THE GEOLOGICAL SURVEY OF WYOMING
HORACE D. THOMAS, State Geologist

REPORT OF INVESTIGATIONS No. 1

THE SALINE LAKE DEPOSITS OF WYOMING

I

THE DOWNEY LAKES

Albany County, Wyoming

BY

S. H. KNIGHT

UNIVERSITY OF WYOMING
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INTRODUCTION

The Geological Survey of Wyoming has planned to issue a series of reports on the saline lake deposits of Wyoming. This report is the first of the series. The second report will treat with the Rock Creek Lakes and others will follow from time to time.

LOCATION

The Downey Lakes are located twenty miles southwest of Laramie, Albany County, Wyoming, in sections 15, 21 and 22, T. 13 N., R. 75 W.

There are three lakes in the group and they will be referred to in this report as the North Lake, the Middle Lake, and the South Lake because of their relative positions. The lakes occupy the deeper portions of a shallow depression which lies a half mile west of the confluence of Sheep Creek and Spring Creek. The depression is two miles long and one-half mile wide with its longer axis extending northeastward.

PURPOSE OF THIS SURVEY

The general occurrence and character of the salt deposits in these lakes have been known for many years. They were briefly described by Rickets[2] in 1888 and by Knight and Slosson[3] in 1901. In view of the fact that the deposit may prove to have economic significance it was thought desirable to carry out sufficiently detailed investigations to determine the extent of the deposits, the tonnage of salts present and their composition.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to Professor R. H. Beckwith and to Professor Horace D. Thomas of the Department of Geology of the University of Wyoming who volunteered their assistance in both field and laboratory investigations. He wishes also to thank Mr. Charles E. Bradford, Mr. Joseph Neely and Mr. David Love, of

[1]Professor of Geology, University of Wyoming; State Geologist 1933-40. A limited number of mimeographed copies of this report were issued in 1934 and the supply was soon exhausted. This printed reissue is identical to the original mimeographed issue.

[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 Bulletin No. 49. Laramie, Wyoming. 1901.

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.

FIELD WORK

Field examinations of these lakes were made during the later part of October and early November of 1933. The lakes were mapped by plane table on a scale of one inch = 500 feet. The thicknesses of the salt deposits were determined at various stations by borings. An inch and a half Hardsock coal augur with a jointed pipe handle was used for boring. With this equipment two men bored through twelve feet of salt with no difficulty. Core samples were taken at various depths by driving a one-inch pipe a few inches into the solid salt at the bottom of the borings.

THE NORTH DOWNEY LAKE

Condition of the Lake: This lake was surveyed on November 1, 1933. The surface of the lake was free from water and composed of solid compact salt. Borings showed that the salt contained very little brine down to depths of from three to four feet. The amount of brine increased gradually, although, in the thickest part of the bed, the salt was sufficiently firm at a depth of six feet to remain in the sampling pipe when it was lifted out of the boring. Below six feet the amount of brine increased to the point where the salt had the constituency of slush. The amount of water present in the brine was, in all probability, only slightly in excess of the amount of the water of crystallization. Directly below the zone of slushy salt is a bed of black soft mud three or more feet in thickness. The mud bed is composed of salt crystals imbedded in insoluble clay-like material. It has a strong odor of hydrogen sulphide.

The area of the North Downey Lake is 25.9 acres. The salt deposit varies from zero to eight feet in thickness. Plate No. I shows the irregular character of the deposit. The computed volume of the salt (plus the insoluble residue) is 3,172,000 cubic feet. Assuming that the average specific gravity of the deposit is 1.4 (Sp. gr. mirabilite = 1.481) there would be 131,737 tons of salt in this lake exclusive of the residue. This figure does not include the salt contained in the mud beneath the salt bed. It is concluded that there are at least 125,000 tons of available salt in this deposit.

Composition of the Salt: The following is a summary of the analyses of six samples of the salt taken at various depths in which the sodium is computed to be present as mirabilite ($Na_2SO_4.10H_2O$) and the magnesium as epsomite ($MgSO_4.7H_2O$). The complete analyses of these samples is given in Table No. III.

