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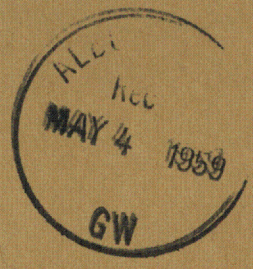
SALT AT SHALLOW DEPTHS IN THE COASTAL PLAIN OF TEXAS AND LOUISIANA

By Charles B. Read



Trace Elements Memorandum Report 1003

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

April 24, 1959

AEC-349/9

Mr. James E. Reeves
Assistant Manager for Test Operations
Albuquerque Operations Office
U. S. Atomic Energy Commission
P. O. Box 5400
Albuquerque, New Mexico

Dear Mr. Reeves:

Transmitted herewith are ten copies of TEM-1003, "Salt at shallow depths in the coastal plain of Texas and Louisiana," by Charles B. Read, April 1959.

This report was prepared as part of our Plowshare project. We plan to incorporate parts of this report in future publications.

Sincerely yours,

Andrew Brown
for Montis R. Klepper
Assistant Chief Geologist

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

April 24, 1959

AEC-350/9

Dr. Daniel R. Miller
Chemistry Branch
Division of Research
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Dan:

Transmitted herewith is one copy of TEM-1003, "Salt at shallow depths in the coastal plain of Texas and Louisiana," by Charles B. Read, April 1959.

This report was prepared as part of our Investigations of Geologic Processes project. We plan to incorporate parts of this report in future publications.

Sincerely yours,

for Montis R. Klepper
Assistant Chief Geologist

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

SALT AT SHALLOW DEPTHS IN THE COASTAL PLAIN OF TEXAS AND LOUISIANA*

By

Charles B. Read

April 1959

Trace Elements Memorandum Report 1003

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*This report concerns work done on behalf of Albuquerque Operations Office and the Division of Research, U. S. Atomic Energy Commission.

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SALT AT SHALLOW DEPTHS IN THE COASTAL PLAIN OF TEXAS AND LOUISIANA

By

Charles B. Read

ABSTRACT

Salt occurs at depths of less than 500 feet in six salt domes in Texas and Louisiana. Extensive mining operations are currently being conducted in each of these domes. These domes are a part of a belt of salt domes that characterize the Gulf Coast province from southwestern Alabama to near Laredo, Texas.

Analyses of rock salt in Gulf Coast salt domes indicate that the sodium chloride content may exceed 98 percent in places. Calcium sulfate is approximately 1 percent in the average sample, and traces of other sulfates, chlorides, carbonates, and silicates comprise the remaining 1 percent.

Structures in the Gulf Coast salt domes consist of layers, folds, shear faults, and lineations. Layers of salt as much as several feet in thickness alternate with thinner layers of anhydrite or gypsum. The folds in the interior of salt domes vary from open to isoclinal. Some of these structures have amplitudes of more than 100 feet. A constant characteristic of the folds is the vertical to very steep inclination of the axial planes. Shear folds occur on the limbs of the larger folds. Lineation is apparent in the layers of anhydrite and is also vertical to nearly vertical.

INTRODUCTION

Salt occurs at depths less than 500 feet in six salt domes in Texas and Louisiana (fig. 1). Underground mining operations are being carried out in each of these domes.

The following notes have been prepared in an effort to furnish data regarding chemical composition and structure of the rock salt in the shallow deposits. The information is in part based on observations by George W. Moore and the writer in the Gulf Coast salt dome province and in part on information obtained from literature on the structure of Gulf Coast salt domes. This work was done by the U. S. Geological Survey on behalf of the Albuquerque Operations Office and the Division of Research, U. S. Atomic Energy Commission.

GEOGRAPHIC DISTRIBUTION OF GULF COAST SALT DOMES

Salt domes occur beneath the Coastal Plain of the Gulf of Mexico in two belts extending from southern Alabama to within a few miles of the International Boundary near Laredo, Texas. The southernmost of these belts, generally referred to as the coastal salt dome province, extends from near Corpus Christi, Texas, to the Mississippi delta southeast of New Orleans, Louisiana. The interior salt dome province extends from Laredo, Texas, to southeastern Alabama. Nearly 300 of these features are known and with relatively few exceptions they are focal areas for the production of petroleum which occurs in deformed strata on the flanks of the domes, or in locally permeable cap rocks above these domes. In addition, sulfur in commercial quantities is obtained from the cap rocks of a few of the domes, and salt is mined by underground methods in six of the very shallow domes (table 1).

