THE GEOLOGICAL SURVEY OF WYOMING
S. H. KNIGHT, State Geologist

REPORT OF INVESTIGATIONS No. 2

THE SALINE LAKE DEPOSITS OF WYOMING
II
THE ROCK CREEK LAKES
Albany County, Wyoming

BY

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LARAMIE, WYOMING
MARCH, 1939

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INTRODUCTION

The Geological Survey of Wyoming is engaged in the study of saline lake deposits of Wyoming. This report is the second of a proposed series. The first report of the series treats with the Downey Lakes, Albany County, Wyoming.[1]

LOCATION

The Rock Creek Lakes are located in west-central Albany County in sections 20, 21, 28 and 29, T. 23 N., R. 76 W. They are twelve miles east of the town of Medicine Bow on the Union Pacific Railroad.

PURPOSE OF THIS SURVEY

Numerous inquiries have been received by the Geological Survey for information on the salt deposits in these lakes. The general character of the salts has been known for many years, but no reliable estimates of the quantity of the various kinds of salts have been available. The purpose of this survey was to make both qualitative and quantitative determinations of the salt deposits. The lakes were briefly described by Ricketts[2] in 1888 and by Knight and Slosson[3] in 1901 and Knight[4] in 1903.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to Professor R. H. Beckwith of the Department of Geology of the University of Wyoming who volunteered his assistance in both field and office investigations. He wishes to thank Mr. Charles E. Bradford, Mr. Joseph Neely and Mr. David Love of the staff of the Geological Survey for their assistance. The writer is indebted to Professor O. A. Beath, Research Chemist of the University of Wyoming, and to his assistants, Mr. Harold Eppson and Mr. Kenneth Stanfield, for the chemical analyses.

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[1]The Downey Lakes, Albany County, Wyoming, by S. H. Knight. The Geological Survey of Wyoming, Report of Investigations No. 1, 6 pages, 2 plates, 1934. Copies of this report will be sent you upon request.

[2]Louis D. Ricketts, Annual Report of the Territorial Geologist to the Governor of Wyoming, Cheyenne, Wyoming, 1888.

[3]W. C. Knight and E. E. Slosson, Alkali Lakes and Deposits, University of Wyoming Experiment Station Bull. No. 49, Laramie, Wyoming, 1901.

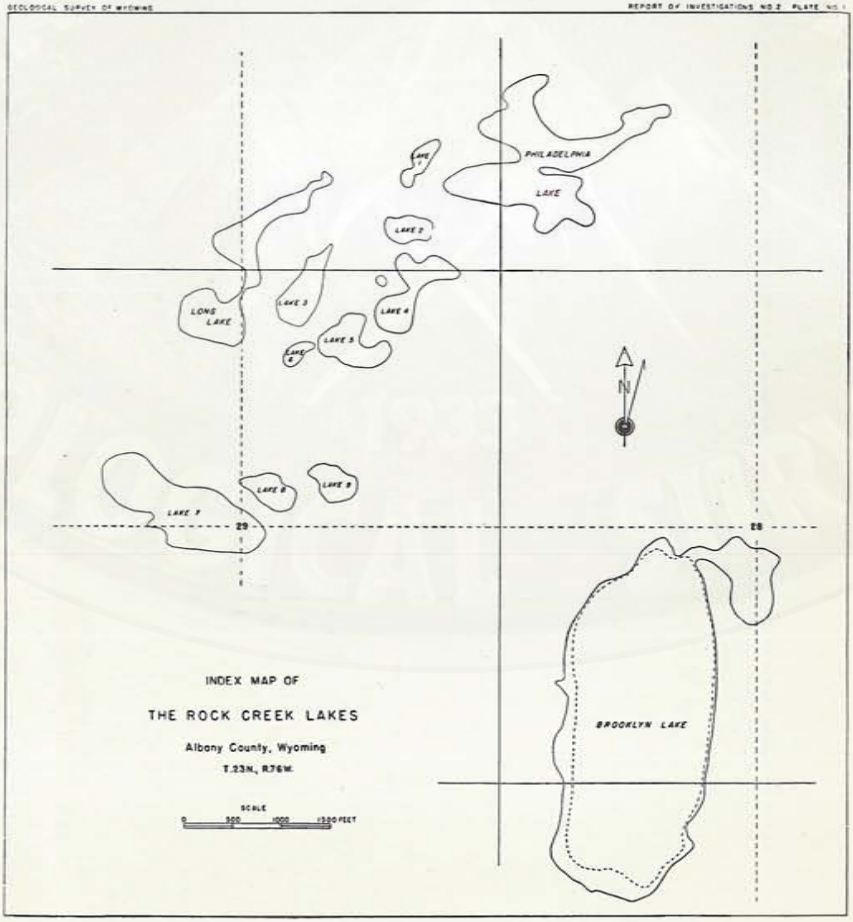
[4]W. C. Knight, Epsom Salts in Wyoming, Engineering and Mining Journal, Vol. 75, p. 259, 1903.

