

Reports

27

A RECONNAISSANCE SURVEY ON THE QUATERNARY HISTORY OF ST. PIERRE ET MIQUELON, FRANCE

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INTRODUCTION

The purpose of this paper is to document several observations on the Quaternary history of the islands of St. Pierre et Miquelon which were determined on visits during 1976 and 1977. The results form part of a more complete study on Quaternary events along the southeastern coast of Newfoundland (Tucker 1979, Tucker and McCann, in press). Because the islands of St. Pierre et Miquelon are close to the Burin Peninsula of Newfoundland, the main portion of the research area, and situated well south of the late-Wisconsinan ice margin proposed by Grant (1977), it was considered essential that they be included in the total study. This presented a logistics problem in that access to more interesting parts of the archipelago is difficult. Due to time constraints, only a brief reconnaissance was carried out. Nevertheless, several important new insights on the Quaternary record were gained and are discussed below.

LOCATION AND PHYSIOGRAPHY

The French islands are situated at the entrance of Fortune Bay approximately 25 km southwest of the Burin Peninsula (Fig. 1), and are contained within the area defined by 46°45' to 47°10'N latitude, and 56°05' to 56°25'W longitude. The territory consists of three principal islands, St. Pierre, Langlade, and Miquelon, as well as a number of smaller islands located northeast of St. Pierre. Langlade and Miquelon although considered separate islands, have been connected by an isthmus of sand dunes some 12 km in length since the end of the eighteenth century (Aubert de la Rue, 1951).

The physiography of the 240 km² territory is similar to that found on the lower Burin Peninsula of Newfoundland in that its surface of 120 to 150 m a.s.l. rises gently to the northeast and is broken only by occasional hills of 150 to 200 m in elevation. The highest, *Morne de la Grande Montagne*, is located on Miquelon, and extends 240 m a.s.l. Surficial cover of the islands is variable. For the most part, St. Pierre is drift-free while Langlade and Miquelon have more extensive thicknesses of surficial material in their uplands. It is heavily masked by organic cover which makes it difficult to interpret depths precisely. Weathered, tor-like rock knobs are more common on Miquelon, which indicates that deposits are thinner than on Langlade. Below 20 m, surficial material is thicker and has a subdued, rolling to planar appearance. This is especially so along the south coast of St. Pierre, the perimeter of Miquelon, and along the west and south coast of Langlade.

Drainage is poorly developed on the islands. Ponds are contained in shallow bedrock depressions or troughs from which streams flow from the local

heights of land to more level ground. Exceptions occur along the west and south coast of Langlade where streams such as *Deuxième Ruisseau Maquine* are incised to a depth of 50 to 60 m in the 150 m a.s.l. plateau. At a point about 20 m a.s.l. the streams have developed a well entrenched pattern of meanders and flow through surficial cover to the coast. A similar pattern occurs on the eastern and northeastern coast of Miquelon, though here, the meanders extend further in elevation because of greater thicknesses of unconsolidated material.

Features of coastal submergence are ubiquitous with major barrier islands, beaches and lagoons occurring around the perimeter of Miquelon and along the south coast of St. Pierre. The town of Miquelon is built on a raised, cobble-gravel foreland that although greater than 1.2 km in east-west extent, is less than 10 m a.s.l. in elevation.

BEDROCK GEOLOGY

The bedrock geology has been interpreted mainly through the work of Aubert de la Rue (1932, 1946, 1951). More recently, it has been generalized by Williams (1978). The oldest units are the Precambrian, sedimentary volcanic rocks found on St. Pierre and Miquelon. These are correlative with the northeasterly trending zone of acidic-basic volcanic rocks, schistose, prophyritic felsite and tuff located on the southwestern coast of the Burin Peninsula. *Le Cap*, north of Miquelon consists of Precambrian metamorphics with zones of quartzite, gneiss, paragneiss and granitization. The bedrock on Langlade is Cambrian to Middle Ordovician in age and reveals suites of rock similar to those in the Dantziac Cove-Fortune area of the Burin Peninsula. These marine shelf sediments contain northeasterly trending belts of red to grey sandstone and siltstone, black slate, quartzites and minor limestone. Minor plugs of intrusive rhyolites are present at the northeastern corner of Langlade.

