EXCURSION C

GLACIAL AND GLACIOMARINE DEPOSITS AND DEGLACIATION OF THE AREA NORTHWEST OF OTTAWA

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This excursion runs north across the Gatineau Hills into the Gatineau River valley, west up the Lapêche Valley and then cuts back through the Gatineau Hills into the Ottawa Valley (Fig. C.1). The prime objectives are to look at marine, glaciomarine and glaciofluvial deposits as they occur in the Gatineau and Lapêche valleys, to examine till north of the limit of the Champlain Sea and to see glaciofluvial deposits and outwash features as they occur at the northern margin of the Champlain Sea.

Stop C-1: Maxwell Quarry

(R.J. Fulton and C.G. Rodrigues)

Abandoned Alcan open pit mine; east side of Route 105 and west side of Gatineau River; 2 km southeast of Wakefield, Québec, elevation ca. 115 m; Figure C.1; map 31 G/12, G.R. 293 518.

To this point the Gatineau Valley contains a fill of grey coloured silty marine clay which appears largely massive but locally contains stringers of silt and roughly horizontal partings. Exposures are generally poor and quickly become vegetated. The waste disposal area in the northern corner of the abandoned pit contains a 10 m cut which exposes clay draped over a ridge of sand. The purpose of this stop is to look at marine clay in the Gatineau Valley.

The sand underlying the clay is a maximum of 8 m thick and has the form of a ridge. The sand is well washed and well sorted, and generally coarse grained with many angular granule and pebble sized particles. Large scale planar cross-stratification is present as are also small trough cross-stratification. The overlying silty clay consists of three poorly defined units. The basal unit contains subhorizontal stratification consisting of couplets of slightly coarser units, up to about 1 cm thick, and finer grained units, 2-5 cm thick. Starved ripples are present in some of the coarser units. No macrofossils have been found but *Cassidulina reniforme – Elphidium clavatum* dominant foraminiferal assemblage and *Cytheropteron pseudomontrosiense* dominant ostracode assemblage are present in this unit. This suggests salinities of 25 to 30‰. The middle unit is massive and appears to have slumped. It contains scattered clasts, thin shelled mollusca (*Hiatella arctica, Macoma balthica* and *Portlandia arctica* and also the sponge *Tethya logani*). The *Portlandia arctica* association dominant lower parts of the unit with *Cassidulina reniforme – Islandiella helenae – Elphidium clavatum* dominant foraminiferal assemblages and *Cytheropteron paralatissimum – C. pseudomontrosiense – C. arcuatum* dominant ostracode assemblage. These fossils are characteristic of high salinity waters (30 to 34‰). The upper part of this unit contains the *Hiatella arctica* macrofaunal association with *Haynesina orbicularis* dominant foraminiferal assemblages and rare ostracodes. The fossils suggest salinities of 15-25‰. The upper unit is largely inaccessible but appears laminated — not unlike the lower unit — and apparently has undergone some deformation. At the western corner of the exposure a channel, filled with brecciated clay, cuts as deeply as 3 m into the undisturbed clay.

The sand must be glaciofluvial in origin but the only thing, other than stratigraphic position, that might suggest this is its ridge form. The clay is marine and the variation in fossil content suggests considerable variation in salinity. The middle unit indicates that the high salinity wedge pushed this far north. The slightly lower salinity water in which the lower unit was deposited might have been produced by mixing of meltwater with the high salinity wedge. Based on the age of fossils associated with the high salinity wedge in the central part of the western basin of the Champlain Sea, the lowest marine unit at this site should be no older than 11.5 ka. Points to be discussed are the origin of the sand at the base of the section and the nature of the stratification in the clay.

Stop C-2: Hall Cemetery Pit

(R.J. Fulton and C.G. Rodrigues)

Gravel pit at the east side of Route 105; 1 km south of Wakefield, 150 m southwest of Hall Cemetery elevation ca. 137 m; Figures C.1 and C.2, map 31 G/12, G.R. 276 523.

