Metazoan burrowing and organic carbon burial in black shale

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Although sub-mm benthic animals (meiofauna) adapted to low oxygen conditions are ubiquitous in modern sediments (Levin, 2003), they leave few recognisable traces so that almost nothing is known about their impact on biogeochemical cycling in the past. New electron imaging techniques have recently identified extensive meiofaunal bioturbation in Pliocene-aged Mediterranean sapropels (Löhr and Kennedy, 2015), a classic anoxic facies. Sapropels are a widely studied model system for anoxic preservation of organic matter (OM), and their record of meiofaunal activity may also be representative of other black shales. An important question that remains unresolved is to what extent meiofaunal reworking impacts on OM preservation in ancient low-oxygen settings.

We study a Pliocene sapropel at high resolution to address this question, combining backscatter electron mapping with stable isotope analysis and RockEval pyrolysis to: 1) identify the onset and extent of meiofaunal burrowing and 2) determine the consequences of meiofaunal burrowing for OM composition. Our results identify a clear threshold at which meiofaunal burrowing becomes pervasive, with close to 100% of organic material present within fecal pellets or physically reworked laminae fragments in samples with > 10% TOC. This is preceded by an interval featuring vertically and horizontally discontinous pockets (<500 μm) of meiofaunally bioturbated material embedded in otherwise laminated sediment, implying that short-lived episodes of benthic amelioration and recolonisation occurred well before fully-fledged benthic reworking.

$\delta^{13}C_{org}$ is depleted by 0.6 and 1.5‰ in partially and comprehensively reworked intervals, relative to laminated intervals. C/N and $\delta^{15}N$ remain unchanged, so that we attribute the $\delta^{13}C_{org}$ offset to bioturbation leading to selective digestion of a ^{13}C enriched OM component rather than a coincidental shift in OM source. Low $\delta^{15}N$ (<-1‰) and petrographic evidence for mass-sedimentation of mat-forming plankton imply selective digestion of ^{13}C-enriched colonial pelagic cyanobacterial (*Trichodesmium*) biomass.

Levin L. A. (2003) Oxygen minimum zone benthos *Oceanography & Mar Biol: Annual Review* **41**, 1–45.

Löhr & Kennedy (2015) Micro-trace fossils reveal pervasive reworking of Pliocene sapropels by low-oxygen-adapted benthic meiofauna. *Nature Communications* **6**, 1–8.