FIELD WORK

Field examinations of these lakes were made during October and November, 1933. The lakes were mapped by plane table on a scale of 1 inch = 500 feet. The respective thicknesses of the surface salt layer and the underlying black mud deposit were determined at various stations. Samples of the surface salt and the underlying black mud also were collected at various stations.

GENERAL DESCRIPTION

The Rock Creek Lake deposits occupy numerous small shallow depressions which have been excavated in a larger undrained depression, the bottom of which lies approximately one hundred feet below the level of the surrounding plateau. This depression is excavated in the red shales and sandstones of the Chugwater formation. The western side



of the basin is flanked by outcrops of the Morrison and Cloverly formations. The position and the outlines of the various lakes examined are shown on the accompanying map (Plate 1).

BROOKLYN LAKE

This lake is the largest and the most southern of the group. It is located in the SW¼ sec. 28 and the NW¼ sec. 33, T. 23 N., R. 76 W. The area of this lake is 116.4 acres. When examined the lake was dry with the exception of an area of approximately 5 acres in the northeast portion of the lake, which was covered by one to two inches of brine.

Surface Salt Deposit.—Most of the surface was covered with a thin crust of salt varying from 0 to 6 inches in thickness. The map (Plate 2) shows the varying thickness of the salt layer as determined from measurements made at 20 stations. The computed volume of the salt is 490,240 cubic feet. Assuming that the average specific gravity of the salt is 1.75 there would be 26,713 short tons of salt in the surface deposit.

Composition of the Surface Salt Deposit.—The following is a summary of the analyses of two samples of the surface deposit taken at stations No. 4 and No. 16 in which sodium is computed to be present as mirabilite ($Na_2SO_4 \cdot 10H_2O$) and the magnesium as epsomite ($MgSO_4 \cdot 7H_2O$).

Brooklyn Lake

(Samples collected Oct. 10, 1933)

