Continuation of an Investigation into the Anaerobic Intrinsic Bioremediation of Whole Gasoline

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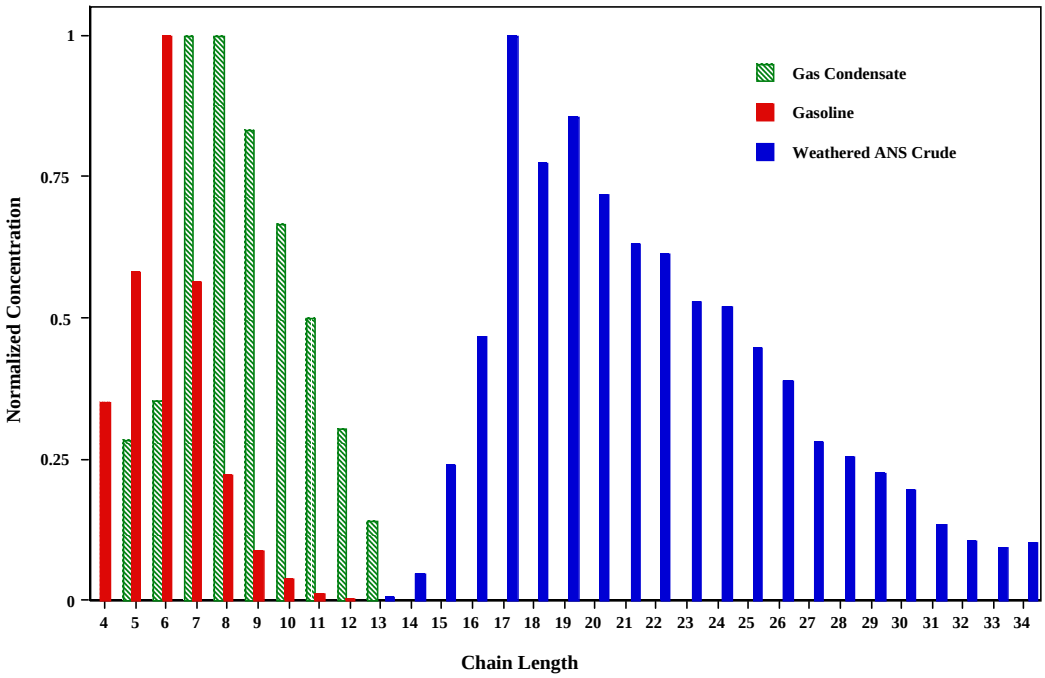
Description:

This research aims to document the extent to which indigenous aquifer microbiota can biodegrade hydrocarbon compounds in the absence of oxygen. Specifically, we are focusing on uncovering the preferred order of anaerobic biodegradation of the individual components of gasoline and other complex hydrocarbon mixtures. Our research site and source of inoculum is a gas condensate-contaminated aquifer near Ft. Lupton, Colorado. By determining both most labile and persistent hydrocarbon compounds this research will provide a diagnostic tool, useful in assessing the extent to which hydrocarbon contamination is undergoing biodegradation and in making risk based corrected action assessments.

