Regional Mapping of Formation Waters from Brine Chemistry Integrated with Petrophysical Data

Regional Mapping of Formation Waters from Brine Chemistry Integrated with Petrophysical Data

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A large digital database of brine-sample chemistry and water-resistivity measurements from a wide range of formations across Kansas is accessible at the Kansas Geological Survey website. Typically, these measurements include ion contents of sodium, calcium, magnesium, chloride, sulfate, and bicarbonate, as well as pH, specific gravity, and water resistivity. In cases where the formation-water resistivity is not available, it can be estimated very closely by a simple algorithm from the brine composition. Although numerous, the geographic distribution of these data is markedly uneven, with a tendency to concentrate in areas of historically high production but with sparse control in peripheral regions. Consequently, systematic patterns from regional mapping of formation-brine geochemistry are often localized with speculative extrapolations elsewhere. However, the increasing availability of digital well-log files on the Kansas Geological Survey website gives the opportunity to augment brine analyses with computations of formation-water resistivities and salinity estimations over larger areas. Kansas formations where this approach has particular value include the Arbuckle limestone, Mississippian units, and the Simpson sandstone. The mapping of formation-water characteristics of these and other units can be used to address questions of regional flow paths, compartmentalization, recharge, and other aspects of interest in energy exploration and production.

Data sources for formation-water resistivity, Rw

(1) measured on brine samples
(2) calculated from chemical composition of brine samples
(3) estimated from resistivity and porosity logs.

Water resistivity estimated from logs:

Either the reconaissance water resistivity Rwa, from:

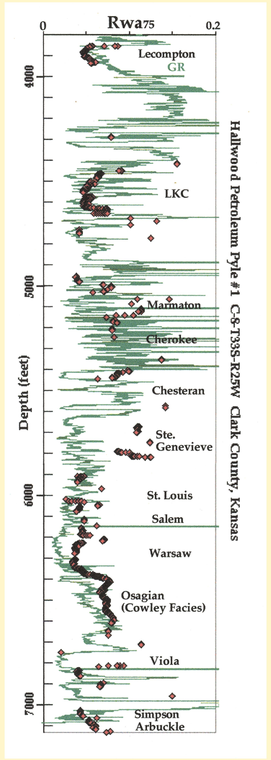
$$R_{wa} = \Phi^m \times R_t$$

where Φ is porosity (fractional),
m is the Archie equation cementation exponent,
and Rt is the log reading of the formation resistivity.

Or the ratio estimate of the water resistivity, Rwr, from:

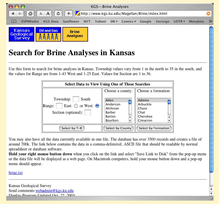
$$R_{wr} = R_{mf} \div (R_{xo} / R_t)$$

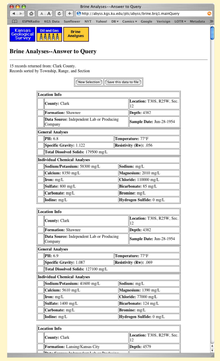
where Rmf is the mud-filtrate resistivity,
Rxo is the flushed-zone resistivity,
and Rt is the log reading of the formation resistivity.



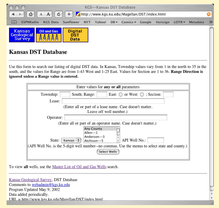
Forty-foot median filtered estimates of formation-water resistivity computed from neutron-density porosity and deep-induction resistivity logs for zones <GR 40 API units and >5% porosity.

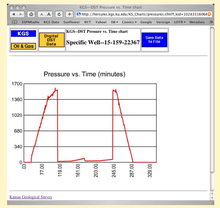
Web Databases



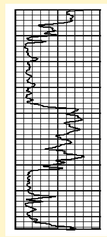


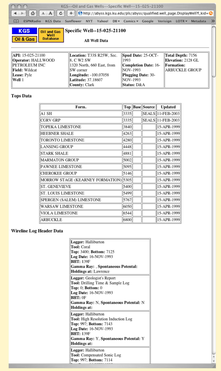
Brine database on KGS website allows selection of data by T-R-S, county, or formation.



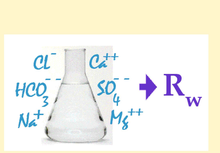


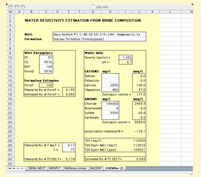
The DST database includes digital pressure data (charted above with Gemini applet) and scanned reports, which often include Rw data.



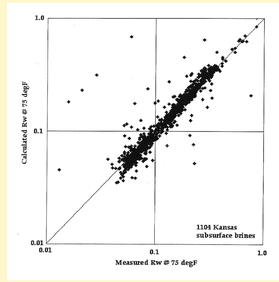


The LAS database connects the well logs to tops, core, cuttings, production data, and other logs in our library.

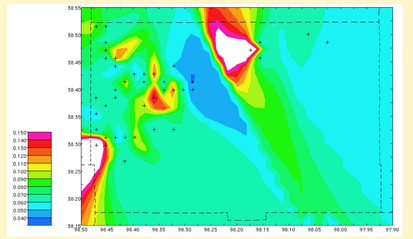




Rw can be estimated from brine composition. These calculations were made for the KGS samples. A comparison of the estimated Rw values shows good correlation with temperature-corrected measured values.

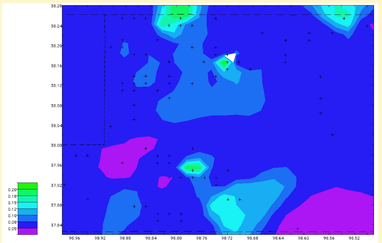


Rice County Rw @ 75 deg. F

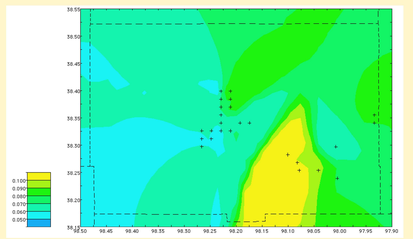


Lansing-Kansas City

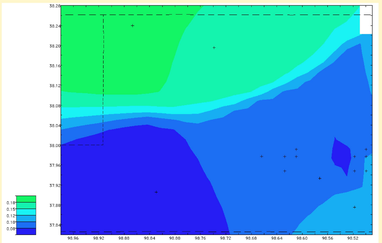
Stafford County Rw @ 75 deg. F



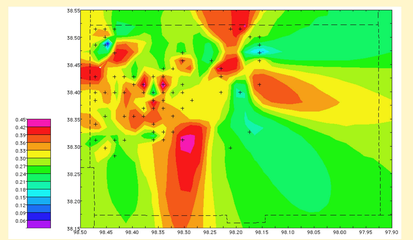
Lansing-Kansas City



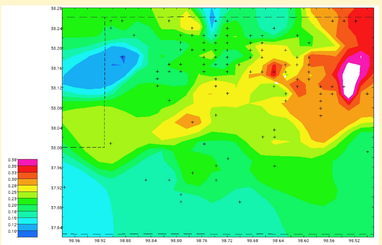
Mississippian



Viola



Arbuckle



Arbuckle