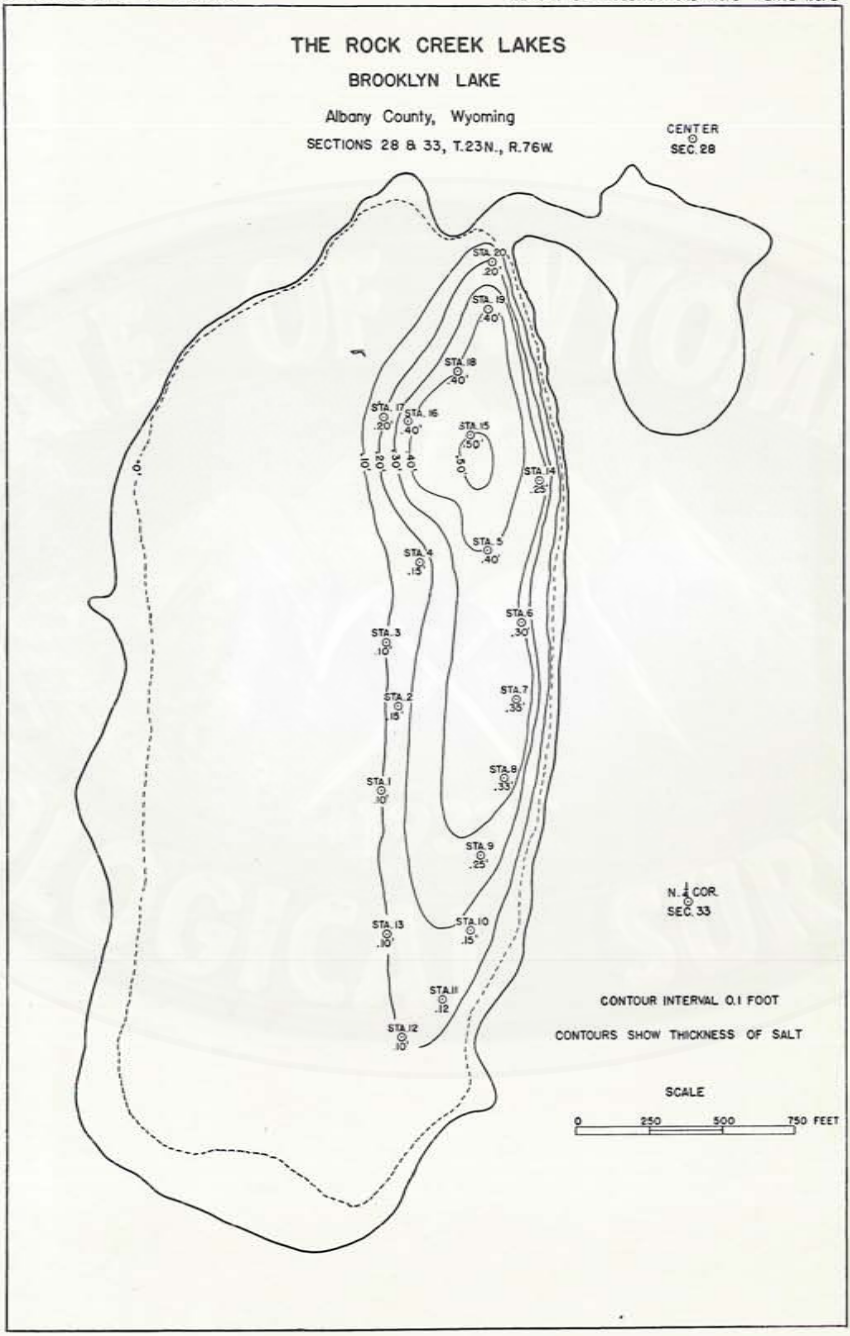
Sample No.	Station No.	% $Na_2SO_4 \cdot 10H_2O$	% $MgSO_4 \cdot 7H_2O$	% Residue in sample	% Combined water as $MgSO_4 \cdot H_2O$
3	4	7.7	83.6	0	11.6
4	16	3.0	88.4	0	12.2
Average		5.3	86.0		

Previously Published Analyses of the Brooklyn Lake Deposits:

Ricketts gave the following analysis of a sample of pure salt collected from Brooklyn Lake in December, 1887:

	Per Cent
Insoluble residue	0.11
Water	49.75
Sulphur trioxide	33.08
Magnesia	16.26
Sodium Chloride	0.21
Sodium Oxide	0.43
Total	99.84

A recast of the above analysis yields 0.03% mirabilite and 96.8% epsomite.


THE ROCK CREEK LAKES
BROOKLYN LAKE
Albany County, Wyoming
SECTIONS 28 & 33, T.23N., R.76W.
CENTER SEC. 28
STA. 20 .20'
STA. 19 .40'
STA. 18 .40'
STA. 17 .20'
STA. 16 .40'
STA. 15 .50'
STA. 14 .20'
STA. 5 .40'
STA. 4 .15'
STA. 3 .10'
STA. 2 .15'
STA. 1 .10'
STA. 6 .30'
STA. 7 .35'
STA. 8 .35'
STA. 9 .25'
STA. 10 .15'
STA. 11 .12'
STA. 12 .10'
STA. 13 .10'
.0'
.10'
.20'
.30'
.40'
.50'
N. ¼ COR. SEC. 33
CONTOUR INTERVAL 0.1 FOOT
CONTOURS SHOW THICKNESS OF SALT
SCALE
0 250 500 750 FEET