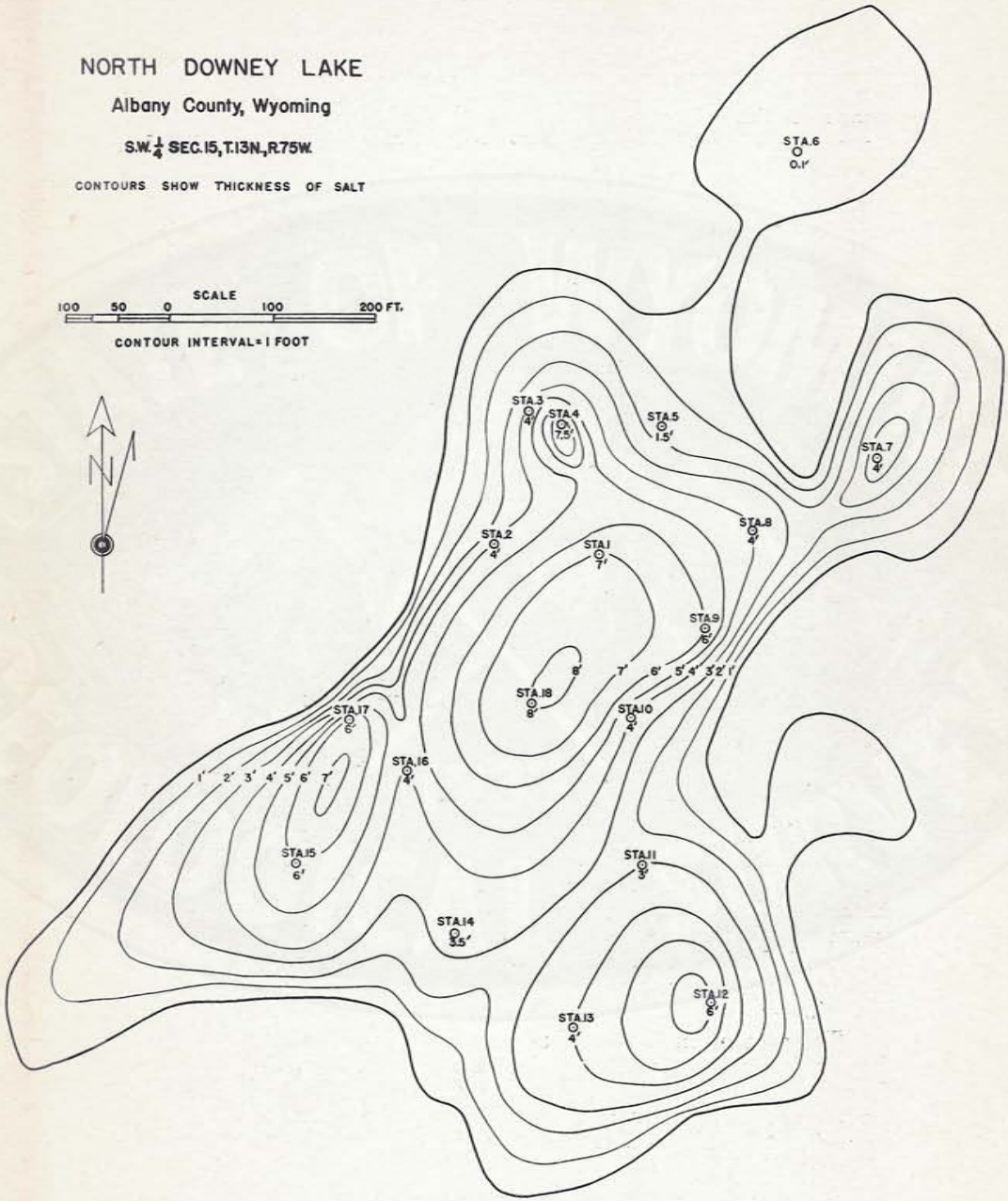
NORTH DOWNEY LAKE
Albany County, Wyoming
S.W. 1/4 SEC. 15, T. 13N., R. 75W.
CONTOURS SHOW THICKNESS OF SALT
SCALE
100 50 0 100 200 FT.
CONTOUR INTERVAL = 1 FOOT
N
STA.1 7'
STA.2 4'
STA.3 4'
STA.4 7.5'
STA.5 1.5'
STA.6 0.1'
STA.7 4'
STA.8 4'
STA.9 6'
STA.10 4'
STA.11 3'
STA.12 6'
STA.13 4'
STA.14 3.5'
STA.15 6'
STA.16 4'
STA.17 6'
STA.18 8'
1' 2' 3' 4' 5' 6' 7'
8' 7' 6' 5' 4' 3' 2' 1'

