Deglaciation History and Geomorphological Character of the Region Between the Agassiz and Superior Basins, Associated with the ‘Interlakes Composite’ of Minnesota and Ontario

Brian A.M. Phillips and Christopher L. Hill

Abstract

As the Des Moines, Rainy and Superior ice lobes withdrew from Minnesota and the Superior Basin after 12,000 B.P., Palaeo-Indian people moved into the region of northeastern Minnesota and northwestern Ontario, which lies between the sequence of lake phases in the Lake Agassiz and in the Superior basins. Scattered evidence of the ‘Interlakes Composite’ is associated with interior lakes, rivers and topographic features such as moraines. However, migration also appears to have consistently followed the changing geography of the Superior and Agassiz lake shorelines, which provides an inexact but useful tool for relative dating. New geomorphic evidence suggests that conditions would have allowed Palaeo-Indians to enter the borderland region prior to the Marquette readvance of around 10,025 B.P., and possibly as early as before 11,000 B.P.

Résumé

A mesure que les lobes glaciaires Des Moines, Rainy et Supérieur se sont retirés du Minnesota et du bassin Supérieur antérieur à 12 000 A.A., la population paléoindienne s’est déplacée dans la région nord-est du Minnesota et nord-ouest de l’Ontario, qui s’étend entre la suite des phases lacustres dans les bassins du lac Agassiz et Supérieur. L’évidence dispersée de la « Composite Interlacs » est associée aux lacs à l’intérieur des terres, les rivières et les traits topographiques tels que les moraines. Cependant, il parait aussi que la migration de la population paléoindienne a régulièrement suivi la géographie variable des zones côtières des lacs Agassiz et Supérieur, ce qui devient un outil inexact mais toutefois utile à la calibration

Introduction

As the Des Moines, Rainy and Superior ice lobes gradually withdrew from central Minnesota, a corridor of freshly deglaciated landscape was revealed that led through northeastern Minnesota into northwestern Ontario, between the extensive area of Lake Agassiz to the north and the declining sequence of lakes occupying the Superior basin to the south. Into this corridor migrated groups of Palaeo-Indians, who it appears, followed closely on the heels of deglaciation. The landscape that early arrivals traversed was one that was periglacial but often flowing with an abundance of meltwater. Large proglacial lakes occupied some areas along the northern side of the corridor, temporarily cascading to lower basins and gradually shrinking in their dimensions. The myriad of lakes in the interior of the corridor probably filled their basins to a much greater degree than at present, and along the southern edge of the corridor the lakes of the Superior basin penetrated far inland of the present lake margin. The people who entered the rugged and still changing landscapes of this corridor came from more southern environments. McLeod (1976, 1981) discussed the perception of the Boreal Forest (1982), and he characterized these peoples as highly mobile family units, sharing traditional sites on a seasonal or sporadic basis. Their adaptation to the conditions of the new region, as evidenced by their toolkit, has resulted in their being identified as the ‘Interlakes Composite’ (Ross 1997), a term which expanded that of the ‘Lakehead Complex’ (Fox, 1975). They left a limited, varied and often confusing deposition of artifactual materials (McLeod 1976) spanning several cultural traditions. The characteristics of their projectile point styles and the variety of raw materials they utilized is discussed by Ross (1995).

Based on the presence of a Clovis point at the Island Lake site, Minnesota, it has been proposed that Palaeo-Indian populations began to occupy parts of northern Minnesota by about 10,500 B.P., and perhaps as early as 11,000 to 10,800 B.P. (Romano and Johnson 1990; dating based on Haynes 1993, see also Holliday 2000). This paper provides evidence, which suggests the potential for such early occupation as far north as Cook County, Minnesota and into the Canadian borderlands, just southwest of Thunder Bay, Ontario.

Deglaciation Summary

Several major phases of late-Wisconsin glacial activity have been distinguished in northeastern Minnesota (Wright and Watts 1968; Lannon and Matsch 1987; Lehr and Hobbs 1992). The three major advances, in chronological order, are the St. Croix phase, the Automba phase and the Nickerson-Alborn phase. Dates quoted here may have to be revised (for example, see Moores and Matsch 1998).
St. Croix Phase

During the St. Croix phase, the Superior and Rainy lobes combined and advanced south and west to build the St. Croix Moraine, between approximately 20,000 and 15,000 B.P. (Clayton and Moran 1982; Mickelson et al. 1983:10; Attig et al. 1985) (Figure 10.1). In the interstadial that followed, the Rainy lobe melted back to the Vermilion Moraine (Wright and Watts 1968:13), proglacial lakes Upham and Aitken I were formed, and the Superior lobe melted back into the Superior basin.

Automba Phase

The Automba phase (Figure 10.1), estimated to have occurred 17,000 to 15,000 B.P. (Wright and Watts 1968), saw the Rainy lobe remain in the vicinity of the Vermilion Moraine, but the Superior lobe advance southwest to build the Mille Lacs Moraine and push up the coastal slopes of the north shore across the southeastern edge of the Toimi drumlin field to form the Highland Moraine, sub-parallel to the Superior lakeshore. This appears to represent the greatest identifiable incursion of the Superior lobe across the north shore and, although the Highland Moraine is not traceable as a feature north of its junction with the Automba margin of the Rainy lobe, the inland margin of the red Superior till can be traced up the shore towards Grand Portage about 2 to 4 miles inland (Figure 10.2). In several locations within the...
Figure 10.2 Proposed Limit of the Superior Lobe on the North Shore of Lake Superior (After Sharp, 1953b, Figure 2).

