Geochronology and Archaeology

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Introduction

When I became seriously involved in Manitoba archaeology back in the mid-1960s (that's CE, not BCE!), environmental reconstruction was considered an important factor in deciphering the archaeological record. In those days, "environmental reconstruction" wasn't something archaeologists did – that was left up to specialists in other fields such as palynology, geology, pedology and palaeontology. The idea was to take note of what these various scientists had to say about natural conditions thousands of years ago, and to determine if their interpretations could help us understand the findings of archaeology. This approach seemed eminently logical, given that culture is humanity's means of adapting to environmental conditions, and trying to appreciate how people were making a go of it in Manitoba 10,000 years ago[1] without taking into account the opportunities and challenges Mother Nature placed before them would surely mean missing a very large boat.

For anyone interested in the Palaeo-Indian period of Manitoba's human history, a grasp of the progress being made in the discipline of Quaternary geology is essential. And one facet of Quaternary geology that has held my interest for many years is geochronology, that is, the study of deposits to determine the nature and duration of events that make up the geological history of an area. Here in Manitoba, two major phenomena have captured the ongoing attention of Quaternary geologists – (1) deglaciation, and (2) the regional drainage patterns that developed during deglaciation.

Deglaciation

Of paramount interest to archaeologists studying the early colonization of Manitoba has been the timing of deglaciation. Since the surface of the Laurentide ice sheet was devoid of plant and animal life, the location of the glacial ice has clear implications as to where evidence of the earliest human presence might or might not be found. Thankfully, geologists have spent a good deal of time and effort tracking the recession of the ice front across the landscape. That's the good news.

[1] All ages in the paper are expressed in radiocarbon years.

Southern Deglaciation Models

The Early Southern Deglaciation Model (ESDm). The not-so-good news is that some highly qualified scientists have been in serious disagreement concerning this very subject. We're concerned here with the 14,000 to 11,000 RCYBP time period and the scheduling of active ice recession in southern Manitoba and southeastern Saskatchewan during that interval. This schedule is based on Canadian C-14 dates that have been taken to indicate that the ice front had receded to the north slope of Riding Mountain by 14,000 years ago. We'll call this the "Early Southern Deglaciation model" (ESDm; Fig. 1). In archaeological terms, by 11,200 years ago (the beginning of Clovis times), the ice front had long receded from southwestern Manitoba to the latitude of Dauphin, and all the area south of that and west of the Agassiz basin was ice-free by the beginning of Clovis time.

Fig. 1. Locations of the ice front during deglaciation of the continental interior. A = ice frontal position at 14,000 BP according to the LSDm; B = ice frontal position at 14,000 BP according to the ESDm. According to the LSD m, line B would equate to ca. 11,200 BP, that is, early Clovis time. Blackened area = extent of Lake Agassiz ca. 11,200 BP. Adapted from a map published by J. Teller, S. Moran and L. Clayton in 1980.

The Late Southern Deglaciation Model (LSDm). However, a number of geologists questioned the validity of the C-14 dates that had been used to argue for an early deglaciation of southwestern Manitoba. They maintained that the Canadian C-14 tests were run on material that was contaminated by old carbon. They pointed to the fact that uncontaminated C-14 dates as early as 14,000 BP had been obtained from wood buried in glacial till directly to the south in Iowa. Thus, it would have been impossible for southwestern Manitoba to be ice-free while the front of the active ice still existed 1,000 kilometres to the south of it! Nor is it possible that deglaciation could have proceeded so fast that both sets of dates – the Canadian and the American – could be correct.

In other words, the deglaciation of southwestern Manitoba was more recent (or, to put it another way, the region remained beneath active ice later) than was implied by the dates obtained from the allegedly contaminated Canadian material that gave rise to the ESDm (Fig. 1). That is, around 11,500 BP virtually all of southwestern Manitoba with the possible exception of Turtle Mountain was still under ice.

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The two deglaciation scenarios reviewed above have important implications for the archaeologist's perception of the natural environment as it was when southwestern Manitoba was initially colonized by Clovis people. If the region was deglaciated as early as 14,000 BP, the landscape would have had almost 3,000 years to recover from the effects of the ice age. If, however, we accept the LSDm, the ice margin was still in the process of receding across the study area *during* most of the Clovis era (11,200-10,800 BP), and very different (periglacial) conditions would have prevailed.

For what it's worth, my own preference lies with the LSDm because it's founded on C-14 dates obtained from uncontaminated wood samples. Also, in the early 2000s Dr Arthur Dyke of the Geological Survey of Canada produced a series of maps that are much more in keeping with the LSDm.