PLATE I

TABLE NO. I

THE NORTH DOWNEY LAKE

(Samples collected November 1, 1933)

Sample No.	Station No.	Depth	% $Na_2SO_4.10H_2O$	% $MgSO_4.7H_2O$	% Residue in assay sample	% Combined water as $MgSO_4.H_2O$
14	1	2′	82	8	8.40	1.18
15	1	4′	88	4	5.16	.66
16	1	6′	95	4	.87	.64
19	4	surface	92	1	.39	.18
20	4	2′	90	4	7.03	.59
21	4	4′	87	6	5.25	.90
Average of Samples.....			.89%	4.5%	4.50%	.69%

The foregoing summary gives the approximate composition of the salts. The mirabilite ranges from 88 per cent to 95 per cent and the epsomite from one to eight per cent. Additional investigation will be necessary to determine whether or not there are any double salts of sodium and magnesium sulphates present in this deposit. According to data in the International Critical Tables, double salts of sodium and magnesium sulphate do not form at the prevailing temperatures at which these salts were probably precipitated. The demonstration of this fact, however, awaits further study.

It is concluded that from 80 per cent to 90 per cent of the deposit is mirabilite and five per cent to ten per cent is epsomite. The insoluble residue averages five per cent. All other compounds, including gypsum, sodium chloride, etc., will average less than five per cent.

THE MIDDLE DOWNEY LAKE

This lake is located 500 feet southwest of the North Downey Lake.

Condition of the Lake: At the time the lake was studied the surface was free from water and covered with salt. The salt was solid, compact and virtually free from brine to a depth of six feet in the thicker portion of the deposit. Below six feet the brine content increased so that the salt was slushy at a depth of eight feet. As in the North Lake the amount of water in the brine probably did not greatly exceed the amount of water of crystallization. A bed of dark mud similar to that found in the North Lake underlies the salt bed.

The area of the Middle Lake is 32.8 acres. Plate No. II shows the physical character of the salt deposit. The computed volume of the salt (plus the insoluble residue) is 5,342,000 cubic feet. Assuming the average specific gravity of the deposit to be 1.4 there are 222,027 tons of salt in this lake, exclusive of the salt contained in the underlying mud bed.

Composition of the Salt: The following table is a summary of the analyses of four samples taken at the surface and at depths of two,

