UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

LITHOLOGIC UNITS USEFUL FOR SOLAR EVAPORATION POND CONSTRUCTION AT SEARLES LAKE, SAN BERNARDINO COUNTY, CALIFORNIA

By

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards or nomenclature

INTRODUCTION

Interest in use of solar evaporation at Searles Lake, Calif., by companies extracting saline minerals from lake brines has increased the need for suitable ponding sites. This report is the result of a preliminary study of prospective ponding sites at Searles Lake.

Searles Lake lies near the southern end of Searles valley and is in the southwestern part of the Basin and Range province. The lake is about 9 miles long and 7 miles wide and has a surface area of about 40 square miles.

The upper Quaternary sedimentary deposits beneath the surface of the lake have been and continue to be a source of potash, sodium carbonate, sodium sulfate, and other industrial materials. At present, brine is pumped from the subsurface on fee land and on federal leases and processed by Kerr-McGee Chemical Corp. and Stauffer Chemical Co. Occidental Petroleum Corp., with several associates, is beginning development of a third plant at the southern end of the lake.

Occidental plans to use evaporating ponds to enrich the brine pumped from the lake before processing it in the plant. Both the large amount of brine which will be used by Occidental to fill the ponds and a decrease in content of the elements recovered in the brine pumped by Stauffer and Kerr-McGee have caused a renewed interest by Stauffer and Kerr-McGee in the total capacity for solar evaporation ponds at Searles Lake.

The observations of this report are based on geologic mapping by G. I. Smith, U.S. Geological Survey, discussions with D. L. Cramer-Bornemann, Kerr-McGee Chemical Corp., and Charles Cowie, Stauffer Chemical Co., and fieldwork in the area by the author.

STRATIGRAPHY

Geologic mapping currently in progress and studies of drill core from the lake by Smith and Haines (1964) indicate a history of sedimentation in the basin of more than 100,000 years.

This report presents the geology from an engineering standpoint and groups the geologic units of earlier studies into five lithologic units based on their adaptability to evaporating-pond construction. A correlation of the units of this study and the informal subsurface units in use at Searles Lake is suggested in the following descriptions and is shown diagrammatically in figure 1. The nomenclature of the informal units was developed to describe the subsurface of the central part of the lake, but lithofacies changes take place toward the surface and margins of the playa.

Older rocks and sediments.--This unit includes all lake sediments older than the laminated mud and all rocks that are not the result of sedimentation within this basin. Mud suitable for ponding is unlikely to be found within the area underlain by this unit.

Laminated mud.--The unit consists chiefly of thin mud layers containing some saline minerals. Near the top of the unit, light-colored laminae of microscopic aragonite crystals occur; their presence is the main criterion to identify the laminated mud. The laminated mud is correlative with a part of the Parting Mud of Smith and Haines (1964).

Silty mud.--Much of the surface of the playa is composed of sediments characterized by interbedded dark-brown mud and halite that locally contain beds of sand and silt. Most of this material, which is younger than the laminated mud, is considered to be part of the Overburden Mud of Smith and Haines (1964). Although in auger samples many layers of plastic clay are found, an equal or greater number of silty layers are present.

Exposed salt.--This unit consists mostly of halite with minor trona and thenardite. Flint and Gale (1959, fig. 3) and Haines (1959, p. 144 and fig. 7) included the areas shown as exposed salt on plate 1 within the Upper Salt; Smith (1962) included the unit in the Overburden Mud for time-stratigraphic consistency. The unit laterally grades into the silty mud.

Alluvium.--This unit which occurs around the margin of the playa includes gravel and sand equivalent in age to the silty mud, fan material, and windblown sand younger than the material designated as laminated mud.

