W1A: UPDATING THE LATE WISCONSIN GEOLOGY OF THE GENESEE VALLEY, DANSVILLE TO AVON, NY: VALLEY HEADS MORAINE (HEINRICH EVENT H1?) TO FOWLERVILLE MORAINE COMPLEX (YOUNGER DRYAS, HEINRICH EVENT H0?)

(A brief summary to accompany an illustrated oral workshop presentation)

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INTRODUCTION

Geological Setting and Previous Investigations

Reevaluation of radiocarbon dates in light of the extended and revised calendar-year chronology for the last 50,000 years has provided important revisions to the Late and Middle Wisconsin glacial stratigraphy of the middle Genesee Valley in west-central New York. The previously unrecognized Middle Wisconsin ice advance at ca. 39,000 calendar years BP (Heinrich Event H4) has been described in detail, based on a sequence of 68 AMS ages by Young and Burr (2006), for exposures at the adjacent Elam and Dewitt sand and gravel excavations along the west bank of the Genesee River 4.5 miles north of Avon, NY (opposite the confluence with Honeoye Creek). The borrow pit exposures are largely overgrown at present, but the stratigraphy is extensively documented with 14 years of photography taken during nearly continuous excavations (Young, 1990 to 2004). Another nearby location with wood of Middle Wisconsin age is located 11 miles southwest of the Elam-DeWitt locality. Well preserved wood was encountered at a depth of 85 feet during water-well drilling by B. Moravic, Inc. on a moraine segment near the Late Wisconsin peccary site described below (see Fowlerville moraine). The age of the well preserved wood from that well is 43,300±1800 ^{14}C years BP or a corrected calendar age of 46,667 YBP (Young and Burr, 2004). This suggests that the Middle Wisconsin advance reached at least as far south as the younger Fowlerville moraine described below. Given the nature of the local buried valley topography, it is likely that a finger of ice (narrow lobe) extended southward from the main ice mass along the buried bedrock valley, a feature that approaches the larger Finger Lake bedrock troughs in scale [See also Karig and Miller (2013) for similar chronology of events in Cayuga Lake trough].

Mike Wilson (1981) completed 1:24,000-scale glacial mapping of portions of the area under the direction of Dr. Ernest Muller in the mid-1970s, before extensive excavations of clay to construct the Monroe County Mill Seat (Riga) landfill at the Elam-DeWitt site exposed the deeper Middle Wisconsin sequence. The basic geology of the Genesee Valley as updated during that general era is described in the Friends of the Pleistocene 51st Annual Meeting guidebook for 1988 (Brennan, 1988), as well as in the contemporaneous article by Muller et al. (1988). The present workshop presentation focuses on the revision of the timing for the Late Wisconsin history from the formation of the Valley Heads moraine (Fig. 1) to a previously undated ice advance corresponding to the time of the Younger Dryas cold interval (ca. 13,000 to 12,000 calendar years BP). All radiocarbon ages mentioned subsequently in this brief summary are calendar corrected ages (1Σ mean; labeled YBP) as determined using the Calib 7.1 program (http://calib.org/calib/) of Stuiver et al., unless otherwise labeled as ^{14}C years BP. Ages done after 1990 are ^{14}C AMS by the Univ. of Arizona lab (AA), by Beta Analytic (#), or Lawrence Livermore Lab (CAMS).

