Trip D

THE LATE PLEISTOCENE OF THE CHAMPLAIN VALLEY, VERMONT

by

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INTRODUCTION

The existing knowledge of Pleistocene events in the Champlain Valley can be discussed in terms of glacial stratigraphy, areal distribution of glacial deposits, and water planes of Lakes Vermont and "New York", (this paper) and the Champlain Sea. The purpose of this field trip is to examine new evidence of glacial and post-glacial events as recently deduced from field study of the Champlain Valley between Burlington and Middlebury, Vermont.

Included in the list of references are recent papers which pertain to the Pleistocene and Recent history of the Champlain Valley. The topographic quadrangles, in order of their first appearance on the field trip, are as follows: Burlington; Fort Ethan Allen; Essex Junction; Mount Philo; Hinesburg; Bristol; Monkton. Acknowledgement is made to Chester A. Howard, Jr. and William R. Parrott, Jr. for data on Stop 16, to Howard for information about surficial deposits near the mountains north of the Winooski River (Fig. 1), to Robert Switzer for field assistance in 1967 and 1968, and to Allen S. Hunt for a review of the manuscript. The work upon which this paper is based was supported in part by funds provided by the U. S. Department of Interior as authorized under the Water Resources Research Act of 1964, Public Law 88-379.

GLACIAL DEPOSITS

Four kinds of glacial deposits can be distinguished. Two varieties of till are found, including a lower, compact, gray-colored till, and a brown, but otherwise similar upper till. At one locality (Stop 16) near Shelburne, Stewart (1961a) has interpreted primarily fabric differences between gray and brown till units as indicative of multiple glaciation. Thus far no evidence of a relatively warm climate separating glacial episodes has been found in Vermont.

In several places is found a highly variable, poorly sorted and washed material that resembles both till and gravel. The deposit is informally referred to in figure 1 as "mantle material", indicating the

