Environment Canada
Environnement Canada

National Water Research Institute
Institut National de Recherche sur les Eaux

BOREHOLE STRATIGRAPHY OF LAKE ERIE POSTGLACIAL DEPOSITS

By

J. P. Coakley

Inland Waters Directorate
Direction Générale des Eaux Intérieures

This manuscript will be published in the Proceedings
of the 3rd Workshop on Coastal Erosion and Sedimentation
November 1 - 2, 1982
and the contents are subject to change.

This copy is to provide information
prior to publication.

BOREHOLE STRATIGRAPHY OF LAKE ERIE

POSTGLACIAL DEPOSITS

By

J. P. Coakley

Shore Processes Section
Hydraulics Division
National Water Research Institute
Canada Centre for Inland Waters
November 1982

INTRODUCTION

La rive canadienne du lac Érie possède les plus grandes vitesses de recul qui ont été mesurées autour des Grands Lacs. L'évolution en course des rives se répercute sur l'utilisation du sol et les plans d'aménagement du lac, c'est pourquoi cette évolution intéresse toute le monde et justifie les recherches entreprises par la Division de l'hydraulique en ce qui concerne l'évolution à long terme de cette rive. L'étude sur la point Longue, brièvement résumée ici, fait partie d'un vaste effort pour expliquer la nature et la chronologie des positions de la rive du lac Érié et de ses différents niveaux d'eau à l'époque postglaciaire soit au course des 12 5000 dernières anées de notre ère.

MANAGEMENT PERSPECTIVE

The north shore of Lake Erie suffers the greatest recursion measured in the Great Lakes. Examination of the geological history of shore features such as Long Point provides insight into the evolution of that shoreline, and assists in development of a suitable model of the origin and growth of the Long Point Spit, in particular.

T.M. Dick
Chief
Hydraulics Division

PERSPECTIVES GESTIONNELLES

La rive nord du lac Érié subit actuellement le plus grand recul, qui a été mesuré autour des Grands Lacs. L'examen de l'évolution géologique des entités littorales comme celle de pointe Longue fournit un aperçu de l'évolution de cette rive et facilite la mise au point d'un modèle approprié expliquant plus particulièrement l'origine et la croissance de la flèche de sable qu'on y trouve.

Le Chef
de la Division
de l'hydraulique

BOREHOLE STRATIGRAPHY OF LAKE ERIE POSTGLACIAL DEPOSITS

by

J. P. Coakley
Hydraulics Division
National Water Research Institute

The Canadian shoreline of Lake Erie contains the highest recession rates measured on the Great Lakes. The impact of ongoing shoreline changes on land use and lake management plans is of general concern and serves as the underlying motivation for the Hydraulics Division's research into the long-term evolution of this shoreline. The study on Long Point briefly summarized here represents part of a comprehensive attempt to unravel the nature and time-history of Lake Erie shoreline positions and water levels over postglacial time (12,500 years ago to present).

Field Studies at Long Point

Field studies consisted of drilling and sampling a total of three deep boreholes on Long Point. This was done to provide a record of vertical and spatial sediment facies in one of the few sites of net shoreline deposition along the Lake Erie shoreline. The NWRI borehole positions and length are shown in Fig. 1, along with those of another borehole put down by Lewis (1966) for research purposes, and two wells drilled for water supply. Sample interval in the NWRI boreholes ranged from 1-2 m (BH1 and 2) to almost continuous (BH3).

Postglacial/Glacial Contact

The main target in the NWRI boreholes, the postglacial/glacial sediment interface (corresponding to the change from high-level glacial lakes to the low-level Early Lake Erie stage some 12,500 years ago) was encountered only in BH3, at around 20 m IGLD. This contact was recorded in the Lewis borehole at around 92 m. Joining these points provides a glacial sediment surface slope of approximately 3 m/km. West of BH3, the slope is initially much steeper (7 m/km), then flattens out to around 1 m/km. Because of the sparse data, the lack of information on the contact in the Lewis borehole, and the undetermined amount of prior erosion of the surface at BH3 and to the west, the original profile of this surface cannot be reconstructed. Thus, the Early Lake Erie shoreline position in the Long Point area can only be guessed at. However, it almost certainly lies between the Lewis borehole and BH3.