Another expression of the LSDm is to found in research carried out west of Thunder Bay in northwestern Ontario. Here, Dr Matt Boyd and his colleagues provide a good example of geologists using the archaeological record, including "negative evidence" thereof, to help them formulate or substantiate hypotheses about the regional deglaciation chronology. They point out the absence of C-14 dates older than ca.10,000 BP, suggesting that the area thereabouts may have been continually under active ice and hence not sub-aerial until *after* 10,000 BP.

To bolster this observation, they note the corresponding absence of early Palaeo-Indian (Clovis:11,300-10,900 BP; Folsom:10,900-10,000 BP) sites between the Agassiz and Superior basins. What we *do* find in the area is Plano materials that post-date 10,000 BP. This is compatible with the LSDm. Here, the geological and archaeological findings (or non-findings) are in close agreement.

Northern Deglaciation Models.

The spirited debate over the timing of southern deglaciation, as reviewed above, was carried out entirely by geologists. Archaeologists were passive onlookers or bystanders throughout the exercise; we simply adopted the latest geological interpretation as the process evolved, and applied the results as they appeared in print to our own ongoing research and writing.

An entirely different scenario unfolded in the North. The geographic focus there was on the area immediately west of Hudson Bay in what was formerly called the Keewatin District, now southern Nunavut. Here again the discussion revolved around early versus late deglaciation, only within a much later and more protracted time frame of 8,000 to 7,000 RCYBP. But this time, archaeologists are at the centre of the debate; Drs James V. Wright and Bryan C.Gordon of the Archaeological Survey of Canada were the leading field researchers of Northern Plano in Nunavut in the 1970s and '80s, and their discoveries are eminently germane to our understanding of the timing of southern Nunavut deglaciation. And as it has turned out, the geological and archaeological chronometric results are in disagreement with one another.

"Northern Plano" is the regional manifestation of Late Palaeo-Indian culture in the `Northwest Territories, and there is consensus that it dates to around 8,000-7,000 BP. There is a pair of archaeological sites on Grant Lake that have been radiocarbon-dated at ca. 8,000 BP. This means that these places were deglaciated, de-watered, and open to the sky ("sub-aerial") by at least 8,000 BP; otherwise, nobody could have lived there at that time.

But the recent geological maps, generated by staff at the Geological Survey of Canada (GSC), tell us that the places where these 8,000-year-old cultural sites were discovered and excavated were under glacial ice 8,000 years ago (Fig. 2). Since people can't live under ice, a conflict obviously exists between the geological and archaeological interpretations. It would seem that somebody's C-14 dates are askew.

Late Northern Deglaciation Model (LNDm). Is there any way we can reconcile this inconsistency? First, let's take a look at the C-14 dates used by the GSC geologists. In past decades, the tests were run on freshwater shells, and it’s been known for a long time now that such shells typically yield erroneously old dates.

In their latest reconstructions of the deglaciation of the North, GSC geologist Dr Arthur Dyke and his colleagues consulted the contents of a radiocarbon data base in conjunction with new postglacial isostatic rebound models. Dates on problematic materials such as marl, freshwater shells, lake sediment with low organic carbonic content, marine sediment, bulk samples with probable blended ages, and most deposit-feeding mollusks from calcareous substrates, were excluded (these deleted counts, many of which were used in previous reconstructions of deglaciation, produced ages that were suspected of being too old).

This left 4,000 acceptable dates, of which marine shells comprised a major percentage had been run on marine shells. These were adjusted for regionally variable marine reservoir effect based on a large new set of radiocarbon ages on live-collected, pre-atomic bomb mollusks from Pacific, Arctic and Atlantic shorelines. The upshot was that deglaciation ages were correspondingly diminished, and that deglaciation was perceived as having been delayed in most places by 1,000-2,000 years compared to earlier interpretations published in 1968 through 1970 and in 1989.

Other studies, independently based at the University of Manitoba (U of M) by Drs James Teller and David Leverington, were also being conducted on the early 2000s that were in one sense complementary to those being carried out at the same time by the GSC. The U of M work was more focused on the history (changing depths and geometry) of Lake Agassiz, but because the proglacial lake and the glacial ice front were intimately connected to one another, the U of M’s effort of necessity had to take into account the whereabouts of the ice margin through time. The outcome of this work was, like its GSC counterpart, also a series of time-transgressive maps depicting the hypothesized ice margin locations associated with the various phases and stages of Lake Agassiz.