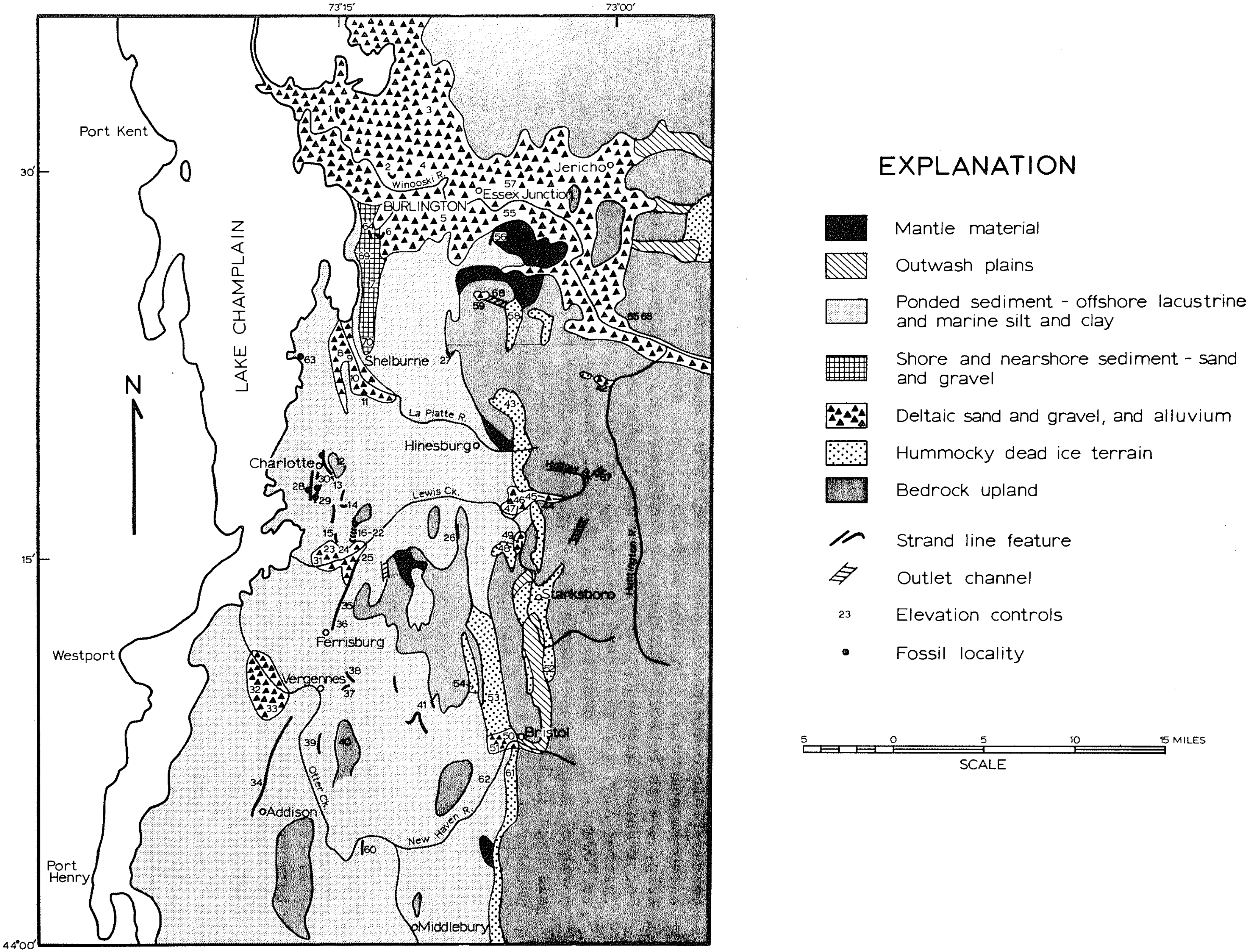


Figure 1 Map of the surficial deposits of the Champlain Valley between Middlebury and vicinity of Burlington.

tendency for the deposit to form a non-descript veneer on the terrain. Mantle material can be definitely related to glaciation by a few scattered exposures of interbedded masses of till; presumably the material in a superglacial drift. Mantle material appears to be most extensive on the south sides of large river valleys.

A fourth glacial deposit is distinguished from mantle material by a distinctive, constructional topography here informally termed "hummocky dead ice terrain". The pattern of this unit on Figure 1 suggests one or possibly more ice margin locations. The scattered patches of hummocky dead ice terrain may delimit an ice margin along the foothills of the Green Mountains. It is tempting to correlate such a margin with morainic features in southern Quebec (Gadd, 1964; McDonald, 1968), and on the north flank of the Adirondack Mountains (Denny, 1966; MacClintock and Terasmae, 1960), thus completing a picture of ice lobation in the Champlain Valley. Although this may be more or less valid, a slightly different, alternative explanation involves successively younger ice marginal features northward in the Champlain Valley. At the core of this problem is the nature of ice retreat in the area. For example, Stewart (1961b) considers regional versus marginal zone retreat of stagnant ice. MacDonald (1968) favors retreat of an active ice front in southern Quebec. Also involved is the degree of geological resolution possible for glacial events.

WATER PLANES

Retreat of the continental ice margin in the Champlain Valley was accompanied by the development of proglacial lake stages of Lake Vermont (Chapman, 1937), "Lake New York" (this paper), and lastly the Champlain Sea (Karrow, 1961). Numerous shoreline features have been identified in this study (Figs. 1 and 2; Appendix). Figure 2 is a cross-sectional plot of the elevation of shoreline and other features against distance along a line oriented N20W, approximately perpendicular to previously determined isobases in the area (Chapman, 1937; Farrand and Gajda, 1962). The positions of enumerated features on Figure 1 were extrapolated along a S70W direction to the cross-section, thus making it possible to compare items of similar uplift and to depict the true rather than apparent tilt of water planes.

The elevation ranges of individual features on Figure 2 reflect the contour intervals of the topographic maps used to determine elevations; more accurate determinations are desirable. Beaches and spits provide relatively precise markers of former water levels but in many cases they are difficult to identify and unquestionable beaches and spits are not numerous. Deltas are relatively inaccurate strandline indicators, but on the other hand they are abundant. Delta elevations given on Figure 2 refer to the delta surface, not the foreset - topset bed contact which, although a better indicator, is rarely observed in this area.