Figure 10.3 Nickerson-Alborn Phase Deglaciation. Around 12,000 years B.P. the St. Louis sublobe advanced from the northwest to form the Culver Moraine. The Nickerson Moraine marks the extent of the Superior lobe. Later, the Lakeview/Porcupine phase of deglaciation saw water from glacial lakes Aitkin and Upham II flow through the St. Louis drainage system (After Phillips, Hill, Fralick and Ross, 1994, p.7; Phillips and Hill, 1994a, p.18).
deep valleys of the north shore, the red Superior till has been observed to overlie grey, carbonate-rich Rainy till (Sharp 1953b:861). At the end of the Automba phase, the Superior lobe retreated into the Superior basin allowing red lacustrine clays to be deposited in the south-west end of the basin in an incipient Lake Duluth or Epi-Duluth lake.

**Nickerson-Alborn Phase, Lakeview/Porcupine Phase**

The subsequent Nickerson-Alborn phase saw the St. Louis sublobe of the Des Moines lobe readvance over the basins of Glacial Lakes Aitken and Upham about 12,000 B.P. (Figure 10.3). The Superior lobe again advanced southwest over the lacustrine floor to build the Thompson-Nickerson Moraine, about 12,000 to 11,000 B.P. It is significant that there is no clear evidence of the degree to which this ice impinged along the north shore. This is also true of a minor subsequent advance of the Superior lobe, the Lakeview/Porcupine phase about 11,000 B.P. (Figure 10.3), although some evidence of an ice margin just to the west of Two Harbors is recorded (Clayton 1984:32–33). More lacustrine clays were deposited in ice marginal lakes of Epi-Duluth type. Human populations using Clovis artifacts may be associated with the ice margins of the Lakeview/Porcupine phase, if Palaeo-Indian people had entered the area by 11,000 B.P.

**Early Minong Levels and Marquette Phase**

Following the Lakeview/Porcupine phase, melt appears to have been sufficient to have permitted the Superior lobe to vacate much of the Superior basin. Anderton et al. (this volume) refers to this ice in withdrawal in the Upper Peninsula of Michigan as ‘Greatlakean’. Retreating to the Ontario north shore, it allowed the eastern outlets of Lake Agassiz to pour catastrophically over the Arctic divide and through Lake Nipigon into Early Lake Minong, the body of water occupying the Superior basin between about 10,800 and 10,000 B.P. (Teller and Thorliefson 1983) (Figure 10.4a). Little is known of Early Lake Minong. The Superior basin was still greatly depressed, and it would not be unreasonable to suggest that water levels were probably similar to that of the Epi-Duluth and Duluth lakes that followed the withdrawal of Marquette ice.

It is at this point in deglaciation history that conditions were favourable for early Palaeo-Indian occupation of the corridor, which had now expanded to include the exposed floor of Lake Agassiz during the accompanying Moorhead low water phase, and the Minnesota shores of Lake Superior, now fully freed from ice contact. This period or interstadial has been named ‘Gribben’ (Karrow et al. 2000) after the forest bed of Lake Gribben, Michigan, which grew during this period.

Evidence for the late stage Marquette Readvance (until recently pegged at 9,900 B.P.) is based upon the rise of Lake Agassiz (the Emerson phase) due to the sealing of the eastern Nipigon outlets (Fenton et al. 1983). Further evidence suggests late ice incursion on the coastal zone of Michigan and Wisconsin, where burial of forest growth by lacustrine and outwash deposits and isolated morainic features has been identified (Hughes and Merry 1978; Drexler et al. 1983; Clayton 1984) (Figure 10.4b). On the basis of additional 

14C dates from the Lake Gribben forest bed and correlation with ice advances elsewhere in the northern hemisphere, Lowell et al. (1999) confirm and refine what is known of the Marquette Advance. They
Figure 10.4a Superior basin, Early Lake Minong, about 10,400 yrs. 14C yrs B.P. Melting back of the Superior lobe allowed the basin to fill with a lake that was contemporaneous with the eastward draining of Lake Agassiz (Moorhead stage) (From Phillips, 1993, p.95).

Figure 10.4b Superior basin, Marquette Readvance of Superior lobe, about 10,000 yrs. 14C yrs B.P. Blockage of the eastern outlets heralded the Emerson phase of Lake Agassiz. The Dog Lake and Marks Moraines trapped glacial Lake Kaministiquia, and Lake Duluth formed in the southwest end of the basin (From Phillips, 1993, p.95).
conclude that the advance lacks the character of a regional surge event on the edge of the Laurentide ice and is a later than average expression of the general advance of ice sheets in the Younger Dryas global cooling event that occurred approximately 11,000 to 10,000 B.P. They identify an advancing ice margin halting at 10,025 B.P. adjacent to the Gribben forest and extending over 1000 km from North Bay, Ontario, along the southern shore of Lake Superior towards Duluth.

West of Duluth the impact of the Marquette Advance is less clear. Evidence of the Marquette Advance on the Minnesota north shore is questionable, and the southwestern end of the Superior basin appears to have remained occupied by a vestige of Early Lake Minong, now termed Lake Duluth. Although possible evidence of overlapping variants of Superior till on the Minnesota north shore could be interpreted as the impinging of Marquette ice (Lehr and Hobbs 1992:51), there is the real possibility that the northwestern margin of the Marquette lobe remained offshore (contrary to Figure 10.4b). This allowed Lake Duluth to lie high against the coastal slopes at least as far north as the international border, north of which Marquette ice is considered to have extended up the Kaministiquia embayment to the position of the Marks Moraine (Farrand and Drexler 1985). It has been assumed by some authors, quite reasonably, that the Marquette Readvance would have obliterated any pre-Marquette shoreline archaeological sites along the Minnesota north shore (Phillips 1993), but such early sites could have been preserved if ice did not in fact, impinge heavily on the shoreline.

High Shoreline in Cook County, Minnesota

There remains a degree of uncertainty as to when and, at what elevation, the body of water named Lake Duluth was first formed. References to independent proglacial lakes formed at the southwest terminus of the Superior lobe vary in their estimation of lake level, chronology and nomenclature.

