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ミランコビッチ・サイクルと炭素循環が Toarcian 海洋無酸素事変に与えた影響
Milankovitch forcing and carbon cycle during the Toarcian Oceanic Anoxic event

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One of the most profound environmental changes in the Mesozoic took place during Toarcian (Early Jurassic), including oceanic anoxia (Toarcian Oceanic Anoxic Event; T-OAE). The T-OAE is characterized by negative carbon isotope excursion (CIE) of up to ˜8 ‰. The T-OAE is considered to have resulted from the release of CO2 by Karoo-Ferrar volcanism and possible methane hydrate dissociation. However, the origin of these perturbations remains strongly debated, primarily due to lack of radiometric age constraints across the T-OAE (e.g. Palfy and Smith, 2000; Kemp et al., 2005, 2011; Suan et al., 2008).

Here we present the orbitally-tuned bio-, and $\delta^{13}C_{org}$ stratigraphy of the Lower Jurassic deep-sea bedded chert sequence at the Katsuyama-Sakahogi section, in the Inuyama area, central Japan, which covers the T-OAE (Ikeda and Tada, 2013; Ikeda and Hori, in review). The sedimentary rhythms of the bedded chert display a full range of climatic precession related cycles; ˜20 kyr cycle as a chert-shale couplet and ˜100 kyr, 405 kyr, ˜2000 to 4000 kyr cycles as chert bed thickness variations (Ikeda et al., 2010; Ikeda and Tada, 2013). Chert-shale cycles and variations in chert bed thickness are interpreted as resulted from changes in the burial rate of biogenic silica (Hori et al., 1993).

By using 405-kyr eccentricity cycle of constant and stable periodicity (Laskar et al., 2004) observed in the Inuyama bedded chert, we established the astronomical time scale (ATS) by counting 405 kyr cycle (˜20 bed cycle; Ikeda and Tada, 2013). Then, this ATS is anchored at the end-Triassic radiolarian extinction level of which age is estimated as 201.4 ± 0.2 Ma based on projection of the U-Pb date measured at the Pucara section, Peru, using the conodont and radiolarian biostratigraphy (e.g. Carter and Hori, 2005; Schoene et al., 2010; Ikeda and Tada, 2013).

This astronomical time scale suggests the absolute ages of the T-OAEs. The timing of two black bedded chert intervals (T-OAEs 1 and 2) and the negative CIE of ˜5 ‰ are within the time interval of radiometric ages from thKaroo-Ferror Lips (Svencen et al., 2007; Jourdan et al., 2008). This result supports the volcanic degassing origin of these carbon cycle perturbations (Palfy and Smith, 2000; Suan et al., 2008).

The termination of black shale deposition occurred at the minimum of 40 kyr obliquity amd 100 kyr and 405 kyr eccentricity cycles. These temporal relations imply the possible impacts of these orbital forcing on the stabilization of carbon cycle perturbation through Earth system dynamics, such as weathering and nutrient cycles.

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