The Geoarchaeology of the Peace Bridge Site, Fort Erie, Ontario

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Abstract:

The Peace Bridge site (AfGr-9) is a very large multi-component site situated at the head of the Niagara River in the Town of Fort Erie, Ontario. On-going archaeological investigations have documented occupations from the Late Archaic period (*circa* 3,580 B.P.) through to the present. Archaeological deposits, sediments, and paleosols exposed through construction activities, bore holes, test pits, and archaeological excavations, reveal the evolution of this riparian landscape and its colonization by Aboriginal peoples. This paper reviews the geoarchaeology of the site and outlines its implications for reconstructing paleoenvironment and interpreting Aboriginal land-use trends.

Introduction

SLIDE 1: TITLE SLIDE

SLIDE 2: EXTENT OF PEACE BRIDGE SITE

Since the spring of 1992, Archaeological Services Inc. has been undertaking salvage excavations at the Peace Bridge site in the Town of Fort Erie. This research has shown that a buried black organic paleosol, containing evidence of approximately 4,000 years of occupation, encompasses an area of more than 24 hectares (60 acres) surrounding the approach to the Canadian end of the Peace Bridge. This paper summarizes geoarchaeological investigations that have been carried out in order to better understand the paleoenvironmental context and formation processes of the site.

Physiography

SLIDE 3: LOCATION OF PEACE BRIDGE SITE

The Peace Bridge site is situated along the upper reach of the Niagara River where it meets Lake Erie. This reach is about 600 metres wide, 4 metres deep, and has an average current of about 13 kilometres per hour. Farther downstream, where the river deepens and widens, the flow drops to around 3 kilometres per hour. North of the Peace Bridge, the constricted river forms a series of rapids where it flows over the Fort Erie-Buffalo sill, a bedrock ridge which controls the level of Lake Erie. The valley is bordered by shelved dolostone and limestone pavements and low clay-plain bluffs. Below the higher bluffs of the Fort Erie moraine, the river has aggraded a floodplain approximately 400 metres wide. The Peace Bridge site is situated on this floodplain. Across the river, below the bluffs of the Buffalo moraine, the river has eroded the bank and the floodplain is much narrower. Although the current riparian environment hardly resembles its pre-settlement

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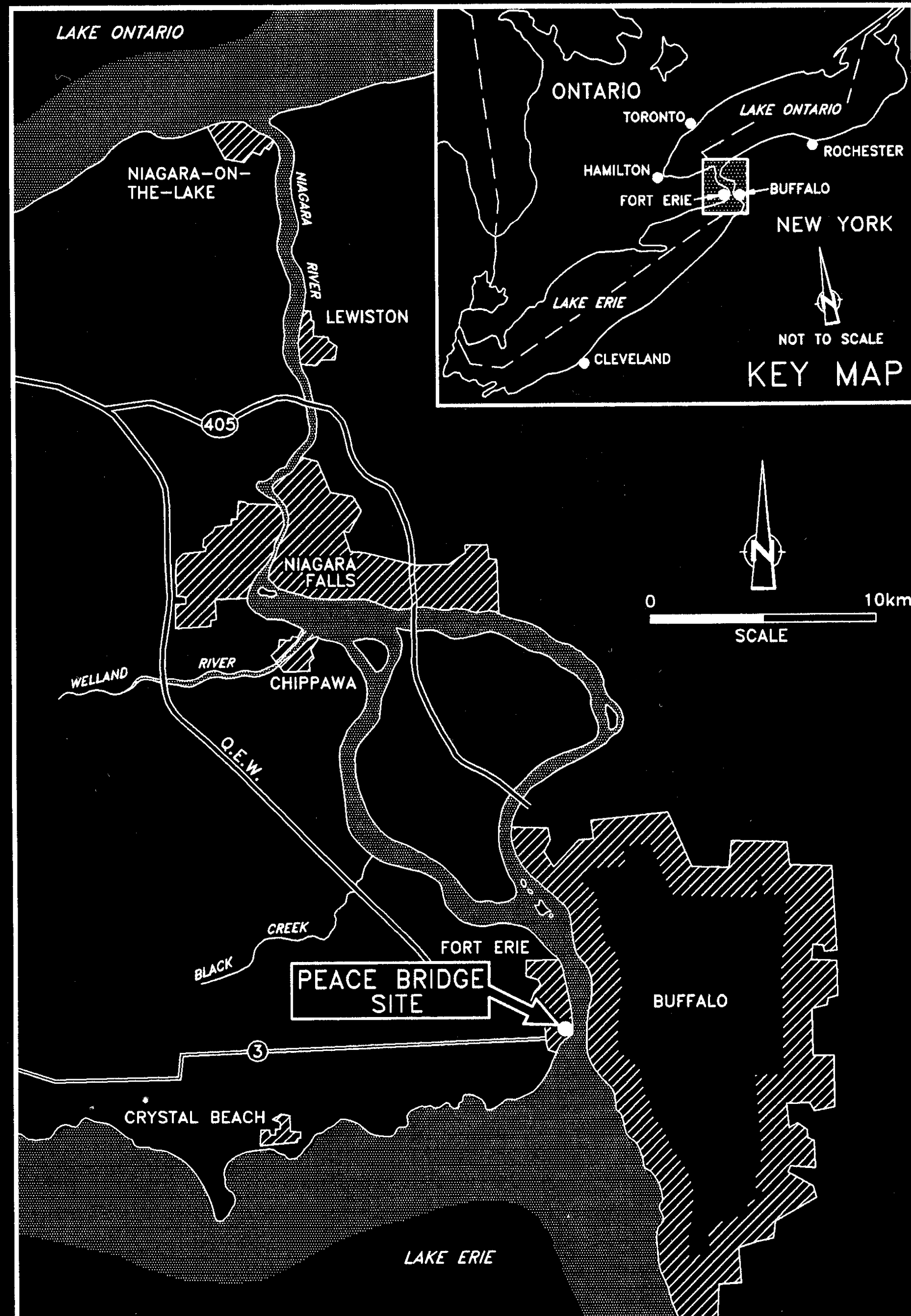
Areal extent of the Peace Bridge site.



The Niagara Frontier.

condition, nearby Navy Island may represent a remnant of this environmental zone.

