Quantifying the Mass of Contaminants in Low-k Zones from Cryogenically Frozen Cores

Eric Roads
Tom Sale
Maria Irianni Renno
Department of Civil & Environmental Engineering,
Fort Collins, CO 80523-1372

Abstract.

Contaminant hydrology has been challenged by the common perception of homogeneous subsurface media. Previous sampling methods neglect the importance of differentiating transmissive and low-k zones. CryoCore is a high-resolution sampling technique that can highlight the occurrence of transmissive and low-k zones as well as the distribution of contaminants in transmissive and low-k zone. CryoCore uses a CSU patented process that preserves core samples downhole using liquid nitrogen. Frozen cores are shipped to CSU on dry ice. Cores are cut into subsamples and analyzed to determine geology, physical properties, contaminant concentrations, and microbial ecology. The data is processed into Excel™ and then stored in gINT™, a relational database. Here, consideration is given to 390 feet of collected core from 31 boreholes from 5 hydrocarbon and 2 chlorinated solvent sites. Data analyses include intra-site and inter-site comparisons.

Tools are developed in gINT™ to automate transformation of collected data into vibrant visual graphical outputs. First, for every borehole, a graphic is generated that includes a comprehensive panel of geology, contaminants of concern and fluid saturations properly presented by depth. Building on this, distributions of contaminants as a function of transmissive or low-k zones are resolved. Lastly, key attributes of mass distribution are compared across individual sites (intra-site comparisons) and between sites (inter-site comparisons).

Our analysis presents a first-ever quantification of contaminant distribution in transmissive and low-k zones. Key insights include the following. First, the fraction of low-k zones at the study sites range between 0% and 94% with a median value of 52%. Secondly, the fraction of contaminant stored in low-k zone range from 0% to 96% with a median value of 46%. Lastly, the total mass of contaminant in low k zone ranges between 0 and 120000 kg/acre with the median value of 1500 kg/acre. Overall, CryoCoring and advanced analytics provides a practical means of quantifying contaminant occurrence in low-k zones and an improved basis for selecting site remedies.