Early Lakes

Glacial Lake Nemadji and other smaller proglacial lakes are referred to as Epi-Duluth, and are generally believed to have coalesced into Lake Duluth as the ice margin receded. Farrand (1960) proposed that coalescence took place at the 331m (1085 feet) level, and later authors concur that the best developed Duluth shoreline features are displayed along the Skyline Parkway (in Duluth, Minnesota) between 330 and 327m (1083 and 1073 feet) (Zarth 1977:81; Moss et al. 1979:23; Phillips et al. 1994). Farrand determined that three distinct stages of Lake Duluth were displayed at 331, 328 and 323m (1085, 1075 and 1060 feet), all water planes appearing horizontal in the Duluth area, but gradually commencing tilt until approximately 0.502m per km (2.65 feet per mile) northeast of French River (Farrand 1960:22) (Figure 10.5). Farrand traced the 331m (1085 feet) level to just north of Grand Marais where it is found at 390–393m (1280–1290 feet) (Sharp 1953a), and suggests that the ice margin was close by. The 328m (1075 feet) level was traced to a feature approaching the international border near Mineral Center at 403m (1323 feet) (Farrand 1960:176). If this level of Lake Duluth is projected across the border it would be found close to 442m (1450 feet) near Thunder Bay, Ontario.

In the vicinity of the Brule River at Judge C.R. Magney State Park, just north of Grand Marais, the highest expected level of the 328m (1075 feet) stage of Lake Duluth is at about
Figure 10.5 Shoreline diagram of the Epi-Duluth, Duluth and selected other shorelines. (After Farrand, 1960; Phillips, Hill, Fralick and Ross, 1994)

Figure 10.6 Former shorelines in Judge C.R. Magney State Park. (From Phillips and Hill, 1993, p.19)
396m (1300 feet), and fairly weak features are recorded at this level (Farrand 1960:175). However, remarkably well-developed shoreline features have been subsequently reported around 427m (1400 feet) in the Brule River area, within Judge C.R. Magney State Park (Phillips and Hill 1993) (Figure 10.6). Shorelines that are higher than Lake Duluth have also been reported in the Duluth area (Schwartz and Theil 1963:198), at Two Harbors (Lannon 1986), and in the vicinity of the Baptism River in Tettegouche State Park (Farrand 1960:168; Phillips and Hill 1994b) (Figure 10.5). These observations can be interpreted in several ways.

Three Shoreline Models

![Shoreline Models](image)

**Figure 10.7a** The Isolated Lakes Hypothesis. In this model, independent drainages form separate proglacial lakes against the Marquette ice margin. Epi-Duluth and Duluth level lakes occupy the southwest of the basin. (From Phillips and Hill, 1994a, p. 31)

**Figure 10.7b** The Narrow Lake Hypothesis. In this model, a high, narrow lake (Epi-Duluth level) lies between the upland coast and the Marquette ice margin offshore. (From Phillips and Hill, 1994a, p. 31)

**Figure 10.7c** The Large Lake Hypothesis. In this model, high shorelines are related to an Early Lake Minong as Superior ice vacated most of the basin and allowed Lake Agassiz to use the eastern outlets. (This figure is new to this paper)

Isolated Proglacial Lakes

The first possibility is that high shoreline features could have been formed in geographically isolated locations as a result of Superior ice impinging on the coastal slopes and damming major river valleys to form independent proglacial lakes (Figure 10.7a). As seen from the ear-
lier discussion, determining which phase of Superior ice would have been responsible is a fair question, particularly since the presence of later Marquette ice on the shore is now questioned. The well-formed nature of the shorelines in Judge C.R. Magney State Park suggests that wave action in small, isolated lake bodies would have been insufficient to form the high shoreline features, especially when the Duluth shorelines below are themselves less well-formed.

A Narrow Lake Bounded by Ice (EPI-Duluth)

A second possibility is that the coalescence of Epi-Duluth proglacial lakes in the Duluth area involved a continuation up the north shore, such that a narrow ribbon of water was formed between the Superior lobe and the coastal slopes (Figure 10.7b). Being a single lake, the present discontinuous segments of this Epi-Duluth lake should demonstrate continuous deformation up shore; however, as yet, too few occurrences of these high water level features have been reported to verify this. However, the well-formed features at both Judge C.R. Magney and Tettegouche State Parks do indicate a tilt similar to that of the Duluth shorelines (Figure 10.5). Once again, it seems unlikely that these well-formed features developed in the limited wave environment offered by a narrow proglacial lake lying parallel to the shore.

A Large Open Lake (Early Lake Minong)

A third possibility is that the high shorelines were formed in an open lake environment without the inhibiting presence of ice (Figure 10.7c). This would have to be Early Lake Minong, the body of water occupying the Superior basin prior to the Marquette advance, and about which relatively little is known. This water body began forming as an early version of Lake Duluth in the southwest corner of the basin and ultimately filled the Superior basin as ice largely vacated it. It received catastrophic overflows from Lake Agassiz via the eastern outlets (Teller and Thorlieison 1983), but a fairly stable water level of the elevation seen on the north shore is not unreasonable. The Marquette Readvance could, in this scenario, have later invaded the lower coastal slopes, with the highest level of Lake Duluth failing to encroach on the former Early Lake Minong shoreline and therefore, permitting it to survive. This is conjectural and there is a need to determine whether this high shoreline level is in evidence elsewhere in the lake basin. Anderton et al. (this volume) note wave-cut features at 490m (1607 feet) and 425m (1394 feet) in the Deer Lake area, and other wave cut features at 428m (1400 feet) and 420m (1380 feet) near Teal Lake, both in Marquette Co., Michigan. However, it has not been established whether these were formed in isolated proglacial lakes or could have been part of the Early Lake Minong shoreline, prior to the Marquette Advance.