Bedrock Geology

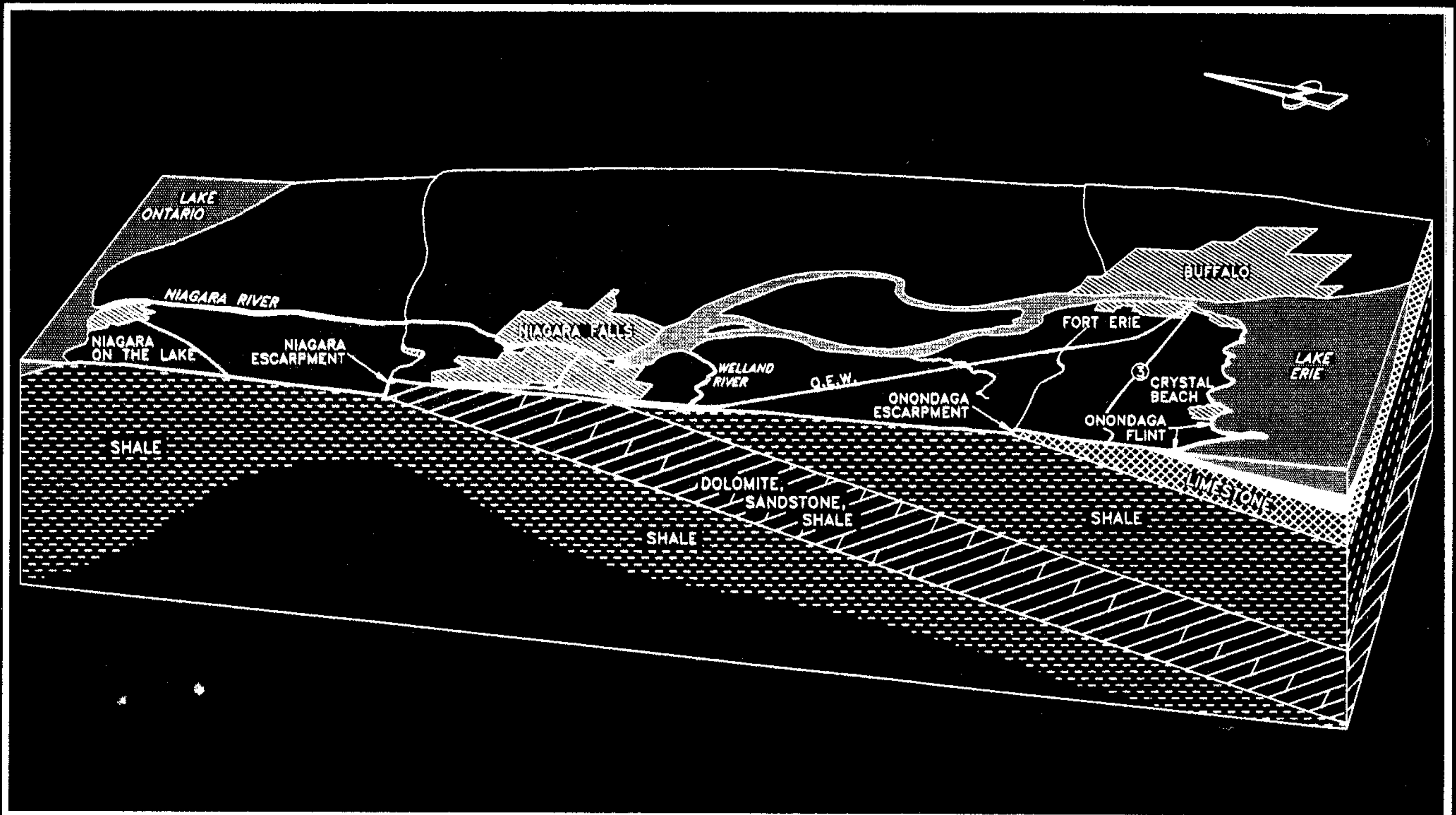
SLIDE 4: NIAGARA BEDROCK CUT-AWAY

The bedrock in the vicinity of the Peace Bridge site consists of dolostone and cherty limestone of upper Silurian and lower Devonian age that slopes gently towards Lake Erie. In areas to the east and west of the Niagara River, these form the striking and ecologically significant Onondaga Escarpment. The chert-rich Clarence Member of the Onondaga Formation outcrops extensively on most of the north shore of Lake Erie from Fort Erie to Nanticoke (Telford and Tarrant 1975; Parkins 1977:86). Commonly known as Onondaga chert, this material was the most widely used toolstone throughout regional prehistory. The Clarence Member underlies the Peace Bridge site and is exposed along the Niagara River waterfront. As the strike of the Onondaga Formation runs roughly east-west (Buehler and Tesmer 1963), it seems likely that Onondaga chert would also have been available to prehistoric peoples along the east side of the river, however, land development has modified the Buffalo waterfront to such an extent that confirmation of this hypothesis is very difficult. Elsewhere on the New York side of the river, the Onondaga Formation is largely buried by Quaternary deposits (Cadwell *et al.* 1986), except along the Onondaga escarpment, where occasional outcrops of chert may have been available (P. Calkin, J. Holland, personal communications 1997).

Quaternary Geology

SLIDE 5: QUATERNARY GEOLOGY OF FORT ERIE AREA

The bedrock ridge of the Onondaga escarpment, which constitutes the most noteworthy topographic feature of the southeastern Niagara peninsula, has been subdued by a series of Late Wisconsinan


LAKE ONTARIO
NIAGARA RIVER
NIAGARA ON THE LAKE
NIAGARA ESCARPMENT
NIAGARA FALLS
WELLAND RIVER
Q.E.W.
BUFFALO
FORT ERIE
3
CRYSTAL BEACH
LAKE ERIE
ONONDAGA ESCARPMENT
ONONDAGA FLINT
SHALE
DOLOMITE, SANDSTONE, SHALE
SHALE
SHALE
LIMESTONE

Surficial Geology

Peace Bridge Site

LEGEND

- × Bedrock outcrop
- ● Data Station
- ⚒ Quarry
- Surficial topography contour line
- Probable paths of iceberg scour
- Raised shorelines

RECENT	
10	Fill
9	Modern Lake Erie Beach Deposits: sand
8	Dune Sand
7	Alluvium: undifferentiated gravel, sand, silt, clay, muck
PLEISTOCENE	
6	Upper Glaciolacustrine Beach or Nearshore Deposits: coarse gravel, gravelly sand, sand
5	Upper Glaciolacustrine Clay Deposits: clayey silt to silty clay
4	Halton Till: silty clay facies
3	Halton Till: silty sand facies
2	Lower Glaciolacustrine Clay Deposits: clayey silt, silty clay
PALEOZOIC	
1	Bedrock: undifferentiated limestone, dolostone, shale

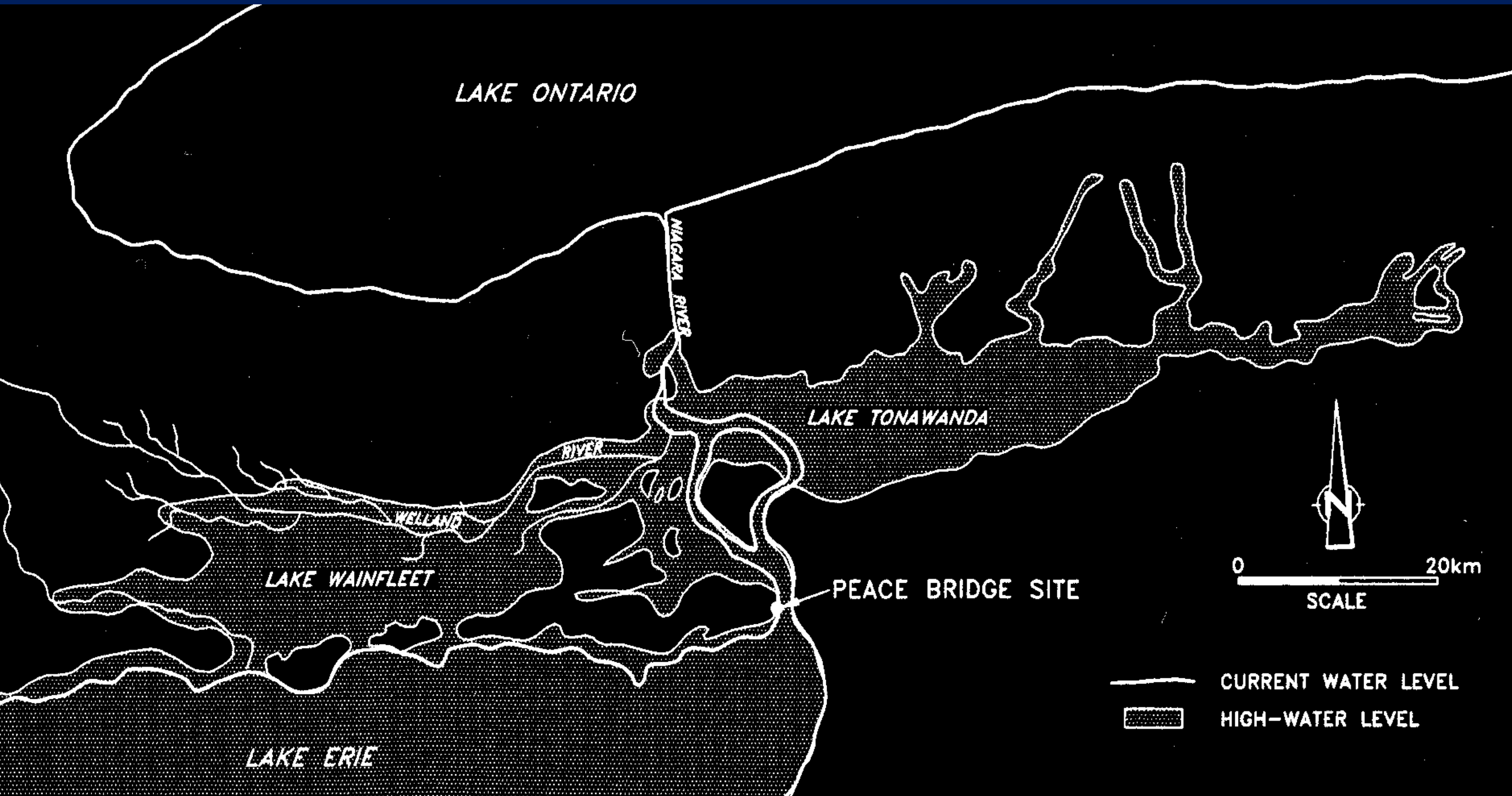
deposits. The most extensive of these is a blanket of glaciolacustrine sediments that was deposited during the Mackinaw interstadial between 14,000 and 13,000 years ago. Readvance of the Erie lobe then deposited the complex suite of Halton diamictons during the Port Huron stadial around 13,000 years ago. A brief pause in the following glacial retreat built the Fort Erie moraine, a feature that is about 6.5 km long, up to 1.5 km wide, and rises about 7 metres above the Onondaga cuesta dipslope.