REVISION OF GLACIAL CHRONOLOGY

Calendar Year Corrections of ^{14}C Ages

Much of the revision of the Genesee Valley history is based on the fact that ages in the ca. ^{14}C 11,000 ± years BP range (uncorrected) are now known to be approximately 2000 years older in actual calendar years. During the 1970s and 1980s the ^{14}C calendar correction programs were in their infancy, were usually calculated by the relevant laboratory prior to the advent of the Internet, and generally did not include calendar corrections for results much beyond ca. 6000 ^{14}C years. From the late 1960s through the early 1980s R.A. Young and students at SUNY Geneseo obtained several ^{14}C ages from miscellaneous wood samples that were in the ca. 11,000 ^{14}C BP range. These were generally obtained from samples at the glacial-postglacial transition horizon, mostly from subsurface borings for highways, bridges, or from USGS studies during those decades (see Table 8 in Mansue et al., 1991, p. II-30 to II-31). At that time, the age of glacial Lake Iroquois was generally believed to be in the 11,500 to 12,600 ^{14}C years BP range (Calkin, 1970), and most of the uncorrected published ^{14}C ages for that lake were greater than 12,000 ^{14}C. Accordingly, this implied that the conventional (pre-AMS) ca. 11,000 ^{14}C year BP ages obtained by R.A. Young were too recent to represent true late "glacial" events and were simply recording random postglacial events associated with a variable and unknown time lag following the last ice recession in the Genesee Valley until organic growth accumulated in various depositional environments (such as bogs, or the base of the Genesee River floodplain sediments). Ages younger than the inferred, but uncorrected, ^{14}C age of the Lake Iroquois shoreline were assumed to be unrealistic as true measurements documenting previously unrecognized late glacial advances south of Lake Ontario. However, the majority of those ages in the ca. 11,000 ^{14}C year BP range are now known to be closer to 13,000 "calendar corrected" years old, and correspond approximately to the Younger Dryas cold episode as determined from GISP2 ice core studies and numerous other dated localities throughout the northern hemisphere (Carlson, 2013). [See end note on laboratory dates following references list.]

Valley Heads Moraine: An advance coincident(?) with Heinrich Event H1

The morphology of the Valley Heads moraine varies considerably across its southern Finger Lakes extent (illustrated by additional images in the accompanying oral workshop). Near Dansville, the moraine is very lobate (Fig. 2) and contains large masses of reworked, deformed lacustrine varves that attest to the readvancing ice reincorporating older proglacial sediments following a recession of unknown magnitude. The headwaters of Canaseraga Creek exhibit an interesting stream capture of the originally south-flowing drainage that has resulted from headward erosion through the moraine at Poag's Hole (Fig. 2).

The age of the glacial readvance to the position of the Valley Heads moraine from the literature is estimated to be approximately 16,600 YBP (Ellis et al., 2004), but we are unaware of any absolute age that is based directly on wood or organics located within the moraine itself. A new limiting age for the moraine that is consistent with that estimated age has been obtained from an apparent buried kettle pond near Geneseo (19 miles north of Dansville) that was subsequently covered by a migrating sand dune (Figs. 3,4). A pre-dune AMS age of 16,545 YBP was obtained from organic debris at the dune-pond sediment contact near a depth of 5 feet (Fig. 3). This age, if accurate, implies that the dune sand may have formed as a result of strong katabatic winds off a nearby ice sheet (a second ^{14}C age on wood as well as an optically stimulated luminescence (OSL) age on the dunes by Lewis Owen are in progress). There was no evidence observed during a large excavation into the dune (Fig. 4) that it had advanced across a surface where small trees or tundra vegetation had become well established. This further supports the suggestion that the dune records unimpeded aeolian deposition immediately following ice recession, across a relatively open landscape close to the ice front. The current age at the Geneseo site strengthens the evidence that the glacial readvance to the Valley Heads position coincides with Heinrich Event H1 in the Atlantic Ocean deep sea sediment records. Heinrich Event H1 is estimated to have occurred at 16,800 YBP (Bond and Loti, 1995).

Fowlerville Moraine Complex: An advance corresponding(?) with the Younger Dryas (YD) cold episode and Heinrich Event H0

Site 1

The broad Fowlerville moraine complex (Figs. 1,5) consists of a series of subparallel till ridges (gray lines, Fig. 5) spread over a north-south distance stretching approximately 4 miles south of Fowlerville, NY. The Genesee River has a notably narrow channel and lacks a wide floodplain where it has eroded through this broad moraine. One of the three small moraine crests on the west side of the valley near Linwood, NY, was the site of the excavation of a complete peccary skeleton (Figs.1,5) on the Lawrence Hill property in 1978 (borrow excavation, east side of Federal Road, 2000 feet south of junction with Fowlerville Rd.; lat. 44.8879, long. 77.9200). The glacial stratigraphy exposed at the peccary excavation demonstrated that the immature animal foundered in quicksand (south-dipping, stratified and ripple laminated outwash sand) at the margin of an active ice sheet, then was buried under a thin till sheet by the continued advance of the nearby ice (Young et al., 1978). Figures 6 through 10 provide some of the evidence explained in more detail in the accompanying workshop presentation. Two dates on the peccary (bone and collagen extract) are 13,002 YBP and 13,045 YBP.