Archaeological Implications

The archaeological implications, especially of the third interpretation, are significant. If Palaeo-Indian people entered the Interlakes corridor in the Gribben period, prior to the Marquette advance (before 10,025 B.P.), then it is entirely possible that they would have migrated up the north shore, which would have served as a fairly obvious route. Evidence of their presence may lie waiting to be found on these high shorelines and also, inland of them.
If the second interpretation is more correct, then the presence of the Marquette lobe offshore may or, may not have inhibited the presence of Palaeo-Indians on the high Epi-Duluth shoreline. Alternatively, if the first interpretation is correct, it is still possible that people would be present on the shores of isolated proglacial lakes, unless nearby ice margins were, in fact, a deterrent to their presence. McLeod noted that the borderland area was open (ca. 12,000 to 11,000 B.P.) and stated that “The possibility that the first people into the area were tundra/parkland caribou hunters exists. This movement would have come from northern Minnesota” (1981:33). More recently (McLeod 1995), speaking of the Thunder Bay area alone, he concluded that Palaeo-Indians camped on the shores of proglacial lakes around 10,000 B.P. He suggested that these people lived within 10 km (6.25 mi) of the glacial front. Anderton et al. (this volume) concur with Buckmaster and Paquette (1996) that Palaeo-Indian people may well have been living within 16 to 24 km (10–15 mi) of the active ice margin in Marquette Co., Michigan; therefore, it is not unlikely that artifacts may be found along this high shoreline, regardless of its relative origin and age. However, the third interpretation would see these sites representing pre-Marquette habitation of the Minnesota north shore.

Current evidence shows that the main migration of these early people followed the withdrawal of the Marquette lobe after 10,025 B.P. Their presence can be traced from Lake Duluth shorelines in the Duluth area (Mulholland and Dahl 1988), northeastwards to later shorelines of the descending series of post-Duluth shorelines, entering the Kaministiquia embayment, Thunder Bay, Ontario. This occurred most obviously after the late Beaver Bay water level, when Minong lake levels prevailed, around 9,500 B.P. (Phillips 1988; Stuart 1993). Although the association of ancestral Lake Superior shorelines with archaeological sites in the Thunder Bay area does provide convenient relative dating, the scenario of coastal migration does not exclude the possibility of earlier migration through the inland portion of the Interlakes corridor, prior to, and during the Marquette advance.

Deglaciation Features of the Borderland Region

It is significant that Sharp’s map of glacial features in Cook County (Sharp 1953b:Fig.2; Grout et al. 1959:Plate 1) shows the undulating inland boundary of the Superior lobe sub-parallel to the shoreline as far north as Mineral Center (Figure 10.8). To the east, the boundary is lost in the rugged topography of the diabase ridges of the Grand Portage area, and its lacustrine red clay-filled valleys and hollows.

Morainic Features

STEEP ROCK AND BRULE MORaines: On the Canadian side of the border, Zoltai (1963) identified several moraines (Figure 10.9). The earliest evidence of ice movement is the one advancing over the whole area from slightly east of north. This Patricia ice (as locally known) accords with the Rainy lobe advance to the St. Croix Moraine through northeastern Minnesota. During the retreat of this ice margin, the ‘Greatlakean’ retreat, the Steep Rock Moraine was formed sometime after ice withdrew from the Vermilion Moraine in Minnesota (Figure 10.1). The moraine does not visibly extend into the tip of northeastern Minnesota, although its southeast trend appears to lead into the area. The Brule Creek Moraine (Figure 10.9) represents a subsequent phase in the recession of the Rainy or Patricia lobe, but its for-
mer eastward continuation has been destroyed by a later event in the Thunder Bay region—the Marquette Advance.

**DOG LAKE AND MARKS MORAINES:** The Dog Lake Moraine represents the southern limit of an ice advance from the Lake Nipigon region to the north and east, which is generally referred to as ice of the Hudson Bay lobe (Figure 10.9). The Marks Moraine, which truncates the earlier Brule Creek Moraine, represents the limit of the Superior ice lobe pushing west and north up the Kaministiquia valley from Lake Superior. The two lobes were contemporaneous and met along the west to east trending Mackenzie Interlobate Moraine. As discussed earlier (Farrand and Drexler 1985), both are interpreted as representing the Marquette Advance on the western side of the Superior basin, the ice margin then running southwest towards Duluth either in contact with, or offshore of the Minnesota coast. Whether the Marks Moraine was formed by Marquette ice alone or, is an older feature that was reoccupied by Marquette ice, has been debated (Julig et al. 1990; Phillips and Ross 1995). More recent research has noted several locations at which bodies of till and fluvioglacial sediments of northern provenance are incorporated within the usually red-coloured Superior till. Noble (personal communication 1995 to B.A. M. Phillips) proposed the idea of inheritance and modification of the Brule Moraine by the Marquette ice advancing up the Kam valley, and this has now been demonstrated as the likely scenario by Tickle (1996) and by Bajc (2000), both of whom describe sections in the Marks Moraine area that show Superior till overriding an older till of northern provenance.

The southward continuation of the curve of the Marks Moraine is presently known only by isolated morainic features, which were first identified by Zoltai (1963) (Figure 10.9), and also
by several isolated ice contact deltas just east of Whitefish Lake and in Lybster and Braeleigh townships to the south (Timko 1995). The morainic material at the east end of Whitefish Lake has recently been confirmed to be of Superior ice provenance (Williams 1999), but a clear continuation of the Marks ice margin has not been traced through the rugged borderland topography of the Norwesterns to the Superior shore, and little is known of the way in which it supposedly turned southwest to parallel the Minnesota north shore. The line is drawn with ease on small scale maps but in reality, the ice margin must have been very irregular in plan shape.

More apparent in the borderlands is the legacy of inundation by a series of subsequent glacial and post-glacial lakes, which have left the region swathed in red lacustrine clays and silts to an elevation of over 427 m (1400 feet) in places. The lacustrine sediments form broad flat areas between the steep-sided, mesa-like ridges of diabase, which characterize the Northwestern hills between the U.S./Canada border and Thunder Bay.

