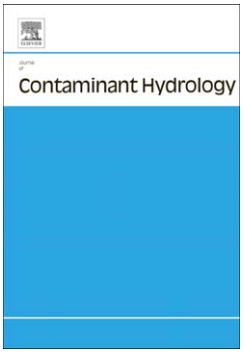

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Laboratory Study of Non-aqueous Phase Liquid and Water Co-boiling During Thermal Treatment

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Abstract

In situ thermal treatment technologies, such as electrical resistance heating and thermal conductive heating, use subsurface temperature measurements in addition to the analysis of soil and groundwater samples to monitor remediation performance. One potential indication of non-aqueous phase liquid (NAPL) removal is an increase in temperature following observations of a co-boiling plateau, during which subsurface temperatures remain constant as NAPL and water co-boil. However, observed co-boiling temperatures can be affected by the composition of the NAPL and the proximity of the NAPL to the temperature measurement location. Results of laboratory heating experiments using single-component and multi-component NAPL showed that local-scale temperature measurements can be mistakenly interpreted as an indication of the end of NAPL-water co-boiling, and that significant NAPL saturations (1% to 9%) remain despite observed increases in temperature. Furthermore, co-boiling of multi-component NAPL results in gradually increasing temperature, rather than a co-boiling plateau. Measurements of gas production can serve as a complementary metric for assessing NAPL removal by providing a larger-scale measurement integrated over multiple smaller-scale NAPL locations. Measurements

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