

GEOCHEMICAL CHARACTERIZATION OF WATERS
AT THE MAXEDON LEASE, PRATT COUNTY

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a report for the
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INTRODUCTION

The Oil and Gas Conservation Division, Kansas Corporation Commission, requested the assistance of the Kansas Geological Survey in identifying the source of dissolved solids in the ground waters within the Maxedon Lease area, T. 27 S., R. 11 W., Section 25, Pratt County. A recovery operation is removing saline water near an area near where oil brines are present in a tank battery. Monitoring wells were installed in the area at shallow to deep levels in the unconsolidated Quaternary sediments of the Great Bend Prairie aquifer which overlies Permian bedrock (Salt Plain Formation).

The source of the salinity was determined using the geochemical methods of Whittemore (1984, 1988). Water samples from the monitoring wells, the saltwater recovery system, the South Fork of the Ninnescah River just southeast of the area, and an oil brine from the tank battery system were collected during November, 1989, and January, 1990, and sent to the Survey. The oil brine is produced mainly from the Lansing Group. The chloride, sulfate, and bromide concentrations of the samples were measured and the salinity source identified based on mixing curve plots.

PROCEDURE

The samples sent to the Survey were filtered through 0.45 μm membrane filter paper before analysis. Chloride, sulfate, and bromide concentrations were determined using automated colorimetric methods on a Technicon AutoAnalyzer II, except for sulfate in the recovery system and oil brine samples which was measured by a turbidimetric method. The estimated maximum error in the chloride determinations is 2% and in the sulfate values is approximately 5%. The estimated maximum error for the bromide measurements >0.3 mg/L is approximately 5%, while the low values are accurate to ± 1 of the significant figure.

RESULTS AND DISCUSSION

The sample identification and results for the waters analyzed are listed in Table 1. All of the waters from the monitoring wells are fresh relative to dissolved-solids contents. Both the

Table 1. Sample Identification and Results. Site 1 and 5 samples and the river water were collected in November, 1989. The rest of the samples were collected in January, 1990. All samples are from T. 27 S., R. 11 W., Section 25. The section location system after the section number represents large to small quarters from left to right. Site 5 wells are part of an observation well network of the U.S. Geological Survey.

Description	Total or screened interval depth, ft	Location within section	Cl, mg/L	SO ₄ , mg/L	Br, mg/L	Br/Cl x 10 ⁴
Site 1, 5 in. well	9	25ADDC	68.7	52	0.13	18.8
Site 1, 2 in. well	30	25ADDC	85	26	0.05	5.9
Well 2	16.5-21.5	25ADCD	162	24	0.14	8.6
Well 3	71-76, 83-88	25ADCB	203	22	0.82	40.4
Site 5	shallow	25DAAA	102	22	0.07	12.4
Site 5	intermediate	25DAAA	139	24	0.05	3.5
Site 5	deep	25DAAA	132	24	0.05	4.2
Recovery system		25ADCD	2,270	44	10.8	47.6
Oil brine		25ADC	92,300	143	451	48.9

chloride and sulfate concentrations are below the recommended drinking-water standards of 250 mg/L. The river water sample contained a chloride concentration slightly above the recommended standard.

The identification of the salinity source at the aquifer base was made using sample data and mixing curves on a plot of bromide/chloride versus chloride concentration (Figure 1). Each of the mixing curves in Figure 1 is calculated from the conservative mixing of two end-member waters. The two dashed mixing curves form the boundaries of a mixing zone between freshwater and saltwater derived from the solution of halite (rock salt) in Permian strata. A freshwater end member was selected for the left end of each of the two dashed mixing curves based on the range in the bromide/chloride ratios of the freshest waters from the area. The saltwater end points for the dashed curves bracket the ratio range for halite-brines from observation wells of Groundwater Management District No. 5 (GMD5) screened in Permian bedrock in Stafford, Pratt, and Reno counties (Whittemore, et al., 1987).

The range in the bromide/chloride ratio at 69 mg/L chloride for the mixing zone between freshwater and halite-brine on Figure 1 is essentially the same as the range at that chloride concentration for uncontaminated freshwaters from observation wells of the GMD5 network screened in the Quaternary aquifer (Whittemore, et al., draft). Points for the waters from all of the monitoring wells in the area of the Maxedon lease except well 3 fall within the freshwater and halite-brine mixing zone. The salinity identification method is very sensitive to detecting oil brine in the presence of waters with a chloride source mainly from halite solution. No oil-field brine contamination could be detected within the limits of the analytical and sampling error in the ground waters that fall within the mixing zone in Figure 1. The waters from the shallow wells plot parallel to the mixing curve boundary at ratios above waters from the intermediate to deep wells. The somewhat higher ratios of the shallow waters could represent soil waters affected by evapotranspiration that reached the water table in the past by recharge during wet periods. The point for the sample from the South Fork of the Ninnescah River plots within the

