Impact of high CO_2 concentrations on the structure of microbial communities in marine sediments

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Microbial communities represent one of the key levels for ecosystem functioning, but their short- and long- term structural and functional responses to changes in ocean pH are not well understood. Sedimentary hydrothermal vent systems leaking CO_2 provide natural gradients in pH and CO_2 concentrations which can be studied as natural analogues to small pH changes, as caused by ocean acidification, and dramatic pH changes, as by focused CO_2 leakage from subsurface reservoirs. Although most studies focused on planktonic communities, only two previous studies have investigated the effects of increased CO_2 levels on benthic ecosystems (Inagaki et al. 2006; Hall-Spencer 2008). Here we examined how natural gradients in pH and CO_2 flux across the Yonaguni Knoll basin of the Okinawa trough impact benthic bacterial communities. Changes in function were assessed as differences in the sustained biomass, and in the respiration of reduced compounds. Changes in bacterial community structure were analysed by community fingerprinting using ARISA (Automated Ribosomal Intergenic Spacer Analysis). Our data show a strong shift in benthic bacterial community structure and function along in situ pH gradients.

Degradation of oil via combination reactions under water pressure in geological basins

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Based on modelling the results from numerous pyrolysis experiments, it has been predicted that oils become thermally unstable at temperatures between 150 and 200°C and crack to lighter hydrocarbons (gas) and pyrobitumen. This hypothesis has been derived using the results from mainly dry or anhydrous pyrolysis experiments, with the models based largely on first order kinetics. Pressure has either been considered to have no effect or a significant effect on the rate at which the oil cracks into lighter products and coke. However both thermodynamic and transition state theory indicate that oil cracking should be retarded by water pressure, and we have recently reported reduced cracking to gas during source rock maturation at high water pressures [1].

In experiments at 350°C under part water, part vapour conditions, oils crack to gases and pyrobitumen due to the ease at which the vapour phase can be compressed. However, when heated under water pressure (500 bar), the extent of cracking is reduced and combination reactions are evident. Such combination reactions are exothermic, whereas cracking reactions are endothermic, suggesting that in basins at temperatures greater than which biodegradation can occur, this pathway can provide a new method for generating tars and bitumens from trapped oils. In deep, relatively cool, high-pressure basins such as the Gulf of Mexico, tars and bitumens are sometimes encountered at depth (20,000 ft.+), and under these conditions combination reactions should be highly favoured over cracking reactions.

However, the effect of water pressure appears limited as with pyrolysis at 420°C under water-pressure (450 bar), thermal cracking occurs. However such temperatures are very unusual in geological basins, but if hot volcanic waters flow through shallow reservoirs containing oil, then cracking may be favoured due to the very high temperature-low pressure conditions.

[1] Carr *et al*. (2009) *Pet. Geoscience* **15**, 17-26.