The objective of this stop is to study the relationships between glaciofluvial, glaciomarine and marine deposits. The main section to be studied is illustrated in Figure C.2.

Unit 1, well washed sand and bouldery gravel, occurs in the floor of the pit and in a few scattered exposures on the west and south pit walls. Stratification is disrupted and in places near vertical. The relationship of this unit to unit 2, a light coloured sand is not clear. This sand is silty, medium to fine grained and in some places appears to contain small scale trough cross-bedding but the stratification is extensively disrupted by slumping and in general dips steeply to the south. Unit 3 is a bouldery diamicton, consisting dominantly of silty clay and contains widely scattered *Portlandia arctica* shells, *Elphidium clavatum – Haynesina orbicularis* foraminiferal association (11 of Table 3) and *Cytheromorpha macchesneyi* ostracode association (8 of Table 3). Accellerator dating on the *Portlandia* shells has given an age of 11 760 ± 120 BP (TO-112R). The sediment is largely massive but locally contains sand stringers which appear to separate the deposit into a series of large irregular blocks. The unit rests conformably on unit 2 and appears to have been deformed along with it. Unit 4 consists of up to 1.5 m thick pebbly, highly fossiliferous, fractured, sandy and silty clay which is conformable with and grades downwards into unit 3. *Hiatella arctica* and *Macoma balthica* are the dominant macrofossils but *Balanus crenatus* is also present. *Elphidium clavatum – Haynesina orbicularis* foraminiferal association (11 of Table 3) occurs throughout the unit; ostracodes are rare and consist mainly of *Cytheromorpha macchesneyi* at the base but a *Heterocyprideis sorbyana – Cytheropteron latissimum* dominant assemblage occurs above. A ^{14}C date of 10 800 ± 100 BP (GSC-4088) was obtained for *Hiatella arctica* shells at the base of this unit. The overlying unit 5 is a generally well washed and well stratified, fossiliferous, medium to fine grained sand. The lower contact is sharp and clasts of clay in the