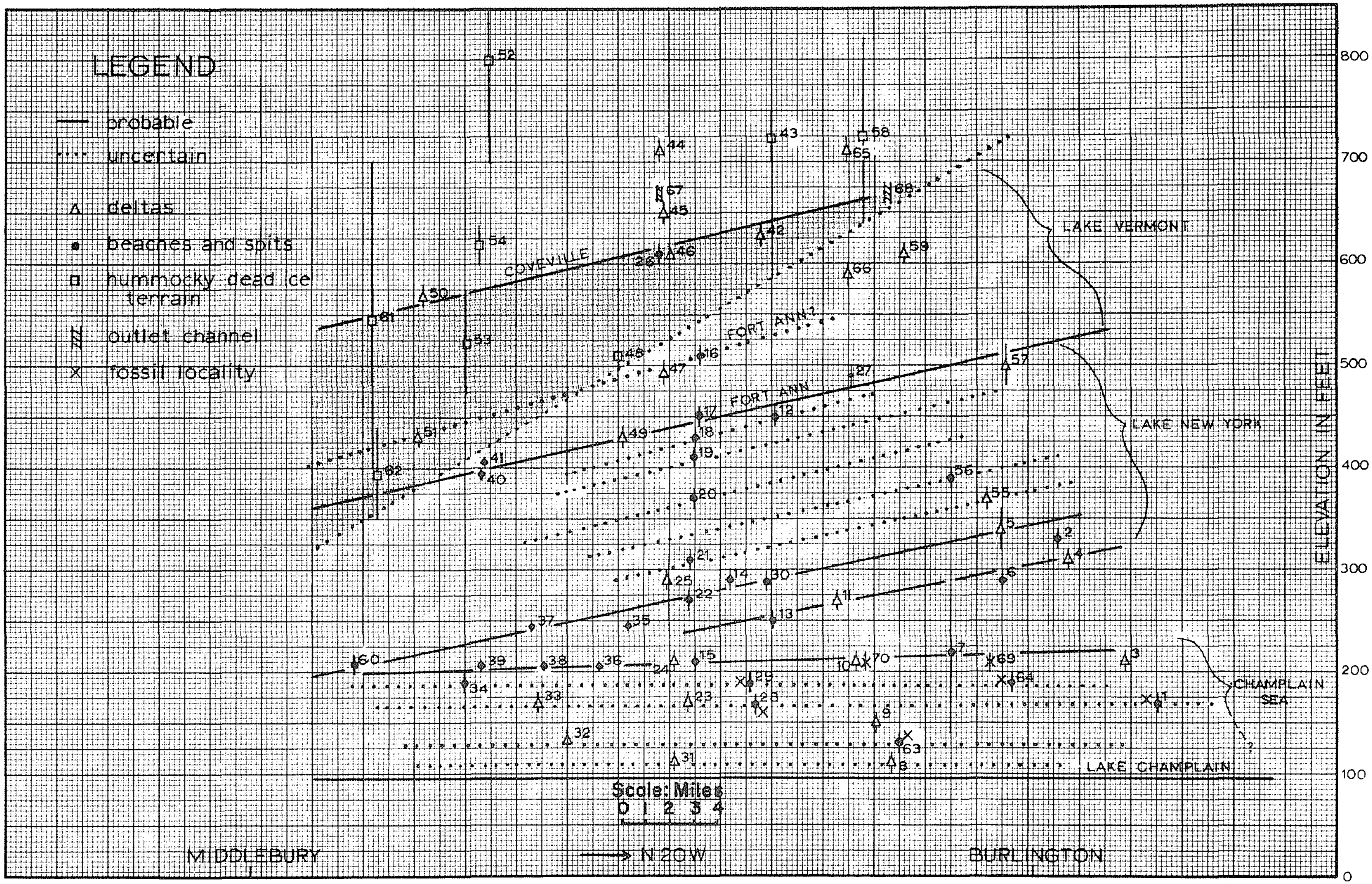


Figure 2 Cross-section of shoreline and other features in the Champlain Valley. Shaded area denotes hummocky dead ice terrain with lacustrine sediment veneer. Vertical bars indicate either the elevation range or the accuracy of the enumerated shoreline or other features.