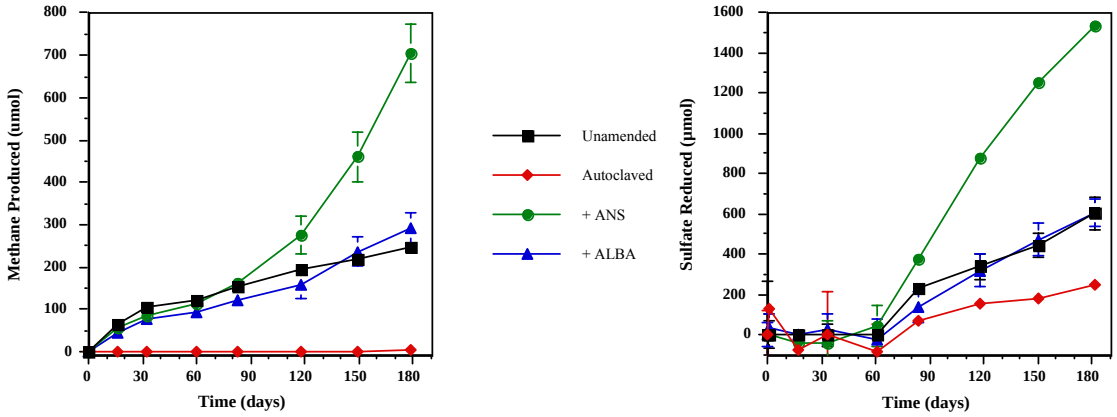
Earlier results indicated that alkanes, major components of all natural and fuel hydrocarbon mixtures, were rapidly biodegraded under both methanogenic and sulfate-reducing conditions by the Ft. Lupton microbiota. Most interesting was the decay of both short chain (C_5-C_8) and long chain (C_{16}-C_{30}) under both conditions. Although the contamination that our site has been exposed to is similar to gasoline in alkane composition, it differs greatly from the weathered Alaska North Slope crude oil (ANS) used as a source of long chain alkanes in our experiments.

Distribution of n-Alkanes in Hydrocarbon Mixtures



After our initial results showed stimulation of methanogenesis and sulfate reduction due to amendments with ANS, we choose to repeat that experiment with a modified experimental design which would enable us to demonstrate the time course of hydrocarbon consumption. Additionally, we expanded to experiment to include ALBA oil, a crude oil that does not contain an appreciable amount of alkane hydrocarbons.

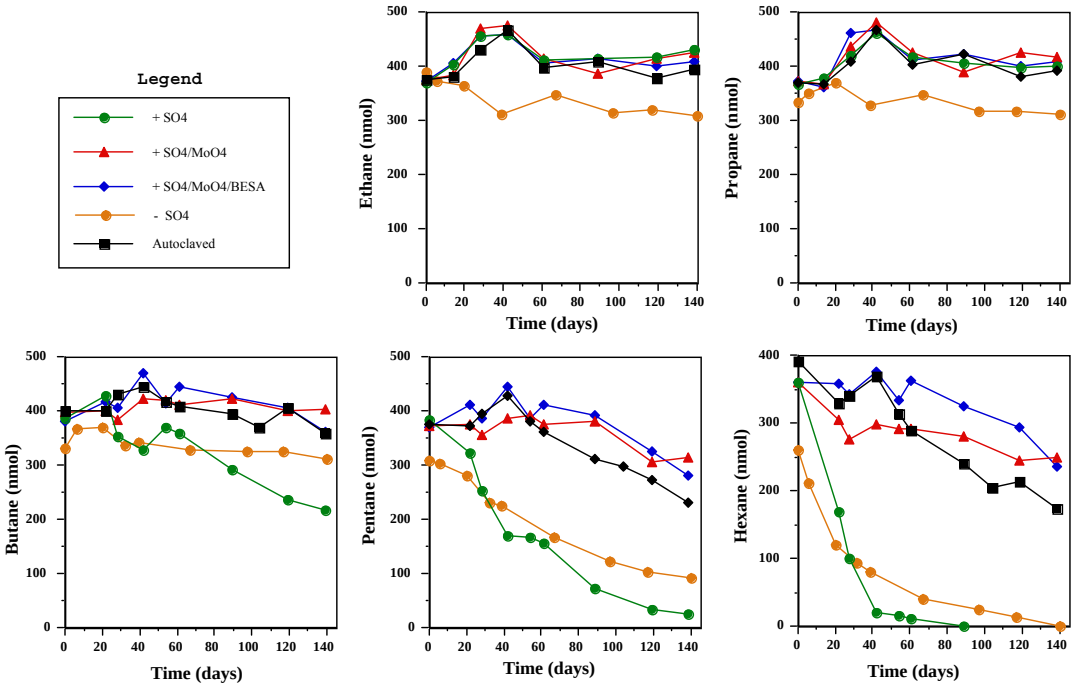
Stimulation of Methanogenesis and Sulfate Reduction due to Crude Oil Amendments



