Event deposition reshapes pre-aged organic carbon signatures and inferred benthic mineralization potential in the oligotrophic Kermadec Trench

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Abstract

Hadal trenches can accumulate laterally supplied organic carbon (OC), but the links among event deposition, OC source mixing, and benthic mineralization in remote pelagic trenches remain uncertain. Here we analyze two gravity cores from the southern and northern Kermadec Trench using sedimentology, bulk and ramped pyrolysis/oxidation (RPO) radiocarbon measurements, bulk and compound-specific carbon isotopes, and lipid biomarkers. Grain-size, sorting, magnetic susceptibility, lithogenic-element, and radiocarbon patterns indicate intervals of sediment remobilization that are compatible with turbidity-current deposition, although the available data do not uniquely assign every event layer to specific earthquakes or continental-margin sources. RPO and bulk ^{14}C results reveal strong age heterogeneity and a larger relative contribution of pre-aged, thermally stable OC in the southern core. Leaf-wax lipids, β-amyrin, C_{32} 1,15-diols, and more negative lipid $\delta^{13}C$ values indicate variable terrestrial-like and riverine-like contributions, whereas short-chain n-alkanes, TOC/TN ratios, and low TOC in coarse layers show that marine input remains substantial and that hydrodynamic dilution is important. Accordingly, event layers are best interpreted as compositionally distinct mixtures rather than simple pulses of quantitatively larger terrestrial OC. BrGDGT-derived DOU values are treated as a mineralization index because the calibration was developed for surface sediments and may be affected by downcore source mixing or diagenesis. Within these constraints, the index and BDGT-0/Archaeol ratios co-vary with event intervals and terrestrial-like biomarkers, suggesting that remobilized OC may be associated with localized benthic mineralization and archaeal community shifts. Our results refine, rather than replace, the established framework of lateral OC transfer to hadal trenches by emphasizing age/reactivity heterogeneity, source-mixing uncertainty, and the need to distinguish relative terrestrial enrichment from absolute carbon delivery.

Key words

Hadal trench; Event deposition; Pre-aged organic carbon; RPO radiocarbon; brGDGT-derived DOU index; Lipid biomarkers

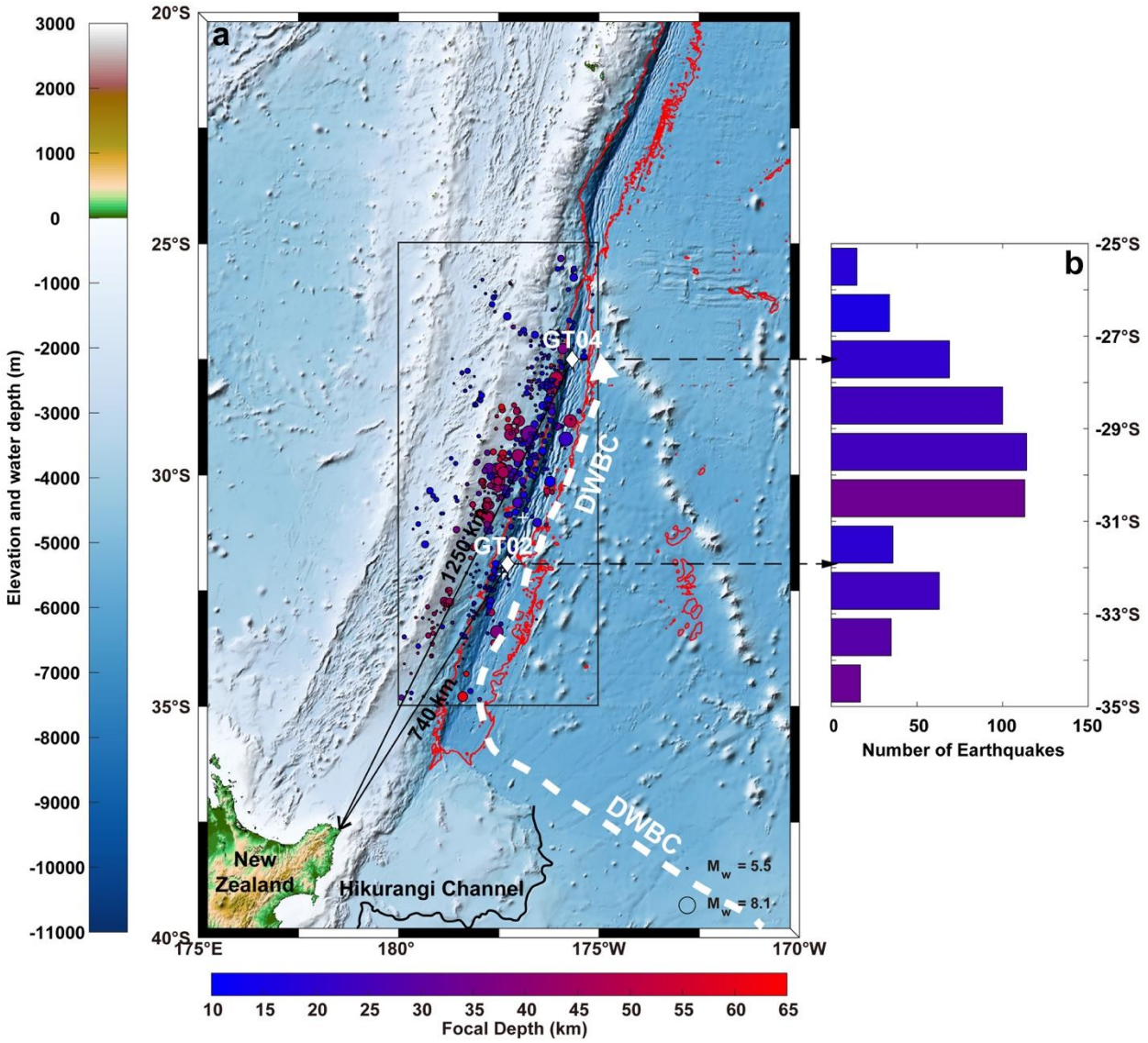

Fig. 1. (a) Distribution of strong earthquakes ($M_w \geq 5.5$) over the past 50 years in the Kermadec Trench region and sampling locations. White diamonds mark the two gravity-core sites. Red lines mark the 6000 m depth contour. (b) Histogram showing the number of earthquakes at each latitude within the black box in panel a. Bar colors represent the average focal depth of earthquakes within each latitude bin. Black dotted arrows indicate the latitude bins corresponding to the two sampling sites. Cores GT02 and GT04 are approximately 740 km and 1250 km away from the New Zealand mainland by straight-line distance, respectively. DWBC: Deep Western Boundary Current, indicated by the white dashed line. Seismicity is used here as regional context for potential sediment remobilization, not as direct evidence linking any individual event layer to a specific earthquake.