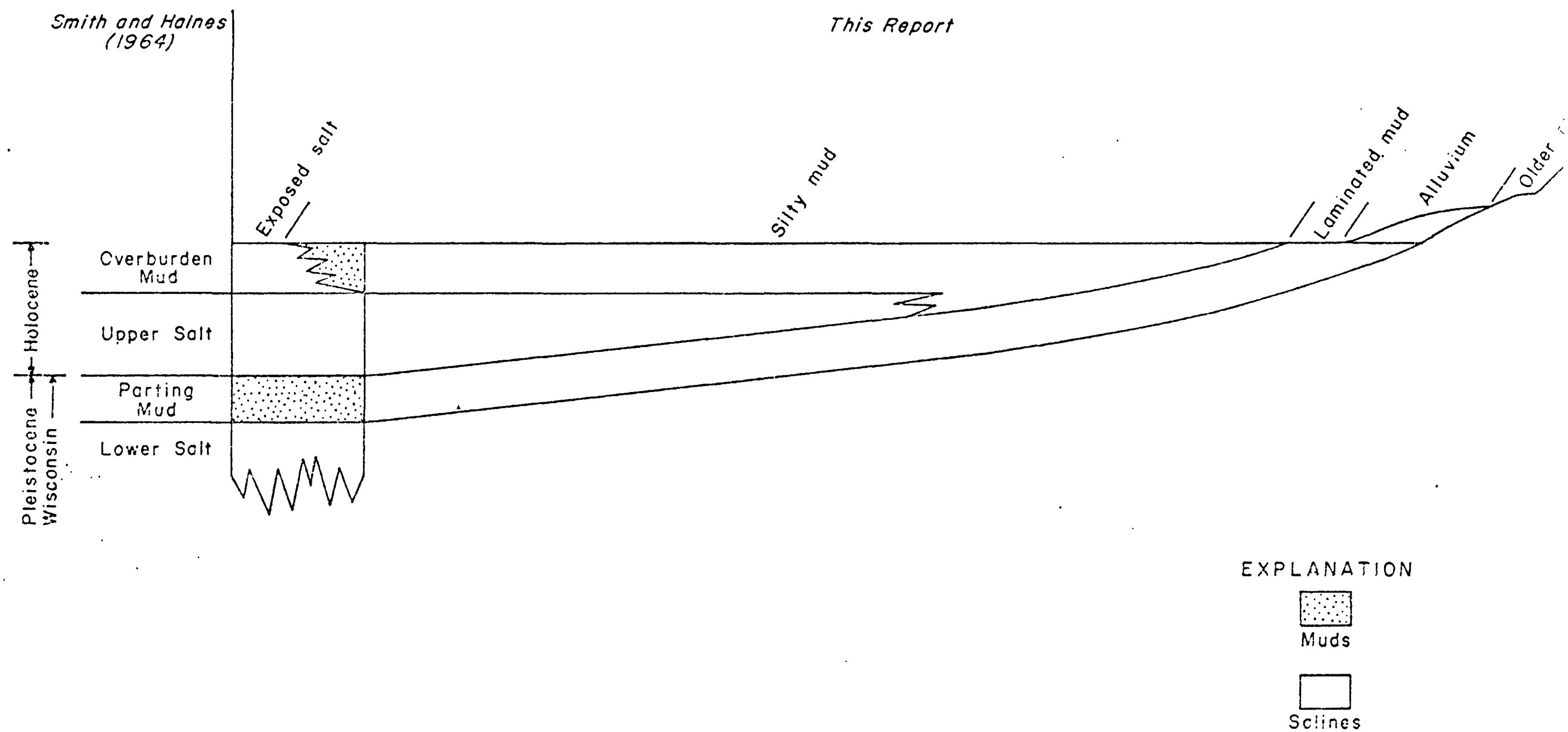

Figure 1.--Diagrammatic correlation of the surface lithologic units of this report and the subsurface stratigraphy of Smith and Haines (1964).

POND REQUIREMENTS

Solar evaporation ponds at Searles Lake will generally be of large size, necessitating a large area of rather low slope. It is generally believed that a slope of less than 10 feet per mile will be required (Kallerud, 1970), thus limiting development to areas within the 1,680-foot contour (pl. 1).

The ponds will also require impermeable bases and sides. Present belief is that an impermeable horizon, mostly free from silt or sand stringers, at least 5 and perhaps as great as 10 feet thick, is needed for an adequate pond base. The embankments constructed to contain the water in the pond must also be of impermeable material, and their bases will have to be anchored to the impermeable material forming the base of the pond in order to retard leakage. It probably would be best to dig a trench some distance into the impermeable zone forming the base of the pond and begin construction of the embankments within the trench. If such a method is used, the surface of the pond need not be impermeable, but a proper impermeable zone must exist near enough to the surface so that embankments based in the impermeable zone can be constructed.

PONDING SITES

The most favorable areas for establishing evaporation ponds appear to be those areas underlain by the laminated mud unit. Of the mud units at Searles Lake, the laminated mud has the least amount of intermixed silt and sand and is remarkably uniform over large areas.

The southwestern part of the playa appears to offer the best sites for ponding. In large areas of secs. 16, 20, 21, 27, and 28, T. 26 S., R. 43 E., the laminated mud is exposed at the surface or is below only a relatively thin covering of younger sediments.

The laminated mud is also exposed to the west of the Trona Railway in secs. 19, 30, and 31, T. 26 S., R. 43 E., Mount Diablo meridian, as ridges or small lenses along hillsides. In this area ponding is not feasible; however, the area may provide a source of mud to be used to seal ponds elsewhere. Another source of sealing mud is small outcrops of clay scattered throughout Salt Wells Canyon.

Along the east margin of the playa, little exploration has been done for suitable pond sites in the laminated mud. Company geologists have expressed the opinion that the laminated mud is too deeply buried by alluvium derived from the Slate Range to the east to be useful for ponding. Development of ponds on the east side of the lake may also be hindered because of abrupt facies changes that may limit the extent of useful muds. Along the northwestern part of the lake the laminated mud is probably deeply buried by alluvium derived from the Argus Range.

The silty mud covers a large part of the playa, but it has drawbacks as a pond material because it contains numerous silty layers that will allow extensive seeping. The majority of the old ponds at Searles Lake were on the silty mud and have been abandoned owing to excessive leakage. Some of the problem may have been due to improper construction and poor seals between the dikes and the bottom of the ponds; more care in construction may allow use of the silty mud as a pond base. Additional sealing of the ponds might be gained by adding clays excavated from the laminated mud unit in areas topographically unsuitable for ponding. The clay could be hauled by conventional methods, or clay slurry could be used to flood the pond.

Kerr-McGee Chemical Corp. is operating evaporation ponds on the silty mud unit east of the Trona Plant to enrich the brine before it is pumped into the plant. A relatively high leakage rate is tolerated.

The near-surface zone in several areas of the lake is relatively unknown and, if a more comprehensive knowledge of suitable ponding sites is desired, considerable time will have to be spent in exploration by either shallow trenching or augering holes. The most promising areas seem to be the southeast area, the east side of the lake, and the northern section of the lake immediately south of the Trona Airport. The major part of the surface covered by the silty mud is fee land or already under leasing agreements and is only available to the controlling company for ponding. This land does have potential for ponding, but before ponds are laid out detailed studies of the underlying sediments will have to be made because of ubiquitous silty horizons and sand stringers within the silty mud.

The areas underlain by exposed salt should generally be avoided because of the possibility of leakage and (or) leaching of the salt and because of possible contamination of the underlying brines which are pumped to the chemical plants.

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