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Methanogenic Oil Degradation in the Dagang Oil Field

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Anaerobic biodegradation is one of the main *in situ* oil transformation processes in subsurface oil reservoirs. Recent studies have provided evidence of biodegradation of residual oil constituents under methanogenic conditions. Methane, like other biogenic gases, may contribute to reduce the viscosity of oil and enhance its flow characteristics (making it more available) but it can also be used as a energy source. So the aim of the present study was to provide reliable information on *in situ* biotransformation of oil under methanogenic conditions, and to assess the feasibility of implementing a MEOR strategy at this site. For this reason, chemical and isotopic analyses of injection and production fluids of the Dagang oil field (Hebei province, China) were performed. Microbial abundances were assessed by qPCR, and clone libraries were performed to study the diversity. In addition, microcosms with either oil or ^{13}C-labelled hydrocarbons were inoculated with injection or production waters to characterize microbial processes *in vitro*.

Geochemical and isotopic data were consistent with *in situ* biogenic methane production linked to aliphatic and aromatic hydrocarbon degradation: GC-MS profiles of petroleum samples were nearly devoid of n-alkanes, linear alkylbenzenes, and alkyltoluenes, and light PAH, confirming that Dagang oil is mostly highly weathered. In addition, carbon and hydrogen isotopic signatures of methane (δ13C$_{CH4}$ and δD$_{CH4}$, respectively), and the bulk isotopic discrimination ($\Delta\delta^{13}$C) between methane and CO_2 (between 32 and 65 $\permil$) were in accordance with previously reported values for methane formation during hydrocarbon degradation. Furthermore, methane-producing Archaea and hydrocarbon-degrading Bacteria were abundant in produced oil-water samples. On the other hand, our laboratory degradation experiments revealed that autochthonous microbiota are capable of significantly degrade oil within several months, with biodegradation patterns resembling those observed *in situ,* and of producing heavy methane from ^{13}C-labelled n-hexadecane or 2-methylnaphthalene (δ^{13}C $>$ 550 and 300, respectively). These results suggest that *in situ* methanogenesis may occur from the aliphatic and polyaromatic fractions of Dagang reservoir fluids. In summary, the studied areas of the Dagang oilfield may have a significant potential for the *in situ* conversion of oil into methane as a possible way to increase total hydrocarbon recovery.