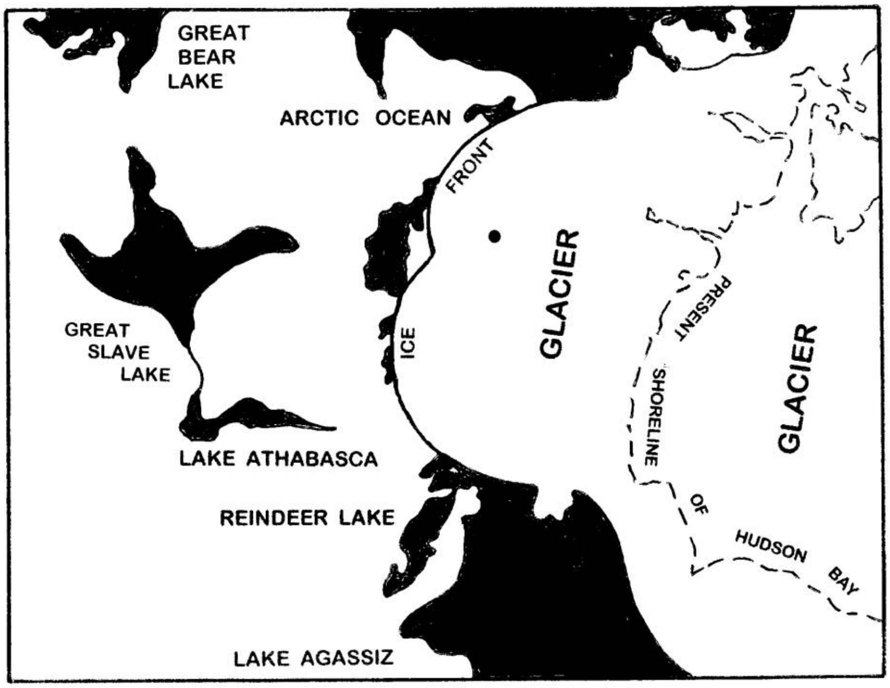

Fig. 2. The LNDm as at 8,000 BP, based on Dyke et al 2004. Redrawing by the present writer. The dot indicates the location of the Grant Lake locality.

The U of M reconstructions comprised a computer-generated series of maps using such variables as strandline elevations and isostatic rebound curves, predicted ice-sheet margins, lake-outlet elevations, and a digital elevation model of modern topographic data. The final map in the sequence is dated to 7,700 BP and depicts the extension of Lake Agassiz into, and the position of the ice front within, our study area. This U of M reconstruction, like the most recent one of the GSC (Fig. 2), has the Grant Lake locality under ice at 8,000 BP and hence conforms to the LNDm.

The U of M version of northern deglaciation history is interesting in that the ice front at the same longitude as Grant Lake at 8,000 BP is positioned at the lower end of Reindeer Lake some 900 km to the south. The 8,000 BP positions of the ice margin in the GSC and U of M models are themselves conspicuously discrepant (Fig. 3), but are consistent with one another to the extent that they both show the 8,000 year-old archaeological sites covered with ice.

