IDENTIFICATION OF SALTWATER SOURCE AFFECTING GROUNDWATER FROM C. RAU WELL, KINGMAN COUNTY

A Report for the

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by

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INTRODUCTION

Saline water has been found in the well of Clarence Rau located in the NW corner of Section 10, T. 29S, R. 5W, Kingman County. The chloride concentration of a sample collected from this well on October 1, 1982 was 1140 mg/L as determined by the Kansas Department of Health and Environment. Water samples collected on the same date from a neighbor's well (David Jump) and a seep from the Ninnescah Shale along the bank of a nearby stream contained 8 and 17 mg/L of dissolved chloride, respectively. Although the Ninnescah Shale contains mineralized water in some areas of Kingman County (Lane, 1960), the concern was that the drilling of an oil well recently about 100 feet from the water well might have caused the problem.

Samples from the Rau and Jump wells were collected on November 16, 1982 by the Department of Health and Environment and sent to the Kansas Geological Survey for identification of the saltwater source by the procedures of Whittemore et al. (1981). These methods are especially effective for distinguishing oil-field-brine from halite-solution-brine sources contaminating waters. This report gives the results of the chemical identification of the water samples provided.

PROCEDURE

Bromide concentrations were measured by an automated phenol red method on a Technicon Autoanalyzer (Basel, et al., 1982). Iodide was determined by automated ceric-arsenious acid oxidation on the Autoanalyzer using a modified food digest cartridge produced by Technicon (Method No. 530-77A). Argentometric titration as used to determine chloride content. T.C. Waugh measured the dissolved sodium content of the November 16 sample by inductively coupled argon plasma spectrophotometry.

RESULTS

Dissolved chloride, bromide, and iodide concentrations for the Rau well sample were 725 mg/L, 0.27 mg/L, and 1.6 µg/L respectively. Chloride and bromide contents for the Jump well were 8.5 mg/L and 0.11 mg/L, respectively. Bromide/chloride weight ratios are plotted versus chloride concentration for these samples in Figure 1. Bromide/chloride values are usually greater than 0.002 for brines from oil-producing strata in Kansas (a common range is 0.003 to 0.005 as used in Figure 1) and within 0.0001 to 0.0003 for halite-solution brines.

The curves in Figure 1 are the boundary lines for the zone of mixing of fresh waters with halite-solution brines from Permian formations and the zone of mixing of fresh waters with typical oil-field brines in Kansas. The locations of the mixing zones are based on analytical data for a large number of fresh to saline groundwaters and subsurface brines, as well as samples prepared by dissolving different sections of cores of the Hutchinson Salt Member of the Wellington Formation. The boundary curves are theoretical lines for the mixing of various amounts of the freshwater (low chloride) and brine (high chloride) endpoints.

