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Constraints on Miocene oceanography and climate in the Western and Central Paratethys: O-, Sr-, and Nd-isotope compositions of marine fish and mammal remains

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ABSTRACT

The Paratethys evolved as a marginal sea during the Alpine–Himalayan orogeny in the Oligo-Miocene. Sediments from the northern Alpine Molasse Basin, the Vienna, and the Pannonian Basins located in the western and central part of the Paratethys thus provide unique information on regional changes in climate and oceanography during a period of active Alpine uplift. Oxygen isotope compositions of well-preserved phosphatic fossils recovered from the sediments support deposition under sub-tropical to warm-temperate climate with water temperatures of 14 to 28 °C for the Miocene. $\delta^{18}O$ values of fossil shark teeth are similar to those reported for other Miocene marine sections and, using the best available estimates of their biostratigraphic age, show a variation until the end of the Badenian similar to that reported for composite global record. The $^{87}Sr/^{86}Sr$ isotope ratios of the fossils follow the global Miocene seawater trend, albeit with a much larger scatter. The deviations of $^{87}Sr/^{86}Sr$ in the samples from the well-constrained seawater curve are interpreted as due to local input of terrestrially-derived Sr. Contribution of local sources is also reflected in the ε_{Nd} values, consistent with input from ancient crystalline rocks (e.g., Bohemian Massif) and/or Mesozoic sediments with $\varepsilon_{Nd} < -9$. On the other hand, there is evidence for input from areas with Neogene volcanism as suggested by samples with elevated ε_{Nd} values > -7. Excluding samples showing local influence on the water column, an average ε_{Nd} value of -7.9 ± 0.5 may be inferred for the Miocene Paratethys. This value is indistinguishable from the ε_{Nd} value of the contemporaneous Indian Ocean, supporting a dominant role of this ocean in the Western and Central Paratethys.

1. Introduction

The Paratethys evolved as an epicontinental sea that was isolated from the Tethys during the Late Eocene–Early Oligocene due to the Alpine orogeny and global changes in sea level (e.g., Rögl and Steininger, 1983, Lemcke, 1988; Bachmann and Müller, 1992; Berger, 1992; Steininger et al., 1996). The Western and Central Paratethys were situated to the north and east of the emerging Alps during the Oligo-Miocene. Theses marine provinces can be further subdivided for smaller basins such as the north-Alpine Molasse, Vienna-, and Pannonian Basins. Sediments deposited in these marginal basins provide an opportunity to examine possible links between Alpine uplift and regional variations in climate (c.f. Raymo and Ruddiman, 1992; Ruddiman, 1997; Zachos et al., 2001). Also important in this tectonic context are the possible marine pathways connecting the various circum-Alpine basins with major marine provinces such as the Mediterranean, the Atlantic and Indian oceans. Such palaeoceanographic pathways may be delineated by using various geochemical methods (e.g., Piepgras and Wasserburg, 1980; Bertram and Elderfield, 1993; Stille et al., 1996).

This study attempts to constrain the palaeoclimatic and palaeoceanographic conditions that existed during deposition of the Early to Middle Miocene sediments of the Western- and Central Paratethys with the help of oxygen, strontium, and neodymium isotope compositions in phosphatic marine fish and mammal skeletal remains. In addition, we provide data of composition of the host sediments. This combination of isotopic data has gained increasing recognition as oceanographic proxies (e.g., Longinelli and Nuti, 1973a,b; Staudigel et al., 1985; Kolodny and Luz, 1991; Ingram, 1995; Vennemann and Hegner, 1998). Foraminifera (Hagmaier, 2002) and ostracods (Janz and Vennemann, 2005) have also been investigated in accompanying studies of Miocene clay-rich sediments from the deeper parts of the Vienna and the Pannonian Basins. The results of these studies will be used for comparison purposes.

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