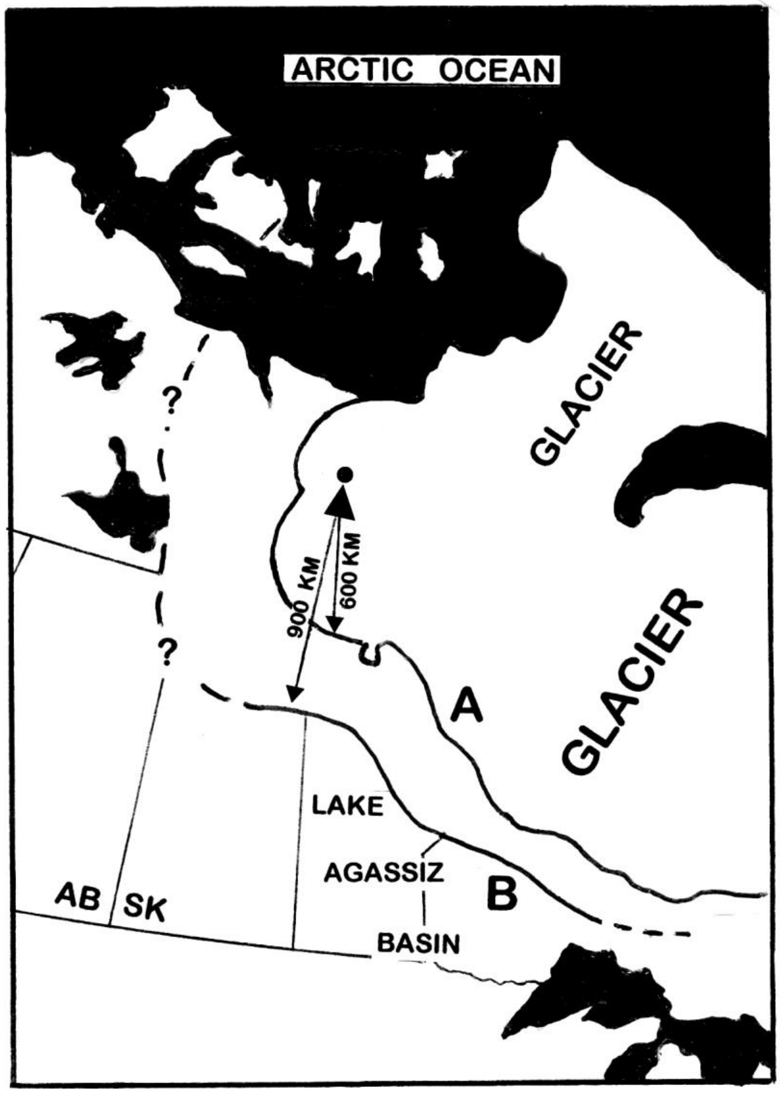

Fig. 3. Position of the ice front according to the GSC (A) and U of M (B) researchers as of 2004. The dot indicates the location of the Grant Lake sites. Both hypotheses conform to the LNDm.

Early Northern Deglaciation Model (ENDm). Let us now return to the 8,000-year-old archaeological sites on Grant Lake. Taken together, the GSC and U of M LNDm's would have these two locations continually under ice until some time *after* 7,000 BP. We have to keep in mind too that the Grant Lake loci would have had to be sub-aerial even *before* 8,000 BP because it would have taken a few hundred years for land stabilization, colonization by slow-growing ground-lichen forage, establishment of caribou migration patterns, and the people's development of a herd-following adaptation to them, all before successful occupation of the local area was possible.

It would seem, then, that the GSC 2004 LNDm doesn't take into account the Grant Lake archaeological dates and their implications. Ironically, an earlier (1987) geological reconstruction of southern Nunavut deglaciation **is** compatible with the archaeological dates (Fig. 4). The later versions, based on more recent research (see above), are not!

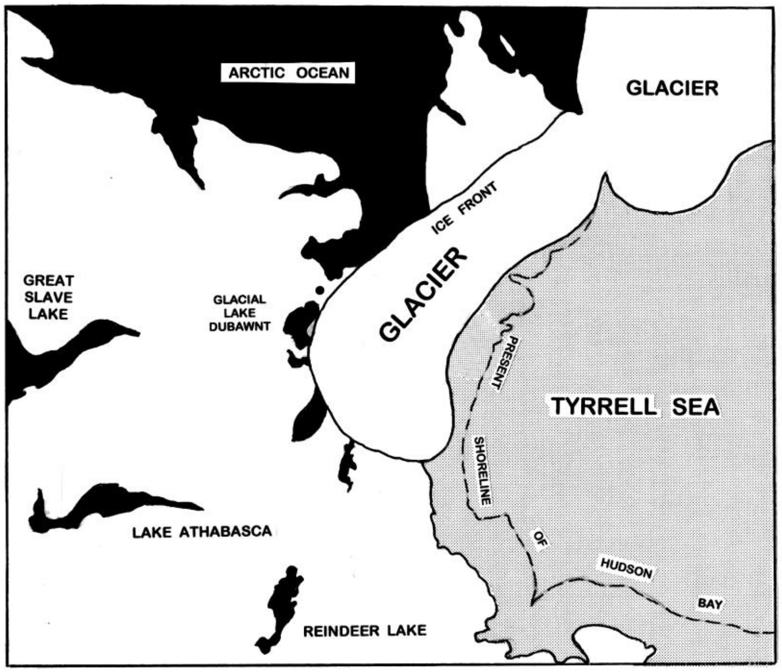

Fig. 4. Portion of a map published by the GSC in 1987, showing the location of Grant Lake (dot) deglaciated at 8,000 BP. This scenario conforms to the ENDm and the archaeological dates. From a map published by A. Dyke & V. Prest in 1987, redrawn by the present writer. Archaeological findings would suggest that the Grant Lake locality was habitable and indeed inhabited at that time.

Palaeodrainage

One area of research in which geology and archaeology have happily yielded complementary results is post-glacial hydrodynamics. The most prominent aspect of regional drainage in central Canada between ~ 12,000 and 7,700 radiocarbon years ago was Glacial Lake Agassiz. Thanks to the efforts of geologist Dr John Elson of McGill University, the history of Lake Agassiz was a topic of ongoing research here in Manitoba when I started in archaeology. And Dr Elson's enquiries into the duration and extent of Lake Agassiz in its various phases and stages were of direct interest to me, for a whole lot of reasons.

