BRIGHAM

YOUNG

UNIVERSITY

# GEOLOGY STUDIES

**Volume 19: Part 2 — December 1972**

## CONTENTS

# Brigham Young University Geology Studies

Volume 19, Part 2 — December 1972

## Contents

A publication of the
Department of Geology
Brigham Young University
Provo, Utah 84601

**Editor**

J. Keith Rigby

*Brigham Young University Geology Studies* is published semiannually by the department. *Geology Studies* consists of graduate student and staff research in the department and occasional papers from other contributors.

Distributed December 22, 1972

*Price $4.00*

# Recent History of Utah Lake as Reflected in Its Sediments: A First Report

Willis H. Brimhall
*Department of Geology, Brigham Young University*

ABSTRACT.—A core sample of sediment, extending from the upper surface of the present lake floor to a depth of 520 centimeters has been analyzed chemically to determine the variations in concentrations of Ca, Fe, P, Na, and Al. The profiles reflect such major historical events as the major fluctuations of the water level, and the air and water pollution of the lake.

The data can be used to calculate average sedimentation rates in recent years. The average rate in the past 40 years is approximately 3.3 centimeters per year and is mostly associated with precipitation of calcite. From about 1885 to 1935 the rate was approximately 2.6 centimeters per year.

The lower section of the core indicates a very low level and a high salinity of the lake waters 200 to 300 years ago.

In general this study points out a potentially useful method for determining some of the recent histories of lakes, for determining sedimentation rates, and for obtaining other useful environmental data.

CONTENTS



## INTRODUCTION

Sediments on the floor of Utah Lake reflect some of the history of the lake. Characteristics of each layer determine the physical conditions prevailing at the time of deposition, and since the layers are deposited on top of one another with the passage of time, it is possible to determine at least a portion of the history of the lake. Data from such samples are especially meaningful when time lines can be established which relate their characteristics to known historical events, especially those events associated with the settlement and urbanization of the land surrounding the lake.

The objective of the present study was to determine the chemical and mineralogical makeup of recent and near-recent sediments in Utah Lake. A suitable sample for a beginning was received from Mr. Robert F. Bolland, Department of Biology, University of Utah, who in September 1970 obtained a core of sediment, 10 centimeters in diameter, extending from the present surface of the lake bed to a depth of about 520 centimeters. The sediment sample consists of recent materials as well as some older materials deposited several hundred years ago, well before the settlement of the region. The sample obtained by Mr. Bolland was taken for the purpose of studying diatoms in the lake. He kindly consented to furnish materials for this study, which was begun in 1971.

The core sample was obtained from the lake bottom about two miles west of the shoreline adjacent to the Geneva Steel Plant.

The work herein reported is an integral part of a series of studies of Utah Lake conducted by the Center for Health and Environmental Studies at Brigham Young University. Such investigations include water chemistry and pesticide levels (Bradshaw et al., 1969, 1972) and biological characteristics of the lake (Eldredge, 1967; Hartman, 1970).

Previous studies on the sediments of Utah Lake have centered largely on particle-size distributions and mechanical properties (Bissell, 1942, 1963; Hunt et al., 1953).

A current engineering investigation related to the present study is the proposed Utah Lake diking project (Fuhriman et al., 1971).

## PROCEDURE

The sample core is mostly monotone gray, fine-grained sediment above 460 centimeters (Text-fig. 1). It consists mainly of calcite diluted by clay and minor amounts of quartz and other materials. Below 460 centimeters the sediment is composed principally of medium-grained quartz sand with a minor amount of silt. A thin layer of peat occurs within the sand layers at a depth of 490 centimeters.

