Reconstruction of the climate condition in the Carnian from bedded chert by using a new index of chemical weathering

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Reconstruction of paleoclimate during the Triassic Period is important for the understanding of the Earth system operated during the super-continent and super-ocean, polarized surface landform condition. In the early Late Triassic, an abrupt warming/humidification event, so-called Carnian Pluvial Episode emerged, which was considered to be triggered by the eruption of LIP and increasing atmospheric CO₂. Previous studies regarding the Carnian Pluvial Episode were mainly performed in the western Tethys realm, while the global impact of the Carnian Pluvial Episode is not well understood. This study newly presents the reconstruction of continental chemical weathering intensity through the Carnian from the pelagic deep-sea sediment, which is preserved as bedded chert in the accretionary complex in Japan. In this study, to unravel the hinterland chemical weathering variation from bedded chert, a new weathering index was introduced. The new index was derived from the multivariate statistical analysis (Independent component analysis) using major element compositions of fresh igneous rock and their weathering profiles. The concentrations (wt. %) of TiO₂, Al₂O₃, Fe₂O₃, MgO, Na₂O, K₂O were used to extract the chemical weathering variation which should be independent from the source rock composition. The newly developed index has two features; (1) It retains the advantage of W index (e.g., applicable to a wide range of rock types; less sensitive to specific element concentrations; Ohta and Arai, 2007). (2) It does not require the SiO₂ and CaO concentration data, and thus applicable to samples with contamination of silica, apatite, or calcite. This new index enables the quantitative reconstruction of chemical weathering not only in bedded chert but also in shallow sea or terrestrial sediments that contain diagenetically derived calcite or biogenic apatite fragment. To investigate the climate of the continental region in the Carnian, more than 80 mudstone samples were successively collected from the bedded chert sequence of Section R, Q, Inuyama area, Mino terrain, which cover the whole Carnian Stage (Sugiyama, 1997, Nakada et al., 2014, Yamashita et al., 2018). After washing in an ultrasonic bath to remove the weathered part of the rock surface, major elements were analyzed by XRF (ZSX Primus II, Rigaku Co., Ltd.). The new chemical weathering index demonstrates a clear increase at the Lower Carnian/Upper Carnian boundary, and this high weathering condition continues about 1.3 million years. Then, the weathering intensity decrease suddenly at the boundary of TR5A and TR5B radiolarian biozones (Tuvalian substage). The onset timing of this high weathering period matches with that of the Carnian Pluvial Episode in Tethys. This result suggests that, in the middle of the Carnian, the prolonged warming/humid period lasted for about 1.3 million years in the broad area of the continental region related to the Carnian Pluvial Episode. This increasing of continental weathering intensity and the changes in fossil assemblage suggest that the Carnian Pluvial Episode was a global phenomenon and this environmental disturbance affected biological evolution not only in the Tethys realm but also in the whole Panthalassa. Thanks go to Prof. Tohru Ohta of Waseda University for kind advice and fruitful discussions. Dr. Kazutaka Yasukawa of the University of Tokyo is thanked for his guidance of Independent component analysis. This study was supported by the National Science Foundation of China (Grant No. 41888101; D. Kemp).

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