The correlations of the shoreline features, shown by various lines on Figure 2, are made assuming that the orientations of water planes in the Valley are somewhat as previously described by others.[1] Although higher, older shoreline features do exist, there is not enough evidence to determine whether or not they are related to major, early stages of Lake Vermont (such as Woodworth's, 1905, "Quaker Springs Stage") or to local, small, and separate lakes. The features here identified as Coveville could be related to local lakes, but the upper limit of lacustrine cover on hummocky, dead ice terrain fits nicely with a distinct, widespread level (Fig. 2).

The tilted (5.8 feet per mile) Coveville plane was purposely drawn to intersect a Coveville delta at Brandon (Chapman, 1937), south of the area mapped, and to coincide with the previously recognized outlet channel near Coveville, New York (Woodworth, 1905). The northward extent of the Coveville plane is problematical and a variety of lines of evidence must be considered. Item 1 . The 560-580 foot Bristol delta (No. 50, Figs. 1 and 2), which lies on the Coveville plane, can be correlated upstream via an outwash plain and longitudinal projection into hummocky dead ice terrain at Starksboro. Thus, the position of an ice margin is located at Starksboro during Coveville time. Item 2. Another Coveville delta exists at Hollow Brook (No. 46), north of Starksboro. In order for Hollow Brook to be confluent with Coveville waters an ice margin north of Hollow Brook is likely, an interpretation which conflicts with Item 1. Items 1 and 2 can be reconciled if: a) northward ice retreat occurred during Coveville time; or b) the configuration of the continental ice margin was highly irregular and complex; or c) the Starksboro hummocky dead ice terrain was constructed by a mass of ice separate from the main body of continental ice; or d) at least one of the deltas is misidentified as Coveville. Item 3. In any case, because the Hollow Brook deltas probably were formed by ponded water which escaped from the Winooski Valley via the Huntington River and Hollow Brook Valleys, an ice margin blocking the Winooski Valley (east of Williston) is indicated. Item 4. Other evidence of ice in the lower Winooski Valley during Coveville time includes: absence of a lacustrine sediment veneer on hummocky dead ice terrain below the Coveville level near Williston (No. 58); presence of a low-level delta (No. 59) formed by escape of local lake water from Winooski Valley via the Oak Hill outlet channel (No. 68); absence of a Coveville-level delta in the Winooski Valley. Item 5. However, Connally (1967) has identified a Coveville delta in the Lamoille Valley (Fig. 1). Also, a problematical delta occurs at the Coveville level in the Huntington Valley. Obviously the problem of the location of the ice margin during Coveville time is complex and cannot be resolved at the present time.

[1]Other interesting hypotheses include: control of Fort Ann level by the present Champlain - Hudson divide (147 feet) near Fort Edward, New York; merger of Lake Albany and Coveville water to form a single level with a hinge line, or temporary blockage of the Fort Edward divide by ice or drift, forcing Coveville drainage through South Bay or Lake George lowlands.

Below the Coveville stage are a few shoreline features which may or may not be correlative as a single plane. However, if connected as shown on Figure 2, the southward projection of the tilted (6.7 feet per mile) plane coincides with the outlet for the Fort Ann stage of Lake Vermont (Chapman, 1937). Thus, the level may be tentatively identified as Fort Ann. However, the slightly greater tilt of this level compared to the Coveville plane suggests an erroneous identification of either Fort Ann or Coveville planes, or both.

Numerous slightly lower shoreline features lie on a well-defined plane (5.3 feet per mile tilt) which also extends to the Fort Ann outlet. The abundance and well-developed character of shoreline features at this level suggest that a major episode of Lake Vermont is represented. No evidence is available to delimit the ice margin during this time but apparently it was north of the area of study.