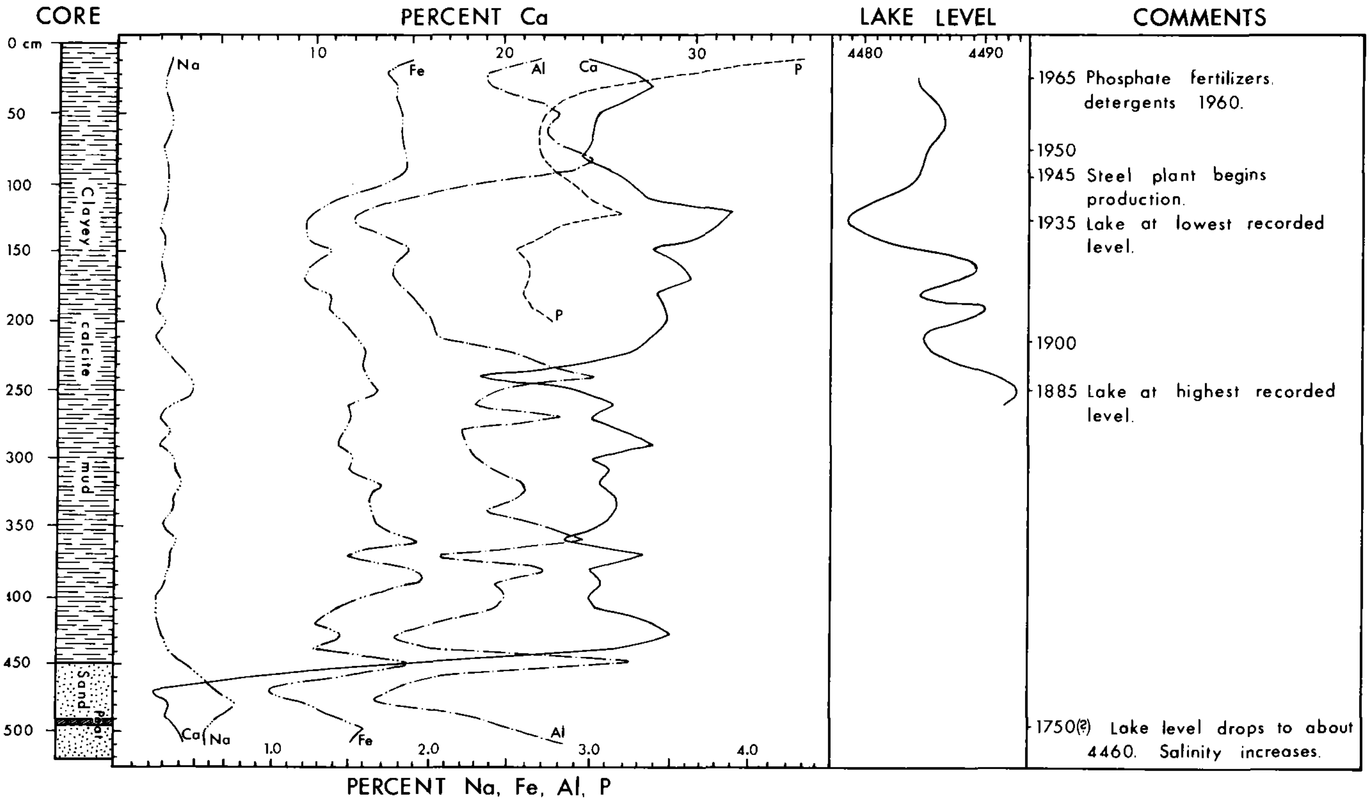
Ca and Al were selected as most representative of the two principal components, calcite and clay. Na was selected as an index to salinity of the lake but (as is shown later) was useful only in a single instance. Fe and P were selected as two elements which might be useful for establishing time lines in the sediments because of the airborne iron oxides emanating from the open-hearth furnaces of the Geneva Steel Plant since about 1945, and because of the widespread use of phosphate fertilizers and detergents in Utah Valley beginning about 1960.

To obtain profiles of these elements, one-gram samples were taken from each 10-centimeter interval of the core, beginning at the top. These samples were dissolved in HF-$HCLO_4$ mixed acid to obtain a solution of the contained metals. The resulting solutions were analyzed by atomic absorption spectrophotometry for Ca, Na, and Fe.

Separate samples of sediment were digested in concentrated $HNO_3$ to dissolve phosphate. The solution containing phosphate was subsequently removed from the insolubles and was precipitated as phosphomolybdate, which in turn was isolated and subsequently dissolved in ammonium hydroxide. P was determined indirectly by measuring Mo with atomic absorption spectrophotometry. Because of the labor involved in the procedure, only the upper portion of the core was analyzed for P.