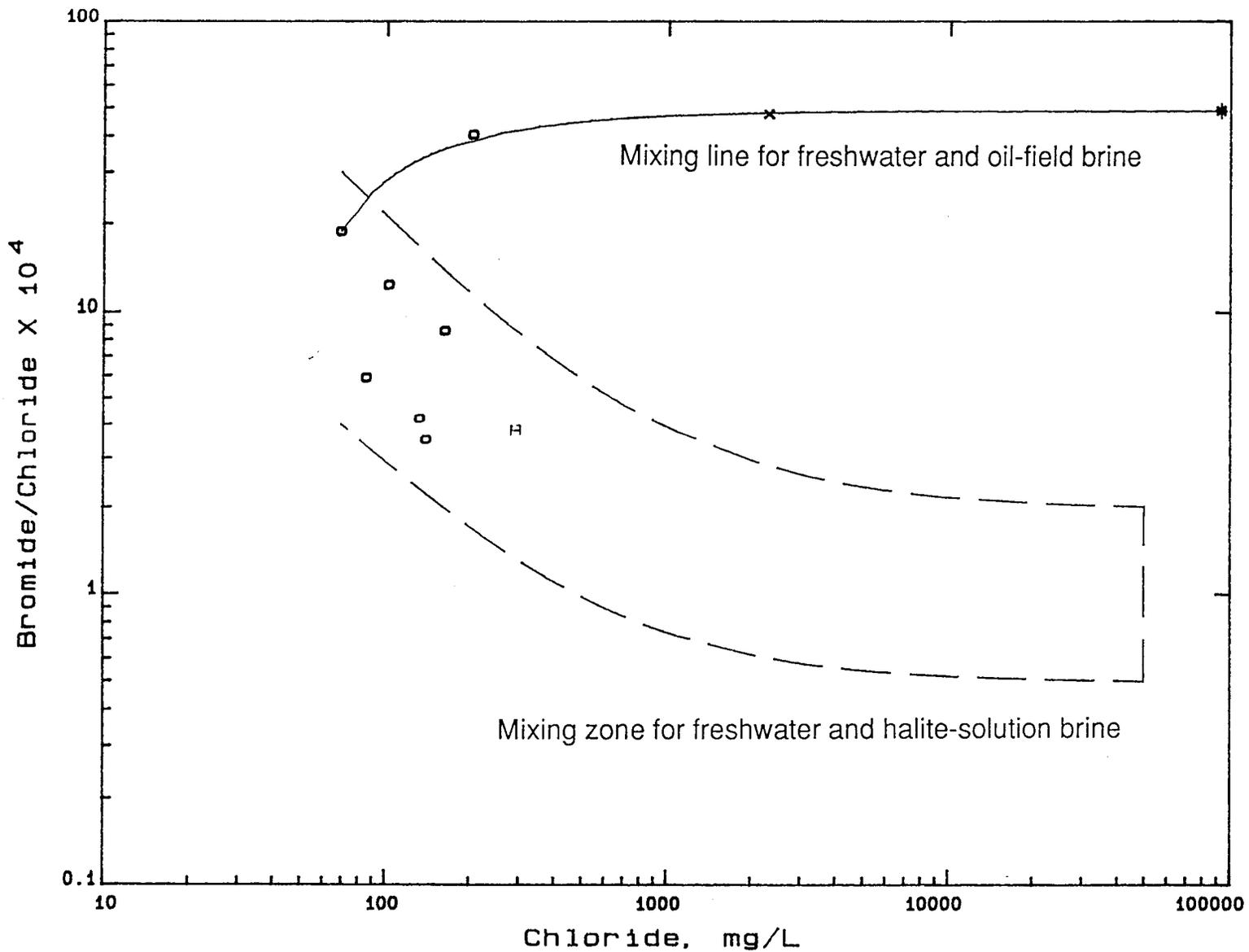


Figure 1. Bromide/Chloride Weight Ratio Versus Chloride Concentration. The symbol * represents oil brine, x is for the recovery system water, o is for the monitoring wells, and R indicates water from the South Fork of the Ninnescah River just south of the study area.

center of the mixing zone, suggesting that it represents a mixture of waters with chemistries similar to the shallow and deeper ground waters in the area.

The bromide/chloride weight ratio for the oil brine is within the 0.002-0.006 range common for most oil brines in Kansas. The solid curve in Figure 1 represents the conservative mixing between the freshwater from the shallow water at site 1 and the oil brine. Points for the water from well 3 and the recovery system fall along the curve. Based on the curve, the contribution of chloride from a natural source to the recovery water is less than 100 mg/L, and the remainder is from oil brine. The chloride contribution from a natural source for well 3 water is probably about 70 mg/L or less, because the well is screened deeper in the aquifer where the bromide/chloride ratios appear to be lower for a given chloride than at shallow depths. The rest of the chloride in the well 3 water is from oil brine with a chemistry similar to that of the oil brine sample.

A graph of sulfate/chloride ratio versus chloride concentration can often be used to assist in salinity identification. However, the chloride concentration at which the identification can be made is usually substantially higher than that for the bromide/chloride method, due to larger natural variations in the sulfate contents of waters. The differences shown by a sulfate/chloride versus chloride graph for the Maxedon lease waters are not great enough to warrant use of the method.

CONCLUSIONS

All of the ground waters sampled from the monitoring wells at the Maxedon lease are fresh. The source of over 95% of the chloride in the saline water from the recovery system in the Maxedon lease is from oil brine with the same chemistry as that in the tank battery system. The only monitoring well that yielded water with a detectable chloride source from oil brine contamination was well 3. Over half of the 203 mg/L chloride concentration in the sample from well 3 is probably derived from oil brine. The rest of the monitoring wells yield water with no detectable contamination from oil brine; the chloride source is chemically similar to that of water in the South Fork of the Ninnescah River just south of the lease.

REFERENCES

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