Below the major Fort Ann level are numerous shoreline features, many of which are too scattered to clearly define any planes. However, several water planes are relatively well documented. "Lake New York" levels (Fig. 2) are so tilted (5.0 feet per mile) that their southward projection intersects Lake Champlain near its southern extremity. In these cases, therefore, southward drainage of Champlain Valley waters into the Hudson Valley is precluded. An alternative, that the southward-projecting planes pass through a hinge line and hence to the Fort Ann outlet, is rejected because of the absence of detectable hinges on Lake Vermont strandlines. It is suggested that after the Fort Ann stage of Lake Vermont, Champlain Valley drainage shifted northward to the St. Lawrence lowland, creating a new system of proglacial lakes informally referred to here as "Lake New York". Progressive ice retreat probably opened successively lower drainage routes on the northwest slope of the Appalachian uplands. The similarity between the tilts of the lowest Fort Ann stage and Lake New York suggests that no significant differential isostatic uplift occurred during this time. Physiographic considerations require that Lake New York drainage must have developed immediately after the lowest Fort Ann water plane on Figure 2, or in other words, that no Lake Vermont level below that shown on Figure 2 could have existed. The northern extent of the Lake New York planes is unknown.

Influx of saline water of the Champlain Sea into the Champlain Valley is indicated by the occurrence of certain mollusks (Wagner, 1967). The highest (and therefore oldest?) of such fossils occur in nearshore sediment at localities 69 and 70 (Fig. 2). Associated beach deposits and deltas delimit a well-defined, tilted (0.63 feet per mile) water plane (Fig. 2). A radiocarbon date of 11,230 $\pm$ 170 years B. P. (I - 3647) has been obtained from shells in a Champlain Sea beach (No. 29, Fig. 2) near the highest marine limit.

The absence of water planes with intermediate tilts between Lake New York and the Champlain Sea is curious. One possible explanation is that no sufficiently long stabilization of water level occurred for shoreline development just prior to the Champlain Sea episode; significant isostatic movements would have had to occur during this time. Another explanation is that ice retreat permitted drainage of the Champlain Valley to a low level, possibly below modern Lake Champlain, during which time isostatic movements occurred. The latter hypothesis is supported by MacClintock's (1958) similar interpetation based on oxidized lacustrine sediment beneath unoxidized marine clays.

The nature and timing of the transition from sea water back to fresh water is unknown. Marine mollusks occur at elevations almost as low as the present level of Lake Champlain but due to the relatively large depth tolerances of the species, the lowermost level of the Champlain Sea is unknown. A minimum estimate of 9,500 years B.P. for the lower age limit of the Champlain Sea was made by Terasmae (1959) from the St. Lawrence lowland.

FIELD TRIP STOPS[1]

Stop 1. Champlain Sea beach (No. 1, Figs. 1 and 2); 3.5 miles northeast of Burlington; exposures in gravel pits on both sides of barn show excellent beach structures and marine mollusks.

Stop 2. Lake New York beach-spit and delta (No. 2, Figs. 1 and 2); end of North Street at northern margin of Winooski; gravel pits are in beach material; slightly lower bench to west is composed of deltaic sand which correlates with No. 4, Figures 1 and 2.

Stop 3. Lake New York beach; No. 56; 1.7 miles southeast of Essex Junction; one of the best developed beach landforms known in the area; terrain immediately east of beach is lake clay and west of beach is a lower level Lake New York delta. Note dunic(?) landforms between stops 3 and 4.

Stop 4. Fort Ann delta; correlative with No. 57; 1.7 miles southeast of Essex Junction; gravel pit shows channel structures characteristic of deltas in this area.

Stop 5. Oak Hill outlet channel; No. 68; 4.8 miles southeast of Essex Junction; gravel pit in channel bottom shows very coarse, poorly sorted gravel; outlet drained a Winooski Valley Lake in post-Coveville (?) time

[1]Figure 3 depicts the field trip route.