Proglacial Lakes

**Glacial Lake O'Connor:** The flat-floored valleys of the Stump and Swamp rivers in Cook County, Minnesota, lie north of Hovland, crossed by County Road 16—the Arrowhead Trail. The water body that occupied these broad valleys was called Lake Omimi by Elftman
and its margins are shown by brown interbedded clay-silt beds that rise to 431 m (1415 feet), and by an overlying layer of red clays that rise to 422 m (1385 feet). Sharp (1953b) dismissed the conclusion that the lake was an extension of Lake Duluth, because he considered the elevation of 422 m (1385 feet) to be too high. The Stump and Swamp valleys are contiguous with the broad valley of the Pigeon River as it flows east from South Fowl Lake (436 m; 1430 feet). Tracing the 427 m (1400 feet) contour towards the northeast into Ontario (Figure 10.10), reveals that an extensive area on both sides of the border would have been flooded by a lake of this elevation. Sharp (1953b:867) records red clays (over brown clays) close to 427 m (1400 feet) in the area of Grand Portage State Park. Red clays have been recorded as draped over the top of ice-contact deltas around the 427 m contour as far north as the Whitefish Lake area (Timko 1995). Since the level of Lake Duluth was projected by Farrand to be only 411 m (1350 feet) near the Pigeon River border, there is reasonable doubt that this large body of water was at first connected to the 328 m (1075 feet) phase of Lake Duluth. Figure 10.10 does not allow for isostatic deformation and does not show that the Superior ice margin must have formed an eastern boundary to the lake. Zoltai (1963:111) named the lake body occupying the Stump, Swamp, Pigeon, and Arrow river basins, ‘Glacial Lake O’Conner,’ and noted that the only recognizable outlet was to the south through the Swamp River basin. Although the Swamp River now flows north to the Pigeon River, the southern end of the lake floor (415–421 m; 1359–1380 feet) is open to the north shore coastal slopes overlooking Howland. Water could have poured from Lake O’Conner into a body of water lying against the coastal slopes along the approximate 427 m (1400 feet) contour, perhaps the same Epi-Duluth lake level as that which was found in Judge C.R. Magney State Park a few miles to the southwest (Phillips and Hill 1993). Since red clays are draped across much of the topography below 427 m (1400 feet) in the Grand Portage area, attaining a considerable thickness of 6 m (20 feet) or more in lower areas, it is very likely that continued deposition took place over parts of this large lake basin from a period of early proglacial lakes through the succession of Duluth and Post-Duluth lake stages.

Archaeological Implication

The presence of extensive proglacial lakes in the borderland area has considerable archaeological implications. Most of the present ridge crests and mesa-like summits of this region formed islands in these lakes, and present topography shows that few of these were connected to the ‘mainland’ until water levels had fallen below approximately 302 m (990 feet)—that is, the low Manitou lake level. Even so, the question arises as to why early people would seek to visit these isolated ridge crests. Assuming that early people were following game and moving up the shore into the Thunder Bay area and beyond, the Grand Portage area was, until a much lower water level, a cul-de-sac that lead only to an expanse of open water.

It would appear that, at the time the Swamp and Stump river valleys were filled with water to the 427 m (1400 feet) level, and in the period of falling water levels that followed, access to the northeast would most logically have been gained by turning inland in the vicinity of the Brule River (Judge C.R. Magney State Park), and heading north towards Whitefish Lake via
South Fowl lake, which at 436m (1430 feet) was close to the western shore of the lake body (Figure 10.11). This constitutes a plausible theory of cul-de-sac and bypass that may account for the paucity of Palaeo-Indian sites on the Superior coast between the border and Thunder Bay. Furthermore, it may account for the known Palaeo-Indian sites at South Fowl Lake, as well as those discovered on East Bearskin Lake, Minnesota and around Arrow and Whitefish lakes in Ontario. The former, a site between North and South Fowl lakes, revealed material from Palaeo-Indian through Archaic to historic periods. Much of the material was Archaic, typically copper, but Palaeo-Indian material was also found (Plateck 1965). The later material came as a result of the Pigeon River being a key routeway into the interior, but the
Paleo-Indian material could possibly have been derived from a cross river route, heading towards the Arrow-Whitefish lakes area.

**Features of the Arrow-Whitefish Lakes Area**

Arrow and Whitefish lakes lie at the eastward end of a chain of lakes extending from Gunflint Lake in Minnesota, through North and Rose lakes—the chain forming a natural linear feature that is roughly followed by the U.S./Canada border. More importantly, it is crossed by a low point of the Arctic divide just southwest of Arrow Lake (Figure 10.12).

**Morainic Features**

**West Whitefish Moraine:** A kettled moraine has been identified at the western end of Whitefish Lake (Pankuch 1997), which, in its original form spanned the entrance to the Gravel Lakes corridor that runs between Whitefish and Arrow lakes (Figure 10.12). Of distinct northern provenance in its composition, it differs substantially from the morainic material at the eastern end of Whitefish Lake that has already been identified as Superior in provenance and probably related to the Marquette Advance (Williams 1999). Three observations are worth noting. On the western side of the moraine is a small, lobate deltaic structure that is interpreted as having been constructed by a flow of ice and sediment off the ice margin into
a proglacial body of water. Secondly, the central portion of the moraine is missing, which suggests that, at some point after its formation, a substantial flow of water along the Gravel Lakes corridor breached and swept away much of the structure. Thirdly, a Palaeo-Indian site (the Pankuch Site) has been recorded on the lobate delta, adjacent to the southern end of the truncation. The material is scattered along a shoreline just above 457m (1500 feet), a lower level than that into which the delta was formed and probably established after breaching of the moraine.

