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On the origin of semiprecessional cycles in carbonate periplatform deposits

L. Reuning (1), **J. J. G. Reijmer** (2), E. Mattioli (3), and C. Betzler (4)

(1) RWTH Aachen, Germany, (2) Vrije Universiteit, Faculty of Earth and Life Sciences, Amsterdam, The Netherlands, (3) UMR 5125 Paléoenvironnements et Paléobiosphere, UFR Sciences de la Terre, Université Lyon 1, Villeurbanne Cedex, France, (4) University of Hamburg, Germany (reuning@geol.rwth-aachen.de / Phone: ++49-241-8095725)

In the periplatform realm of carbonate banks, such as the Great Bahama Bank and the inner lagoon of the Maldives, variations in aragonite content are widely used as a cyclostratigraphic tool. The same applies to calcareous alternations that are thought to be the diagenetic end product of aragonite-rich precursor sediments. Most authors argue that calcareous rhythmites record a primary environmental signal on Milankovitch timescales. This view has been challenged by studies that propose an origin of rhythmic carbonate successions solely from diagenetic self-organization, without the need of primary sedimentary differences. An entirely diagenetic origin, however, of calcareous rhythmites, would question the value of these alternations as a tool in cyclostratigraphy.

We present two case-studies that not only demonstrate strong precession and eccentricity cycles in aragonite content, but also aragonite variations on sub-Milankovitch timescales.

The aragonite content in the early Pliocene sediments from the GBB (ODP Leg 166) shows a clear semiprecession cycle. The covariation between aragonite content and the δ^{18}O-signal, recorded in the test of the foraminifera *G. sacculifer*, indicates a close link between the Caribbean freshwater balance and associated wind induced aragonite export from the carbonate ramp. We propose that these sea level independent semiprecession cycles in the hydrological balance are generated by insolation changes near the equator.

At the Maldives (ODP Leg 115) the concentration of chlorophyll a degradation prod-

ucts, i.e. chlorins, and organic carbon content in contrast are dominated by eccentricity and precession cycles throughout the whole interval. Based on the organic geochemical proxies the variable degree of sulphate reduction could be evaluated. 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.

The outcome of these studies support 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, diagenetically stable proxies have to be used.

The processes steering the development of sub-Milankovitch cycles differ significantly in both case studies. Nevertheless, our results clearly show that the diagenetic pattern was not self-organized, since the rhythmic diagenesis was governed by primary rhythmic changes in sediment composition. The assumption that self-organization of the sediment could result in regular cyclic variations on sub-Milankovitch and Milankovitch scales thus could be ruled out in both case studies.