A sample collected by Dr. W. C. Knight in February, 1898, gave the following analysis calculated as dry alkali salts:

Sodium sulphate (Na_2SO_4)	22.13
Sodium chloride (NaCl)	.69
Magnesium sulphate ($MgSO_4$)	77.18

Another analysis published by W. C. Knight in 1903 is as follows:

Sodium sulphate (Na_2SO_4)	25.61
Sodium chloride (NaCl)	5.28
Magnesium sulphate ($MgSO_4$)	70.11

It is concluded from the analyses of the samples collected in October, 1933, that the surface deposit was composed at that time of approximately 25,000 tons of epsomite and 1,500 tons if mirabilite. According to the International Critical Tables, double salts of sodium and magnesium sulphates do not form at the prevailing temperatures at which these salts were probably precipitated.

Salts in black mud beneath the surface deposit in Brooklyn Lake.— Lying between the surface salt deposit and the sandy floor of the lake bed is a layer of black mud varying from 0 to 6 feet in thickness. Several measurements indicate that the black mud has an average thickness of 3 feet. Analyses of two samples of the mud layer are given in the following table:

Analyses of black mud samples from Brooklyn Lake
(Samples collected October 10th, 1933)

Sample No.	Station No.	Insoluble residue	% $Na_2SO_4 \cdot 10H_2O$	% $MgSO_4 \cdot 7H_2O$	% Combined water as $MgSO_4 \cdot H_2O$
11. A composite sample of the mud bed	8	61.84	17.00	23.00	2.11
12. A sample of the upper six inches of the mud bed	16	66.34	12.00	18.00	1.53
Average		64.09	14.50	20.50	1.83

It is evident from the above analyses that a large amount of salt is contained in the mud layer. Computations of the amount of salt contained in the mud layer based upon (1) the average composition and (2) the average specific gravity of 1.8 and (3) the average thickness of the mud layer of 3 feet over 100 acres, follows:

	Approximate number of short tons
Mirabilite ($Na_2SO_4 \cdot 10H_2O$)	100,000
Epsomite ($MgSO_4 \cdot 7H_2O$)	150,000

Summary of the Brooklyn Lake Salt Deposits

	Approximate tonnage of surface deposit	Approximate tonnage in black mud	Approximate total tonnage of salt
Mirabilite ($Na_2SO_4 \cdot 10H_2O$)	1,500	100,000	101,500
Epsomite ($MgSO_4 \cdot 7H_2O$)	25,000	150,000	175,000

The above estimates are believed to be conservative.

What percentage of the salt contained in the black mud layer may be taken into solution when the lake is flooded is not known. It is believed that a considerable portion of the salt contained in the mud layer is dissolved when the lake is extensively flooded.

A sample of the sandy floor of the lake bed was collected at station No. 8. The sandy layer lies directly below the black mud layer. Analysis No. 10 in table No. 1 was made on an average sample of the upper one foot of this sandy layer. It is of interest to note that this sample contained 12% mirabilite and 14% epsomite.

PHILADELPHIA LAKE

This lake lies one half mile north of Brooklyn Lake in the SW¼ sec. 21 and the SE¼ sec. 20, T. 23 N., R. 76 W. The lake is very irregular in outline and covers an area of approximately 40 acres. When examined on November 1, 1933, and again in July, 1935, the lake was dry. A layer of soft black mud covered the surface. Thin irregular patches of sodium salts were scattered over the mud surface. These patches varied from 0 to 2 inches in thickness. No attempt was made to estimate the tonnage of the surface salt accumulation on this lake, owing to the limited amount. The analysis of a sample of crystalline salt from this lake (see analysis No. 9, table No. 1) yielded 75% epsomite and 21% mirabilite.