**Gravel Lakes Moraines:** The remains of three more morainic features lie within the Gravel Lakes corridor, each in effect spanning the respective east, west and north entrances to the valley (Figure 10.12). The provenance of these features is the same as the West Whitefish Moraine, and their topography suggests that they represent contemporaneous (or nearly so) positions of ice as it vacated the central part of the valley. Several lithic Palaeo-Indian sites have been recorded in the Gravel Lakes corridor, strongly accordant in level with proglacial or postglacial lakes at the levels of 472m (1550 feet) and 457m (1500 feet) (McLeod and Phillips, unpublished field notes).

**Sandstone Creek Moraines:** A series of similar morainic features are found partially spanning the Sandstone Creek at the western end of the Gravel Lakes corridor (Figure 10.12), and moraines composed of northern but heavily local material can be traced to the west along the grain of the topography.

**Iron Range Moraine:** Probably continuous with the Sandstone moraines, the Iron Range Moraine can be followed to the west, along the north side of the ridge that separates Sandstone Lake from Arrow Lake (Figure 10.12). In the rock-walled valley of Dodds Pond, the
feature is represented by a kettled and deformed apex of an ice-contact delta, the Narrows Delta. Further west, the moraine extends along the south side of Iron Range Lake, sometimes as a separate ridge but in places plastered against the rising ground to the south. Near Prelate Lake, the feature appears to merge with the position of the northwest-southeast trending Steep Rock Moraine.

The scenario is akin to valley deglaciation. The landscape of high, rock-walled mesa-like rock masses separated by deep valleys, encouraged ice to remain longest in the valleys around and between the upland masses, gradually melting back to exhumate the lower topography. These minor, cross-valley moraines were formed as ice stagnated or even locally readvanced during the general recession, small localized proglacial lakes forming between them. In terms of deglaciation chronology, it is likely that these recently mapped morainic features represent stages of the decay of the Rainy (or Patricia) ice lobe as it melted back from the Steep Rock Moraine towards the position of the Brule Moraine, during the Gribben interstadial. The Marquette Readvance later emplaced the Marks Moraine close to the eastern end of Whitefish Lake. Thus, the study area is complicated by the potential overlap of features of Marquette age with those of the earlier period.

Proglacial Lakes

GLACIAL LAKE ARROW: At the eastern end of Arrow Lake there lies a large deltaic structure (Figure 10.12). About 1 square mile (2.6 square km) in area, the feature is built out from the bedrock saddle separating Whitefish from Arrow Lake. It lacks any present day source of water and sediment, is backed by a precipitous slope into Whitefish Lake, and lies at an elevation over 503 m (1650 feet) at its apex, 42 m (138 feet) above the present level of Arrow Lake. The feature was formed in contact with ice filling the Whitefish basin and is composed of a huge quantity of fluvial-glacial sediment that spilled over the bedrock saddle into a body of water in the Arrow basin that was at least 503 m (1650 feet) in elevation (Pankuch 1997). Distributary channels incise the delta surface, revealing a subsequent history of water level decline after initial formation, and a complex of lower braided channels and shoreline features exist between the delta front and the present shore of Arrow Lake (460 m; 1510 feet).

Similarly, the Narrows Delta, a smaller feature in area, built up into this 503 m (1650 feet) body of water in its early stages, and lower terraces and distributary channels later developed across its surface. The water and sediment source for this feature would have been from ice lying along the position of the Iron Range Moraine and later, from a proglacial lake occupying the Sandstone Lake basin when ice had retreated further north, possibly north of the Arctic Divide (Figure 10.12).

Immediately striking is the requirement that an ice marginal water body existed within the Arrow Lake basin at a present elevation of 503 m (1650 feet), much higher than evidence of any other early lakes. The delta is composed primarily of varieties of igneous and metamorphic rocks from the area to the north and west (Pankuch 1997), suggesting that it was formed when ice occupied the position of the West Whitefish Moraine.

The presence of the East Arrow Delta raises the question of which glacial lake occupied the Arrow basin at the time of formation and of what geographic extent was this lake. In the process of investigating this, Phillips (1997) determined that a lake lying along the current
503m (1650 feet) contour would extend westward along the Gunflint-Arrow lakes chain, cross the Arctic divide and continue into northern Cook County without topographic interruption, forming a southwest-northeast trending body of water lying against the northern slope of the high ground of the Boundary Waters Canoe Wilderness Area (BWCWA). In order to take into account the degree of isostatic deformation that has taken place since the presence of this extensive proglacial lake, a retrodeformation analysis was undertaken, using an available digital elevation matrix and appropriate GIS software. From diagrams of uplift and displacement of Lake Agassiz shorelines (Teller et al. 1996) it was determined that, should the Upper Herman stage of Lake Agassiz (ca. 11,200 B.P.) be hypothesized as extending further east than currently conceived, this lake stage, initially of 323m (1060 feet) at the southern (Minnesota River) outlet, would have been deformed to an elevation of 501m (1644 feet) if traced as far east as Arrow Lake (178m or 584 feet of uplift). By first constructing a deformation surface and then subtracting it from the present DEM of the Arctic basin portion of Minnesota, Phillips (1997) reproduced the topography of the area in Upper Herman times. Flooding this topography to the 1060 fasl (323m) level reconstructed the Upper Herman stage of Lake Agassiz. On the model this is seen to extend eastwards along the northern flank of the high ground of east central Minnesota and across the U.S./Canada border into the Gunflint-Arrow lake chain, where it crosses the Arctic watershed into Arrow Lake (Figure 10.13). The East Arrow Delta could have been formed in a water body of 1650 fasl (503m) which was a part of Lake Agassiz. Wasting ice would have lain immediately to the north,
forming the north shore of the narrowing outlet. The water would have flowed from the Arrow Lake basin into Early Lake Minong in the Superior basin, via what is now the misfit Arrow River valley.

