

Variation in depositional conditions across the Toarcian (Early Jurassic) OAE: Mudstone lithofacies analysis of the Nishinakayama Formation

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The early Toarcian (Early Jurassic) oceanic anoxic event (T-OAE) was a significant palaeoenvironmental perturbation that led to marked changes in ocean and atmospheric chemistry. This event is characterized by the widespread occurrence of a ~3–7‰ negative excursion in the carbon-isotope ($\delta^{13}\text{C}$) composition of marine organic and inorganic matter and terrestrial plant material. In addition, one of the distinct phenomena during the early Toarcian is the abrupt rise of $p\text{CO}_2$ and consequent global warming, which led to tropical to subtropical storm intensification. Although such storms are predicted to have been intensified globally at low to mid latitudes during the Early Jurassic, tropical storm intensification outside the Tethys realm has not been demonstrated. To address this issue, we investigated the Nishinakayama Formation of the Toyora area, southwest Japan, which represents an organic-rich silty mudstone-dominated succession deposited at the shallow margin of the northwestern Panthalassa Ocean. First, we established a high-resolution carbon-isotope chemostratigraphy. As a result, the characteristic T-OAE negative $\delta^{13}\text{C}$ excursion was recognized around the middle part of the Nishinakayama Formation, making accurate international correlation possible. Then, we carried out a mudstone microfabric analysis to reconstruct hydrological and sedimentological changes. Our results indicate that the Nishinakayama black silty mudstones exhibit a variety of microfabrics, sedimentary structures, and textures. These features indicate a dynamic range of depositional conditions. In particular, we note evidence for mudstone deposition by bottom currents, and silty mudstones exhibiting evidence of energetic conditions are concentrated during the carbon-isotope negative excursion interval. Mudstones from the pre- and post-excursion intervals generally show parallel-laminated features that suggest settling from suspension. These sedimentological changes, in combination with carbon isotope stratigraphy, provide the first evidence for storm intensification during the T-OAE interval from the mid latitude Panthalassic margin. Our results are consistent with previously published papers documenting sedimentological changes in Tethyan T-OAE successions.

Keywords: Toarcian oceanic anoxic event, Panthalassa, Nishinakayama Formation