PREVIOUS RESEARCH

Information on Quaternary deposits is contained in the various reports of Aubert de la Rue. He contended (1932) that the islands were completely glaciated by ice originating in Newfoundland. This was indicated by the presence of foreign, coarse-grained erratics lying on quartzite at *Belle Rivière*, Langlade, as well as on the lowland north of Miquelon. He further suggested that a terrestrial link with Newfoundland occurred during this stage. Ground moraine is described as being 3.5 m thick, except at *Petit Barachois* and on the lower east coast of Miquelon where deposits are greater than 30 m thick. Small frontal moraines, a result of local cirque glaciers, were noted at Miquelon, though their exact locations were not described. Aubert de la Rue mentioned the occurrence of micro-indicators of

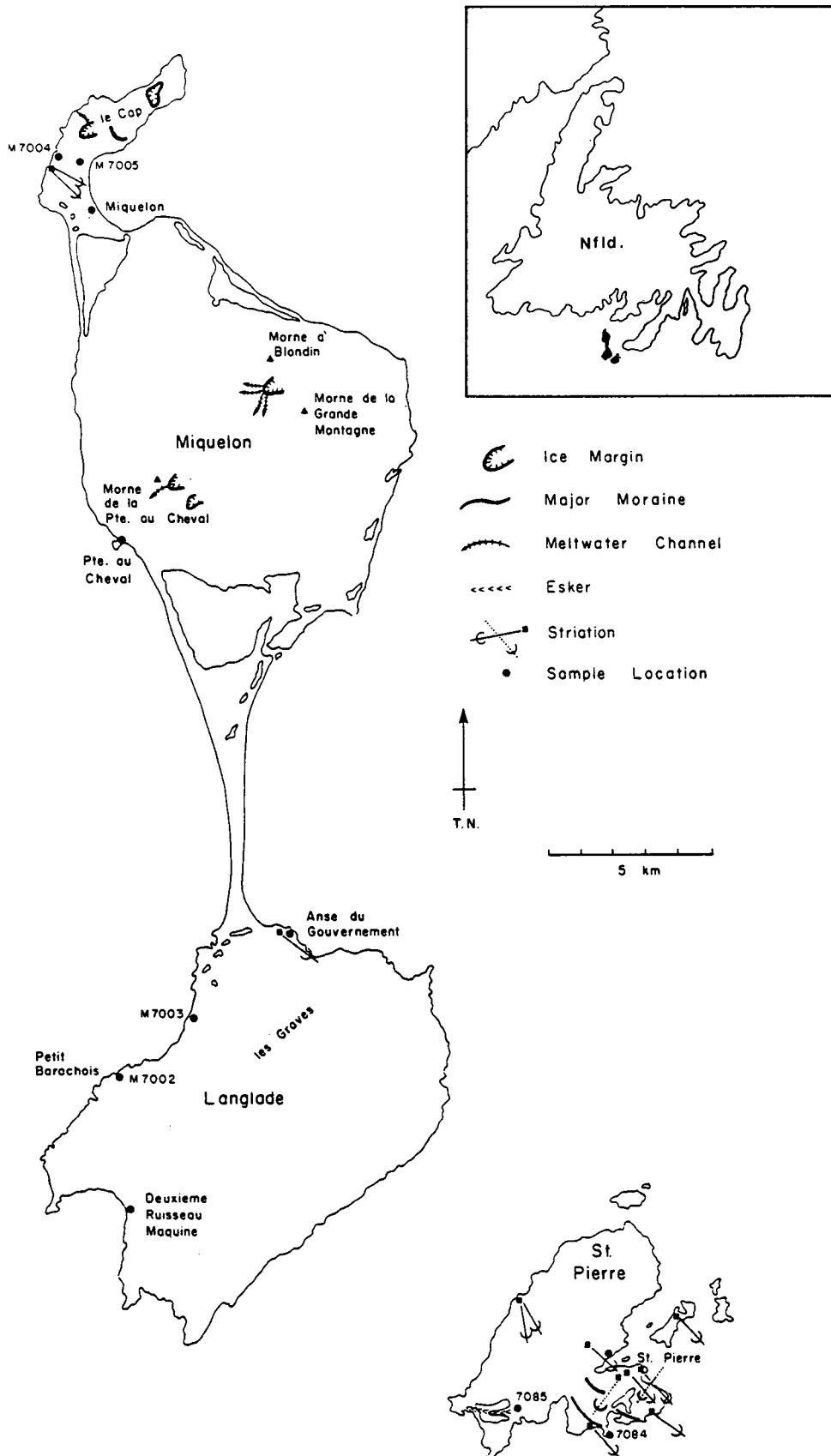


FIG. 1 Location map and glacial features.