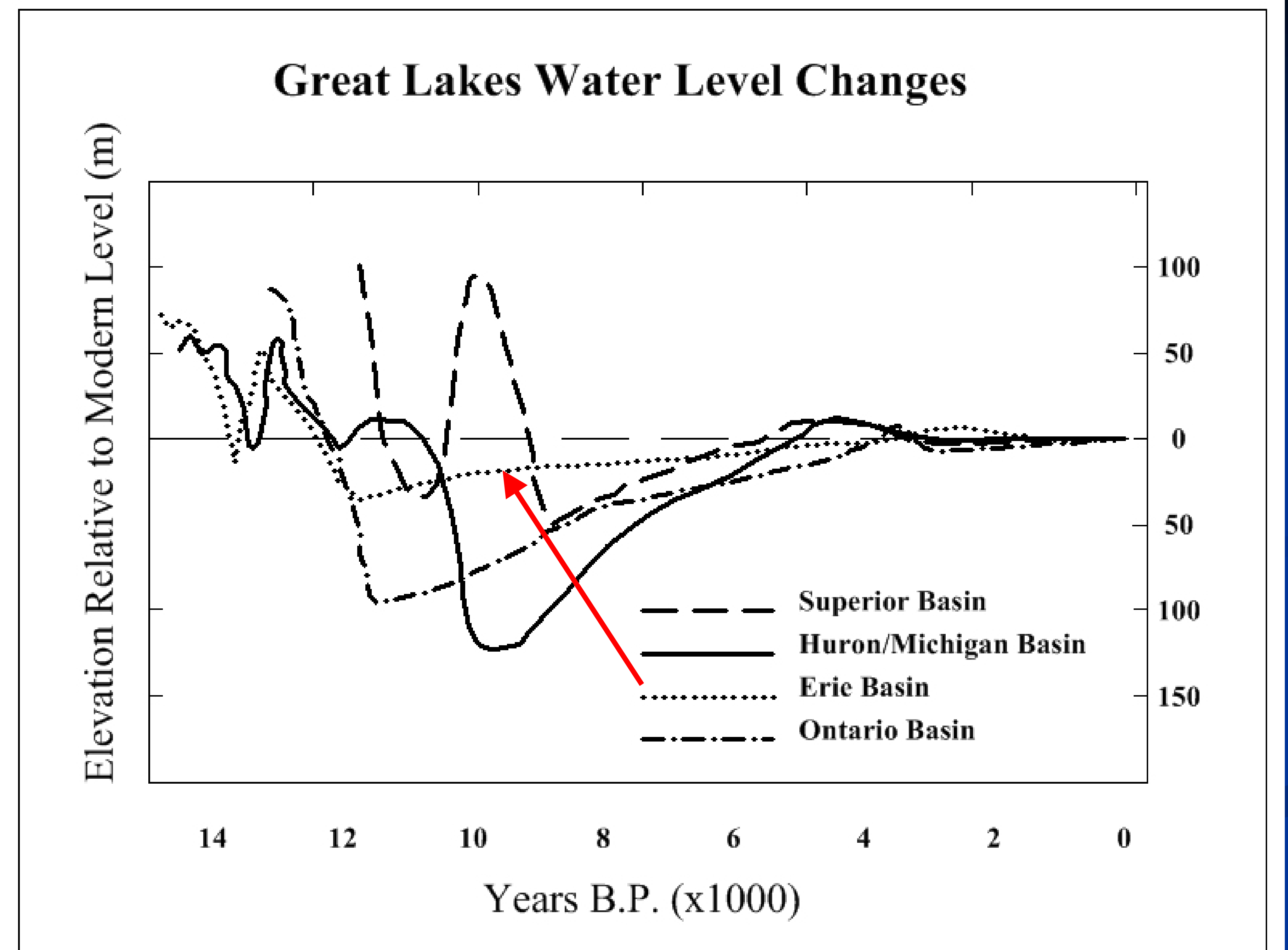
SLIDE 6: LAKES WAINFLEET & TONAWANDA

As the ice front retreated to the Niagara Escarpment, a series of proglacial lakes inundated the Niagara Peninsula to the south and laid down deposits of finely laminated clay and silt. When the ice retreated beyond the Niagara Escarpment around 12,400 B.P., flow via the Niagara River over the falls began, marking the beginning of early Lake Erie. Residual waters ponded between the Onondaga and Niagara escarpments formed lakes Tonawanda and Wainfleet on the American and Canadian sides of the Niagara River, respectively (Calkin and Feenstra 1985:163); Douglas 2003; Feenstra 1981).

SLIDE 7: LAKE LEVEL CHANGES

The evolution of Lake Erie since its inception is characterized by a complex sequence of fluctuating levels controlled largely by variations of inflow from the Huron basin, and by changes in the controlling sills of the Niagara River attributable to the countervailing effects of erosion and isostatic rebound. Meteorological conditions have also contributed to fluctuations in lake level. Annual fluctuations historically range about a metre on average, although extreme rises of up to 2.4 metres have been recorded. From deglaciation until around 10,000 BP, a sill at Fort Erie/Buffalo (~170 m asl) was in control. During this time, the main highstand of Lake Algonquin (*ca.* 11,200 - 10,200 B.P.) attained an elevation of 180 m in the Huron basin and likely contributed waters to Lake Erie.


LAKE ONTARIO
NIAGARA RIVER
LAKE TONAWANDA
RIVER
WELLAND
LAKE WAINFLEET
PEACE BRIDGE SITE
LAKE ERIE
N
0
20km
SCALE
CURRENT WATER LEVEL
HIGH-WATER LEVEL



Great Lakes Water Level Changes
Elevation Relative to Modern Level (m)
100
50
0
50
100
150
Superior Basin
Huron/Michigan Basin
Erie Basin
Ontario Basin
14
12
10
8
6
4
2
0
Years B.P. (x1000)

Control then switched to the Lyell/Johnson sill (~173 m asl) at Niagara Falls, as isostatic rebound raised it to, and eventually about 3 metres above, the Fort Erie/Buffalo sill. Water became ponded again within the Tonawanda/Wainfleet basin at this time, as water levels there approached or achieved confluence with Lake Erie (Douglas 2003: 181; Pengelly *et al.* 1997).

SLIDE 8: EXTENT OF PEACE BRIDGE SITE WITH PROFILE & SAMPLING SITES

At the Peace Bridge site, between the waterfront and the base of the Fort Erie moraine scarp to the west, the river terrace ranges in elevation from about 174 to 178 metres above sea level, while the brow of the moraine stands at around 183 m asl. This suggests that the terrace was eroded in early postglacial times and implies generally lower water levels in the Erie basin immediately thereafter (Calkin and Brett 1978; Tinkler *et al.* 1992:231-232).

Sedimentation resumed in the vicinity of the Peace Bridge site around 10,000 years ago, as water levels rose to meet the elevation of the Lyell/Johnson sill.

SLIDE 9: BEACH PIT PROFILE

This is confirmed by a radiocarbon date of 9,890 +/- 80 B.P. from the base of a five-metre-deep sedimentary profile at the Beach Pit profile of the Peace Bridge site (Douglas 2003).

SLIDE 10: BEACH PIT POLLEN SPECTRUM

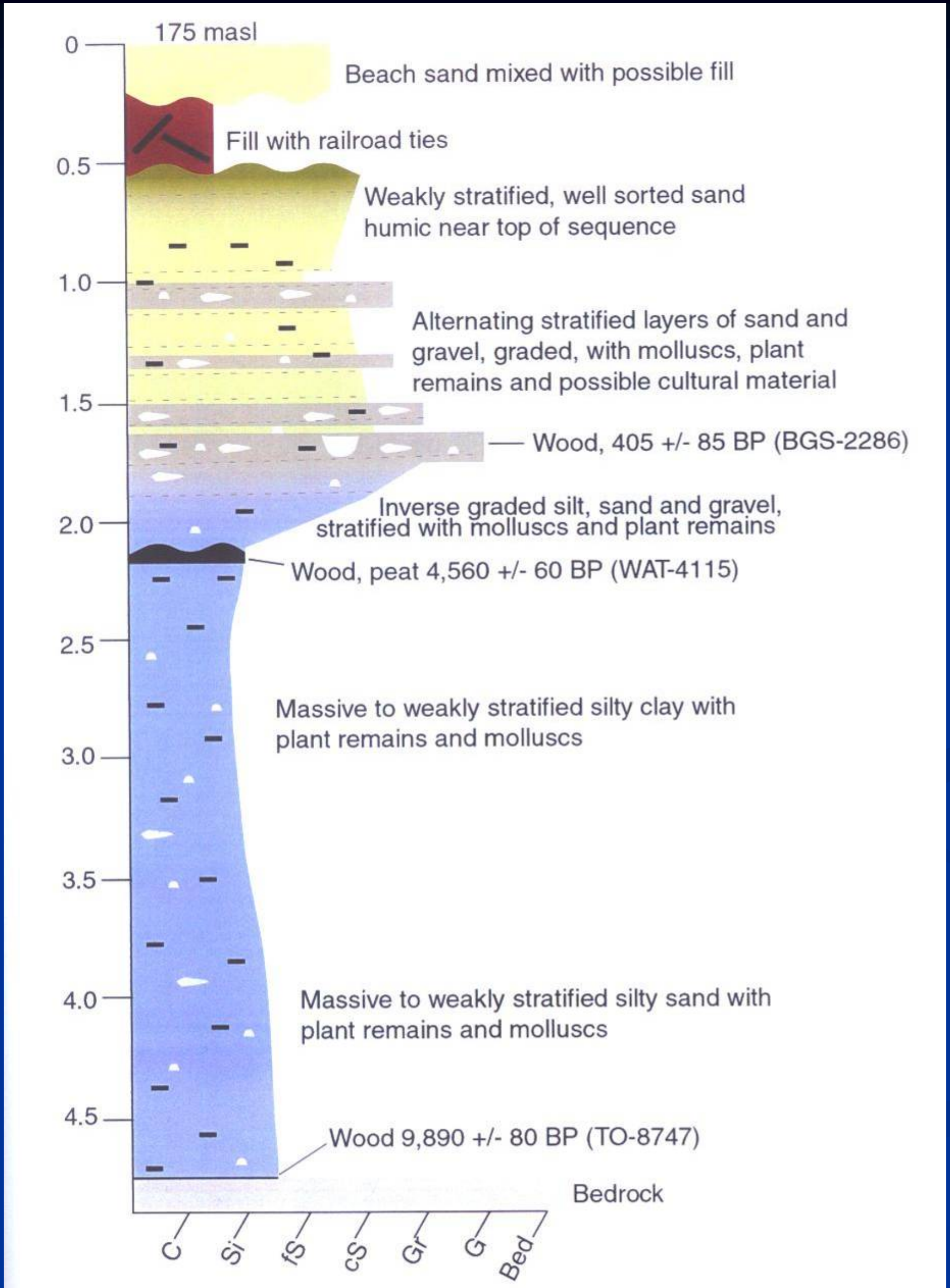
A pollen spectrum compiled from this profile records a wetland succession from a deep, open-water wetland to a shallow marsh between 9,890 and 7,500 B.P. This spectrum also records the return to a deep water marsh environment in an interval consistent with the Nipissing I rise of Great Lakes water levels between 5,500 and 4,700 B.P. Water levels at the Peace Bridge site dropped again after the Nipissing I transgression and remained low enough for a shrub-carr wetland community to develop. This community is indicated by pollen and a woody peat layer in the sedimentary profile,

Areal extent of the Peace Bridge site.

