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The prokaryotes and their activities and habitats in sub-seafloor sediments.

Although deep marine sediments contain the Earth's largest organic carbon reservoir, it was considered until recently, to be devoid of life below the top ~10 m. Detailed microbiological analysis (direct and viable cell counts, activity, cultivation, molecular genetic diversity, intact lipid biomarkers) of sediments obtained by the Ocean Drilling and Integrated Ocean Drilling Program, however, has completely changed this perception. In deep sediments, worldwide, prokaryotes are present and generally cell numbers decrease exponentially with increasing depth. This presumably reflects the preferential utilization of the most labile sedimentary organic matter, resulting in organic matter recalcitrance increasing with depth, and hence, decreasing cell numbers. However remarkably, sizeable populations (~10^6/cm^3) are still present in sediments in excess of 1 km deep and 100 My old. Also prokaryotes can be present in the complete sediment column down to basement rock, where activity can be stimulated by flow of oxidised fluids along the basement. It has been estimated that prokaryotic sub-seafloor biomass may represent up to a third of all living biomass on Earth and the majority of prokaryotic cells.

The thermodynamic depth zonation of prokaryotic activities that is characteristic of shallow marine sediments does not consistently occur in deep sediments, making claims based on geochemical modelling, that most microorganisms in subseafloor sediments are either inactive or adapted for extraordinarily low metabolic activity questionable. Despite this, deep sediment prokaryotes overall do grow very slowly, if at all, but they are not buried cells dieing slowly, as they are stimulated at depth where new energy sources are available.

There are a range of distinct sub-seafloor habitats. These include deep biosphere "hot spots" such as gas hydrate deposits, geochemical and lithological interfaces, and ancient organic rich layers (e.g. sapropels, diatom layers and Cretaceous black shales). In addition, as temperatures increase with depth, the reactivity of recalcitrant organic matter may increase leading to a low continuing energy supply. In deeper layers and at higher temperatures direct formation of thermogenic compounds can fuel the base of the deep biosphere.

Some prokaryotic taxa, predominantly uncultured, seem to be characteristic of deep sediments (e.g. *Chloroflexi*, *Gamma*-, *Alpha*- & *Beta -proteobacteria*, *Bacteriodetes*, *Plancotomycetes*, JS1, OP8 and NT-B2; Miscellaneous Crenarchaeotic Group, South African Gold Mine Euryarchaeotic Group, Deep Sea Archaeal Group, Marine Benthic Group D & C and Marine Group 1). although their distribution varies at different sites. Although sulphate reduction and methanogenesis are important prokaryotic activities in most deep sediments, the prokaryotes conducting these processes are often not detected by molecular genetic analysis with standard 16S rRNA and functional gene primers. This suggests that these activities may be the result of low numbers of relatively active prokaryotes or by some of the many uncultured taxa present. In addition, we have yet to reach the extreme limit of the sub-seafloor biosphere and this might extend the known limits of life on Earth, and have implications for the origin of life on Earth and possible existence of deep biospheres on other planets.

Professor Parkes is a microbial ecologist who has an international research record in Geomicrobiology and Biogeochemistry of sediments. He regularly gives international keynote lectures and has authored or co-authored over 100 research papers. He has pioneered research on the presence and activity of microorganisms in geological formations and settings, particularly in the deep subsurface. Environments studied include sub-seafloor sediments, marine gas hydrates, metalliferous sediments, lignite/coal formations, hydrothermal systems, and ice. He has played a major role in establishing the globally huge bacterial populations present in the subsurface (ca. 90% of all bacteria), which can have a profound effect on the environment, such as, global biogeochemical cycles, methane production, and biosphere; geosphere interactions. He is a Distinguished Research Professor at Cardiff University where he has establish a new Geomicrobiology Research Group. He has consistently been awarded grants from both NERC and EU (e.g. co-ordinator of the DeepBUG project), plus additional grants from the European Science Foundation, The Leverhulme Trust and commercial organisations. He is a member of the NERC Peer Review College, has been on a number of NERC and other Grant Committees, as well as international committees (e.g. ISEB, ISSM). He is on the Editorial Board of the Environmental Microbiology Journal and reviews for a range of Journals and funding agencies. His current group comprises a lecturer, 4 PDRA's, 1 technician and 4 Ph.D.