ice movement such as *rôches moutonnées*, glacial polish, and striae oriented at 110° to 150° azimuth located northeast of the town of St. Pierre and near Pointe au Cheval, Miquelon. Periglacial features such as solifluction lobes, talus and felsenmeer are also described at various locations, as are aeolian ventifacts and grass covered dunes at Petit Barachois which are said to overlie till. He determined the source of the dune material to be postglacial marine sands and gravels, so called because of the lack of overlying erratics. Although he was aware of the 15 to 20 m a.s.l. raised terrace remnants at the head of Fortune Bay, Newfoundland, he did not consider that the French territory had been affected by isostatic uplift since the end of the last glaciation; rather, that bay mouth bars and tombolos indicate that submergence is occurring.

GLACIAL PATTERNS

The St. Pierre et Miquelon archipelago could most aptly be described as having a homogenous surface morphology with a distinct lack of glacial features indicating directions of former ice movement. There are, however, several limited patterns that were developed and are detailed in Figure 1. Along the lower south coast of St. Pierre there are two poorly preserved recessional moraine remnants that are oriented northwest-southeast, and are open towards the northeast. They are less than 15 m in height, highly dissected, and rock-cored. At Anse de Savoyard, 2.5 km to the west, an esker that is oriented approximately west-northwest, crosses the harbour and extends below sea level. This suggests that the last glacial, hydrological gradient was to the west or northwest. Above 25 m a.s.l., St. Pierre is essentially free of either drift or glacial features.

Both Langlade and Miquelon have significantly different surface morphologies to that of St. Pierre. The valleys along the steep southern and eastern coasts of Langlade contain thick sequences of surficial material that have been cut by fluvial action. As well, coastal sections contain as much as 50 m of unconsolidated deposits that have been well exposed because of coastal storms and marine erosion. The highland areas are drift covered, but generally, bedrock is close to the surface, Air-photo analysis reveals no features that might be termed ice marginal, and drainage is well integrated with the present landscape. Near the north-western corner of the island, several fossil drainage channels are evident, but these are considered to represent normal incision of a fluvial system rather than meltwater flow.

The surficial cover of Miquelon is not as subdued as that on Langlade. The highlands have a more rugged appearance and till is not as thick either in the uplands or in coastal sections. Interestingly, the central uplands contain several arcuate, relict ice margins that are open to the northeast. They are located at 120 to 130 m between Morne à Blondin and Morne de la Grande Montagne in the east, and Morne de la Pointe au Cheval in the southwest. All three ice margins are poorly preserved, and were identified mainly because of the presence of meltwater channels that

radiate away to the southwest. On le Cap of Miquelon, there are three former ice marginal positions. The most prominent is situated just south of Butte au Berry and consists of a small cirque with a recessional moraine on its southwest slope. In all cases, meltwater flow from these positions was to the west and southwest.

Because field work on St. Pierre et Miquelon was limited, the pattern of striae that was discovered is less than ideal, however, two trends developed. The most well developed mirror ice flow from the south coast of Newfoundland and are oriented 135° to 160° . The younger were measured only southeast of the town of St. Pierre, but significantly, are directed 220° which is perpendicular to the long axis of the recessional moraines mapped along the south coast of the island.

GLACIAL DEPOSITS AND STRATIGRAPHY

Surficial material was collected on St. Pierre for textural and provenance analyses. There were several reasons for this. It was hoped that a more precise insight could be gained on the distance and directions of glacial transport. Also, it appeared from air-photo analysis that much of the lowland had been inundated by the sea at some point, and again, this needed clarification.

Sample 7084 was retrieved from a 3-m coastal section located at Tête du Petit Havre. The material is a washed, medium brown, sandy till with angular to sub-angular clasts averaging 8 to 10 cm in diameter. More than 80 per cent of the clasts are local Precambrian rhyolites, and rhyolitic breccias and tuffs. Transport from Miquelon is indicated by the presence of Paleozoic phyllites and Cambrian quartzites. No distinct transport from Newfoundland was readily discernible from the analysis. The texture of the sample is very sandy, with a mean grain size of 0.70ϕ , and very poor sorting. The mean grain-size parameters compare favorably with those of the upper tills of the St. Lawrence plateau described in Tucker (1979). A distinct lack of matrix in the upper half metre of the section would suggest that the material had been reworked to some extent by marine action.

