Astronomical cycles of deep-sea redox conditions during the Toarcian oceanic anoxic event

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Global warming is causing oceanic anoxia, and global warming was also causing oceanic anoxic events during geological past. In the early Jurassic Toarcian, when fossil diversity was at its lowest, mass volcanic activity raised atmospheric pCO2 rapidly, and warming caused the early Toarcian Oceanic Anoxic Event (T-OAE) with massive melting of the Arctic ice sheet. Cyclic changes in δ13C values during the T-OAE have proposed a methane release associated with insolation, but its effect on oceanic redox is unknown. In this study, we examined the microsedimentary fabric of the bedded chert of the Sakahogi section of the Mino Terrane, a low-latitude deep-sea sediment, using Scanning Electron Microscopy (SEM), Field Emission Electron Probe Micro Analysis (FE-EPMA), and Image J to estimate redox conditions of bottom water and middle water. Sediment fabrics show cycles of about 100 mm at the Pl/To boundary and about 20,30 50, and 130 mm at the T-OAE. Assuming an average sedimentation rate of about 1 mm per millennium, these predominant cycles correspond to the Milankovitch cycles, 20kyr, 40kyr, 100kyr, cycles. In addition, during the period of negative δ13C excursionat T-OAE, lamination is dominant in the black mudstones and bioturbation was observed in cherts. On the glacial cycle, redox condition of low-latitude bottom waters was strongly influenced by changes in the rate of subduction from the poles as the ice sheet expands and contracts, and radiolarian productivity was strongly influenced by trade wind intensity through the meridional temperature gradient changes. Thus, Milankovitch paced methane release from cryosphere and associated ice sheet shrinkage and expansion, which may have affected ocean-atmospheric circulation and influenced deep-sea redox and radiolarian productivity in low latitude region, resulting in deposition of laminated black mudstone and bioturbated radiolarian chert. Such astronomical cycle oceanic environmental changes may have contributed to the slow recovery of fossil diversity.

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