Astronomical Tuning of Upper Jurassic - Lower Cretaceous Sediments (Volgian-Ryazanian Stages), Norwegian Sea

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During the late Jurassic to early Cretaceous period, major petroleum source rocks formed in the Greenland-Norwegian Seaway. Core 6814/04-U-02, drilled in 1991 in the Ribban Basin (Norwegian Sea), samples these sedimentary rocks, including the early Volgian to Berriasian (Ryazanian) that we are focusing on. The drilled facies consist of an undisturbed section of laminated organic rich shales with intercalated carbonate beds that were deposited in relatively deep water. Persistent, meter-scale sedimentary cyclicity suggests action from orbital forcing and an opportunity to define an astronomical time scale for the interval. Astronomically forced insolation affecting periodic climatic change is the source of the cyclicity. Factors related to weathering, productivity, transport and deposition were all sensitive to the climatic changes. Spectral analysis of high-resolution lightness data (for which different lightness is assumed to represent different sediment facies) reveals sedimentary cycles with wavelengths at 13 m, 3.3 m, 1 m, 0.8 m and 0.67 m. When calibrating the 13 m cycles to the 405 kyr (long) orbital eccentricity cycle, the wavelengths correspond to 405 kyr, 100 kyr, 37 kyr, 25 kyr and 20 kyr, respectively. While eccentricity dominates the interval from 67 to 121 m, obliquity dominates from 121 to 191 m. Minimal tuning to 405-kyr (long eccentricity), 100-kyr (short eccentricity) and 37 kyr (obliquity) shows dramatic improvement in the resolution of astronomical signal with progressively higher frequency tuning. The obliquity-tuned spectrum has a strong (tuned) peak at 37 kyr, well resolved spectral peaks at 405 kyr and 125 kyr, and a significant 21 kyr cycle, and indicates obliquity-dominated climate change during the Volgian. This strong obliquity response is associated with enhanced oceanic anoxia. The duration over the entire 67 to 191 m interval is 4.292 myr, 4.10 myr and 4.05 myr when minimally tuned to 37 kyr, 100 kyr and 405 kyr cycles, respectively. Assuming that the obliquity tuning provides the most accurate chronology, the Ryazanian interval (67 to 87 m) has at least a 660 kyr duration; the remaining 104 meters (87 m to 191 m) is Volgian with a duration of 3.632 myr. The core does not reach the base of the Volgian, but can be correlated to the Tithonian portion of the astronomically tuned British Kimmeridge Clay. The top part of the core correlates to Berriasian cyclostratigraphy of the Miravetes Formation in Spain.