Lithologic sources were also determined for clasts contained in the esker at Anse de Savoyard (Location 7085). Although the majority were locally derived from rhyolites, agglomerates, rhyolitic tuffs and breccias as well as basalt, 10 per cent had sources on Langlade. The possibility exists that some of this material may have been from Newfoundland especially when considered in light of the onshore striae near St. Pierre, although, with local sources so predominant, proving a Newfoundland origin becomes difficult.

Based on a preliminary interpretation of air photos, a foot traverse was carried out from Miquelon to Petit Barachois, which is located about mid-point on the western coast of Langlade. It was felt that even a cursory appraisal of the nearly 40 m of surficial material at this site would significantly aid the interpretation of Quaternary events on the southeastern coast of Newfoundland. Aubert de la Rue (1946) described



FIG. 2 Lower portion of Petit Barachois, Langlade section. Spade indicates location of sample M7002B.

the west coast of Langlade as containing till derived from the Newfoundland ice sheet overlain by as much as 7 m of aeolian sand. Between the two units, he reported finding roots which he interpreted as being postglacial in age. Unfortunately, they were not rediscovered during the present writer's brief visit to Langlade in 1977.

The section is located on the coast 0.9 km southwest of Petit Barachois and in detail (Fig. 2), the lower portion reveals 2.4 m of red sandstone which is overlain by 18 m of compact, grey-pink marine silt and sand. The unit contains rounded to subrounded cobbles and pebbles many of which, though not all, are striated. These are considered to have been deposited by ice rafting from Newfoundland sources. Provenance of the clasts (Sample M7002A) indicates that although most is local, Cambrian and Paleozoic material, 4 percent is coarse grained, Devonian granite that probably originated in the Cape la Hune-Rencontre West area of Newfoundland (see Williams, 1971). At 2.6 m and 16.6 m, two distinct, horizontal beds of grey, laminated marine silt were noted. The first is 30 cm thick, and the second was measured as being 1.4 m in depth. Significantly, both contain benthonic marine foraminifera of species similar in age and paleoenvironment to those

occurring at Dantzic Cove on the Burin Peninsula (Table 1). Vilks (pers. comm.) considered that the foraminifera indicate a paleoenvironment of inner shelf, marginal marine conditions, possibly an estuarine bay with a salt wedge. They are also similar to a suite at Salmon River, Nova Scotia, dated at 38,600 B.P. (Nielsen 1974, Wagner 1977) and, hence, are thought to be an indicator of mid-Wisconsinan marine overlap.

At several points on the surface of this lower marine unit, small concretions were discovered that have been termed marlekor or imatra stones by Pettijohn (1975). The examples noted have irregular central columns with round nodules up to 3 cm in diameter. In addition, simpler, discoid forms of varying dimensions were found at the site. Marlekor were also noted on Langlade by Aubert de la Rue (1946) who considered the "pseudo-concrétions argilosableuses" to be a post glacial form. He suggested that they originated at the interface of 7 m of dune sands overlying 25 m of till, when calcite-rich groundwater reached a sub-aerial environment. The present author disagrees with Aubert de la Rue on both interpretations. The lower unit is not considered to be till despite the foreign clasts, and the concretions are not a sub-aerial form. Because specimens were dug from within, as well as being collected on the surface of the unit, the origin described by Tarr (1935) for similar, glaciolacustrine features is thought to be more likely. He believed their source to be calcite and Al-Fe-Mn compounds brought into the submarine environment from glacier-fed waters both as clastic grains and in soluble form. These were deposited mechanically, chemically and organically, chiefly in the silts. The cold, CO₂-rich waters that were buried with the silts gradually dissolved the deposited particles. Subsequently, due to climatic changes, these waters became warmer, which caused a loss of their CO₂ content, and deposition of the various compounds with changes in water pH. Later, subaerial groundwater flow added to the forms, with the greatest increase in material occurring on their up-surface sides. This genesis adds credence to calling the lower unit marine, especially because silty tills known in the local area are so lacking in calcite and Al-Fe-Mn compounds as to be unsuitable as a direct source. In fact, the Langlade marlekor contain so little calcite that no attempt could be made to date them by isotopic methods.