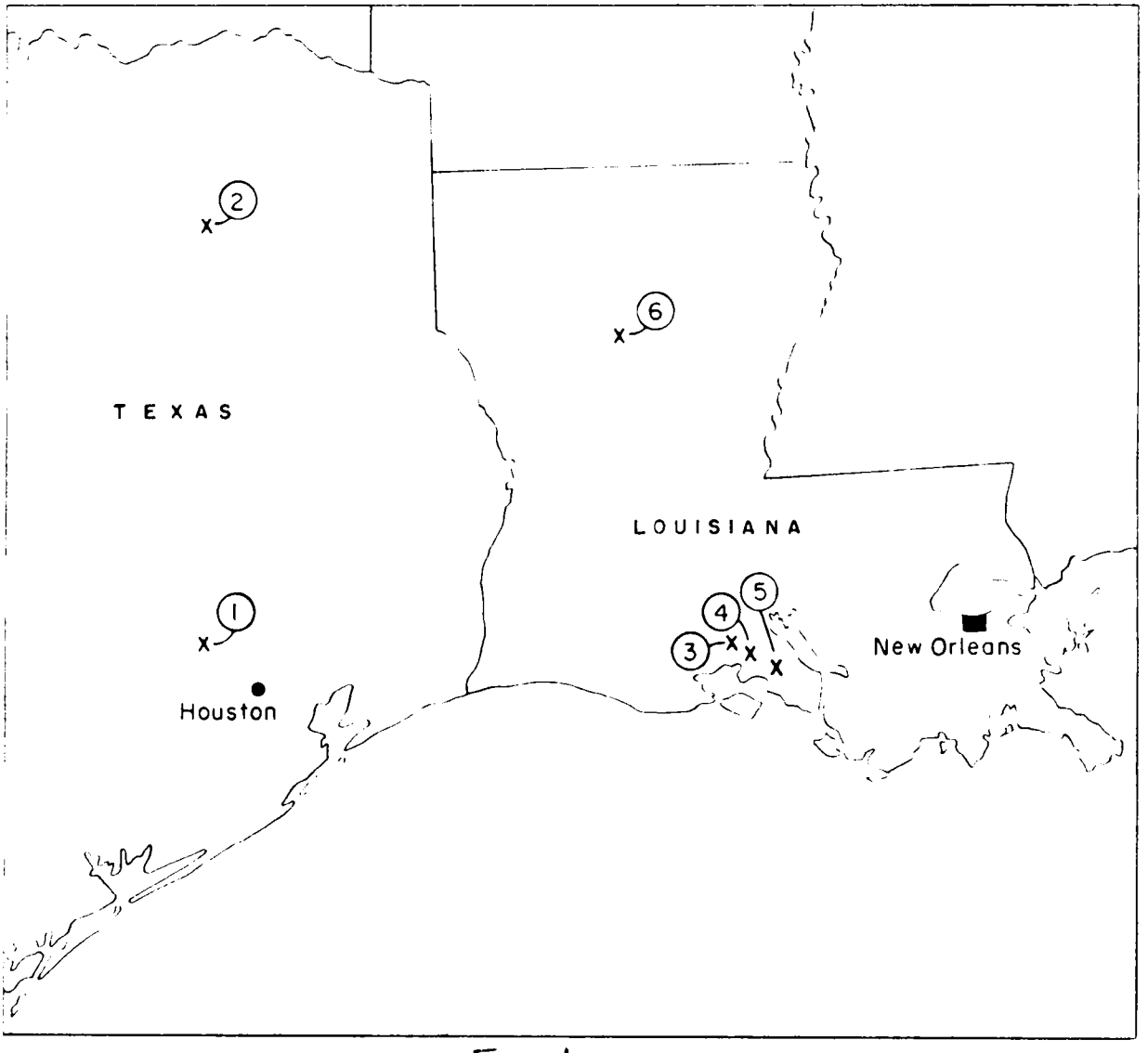

Fig 1

Index map of Louisiana and east Texas showing locations of six salt domes listed in table 1.

Table 1.--Mines in salt domes in the Gulf Coast area

	Mine operator and location	Depth to top of salt (feet)	Maximum depth of mine workings (feet)
1./	United Salt Corporation mine, Hockley, Harris County, Texas	117	1,525
2.	Morton Salt Company, Kleer mine, Grand Saline, Van Zandt County, Texas	213	700
3.	Morton Salt Company mine, Jefferson Island, New Iberia, Iberia Parish, Louisiana	100	900
4.	International Salt Company mine, Avery Island, New Iberia, Iberia Parish, Louisiana	54	518
5.	Myles Salt Company mine, Weeks Island, New Iberia, Iberia Parish, Louisiana	100	645
6.	Carey Salt Company mine, Winnfield, Union Parish, Louisiana	440	838

1/ Numbers refer to areas shown on figure 1.

CHEMICAL COMPOSITION OF ROCK SALT IN GULF COAST SALT DOMES

In view of the amount of geologic investigation and physical prospecting for mineral resources in the Gulf Coast salt dome province, it is surprising that so few chemical analyses of rock salt in the domes are available. Most of the information concerning chemical composition pertains to six domes where mining operations are being carried out. Several analyses are listed in table 2.

Table 2.--Analyses of Rock Salt in Gulf Coast Salt Domes.

