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Milankovitch cyclicity in Paleoproterozoic BIF of the Kuruman Iron Formation in South Africa

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Large-scale deposition of banded iron formations (BIFs) between 2.8 and 1.9 billion years ago has been primarily interpreted in terms of hydrothermal plume activity1, continental growth2 and the dynamic rise of oxygen in the ocean and atmosphere3. In contrast, not much attention has been paid so far to climatic variability and its role in the formation of BIFs. Yet, Milankovitch forcing linked to Earth's orbital and inclination parameters and the resultant climate oscillations on the 104 – 106 year scale must have been operative at that time4 and may explain rhythmic layering that has previously been observed in BIFs5,6. However, this hypothesis has never been tested, partly as a consequence of the large uncertainties in BIF depositional rates. For this reason, we decided to carry out an integrated stratigraphic study of Paleoproterozoic BIF in the Kuruman Formation of the Griqualand West Basin in South Africa, combining cyclostratigraphic analysis with high-precision TIMS U-Pb zircon dating of several ash intervals interbedded in the BIF. In the field, we identified a characteristic hierarchical cycle pattern in the weathering profile of the Kuruman BIF. This pattern, which can be traced over a distance of 250 km, can be explained by the superposition of two different cycles. Based on the results of spectral analysis, several Milankovitch hypotheses in terms of precession, obliquity and eccentricity can be formulated. The expectation is that the new and much improved U-Pb ages can be used to distinguish between hypotheses.

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