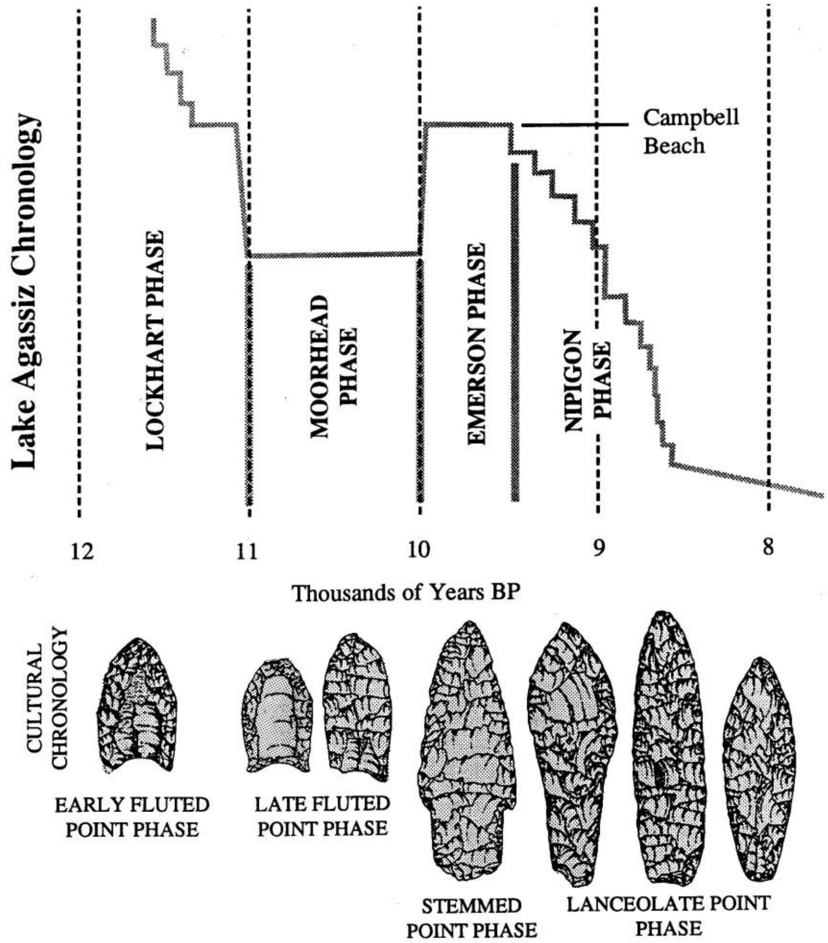

Fig. 5. Example of an environmental/cultural correlation (now out of date). Drafting by the present writer.

For one thing, human beings, in the normal scheme of things, are land animals. This means that the amount of ground surface covered by the lake, and for how long, could theoretically provide us with a timetable for the early post-glacial colonization of large areas of the province. So for the past 40 years I have kept a close eye on the progress of Lake Agassiz studies by such prominent geologists as Drs Rudy Klassen, Jim Teller, Lee Clayton, Erik Nielsen, Tim Fisher and others. The idea has been to use their chronologies as a basis upon which to provisionally interpret the archaeological data. One result was the correlation of the Palaeo-Indian record with the developmental phases of Lake Agassiz in diagrammatic form (e.g., Fig. 5) to explain the distribution of certain artifact classes in and around the Lake Agassiz basin.

So my *modus operandi* was to piggy-back on the geologists. But there's one very important caveat that we must bear in mind when using geochronologies in this fashion.

Both geologists and archaeologists, as scientists, are subject to the same rules and constraints. We all know that any "conclusion" we come to at any particular time is hypothetical, not final. This means that a geologist's interpretations can never be considered the last word, but rather the latest result in an ongoing process. No student of the ancient past should ever assume that his/her conclusions will be final. And sometimes the current, best reconstructions may require serious overhaul as a consequence of further testing.