	(1)	(2)	(3)	(4)	(5)
NaCl	98.88	98.92	95.72	97.71	98.73
$CaSO_4$	1.09	1.04	3.95	2.1	1.19
$CaCO_3$	0.01	0.01			
Na_2SO_4	0.01	0.02		0.04	
$MgCl_2$	trace	trace	0.01		0.01
Insoluble	trace		0.03	0.06	0.05

(1) Sample of salt from Morton Salt Company, Kleer mine, Grand Saline Dome, Texas (Balk, 1949).

(2) Sample of salt from Morton Salt Company, Kleer mine, Grand Saline Dome, Texas (Balk, 1949).

(3) Old Hackberry Dome, Lake Charles, Louisiana (Taylor, 1938)

(4) Choctaw Dome, Baton Rouge, Louisiana (Taylor, 1938).

(5) Avery Island Salt Dome, Louisiana (Taylor, 1882).

On the assumption that the these analyses are typical, the Gulf Coast salt domes are characterized by relatively pure rock salt inasmuch as sodium chloride may be in excess of 98 percent in the samples reported. Calcium sulfate (anhydrite and gypsum) accounts for slightly over 1 percent and only traces of calcium carbonate, sodium sulfate, and

magnesium chloride are present. Although insoluble material is usually indicated as present only in traces, locally there are large erratic blocks of fine-grained sandstone near the margins of the salt domes. However, in terms of bulk composition these erratic blocks of sandstone are substantially less than 1 percent of the total volume of materials except along the margins of the salt domes where greater quantities of such sedimentary materials may occur.

STRUCTURE OF THE SALT IN THE GULF COAST SALT DOMES

Structures that have been observed in Gulf Coast salt domes have been described as layers, folds, shear folds, and lineations. According to Balk (1949, 1953) fractures such as joints are absent. He also reports that faulting has not been observed in the interior of salt domes, although it seems possible that there may be considerable faulting on the margins of domes. Balk also reports that unconformable contacts between layers of salt have not been observed, but instead layers of salt with different strikes are separated by a zone of compact and massive salt.

In consequence Gulf Coast salt domes, on the basis of the few that have been investigated in detail, are characterized by structural complexities which are rather uniformly predictable. A brief discussion of some of these structural complexities based largely on Balk's studies of the Grand Saline (1949) and Jefferson Island (1953) domes follows.

Layers.--All salt domes on the Gulf Coast that have been penetrated by mine workings or drills exhibit layering and this is believed to be characteristic of all the domes of the province. The layers range from an inch or less to a few feet thick. However, most of the layers are less than 6 inches in thickness and many are only a fraction of an inch. The layers are ordinarily relatively thick tabular or lenticular bodies

of salt that vary greatly in texture and alternate with very thin layers of anhydrite or gypsum. The boundaries between the alternating layers of salt and anhydrite or gypsum appear to be sharp when viewed from a distance. However, according to Balk (1949) the layers are seen to be gradational when examined in thin sections.

The origin of the layering is problematical. The alternations of halite and anhydrite suggests bedding structures that might have developed during precipitation of the evaporites and hence may be seasonal. However, when the fact that the rock salt in salt domes has risen several miles with respect to the parent salt body at depth is taken into account, one is inclined to speculate on the possible origin of the salt layering as a result of metamorphic processes. The layering may be a type of foliation.

Folds.--The very regular layers in salt domes are, on the basis of available information, complexly folded as a result of the intense deformation of the salt during the process of emplacement of the domes. Figure 2, which is Balk's map of the Grand Saline salt dome (1949), shows the complexity of this folding as determined by plotting some of the more readily traceable layers. The amplitude of the folds varies from a few inches up to 100 feet or more. Many of the folds are open but others are isoclinal. Many of the fold axes, as well as axial planes, are vertical to nearly vertical, and all are steep.

Shear folds.--The limbs of the larger folds are characterized by very many small shear folds, some of which are indicated on figure 2. These may involve many layers, but most commonly involve only a few. Areas of shear folding grade rather abruptly into uncontorted layers of salt on the limbs of some folds, but this is not a constant characteristic inasmuch as elsewhere transitions may be noted.

Lineation.--Vertical to very steep lineation as streaks of anhydrite crystals is characteristic of these rock salt deposits according to Balk (1949, 1953). It seems possible that similar lineation may be characteristic of halite crystals although this is rather difficult to determine with existing techniques.

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TEM-1003
Fig. 2

Salt Structure
in the
Grand Saline Salt Dome, Texas
as exposed in 1946-47 in the
Kleer Mine, Morton Salt Co.

Legend

- 75 — Salt layers dip 75° SE
- Salt layers vertical
- 60 — Trend and plunge angle of streaks of anhydrite, distorted halite crystals, or axes of folds (ax)
- Vertical streaks of anhydrite or halite
- Nearly structureless salt
- Walls of rooms and tunnels
- Particularly dark salt layer
- + Shaft

North
9° E

Scale: 0 100 feet 200 300 400 500

PLATE 1.—Structure map of Kleer Mine, Grand Saline, Texas.