Beach Pit Profile & Sampling Site

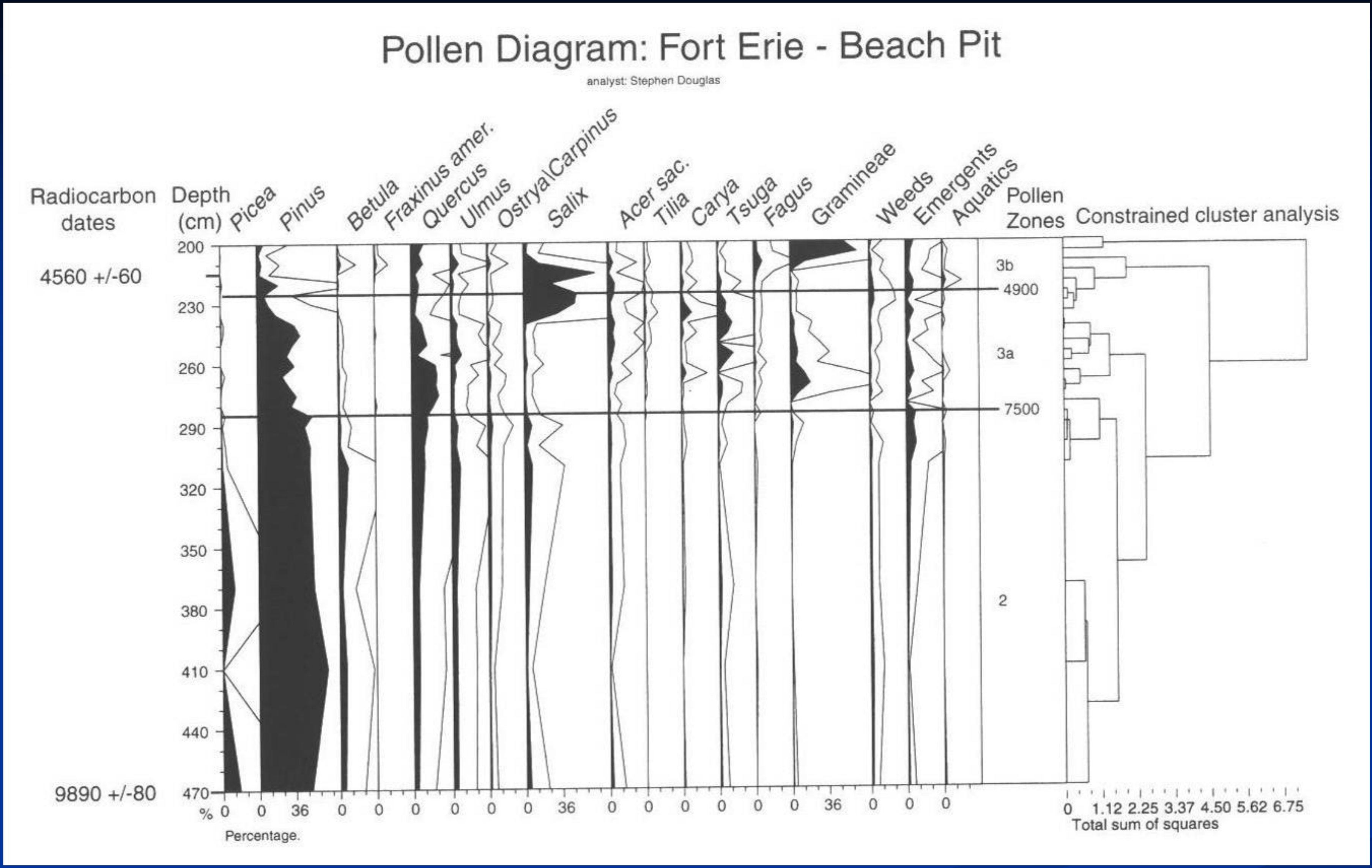
Truck Pad Profile & Sampling Site

Pier 2 Profile and Sampling Site



Stratigraphy of the Beach Pit, with note of radiocarbon dates.

The colouring of the section approximates that of the sediments.



Pollen diagram from the lacustrine sediments at the Beach Pit, showing depth, radiocarbon dates, inferred pollen zones, relative dates based on pollen zonation, and a constrained cluster analysis.

which has been radiocarbon dated to 4,560 +/- 60 B.P. Sometime after this date, water levels once again rose during the Nipissing II transgression, which has been dated elsewhere to between 4,300 and 4,000 B.P. Nipissing II brought water levels up to around 180 metres, thereby inundating the entire floodplain terrace. Pollen, plant macrofossil, and mollusc assemblages suggest the development of a deep-water marsh or open-water environment at this time. Nipissing II ended with the lowering of waters to near modern levels between about 3,800 and 3,900 B.P. This lowering of water levels seems to have been linked to erosion of the Lyell-Johnson sill at Niagara Falls and the return of control for Lake Erie levels to the Fort Erie-Buffalo sill. With this change, a gradient was established between the upper Niagara River and the Fort Erie-Buffalo sill. Depositional conditions in the upper Niagara River were thus transformed from lacustrine to alluvial for the first time since before 10,000 B.P.

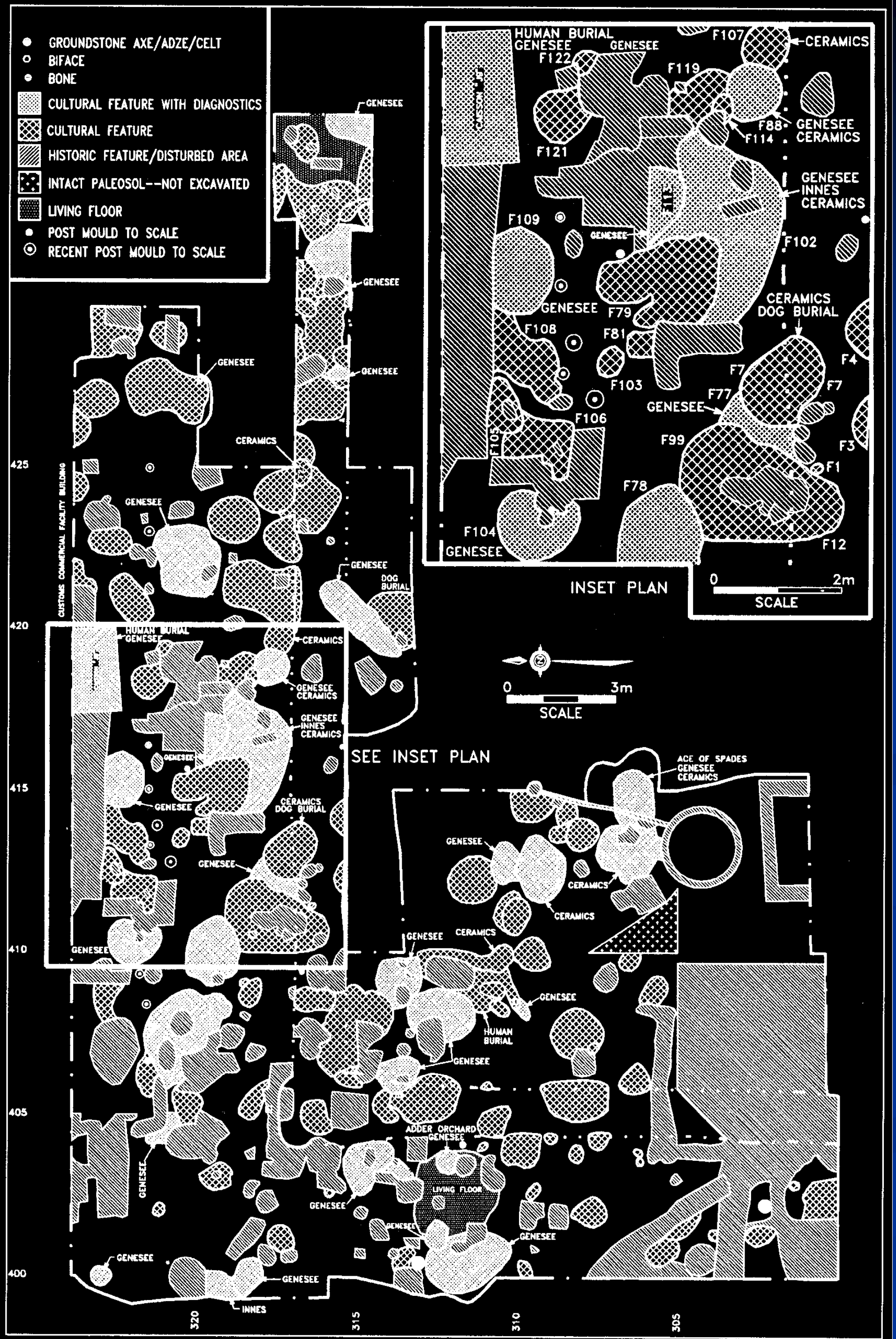
SLIDE 11: STEPHEN DOUGLAS AT BEACH PIT PROFILE

This transition is reflected in the sedimentary profile at the Peace Bridge site, where lacustrine clay is overlain by alluvial sands. Although it is possible that the higher, western margins of the floodplain terrace may have been occasionally exposed earlier, the current terrace seems to have finally emerged at about this time.

