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Résumé de l'article

La plus grande partie de l'inlandsis laurentidien qui couvrait le Maine, les Maritimes et le sud du Québec était une « calotte glaciaire marine », sa base étant sous le niveau marin de l'époque. Les conditions le permettant, des baies de vêlage se sont développées le long de courants de glace et ont morcelle la calotte, si bien que les parties au-dessus du niveau de la mer sont devenues des calottes résiduelles. Vers 12 800 ans BP une baie de vêlage a occupé les basses terres du Saint-Laurent jusqu'à Ottawa. En même temps, une baie plus petite se développait dans le centre du Maine. Le drainage simultané de la glace, au nord, dans la baie de vêlage du Saint-Laurent et, au sud, dans celle du Maine a abaissé la surface de la calotte glaciaire jusqu'à ce qu'elle se divise le long des monts frontaliers et Longfellow (NE-SO) ainsi qu'en d'autres régions de hautes terres. Cette calotte glaciaire, d'abord très étendue, a donc été isolée au-dessus d'une partie du Maine, du Québec et du Nouveau-Brunswick. Elle était limitée à l'ouest par la baie de vêlage du centre du Maine, au nord par celle des basses terres du Saint-Laurent, au sud par la baie de Fundy et à l'est par le golfe du Saint-Laurent. Dans la région côtière du Maine, à l'est de la baie de vêlage, la marge glaciaire a reculé au-dessus de la limite marine sur au moins 40 km, puis a réavancé jusqu'à la moraine de Pineo Ridge vers 12 700 BP. Ces événements sont les équivalents stratigraphiques et chronologiques de la récession de Cary-Port Huron, suivie de la récurrence de Port Huron, dans la région des Grands Lacs.

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THE IMPLICATIONS OF THE PINEO RIDGE READVANCE IN MAINE

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ABSTRACT Much of the Laurentide ice sheet in Maine, Atlantic Provinces, and southern Quebec was a "marine ice sheet," that is it was grounded below the prevailing sea level. When proper conditions prevailed, calving bays progressed into the ice sheet along ice streams partitioning it, leaving those portions grounded above sea level as residual ice caps. At least by 12,800 yrs. BP a calving bay had progressed up the St. Lawrence Lowland at least to Ottawa while a similar, but less extensive calving bay developed in Central Maine at approximately the same time. Concurrently, ice draining north into the St. Lawrence and south into the Central Maine calving bays rapidly lowered the surface of the intervening ice sheet until it eventually divided over the NE-SW trending Boundary and Longfellow Mountains and probably over other highland areas as well. A major consequence of these nearly simultaneous processes was the separation of an initial large ice cap over part of Maine, New Brunswick, and Québec which was bounded on the west by the calving bay in Central Maine, to the north by the calving bay in the St. Lawrence Lowland, to the south by the Bay of Fundy, and to the east by the Gulf of St. Lawrence. In coastal Maine, east of the calving bay, the margin of the ice cap receded above the marine limit at least 40 km and subsequently readvanced terminating at Pineo Ridge moraine approximately 12,700 yrs. BP. These events are the stratigraphic and chronologic equivalent of the Cary-Pt. Huron recession / Pt. Huron readvance of the Great Lakes region.

RÉSUMÉ *Les implications de la récurrence de Pineo Ridge au Maine.* La plus grande partie de l'inlandsis laurentidien qui couvrait le Maine, les Maritimes et le sud du Québec était une «calotte glaciaire marine», sa base étant sous le niveau marin de l'époque. Les conditions le permettant, des baies de vêlage se sont développées le long de courants de glace et ont morcellé la calotte, si bien que les parties au-dessus du niveau de la mer sont devenues des calottes résiduelles. Vers 12 800 ans BP une baie de vêlage a occupé les basses terres du Saint-Laurent jusqu'à Ottawa. En même temps, une baie plus petite se développait dans le centre du Maine. Le drainage simultané de la glace, au nord, dans la baie de vêlage du Saint-Laurent et, au sud, dans celle du Maine a abaissé la surface de la calotte glaciaire jusqu'à ce qu'elle se divise le long des monts frontaliers et Longfellow (NE-SO) ainsi qu'en d'autres régions de hautes terres. Cette calotte glaciaire, d'abord très étendue, a donc été isolée au-dessus d'une partie du Maine, du Québec et du Nouveau-Brunswick. Elle était limitée à l'ouest par la baie de vêlage du centre du Maine, au nord par celle des basses terres du Saint-Laurent, au sud par la baie de Fundy et à l'est par le golfe du Saint-Laurent. Dans la région côtière du Maine, à l'est de la baie de vêlage, la marge glaciaire a reculé au-dessus de la limite marine sur au moins 40 km, puis a réavancé jusqu'à la moraine de Pineo Ridge vers 12 700 BP. Ces événements sont les équivalents stratigraphiques et chronologiques de la récession de Cary-Port Huron, suivie de la récurrence de Port Huron, dans la région des Grands Lacs.