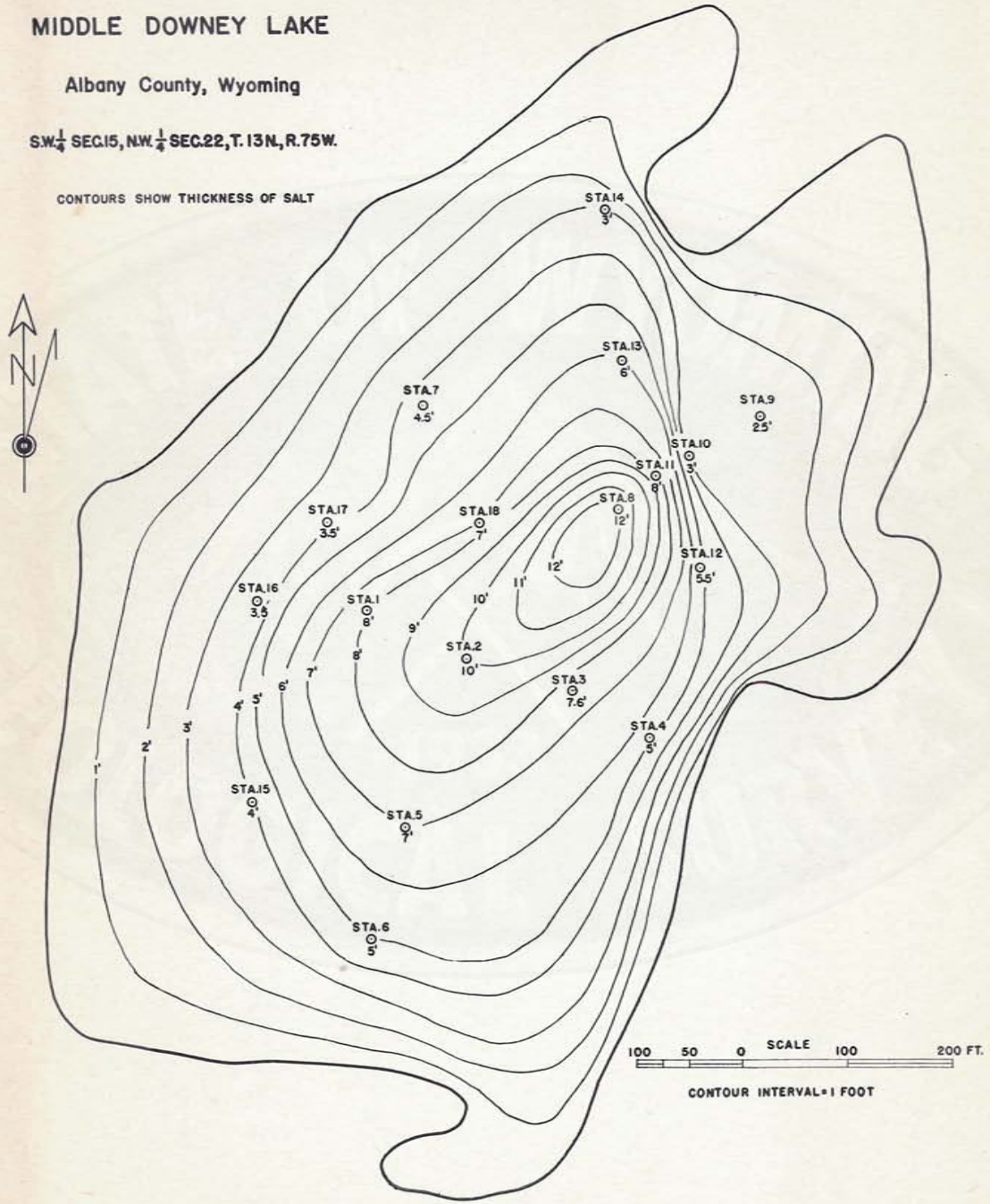
MIDDLE DOWNEY LAKE
Albany County, Wyoming
S.W.¼ SEC.15, N.W.¼ SEC.22, T. 13 N., R. 75 W.
CONTOURS SHOW THICKNESS OF SALT
N
STA.14 3'
STA.13 6'
STA.7 4.5'
STA.9 2.5'
STA.10 3'
STA.11 8'
STA.8 12'
STA.17 3.5'
STA.18 7'
STA.12 5.5'
STA.16 3.5'
STA.1 8'
STA.2 10'
STA.3 7.6'
STA.4 3'
STA.15 4'
STA.5 7'
STA.6 5'
1'
2'
3'
4'
5'
6'
7'
8'
9'
10'
11'
12'
100 50 0 SCALE 100 200 FT.
CONTOUR INTERVAL = 1 FOOT

PLATE II

four and six feet at station eight (Plate No. II) in which sodium is computed to be present as mirabilite and the magnesium as epsomite. The complete analyses of the samples are given in Table No. III.

TABLE NO. II

THE MIDDLE DOWNEY LAKE

(Samples taken October 28, 1933)

Sample No.	Station No.	Depth	$Na_2SO_4.10H_2O$	$MgSO_4.7H_2O$	Residue in assay sample	Combined water as $MgSO_4.H_2O$
22	8	surface	96	2	.16	.29
23	8	2′	86	9	7.61	1.44
24	8	4′	83	7	10.56	.95
25	8	6′	70	8	15.04	1.05
Average of Samples.....			83.75	6.50	8.44	.93

These analyses compare favorably with the analyses of the samples taken from the North Downey Lake. They average five per cent lower in mirabilite and two per cent higher in epsomite. The residue is four per cent higher than in the North Lake.