SLIDE 12: TRUCK PAD FEATURES

Supporting evidence for this comes from the earliest clear evidence for human occupation of the Peace Bridge site, which is attributable to Late Archaic period. Nut shell from two of these Late Archaic deposits has yielded radiocarbon dates of 3,470 B.P. +/- 60 and 3,580 B.P. +/- 60, respectively.

Lacustrine/alluvium transition at the Beach Pit. Stephen Douglas points to dark gray lacustrine silty clay that coarsens upward into coarse sand alluvium.



Pre-contact Aboriginal cultural features at Truck Pad Locality, Peace Bridge site.

Carbonized nut shell from Late Archaic period features has yielded radiocarbon dates of 3,470 B.P. +/- 60 and 3,580 B.P. +/- 60.

Throughout the last three millennia, water levels in the Erie basin appear to have been largely within the modern range due to the relative stability of inflow and the controlling sill, although isostatic rebound continues to gradually lift the north shore. Meteorologically produced lake-level fluctuations also occur, and several short-term rises have been suggested (Pengelly *et al.* 1997).

Soils

SLIDE 13: ROB & DEB IN HOLE

The soils of the southeastern Niagara Peninsula are typically dominated by compacted, level, poorly drained, acidic clays of glacio-lacustrine origin. Better drained loams and clay loams, however, are associated with the till deposits of the Crystal Beach and Fort Erie Moraines, while coarser, well-drained soils are associated with glaciolacustrine beach/ off-shore bar deposits and more recent eolian and wave-deposited sediments of the Lake Erie coast.

At the Peace Bridge site the soil parent material is typically alluvial sand generally over 2 metres deep. A dark, organic A horizon has developed on this sand as well as a light brown B horizon. These horizons are often encountered as a buried paleosol overlain with various fill matrices and asphalt. The topsoil horizon frequently contains large quantities of prehistoric cultural material, especially lithic debitage. These soils are porous and well drained.

Boreholes suggest some variability in the bedrock topography. Deep excavations near the Peace Bridge reveal sand overlying a thin, cherty gravel lag resting on bedrock at a depth of less than 2 metres. Excavations and boreholes farther north, however, indicated deeper deposits, with 2 metres

of alluvial sand overlying 3 metres of lacustrine clay. Gleying at depths below about 2 metres demarcates the water table, which roughly corresponds to the elevation of the river (McGlone & Associates 1993). This suggests that significant rises in the river level would have affected the drainage properties of these soils through the raising and lowering of the water table.

SLIDE 14: PALEOSOL ANALYSIS - STRUCTURE

Direct evidence of periodic inundation of the Peace Bridge site has been encountered in the course of excavations south of the Peace Bridge. At Pier 2, two buried paleosols have been documented, one directly overlying the other. Analysis of soil structure,

