Millenial- to orbital-scale paleoclimatic changes in the mid-Cretaceous from Mongolian lacustrine records

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The mid-Cretaceous period is characterized by an extremely warm "greenhouse" climate, elevated atmospheric CO_2 level, and repetitions of Ocean Anoxic Events (OAEs); however, the response of terrestrial climate system against these marked events have been poorly understood. To evaluate interaction between the land and the ocean during the OAE interval, we investigated terrestrial paleoclimatic changes from lacustrine records at an intra-continental site in southeast Mongolia.

The Aptian lacustrine deposits (Shinekhudag Formation) are widely distributed in southeast Mongolia. The formation is about 250 m thick and composed of rhythmically alternating beds of dark gray shale, light gray dolomitic marl and yellowish dolomite. Based on the radiometric age dating, the formation is considered to be deposited between ca. 123–119 Ma of the Early Aptian time, and the calculated sedimentation rate is ca. 6.3–12.5 cm/kyr.

In order to obtain the paleoclimatic signals and their controlling factors from this record, we performed XRF and ICP-MS analysis for major and minor element compositions of the bulk samples. Based on the factor analysis of major and minor element compositions, several climatic signals (e.g., precipitation, weathering, redox condition of lake bottom) were obtained. Spectral analysis of each factor scores reveals cycles involving approximately 2, 6, 20, 40, and 100 kyr, based on the average sedimentation rate of 10 cm/kyr. The latter three values are in accordance with orbital precession, obliquity, and eccentricity cycles, respectively. Therefore, the Shinekhudag lacustrine deposits are interpreted to record the millennial- to orbital-scale paleoclimatic and paleohydrologic changes during the Early Aptian time of OAE1a and post-OAE1a intervals.