РЕЗЮМЕ ЯВЛЕНИЯ СВЯЗАННЫ С ПРОДВИЖКОЙ ПАЙНС РИДЖ В ШТАТЕ МЭЙН. Находившийся в штате Мэйн, в при-атлантических провинциях Канады и в южном Квебеке Лаврентийский покровный лед был, в большинстве, «морским покровным льдом» т.е. расположенным ниже преобладающего, в те времена, уровня моря. Когда подходящие условия преобладали, бухты, обламывающие ледник, прогрессировали внутрь покровного льда по потокам в леднике и секционировали его, оставляя те заземленные порции, оказавшись выше уровня моря, как остаточные лекниковые купола. По крайней мере 1.2800 лет назад одна такая бухта прогрессировала вдоль долины реки Св. Лаврентия почти до Оттавы. Приблизительно в то же самое время, такая же, но менее крупная бухта образовывалась в центре штата Мэйн. В результате, лед который дренировал на север в обламывающую ледник бухту находившись в долине реки Св. Лаврентия, вместе с тем льдом который дренировал на юг в бухту в центре штата Мэйн, быстро понизили поверхность покровного льда, лежавшего между этими бухтами что привело к тому что лед секционировался в горах (и возможно и в горных местах) протянувшихся с северо-востока на югозапад и называющихся Баундари и Лонгфелло. Важным результатом этих почти одновременных процессов было отделение крупного ледникового купола в районах штата Мэйн, провинциях Нью Бранзвик и Квебек. Этот купол граничил с бухтой в центре Мэйн на западе, с бухтой лежавшей в долине реки Св. Лаврентия на севере, с бухтой (морской) Фанди на юге и с заливом Св. Лаврентия на востоке. Приблизительно 12700 лет тому назад, в районе морского побережья штата Мэйн к востоку от бухты, край ледникового купола отступил от берега моря не меньше чем на 40км. и впоследствии сделал продвижку, закончившуюся на морене Пайнс Ридж. Описанные события являются стратиграфическим и хронологическим эквивалентом отступания по названию Кари-Порт Гурон и продвижки по названию Порт Гурон в районе Великих Озер.

PURPOSE

The purpose of this paper is to briefly review the current understanding of the late Wisconsin ice recession in the Northeast with the purpose of stimulating interest and future research in critical areas with the goal of determining the true model of deglaciation and its regional and perhaps global significance.

CURRENT UNDERSTANDING

Research primarily during the last ten years has demonstrated that much of the Laurentide ice sheet in southern Québec, Maine, and portions of the Maritime Provinces was a "marine-based ice sheet," that is, it was an ice sheet grounded below the prevailing sea level (PREST and GRANT, 1969; BORNS, 1973; STUIVER and BORNS, 1975).

When proper conditions existed, marine calving bays developed at the sea-glacier contact and progressed rapidly (THOMAS, 1977) into the ice sheet along ice streams resulting in a surface lowering and partitioning of the ice sheet, leaving large segments of the ice sheet grounded above sea level as residual ice caps.