Above the 18 m of grey-pink marine silt and sand, there is a distinct facies change to very loose, planar cross-bedded, coarse, quartzose sand and cobble gravel. At Petit Barachois, this unit extends to a height of 35.2 m of which the upper 10 m or so has been dissected by fluvial action and reworked by aeolian processes. Similar stratigraphy exists in a river cut near the mouth of Ruisseau Debons, 1.8 km northeast of Petit Barachois (Location M7003). Here, 11.5 m of contorted marine silt, sand and ice-rafted debris containing foreign clasts are overlain by quartz-rich aeolian sands derived from the marine sands and gravels. Farther north, this material has supplied much of the sands which constitute the isthmus between Langlade and Miquelon.

Despite the report of plant roots beneath the aeolian material (Aubert de la Rue 1946), the whole sequence of material along the west coast of

TABLE 1

Foraminifera Suites Burin Peninsula,
Newfoundland - St. Pierre et Miquelon (G. Vilks, pers. comm.)

SPECIES	SAMPLE NUMBER					PALEOENVIRONMENT*
	7-004B Dantzic Cove	7-121B Salmonier Pond	M7002B Petit Barachois	M7002E Petit Barachois	Salmon River, N.S. (after Wagner, 1977)	
<i>Astrononion gallowayi</i>	x	x	x	x	x	arctic, cold water
<i>Bolivina pseudopunctata</i>				x	x	silty, nearshore abyssal
<i>Bolivina pseudoplicata</i>		x			x	open water
<i>Bolivina subaenariensis</i>				x	x	open water
<i>Bolivina spatulata</i>	x	x			x	open water
<i>Buccella frigida</i>	x		x			nearshore, open bay
<i>Bulimina</i> sp.	x					ancient, nearshore - abyssal
<i>Bulimina aculeata</i>				x	x	ancient, nearshore - abyssal
<i>Bulimina</i> cf. <i>gibba</i>			x			ancient, nearshore - abyssal
<i>Cassidella complanata</i>		x		x		deep water, outer shelf
<i>Cibicides concentricus</i>					x	sandy nearshore - abyssal
<i>Cibicides lobatulus</i>	x	x	x	x	x	sandy nearshore
<i>Elphidium barletti</i>		x				low saline, shallow water
<i>Elphidium clavatum</i>	x	x	x	x	x	low saline, shallow water
<i>Elphidium Subarcticum</i>			x		x	low saline, shallow water
<i>Elphidium oregonense</i>			x			low saline, shallow water
<i>Eoponidella pulchella</i>				x	x	low saline, lagoonal
<i>Epistominella takayanagii</i>				x		bathyal zone, shelf edge
<i>Eponides tenera</i>						sandy, nearshore - abyssal
<i>Eponides</i> sp.		x				sandy, nearshore - abyssal
<i>Fissurina marginata</i>	x		x	x	x	bathyal - outer shelf
<i>Glabratella wrightii</i>	x			x	x	ancient, nearshore
<i>Globigerina quinqueloba</i>		x				cold water, marine nearshore
<i>Islandiella islandica</i>	x	x	x	x	x	low saline, shallow water
<i>Islandiella norcrossi</i>			x	x	x	low saline, shallow water
<i>Islandiella Teretis</i>		x				low saline, shallow water
<i>Lagema striata</i>		x				clay, nearshore - abyssal
<i>Neogloboquadrina pachyderma</i>		x		x	x	arctic
<i>Nonionello auriculata</i>		x	x	x		sandy, nearshore - bathyal
<i>Oolina borealis</i>	x		x		x	temperate, nearshore - bathyal
<i>Protelphidium orbiculare</i>	x	x	x	x	x	low saline
<i>Rosalina</i> sp.				x		sandy coastal
<i>Trifarina fluens</i>			x	x	x	nearshore - bathyal
<i>Virgulina fusiformis</i>		x		x	x	nearshore - abyssal
<i>Virgulina schreibersiana</i>				x		nearshore - abyssal

*Additional information on paleoenvironments after Galloway (1933).

RAISED BENCHES, TERRACES AND MARINE OVERLAP

There is ample morphological evidence of marine overlap, despite the contrary findings of Aubert de la Rue. At locations such as le Cap, Miquelon, and near Petit Barachois, bench remnants are visible at 2.4 and 2.6 m. These have been assigned to the 4 ± 1 m Sangamonian set visible around the perimeter of the Burin Peninsula because they are striated and capped by surficial material.

