More reducing bottom-water redox conditions during the Last Glacial Maximum in the southern Challenger Deep (Mariana Trench, western Pacific) driven by enhanced productivity

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The modern southern Mariana Trench is characterized by oligotrophic surface waters, resulting in low primary productivity and well-oxygenated bottom waters. This study investigates changes in the redox conditions of bottom waters in the southern Mariana Trench during the Last Glacial Maximum (LGM) and their potential causes. We measured major, trace, and rare earth elements (REE) in three gravity cores (GC03, GC04, and GC05) and one box core (BC11) retrieved from the southern Challenger Deep at water depths from 5289 to 7118 m. The upper sediment layers of both GC05 and BC11 are dominated by valve fragments of the giant diatom *Ethmodiscus rex*, forming laminated diatom mats (LDMs). ^{14}C-AMS dates of bulk organic matter show that the LDMs accumulated between 18.4 and 21.8 kyr B.P., corresponding to the LGM. Modest enrichments of U and Mo along with weak or absent Ce anomalies in the LDM point to suboxic conditions during the LGM. In contrast, non-LDM samples exhibit little to no enrichment of redox-sensitive elements as well as negative Ce anomalies, indicating deposition under oxic bottom-water conditions. The Ce anomalies are considered valid proxies for bottom-water redox conditions because REE signatures were acquired in the early diagenetic environment, as indicated by strong P-REE correlations and middle-REE enrichment associated with early diagenetic cycling of Fe-Mn oxyhydroxides in the sediment column followed by capture of the REE signal by biogenic and/or authigenic apatite. We postulate that the more reducing bottom-water conditions during the LGM were linked to increased primary productivity induced by enhanced Asian dust input. As shown in earlier studies, the increased primary productivity associated with *Ethmodiscus rex* blooms in the eastern Philippine Sea played a significant role in capturing atmospheric CO_2 during the LGM. Consequently, the magnitude of atmospheric CO_2 sequestration by giant diatom blooms during the LGM may have been greater than previously envisaged.

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