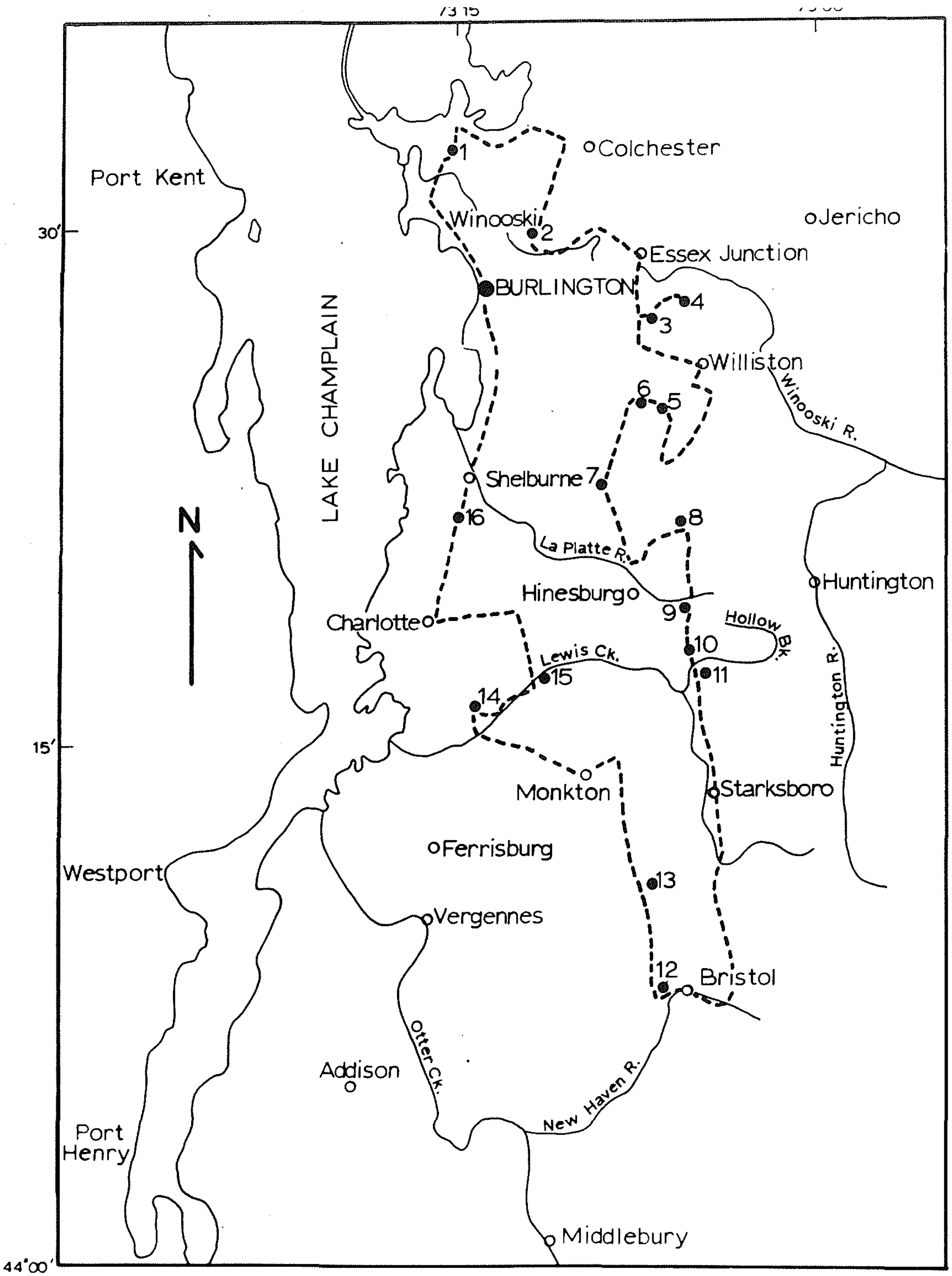
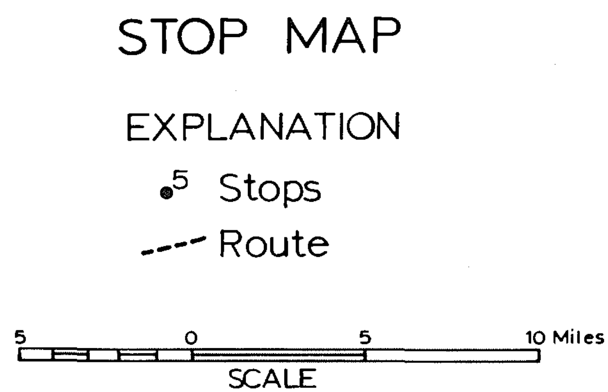


Figure 3 Map of field trip route and locations of stops.



and therefore proves (?) that ice blocked the Winooski Valley during Coveville time.