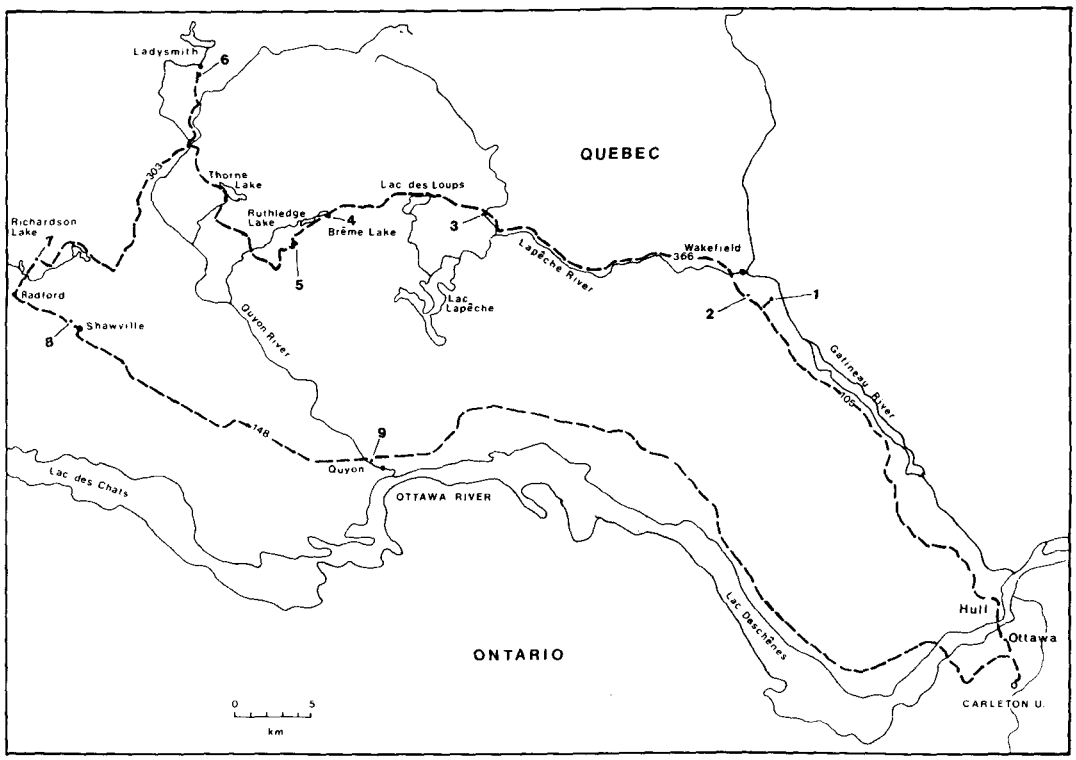

Figure C.1: Route map for Excursion C

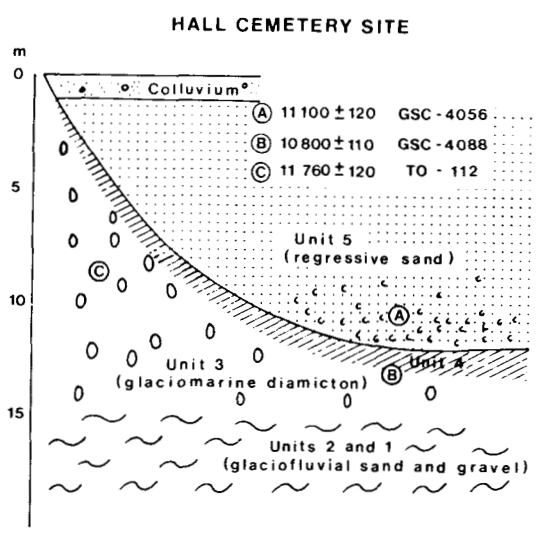

Figure C.2: Stratigraphic relationships of units exposed at Hall Cemetery (Stop C-2)

sand indicate that some reworking of the underlying unit occurred. The sand contains both trough and channel cross-bedding. It contains *Macoma balthica* association macrofossils and only rare microfossils. A radiocarbon date on *Macoma balthica* from 1.5 m above the base of the sand gave an age of 11 100 ± 120 BP (GSC-4056). Gravelly colluvium is the upper unit of the exposure.

Units 1 and 2 are glaciofluvial deposits that were laid down on ice and slumped as it melted. Unit 3 is a glaciomarine sediment (debris rained from glacier into marine water) which was deposited on top of the glaciofluvial sediments about 11.7 ka and deformed conformably with unit 2 as underlying ice melted. Based on data northwest and north of this site, marine limit was at or slightly above 200 m. The surface of unit 3 formed the sea bed and abundant marine life burrowed into unit 3 or was buried by minor slumping that occurred on the irregular morainal topography. An age of 10.8 ka is indicated for shells at the base of this unit but this is 300 years younger than shells 3 m higher in the section. A hollow (kettle?) which remained in the central part of the main exposure was filled with sand about 11.1 ka, probably as a result of tidal activity during final stages of marine regression. By this time about 60 m of rebound had occurred. The faunal association indicates intermediate salinity (15-20‰; Table 3) and cold water temperatures.

The three dates do not fall in correct stratigraphic order. Each date is on a different species. Do different species fractionate carbon isotopes differently or interact differently with bottom sediment? Also the three dates are on shells from different marine environments (glaciomarine, stratified marine, tidal). Is it possible that the ^{12}C to ^{14}C ratio was different in each environment?

Points to be discussed are the origin and interpretation of units 3, 4 and 5 and problems with shell radiocarbon dates in this region.

The Lapêche Valley joins the Gatineau Valley west of stop C-2. Marine clay underlies the valley floor almost as far west as Lac des Loups. The ice contact glaciofluvial deposits on the north side of the road, which contain the large gravel pits, may be remnants of ice marginal deltas, have a coarse marine(?) boulder lag 1-2 m below their surface, and rise to an elevation of about 195 m in the pit near stop C-3.