The contact in BH3 clearly represents a period of erosion and is topped by a thin shell/sand lag deposit. The nature and duration of this erosion episode are being investigated using one-dimensional consolidation testing (Terzaghi and Peck, 1967; Rominger and Rutledge, 1952). Initial results (Fig. 2) suggest that the underlying clay is overconsolidated, indicating an undetermined interval of erosion or desiccation or both.

Borehole Sedimentary Sequence

The upper portion of the sedimentary sequence below Long Point is typified by the section in BH3 (Fig. 2). Lewis' borehole penetrated other units down to bedrock., Boreholes 1 and 2 intersected only the uppermost portion. The section consistently comprised three postglacial units (clayey silt unit at the base, overlain by a silt/fine sand interbedded unit, with a clean sorted sand unit on top) overlying a stiff fine clay unit of glaciolacustrine origin.

The postglacial section in all the boreholes is characterized by a coarsening upward pattern, similar to patterns described off Presque Isle, at Pointe-aux-Pins, and the Point Pelee shoal. Its association with sandy forelands suggests that this pattern is an indication of the transgression of lake levels during postglacial time, which resulted in the migration shoreward of offshore sand barriers or spits (sand unit) over lagoonal or open bay fine sediments (clayey silt unit). The transitional fine sand/silt interbedded unit can thus be interpreted as a lower shoreface or spit platform deposit.

Such an evolutionary model is frequently evoked to explain transgressive sequences associated with the barrier islands of the eastern and southern U.S. coast (Kraft, 1971; Moslow and Heron, 1981). However, its applicability to the Long Point foreland will have to be confirmed by other work now in progress on the trends of subaerial dune/beach ridges of Long Point and on a revised model of postglacial lake levels in the Erie basin. Furthermore, borehole data from other parts of the Lake Erie basin are being compiled to define better the details of postglacial lake level trends.

Conclusions

The boreholes drilled on Long Point have provided information on subsurface sedimentary sequences and basal contact geometry which will assist in our understanding of the postglacial evolution of the Lake Erie shoreline, in general, and in developing a suitable model for the origin and growth of the Long Point spit, in particular.

References

Kraft, J. C., 1971. "Sedimentary Facies Patterns and Geologic History of a Holocene Marine Transgression". Geol. Soc. Am., Bull. 82, pp. 2131-2158.

Lewis, C.F.M., 1966. "Sedimentation Studies of Unconsolidated Deposits in the Erie Basin". Unpublished Ph. D. Thesis, University of Toronto, 135 p.

Terzaghi, K. and R. B. Peck, 1967. "Soil Mechanics in Engineering Practice". John Wiley and Sons, Inc., 729 p.

Moslow, T. F. and S. D. Heron, Jr., 1981. "Holocene Depositional History of a Microtidal Cuspate Foreland Cape: Cape Lookout, North Carolina. Mar. Geol. 41, pp. 251-270.

Rominger, J. F. and P. C. Rutledge, 1952. "Use of Soil Mechanics Data in Correlation and Interpretation of Lake Agassiz Sediments. Jour. Geology 60, pp 160-180.