Stop 6. Ice-contact delta; No. 59; 1.2 miles northeast of stop 5; numerous gravel pits in vicinity show progressively finer material from stop 5 to stop 6 where cross-bedded fine gravel, sand, and silt are exposed in pit; ice-contact nature of delta is suggested by poorly sorted gravel in nearby vegetated area to southwest; delta was apparently formed by Oak Hill channel water drainage into local lake impounded by continental ice.

Stop 7. Fort Ann bench; No. 27; 3 miles northwest of Hinesburg at Junction of Routes 116 and 2A; road cut exposes coarse, poorly sorted gravel underlying (?) boulder-strewn (lag?) bench on hillside. A problem exists here in that the topography and the lag (?) suggest an erosional environment whereas the road cut indicates a depositional environment. Possibly mantle material (see text) has been modified by wave action.

Stop 8. Hummocky dead ice terrain; No. 43; 1.8 miles northeast of Hinesburg; stop is at gravel pit showing poorly sorted character of deposit; ice contact structures are visible in places in the vicinity from time to time.

Stop 9. Ice-contact delta?; 1.5 miles southeast of Hinesburg; this is a brief photography stop. Large scale cross-bedding is in kame terrace, delta, or ice-contact delta(?). The last named possibility is favored here.

Stop 10. Kame terrace; 2 miles southeast of Hinesburg along Route 116; gravel pits in vicinity show characteristic ice-contact features.

Stop 11. Pre-Coveville (Nos. 44 and 45), Coveville (No. 46), and upper Fort Ann (No. 47) deltas; 3 miles southeast of Hinesburg along Route 116; deltas were constructed by water from a local Winooski Valley lake which drained through an outlet channel (No. 67) at the divide between Hollow Brook and Huntington River; gravel pits show coarse gravel with large scale foreset bedding and less obvious topset bedding in places.

Stop 12. Coveville (No. 50) and upper Fort Ann (No. 51) deltas; the village of Bristol is located on the Coveville delta and the upper Fort Ann delta just west of Bristol; gravel pits show features similar to those at stop 11.

Stop 13. Lacustrine sediment veneered hummocky dead ice terrain; No. 53, 3 miles north of Bristol; gravel pit exposes ice-contact material overlain by and interbedded (?) with lacustrine sediment; features suggest glacial and lacustrine sedimentation in close proximity.

Stop 14. Shoreline features of Lakes Fort Ann and New York; Nos. 16-22; southwest side of Mount Philo; a spectacular succession of six wave-cut benches and one beach-spit.

Stop 15. Two(?) till locality; 3.2 miles northeast of North Ferrisburg; north bank of Lewis Creek. Stewart (1961a, Stop 6) reports two till units with intervening lake sediment. The present investigation showed complex vertical and horizontal variations. At the east end of the exposure occurs (bottom to top): gray till (25 feet); till or gravel (30 feet); slumped lake clays. At the west end: gray till (25 feet); lake sediment (25 feet). At the middle of the exposure as many as five till units with intervening lake sediment have been counted. Lateral relationships are difficult to determine due to the steepness of the exposure but facies changes are likely.

Stop 16. Two(?) till locality; 1.3 miles south of Shelburne Village along Route 7; stream bank exposures of a lower gray till and upper brown till; Stewart's (1961a, Stop 4) type locality for the Shelburne (gray) and Burlington (brown) tills. At the time of this writing, fabric and clay mineralogy analyses are being made. This information will hopefully be available for field trip presentation.

