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Using higher plant biomarkers to obtain new carbon isotopic records across the PETM

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The Paleocene-Eocene Thermal Maximum is one of the most dramatic climate events in Earth history, characterised by a rapid negative shift in the carbon isotopic composition of marine carbon attributed to the release of methane from gas hydrates. Carbon isotopic records have also been obtained from terrestrial settings, and these are critical for defining the magnitude of the shift in atmospheric CO_2 δ^{13}C values. However, such records are limited in number and resolution. Here we report the investigation of three PETM sedimentary sequences dominated by terrestrial organic matter: a Kumara, NZ, section deposited in deltaic to nearshore marine sediments; the Cobham lignite (England), deposited in a coastal margin flood-plain setting; and Tanzanian continental margin sediments. In each, carbon isotopic analyses of higher plant biomarkers provides direct records of changes in higher plant vegetation and, thus, atmospheric CO_2(despite significant changes in bulk organic matter sources in the Kumara section and marine deposition in the Tanzanian section).

The focus of this presentation will be on the Kumara section, a mixture of sandstones, mudstones and coals with total organic contents ranging from 0.5 to 36%. Throughout most of the 50-m section examined, the organic matter is dominated by terrestrial biomarkers derived from either higher plants (e.g. n-alkanes with a strong odd-over-even predominance) or bacteria (hopanes), consistent with deposition in a riverine or deltaic setting. N-alkane δ^{13}C values were measured and a 4‰ negative shift proves

that the studied interval spans the PETM. Intriguingly, the negative isotope excursion is associated with a dramatic change in biomarker assemblages. First, pristane and phytane (derived from algal chlorophyll) and low-molecular-weight $n-$alkanes become more abundant, indicating a shift to marine dominated conditions; after the return to pre-excursion carbon isotopic compositions, biomarker assemblages again become dominated by terrestrial inputs. Second, a variety of biomarker proxies suggest that bottom waters and sediments became more reducing. These shifts in depositional setting are consistent with lithologic changes (organic-lean sandstones become predominant) and provide possible evidence for sea level rise associated with the PETM. Third, the abundance of oleananes, biomarkers for angiosperms, increases dramatically during the isotope excursion. This could reflect the change in depositional environment; more intriguingly, it could reflect a dramatic change in the higher plant assemblage. Thus, lipid biomarkers not only represent a source of high-resolution isotopic records, they also provide further evidence for changes in depositional environment and past biota.