SLIDE 15: PALEOSOL ANALYSIS - PARTICLE SIZE

particle size,

SLIDE 16: PALEOSOL ANALYSIS - SAND FRACTION

sand fraction,

SLIDE 17: PALEOSOL ANALYSIS – pH

pH,

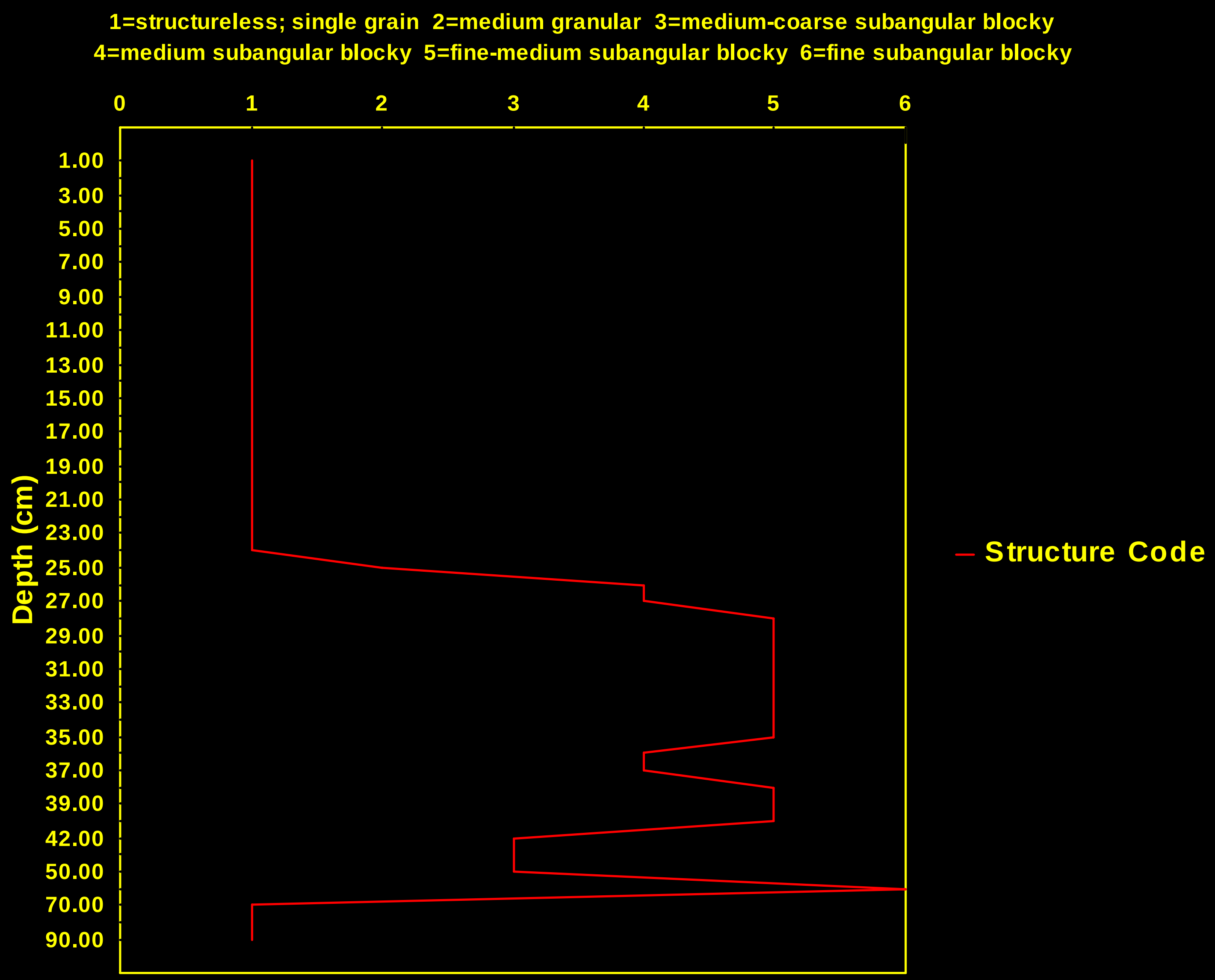
SLIDE 18: PALEOSOL ANALYSIS – PERCENT OF CALCIUM CARBONATE EQUIVALENT

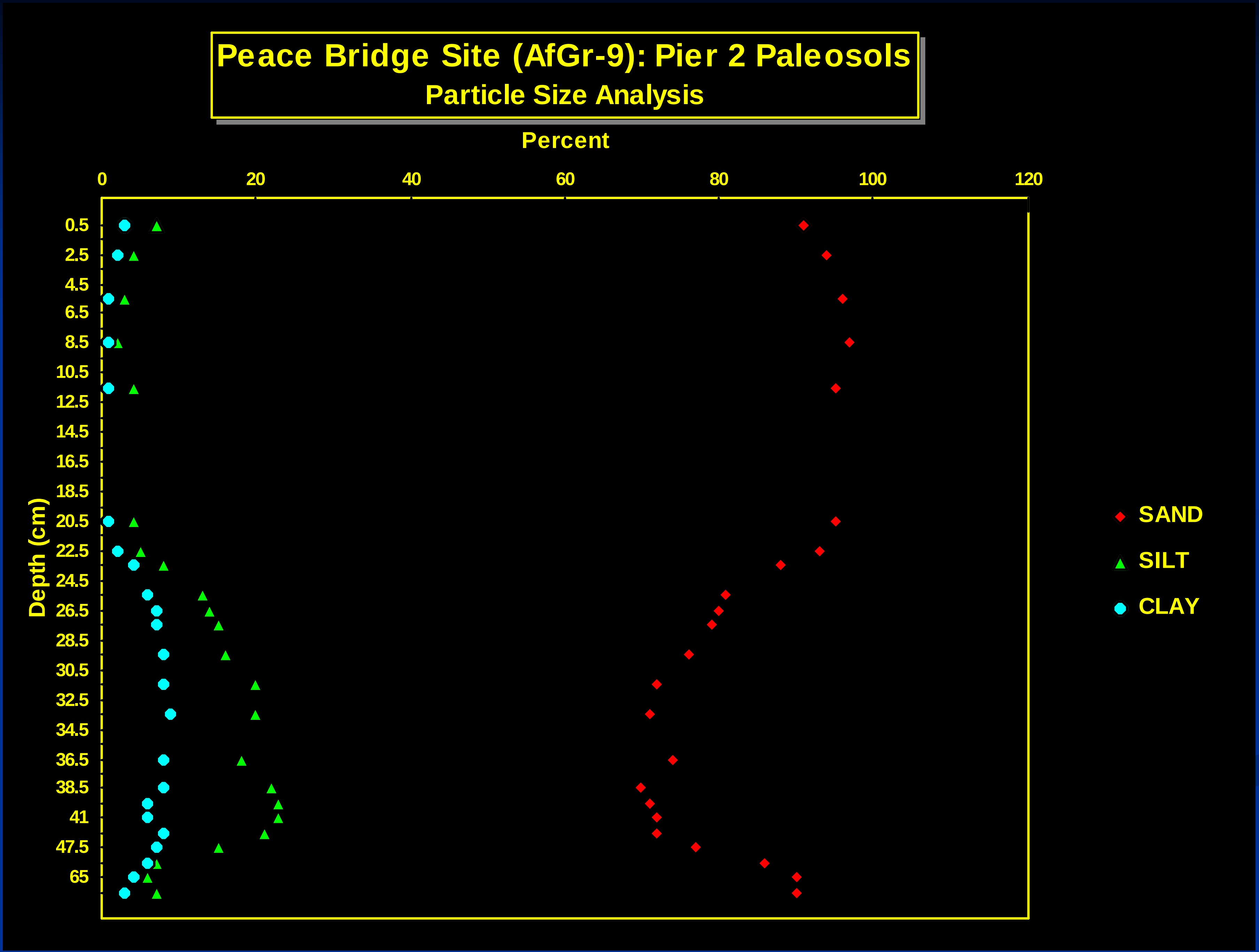
percent of calcium carbonate equivalent,

SLIDE 19: PALEOSOL ANALYSIS - ORGANIC CARBON

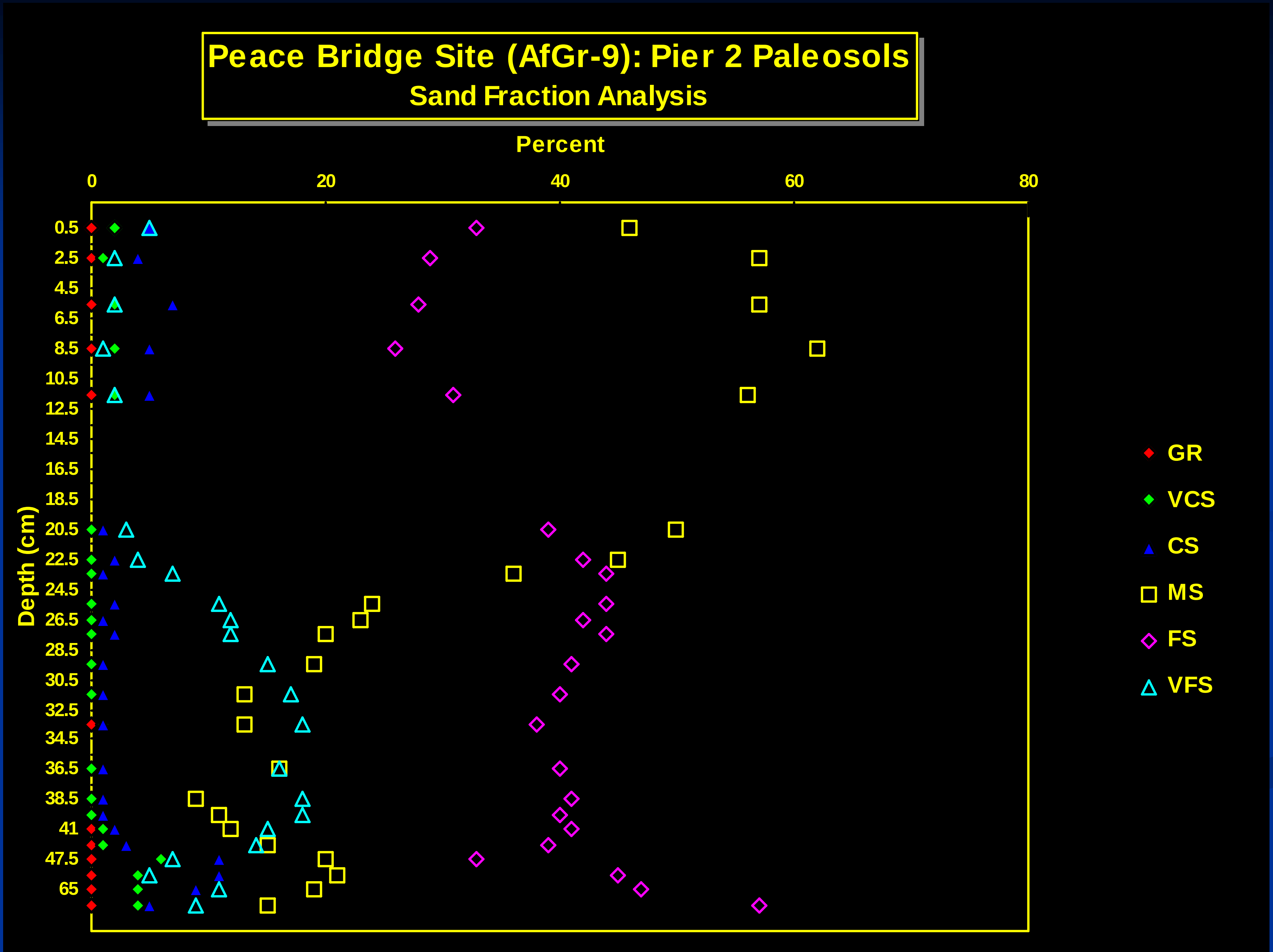
and organic carbon indicate that the lower horizon is a Brunisolic paleosol which developed on a relatively stable surface of silty sand over an extended period. The upper horizon, which has developed on a somewhat more coarse deposit of sandy alluvium approximately 20 cm thick, appears to be an immature Regosol. This preliminary classification is based on its less well-developed stratification and a relatively lower proportion of organic material in its A horizon. The

