Geophysical Research Abstracts, Vol. 8, 05503, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05503

Paleoceanography of Tethyan Campanian-Maastrichtian phosphorites as deduced from the N and C isotopic composition of associated organic matter

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Phosphorite successions are often associated with intervals of organic-rich sediments and it is generally believed that P transfer via upwelling drives high primary production and that the rain of P-bearing organic matter is subsequently diagenetically transformed from the organic to inorganic phase. Thus, most models of phosphogenesis involve upwelling as a principal step. In this study we have examined the carbon and nitrogen isotopic composition of organic matter throughout the Negev Phosphate and associated overlying Oil Shale sequence in Israel with the aim of clarifying the degree of primary productivity during the sedimentation of organic-rich and organic–lean intervals. The organic matter in this interval is decidedly of marine origin. Our results show that low values of δ^{13}Corg and δ^{15}Norg occur in association with markedly elevated TOC (5 to 15%) in the lower, phosphorite-dominated part of the sequence. δ^{13}Corg near the base of the section are ca. –29‰, while δ^{15}Norg values are ca. +4‰. Above this, both δ^{13}Corg and δ^{15}Norg progressively increase up section to positive values of ca. –26.5‰ and +8‰, respectively. This trend is interpreted to represent a maximum intensification of nutrient supply and resultant productivities reflected in lower parts of the section (where P accumulation rates are highest), followed by substantially waning upwelling and (siliceous) organic productivity up section. In comparison with globally-averaged marine δ^{13}Corg, the TOC-enriched lower interval is anomalously depleted in ^{13}Corg by about 3‰ to 4‰. The simplest explanation for this depletion is regenerative recycling of upwelled ^{13}C-depleted total dissolved carbon in the water column, although chemoautotrophic OM cannot be discounted.

Relatively low δ^{15}Norg within this zone is likely due to the constant high supply of nitrate. Despite high production, net nitrate utilization is low because the nitrate pool is kept high during persistent upwelling. Thus, the selective uptake of ^{14}N during photosynthesis does not enrich the residual pool of nitrate in the heavier isotope during persistent upwelling. This is analogous to processes governing the isotopic composition of Corg within the immediate locus of maximum nutrient upwelling in the equatorial Pacific today. Up section, increases in δ^{15}Norg reflect waning productivity, and the shift to positive δ^{13}Corg reflecting a return to average global values for the remainder of the Maastrichtian and Paleogene.