Ricketts[1] describes this lake as follows:

> "The Philadelphia Lake has an area of about 40 acres and is very irregular in outline. Close to the shore the bottom is composed of black mud similar to that in the Brooklyn Lake. Further out there is a thin crust of magnesium sulphate over the mud. But in this lake the mud is found to rest upon a heavy deposit of solid salt. Two pits sunk in the lake showed in one case four, in another six and one half feet of this salt. A third pit sunk near the shore showed less than one foot. These few pits do not afford sufficient data for an estimation of the size of the deposit, but they do develop the fact that it is a large one. The following analysis will show the composition of this salt. The insoluble residue in this and other analyses means the residue insoluble in hot water:"

Insoluble residue	3.38
Water	48.90
Sulphur trioxide	31.33
Magnesia	15.62
Sodium Chloride	0.44
Sodium Oxide	0.07
	99.74

[1]Ricketts, L. D., Annual Report of the Territorial Geologist, to the Governor of Wyoming, Jan., 1888, p. 54.

An unsuccessful attempt was made to determine the position and character of this bed at the time the survey was made. The heavy mechanical enquipment and labor necessary to explore this bed was not, however, available at the time. Further field studies will be necessary before the facts incident to the existence, character and composition of this bed are known.

The remaining small lakes of this group did not contain an appreciable amount of crystalline salts as surface incrustations.

ANALYZED SAMPLES

Collected Oct. 10, 1933 and Nov. 1, 1933

SAMPLE NO.	LOCALITY
1.	Long Lake. Sample of Spring Water.
2.	Long Lake. Salt sample, 100 feet W. of spring.
3.	Brooklyn Lake. Surface sample. Station No. 4.
4.	Brooklyn Lake. Surface sample. Station No. 16.
5.	Lake No. 1. Surface sample.
6.	Lake No. 2. Surface sample.
7.	Lake No. 3. Surface sample.
8.	Lake No. 4. Surface sample.
9.	Philadelphia Lake. Surface sample.
10.	Brooklyn Lake. Sand, 4 feet below surface.
11.	Brooklyn Lake. Mud, station No. 8.
12.	Brooklyn Lake. Mud just under salt.
13.	Philadelphia Lake. Mud sample.

Analyses of these samples are given on the following page.

TABLE NO. 1—ANALYSES OF SAMPLES FROM ROCK CREEK LAKES

%	1	2	3	4	5	6	7	8	9	10	11	12	13
Residue.....	.0	0.3	.0	.0	.0	.05	.11	.46	1.39	77.81	61.84	66.35	60.26
CaO.....	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.81	5.28	5.50	6.94
MgO.....	86 gm/1	21.1	25.9	27.3	24.8	21.00	28.25	27.91	24.85	2.79	4.72	3.48	3.35
SO_3.....	188 gm/1	53.9	52.7	54.6	54.5	52.85	55.07	55.77	51.98	9.88	19.41	16.12	17.48
Cl.....	82.1 gm/1	1.0	1.2	1.0	0.8	1.80	.76	.34	1.28	.48	.86	.96	.60
Na_2O.....	76 gm/1	8.9	2.8	1.1	4.5	12.19	1.97	2.92	8.79	2.60	4.24	2.70	2.88
Total.....	432.1 gm/1	85.2	82.6	84.0	84.6	87.89	86.16	87.40	88.29	96.37	96.35	95.11	91.51
†Comb. water as $MgSO_4 \cdot H_2O$.....	38.4 gm/1	9.5	11.6	12.2	11.2	9.36	12.60	12.46	11.08	1.25	2.11	1.55	1.50
*Total plus combination water..	470.5 gm/1	94.7	94.2	96.2	95.8	97.25	98.76	99.86	99.37	97.62	98.46	96.66	93.01
$\%MgSO_4 \cdot 7H_2O$...	526 gm/1	67.3	83.6	88.4	79.5	65.00	89.00	87.00	75.00	14.00	23.00	18.00	17.00
$\%Na_2SO_4 \cdot 10H_2O$..	395 gm/1	24.2	7.7	3.0	12.3	28.00	5.00	8.00	21.00	12.00	17.00	12.00	13.00
Total Solids.....	482.5 gm/1												

NOTE: * is the total of † and all above †.