Stop C-3: North Branch Lapêche River

(R.J. Fulton and C.G. Rodrigues)

Streamcut, west bank of north branch of Lapêche River immediately downstream from crossing of Route 366; 4 km east of the east end of Lac des Loups; elevation ca. 170 m; Figure C.1; map 31 F/9, G.R. 109 583.

Marine quiet water and nearshore (?) sediments.

The lowest unit is 2-4 m of blocky silty clay with horizontal stratification. This is cross-cut by 1-3 m of well stratified silt grading upwards into sandy silt with bedding dipping towards the south. There is an upward gradation within the well stratified unit with blocky clay layers that occur as interbeds with well stratified silt near the base of the unit becoming thinner upwards. *Portlandia arctica* macrofossils, *Elphidium clavatum – Haynesina orbicularis* foraminiferal association (11 of Table 3) and *Cytheromorpha macchesneyi* ostracode association (8 of Table 3) occur near the base of the section. These are indicative of intermediate salinity (15-20‰). *Macoma balthica* occur near the top but microfaunal remains are rare. The similarity of the microfaunal assemblage at the base of this section to that occurring in unit 3 and lower unit 4 at the Hall Cemetery pit (Stop C-2) suggest that the lowest unit at this section might also date from early submergence.

Points to be discussed are nature and origin of primary stratification and secondary blocky structures, environment of sediment deposition and depth of water required for clay deposition.

Marine limit 5 km to the north of Stop C-3 is ca. 195 m. A short distance west of this site there are sand ridges that probably are nearshore bars formed during regression. About 2 km to the west the road climbs above 195 m but at this point there are no deposits or features that might indicate marine limit has been crossed. Lac des Loups, 4 km to the west, occupies an ice block depression in an outwash terrace and is lower than 195 m, but there is no evidence that it was occupied by the sea.

Stop C-4: Lac Brême

(R.J. Fulton)

Roadcut on Lac des Loups – Quyon road, at east end of Lac Brême, 6 km west of Lac des Loups; Figure C.1; map 31 F/9, G.R. 005 585.

Roadcut in till.

This 3-m exposure consists of sandy matrix till including abundant angular clasts. The till is loose and

ainly massive. It is a uniform grey brown colour with an pparent 50 cm surface oxidized zone. There are no ructures that might indicate the environment of deposi-n of the till although the lack of structures and lack of mpaction might suggest that this is of ablation or flow l origin. Another possibility is that this is a colluvial posit resulting from the accumulation of debris (mainly rived from till) at the base of the slope.

Points to be discussed at this stop are whether or t this is a till and criteria that might be used to deter-ine the depositional environment of the sediment.

op C-5: Ruthledge

(R.J. Fulton)

Terrace surface on Lac des Loups-Quyon road overlook-g fields 1 km south of Ruthledge Lake; elevation ca. 190 m; gure C.1; map 31 F/9, G.R. 981 567.

This stop permits a view of morainal deposits at e margin of the Champlain Sea basin.

At this point we are at the southern end of an twash terrace. The small step several tens of metres to e north is considered to be the highest evidence of arine activity on this feature (elevation 193 m). A bench the same elevation can be seen near the top of the hill to e south. Ruthledge Lake and Lac Brême to the north, in dition to several smaller closed depressions, are kettle les in this small terrace. The large depression to the uth is also an ice block depression but it has been partly ed by silt. The hills to the south and the area to the st are underlain by ice contact glaciofluvial deposits th marine silts lapping onto those from the south.

Glaciofluvial deposits were dumped on and at margin of glacier ice which apparently stagnated near western wall of the valley at this point. The gravel is ck and extensive but the outwash systems leading to s area from the north are widely separated and short. is suggests that the active ice margin was at or just th of the Ottawa Valley when these glaciofluvial de-sits were formed.

