**Panel 2 of 4**

Estimating Multiphase Hydraulic Properties at a Crude-Oil Spill Site

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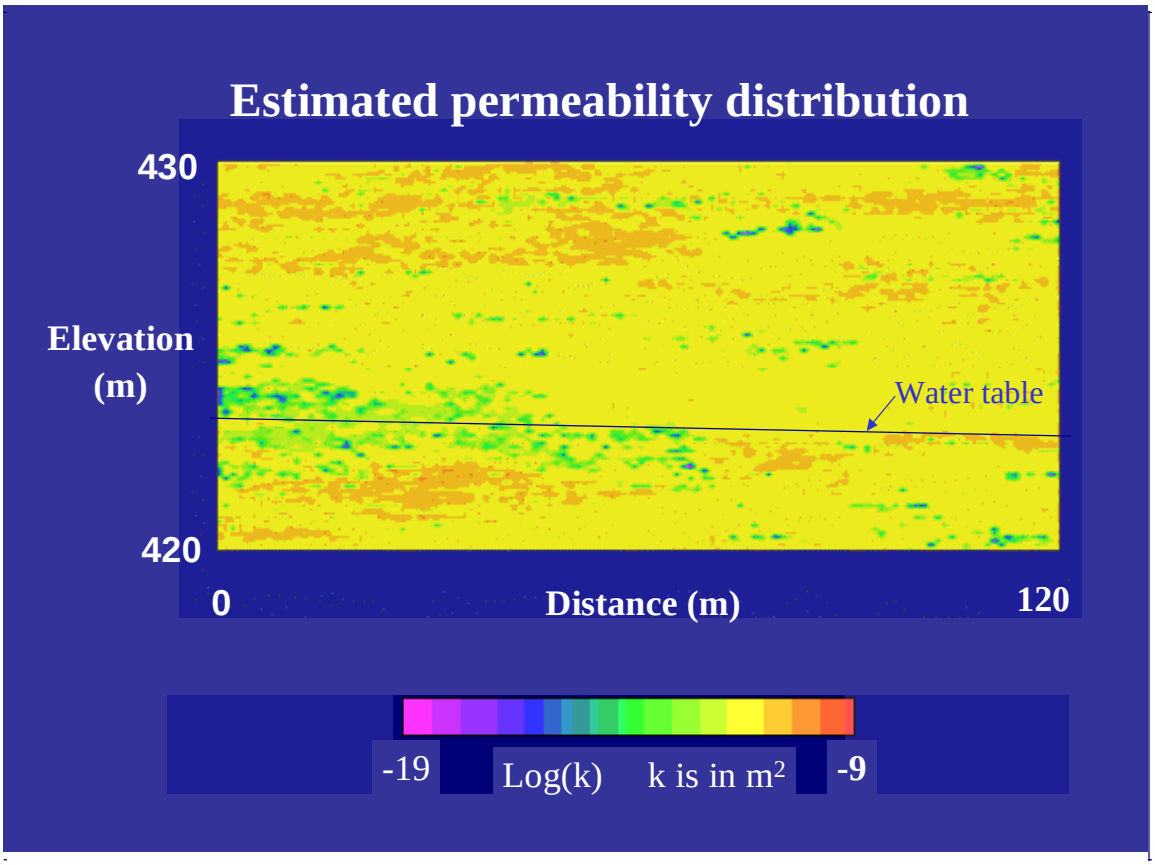
ESTIMATING PERMEABILITY FROM PARTICLE-SIZE ANALYSIS:

The aquifer material at the Bemidji site is glacial outwash sand with some silt. The measured particle-size analyses are well represented by a lognormal distribution function. The formula of Krumbein and Monk (1942) was found to give a good estimate of permeability:

$$K \text{ (in } m^2) = (7.5 \times 10^{-10})\, G^2\, e^{-1.31\sigma}.$$

G is the geometric mean particle size in mm, and s is the standard deviation of Krumbein's f lognormal distribution function. The database of estimated permeability values was used to create a model aquifer for use in computer simulations. Geostatistical methods were used to extrapolate between points in order to estimate permeability on a uniform grid. A two-dimensional slice of the permeability distribution along the main transect of the oil pool is shown below.




ESTIMATING AIR-WATER CAPILLARY PRESSURE CURVES:

For each core sample, the method of Arya and Paris (1981) was used to estimate the air-water capillary pressure curve from the measured particle size distributions and the porosity. The estimated relationship between capillary pressure and water saturation, $S_w$, was fitted to a Van Genuchten (1980) function,

$$S_w = [1 + (\alpha P)^n]^{-m},$$

yielding a value of $\alpha$ and n for each core (m=1-1/n). The residual water saturation was assumed to be zero.

In order to estimate the parameters on the regular grid of the model aquifer, an approach based on Miller-Miller (1956) scaling was used. Given the estimated value of permeability at each grid point, corresponding values of a and n were calculated using the similar-media scaling law:

$$\alpha = (k / k_a)^{1/2} \alpha_a \quad \text{and} \quad n=n_a$$

where $k_a$, $\alpha_a$, and $n_a$ are the average values for all the cores.