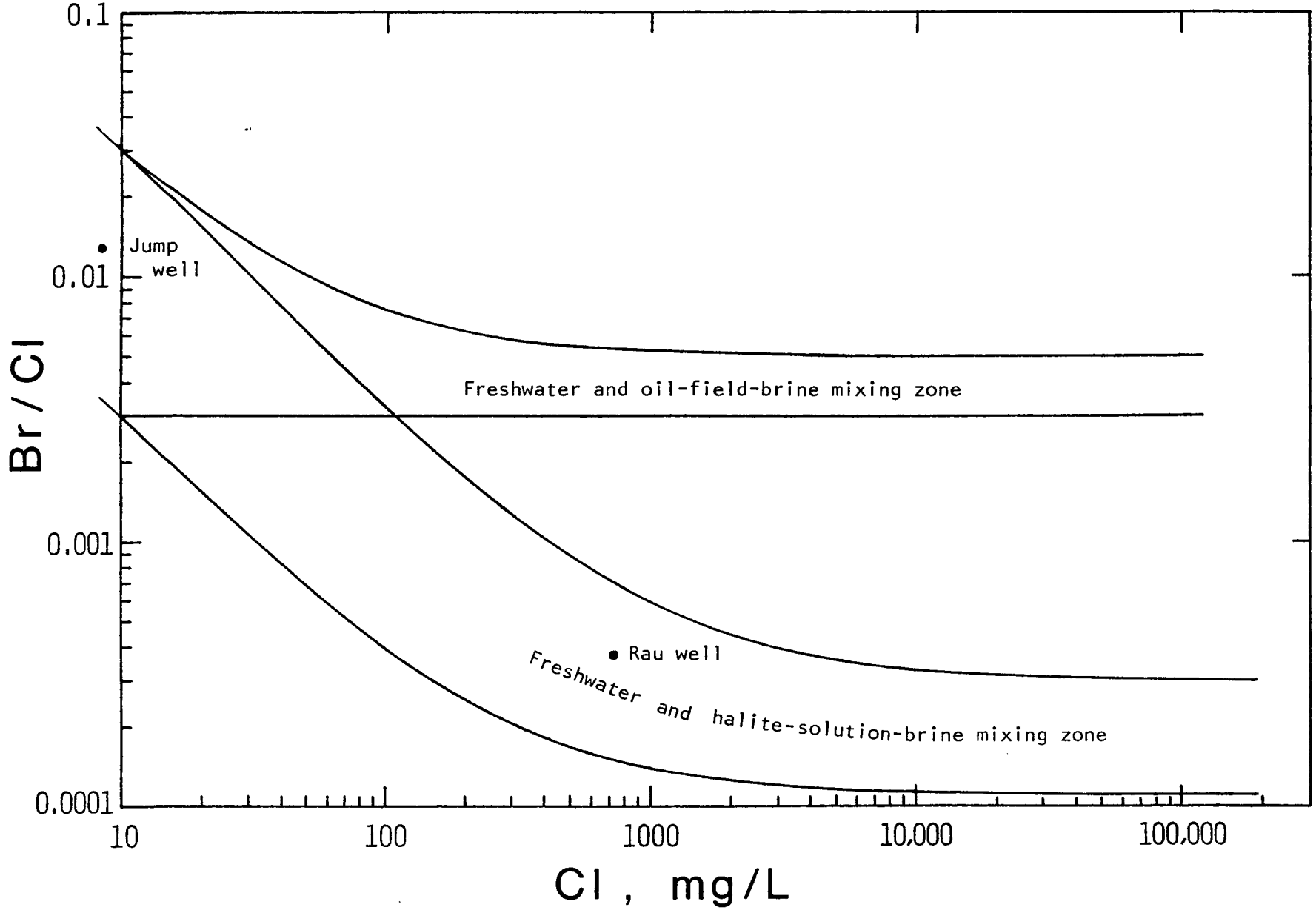

Figure 1. Zones of Mixing of Fresh Waters with Oil-Field Brines and Halite-Solution Brines in Kansas

The point on Figure 1 for the Jump well falls in the middle of the freshwater range for bromide/chloride ratios at the given chloride (just to the left of the 10 mg/L chloride concentration which was the low value used previously for drawing the figure). The Rau well water plots in the middle of the mixing zone of fresh waters with halite-solution brines from Permian strata.

The iodide/chloride ratio for the Rau sample was 2.2×10^{-6}. This value falls at the lower edge of a zone for the mixing of fresh waters and halite-solution brines based on a figure drawn in a similar manner to Figure 1 using previous data for Kansas. If the source had been oil-field brine, the ratio would have been expected to be much higher.

The dissolved sodium contents of the samples collected from the Rau well on October 1 and November 16 were 275 and 217 mg/L, respectively. (The value for the earlier sample is from the Department of Health and Environment.) These give sodium/chloride ratios of 0.24 and 0.30, respectively, for the two samples. Sodium/chloride values for groundwaters in the Great Bend Prairie to the west of Kingman County are generally greater than 0.6 for chloride concentrations in the range of 700-1200 mg/L. The low ratios for the Rau well samples suggest that the salt water was not encountered originally in the bottom of the zone in which the well is screened, but that it migrated to the well. Fresh groundwaters in Kingman County as well as in most of Kansas usually have much higher ratios of (calcium + magnesium)/sodium than salt waters. Adsorbed ions on clays in the sediments in contact with the fresh waters would be in approximate equilibrium with the dissolved ions. Thus, sodium would tend to be adsorbed and exchanged for calcium and magnesium

as salt waters moved into a freshwater portion of an aquifer. The chloride concentration would be unaffected, therefore the sodium/chloride ratio would decrease.

There are two possible ways in which the salt water from the Permian rocks could reach the Rau well. Salt water in Permian strata close to and at lower elevations than the South Fork of the Ninnescah River near the Pratt County and Kingman County line is under artesian pressure, which causes the salt water to enter the river (P. Cobb, unpublished data). Both the Rau well and the nearby oil well are relatively close to the South Fork of the Ninnescah River in eastern Kingman County. Assuming that similar artesian conditions were present near the river, drawdown from the Rau well might cause slow upconing of salt water from Permian rock below the well. The other possibility is that Permian salt water could move up along the outside of the casing of the oil well if the cement around the surface casing did not completely seal the space next to the borehole. Hydrogeologic studies would be needed to determine which of these pathways causes the salinity in Mr. Rau's well water.

CONCLUSION

The source of salt water contaminating the well water of Mr. Rau is natural salt water from Permian strata and not brine from the producing horizon of a nearby oil well.

REFERENCES

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