Approximately 20 to 25 m of submergence is recorded around St. Pierre, Langlade and Miquelon (Fig. 3). It is shown by a distinct break in slope between an upland of till, vegetated rock and deeply incised streams, and a lowland of subdued terrain. The lowland is capped by marine sands and gravels, and aeolian material. Because the break in slope occurs at approximately the same height above sea level as the 20 m a.s.l. collapsed stack at Jacques Fontaine and other raised marine features located farther south on the Burin Peninsula of Newfoundland (Tucker 1979), it is thought to represent the relatively stable and long-term marine stand occurring during the mid-Wisconsinan.

A 9.6 m a.s.l. raised spit at le Cap, Miquelon, along with similar, raised marine bars on the northern coast of the island of Miquelon, and a 6.4 m a.s.l. marine terrace at Anse du Gouvernement (Fig. 4), are thought to be late-Wisconsinan in age because of their northward tilt and general agreement with the pattern of post-glacial emergence derived for the Burin Peninsula.

DISCUSSION

These observations on the Quaternary of the French archipelago lead to several conclusions not previously documented. Most important is that it appears that all of Langlade, most of Miquelon, and the highland of St. Pierre were not glaciated during the late-Wisconsinan. This is suggested by the distinct lack of till at the Petit Barachois section of Langlade, the presence of Salmon River, Nova Scotia correlative forams at the same location, and the general absence of ice stagnation features in the uplands. The southwest, onshore directed striae, cutting earlier striae resulting from mainland, Newfoundland ice, along with southwesterly oriented morainal remnants, eskers and meltwater channels, imply that the last ice to affect the southern coastal portion of St. Pierre and the west coast of Miquelon was the same that influenced the lower Burin Peninsula during the late, mid-Wisconsinan (Tucker and McCann, in press). It is not clear if the Burin Peninsula ice was continuous with that in the Miquelon highlands. It may be that limited patches of ice existed beyond a well defined terminus in a manner similar to that described for the late-Wisconsin limit near Terrenceville and Swift Current at the head of the Burin Peninsula. Certainly, the greater than 275 m deep channel between Miquelon and the Burin Peninsula (Canadian Hydrographic Service 1970) would deem this situation plausible because it is unlikely that so limited a cap would have been able to cross such a barrier. Although stratigraphic work on Langlade is incomplete, and only loosely correlated by way of the foraminifera with that on the southwest Burin Peninsula, it is considered precise enough to place more accurately the dispersal centre of

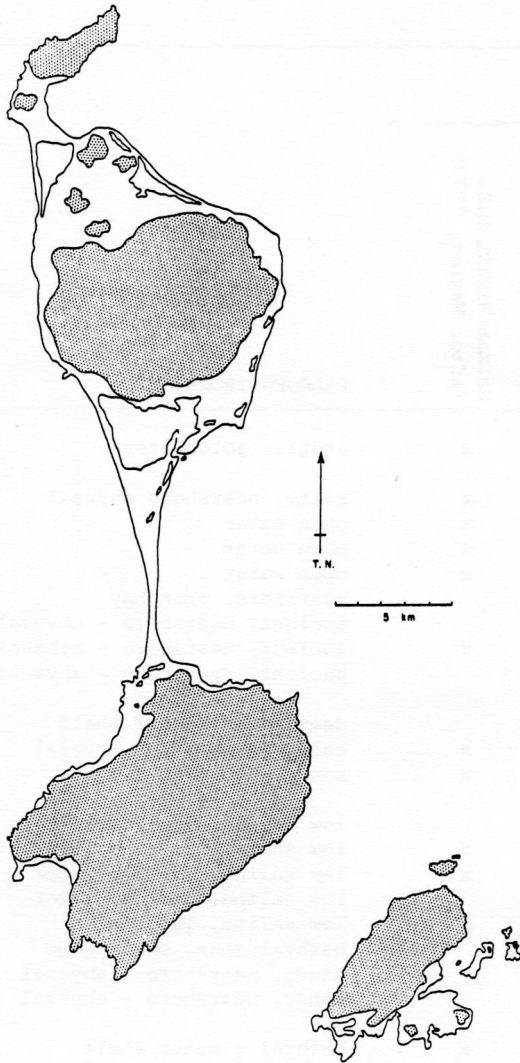


FIG. 3 Mid-Wisconsinan submergence.