The fine grained sediments which occupy the pression to the south, and which will be seen at several ces along the route to the west, locally contain fossils. ause the fine grained sediments occupy but do not fill kettle holes, ice blocks buried in the gravel must not e completely melted when the Champlain Sea re-ssed from the area.

Much of the road between this point and Thorne e is built on littoral sand and gravel which apparently rks marine limit in this area. In several places silty clay be seen to underlie and extend to within a few metres he highest littoral features. This suggests that either feature is not the marine limit or that the fine grained iments were being deposited very close to the former ch.

Stop C-6: Ladysmith

(R.J. Fulton)

Roadcut on east side of Route 303, 0.5 km south of Ladysmith; Figures C.1 and C.3; map 31 F/16, G.R. 918 680.

This stop affords an opportunity to examine one of the thickest till exposures in the region.

Up to 15 cm of sandy silt occurs at the surface and is considered to be eolian sediment. Below this is 20-50 cm of pebbly silty sand which is probably colluviated till with an admixture of the overlying fine grained sediment. Bouldery, sandy till as much as 6 m thick lies below these surface layers. The matrix of the till consists of 70-86% sand (2.0-0.63 mm), 12-26% silt (0.63-0.04 mm) and 2-6% clay (less than 0.04 mm). Carbonate content is very low with 8 samples ranging from 0.3-1.1%. Chemical analyses of seven trace elements run on 8 samples spaced at 40 cm intervals in a vertical profile, show little variation throughout the deposit (Fig. C.3). The clasts are largely angular, range up to 75 cm in size and few are marked by striations.

The matrix is moderately compact and shows a small degree of fissility. Siltier and sandier facies are present and stringers of silty matrix can locally be seen. In general, structures are not obvious but an indistinct subhorizontal stratification can locally be noted. Also in some places sandier, possibly washed till occurs below boulders and locally small lenses of sorted sediment are present. The lack of well striated clasts, and lack of structures suggesting that shearing occurred during deposition, could be used as negative evidence that this is not a lodgment till. The inclusion of some sorted sediment and of local washed zones might be used as evidence that this is a meltout till.

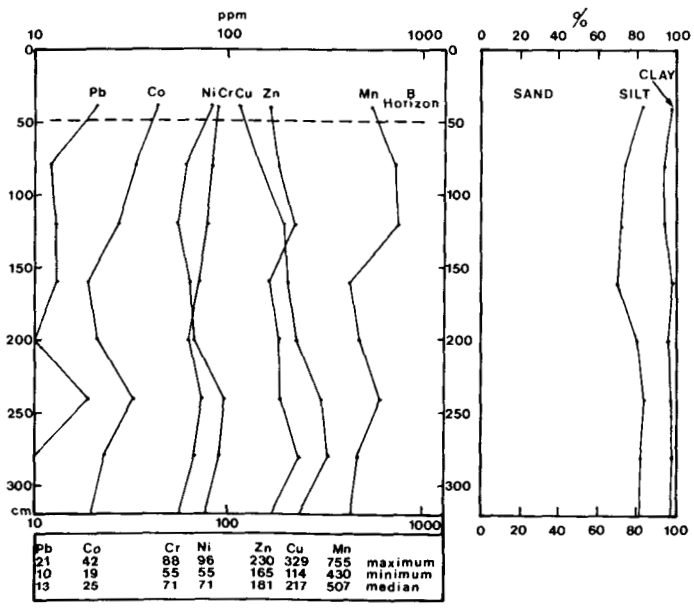

Figure C.3: Variation in trace element concentration and texture of till exposed at Ladysmith (Stop C-6)

The main point to be discussed is criteria that might be used to determine the genesis of this sediment.

South of this exposure Route 303 follows the valley of the Quyon River which in this area is lined with glaciofluvial and postglacial terraces. Where the river leaves the hills and enters the Ottawa Valley there are a series of gravel and sand levels which probably developed as a glaciofluvial delta and then as a series of normal deltas at the margin of the Champlain Sea (Fig. C.4). The highest of these is at ca. 180 m which is probably marine limit in this area. To the south the pebbly sand, which makes up the surface of a flat littoral plain, overlies silty clay indicating it was constructed as an offlap sequence.

