

## Remedial Amendments with Integrated Control of Methane Production

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**Background/Objectives.** Methanogens/Archaea are often the dominant microbes in reduced environments and methanogenesis is a practical component of anaerobic bioremediation. Given that methanogens can replicate in 1 to 2 hours (whereas *Dehalococcoides* spp. for example double in 24 to 48 hours) they often bloom and dominate following the addition of conventional organic hydrogen donors such as (emulsified) oils/lecithin, sugars and conventional ISCR reagents, thereby liberating large amounts of methane gas (values exceeding 800 mg/L in water and >100,000 ppmv in soil gas have been reported). There are at least three important consequences of this response:

1. **Cost** - by utilizing hydrogen, the methanogens compete with dechlorinating microbes, thus making inefficient use of the amendment (some calculations indicated >90% waste via methane production);
2. **Safety** - elevated methane concentrations can exceed current and pending regulations of < 1 to <28 ppm in groundwater, and/or <0.5% v/v methane in soil gas (e.g., <10% of the LEL); methane gas will induce vapor migration potentially causing indoor air issues of VOCs; and
3. **Performance** – Archaea are inefficient dechlorinators and yield dead-end catabolites; rapid growth of methanogens consumes alkalinity while generating acids = aquifer acidification; biomethylation can mobilize heavy metals such as arsenic causing secondary contaminant issues.

**Approach/Activities.** Provect-CH4® is a patented formulation of natural statins and/or essential plant oils that selectively inhibit protein biosynthesis and activity of enzyme systems unique to Archaea. To improve remedial efficacy, this antimethanogenic reagent (AMR) has been integrated into various amendments including: Provect-IR® and Provect-IRM® antimethanogenic ISCR reagents, Provect-ERD CH4™ Ole Ego antimethanogenic, liquid ERD reagent, Provect-EZVI CH4™ antimethanogenic DNAPL treatment technology, and AquaGate®-CH4™ antimethanogenic reactive capping technology.

**Results/Lessons Learned.** Controlling methanogenesis during remedial actions is becoming commonplace among seasoned professionals as the positive effects on remedial performance, safety, regulatory compliance and sustainability become understood. During the presentation the following topics will be discussed:

1. **What is the Problem with Methane?** – Reasons why State and Federal (U.S. EPA; DoD) agencies have instituted programs to monitor methane production and regulate/guide the remediation industry.
2. **How can We Control Methanogens?** – Detailed, yet easy to understand explanation of the nature and mode-of-action of organic AMRs will be presented, and technologies that specifically govern methanogens will be described
3. **Cost and Benefit Analysis** – Project examples (dry cleaning facilities in urban settings; industrial sites impacted by chlorinated solvents) will present the effective use of AMRs to actively control methanogenesis during remedial actions.