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Perchlorate reduction by microbes inhabiting oil reservoirs

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Microbial perchlorate and chlorate reduction is a unique type of anaerobic respiration as during reduction of (per)chlorate chlorite is formed, which is then split into chloride and molecular oxygen. In recent years it was demonstrated that (per)chlorate-reducing bacteria may employ oxygenase-dependent pathways for the degradation of aromatic and aliphatic hydrocarbons. These findings suggested that (per)chlorate may be used as oxygen-releasing compound in anoxic environments that contain hydrocarbons, such as polluted soil sites and oil reservoirs.

We started to study perchlorate reduction by microbes possibly inhabiting oil reservoirs. One of the organisms studied was Archaeoglobus fulgidus. This extremely thermophilic archaeon is known as a major contributor to souring in hot oil reservoirs. A. fulgidus turned out to be able to use perchlorate as terminal electron acceptor for growth with lactate (Liebensteiner et al 2013). Genome based physiological experiments indicated that A. fulgidus possesses a novel perchlorate reduction pathway. Perchlorate is first reduced to chlorite, but chlorite is not split into chloride and molecular oxygen as occurs in bacteria. Rather, chlorite reacts chemically with sulfide, forming oxidized sulfur compounds, which are reduced to sulfide in the electron transport chain by the archaeon. The dependence of perchlorate reduction on sulfur compounds could be shown.

The implications of our findings as novel strategy for microbiological enhanced oil recovery and for souring mitigation are discussed.

Liebensteiner MG, Pinkse MWH, Schaap PJ, Stams AJM and Lomans BP (2013) Archaeal (per)chlorate reduction at high temperature, a matter of abiotic-biotic reactions. Science 340: 85-87