THE SOUTH DOWNEY LAKE

This lake is located 3,000 feet southwest of the Middle Lake and is the largest of the three. Its surface area is 38.3 acres. The lake does not contain a large body of crystallized salt. When examined a third of its area was covered by one to three inches of water. Beneath the water was a thin crust of salt varying from one to six inches in thickness. Beneath the salt crust was dark mud mixed with salt crystals. No attempt was made to estimate the amount of salt present in this lake. The analyses of a surface sample of salt from this lake (see Sample No. 18, Table No. III) show it to contain forty per cent epsomite and fifty-seven per cent mirabilite. The magnesium content of the salts in the lake is much higher than that of the salts in the North Lake or Middle Lake. A sample of the dark mud taken at a depth of three feet below the surface analyzed twenty per cent epsomite and forty-seven per cent mirabilite (see Sample No. 17, Table No. III.)

SUMMARY OF THE DEPOSITS

Lake	Size in Acres	Approximate tonnage of epsomite	Approximate tonnage of mirabilite	Approximate tonnage of all other salts	Approximate tonnage of insoluble residue	Approximate total tonnage
North Downey .	25.9	6,000	110,000	2,000	7,000	125,000
Middle Downey .	32.8	13,000	169,000	5,000	15,000	200,000
TOTAL . . .	58.7	19,000	279,000	7,000	22,000	325,000

ANALYSES OF SALT SAMPLES FROM THE DOWNEY LAKES

(Samples collected October 29 and November 1, 1933. Analyses made on oven-dried samples)

Lab. No.	14	15	16	17	18	19	20	21	22	23	24	25
LOCATION	North Lake Station No. 1, Depth 2 Feet	North Lake Station No. 1, Depth 4 Feet	North Lake Station No. 1, Depth 6 Feet	South Lake, Surface	South Lake, Dark Muck, Depth 3 Feet	North Lake Station No. 4, Surface	North Lake Station No. 4, Depth 2 Feet	North Lake Station No. 4, Depth 4 Feet	Middle Lake Station No. 8, Surface	Middle Lake Station No. 8, Depth 2 Feet	Middle Lake Station No. 8, Depth 4 Feet	Middle Lake Station No. 8, Depth 6 Feet
Per cent Residue	8.40	5.16	.87	28.25	.39	.43	7.03	5.25	.16	7.61	10.56	15.04
CaO	.97	1.61	.00	3.04	.00	1.43	.80	1.20	.52	2.70	2.64	3.61
MgO	2.64	1.49	1.43	5.22	13.76	.40	1.33	2.01	.64	3.22	2.13	2.36
SO_3	50.01	52.90	55.40	36.45	54.56	56.10	52.85	52.20	56.16	46.42	49.18	50.65
Cl	.26	.16	.16	.32	.18	.10	.06	.22	.10	.28	.14	.28
Na_2O	33.92	35.60	41.10	19.63	23.34	36.85	36.10	34.98	41.30	35.32	31.20	23.75
Total	96.20	96.92	98.96	92.91	92.23	95.31	98.17	95.86	98.88	95.55	95.85	95.69
Combined Water as $MgSO_4.H_2O$	1.18	.66	.64	2.33	6.14	.18	.59	.90	.29	1.44	.95	1.05
Total Plus Combined H_2O	97.38	97.58	99.60	95.24	98.37	95.49	98.76	96.76	99.17	96.99	96.80	96.74

ORIGIN OF SALT DEPOSITS

Two interpretations have been advanced to explain the origin of these and similar deposits. These interpretations are briefly stated as follows: (1) The lakes are fed by springs, the waters of which are heavily charged with sodium and magnesium salts. Upon the evaporation of the water the salts are deposited. (2) The salts are leached from the rocks which are exposed around the sides of the drainage basin and transported into the lake basins by the run-off.

Available evidence as to the origin of the Downey Lakes supports the spring theory of origin. No attempt will be made in this report to discuss the origin of these deposits.