Peace Bridge Site (AfGr-9): Pier 2 Paleosols
Soil Structure Analysis



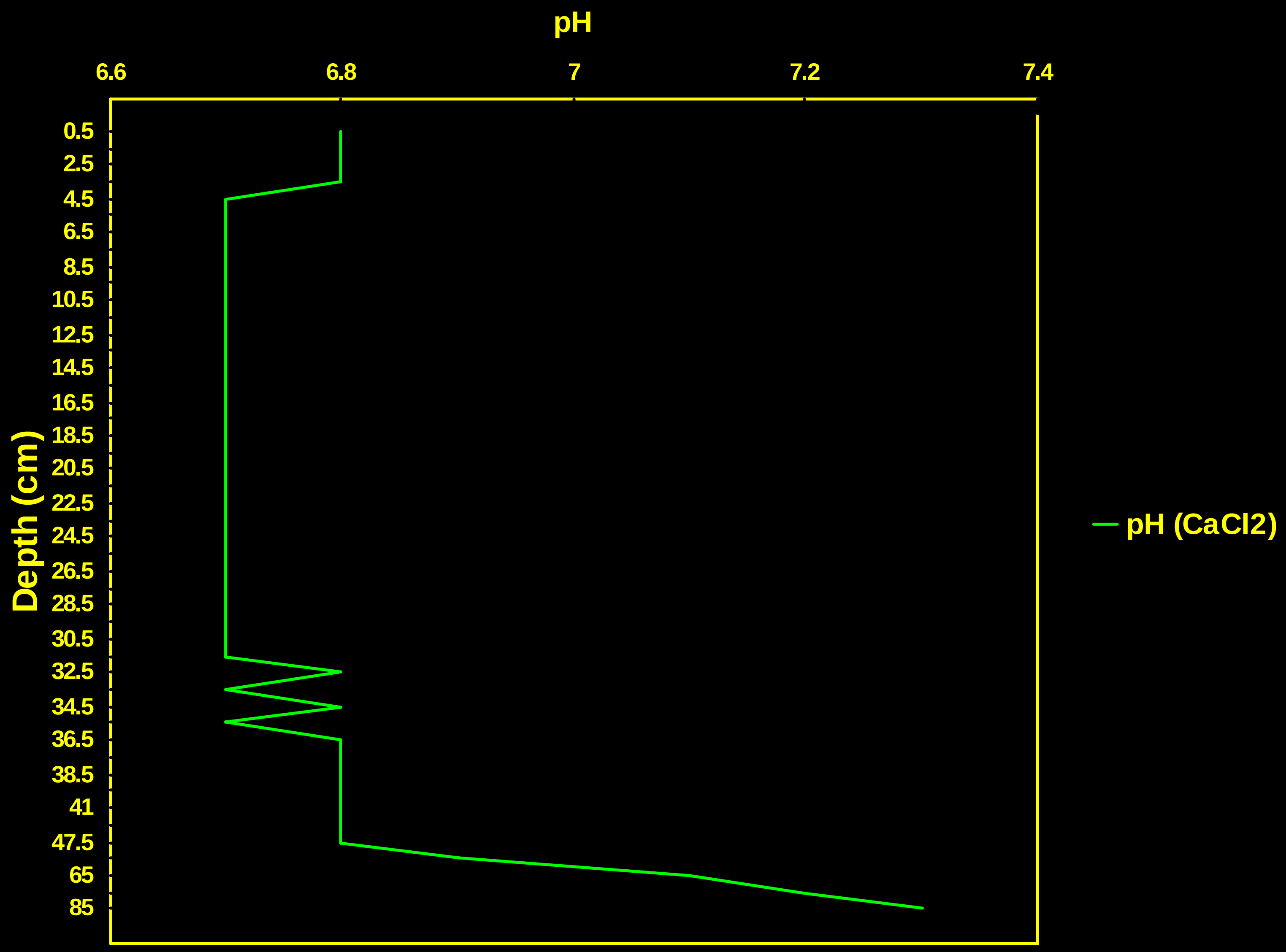


Peace Bridge Site (AfGr-9): Pier 2 Paleosols
Particle Size Analysis
Percent
0
20
40
60
80
100
120
Depth (cm)
0.5
2.5
4.5
6.5
8.5
10.5
12.5
14.5
16.5
18.5
20.5
22.5
24.5
26.5
28.5
30.5
32.5
34.5
36.5
38.5
41
47.5
65
SAND
SILT
CLAY


Peace Bridge Site (AfGr-9): Pier 2 Paleosols
Sand Fraction Analysis
Percent
0
20
40
60
80
Depth (cm)
0.5
2.5
4.5
6.5
8.5
10.5
12.5
14.5
16.5
18.5
20.5
22.5
24.5
26.5
28.5
30.5
32.5
34.5
36.5
38.5
41
47.5
65
GR
VCS
CS
MS
FS
VFS

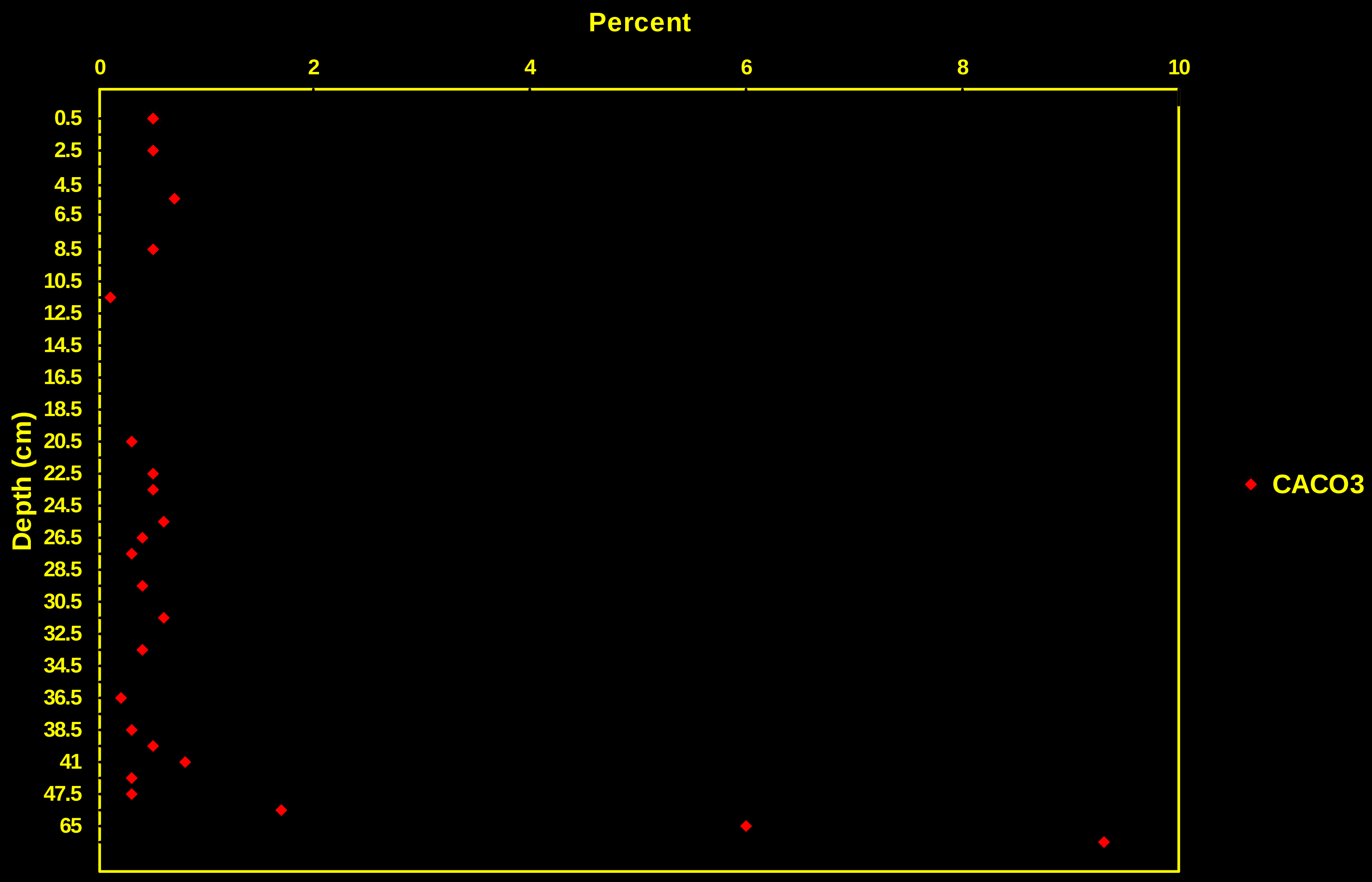
Peace Bridge Site (AfGr-9): Pier 2 Paleosols