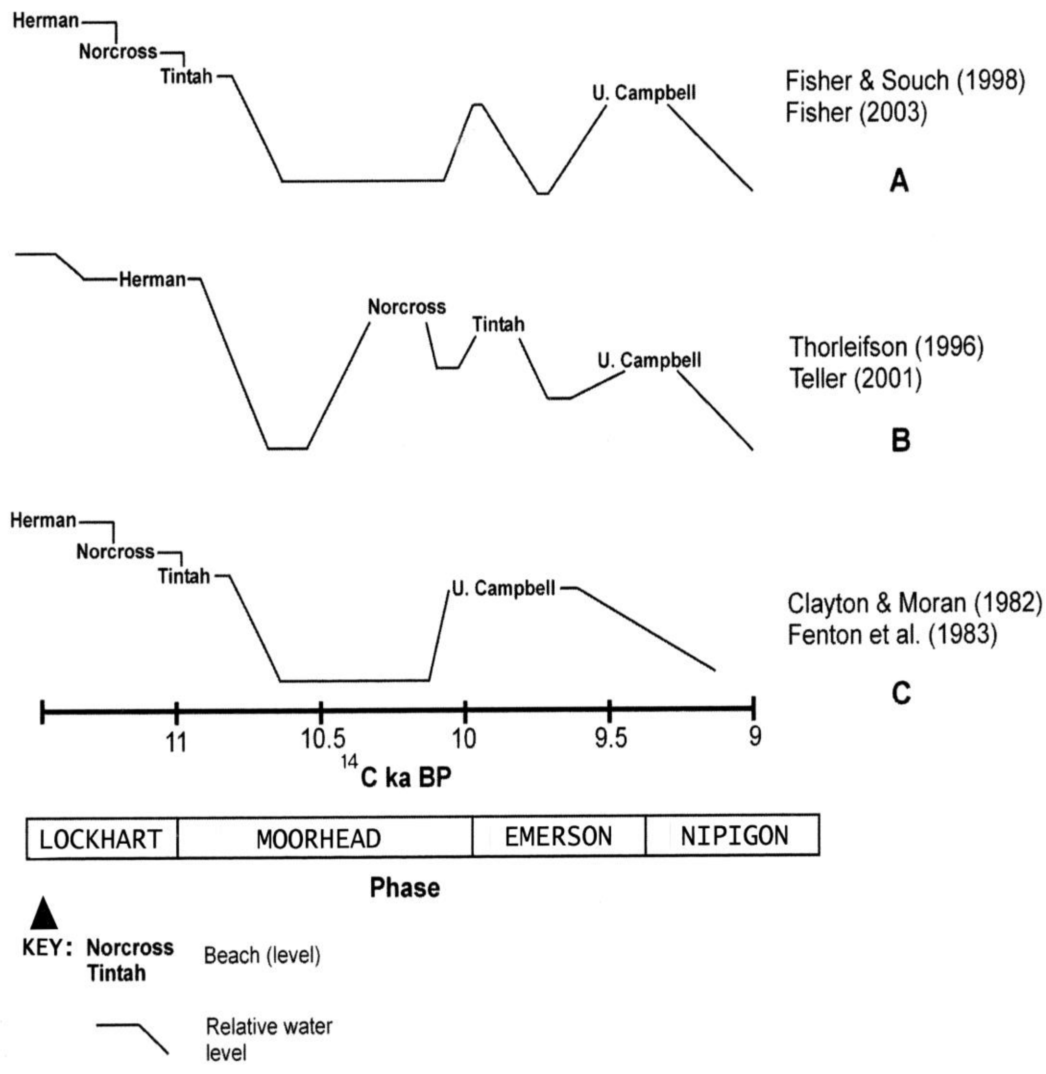

Fig. 6A. Summary of three scenarios for the history of L. Agassiz water-level fluctuations. Note disagreements regarding the duration of the Moorhead low-stand, the temporal positions of the Norcross and Tintah high-stands, and the timing of the Upper Campbell beach formation during the Emerson and Nipigonphases. Courtesy of Dr Matthew Boyd, Department of Anthropology, Lakehead University.