Stop C-7: Richardson Lake

(R.J. Fulton)

Junction of Clarendon 8th line and road to the east of Richardson Lake, 2.5 km north of Radford and 5 km northwest of Shawville; elevation ca. 180 m; Figures C.1 and C.4; map 31 F/10, G.R. 809 557.

This is an opportunity to describe the main Quaternary geomorphic features in this area and to discuss their probable genesis.

After leaving Route 303 we first crossed a low relief hummocky area with some closed depressions. In places the surface is underlain by silt but in general it is underlain by sand. However, wherever it is possible to see below the surface unit, coarse gravel is present. This area consists of ice contact gravel, in which kettles have been partly filled with marine silt and clay, which has been veneered by a sand that is either a littoral regressive deposit or a wind deposited cover sand. Prendergast Lake occupies one of the kettles and fossil dunes northeast of the lake attest to the former role of the wind in moving the surface sand. In most areas the surface sand is no more than 50 cm thick but without this, extensive areas of glaciofluvial gravel in the region could not be used for agricultural purposes.

Between Prendergast Lake and Richardson Lake is an extensive subaerial glaciofluvial fan (Fig. C.4). Lac

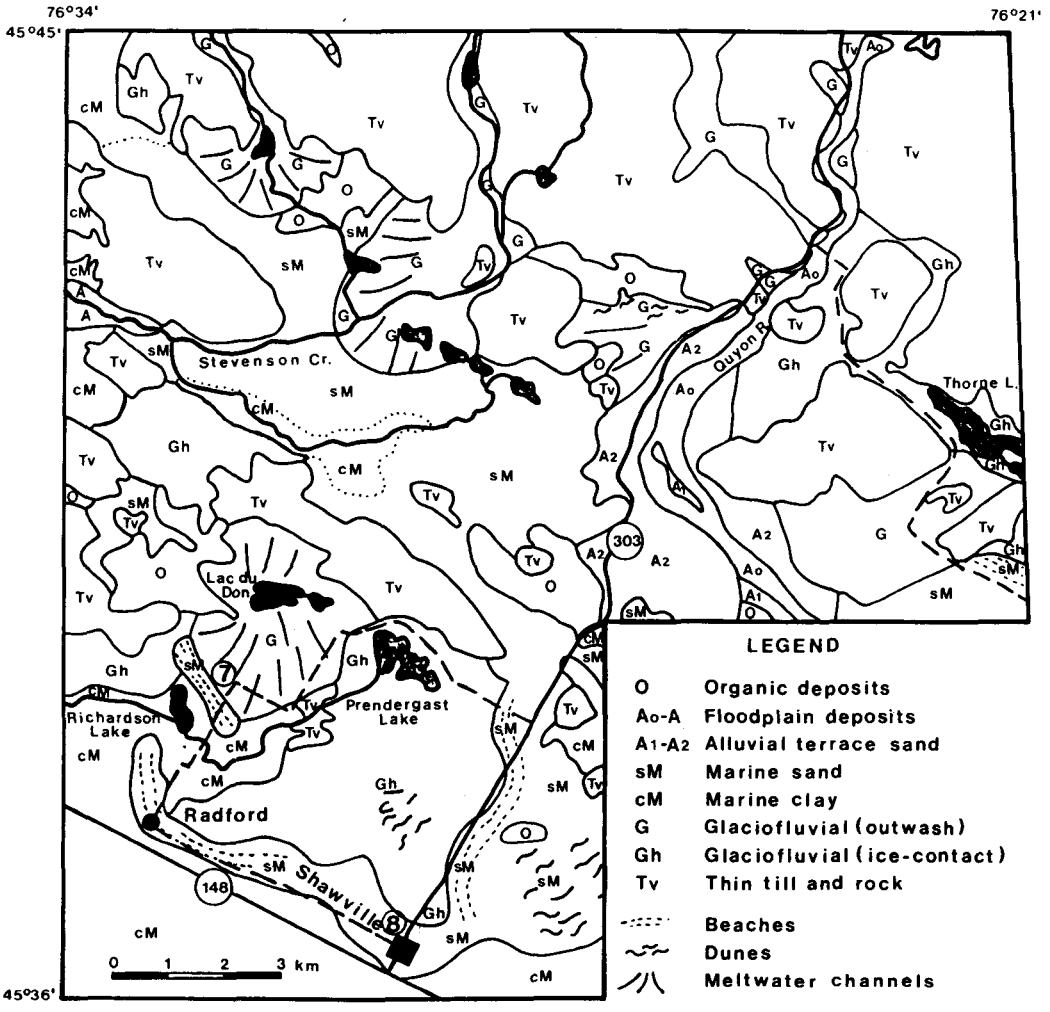

Figure C.4: Map outlining the major surficial geology deposits of the area north of Shawville

lu Don (to the north) occupies a large kettle in this fan ınd a gravel pit to the west of Lac du Don exposes up to !0 m of coarse bouldery gravel. The small ridges and :hannels that can be seen on the surface of the feature ›utline a general fan pattern. To the northeast of Richardson Lake is a low ridge that is approximately ›erpendicular to the channels and is interpreted as a narine beach.

To the north, this outwash feature is isolated rom other glaciofluvial deposits by lower areas occupied ›y fine grained marine deposits (Fig. C.4). Hence, at the ime of deposition, the meltwater that formed this feature nust have flowed directly from ice. Distributary chan-ıels are still visible on the surface of the deposit and onsequently the surface must not have been subject to narine erosion. This leads to the conclusion that the ›each at the distal margin of the fan marks marine limit. 'he elevation of this feature is 184 m. This is 7 m lower han the elevation of the marine limit at stop C-5.