Site 2

During a Genesee River study, funded by the US Army Corps of Engineers (Young, 2003), several partial logs and associated organic debris were uncovered in a thin till sandwiched between two sets of glacial varves on the east bank of the Genesee River near Avon, NY (Figs. 1,5,11,12). The thirteen ^{14}C ages obtained from this section are shown on the accompanying diagram (Fig. 11). Despite the well exposed "apparent" glacial stratigraphy, the site was tentatively and hesitantly described by Young (2012) as representing logs buried by a local landslide in order to account for the relatively young age and diamict-like texture. A large landslide did occur in 1972 on the same side of the river 2 miles further south at Oxbow Lane (See photo, Young and Rhodes, 1973, p. E-5). Young's (2012) tentative landslide interpretation was based exclusively on the relatively young ^{14}C ages, as related to the purported older age of the glacial Lake Iroquois shoreline. However, the wood-bearing diamict is in normal conformable contact with the varved lacustrine sediments above and below the till, a relationship not indicative of a heterogeneous, gravity-driven deposit (Figs. 11-14). As a result of subsequent reviews and calendar corrections of the accumulating radiocarbon chronology for glacial events ca. 13,000 YBP, as well as unpublished data from other sites in western NY, the landslide assumption has been abandoned in favor of the obvious glacial nature of the preserved stratigraphic section, in addition to the orderly and thousand-year-long chronologic span of ^{14}C ages (Fig. 11). In support of the glacial transport interpretation, the logs buried in the till have no attached branches, are stripped entirely of bark, and are aligned in parallel, north-south orientations

(Fig. 13). Had this been a landslide along the Genesee River, any such catastrophically buried trees would have preserved evidence of branches and bark from a rapid, gravity-related burial, whereas subglacial transport of small trees would likely trim both bark and branches from the trunks. The slight age reversals in units 2 and 3 (Fig. 11) indicate scouring by advancing ice from progressively deeper organic horizons of older (re-incorporated) bog deposits.

Additional glacial recession dates

There are additional Younger-Dryas-linked ^{14}C ages from two drill hole samples shown on Figure 1 and located: 1) Below the Canaseraga Creek floodplain 6.5 miles south of Geneseo (Keshequa Ck at railroad; Interstate I-390 test boring), and 2) Five miles northwest of Avon (Dugan Creek channel, Muller et al., 1988). The Keshequa Creek sample was a 1-inch diameter piece of wood (with branch stubs) from a depth of approximately 32 feet at the contact of Keshequa Creek (Genesee Valley) sediments with the underlying glaciolacustrine sediments of the youngest recessional proglacial lake in the valley.

The Dugan Creek channel sample is from woody debris at the basal peat-till contact (depth 8.8 ft) that was hand cored by R. A. Young and students near Baker (old RR stop at Lacy Rd.) in the late Wisconsin outwash channel that discharged southwestward into the Genesee Valley (Young, in Muller et al, 1988, p. 63; Young, 1988). The wood age of the basal floodplain sample recovered at Keshequa Creek has a calendar corrected age of 13,012 ± 160 YBP. The Dugan Creek sample is slightly younger with an age of 12,917 ± 160 YBP, consistent with its more northerly location.

