BIOLOGICAL ANAEROBIC DEGRADATION OF 1,2-DCA AND DCM COMBINED WITH RECIRCULATED GROUNDWATER HEATING

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Background/Objectives

The production of barium and strontium salts, followed by past production of ion exchange resins and glues, constituted harmful activities for soil and groundwater. The risk evaluation of the site showed that vertical migration of the contamination, through the semi permeable unit (SP-unit) into the underlying chalk aquifer, is a potential hazard. GreenSoil conducted a field test to investigate the feasibility of anaerobic dechlorination to reduce the risk of spreading of mainly 1,2-DCA, DCM and VC.

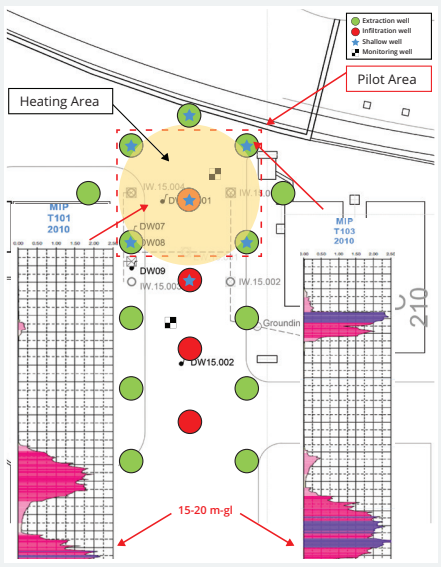

Figure 1. *Pilot test layout and MIP results in different locations.*

Approach/Activities

The main contaminants are known to be biologically degradable under anaerobic conditions. The main purposes of the pilot test were

a) the stimulation of the complete biological anaerobic degradation of all VOCs by dosing Dehalo-GS (electron donor);

b) the investigation of the effect of recirculated heated groundwater. By circulation of groundwater, dechlorinating bacteria, electron donor and heated water will be distributed and contaminants will be mobilized and therefore become more bioavailable. Water was heated to about 25°C to stimulate biological activity based on microcosm tests that were done prior to the pilot test. The pilot test area and layout are indicated in Fig. 1.

Results/Lesson learned

A fast and clear decrease of high concentrations of DCM and 1,2 DCA was observed (Fig. 2). Concentrations up to 200,000 µg/l were degraded within 3 months. Concentrations of Chloromethane, a possible degradation product of DCM, were typically < 10 µg/l and often below detection limit, indicating that it did not accumulate and was likely further degraded to methane or DCM was degraded via another degradation pathway.
Increased concentrations of the degradation products ethene (up to 12,000 µg/l) and methane (up to about 7,000 µg/l), indicated successful biological degradation (Fig. 3).

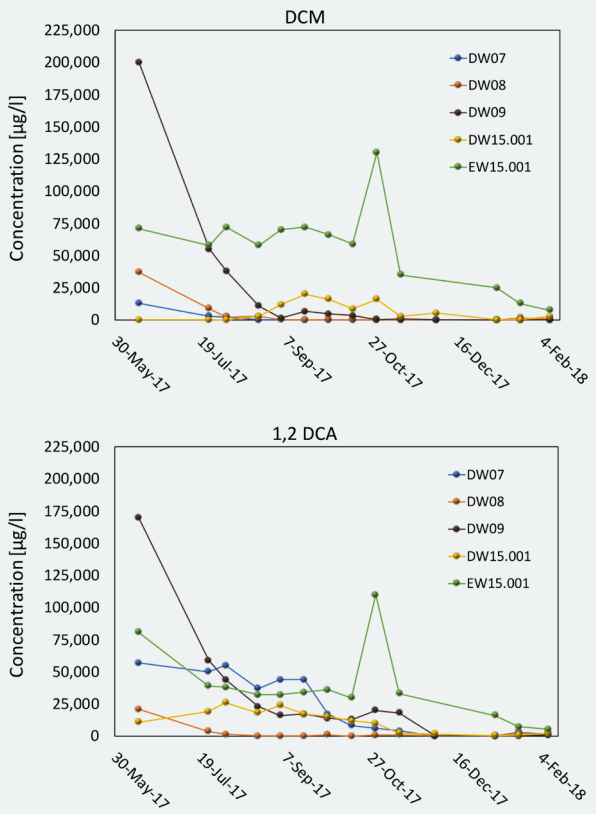

Figure 2. *Concentrations of DCM (left) and DCA (right) versus time for four monitoring wells and one extraction well.*

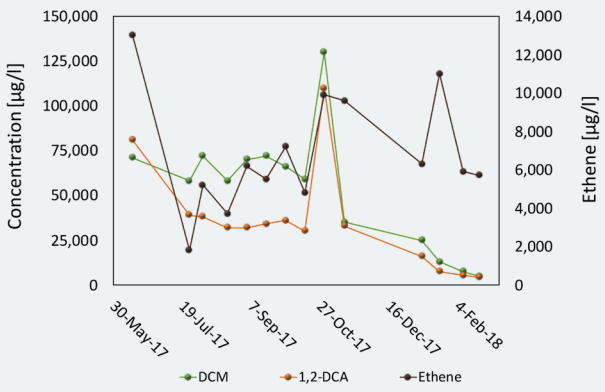

Figure 3. *Concentrations of different compounds (1,2 DCA, DCM and ethene) versus time of the central extraction well (EW 15.001).*

Molecular analysis also confirmed the presence and increase of the natural bacterial population that are most likely involved in the degradation of DCA and DCM (Fig. 4). *Dehalococcoides, Dehalobacter and Dehalogenimonas* were detected in high numbers up to 1010 cells/l. *Dehalococcoides* increased significantly during the pilot compared to before the pilot test.

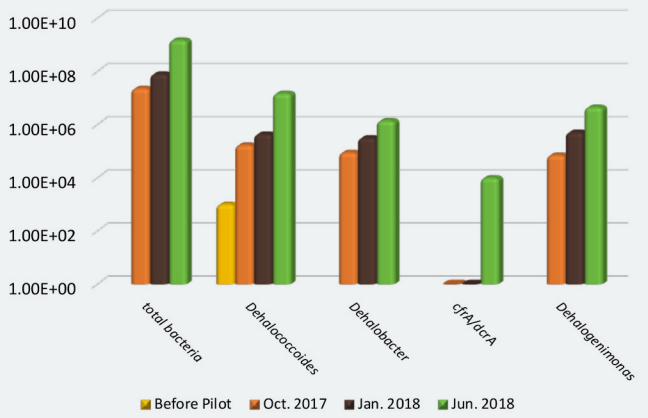

Figure 4. *Amount of total bacteria, Dehalococcoides, Dehalobacter, cfrA/dcrA and Dehalogenimonas in the extraction well EW 15.001.*

Figure 5. *Full-scale system works.*

Most of the degradation took place before the heating of the groundwater was observed in-situ. Therefore the fast degradation is mainly attributed to the dosage of electron donor. Although heating of groundwater was demonstrated during the pilot test, the additional effect on the degradation could not be fully assessed as complete degradation has preceeded the heating process.
Consequently, these results demonstrated the high efficiency of the biological anaerobic remediation approach with or without heating. GreenSoil is currently conducting a full-scale system at the site (Fig. 5).