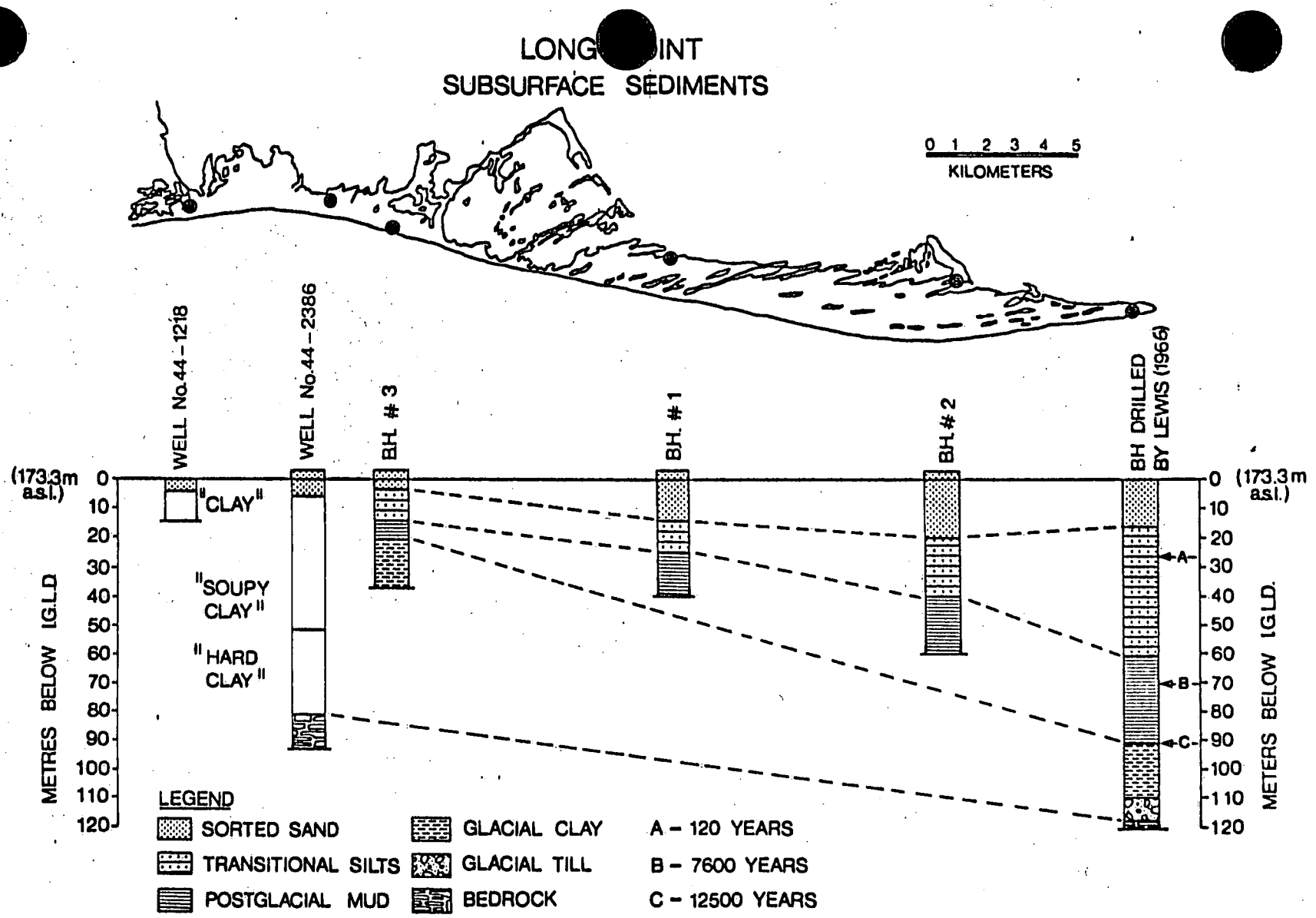

Figure 1 Location of all boreholes on Long Point (top) and an interpretative cross section (bottom) showing vertical distribution and inferred spatial correlation of sedimentary units. Age estimates shown beside the Lewis borehole are based on pollen data (A, B) and on the presumed age of Early Lake Erie (C).

