Detecting Free Phase Product Outside of Polyvinyl Chloride (PVC) Well Casings

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Borehole conductivity probes have been traditionally used to identify bulk formation resistivity changes in uncased and non-metallic cased holes for nearly two decades. Advances in microelectronics have made it possible to build borehole conductivity probes of much smaller diameter, allowing the probes to be run in 2-inch PVC wells widely used to monitor environmental conditions at contaminated sites. The presence of significant quantities of high resistivity Light Non-Aqueous Phase Liquid (LNAPL) hydrocarbons (motor fuels) measurably impacts the bulk resistivity, and in most cases, can be easily identified outside of the borehole. The transmitter-receiver spacing can be configured to "mull" signals inside and near the borehole, neglecting the influence of borehole fluids, casing, and sand pack, and to measure the bulk resistivity of the formation 12 to 36 inches from the borehole. Stratified floating product LNAPL can easily be identified throughout the borehole, including product perched on clay layers above the water table, outside the borehole, if present. In one study involving an old petroleum refinery, more than 70 boreholes were logged with the conductivity probe to evaluate its effectiveness in detecting free product thickness outside of PVC casings. The data from the borehole geophysical logs were confirmed with adjacent borehole drilling data (Shelby tubes) and insitu fluorometric data from a probe designed to detect subsurface hydrocarbons. A comparison between the various methods of detecting LNAPLs indicated that correlation of the conductivity with probe data, and the presence of LNAPLs, were in very good agreement.