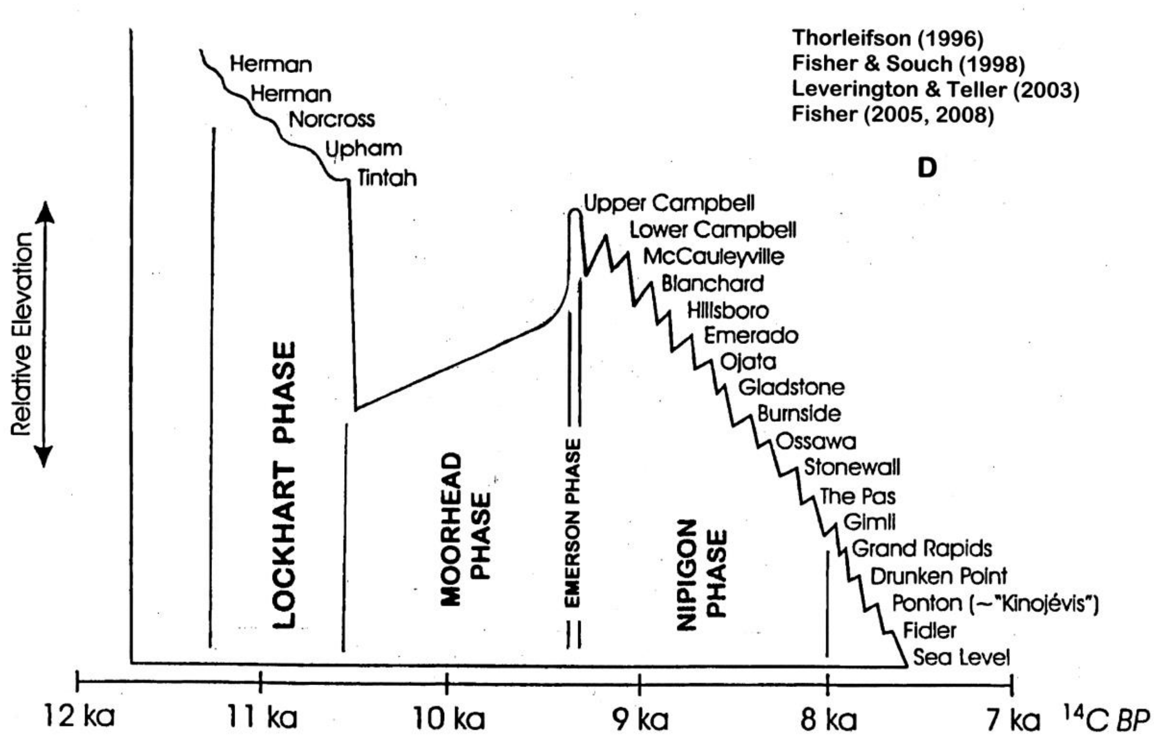

Fig. 6B. A more recent summary of the history of L. Agassiz water-level fluctuations. This diagram exhibits some radical departures from its predecessors depicted in Fig. 6A.

The contents of Figure 6, courtesy of a number of prominent geologists, bear this out rather well; together they depict four different Lake Agassiz chronologies, one of which dates all the way back to 1982. Even if you're not familiar with diagrams such as these, it's clear just by looking at them that they're notably different from one another, and that there has been a significant change in thinking about Lake Agassiz history over the past 25 years or so. Note that two of the more *coeval* models, shown in Figure 6 as A and B, are also quite different. So not only does the model change over time as more research is done; geologists are likely as not to disagree with one another and come up with significantly different interpretations *at the same time* in light of conflicting or ambiguous information at hand. In short, (1) the geologist's model is "subject to change without notice" in light of new-found data, and (2) more than one model may be on the books at any one time.

Now, Figure 6 tells us, among other things, that Lake Agassiz stood at relatively high levels, and that its basin was widely inundated, during the Lockhart, Emerson, and the early Nipigon phases. This may explain why (1) Clovis fluted points are absent, (2) stemmed Plano (Alberta, Cody) Plano points are rare, and the later Plano lanceolate (Nipawin) forms are relatively common, within the basin.

However, few of these cultural expressions are C-14 dated in Manitoba, and so their temporal positioning in the diagrams is based in large part on cross-dating with radiocarbon-assayed recoveries from well outside of the province and/or on observations on where the various projectile point types have, and have not, been found relative to the Agassiz strandlines here in Manitoba. And that's fine, as long as we bear in mind that our reference points -- the time frames of the lake's phases and the constituent beaches and water levels -- are themselves up for grabs.

Well then, where does all this leave the archaeologist, who looks to his geologist colleagues for guidance and clues about the meaning of his own archaeological field data? For some, the inconclusiveness of the geologists' interpretations may prove frustrating because the geological models are unable to provide us with a firm and enduring foundation upon which to build our own hypotheses.

However, we can't fault the geologists for changing their minds in light of new data: that's the nature of scientific research. Under these circumstances, we can utilize the broad, generally-accepted outline of the geochronologies rather than the controversial specifics. The trick, then, is to remain flexible and not become too heavily reliant on works-in-progress in other disciplines -- in this case, geochronologies -- as convenient quick-fix devices for "explaining" or interpreting archaeological data. There are no free lunches.

As for those situations where two conflicting interpretations by different geologists exist at the same time, I personally find the situation intellectually stimulating because it provides us with *options* on the basis of which we as archaeologists can devise alternatives of our own. Once these alternatives are formulated, we can test them and see which ones (if any) hold up best under scrutiny.

There's another way to view the geologist-archaeologist relationship: we archaeologists may want to avail our own results to the geologists in order to assist them in their work, in which case *we're* helping *them*, not vice versa. Given the qualitative and quantitative limitations of Manitoba's known Palaeo-Indian record, the outcome of such an exercise would be highly tentative, and a devil's advocate might see it as a clear case of the blind leading the blind. Nonetheless, the aforementioned John Elson took serious notice of the known archaeological record when formulating his prototypic Lake Agassiz chronology back in the 1950s. Archaeologist R.S. MacNeish, who was also working in southern Manitoba at the same time, acquainted Elson with what he had learned, compliments of his forerunner Dr Boyd Wettlaufer, about certain types of Palaeo points – Folsom, Plainview, Agate Basin, and “Yuma” (Scottsbluff, Eden) – within the province. The C-14 dating of sites in the United States that contained these same point types covered a period of some 3,500 years, or 10,500 – 7,000 BP. This information, along with the Palaeo point-type distribution in Manitoba (around, but not within, the Lake Agassiz basin) played a substantive role in Elson’s hypothesis that “Lake Agassiz II,” defined on the ground by the Campbell strandline, endured throughout that period of time.