## RESULTS AND DISCUSSION

Profiles of concentrations of the elements are plotted in Text-figure 1. The Ca profile is of prime interest because the sediments of the lake consist mainly of calcium carbonate. The profile demonstrates a peak of 33% Ca at 120 centimeters, and a low of 18% at 240 centimeters. These percentages correspond to 82% and 45% calcite, respectively. It is reasonable to associate the peak at 120 centimeters with the lowest level of the lake in 1934-35, when precipitation of dissolved matter should have been at a maximum.




TEXT-FIGURE 1.—Utah Lake sediment sample and associated profiles.

The low at 240 centimeters is assigned to the highest levels of the lake, which occurred in 1885. Since data of the yearly fluctuations of lake level extending to 1884 (Jordan River Pump Station, 1960) are available, the lake level as a function of time can be tied to the Ca profile as a function of time by use of the dates 1885 and 1935 mentioned above. This data is plotted in the upper right-hand corner of Text-figure 1. Note that the minor variations in both profiles are matched rather well: when the lake rises, Ca concentration in the sediment falls, and when the lake drops, the Ca rises. These regularities strongly suggest the correctness of the time assignments, and other data also support them.

Iron concentration in the sediments increases markedly at a depth between 80 and 110 centimeters. A plausible reason for the increase is the introduction of airborne iron-oxide dusts to the lake from the nearby Geneva Steel Plant, which began operation about 1945. Since that time, orange red dusts from the open-hearth furnaces have blanketed the vicinity with iron oxide and other effluents. Moreover, the marked increase of P near the top of the profile at about 20 centimeters depth is probably due to the increased use of phosphate fertilizers and detergents, beginning about 1960.

These data suggest that the time lines established in the upper section of the core are substantially correct. That portion of the core below about 300 centimeters can be assigned to presettlement times. Thus far it has not been possible to assign time lines in this section. However, the marked decrease in the element profiles at about 450 centimeters is due to a change of sediment composition from calcitic mud to quartz sand, presumably deposited along a shoreline established during an exceedingly low level of the lake about 250 years ago. If this interpretation is correct, the climate at this time must have been much drier than at present.

The foregoing data permit calculation of sedimentation rates—at least on a preliminary basis. Between 1935 and 1965, 100 centimeters of sediment accumulated—at an astonishingly high average rate of 3.3 centimeters per year. Between 1885 and 1935, 130 centimeters accumulated—at an average rate of 2.6 centimeters per year. The higher rate in later years probably can be attributed to increased inputs of sediments transported to the lake as solids and salts from agricultural and, later, from urban development. The principal component is calcite, which averages somewhat more than 60% of the sediment.

Projection of the recent sedimentation rate suggests that the lake, now at an average depth of about eight feet, or 240 centimeters, has an expected life of about 75 years! At that time, if present sedimentation rates are correct and continue, Utah Lake will be a mud flat.

It is not presently known whether the calculated rate is typical of the entire lake. The area from which the sample core used in this study was taken is located adjacent to no major drainages which might flush in unusually large amounts of sediment. Moreover, the main component of the sediment appears to be chemically rather than mechanically precipitated—calcite predominates over clay. Reference to the profile of Al in the core shows that it has an almost perfectly inverse trend to Ca. An increase of Ca corresponds to increased deposition of calcite, which "dilutes" the accompanying clay fraction containing Al. Since the major component of the sediment is calcite, accounting for the high rate of sedimentation is the same as accounting for the source of calcite. Ca is moved to the lake both as dissolved salt in surface and ground water and as detrital calcite entrained in muddy water draining into the lake. The relative importance of these sources is not yet assessed.

## PRESETTLEMENT HISTORY

The presence of sand in the interval 540-520 centimeters, an enclosed layer of peat at 490 centimeters, and the rapid rise in the Na concentration of the sediment indicate a drastic lowering of the level of Utah Lake and a large increase in its salinity. The sand and peat can be explained only by a lakeward migration of the shoreline, and the thickness of 70 centimeters for these sediments indicates a prolonged stay at that level.