Beginning about approximately 15,300 yrs. BP (KAYE, 1964), the margin of the Laurentide ice sheet retreated across the Gulf of Maine from its maximum extent on the continental shelf (SCHLEE and PRATT, 1970; TUCHOLKE and HOLLISTER, 1973) and passing parallel to and across the present Maine coastal zone about 13,200 yrs. BP accompanied by a marine invasion (BORNS, 1973; STUIVER and BORNS, 1975). The lowlands of central Maine became a calving bay as did the Bay of Fundy at approximately the same time. As the ice margin continued to retreat inland in Maine the accompanying marine transgression reached its furthest inland position at Millinocket, Maine, approximately 150 km from the present coast, about 12,700 yrs. BP (STUIVER and BORNS, 1975).

To the east of the calving bay in Maine and New Brunswick the margin of the receding ice sheet, grounded above the prevailing sea level, continued to more slowly recede inland. In eastern coastal Maine the margin receded at least 40 km landward of the upper marine limit.

A date of 12,800 yrs. BP on marine shells reported from the St. Lawrence Lowlands (Prest, pers. comm.) demonstrates that by that time a calving bay had progressed up the Lowlands from the Gulf of St. Lawrence to the vicinity of Ottawa, Ontario. Because of the presence of Laurentide ice in Maine at this time, it is clear that this marine incursion partitioned the Laurentide ice sheet leaving a residual ice cap to the south of the St. Lawrence Lowlands over Québec, Maine, and New Brunswick after 12,800 yrs. BP while at the same time the margin of the main Laurentide ice sheet lay along the northern margin of the sea filling the St. Lawrence Lowland.

Following the recession in coastal Maine, the margin readvanced approximately 40 km parallel to the present coast and terminated in the sea forming the Pineo Ridge moraine system (BORNS, 1973) in Maine, and its probable equivalent, the deposits of the Pennfield Phase in New Brunswick (GADD, 1971) at approximately 12,700 yrs BP (BORNS, 1973; STUIVER and BORNS, 1975).

This oscillation is roughly the stratigraphic and chronologic equivalent of the Cary — Port Huron recession and subsequent Port Huron readvance of the Great Lakes region (FARRAND, ZAHNER, and BENNINGHOFF, 1969) but was related to an ice cap rather than to the Laurentide Ice Sheet.

The general recession inland from the Maine coast, underway approximately 13,200 yrs BP was most probably resulted from direct contact between the ice margin and the sea. In central Maine this sea-ice relationship continued inland for about 100 km (GOLDTHWAIT, 1949; BORNS and HAGAR, 1965). However, in eastern Maine, where the elevations are higher, the upper marine limit is only approximately 25 km inland of the present coast. Here the margin receded well above the upper marine limit and subsequently readvanced and terminated in the sea near the upper marine limit (BORNS, 1973).

These spatial relationships suggest that at least those portions of the oscillation occurring above sea level represent a response of the ice cap to a climatic pulse. However, the terminal position of the readvance, marked by the Pineo Ridge moraine system, was probably controlled by the level of the sea (HOLLIN, 1962).

Subsequent to the Pineo Ridge readvance the margin of the ice cap in east central Maine receded northward above the upper marine limit. To the east, in the broad valley of the south-flowing St. John River of New Brunswick, LEE (1959 and 1962) and GADD (1973) noted several recessional ice marginal positions. Two of these positions, one at Woodstock and another to the north at Grand Falls (LEE, 1959 and 1962), appear to have equivalents in adjacent eastern Maine (Genes, pers. comm.). These events in both New Brunswick and Maine are as yet undated but clearly are younger than 12,700 yrs. BP.

IMPLICATIONS TO CONSIDER

Based upon our present understanding of these late glacial events in Maine and in the St. Lawrence Lowland, the following points are made:

1) Following the partitioning of the Laurentide ice sheet by the calving bay in the St. Lawrence Lowland, an ice divide, whose geometry is yet undetermined, developed south of the Lowlands and the ice in northern Maine and its flow would have readjusted to a northerly flow at least in the border area.
2) Stratigraphic equivalents of the pre-Pineo Ridge recession and subsequent Pineo Ridge readvance should be expected around the periphery of the ice cap south of the St. Lawrence Lowland and west of the Gulf of St. Lawrence.
3) Deposits marking subsequent marginal positions and possible oscillations related to the shrinking and final disappearance of the ice cap should be present in Québec, Maine, and New Brunswick.

