**Response of burrowing organisms to burial of organic matter and oxygenation**

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Sediments represent a habitat utilized by organisms. Bioturbation is the rule and trace fossils potentially occur in nearly all depositional settings. Traces are produced within the uppermost part of the sediment and hence, reflect the environmental situation on and within surface sediments. Trace fossils are autochthonous and often characterize an environment better than body fossils.

Macro-organisms cannot live without oxygen (even at low levels and maybe temporary) and organic matter (= food). In response to availability of organic matter and oxygen on and within the sediment, the seafloor habitat is split up into ecological niches, called tiers. Tiering is documented by the cross-cutting of burrows indicating their relative time and depth of formation: A burrow produced shallow within sediment is cross-cut by all others, whereas the deepest produced burrow cross-cuts all others, but is not crosscut itself.

To decipher environmental conditions by means of trace fossils, the analysis of the so-called ichnofabric has become a common approach. Ichnofabrics result from bioturbation at all scales, including *all* aspects of textures and internal structures. Important are (1) degree of bioturbation, (2) proportion of the various burrow types, such as biodeformational structures and trace fossils, (3) size, (4) penetration depth, and (4) cross-cutting relationships of burrows.

Organic matter is affected by oxidation, when settling to the seafloor. The deeper the water, the more organic matter is oxidized. On the seafloor, sedimentation rate controls organic matter burial: The higher the sedimentation rate, the more organic matter is buried. With respect to bioturbation, two endmembers can be distinguished in well-oxygenated settings: (1) Organic-rich sediments are often anoxic and gray-greenish colored; large burrows are present that penetrate deep. (2) Sediments low in organic matter are oxic and reddish; burrows are small and do not penetrate deep.

Oxygen diffuses only a few millimeters from the surface into unbioturbated deposits. In contrast, burrowers pump oxygenated water into the sediment and expand the oxygenated zone. The oxygen flux into sediment due to bioturbation is the higher, the more organic matter is buried within the sediment. Oxygenation causes remineralization of organic matter and hence, may fuel primary production.

In anoxic sediments having oxygen-free pore water but being overlain by oxygenated bottom water, endobenthic organisms move temporarily into the oxygenated zone or maintain an open connection to the seafloor. So, in organic-rich sediments (>0.5-1% Corg), many burrowers have an open connection to the seafloor for supply with respiration water.

Decreasing oxygen content of the bottom water is recorded by ichnological parameters that show a decrease of (1) bioturbation intensity/degree of bioturbation, (2) diversity of burrows, (3) burrow size, (4) burrow penetration depth, and (5) number and vertical extent of tiers that become telescoped and move upward and finally disappear in descending order, but the surface mixed layer disappears last. Improving oxygenation leads to inversion of the above trends.