Response of sediment microbial communities to crude oil contamination in marine sediment microbial fuel cells under ferric iron stimulation

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In this study, response of the microbial communities associated with the bioremediation of crude oil contaminated marine sediments was addressed using sediment microbial fuel cells (SMFCs). Crude oil was spiked into marine sediments at 1 g/kg of dry sediment to simulate a heavily contaminated marine environment. Conventional SMFCs were used with carbon fiber brushes as the electrode components and were enhanced with ferric iron to stimulate electrochemically active bacteria. Controls were operated under open circuit with and without ferric iron stimulation, with the latter condition simulating natural attenuation. Crude oil removal in the Fe enhanced SMFCs reached 22.0 ± 5.5% and was comparable to the measured removal in the control treatments (19.2 ± 7.4% in natural attenuation SMFCs and 15.2 ± 2.7% in Fe stimulated open circuit SMFCs), indicating no major enhancement to biodegradation under the applied experimental conditions. The low removal efficiency could be due to limitations in the mass transfer of the electron donor to the microbes and the anodes. The microbial community structure showed similarity between the iron stimulated SMFCs operated under the open and closed circuit. Natural attenuation SMFCs showed a unique profile. All SMFCs showed high relative abundances of hydrocarbon degrading bacteria rather than anode reducers, such as Marinobacter and Arthrobacter in the case of the natural attenuation SMFCs, and Gordonia in the case of iron stimulated SMFCs. This indicated that the microbial structure during the bioremediation process was mainly determined by the presence of petroleum contamination and to a lesser extent the presence of the ferric iron, with no major involvement of the anode as a terminal electron acceptor. Under the adopted experimental conditions, the absence of electrochemically active microbes throughout the biodegradation process indicates that the use of SMFCs in crude oil bioremediation is not a successful approach. Further studies are required to optimize SMFCs systems for this aim.