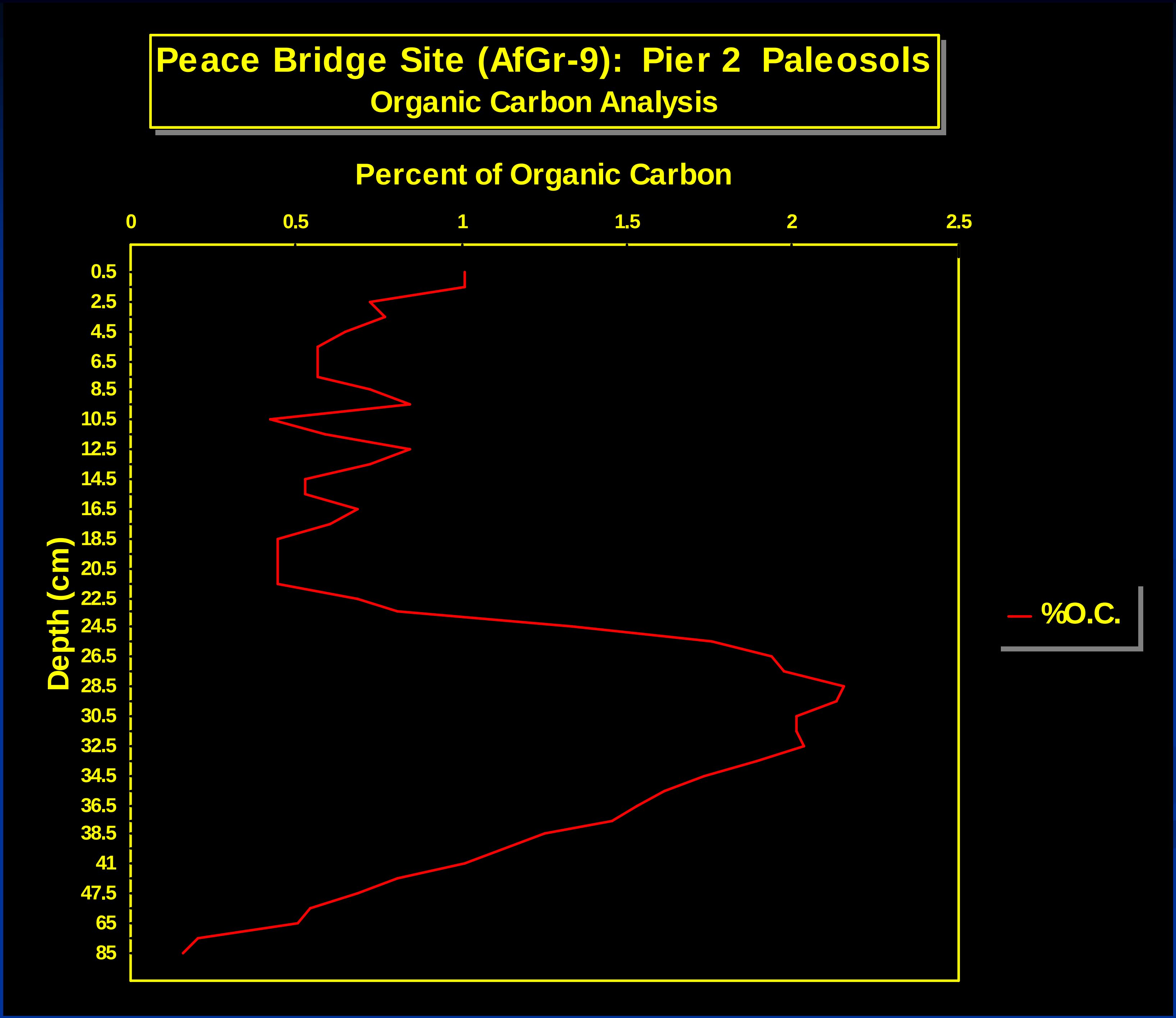
pH Analysis



Peace Bridge Site (AfGr-9): Pier 2 Paleosols

Calcium Carbonate Analysis





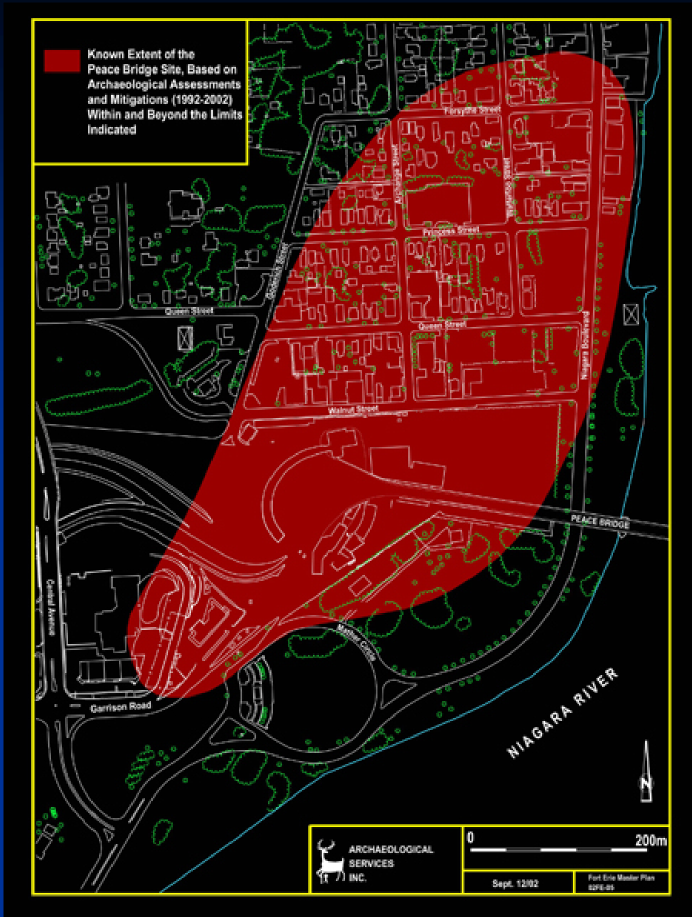
Peace Bridge Site (AfGr-9): Pier 2 Paleosols
Organic Carbon Analysis
Percent of Organic Carbon
0
0.5
1
1.5
2
2.5
Depth (cm)
0.5
2.5
4.5
6.5
8.5
10.5
12.5
14.5
16.5
18.5
20.5
22.5
24.5
26.5
28.5
30.5
32.5
34.5
36.5
38.5
41
47.5
65
85
%O.C.

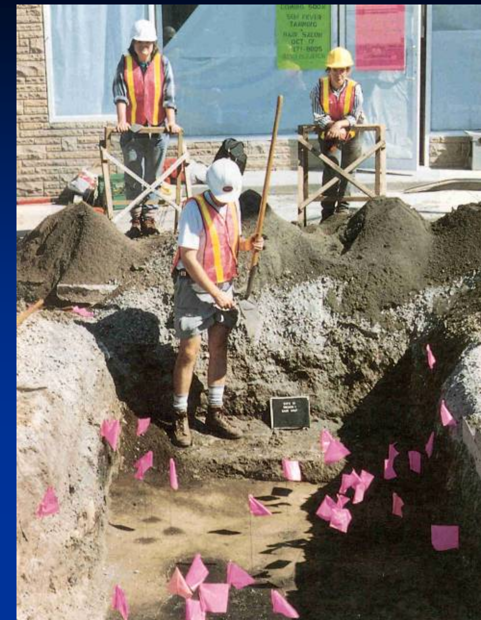
presence of Transitional Woodland ceramics in the lower paleosol suggest that this horizon dates between the end of the Nipissing II rise around 3,800 B.P. and the beginning of the Late Woodland period around 1,150 B.P. In New York State, deposits similar to the upper paleosol have been attributed to climatic change associated with events of the Little Ice Age of *ca.* 450 to 70 B.P. (Monaghan personal communication 1997). Further analysis will be required to determine the nature and age of these soils with certainty.

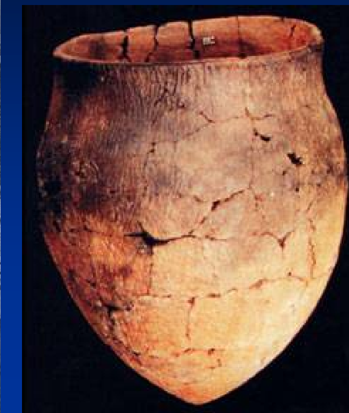
Conclusions

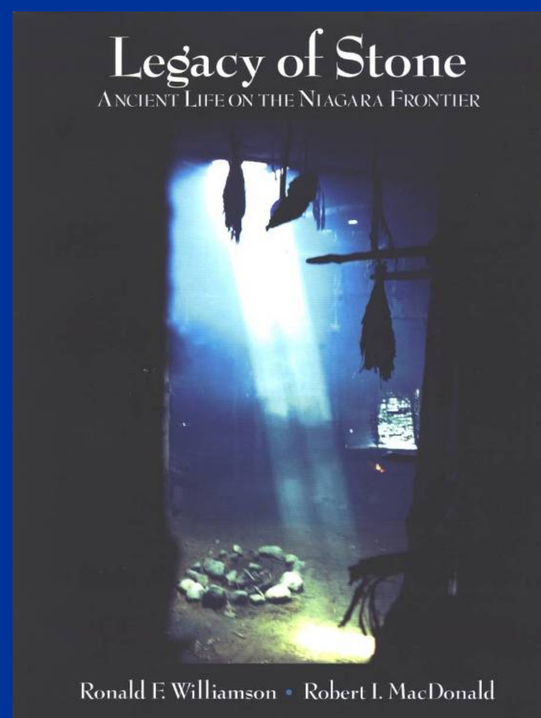
SLIDE 20: PEACE BRIDGE COLLAGE

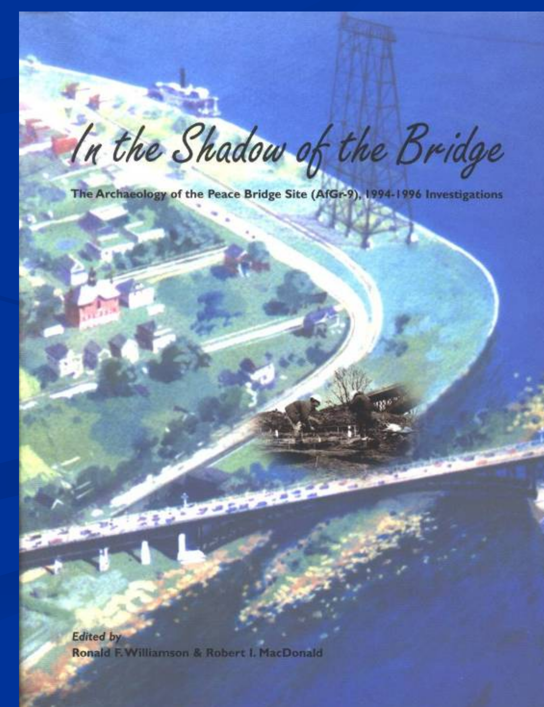
In conclusion, geoarchaeological investigations have helped to answer some key questions regarding the paleoenvironment and formation of the Peace Bridge site. It now seems clear that prior to the end of Nipissing II around 3,800 B.P., most if not all of the current terrace was a lacustrine wetland. While undoubtedly an attractive foraging habitat for Archaic hunter-gatherers, it would not have been accessible for settlement nor would the Onondaga chert have been exposed at this locality. This changed once waters in the Erie basin fell to modern levels and a fluvial regime was established in the upper reaches of the Niagara River. This created the broad floodplain on which the Peace Bridge site was established and exposed the chert beds along the waterfront. Although subject to occasional flooding, this did diminish the appeal of this location for human occupation. During the following four millennia, intensive exploitation of the Onondaga chert and the rich aquatic resources of the Niagara River and Lake Erie waterfronts contributed to the creation of one of the largest aboriginal settlements in the Great Lakes basin.


Known Extent of the Peace Bridge Site, Based on Archaeological Assessments and Mitigations (1992-2002) Within and Beyond the Limits Indicated
Queen Street
Walnut Street
PEACE BRIDGE
Garrison Road
NIAGARA RIVER
ARCHAEOLOGICAL SERVICES INC.
0
200m
Sept. 12/02






Legacy of Stone
Ancient Life on the Niagara Frontier
Ronald F. Williamson • Robert I. MacDonald


In the Shadow of the Bridge
The Archaeology of the Peace Bridge Site (AfGr-9), 1994-1996 Investigations
Edited by
Ronald F. Williamson & Robert I. MacDonald