Applications of the Combined OI-HPT Logging System for HRSC (Optical Imaging – Hydraulic Profiling Tool)

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Background/Objectives. The presence of nonaqueous phase liquids (NAPL) at many facilities impacts the life span and development of contaminant plumes and success of remedial measures. Defining the presence and extent of NAPL is an integral part of HRSC, development of accurate CSMs and remedial plan. The innovative Optical Imaging Profiler (OIP) provides new technology for detection of NAPL fluorescence and viewing images of fluorescence during/post logging. A CMOS camera is mounted inside the probe behind a sapphire window to capture images in situ. The first OIP probe was equipped with an ultraviolet (275 nm) light emitting diode (UV LED) to induce fluorescence of many petroleum fuels. This probe is equipped with a visible (VIS) LED to capture images of soil texture and color at selected depths. For fluorescence detection of coal tars and creosote an OIP probe with a Green (520 nm) laser diode is available and includes an infrared (IR) LED to provide images of soil texture. All OIP probes include an EC array for logging bulk formation electrical conductivity. However, in some settings EC may not be an effective guide to lithology. Due to this limitation and desire for better data about formation permeability the Hydraulic Profiling Tool (HPT) sensor has been added to the OIP probe. The OI-HPT was released in 2018 providing a unique and versatile probe for site investigation.

Approach/Activities. OI-HPT logs have been obtained at several sites in different states with different LNAPL products present. The probe is typically advanced at approximately 2 cm/sec (4 ft/min) while logging. Images are captured at 30 frames per second and displayed onscreen as logging. Logging can be performed with any of the light sources and one image is saved to file every 0.05ft (~15mm) during advancement. Advancement can be halted and still images obtained with either or both light sources. Still images provide better clarity and sharpness than images captured during active advancement. Images of fluorescence can show the distribution of NAPL in the formation matrix. VIS and IR images provide useful information about formation texture and particles/features as small as 0.1mm (0.008-inches) diameter can be distinguished in the 7 mm X 9.5 mm images. A digital scale in the viewing software provides for onscreen measurement. OI-HPT logs, cross sections and 3D visualizations help define NAPL distribution in the subsurface.

Results/Lessons Learned. The OI-HPT system provides a combination of optical/visual and digital data previously unavailable to the project manager. Still images can be captured at depths of interest where NAPL is present or where formation changes occur as observed with EC and HPT data. Images of fluorescence help understand the distribution and behavior of NAPL alternately VIS or IR images provide high resolution information about the formation matrix. Interestingly, logging can be conducted with the VIS LED to provide VIS-HPT so the operator has images of the formation matrix every 15 mm as well as the EC and HPT data. Under appropriate conditions the OI-HPT data stream can provide estimates of hydraulic conductivity and EC data can yield estimates of groundwater specific conductance. The OI-HPT system provides a unique and powerful weapon for site investigation even when NAPLs are not present.