Richardson Lake is another kettle lake that has ›een partially filled with silt. The steep slopes leading to he lake suggest that ice was still melting from the depres-ion after the end of silt deposition. The broad sand-ored feature to the south of Richardson Lake is a marine ›ar built northwest from the glaciofluvial highland to the ıorth of Shawville. Marine clay directly underlies and ·xtends to the south of this feature. Shallow geophysical urveys indicate that approximately 100 m of post last ;laciation deposits overlie rock at Radford (the point vhere the field trip route crosses this feature).

›top C-8: Shawville

(R.J. Fulton)

Gravel pit in western outskirts of Shawville, 100 m orth of the junction of Rectory Road and John Dale Drive; levation ca. 170 m; Figures C.1 and C.5; map 31 F/10, G.R. 830 15.

This pit illustrates how difficult it is to find evi-ence of, and to date, marine submergence in this area.

The gravel pit lies at the southern, marine trim-ıed, edge of the highland that lies north of Shawville. 'he surface of this upland is a silty fine to medium rained sand but at depth it apparently consists of a omplex of glaciofluvial deposits similar to those exposed ı this gravel pit. A kettle hole lies at the base of the scarpment a short distance to the east.

The main unit in the pit is variably textured and ariably stratified gravel, sand and boulder gravel. In ome places the stratification is disrupted and there is no oubt that this material is glaciofluvial in origin, but in ther places the sand is well sorted, well stratified, shows o sign of disruption and might be regressive marine and. The surface unit consists of 1-3 m of silty sand, ›cally marked by subhorizontal, wavy stratification pro-uced by cyclically occurring clay-rich layers. The sand is onsidered to be eolian in origin and the apparent strat-ification is thought to be a series of clay fronts that have migrated downwards through soil forming processes.

At the southeast corner of the pit a boulder layer with a well washed coarse sand matrix truncates the glaciofluvial sediment and underlies the eolian silty sand (Fig. C.5). This unit is considered to be a lag developed by wave erosion when the Champlain Sea was at this level (170 m). Sparse paired valves of *Macoma balthica*, dated 11 400 ± 190 (GSC-3670; Blake, 1983), occur between and under boulders. The reliability of this date might be questioned because the layer from which the shells were collected lies in or near the modern soil profile. Consequently at some places shells have been partly leached and at others the undersides of pebbles and boulders (and possibly of shells) are coated with a layer of precipitated calcium carbonate.