If the sedimentation rate of 2.6 centimeters per year previously determined for the interval from 1885 to 1935 is extrapolated, the lowering of the lake took place about 1750. It is likely, however, that the sedimentation rate was somewhat lower in presettlement times and that the low stand of the lake took place sometime around the year 1700. In 1776, Father Escalante, one of the first white men to visit Utah Lake, noted its shoreline and the fine quality of its water. (Auerbach, 1944, p. 69.) The low stand must have taken place before this time.

The core sediments provide perspective on the history of the lake. It is commonly said these days that man has degraded the lake and its surroundings. It appears equally true, however, that nature did the same thing, and on a grander scale, a few hundred years ago. It is equally clear that nature restored the lake by the time the first white men came into the region. It is easily seen that it is an oversimplification to ascribe all environmental deterioration and restoration to the agency of man: nature degrades and nature restores, too. Such relationships are seen more clearly by studies such as this one, which is cast into a historical framework covering several hundred years or more.

## FUTURE WORK

The present study is based on a single core sample. The degree to which it represents the lake as a whole is as yet unknown. It seems imperative that at least a dozen more cores be taken from the length and breadth of the lake for further and more detailed examination. Some questions to be answered include (1) Are the high sedimentation rates found in this study typical of the whole? (2) What was the history of the lake beyond several hundred years ago? (3) What biological changes accompanied the low stand of the lake several hundred years ago? (4) What are the major sources of calcite in the lake sediment? (5) Is groundwater one of those major sources? (6) What is the expected life of the present lake basin? (7) How long will it be before the basin fills up with sediment? Future studies will be aimed at providing answers to these questions.

## CREDITS

This work was financed by a grant to the author from the Research Division of Brigham Young University, 1971-72. The work was encouraged by colleagues in the Center for Health and Environmental Studies and in the

Department of Geology at Brigham Young University. Mr. Robert F. Bolland, Department of Biology, University of Utah, took the core and made samples available.

## REFERENCES CITED

Auerbach, H. S., 1944, Father Escalante's journal, 1776-77: Utah Hist. Soc. Salt Lake City, Utah, p. 142.

Bissell, H. J., 1942, Preliminary study of the bottom sediments of Utah Lake: *in* P. D. Trask, [chm.], Report of the Committee on sedimentation: Natl. Research Council, Div. Geology and Geography Ann. Rpt. 1940-41. Exhibit H, p. 62-69.

———, Lake Bonneville: Geology of Southern Utah Valley, Utah: U. S. Geol. Survey Prof. Paper 257-B, 130 p.

Bradshaw, J. S., et al., 1969, The water chemistry and pesticide levels of Utah Lake: Proc. Utah Acad. Sci., v. 46, part 2, p. 81-101.

———, 1972., The chemical responses of Utah Lake to nutrient inflow: Jour. Water Pollution Control Federation, in press.

