

Alternation of oxic and ferruginous intervals in pond sediments of Reykjanes Ridge, North Atlantic Ocean

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Color changes are typical features of marine sediments and can reflect changes in sedimentation and in the composition of particles reaching the seafloor as well as post-depositional phenomena like redox changes. The latter are primarily driven by organic matter degradation with different electron acceptors. In this study, we examined pond sediments from three sites at the eastern flank of the Reykjanes Ridge, North Atlantic Ocean, where alternating brown and blueish sediment layers are observed. Using ex-situ oxygen measurements, pore-water and solid-phase geochemistry, as well as a multi-proxy age dating approach utilizing ²³⁰Th_{ex} and paleomagnetic data, we assess the geochemical properties and the age of these deposits. The sediments recovered date back to ~150 ka BP. Oxygen analyses are typically only performed in surface sediments. In contrast, in our study, we carried out ex-situ oxygen measurements over the entire length of the gravity cores. As a unique finding, we observe alternations of oxic (i.e., containing oxygen) and ferruginous (i.e., Fe²⁺-containing) intervals – in particular the presence of oxic zones in deeper subsurface sediments at all three sites. While the oxygen-containing intervals coincide with layers of brown sediment, ferruginous conditions were detected in the blueish layers.

The occurrence and persistence of the observed oxic and ferruginous zones may be due to temporal variations in electron acceptor and donor availability in the sediments. We suggest that the most likely drivers for changing the balance of the latter are climatic and paleoceanographic variations in the North Atlantic Ocean over glacial/interglacial cycles, which caused changes in bottom-water oxygen concentrations, sedimentation rates, as well as the amount, origin and reactivity of organic matter. This study offers new insights into the redox dynamics that shape geochemical zonation in marine sediments. Our results suggest that oxic intervals are not confined to the top-section of the sedimentary pile but reappear at considerable sediment depth.

These findings have broader implications for organic carbon preservation in widespread ridge flank sediment ponds and demonstrate the potential of climatic and paleoceanographic variability over glacial/interglacial timescales to modulate sedimentary processes and redox conditions.