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Cretaceous Black Shales in the Pacific: The Equatorial Position Hypothesis

Max J. Bouwmeester[1], Lydian Boschman[2], Nienke Berends[1], Jeremy D. Owens[3], Ben C. Gill[4], and João P. Trabucho Alexandre[1]

[1]Department of Earth Sciences, Utrecht University, Utrecht, The Netherlands
[2]Department of Environmental System Science, ETH Zürich, Zürich, Switzerland
[3]National High Magnetic Field Laboratory, Florida State University, Tallahassee, USA
[4]Department of Geosciences, Virginia Polytechnic Institute and State University, Blacksburg, USA

Although anoxia is rare in modern oceans, the marine stratigraphic record is punctuated by sedimentary and geochemical evidence for episodes of widespread oceanic anoxia. The last time in Earth history that a large volume of the ocean became anoxic was in the middle Cretaceous: black organic-carbon-rich muds were repeatedly preserved on the deep seafloor during oceanic anoxic events (OAEs).

Sedimentary and geochemical evidence for oceanic anoxia during OAEs comes mainly from the Atlantic and Tethys Oceans. Data from the Pacific Ocean, which was the largest ocean basin in the middle Cretaceous, is scarce and equivocal. Based on black shales deposited at depths of about 500–1500 m on seamounts, Monteiro et al. (2012) have suggested that at least 50 vol% of the ocean was anoxic at the climax of Cretaceous oceanic anoxia during the late Cenomanian. They also included a single black shale at DSDP Site 585 in the Mariana Basin as evidence for anoxia in the deep Pacific. We will show, however, that this is a mud turbidite reworked from shallower water.

For this study, we reviewed all available data and publications from scientific drilling that recovered Cretaceous sediments in the Pacific Ocean. The little available Cretaceous record from the Pacific consists mainly of well-oxidized sediments. The exceptions are black shales that occur at depths of about 500–1500 m on seamounts. Takashima et al. (2011) have shown that the Asian and North American continental margins of the Pacific were indeed oxic for most of the late Cenomanian OAE.

We used a new paleomagnetic reconstruction of the Pacific plate back to 150 Ma to show that all investigated Cretaceous organic-carbon-rich sediments in the Pacific Ocean were deposited while the site was located in the Equatorial Divergence Zone (10°S to 10°N). We therefore argue that organic matter deposition in the Pacific Ocean might not have been directly related to OAEs, but rather be associated with the passage of seamounts beneath the equatorial belt of high productivity.

Several authors have challenged suggestions that OAEs were characterized by globally pervasive anoxic deep water and pointed to the difficulty in sustaining whole-ocean anoxia, even in warm oceans. We agree and our results show that oceanic anoxia in the Pacific is a local phenomenon superposed on a global trend of expanded oxygen minima in the ocean.