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Emerging cycles: diagenesis caught in the act

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In the periplatform realm of carbonate banks aragonite cycles are widely used as cyclo-stratigraphic tool. The same holds for marl-limestone alternations that are thought to be the final diagenetic stage of aragonite-rich precursor sediments. This approach builds on the assumption, that individual aragonite cycles directly reflect changes in the environmental conditions on Milankovitch timescales. However, it has been proposed that the formation of these cycles could be attributed solely to self-organization of sediment, without the need of primary sedimentary differences. This would question the value of marl-limestone alternations for cyclo-stratigraphy because their formation would not depend on external forcing.

We present a record from the early Pliocene of the Maldives (ODP Leg 115), which comprises strong precession and eccentricity cycles in aragonite content. An additional sub-Milankovitch cycle emerges in the lower part of the investigated interval. The concentration of chlorophyll a degradation products, i.e. chlorins, and organic carbon content in contrast are dominated by precession cycles throughout the whole interval. Based on the organic geochemical proxies we can evaluate the variable degree of sulphate reduction. The extent of organic matter remineralisation in the sediment is coupled to changes in paleoproductivity and also follows a precession cycle. This differential degree of organic matter degradation initiates a rhythmic dissolution and reprecipitation of carbonates. The diagenesis in the studied cores does not simply enhance the primary differences in sediment composition, but introduces an additional sub-Milankovitch frequency that was not present in the primary frequency band and does not carry any paleoenvironmental information.

On the other hand the diagenetic pattern is not entirely self-organized, since the rhythmic diagenesis is governed by a primary rhythmic change in sediment composition,

albeit on a different frequency. The outcome of our study supports the idea that paleoenvironmental information can be gained from calcareous rhythmites; but not all contain a primary signal. The straightforward interpretation of these sedimentary cycles as simple paleoclimate archives hence can be misleading. To differentiate between paleoclimate and diagenetic influences, diagenetic stable proxies have to be used.