Both of these samples appear to record the rapid or contemporaneous revegetation of the valley following recession of the most recent (Younger Dryas) glacial event. The conclusion that revegetation occurred essentially coincident with the brief ice advance and withdrawal is based on observations of modern glaciers, plus the fact that the *juvenile** peccary's burial by quicksand on the crest of the moraine implies that the animals were living and breeding close to the active ice front, which implies an adequate source of appropriate vegetation. **Peccary's molars and tusks were still erupting (Fig. 8).*

In addition to the corrected calendar ages of these numerous Genesee Valley deposits, with ages largely in the 12,900 to 13,500 YBP range, the Greenland ice core project (GISP2) and other detailed studies have now provided a detailed and well dated climatic history back through this critical interval of unusual climatic diversity (Anderson, 2006; Brauer et al., 2014; Lemieux-Dudon, B. et al., 2010; Svensson et al., 2008). The approximate ages of the key events are on Figure 15. Based on this chronology, the two sites on and near the Fowlerville moraine, as well as the glacial-postglacial contact samples, appear to coincide closely with the timing of the Younger Dryas cold interval, which is also recorded in the oceanic sediments as Heinrich layer H0. Dates on wood in glacial till naturally must be older than the associated glacial advance, thus accounting for dates that slightly overlap the ca. 14,000+ YBP range.

CONCLUSIONS

There is now ample evidence of a late glacial advance along the Genesee Valley to a position approximately 3.5 miles north of Geneseo, NY, culminating in a ca. 13,000 YBP moraine. Additional sites with similar wood-in-till ages are the subject of ongoing field studies for which the supporting data cannot be released at the present time, pending approval and release of a final report. The close correspondence of the Genesee Valley ages reported here with the well documented age of the Younger Dryas cold interval (approximate 1000-year length) seems to establish that this northern hemisphere event was accompanied by a late glacial advance well south of the modern Lake Ontario shoreline at a time that coincides closely with the proposed age for the initiation of glacial Lake Iroquois in the Ontario basin (Anderson and Lewis, 2012). This implies that either the proposed age of Lake Iroquois is slightly too old, and/or that the recession of the ice front from the Genesee Valley was a very rapid event. Mickelson et al. (2007) describe significant new evidence of new sites with similar Younger Dryas-age, post Two Creeks, chronology in Wisconsin. These upper Midwest localities are described as documenting rapid ice advances involving proposed wet-bed conditions, a scenario that may fit the Genesee Valley history.

The Pinnacle Hills kame moraine, located along the southern edge of Rochester, NY, was capped by a till sheet that postdated the stratified kame deposits below in many places. The photographs taken by Fairchild (1923, 1928) of the numerous exposures in working sand and gravel pits indicate that the till was at least 20 feet thick in places (estimated from wagons and human figures included in the photographs). It is possible that the Pinnacle Hills moraine was overridden by the Younger Dryas ice advance without destroying the basic relief and morphology of the kame moraine. Such ice readvances over preexisting morainal topography without destroying the older morphology have been reported elsewhere in PA and OH (Fleeger, 2005; Thomas et al., 1987). If such were the case for the Pinnacle Hills moraine it would be compatible with a rapid withdrawal of the ice from Fowlerville to the Ontario basin. This would avoid the necessity for having the retreating glacier stall near Rochester, build the impressive Pinnacle Hills kame moraine, and then readvance some distance over the kame moraine sediments, before rapidly retreating again in time to allow glacial Lake Iroquois to form within the narrow time frame. Alternatively, the estimated age of glacial Lake Iroquois may need to be reconsidered.

Overall there is increasing evidence that some North Atlantic Heinrich glacial surges (Hemming, 2004) are approximately contemporaneous or nearly synchronous with glacial advances that are represented by prominent terrestrial moraines (Moores and Lehr, 1997). This is especially true for the Middle to Late Wisconsin glacial history of the Genesee Valley. Additional information on the general revision of the Late Wisconsin time-stratigraphic classification scheme are reviewed in Karrow et al., (2000).

