

# **Application of Geophysical Log Analysis to Understand Lateral and Vertical Salinity Distribution in a Carbonate Aquifer, Eastern Province, KSA**

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## **Abstract**

Aquifers often possess significant variations in salinity, both laterally and vertically. The vertical variation is usually more profound in aquifers with strong vertical differences in hydraulic properties. While standard mapping techniques are useful in understanding the broader lateral distribution, comprehending and quantifying the vertical distribution in salinity remains difficult. This is mainly due to the absence of sample data as water wells are typically completed in the full permeable thickness of the relevant formation or member. We present the use of the geophysical log data from a water well to assess the vertical salinity distribution in water wells. The Archie equation was applied to geophysical log data for a carbonate aquifer in order to derive a proxy for the salinity at different depths. A method which incorporates site-specific corrections relating to the variation in temperature with depth was applied. By scaling these relative values for the variation in salinity with depth to the absolute in situ measurements and then kriging the resultant data, it became possible to generate a good three-dimensional understanding of the salinity and its vertical variability across the aquifer. Having a detailed representation of vertical and horizontal salinity differences means an increase in the confidence of groundwater flow model predictions used to evaluate groundwater management scenarios. This technique provides an effective means of mapping groundwater total dissolved solids (TDS) through the use of borehole geophysics (wireline logging) and water geochemistry (sampling).