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Geochemical compositions of Miocene marine fossils as palaeoclimatic and palaeoceanographic proxies for circum-Alpine sediments

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In order to determine the influence of Miocene Alpine upliftment on the regional climate and oceanography, trace element compositions, including those of rare earth elements (REE), as well as isotopic compositions of Sr, Nd, O, and C are being investigated for a number of different well-preserved fossils and their embedding sediments. These geochemical proxies are being analyzed for a number of different localities around the Alps to help constrain the differences in palaeoceonographic conditions during the deposition of the circum-Alpine Miocene sediments. Results from these Molasse sediments will then be interpreted relative to the results from similar proxies used to determine global changes in climate and oceanography in the context of evaluating any differences between local and regional changes and hence determining the influence of the Alpine orogeny.

New results (REE patterns, $^{87}Sr/^{86}Sr$, $\delta^{18}O$ values) largely for fossil shark teeth from the Swiss Upper Marine Molasse, representing the extreme western part of the Paratethys during the Lower Miocene, as well as from the Pannonian Basin of Hungary, representing the Central Paratethys during the Lower and Middle Miocene, have been obtained. Shark teeth were chosen because the biogenic phosphates are commonly thought to be more robust to post-depositional, diagenetic alteration compared to carbonates from the same sediments. For comparison purposes, however, carbonate fossils are also being analyzed for a number of localities. The samples have been selected from localities that have been well-characterized in terms of their biostratigraphy, but additional Sr isotope measurements are used to confirm their relative ages as well as to estimate whether or not open marine conditions existed during formation

of the biogenic phosphate.

Average δ^{18}O values from the Swiss samples are similar to those measured for the same time period from Molasse deposits in southern Germany and Austria (Vennemann & Hegner, 1998; Vennemann et al., 2001), varying between 20.1 and 23 permil. Those from the Hungarian sections extend to lower δ^{18}O values (about 19 permil and further up-section also to higher δ^{18}O values (about 23.5 permil. All the variations measured so far correspond well to relative changes in δ^{18}O values observed for the global records though (e.g. Zachos et al., 2001). Individual teeth from La Molière (Swiss Molasse), however, clearly indicate a strong influence of freshwater and/or possibly even the migration of some of the sharks into freshwater systems as they have extremely low δ^{18}O values of 11.3 to 11.9 permil.

Despite of the similarity in δ^{18}O values between clearly open-marine shark teeth from the different deposits, the REE compositions of some of these teeth are surprisingly variable. The more resistant enameloid usually has lower overall concentrations in REE than the originally more porous dentine and root, supporting a smaller amount of post-mortem enrichment in the enameloid relative to the root zones. The REE patterns are also quite variable, with some of the fossils having patterns typical for seawater, that is enriched in HREEs with a negative Ce anomaly, while other patterns have MREE enrichment (bell-shaped pattern) that is commonly interpreted as a diagenetic imprint (e.g. Lécuyer, 2004). Such variations in concentration and patterns for the REE may be present in individual teeth. As most of the REEs are incorporated into the phosphate structure after deposition (e.g. Shaw & Wasserburg, 1985), these differences would indicate variable post-mortem influences on the phosphate, reflecting also differences in the depositional environment and taphonomic processes. In spite of this variability, some general trends can be observed for patterns of the different localities.

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