massive carbon input and greater continental weathering. The suspected link involves global warming and enhanced seasonality in precipitation. We are evaluating this model further by identifying hyperthermal events in DSDP sites from the Indian Ocean, and assessing whether they are related to carbonate dissolution or siliciclastic dilution.