Toarcian redox history and biotic response in NW Panthalassic margin: Multiproxy 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 redox condition and ecosystem. This event is characterized by the widespread occurrence of a ~3–7‰ negative excursion in the carbon-isotope ($\delta^{13}C$) 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 pCO_2 and consequent global warming, which led to enhanced hydrological cycles and ocean anoxia. Despite such global impacts of the event, the precise palaeoenvironmental and palaeoecological changes during the event from sections outside of the Boreal and Tethys realms are uncertain. To address this issue and further expand our understanding of the nature of the event, 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. In particular, we focused on the reconstruction of ocean redox history and biotic response, based on available new data. As a result, pyrite framboid size analysis suggested that water-column euxinia occurred during the negative $\delta^{13}C$ excursion, although available geochemical data suggested suboxic bottom water. According to our results and previous studies that indicate a pelagic euxinia in the central Panthalassa, widespread euxinic condition was achieved in the Panthalassa Ocean during the T-OAE. Detailed sedimentological analysis of silty mudstones and sandstones revealed that terrigenous material input was increased during the negative $\delta^{13}C$ excursion. In addition, at least in some cases during the negative $\delta^{13}C$ excursion, terrigenous material was directly delivered from river floods by hyperpycnal flows, which may have provided oxic water into bottom water. Ammonite (e.g., *Dactylioceras* and *Harpoceras*) size analysis suggested that ammonites were, in general, negatively affected by water-column euxinia, although there were species-specific differences in biotic response between *Dactylioceras* and *Harpoceras*. Namely, the size of *Dactylioceras* decreased during the interval of water-column euxinia and its aftermath. On the other hand, the size of *Harpoceras* also decreased during the interval of water-column euxinia, but increased directly after the termination of the euxinic interval. The same pattern was also recognized in *Dactylioceras* and *Harpoceras* in Tethys realm, suggesting the global nature of biotic response to the Toarcian palaeoenvironmental perturbations.

