OKLAHOMA "ALKALI" WATERS AND WATER RESIDUES

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Certain saline waters and water residues—the so-called "alkali spots"—present some interesting scientific and economic problems, which it is the purpose of this memorandum to call attention to and briefly discuss.

GENERAL CHEMICAL COMPOSITION

With the exception of the well-known salt plains, most "alkali spots" and the waters of which these are the residue, contain, in the usual order of relative abundance, normal sodium sulfate, Na_2SO_4, sodium bicarbonate, $NaHCO_3$, sodium chloride, common salt, NaCl and sometimes a small amount of normal sodium carbonate, "black alkali," Na_2CO_3. The distinguishing chemical feature of the "alkali spot" appears to be the predominance of sodium sulfate over any other single salt and this serves to identify it when there is a question of possible pollution of land by oil field brines, in which case common salt usually predominates.

GENERAL PHYSICAL CHARACTERISTICS

The usual distinguishing feature of an "alkali" water residue is efflorescence, which is a property of the principal compound, sodium sulfate, contained therein. This characteristic serves to distinguish the usual natural residue from the residue from oil field brines, which is ordinarily hygroscopic or moist due to contained calcium chloride. Following from the efflorescent property, the "alkali" residue is non crystalline and powdery while the brine residue is usually distinctly crystalline and darker than that of the white "alkali spot." If the "alkali spot" contains sodium carbonate it may be black owing to colloidally dispersed organic matter in which case it has been mistaken for an oil seep, owing to the color and slippery "feel" of the contained alkali.

QUANTATIVE ANALYSES OF "ALKALI" WATER RESIDUES

In Table I, are presented analyses of *unheated* water residues calculated to a moisture free basis. This serves to preserve the sodium bicarbonate, which would be decomposed upon boiling.

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TABLE I

Analyses of Unheated Water Residues (Approximately Residues from Natural Solar Evaporation). Reported in percentage of ion concentration on a dry basis

Constituent Ion	1	2	3	4	5
Na+, Sodium	24.170	24.28	27.14	26.14	
Ca++, Calcium	2.317	2.49	0.69	0.57	2.57
Mg++, Magnesium	4.103	3.78	0.13	0.15	
Al_2O_3			0.58	0.66	
Fe_2O_3			0.03	0.02	
R_2O_3	0.246	0.28			
Cl-, Chloride	9.133	9.06	2.42	2.54	2.70
HCO_3-, BiCarbonate	2.091	1.77	48.23	36.13	
SO_4--, Sulfate	57.720	58.22	18.12	16.87	60.33
SiO_2, Silica	0.223	0.10	2.84	6.88	

Sample 1. "Alkali Spot," about S. line SE¼ Sec. 7-T8N-R2W. About two miles south of Lindsay street, Norman, Okla. Sampled by A. C. Shead. Analyzed by H. Mauzee Davis.

Sample 2. Same as Sample 1. Analyzed by Edward A. Burch.

Sample 3. Water from Well No. 2, 660 feet deep, drilled in 1927 on campus of University of Oklahoma, east of field house. Analysis by Roy K. Valla.

Sample 4. Same as Sample 3. Analyzed by Sidney E. Miller.

Sample 5. "Alkali Spot," NE¼ Sec. 28-T25N-R1W. Sampled and analyzed by A. C. Shead.

In Table II are presented analyses of heated water residues "boiler scale.. These show the effect of heat on original bicarbonates changing them to carbonates with the escape of CO_2 causing foaming.

