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Era of the BioGeoPhysioChemohydrogeologist Is Now: Integration of Disparate Lines of Evidence to Craft Robust LNAPL Conceptual Site Models in Support of LNAPL Remedies

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Background/Objectives. Powerful new technologies and scientific developments to better understand and manage the complex processes resulting in LNAPL plume stability and degradation have emerged in recent years. Late 1990's and early 2000's advances in the LNAPL CSM originate mainly from development of physical concepts. Middle 2000s to current NSZD concepts have been developed consisting of measurements methods, applicability to plume stability and more recently a more detailed CSM of NSZD. In this era biophysiochemohydrogeologists (i.e., a nerd to the 5th power) are needed to integrate the sum of CSM aspects such that an integrated CSM can be used to select improved remedies. Each of these aspects now utilizes quantitative data for physical and biodegradation aspects of remediation. Based on our knowledge to date the current scientific concepts and methodologies have not been fully integrated within more robust conceptual site models in order to recognize the full benefit of their potential for integration.

Approach/Activities. In this presentation, hydrogeological setting, LNAPL mobility, compositional, and biodegradation concepts will all be related for a more robust conceptual site model. This integration will provide robust support for the application of evolutionary LNAPL remedy technologies. Forensic science practitioners have long recognized and understood the role of multiple degradation processes and their effect on LNAPL plumes in the subsurface, but the role of these degradation processes in actively limiting LNAPL plume migration and removing the LNAPL source mass has only been quantified as natural source zone depletion relatively recently. Similarly, as the scientific community has demonstrated the attainment of bulk plume stability and low remaining recoverability via LNAPL transmissivity and flux measurements at most LNAPL sites, the focus has shifted to hydrocarbon sheen processes and controls. Yet all of these topics are intimately bound together and their evaluation should be integrated within one comprehensive LNAPL conceptual site model in order to fully understand and manage any residual LNAPL risk issues.

Results/Lessons Learned. LNAPL risk management is a comprehensive science that must consider multiple physical and biological processes, that must integrate multiple disparate scientific methodologies and engineered technologies both old and new, and that must fully capture and conceptualize all of these processes in order to accurately quantify risk in all extant LNAPL phases (immiscible phase, dissolved, sorbed, vapor, sheen). By incorporating all old, new and developing scientific and engineered advances into robust conceptual site models, risk may be confidently quantified and managed. Examples of CSMs explaining the fully integrated science will highlight forensics as related to NSZD and NSZD as related to plume stability, and quantified LNAPL recoverability for an improved comprehensive remedy selection.