Langlade is thought to be a coarsening upward, regressive sequence of shallow water marine to nearshore and subaerial silts, sands and gravels. One would hope, with closer study, to find that the marine unit is underlain by a grey-pink, silty, sandy "Fortune Bay Event" till described in Tucker and McCann (in press). This would complete a sequence similar to that exposed along the lower, southwestern coast of the Burin Peninsula, and extend the range of deposits back to the early Wisconsinan. No detailed analyses were attempted on Miquelon, but it is thought that all deposits below 20 m have been reworked by marine action to some extent. This conclusion is based on cursory examination of coastal material near Grande Anse du Ouest (M7005).

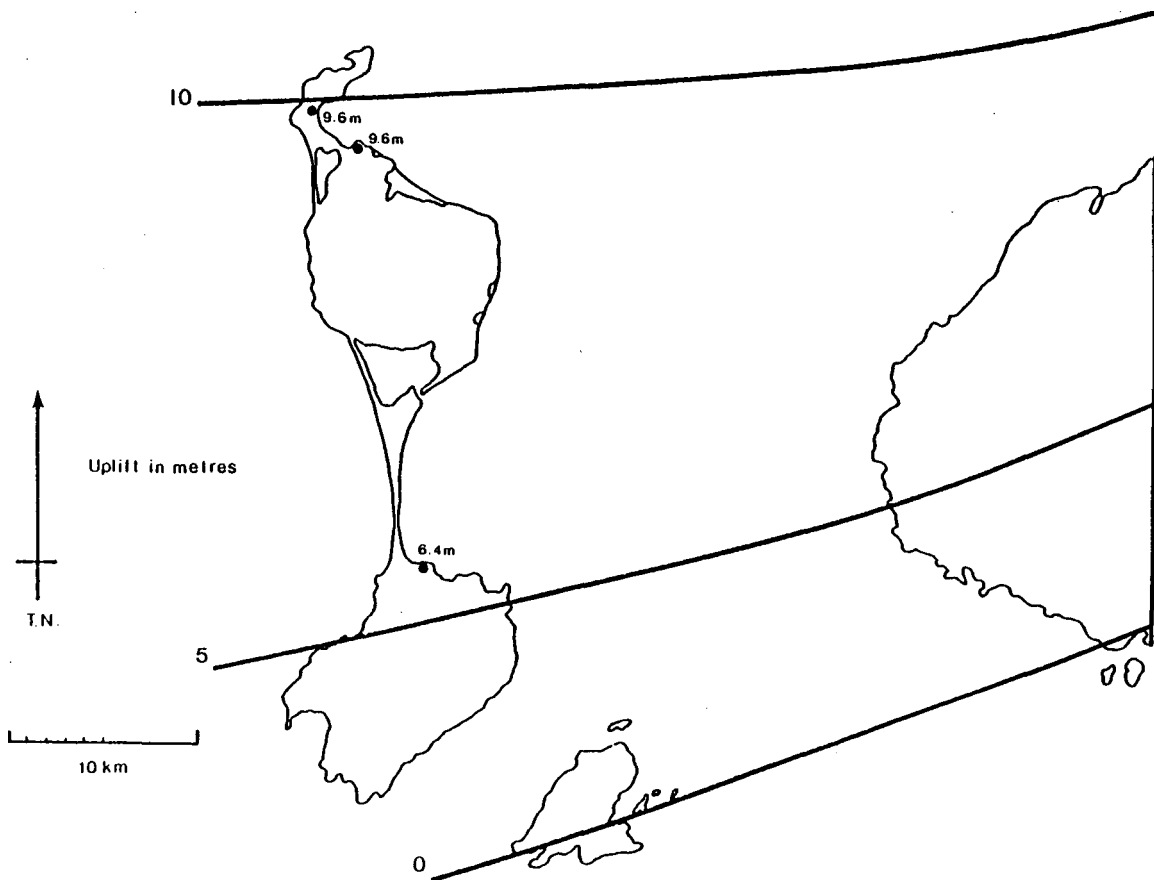


FIG. 4 Isopleths of postglacial emergence.

the late mid-Wisconsinan ice to the southeast, but west of the 250 m channel which cuts the centre of Placentia Bay (Canadian Hydrographic Service 1970).

Three periods of marine overlap are thought to have occurred: one during the Sangamonian, which cut the marine bench at approximately 2.6 m; one during the mid-Wisconsinan, from which about 20 m of overlap is recorded over unconsolidated deposits; and a final, lower, late-Wisconsinan overlap on the northern tip of Langlade and around the coast of Miquelon. The southern portions of Langlade and St. Pierre are considered to be submerged in a manner similar to the southeast coast of the Burin Peninsula.

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