

EGU21-4080

<https://doi.org/10.5194/egusphere-egu21-4080>

EGU General Assembly 2021

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The influence of tectonic migration of ocean floor on (bio-)geochemical and diagenetic processes in subseafloor sediments from the Nankai Trough off Japan

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(Bio-)geochemical processes in subseafloor sediments are closely coupled to global element cycles. To gain an improved understanding of changes in (bio-)geochemical conditions on geological timescales, we investigate sediment cores from a 1180 m deep hole in the Nankai Trough offshore Japan (Site C0023). The sediment cores were taken during International Ocean Discovery Program (IODP) Expedition 370 (Temperature Limit of the Deep Biosphere off Muroto), which aimed at exploring the prerequisites and limits of deep microbial life [1]. Over the past 15 Ma, Site C0023 has moved ~750 km relative to its present-day geographic position from the central Shikoku Basin to the Nankai Trough due to motion of the Philippine Sea plate [2]. During its tectonic migration, Site C0023 has experienced significant changes in depositional and thermal conditions as well as resulting (bio-)geochemical processes.

By combining a large set of complementary pore-water, solid-phase and rock magnetic data with sedimentation rates and sediment ages, our aim is to (1) reconstruct the evolution of (bio-)geochemical processes, especially the cycling of iron, along the tectonic migration, and to (2) investigate if iron(III) minerals are still available to serve as energy substrate for microbial respiration in the deep sediments. Our results demonstrate that a transition from organic carbon-starved conditions with predominantly aerobic respiration processes to an elevated carbon burial environment with increased sedimentation occurred at ~2.5 Ma. Higher rates of organic carbon burial as a consequence of an increased nutrient supply and primary productivity likely stimulated the onset of organoclastic iron and sulfate reduction, biogenic methanogenesis and anaerobic oxidation of methane. A significant temperature increase by ~50°C across the sediment column associated with trench-style sedimentation since ~0.5 Ma potentially increased the bioavailability

of organic matter and enhanced biogenic methane production. The resulting shifts in reaction fronts led to a diagenetic transformation of iron (oxyhydr)oxides into pyrite in the lower organic carbon-starved sediments several millions of years after burial. We also show that high amounts of iron(III), which were preserved in the deeply buried sediments due to carbon-starved conditions are still available as energy substrate for microbially mediated processes at Site C0023.

Our study emphasizes that depositional and thermal changes ultimately driven by the tectonically induced migration have the potential to strongly influence and control geochemical conditions and (bio-)geochemical processes within the whole sediment column. Such studies are needed to gain a fundamental understanding of the coupling between depositional history, (bio-)geochemical processes and the resulting diagenetic overprint on geological timescales, thereby linking the sedimentary iron, sulfur and carbon cycles.

References:

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[2] Mahony, S.H. et al., 2011. *Bulletin* 123: 2201-2223.