POSSIBLE CORRELATIONS

In the Great Lakes region the overall recession of the late Wisconsin ice sheet was marked by a significant reversal during the well-known Port Huron Stade (FARRAND, ZAHNER, and BENNINGHOFF, 1969) and a subsequent hesitation during the Algonquin Stade (SAARNISTO, 1974).

In the east, the recession of the ice cap in Maine was interrupted by the Pineo Ridge readvance and by at least two subsequent hesitations before its final dissipation. To the north the recession of the edge of the main body of the Laurentide ice sheet on the north slope of the St. Lawrence Lowland was interrupted by the event that produced the St. Narcisse moraine system (DENIS, 1974; LASALLE and ELSON, 1975).

The Port Huron readvance is the stratigraphic and approximate chronological equivalent of the Pineo Ridge readvance (BORNS and DENTON, 1972) and both occurred between 13,000 and 12,000 yrs BP while the marginal moraines of the Algonquin Stade and St. Narcisse moraine system were most probably developed between 11,000 and 10,000 yrs BP.

In addition, these events approximately coincide with north-south oscillations of the polar water margin in the North Atlantic Ocean (RUDDIMAN and McINTRYE, 1973), with oscillations of air temperatures recorded in the Greenland ice sheet (DANSGAARD, JOHNSEN, CLAUSEN and LANGWAY, 1971) and approximately with late Weichselian ice marginal and vegetational changes in northern Europe (MANGERUD, 1970).

Although a great deal more research is necessary the chronology and significance of these events when combined suggest a hemispheric climatic pattern including "cold" periods roughly between 13,000 and 12,000 yrs BP and between 11,000 and 10,000 yrs. BP separated by a "warm" period from approximately 12,000 to 11,000 yrs. BP.

CONCLUSION

Based upon our current understanding of events, and upon the fact that large portions of the late Wisconsin Laurentide ice sheet in the Northeast was "marine based," a model of deglaciation for Maine, southern Québec, and, in part, for New Brunswick, has been suggested for contemplation.

In addition, correlations have been suggested that, if true, imply climatic changes of possible hemispheric proportion that occurred roughly between 13,000 and 10,000 years ago.

A great deal of coordinated research will be required in carefully selected areas to prove or disprove these hypotheses in addition to the greal deal of new data that has been already gathered during the last decade by a great many researchers working in the Northeast.

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QUESTIONS AND COMMENTS

N.-A. MÖRNER:

"With regard to your last slide on the correlations, I think those correlations can easily be made more detailed and be extended geographically (see *Boreas*, 2, p. 33-53). I think such extended and detailed correlations give clear evidence of the fact that we are dealing with global climatic signals. Locally, those signals may be quite differently picked up, which may lead to apparent dissimilarities. I will restrict myself to one example."

H. W. BORNS JR.:

"The Older Dryas Stadial in Scandinavia dated at 11,900-11,750 BP (consisting of a 30-yrs cold phase, a 75-yrs warmer interval and a 50-yrs cold phase) corresponds almost exactly with the beginning of the Greatlakean Readvance (earlier: "Valders" Readvance). Because it took quite a time to melt away the Greatlakean ice lobe, this stadial seems to have lasted much longer than the Older Dryas Stadial. For the global correlations, however, it is only the readvance itself (and not the melting-away phase) of the Greatlakean Stadial that is of interest. Similar evaluations and extended studies lead — in my opinion — to a much more detailed correlation scheme than the one shown by you *cf.* the papers by Dreimanis and myself)."

A. DREIMANIS:

"In the correlation table with Europe, even a closer parallelism may be obtained at the 13,000 BP range, if the Raunis interstadial of the Eastern Baltic region would be considered (it has at least the ^{14}C dates slighty older than 13,000 BP)."

I. A. BROOKES:

"I have recently obtained a date of 12,000 ± 140 years BP (GSC-2295) on shells in sands deposited in a glacio-marine kame delta at Stephenville, Newfoundland. This dates the attainment of a terminal position previously called the "Robinsons Head Drift" readvance around St. George's Bay. I believe in a local glacio-dynamic cause for the event not withstanding any ^{14}C correlations that might be made."