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Using the FMS image to improve interpretation of sedimentary cyclicity and climate change for the Late Jurassic

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The Late Jurassic Kimmeridge Clay Formation (KCF) is an important regional organic-rich mudstone of Late Jurassic (Kimmeridgeina-Tithonian) age. The main rock types are medium dark-grey marls, dark-grey shales, dark grey-black laminated shales, greyish brownish black mudstones, pale-grey coccolithic limestones, and grey to pale yellow limestones and dolostones, and these reveal an obvious sedimentary cyclicity. In this study, we use the Formation Microscanner (FMS) resistivity image, which gives a stratigraphically high-resolution record, to identify regular sedimentary cycles. According to the conductive (dark colour on the images) and resistive (light colour) image-facies type, we have counted the cycles in the FMS image log for the KCF of the Swanworth Quarry 1, Dorset, UK, and found an average cycle thickness of 0.912 m. Spectral analysis demonstrates that the cycles are expressed as medium-amplitude cycles of 0.82-2.05 m wavelength (previously, spectral analysis has identified large-amplitude cycle of 1.87-4.05 m wavelength using other lower resolution data). Furthermore, evolutional spectra of the Neutron Porosity Limestone log data show that dominant Milankovitch cycles varied between short-eccentricity, obliquity, and precession during sedimentation. The $\sim$1m wavelength cycles are inferred to be precession-related. Spectral analysis shows that the cycles are regular in thickness, implying a regular fluctuation in the environment of deposition driven by the precessional astronomical cycle ($\sim$19ky). We use the cycle thickness divided by the precessional astronomical cycle to obtain a sedimentation rate curve. The sedimentation rate variation curve can be used to infer the relationship between the palaeoproductivity, climate, and sea-level change driven by the Milankovitch climatic forcing mechanism.