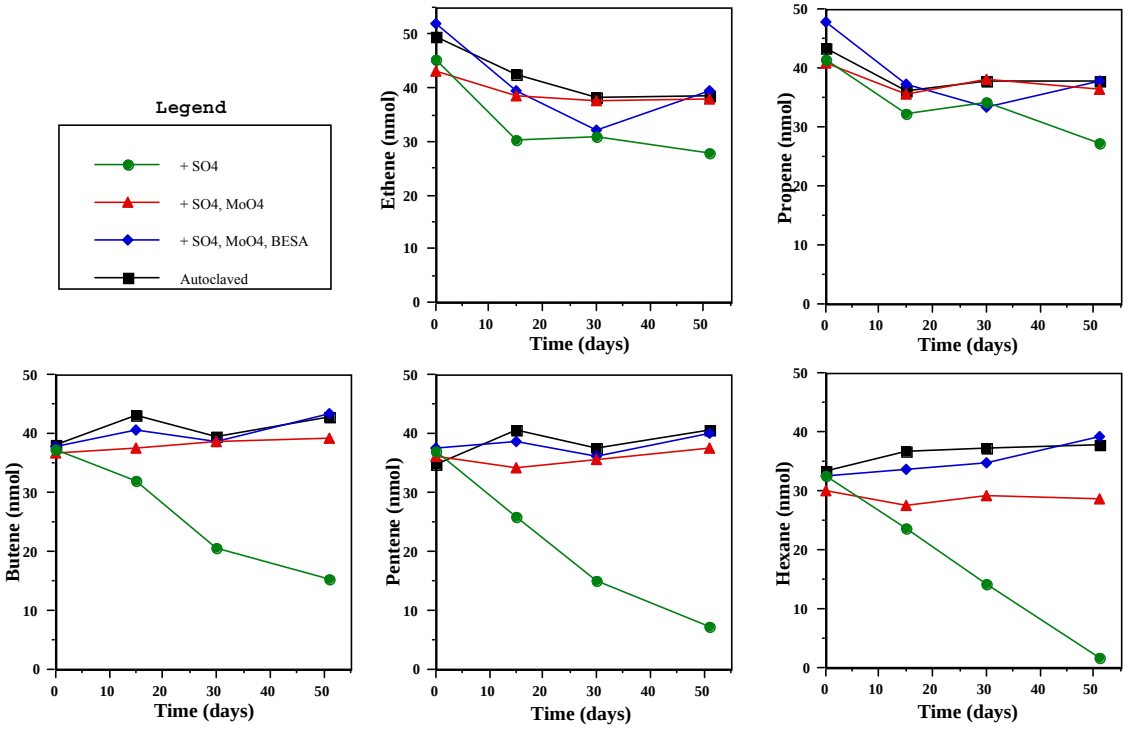
As previously shown, sulfate reduction and methanogenesis were both greatly enhanced by the ANS amendment. After 180 days, there is also some indication that the ALBA amendment has begun to stimulate methanogenesis as well. The possible source of electron donor in this case would be the polyaromatic fraction. Samples have been sacrificed and preserved throughout this time course, and their residual hydrocarbons will be analyzed in order to demonstrate the preferential order of hydrocarbon decay by these sediments.

We have also initiated experiments designed to test the limit of short chain hydrocarbon degradation by the Ft. Lupton microbiota. In one experiment, a group of n-alkanes consisting of methane, ethane, propane, butane, pentane and hexane have been provided as gaseous substrates in equimolar amounts. In a separate experiment, a group of n-1-alkenes consisting of ethene, propene, butene, pentene, and hexene were used as substrates. As shown in the following figures, our preliminary results indicate that the C_4-C_6 alkanes and alkenes are biodegraded under at least one condition.

Short Chain Alkane Biodegradation by Ft. Lupton Sediments



Short Chain n-1-Alkene Biodegradation byFt. Lupton Sediments



Our results indicate that the indigenous microbiota at Ft. Lupton harbor metabolic activities which are not dependent on the presence of oxygen that are able to biodegrade a large fraction of the non-aromatic fraction of diverse hydrocarbon mixtures.