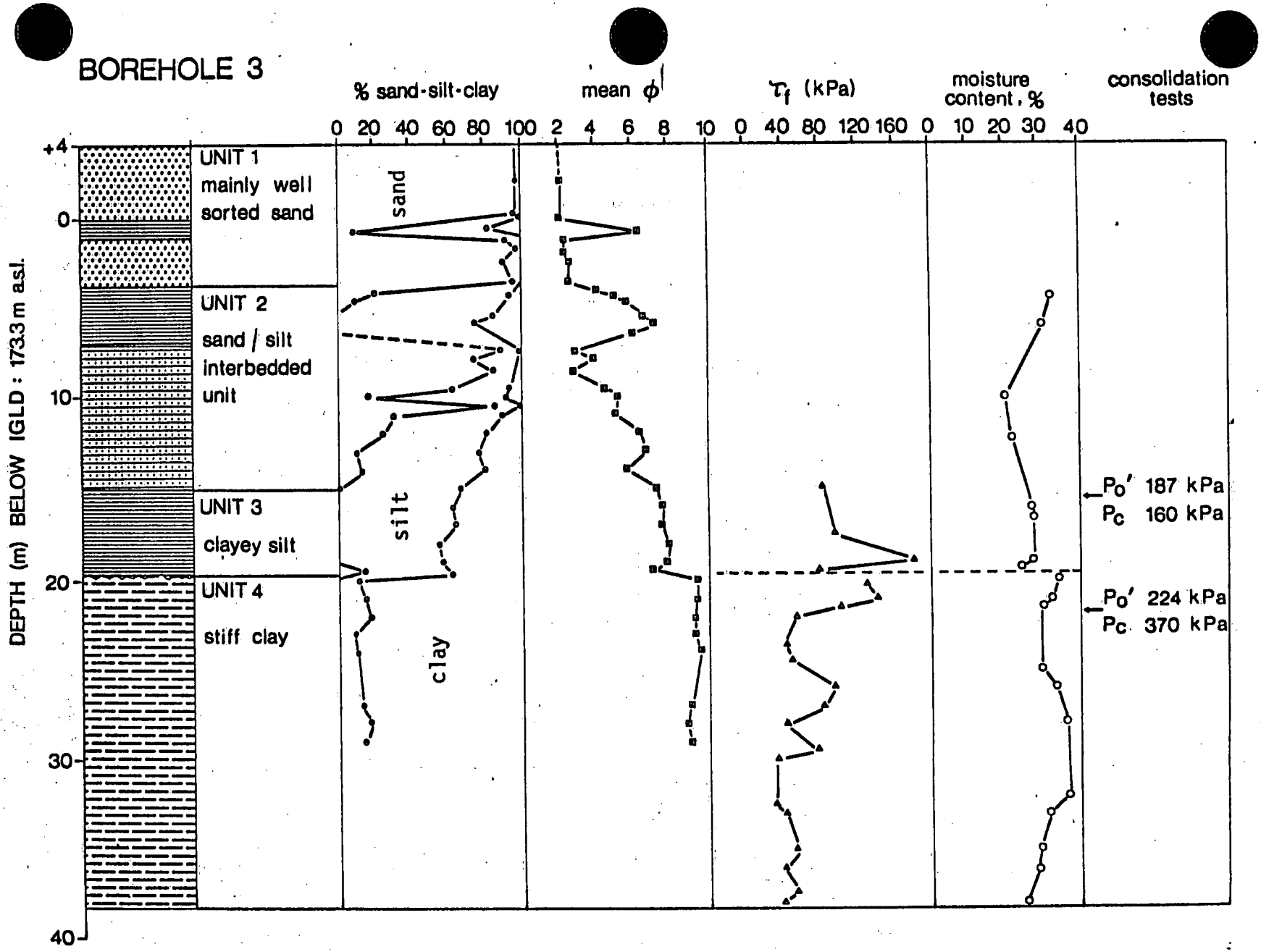

Figure 2 Borehole log of sedimentary units in BH 3. Also plotted are profiles of grain size relationships and geotechnical data. τ_f is based on measurements of undrained shear strength using a fall-cone test.

Date Due

BRODART, INC. Cat. No. 23 233 Printed in U.S.A.