FIGURES

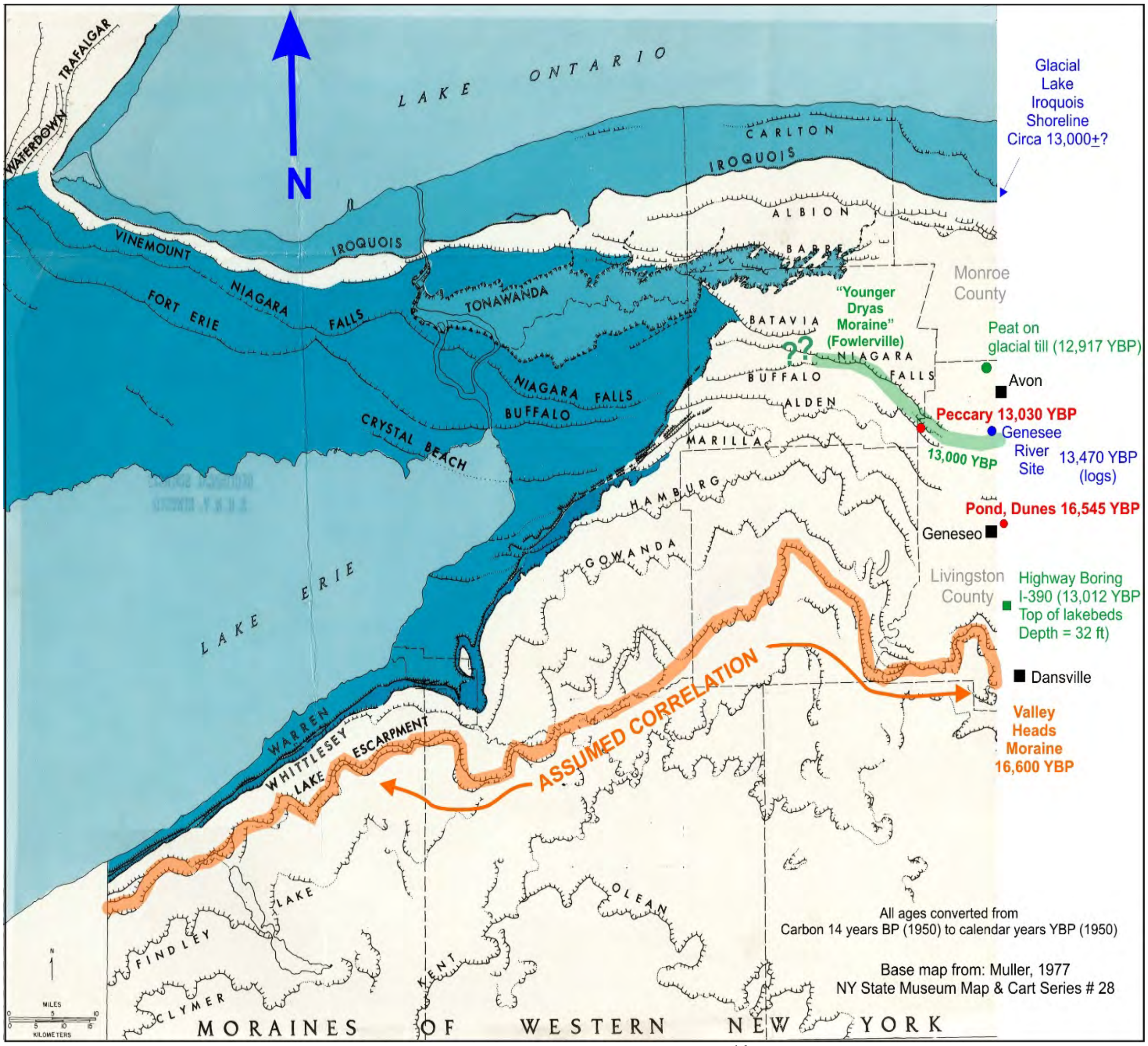

Figure 1. Generalized diagram of major moraines and some of the ^{14}C ages discussed in this presentation. The assumed correlation of the Valley Heads moraine with the Lake Escarpment moraine is from literature sources, such as Calkin (1970) and Muller and Calkin (1993). The age and westward correlation of the ca. 13,000 YBP Fowlerville moraine containing the complete buried peccary skeleton is uncertain, because the original Muller Niagara sheet map did not appear to recognize the Fowlerville moraine complex, presumably due to its broad and subdued topography (compare with Figure 5). Note: Moraine base map with color additions by authors is taken from descriptive legend portion of the original edition of the Niagara sheet of the Quaternary Geology of New York (Muller, 1977), which was subsequently revised to conform to USGS standards for colors and descriptive sedimentary unit labels. Squares are towns, circles are ^{14}C sample sites.

