Sapropels were reworked by low-oxygen adapted benthic meiofauna

STEFAN LÖHR*[1] AND MARTIN KENNEDY[1]

[1]Earth & Planetary Sciences, Macquarie University, North Ryde 2109, NSW, Australia (correspondence: stefan.loehr@mq.edu.au)

The dynamic interaction between marine sediments and burrowing fauna represents one of the key biogeochemical processes on Earth. Benthic animals facilitate sediment irrigation and oxygen ingress through burrowing, and accelerate organic matter (OM) degradation through ingestion, physical comminution and enzymatic breakdown. Since their proliferation in the Cambrian, animal burrowers have left an indelible signature on the sedimentary record in almost all marine environments, with the seeming exception of low oxygen environments. In modern environments, however, sub-mm benthic meiofaunal animals are adapted to low oxygen, even sulfidic conditions. Yet almost nothing is known about their impact on ancient marine sediments because they leave few recognizable traces. Here we show, in Pliocene-aged sapropels from three sites in the Eastern Mediterranean, the first reported trace fossil evidence of meiofaunal activity and its relation to changing oxygenation.

The Pliocene sapropels are a classic low-oxygen facies. We apply a novel imaging approach comprising back scatter electron (BSE) microscopy of Ar-ion polished samples to demonstrate that meiofauna comprehensively reworked the uppermost 3-4 cm of the sapropels under oxygen-depleted conditions that excluded benthic macrofauna. The meiofauna fragmented and ingested organic laminae, emplacing 15-70 μm diameter faecal pellets without visibly influencing the macroscopic sediment fabric.

Benthic nematodes are a common, widespread class of meiofauna in modern sediments, and are able to tolerate severely dysoxic and even sulfidic conditions. Nematodes from modern low-oxygen settings have body diameters closely corresponding to the size range of the faecal pellets, so that we interpret the concentration of pellets to be the product of marine nematodes living in and reworking the sediment during freshening phases of sapropel deposition.

Meiofaunal traces are present in Pliocene sapropels at all three sites studied. This raises the question: while sapropels are commonly used as a model system for anoxic preservation of OM, are they also generally representative of meiofaunal modification that has as yet gone unnoticed in other fine-grained sediments from low-oxygen settings? How common is meiofaunal reworking of sediments under low oxygen conditions that are prohibitive to macrofauna, such as those typical of the Phanerozoic mass-extinctions?