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The utilisation of hydraulic fracturing chemicals as a carbon source by microorganisms cultivated from UK flowback fluids and soils

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Biogeochemical changes in the terrestrial subsurface related to hydraulic fracturing have been studied extensively in the US and Canada where fracturing for natural gas is widespread. The geological context and composition of fracturing fluids in recent UK shale gas extraction operations differ markedly from those in North America, yet little is known about the biogeochemical impacts in UK shale formations. Fracturing fluid is pumped down well at high pressure, where it interacts with the deep subsurface environment, returning flowback fluids with distinct biogeochemical signatures that offer a window into these manmade ecosystems. The composition of flowback fluids can impact gas recovery, wastewater treatment, and potentially the wider environment if leaked or spilled.

We investigated the effects of UK fracturing fluid chemicals on subsurface and soil microbial communities. Flowback fluids collected from a UK exploratory shale gas well, and soils from a UK geothermal observatory, were cultivated in oxic and anoxic growth media. Microorganisms from the flowback fluids were identified and changes to community composition studied using 16S rRNA gene sequencing. Microcosm experiments were initiated to monitor the ability of these microorganisms to utilise common fracturing chemicals as a carbon source for growth, namely guar gum (gelling agent), polyacrylamide (friction reducer) and glutaraldehyde (biocide). Growth was monitored using OD600 and flow cytometry, and total organic carbon measured over a 2-week period. Additional microcosms were set up to monitor the biodegradation of glutaraldehyde by soil microorganisms in saline conditions and in the presence of other fracturing chemicals.

Initial results suggest that guar gum is more bioavailable than polyacrylamide (consistent with recent findings) and can be used as the sole carbon source in oxic conditions by microorganisms cultivated from flowback fluids collected at later stages of fracturing. Despite its intended use as a biocide, soil microorganisms could utilise glutaraldehyde and salinity did not significantly impact the rate of biodegradation in oxic conditions. These results have industrial, economic, and environmental implications since microbial growth in such environments can impact gas recovery via biofouling, biocorrosion, and reservoir souring, while changes to the soil microbial communities could affect water quality and subsurface biogeochemical cycles.