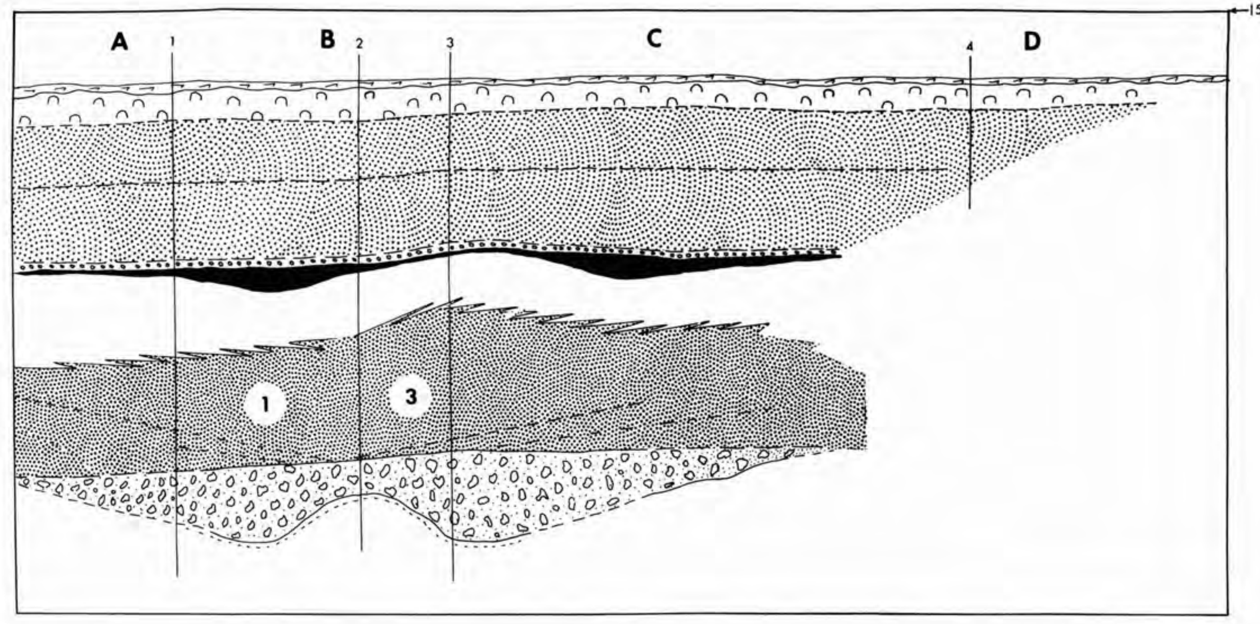
Eldredge, J. D., 1967, The effects of time and age on DDT concentration in the diet of white bass, *Rocus Chrysops,* of Utah Lake: unpub. M.S. thesis, Univ of Univ. of Utah, 22 p.

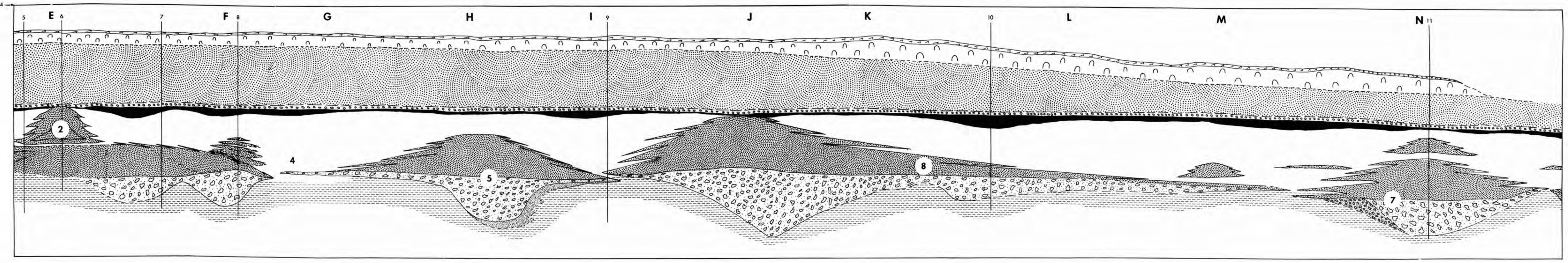
Fuhriman, D. K., et al., 1971, Progress report: Lake diking as a water quality management tool: Brigham Young Univ. Press, 19 p.

Hartman, L., 1970, Species of *Fungi Imperfecti* present in Utah Lake: unpub. M.S. thesis, Brigham Young University, 54 p.

Hunt, C. B., et al., 1953, Lake Bonneville: Geology on northern Utah Valley, Utah: U.S. Geol. Survey Prof. Paper 257-A, 99 p.

Jordan River Pumping Station, 1960, Fluctuation of water levels of Utah Lake.






1


2


3


4

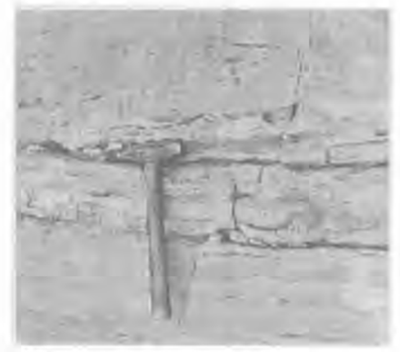

5


5a


1a


1b


2a


2b


5b


5c


6


2c


2d


2e


5d



7


8


9


10

0 1000 2000
Scale in feet