In summary, evidence does suggest the possibility for Arrow Lake potentially acting as an early eastern outlet for Lake Agassiz, before, and at the time that ice lay against the Steep Rock Moraine. In doing so, a natural route was provided for Palaeo-Indians moving eastwards through northern Minnesota along, or parallel to, the southern shore of Lake Agassiz. Only when ice withdrew towards the position of the Brule Moraine would an Agassiz flow have used the flatrock outlet, and this would have followed the construction of the West Whitefish Moraine and those of the Gravel Lakes and Sandstone areas.

Lakes of Lower Level

Reference has already been made to lower lakes associated with the moraines of the Arrow-Whitefish area, particularly one at the 472m (1550 feet) level. The fact that the East Arrow Delta is incised by a discharge channel that built a small elongated delta into a water level of about 488m (1600 feet), suggests that some water was still flowing from the Whitefish Lake basin after water levels had begun to fall in the Arrow Lake basin. No features of the 488m (1600 feet) are found in the Whitefish Lake basin east of the West Whitefish Moraine. A continuous series of raised beach and minor bluff features extends from 488m (1600 feet) to the present water level of Arrow Lake (460m; 1510 feet), one of the more marked ones being a 472m (1550 feet) bluff. This can be traced into and through the Gravel Lakes corridor to the Whitefish Lake basin. An interpretation of this paleogeography is that, as ice melted back from the West Whitefish Moraine, water between the ice and the moraine continued to spill over the saddle to incise a channel into the now emerged East Arrow Delta. However, pressure on the moraine was such that breaching followed and water levels in the Whitefish basin fell to the 472m (1550 feet) level of the Arrow Lake basin, before continuing to decline to its present level of 406m (1329 feet). The Tower Road site (DBJm-6) on the slopes above the north side of Whitefish Lake lies on the 472m (1550 feet) contour, of similar elevation to several sites within the Gravel Lakes corridor. Traced east and north, the 472m (1550 feet) level is found to be the apex of the North River Delta (Figure 10.12), a kettled delta formed by meltwater spilling southwards from the position of the Brule Moraine. Bajc (2000) reports an ice contact delta built off the Brule Moraine that grades to a water level of 457–472m (1500–1548 feet), which he correlates with a lower Herman stage of Lake Agassiz. An interpretation of this paleogeography is that lake levels of 472m (1550 feet) and lower, accord to the period at which ice had melted back from the Whitefish-Gravel Lakes area to the position of the Brule Moraine. The sustained influence of Lake Agassiz, of a lower Herman level, is shown by the clay sequences in the Whitefish River valley where red clays of a western (Agassiz) source, overlie dark clays of a more local northern and eastern source (Culbert 1999). Although the chronology and relationship to Lake O’Connor and other proglacial lakes of the region is as yet, not wholly clear, both Culbert (1999) and Bajc (2000) agree that the Whitefish valley clay sequence was later over-ridden by Marquette ice.

Within the Whitefish Lake basin and the area to the east of it, a marked shoreline feature occurs at the a 442m (1450 feet) level. Evidence of this was reported by Timko (1995), who
associated the feature with the wasting of Marquette ice from the morainic position found at the east end of Whitefish Lake. Since Jahnke (1993) traced a 442 m (1450 feet) and a 427 m (1400 feet) shoreline along the southern flank of the Marks Moraine towards Whitefish Lake, the association is logical, his proglacial 'Lake Cedar Creek' (named after a local stream and resulting from the melt back of the Superior lobe from the Marks Moraine) being contiguous with Timko's 'Lake Strange' (named after Strange Township).

Demonstrated here is the complexity resulting from the occupation of the Whitefish Lake basin by two successive ice marginal events, separated by at least 1000 years, and the overlap of their respective features. Current interpretation places these lower lake levels as that of Marquette age and later. Baje (2000) notes that similar silty clays lie both below and above the Marquette till in some Whitefish valley sections, suggesting that Superior ice re-established a proglacial lake similar to Lake O'Connor, at least in part, and sedimentation continued during and after Marquette ice began melting back.

Archaeological Implication

Holliday (2000) has recently reviewed Palaeo-Indian 14C chronology and concludes that the Clovis projectile point tradition was from 11,200 to 10,700 B.P. (13,500 to 12,800 calendar yrs. B.P.), the Folsom (fluted point) tradition from 10,000 to 10,000 B.P. (12,800 to 11,800 calendar yrs. B.P.), and the unfurled point traditions, generically referred to as the Plano tradition (Plainview-Agate Basin-Hell Gap-Cody-Scottsbluff-Eden sequence) from 10,000 to 9000 B.P. (11,200 to 9,800 calendar yrs. B.P.) Some caution is needed in applying such dates rigidly, since there is a diachronic component with location. Anderson et al. (this volume) conclude that the Agate Basin tradition approximates with the Gribben interstadial and that the Hell Gap tradition was contemporaneous with the Marquette advance. They correlate the Great Lakes Cody tradition with Lake Minong (9,500 B.P.) and post-Minong time. McLeod (2000) notes that most lithic points found in the Thunder Bay area are of lanceolate shape and are difficult to assign to a single type. He further comments that this variation, apparently typical of the Lakehead Complex and the Plano tradition for Northwestern Ontario, makes it difficult to use projectile points for relative dating of sites.

If the Gunflint-Arrow Lakes corridor was used as an early eastern outlet of Lake Agassiz, at the Upper Herman stage, the south shore of Lake Agassiz would have provided a logical route for Palaeo-Indian people, as they perhaps used the recently vacated moraines as routes, and followed game eastwards from the Red River-Minnesota River southern outlet along the northern flank of the Minnesota highlands. Ironically, the northern parts of the counties of St. Louis, Lake and Cook, where the Upper Herman shoreline lay, are remote, and very little research has been conducted in the area.

