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What are the implications of rapid global warming for landslide-triggered turbidity current activity?

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A geologically short-lived ($\sim$170kyr) episode of global warming occurred at $\sim$55Ma, termed the Initial Eocene Thermal Maximum (IETM). Global temperatures rose by up to 8oC over only $\sim$10kyr and a massive perturbation of the global carbon cycle occurred; creating a negative carbon isotopic ($\sim$-4% δ13C) excursion in sedimentary records. This interval has relevance to study of future climate change and its influence on geohazards including submarine landslides and turbidity currents. We analyse the recurrence frequency of turbidity currents, potentially initiated from large-volume slope failures. The study focuses on two sedimentary intervals that straddle the IETM and we discuss implications for turbidity current triggering.

We present the results of statistical analyses (regression, generalised linear model, and proportional hazards model) for extensive turbidite records from an outcrop at Zumaia in NE Spain (N=285; 54.0 to 56.5 Ma) and based on ODP site 1068 on the Iberian Margin (N=1571; 48.2 to 67.6 Ma). The sedimentary sequences provide clear differentiation between hemipelagic and turbiditic mud with only negligible evidence of erosion. We infer dates for turbidites by converting hemipelagic bed thicknesses to time using interval-averaged accumulation rates. Multi-proxy dating techniques provide good age constraint. The background trend for the Zumaia record shows a near-exponential distribution of turbidite recurrence intervals, while the Iberian Margin shows a log-normal response. This is interpreted to be related to regional time-independence (exponential) and the effects of additive processes (log-normal). We discuss how a log-normal response may actually be generated over geological timescales from multiple shorter periods of random turbidite recurrence.

The IETM interval shows a dramatic departure from both these background trends, however. This is marked by prolonged hiatuses (0.1 and 0.6 Myr duration) in turbidity current activity in contrast to the arithmetic mean recurrence, λ, for the full records (λ=0.007 and 0.0125 Myr). This period of inactivity is coincident with a dramatic carbon isotopic excursion (i.e. warmest part of the IETM) and heavily skews statistical analyses for both records. Dramatic global warming appears to exert a strong control on inhibiting turbidity current activity; whereas the effects of sea level change are not shown to be statistically significant.

Rapid global warming is often implicated as a potential landslide trigger, due to dissociation of gas hydrates in response to elevated ocean temperatures. Other studies have suggested that intense global warming may actually be attributed to the atmospheric release of gas hydrates following catastrophic failure of large parts of a continental slope. Either way, a greater intensity of landslide and resultant turbidity current activity would be expected during the IETM; however, our findings are to the contrary. We offer some explanations in relation to potential triggers. Our work suggests that previous rapid global warming at the IETM did not trigger more frequent turbidity currents. This has direct relevance to future assessments relating to landslide-triggered tsunami hazard, and breakage of subsea cables by turbidity currents.