

Antarctic microbes clean up petroleum pollutants

Under the right conditions, microorganisms in Antarctic soils and marine sediments could help environmental managers clean up fuel and oil spills.

In two experiments, Australian Antarctic Division (AAD) scientist Dr Shane Powell, and her colleagues from the AAD and the University of Saskatchewan in Canada, found that fertiliser increased the natural microbial bioremediation (clean up) of soils contaminated by diesel; while in marine sediments, biodegradable oil and Special Antarctic Blend diesel were more readily degraded by the resident microbes than synthetic oils.

The first experiment tested the effect of fertiliser on the bioremediation of a spill of Special Antarctic Blend diesel, which occurred at Old Casey Research Station in East Antarctica more than 20 years ago. The team added fertiliser to containers of contaminated soil and buried them near the contaminated site. Containers of contaminated soil, without fertiliser, were included as controls. After five years, samples from the top, middle and bottom of the containers were tested for the presence of diesel hydrocarbons and the microbial genes responsible for hydrocarbon degradation, as well as the number of microbes and the composition of the microbial community.

The researchers found that fertilisation had the greatest effect on the middle and bottom regions of the contaminated soil profile, where oxygen was limited. Not only had the hydrocarbon contamination decreased, but there was a change in the microbial community composition, with more denitrifying bacteria present. These bacteria use nitrate supplied by the fertiliser to help metabolise hydrocarbons.

‘Our results indicate that in Antarctic soils, fertilisation stimulates denitrifying bacteria to degrade hydrocarbons in the anoxic portion of the soil profile,’ Dr Powell said.

‘Further studies showed that when these communities were exposed to oxygen, hydrocarbon degradation was inhibited. This refutes the commonly held belief that polar soils need to be aerated to enhance bioremediation.’

The finding provides environmental managers in Antarctica with a more efficient and effective means of cleaning up fuel spills than current methods, which include excavating the soil and shipping it to warmer, temperate regions; relying on the slower, natural bioremediation process; or heating the soil to speed this natural process.

In the second experiment, Dr Powell and her colleagues looked at the effects of Special Antarctic Blend diesel and three lubricating oils – biodegradable oil, synthetic oil and the same synthetic oil after use in a vehicle – on microbial numbers and community structure in the pristine O’Brien Bay near Casey Station.

The team collected trays of clean sediment from the bay and added the different contaminants, before returning the trays to the bottom of the bay. Five weeks later, they measured the number of microbes and assessed the types of microbes present in clean and contaminated samples.

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‘We found a significant increase in the number of microbes in the sediments contaminated with diesel and biodegradable oil, compared to uncontaminated sediment,’ Dr Powell said.

‘This suggests that the bacteria can use chemicals in the diesel and biodegradable oil to grow.’

The scientists also found that the types of microbes present in the diesel and synthetic oil treatments were significantly different to those in the untreated control. However, there were no significant differences in the types of microbes present in the control and the biodegradable oil treatment.

‘This provides the first evidence that using biodegradable oils might be of



Dr Belinda Thompson retrieves a tray of sediment core samples collected by divers underneath the sea ice. The samples will be analysed for their chemical, microbial and biological composition. In the background, expeditioners watch the air lines to the divers. Shane Powell, Australian Antarctic Division, © Commonwealth of Australia

genuine environmental benefit in the Antarctic,’ Dr Powell said.

However, she cautioned that while microbes may be able to degrade biodegradable oil, the oil may impact at other levels of the ecosystem before it is removed from the environment, and the components of the oil that take longest to degrade may also be the most toxic.

Longer-term studies are now underway to determine whether the changes in microbial numbers and community structure continue to be seen over a five-year period.

• Wendy Pyper

More information:

Powell SM, Ferguson SH, Snape I and Siciliano SD (2006) Fertilisation stimulates anaerobic fuel degradation of Antarctic soils by denitrifying microorganisms. *Environmental Science & Technology* 40: 2011–2017.

Powell SM, Snape I, Bowman JB, Thompson BAW, Stark JS, McCammon SA and Riddle MJ (2005) A comparison of the short term effects of diesel fuel and lubricant oils on Antarctic benthic microbial communities. *Journal of Experimental Marine Biology and Ecology* 322: 53–65.

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