TABLE II

Analyses of Heated Water Residues (Boiler "Scale")
Reported in Percentage of Ion Cones on "As Received" Basis

Constituent Ion	1	2	3
Na+, Sodium	36.45	35.69	38.81
K+, Potassium			0.59
Ca++, Calcium	0.00	0.00	0.00
Mg++, Magnesium	-	0.34	0.00
Al+++, Aluminum			0.22
Fe+++, Ferric Iron			0.04
R_2O_3		0.60	
Cl-, Chloride	1.68	1.87	0.73
HCO_3-, Bicarbonate		0.84	
CO_3--, Carbonate	15.18	15.60	48.01
SO_4--, Sulfate	45.78	43.50	6.05
SiO_2, Silica	0.29	1.18	1.85
H_2O, Water	0.45	0.21	3.61
TOTAL	99.83	99.83	99.91

Sample 1. White boiler residue from University of Oklahoma Well No. 1. Analysis by Glenn Purcell.

Sample 2. Darker than 1, but from same source. Color due to iron from boiler. Analysis by Chas. Forrest.

Sample. 3. Boiler residue from Norman Milling & Grain Co. 525 foot wells at corner of Comanche street and Santa Fe R.R., Norman, Okla. Analyzed by Dana Hefley.

All samples collected by A. C. Shead.

Such waters as yield residues of the nature shown by the analyses cited cause a number of economic problems of a more or less serious nature.

IMPAIRED SOIL FERTILITY DUE TO "ALKALI"

The chief loss occasioned is probably that due to impaired soil fertility. This ranges in degree from total barrenness when the salts reach a concentration of from 0.8 to 1.0 per cent of the soil in alkali spots or contain an appreciable amount of "black alkali," to occasional crop damage in certain dry years. The area affected is probably unknown but must aggregate an enormous acreage, evident even to a casual observer. Little chemical relief can be afforded except in case of small amounts of "black alkali" when the application of a little gypsum is said to destroy the sodium carbonate.

"ALKALI" IN IRRIGATION WATERS

Since irrigation or sprinkling water is applied to soils, grass and crops may be harmed by the use of unsuitable water. One water is known to injure vegetation when applied in quantity during a drouth even though it has a pH of but 8 due to slight traces of sodium bicarbonate. A small quantity of finely pulverized gypsum applied to the soil would probably remedy the condition in such cases. Boiling a water containing sodium bicarbonate develops black alkali and renders it unfit for watering plants.

"ALKALI" IN SOIL POLLUTION CASES

Cases often arise in court over possible pollution of soils by the overflow of streams carrying salt from oil field brines. In such instances it is often a question whether the salt found arises from pollution, from manuring, or from "alkali spots" already upon the land. These alternatives can generally be decided by the fact that oil field salts are genally crystalline and hygroscopic while those from "alkali spots" are usually non crystalline and efflorescent.

"ALKALI" CORROSION

Amphoteric metals are corroded by sodium carbonate solutions, even when dilute. One instance can be cited where the zinc galvanizing of ice cans was corroded badly by an alkaline city water with the destruction of the coating and concomitant formation of poorly conducting zinc carbonate upon the surface which hindered the efficient freezing of ice.

Aluminum tea kettles and other apparatus of this material are often destroyed by sodium carbonate solutions formed by thermal decomposition of baking soda in the water and this trouble is aggravated by concentration.

FOAMING AND PRIMING IN BOILERS DUE TO "ALKALI" WATERS

As small an amount as one thousand parts per million of alkali metal salts causes foaming and priming in boilers when boiled down to one-fourth the original volume. In one instance, about 4,500 pounds of water was blown off per day with an attendant enormous heat loss. The trouble became so acute that distilled water was produced in some old boilers to make up the boiler supply.

EFFECT OF "ALKALI" WATERS ON HEALTH

One water containing about 750 parts per million of Glaubers salts proved very cathartic to some individuals and occasioned marked physical discomfort, especially to newcomers unused to the ingestion of "gyp" waters.

GEOLOGIC SIGNIFICANCE OF "ALKALI"

While the "alkali" spots themselves are remarkable geological phenomena, there is reason to believe that sulfate from them is the source of that radical found in the widespread barite deposits of Oklahoma.

SUMMARY

This memorandum presents some analyses of the saline residues of so-called "alkali" waters and attempts to point out their connection with some economic problems.