Anaerobic Microbial Dechlorination of Chlordecone in Microcosms from Guadeloupe Soil

Line Lomheim, Andrei Starostine, Robert Flick, Amy Li, Luz A. Puentes Jácome, and Elizabeth A. Edwards (Elizabeth.edwards@utoronto.ca)
(Department of Chemical Engineering and Applied Chemistry, University of Toronto)
Suly Rambinaising, Laurent Laquitaine, Corine Jean-Marius, Ronald Ranguin, and ***Sarra Gaspard*** (sarra.gaspard@univ-antilles.fr)
(Laboratory COVACHIM-M2E, EA 3592, Université des Antilles, Pointe-à-Pitre)

Background/Objectives. The use of chlordecone as the active ingredient in pesticide formulations has resulted in extensive pollution of large land areas in the French West Indies. These areas were treated with pesticides to control the banana black weevil. Although the use of these pesticides is currently banned, chlordecone strongly adsorbs to soil and is highly recalcitrant due to its complex bis-homocubane structure. However, under reducing conditions, abiotic chemical transformation involving Vitamin B12 (1,2) has been reported to break down chlordecone to C_9 compounds, believed to be "open cage" structures. More recently, these C_9 compounds, characterized as polychloroindenes, were also observed as products from anaerobic biological transformation in bacterial consortia and isolated *Citrobacter* spp. *(3).*

Approach/Activities. In order to investigate the biodegradability of chlordecone, microcosms were constructed anaerobically from chlordecone-impacted Guadeloupe soil and sludge. The microcosms were incubated and repeatedly amended with chlordecone and electron donor (ethanol and acetone) over a period of 7 years. During this time, some transfers were made, and the microcosms were periodically analyzed for chlordecone and potential degradation products using LC-MS, and methane using GC-FID. DNA was extracted from some of the microcosms, and the microbial community was analyzed using 16S amplicon sequencing (Illumina MiSeq). The biodegradability of chlordecone was studied in the presence of TCE (trichloroethylene) in some microcosms.

Results/Lessons Learned. Degradation products of chlordecone were detected in all the biologically active microcosms. Observed products include monohydro- and dihydrochlordecone derivatives ($C_{10}H_{10-n}O_2H_{n+1}$ n= 1,2), as well as C_9- polychloroindene compounds ($C_9Cl_{5-n}H_{3+n}$ n=0,1) and carboxylic polychloroindene derivatives ($C_{10}Cl_{4-n}O_2H_{4+n}$, n=0-4), assumed to be "open cage" structures with significant dechlorination also characterized in other studies (1,2,3), but which are not present in sterile controls. Chlordecone concentrations decreased in active microcosms. In the presence of TCE, some chlordecone metabolites are also found. Results from microbial community analysis show enrichment of several organisms possibly involved in chlordecone biodegradation. In two microcosms with no methanogenesis we see high relative abundance of *Desulfovibrio* and *Sporomusa*, while in two of the microcosms with methane production, we see enrichment of two highly similar *Anaerolinaceae* species (*Pelolinea* and *Leptolinea*), *Bathyarchaeota*, and two methanogens (*Methanoregula* and *Methanosaeta*). Some metabolites identified in this study are also detected in the field, showing that a bioremediation process could be envisioned.