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The Deep Sea and Sub-seafloor Frontier: Past, present and future links in sedimentary seafloor and sub-seafloor ecosystems

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Deep-sea sediments cover nearly two thirds of the Earth's surface, and the microbial processes within them provide drive the nutrient regeneration and global biogeochemical cycles that are essential to sustain primary and secondary production in the oceans. The sediment-ocean interface forms a dynamic boundary that separates the mostly anoxic deep biosphere and the ocean crust ecosystems from the turbulent, oxidised deep ocean water column, which is the main conduit of energy to the seabed. A simple depth profile of biomass, principally as microbial cell counts, illustrates the importance of the sedimentary seafloor interface. In the water column 104 cells per cm3 are the typical densities of microbial cells in the water column. Volumetric abundances abruptly rise to 109 cells cm^-3 within the surface sediments. Even in the most energy poor, ultra-oligotrophic region of the South Pacific Gyre, cell counts exceed 106 cells cm^-3 at surface sediments. Below the surface meter of sediment, volumetric cell counts decline in a logarithmic fashion, reaching values of 104 cells cm^-3 only after tens to hundreds of meters of sediment depth. Correspondingly, microbial activities, excluding hotspots or deeply buried high-energy interfaces, decline even more precipitously with increasing depth. Thus, the surface and near-surface seafloor represents a plate of high microbial abundance, high microbial diversity, high microbial activity separating the vast deep biosphere habitat from the deep ocean water masses that dictate climate. Furthermore, this zone is characterized by a close interaction between microbes, which make up around 90% of the seafloor benthic biomass, and the less abundant (macro-)fauna. The latter, however, have a strong impact on functioning and diversity of seafloor habitats.

This DS3F project focuses on surface and near surface processes in deep-sea sedimentary environments. From the the perspective of surface and near-surface sediment ecosystems, two broad avenues of inquiry, one "top-down" and the second "bottom up" are proposed. (1) How do processes and community structure in seafloor surface ecosystems affect the deep biosphere on millennial and greater time-scales? Understanding these deep biosphere processes requires the fundamental understanding of the surface ecosystem linked with deep sediment records. (2) Just as processes occurring within surface sediments can impact down-sediment microbiology, geochemistry, interpretation of paleo-proxies, and mineralogy, deep-seated sedimentary processes can directly impact the surface seafloor and deep sea. A major question is the quantitative impact of these deep processes on the surface world and their effect on climate response. Highlights of a recent workshop addressing some of these questions will be presented.