Topics for discussion at this site are evidence which might indicate the relationship between elevation of a dated site and that of contemporaneous sea level and the reliability of radiocarbon dates on shells collected from within modern soil horizons.

To the east of Shawville, Route 148 is on the now dissected former floor of the Champlain Sea. Locally glaciofluvial gravel pokes through the general clay cover. In many places this gravel seems to be associated with bedrock highs. About 8 km east of Shawville, the road drops onto a lower level that is a fluvial terrace cut in the fine grained Champlain Sea sediments. The road is largely on river cut terraces between here and Ottawa. In many places marine silt occurs at the surface of these features but in other places a metre or two of sand overlies the fine grained sediment. These terraces might relate to

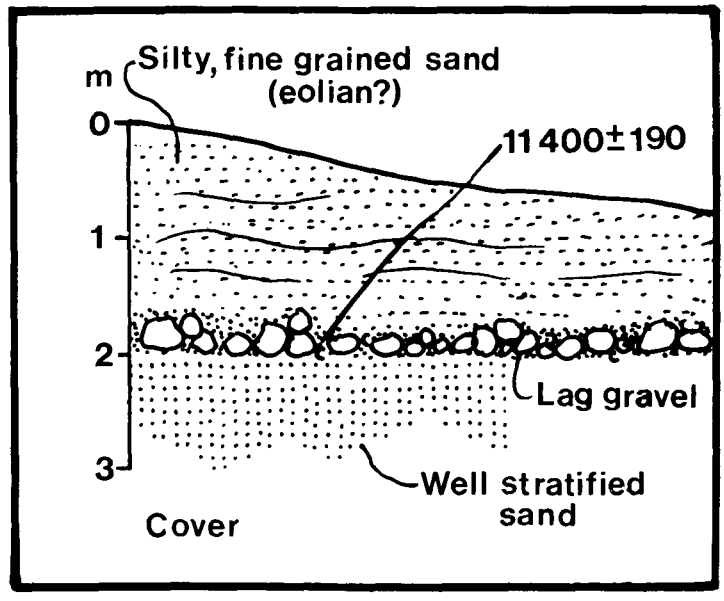

Figure C.5: Marine gravel lag truncating well stratified glaciofluvial? sand and underlying eolian sand, Shawville (Stop C-8)

changes in flow regimes of the Ottawa River, halts during periods of downcutting or levels of former channel floors at which rock, protruding through the marine fill, diverted the river to a new channel. They might also have formed by simple migration of the river channel as the floodplain was uplifted.

Stop C-9: Quyon

(R.J. Fulton)

Artificial cut in side of a knob on the south side of route 148, 0.5 km east of the bridge over the Quyon River; Figure C.1; map 31 F/9, G.R. 029 420.

The silty clay exposed in this cut is thought to be a landslide deposit.

From about 3 km to the west, to this point, Route 148 crosses an old landslide scar. The bottom of this feature is generally smooth or gently undulating but locally contains anomalous ridges or hummocks similar to the one at this site. The material exposed here is largely clay with scattered interbedded sand layers, pods, and blocks. Stratification is deformed and faulted and fine grained sediments are fractured. There is no extensive area of hummocky slide deposits to the south of Quyon, so apparently most of the slide debris has been carried away by the Ottawa River. The question is why did the marine clay fail at this point? This area lies to the south of an extensive area known to be underlain by glaciofluvial deposits which are buried by fine grained marine sediment (see Stop C-5). Occurrence of the slide(s) which produced this large scar on the Quyon River is probably related to erosional unloading of a pressurized aquifer that was present in the buried porous sediments.

Topics for discussion at this site are the recognition of marine sediments that have been involved in landsliding and age of landsliding.