In Situ Chemical Reduction (ISCR) for Removal of Kepone from Tropical Soils

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Remediation of Chlorinated and Recalcitrant Compounds
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Background/Objectives. The global use of organochlorine pesticides (OCPs) such as Lindane, DDT, Dieldrin, Kepone, Chlordane and Toxaphene has resulted in long-term soil impacts at many sites. Given the potential risks to human health and the environment, some OCP-impacted sites require treatment. One example being the use of the insecticide Kepone (1,1a,3,3a,4,5,5,5a,5b,6-Decachlorooctahydro-2*H*-1,3,4-(methanetriyl)cyclobuta[*cd*]pentalen-2-one) on banana plantations until the late nineties in the French West Indies (FWI) islands (Caribbean) which has resulted in the contamination of drinking water supplies, bans on vegetables, fish and sea food consumption and commercialization, and increased occurrence of prostate cancer. As in many other cases, the "dig-and-dump" approach is not practical here due to the magnitude of the problem, access issues, and/or resource constraints. Alternatively, "bioremediation" may potentially be used to treat the soils on site, often at lower costs, and certainly in a more sustainable manner. Unfortunately, most OCPs, notably kepone, are not amenable to conventional bioremediation technologies,

Approach/Activities. As defined herein *in situ* chemical reduction (ISCR) entails the combined effects of stimulated biological oxygen consumption (via "fermentation" of complex organic carbon sources)and direct chemical reduction with reduced metals, leading to enhanced decomposition reactions that are realized at the lowered redox (E_h) conditions. To facilitate ISCR conditions, DARAMEND ® amendments combine controlled-release carbon with a reduced metal - such as zero valent iron (ZVI) or zinc - to stimulate the degradation) of persistent organic compounds without accumulation of catabolic intermediates. Most soils can be effectively treated in a reasonable time frame (*e.g.*, from 4 to 8 weeks) using standard agricultural machinery at a price typically less than US$20 per tonne of soil treated. In the present work, ISCR with Daramend was applied on the 3 major soil types of the FWI in studies under controlled conditions (26 °C temperature, soil water content) and with detailed physicochemical and microbiological monitoring.

Results/Lessons Learned. The presentation will summarize the ISCR approach followed by results from technology validation tests for remediation of kepone impacted soils (3 typical tropical soil types) from banana fields of the FWI. Mesocosm studies conducted with site soils demonstrated a 90 % decrease in kepone concentration for the nitisoil, 88 % for the ferralsoil and 47 % for the andosoil, with significant fluctuations over time in the control and treated soils. Unexpected buffering capacity of the redox potential (most values in the -200 mV range, vs. the targeted -500 mV corrected for the potential of the Standard Hydrogen Electrode) was observed in the tropical soils, particularly in the andosoil. Dechlorinated (up to minus 7 Cl atoms) transformation products were observed and subsequently identified; significant changes in the structure and activities of the bacterial communities of the three soils were also observed. A tentative degradation pathway for Kepone can therefore be suggested. Additional data will be presented on ecotoxicity and bioaccumulation studies. On-site field validation is scheduled for 2012 - 2013.

Proposed PLATFORM Session: DICK BROWN Pesticides/herbicides 1F

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