One interesting find is that of Palaeo-Indian material in 1999 in McCarthy Beach State Park, St. Louis County, Minnesota (Radford, D., personal communication to B.A.M. Phillips) (Figure 10.13). The northwest-southeast axis of the park follows an end moraine and on the northeast flank, at a present elevation of 425 m (1394 feet), lies the Upper Herman shoreline (323 m (1060 feet). The site lies between two small lakes below the southwest facing flank of the moraine. It is interesting to note that the site lies on a nearby small lake of southern
aspect, rather than on the north facing slope of the shore of Lake Agassiz. Two lanceolate points were found and a report is pending.

Another perhaps more significant find was reported by Mulholland (2000). North of Virginia, St. Louis Co., Minnesota, on the Big Rice Moraine (Figure 10.13) a jasper-taconite point, fluted on both sides, was found. This Folsom tradition point denotes a Palaeo-Indian presence in the pre-Marquette period. Along the south side of Big Rice Lake (437m; 1435 feet), the Big Rice Moraine forms a west to east watershed divide, which rises to about 472m (1550 feet). Referring to the retrodeformed model of elevation in the Upper Herman lake stage of Lake Agassiz, it is seen that a narrow, sheltered reentrant of the lake approached within a very short distance of the northwest corner of Big Rice Lake. The 323m (1060 feet) lake level is equivalent in the model to the present 436m (1430 feet) contour and may well have extended into the Big Rice basin to the foot of the Big Rice Moraine. Again, the compelling suggestion is that Palaeo-Indian people were present on the southern shore of the Upper Herman stage of Lake Agassiz and may well have travelled eastwards along the shore, into the Gunflint-Arrow-Whitefish area.

Further east, there are no identified sites until the Gunflint-Arrow-Whitefish lakes corridor is reached. Here, following the bypass/cul-de-sac theory presented earlier, the inland Agassiz shore route met with the coastal route and diverted inland. A recent excavation was conducted by Peters (1990) at East Bearskin Lake, just south of the Gunflint-Arrow lakes corridor in Cook County, Minnesota (Figure 10.13). The points that were found were termed 'Holcombe,' a point style that falls into the period of transition from Folsom to Plano, post-dating 10,400 B.P. This is currently the oldest site close to the Gunflint-Arrow-Whitefish lakes corridor.

The Marquette Readvance maximum, dated by Lowell et al. (1999) at 10,025 ± 100 14C yrs. B.P. accords with a calendar date of about 11,000 B.P. (based on Lowell and Teller 1994, and Taylor et al. 1996). The retreat of Rainy (Patricia) ice from the area to a position just east of Lake Nipigon took place just before the Younger Dryas cooling event, dated 11,000 to 10,000 B.P. (Lowell et al. 1999) when readvance occurred. Thus, the age of the sites of the Arrow-Whitefish area fall in a window between the Upper Herman stage of Lake Agassiz, when the lake is believed to have used an eastern outlet through the Arrow Lake corridor, and the period following the Marquette readvance, when Palaeo-Indian people occupied the Beaver Bay and Minong levels of Lake Superior in the Kaministiquia valley.

McLeod (2000) suggests that the earliest arrivals in the Thunder Bay area were people who used Agate Basin and Hell Gap artifacts. They entered about the time of the Marquette readvance, possibly forced eastward by the rising waters of Lake Agassiz, which resulted from the closure of the eastern Lake Nipigon outlets. McLeod interprets the sites of the Arrow-Whitefish area as associated with proglacial lakes that resulted from Marquette ice damming, and notes that these people camped within 2 km (1.25 mi) of the glacial front. McLeod (1981) suggests that these people stayed in the area, adapting to the developing Boreal Forest environment. As Marquette ice retreated, these people moved east into the Kaministiquia valley, down to the Beaver Bay and Minong lakeshores of Lake Superior, where evidence of their presence is more abundant (Phillips 1988; Stuart 1993; Phillips and Ross 1995; Hamilton 1996).
Discussion

Based on the fact that there is no artifactual evidence to suggest otherwise, it is archaeologically appropriate to associate the Palaeo-Indian sites of the Arrow-Whitefish area with the period of the Marquette Advance and beyond (McLeod 2001). However, earlier in this paper, the interpretation of the moraine and glacial lake sequence led to the conclusion that the West Whitefish Moraine is of Rainy lobe and not Superior lobe provenance (Pankuch 1997). Furthermore, the 472 m (1550 feet) shoreline, along which a number of sites lie, is associated with deltas that result from the melt back of ice to the Brule Moraine, not with the Marks Moraine (Marquette). In addition, the 503 m (1650 feet) East Arrow Delta and the evidence from the retrodeformation model, implies the possibility that the Upper Herman stage of Lake Agassiz used the Gunflint-Arrow lakes corridor as an early eastern outlet, around 11,200 14C yrs. B.P., potentially forcing the movement of Palaeo-Indian people into the area. On paleogeographic evidence alone, there is the very real possibility that current evidence of Palaeo-Indian presence in the Arrow-Whitefish corridor could be extended back to the time when Rainy (Patricia) lobe ice lay at, or about the Brule Moraine. This is about 1000 years before the Marquette Readvance and very possibly prior to 11,000 B.P.

Ongoing fieldwork by McLeod and Phillips, Ross, Hamilton and others will hopefully clarify the palaeohistory of the Minnesota-Ontario borderlands in due course, particularly if points of a distinct pre-Plano tradition are found in the Gunflint-Arrow-Whitefish corridor.

Acknowledgments

The authors would like to acknowledge the work of Mrs. Cathy Chapin who drafted and redrafted the figures for this paper as it evolved. Mrs. Chapin is Cartographer and Map Librarian in the Department of Geography, Lakehead University, Thunder Bay, Ontario.

Our thanks is also due to Mr. Bill Ross, Archaeology Branch, Ontario Ministry of Citizenship, Culture and Recreation and Mr. Mike McLeod, Boreal Heritage Consulting, both of Thunder Bay, Ontario, who reviewed the draft of this paper and offered helpful advice on improvements.

References


