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Varying bottom water oxygenation during deposition of organic-rich, bioclastic carbonates on a southern Tethys ramp (lower-middle Eocene, Tunisia)

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Redox-sensitive and sulphide-forming metals are variably enriched in the bioclastic carbonates of the lower-middle Eocene Bou Dabbous Formation (BDFm) of north-central Tunisia. The occurrence of trace metal enrichment in sediments that contain benthic fossils is a long standing sedimentary anomaly with respect to the level of bottom water oxygenation during deposition. In the BDFm, varying levels of oxygen depletion, suggested by varying trace metal enrichment, further compounds this question. An integrated sedimentological, paleontological and geochemical study of the BDFm is underway in order to address as to what controls the magnitude and physical extend of this oxygen depletion.

Up to 4 lithofacies are distinguished in the seven sections studied. Common characteristics in all of them include alternating, massive limestones and marly limestones with abundant planktonic foraminifera and common to rare phosphatic grains and disseminated pyrite. The main difference among lithofacies is the amount of benthic fossils (e.g., echinoids, bivalves, foraminifera), being higher in lithofacies 1 and 2 and lower in lithofacies 3 and 4. Lithofacies 4 is characterised by laminated fabrics with mm-thick, phosphatic laminae alternating with thicker, black bands. All lithofacies were deposited in the distal part of a ramp, with the less bioclastic lithofacies 3 and 4 representing the most distal deposits. However, a fraction of the benthic bioclasts in all lithofacies represents in situ fossil remains.

Coupled with the presence of in situ benthic fossils, clear enrichment of Cr, U and V in lithofacies 2, 3 and 4 of six sections studied indicate suboxic bottom waters during their deposition. Consistent with some dissolved oxygen in bottom waters allowing seafloor colonisation by benthic organisms, these lithofacies are only moderately enriched in Mo (up to 9 ppm) and suggests a steep redox boundary close below the sediment/water interface, where anoxia could have fully developed. Continued organic matter degradation after deposition led to oxygen depletion in bottom waters and within the sediments, as inferred from the existence of high trace metal enrichment in the majority of the samples with higher organic carbon content (up to 4.5%). Further, the enrichment in Cu, Ni and Zn suggests high production rates in surface waters that governed organic matter flux to the seafloor. On the other hand, the section with samples that show both much lower trace metal enrichment and organic carbon content possibly experienced much better oxygenated bottom waters. Thus, we conclude that bottom waters varied between suboxic and better oxygenated conditions across the depositional setting possibly controlled by discontinuous areas with high surface production rates in an unrestricted open marine ramp.