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APPENDIX

No.	Feature	Quadrangle	Miscellaneous	Elevation (ft.)
1.	beach	Ft. Ethan Allen	mollusks	160-180
2.	beach-spit	Ft. Ethan Allen	----	320-340
3.	delta	Ft. Ethan Allen	Winooski River	200-220
4.	delta	Ft. Ethan Allen	Winooski River	300-320
5.	delta	Burlington	Winooski River	320-360
6.	beach	Burlington	UVM Poultry Research	280-300
7.	beach	Burlington	UVM agricultural Research	140-300
8.	delta	Burlington	LaPlatte River	100-120
9.	delta	Burlington	LaPlatte River	140-160
10.	delta	Mt. Philo	LaPlatte River	200-220
11.	delta	Mt. Philo	LaPlatte River	260-280
12.	beach?	Mt. Philo	possibly kame terrace	440-260
13.	beach	Mt. Philo	----	240-260
14.	beach	Mt. Philo	----	280-300
15.	beach	Mt. Philo	----	200-220
16.	beach-spit	Mt. Philo	----	500-520
17.	beach	Mt. Philo	----	440-460
18.	beach	Mt. Philo	----	420-440
19.	beach	Mt. Philo	----	400-420
20.	beach	Mt. Philo	----	360-380
21.	beach	Mt. Philo	----	300-320

No.	Feature	Quadrangle	Miscellaneous	Elevation (ft.)
22.	beach	Mt. Philo	----	260-280
23.	delta	Mt. Philo	Lewis Creek	160-180
24.	delta	Mt. Philo	Lewis Creek	200-220
25.	delta	Mt. Philo	Lewis Creek	280-300
26.	beach?	Mt. Philo	possibly kame terrace	600-620
27.	beach?	Mt. Philo	possibly kame terrace	480-500
28.	beach	Willsboro	whale locality	160-180
29.	beach	Willsboro	mollusks	180-200
30.	beach?	Willsboro	----	280-300
31.	delta	Port Henry	Lewis Creek	100-120
32.	delta	Port Henry	Otter Creek	120-140
33.	delta	Port Henry	Otter Creek	160-180
34.	beach	Port Henry	----	180-200
35.	beach	Monkton	----	240-250
36.	beach	Monkton	----	200-210
37.	beach	Monkton	----	240-250
38.	beach	Monkton	----	200-210
39.	beach	Monkton	----	200-210
40.	beach	Monkton	----	390-400
41.	beach-spit	Monkton	----	400-410
42.	delta	Huntington	Huntington River tributary	620-640
43.	hummocky terrain	Hinesburg	----	700-750

No.	Feature	Quadrangle	Miscellaneous	Elevation (ft.)
44.	delta	Hinesburg	Hollow Brook	700-720
45.	delta	Hinesburg	Hollow Brook	640-660
46.	delta	Hinesburg	Hollow Brook	600-620
47.	delta	Hinesburg	Hollow Brook	460-500
48.	hummocky terrain	Hinesburg	lake sediment veneer	500-520
49.	delta	Hinesburg	Lewis Creek	420-440
50.	delta	Bristol	New Haven River	560-580
51.	delta	Bristol	New Haven River	420-440
52.	hummocky terrain	Bristol	----	700-900
53.	hummocky terrain	Bristol	lake sediment veneer up to 560-580 feet	480-580
54.	hummocky terrain	Bristol	----	600-640
55.	delta	Essex Junction	Winooski River	360-380
56.	beach	Essex Junction	----	380-400
57.	delta	Essex Junction	Winooski River	480-520
58.	hummocky terrain	Essex Junction	----	640-820
59.	delta	Essex Junction	Oak Hill channel	600-620
60.	beach	Middlebury	----	200-220
61.	hummocky terrain	South Mountain	----	400-700
62.	hummocky terrain	South Mountain	lake sediment veneer	360-440

No.	Feature	Quadrangle	Miscellaneous	Elevation (ft.)
63.	beach?	Willsboro	mollusks	120-140
64.	beach	Burlington	mollusks	180-200
65.	delta?	Richmond	Winooski River	700-720
66.	delta?	Richmond	Winooski River	580-600
67.	outlet channel	Hinesburg	Hollow Brook	660-680
68.	outlet channel	Essex Junction	Oak Hill	660-680
69.	nearshore sediment	Burlington	mollusks	200-220
70.	nearshore sediment	Burlington	mollusks	200-220