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# Long-period variations in the Earth's obliquity and their relation to third-order eustatic cycles during the Middle-Late Miocene record from Mediterranean and the Paratethys area

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Several authors suggested a relationship between glacio-eustatic sea-level oscillations and the 1.2 Myr long-periodic variations in obliquity. In this particular orbital configuration prominent oxygen isotope excursions to heavier values have been found (Lourens & Hilgen 1997; Turco et al. 2001; Zachos et al. 2001; Wade & Palike 2004; Abels et al. 2006).

The Paratethys and the Mediterranean represent two key areas to test this scenario.

The Middle Miocene Serravallian Stage (Mediterranean area) and Sarmatian regional stage (Paratethys area) and the Upper Miocene Tortonian Stage (Mediterranean area) and Pannonian regional stage (Paratethys area) represent crucial time interval for the Mediterranean-Paratethys system. The timing of the transition from the shallow-marine Sarmatian deposits up to the Pannonian continental strata of the central Paratethys represents a debate open problem as well as the transition between relatively deep-marine Badenian up to shallow-marine Sarmatian ones.

Hydrocarbon drilling exploration in the Middle and Upper Miocene sediments of the Vienna Basin recorded a complete succession of marls and sands used as a marker-system for the regional the correlation of wells (Harzhauser & Piller 2004), where the third-order eustatic cycles in the Haq et al. (1987) curve are clearly marked by drastic change in depositional system.

The astronomical tuning of high-resolution geophysical raw-data of the 2200 m long sedimentary interval of the OMV-well Eichhhron1 show the existence of low-frequency cycles linked to Milankovitch oscillations. In particular, power spectral analysis revealed the occurrence of significant frequency corresponding to periods of 1.2 My, 407kyr, 100kyr and 43kyr.

Significant coherence at frequency corresponding to a period of 394ky confirms our tuning over the 400kyr eccentricity cycles.

This astronomical tuning suggest that the Sarmatian/Pannonian and Badenian/Sarmatian boundaries have an age of 11.42 and 13.14 My respectively.

The tuning of the Sarmatian/Pannonian records confirms that the beginning of the Lake Pannon is very close to the Miller event Mi5 and coincides with a period of minimum amplitudes in obliquity related to the 1.2-Myr cycle and coincides with the abrupt sea level drop TB 3.1.

Moreover, the orbital configuration during the warmer period in between Mi5 and Mi6 corresponding with a maximum in the long-term 2.3 My eccentricity cycles, is confirms by the occurrence of lignites in the Paratethys record. The lignites facies which reflect the strong influence of 100 kyr eccentricity cycles correspond in the Mediterranean to small-scale and large-scale sapropel-clusters to 100 and 400 kyr eccentricity maxima.

In addition, the Badenian/Sarmatian boundary which falls close to the Miller event Mi4, which corresponds with a period of minimum amplitudes in obliquity related to the 1.2-Myr cycle, coincides with the sea level drop TB 2.6.

Our results prove that Paratehtys sea-level drop which mark the Sarmatian/Pannonian transition and the Badenian/Sarmatian were dominantly obliquity controlled with additional influence of the100 and 400 kyr eccentricity cycles.