Our grasp of the time correlates of the various Palaeo-Indian point types have changed significantly since the 1950s, and Elson’s hypothesis that Lake Agassiz still stood at the Campbell level 7,000 years ago has long been rendered untenable in light of subsequent research (e.g., see Figure 6B). Nonetheless, it was accepted as valid in its day, and the basic approach – combining geological and archaeological information to produce a geochronology – can still have merit provided we keep in mind its limitations and realize that any conclusions we might draw are subject to ongoing scrutiny and analysis.

But note that Elson wasn’t the only party to gain from the experience: MacNeish came away from it with an understanding of why certain Palaeo-Indian index fossils were distributed across southern Manitoba the way they were (Fig. 7), and this understanding was based directly on what Elson was able to tell him about the surficial geology and drainage history of the region. A much more sophisticated rendition of integrated, multi-disciplinary research has been embodied more recently in the work of geoarchaeologist Dr Matt Boyd of Lakehead University whose studies in southwestern Manitoba incorporated both geological and archaeological data, and those of other fields as well, to produce holistic cultural-ecological models of past environments and human-land relationships during Palaeo-Indian times.

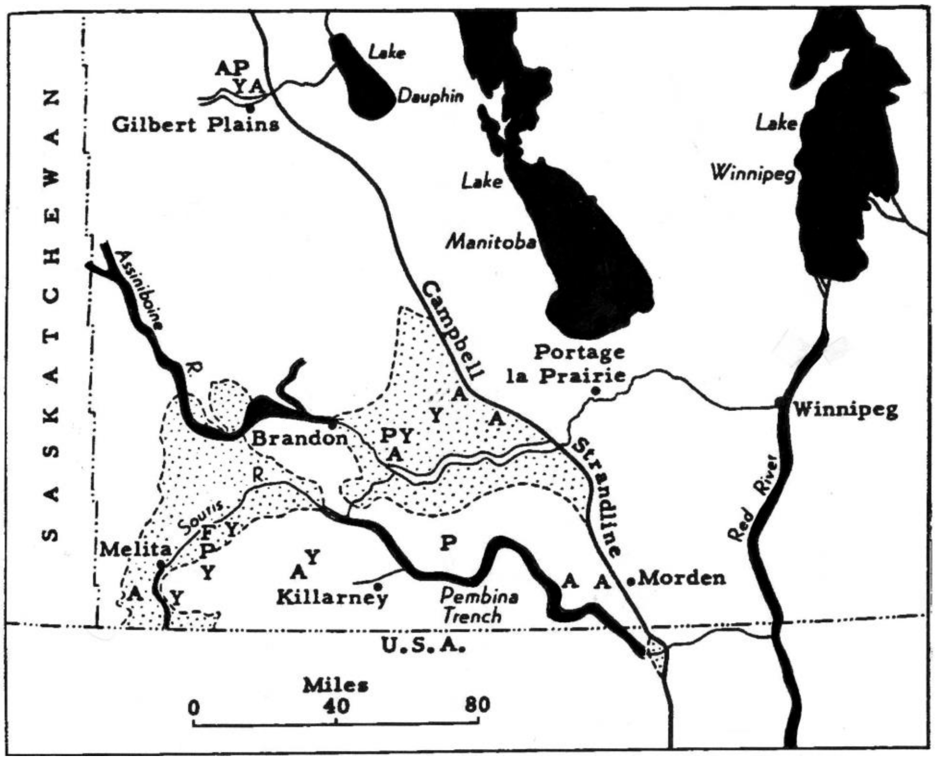

Fig. 7. Adaptation of Elson's 1955 cultural geography of southern Manitoba map. The right stippled area is the upper Assiniboine delta, the left, the Lake Souris (now Lake Hind) basin. The lettered Palaeo-Indian site location indicators are as follows: F = Folsom, A = Agate Basin, P = Plainview, Y = Yuma. Note that there are no Palaeo sites identified within the Agassiz basin (i.e., east of the Campbell strandline).

There's one final point I would like to make here. An ongoing mandate of the archaeological community is communication with the general public. John and Jane Q. Citizen may be interested in learning about the way things were during the Ice Age, but probably not in the controversial, fine-print details and debates about them that play out in academic circles. In spite of the limited hard data we have to go on and the scholarly controversies that surround them, we can still write credible and interesting stories in broad, general terms about the human colonization of Manitoba in response to the retreating continental glacier and an expanding, fluctuating and finally receding glacial Lake Agassiz. Inevitably, geological and cultural chronologies are key components of the big picture.