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Orbital Forcing of a Low-Latitude Lacustrine Ecosystem During the Middle Devonian: Implications for the Onset of the Middle Paleozoic Icehouse World

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The penultimate transition between greenhouse and icehouse conditions occurred in the mid-Paleozoic and is usually considered to have begun in the Carboniferous. However, analysis of lacustrine rift strata of the Caithness Flagstone Group in the Orcadian Basin of northern Scotland suggest that the ice-house transition may have begun earlier, during this Middle Devonian (Eifelian-Givetian; 370-420 Ma) times. The Caithness Flagstone Group was deposited in the tropics ($\sim$15°S) and provides an excellent sedimentary archive to study this mid-Paleozoic climate transition. The repetitive facies assemblages have been interpreted to represent transitions between perennial lacustrine environments, and ephemeral playa or sub-aerial floodplain conditions. Unlike very similar and well-documented hot house lacustrine deposits at similar latitudes in the Mesozoic, analysis of corehole gamma ray logs and lacustrine facies data by Fourier and wavelet methods demonstrates a prominent cyclicity at the obliquity (40 ky) as well as at precessional (18 ky) (and eccentricity - $\sim$100 ky and 405 ky) frequencies. The presence of spectral power in the obliquity band is unexpected for local forcing at low latitudes. This suggests a high-latitude influence on low-latitude climate, potentially amplified by ice sheets, or an as of yet unexplained telecommunication. These data support the idea that by Middle Devonian times, the Earth's climate was drifting from a hothouse to an icehouse regime, the most likely cause of which was a long-term decrease in CO_2 caused by the expansion of terrestrial vascular plants.