Evaluating the Relative Contributions of Tectonics and Eustacy from a High-Resolution Stratigraphic Record: A Case Study from the Vienna Basin

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An integrated methodology to obtain a high-resolution stratigraphic record is presented that forms the basis for evaluating the relative contributions of eustacy, tectonics and other potential factors that control sedimentary basin infills. The method is based on seismic and borehole data and combines seismic stratigraphy, biostratigraphy, magnetostratigraphy and cyclostratigraphy. Micropaleontological analyses from cuttings or cores provide the biostratigraphic framework. Further refinement is obtained with paleomagnetic logging data, a unique technology that provides a continuous record of the remanent magnetic polarities of the sedimentary sequences traversed by the borehole. This record is compared with the global polarity time scale (GPTS) to determine the polarity reversals. Analysis of the seismic data set then provides temporal gaps such as unconformities and their lateral equivalents, as well cut-outs caused by faulting. Electrical images provide detailed structural information in the wellbore and are used to corroborate these time gaps. The combination of these methods results in a temporal record of the sedimentary sequence with a resolution of about 100 ka. The electrical borehole images, with a vertical resolution of about 1 cm, are then used for a spectral frequency analysis in order to identify potential higher-order cyclicities. The sum of the results forms the basis for evaluating the relative contributions of tectonics, eustacy and other factors.

The methodology is applied to a dataset covering about 5 Ma from the Middle to Late Miocene in the Central Paratethyan Vienna Basin. Both well and seismic data are of excellent quality, but paucity of microfossils and low magnetizations in the Badenian resulted in greater uncertainties for that stage. After establishing the chronostratigraphic framework and correcting for temporal gaps, the sedimentation rates are found to increase towards the Sarmatian to more than 0.7 m/ka, and gradually decrease thereafter to reach about 0.3 m/ka in the upper Pannonian, the highest stratigraphic section. This development is attributed to the waning tectonic influence of the Alpine orogeny and the beginning of sediment by-pass towards the Pannonian basin. The cyclostratigraphic results were found to show a strong allocyclic orbital forcing superposed onto the overall tectonic evolution of the basin.