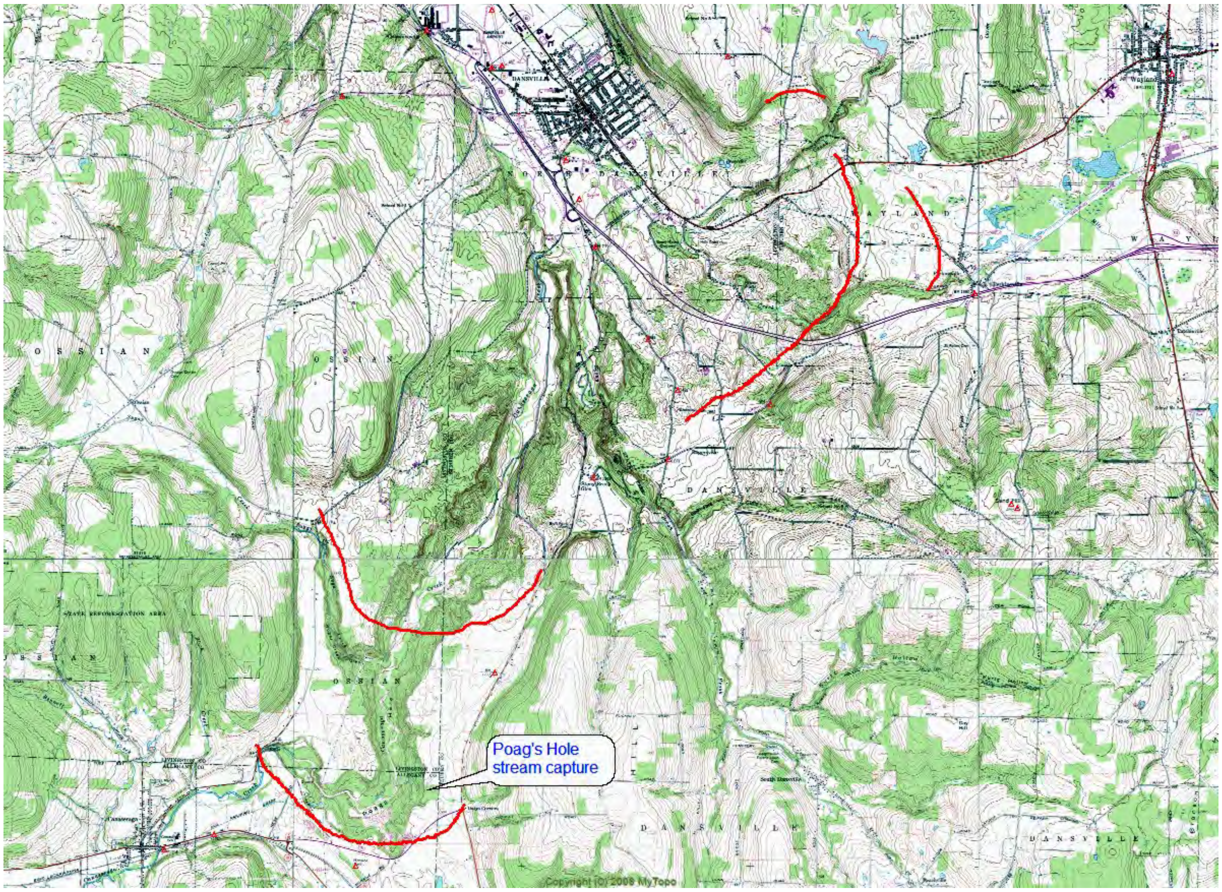

Figure 2. Numerous morainal crests (red curves) near Dansville-Wayland section of Valley Heads moraine. Dansville, NY 1:24,000 scale (7.5 minute) topographic map.


Figure 3. Left is Geneseo dune/pond contact; right is debris in dark organic layers (1 mm grid).

Figure 4. Five foot deep trench exposing dune covering Geneseo kettle pond site.

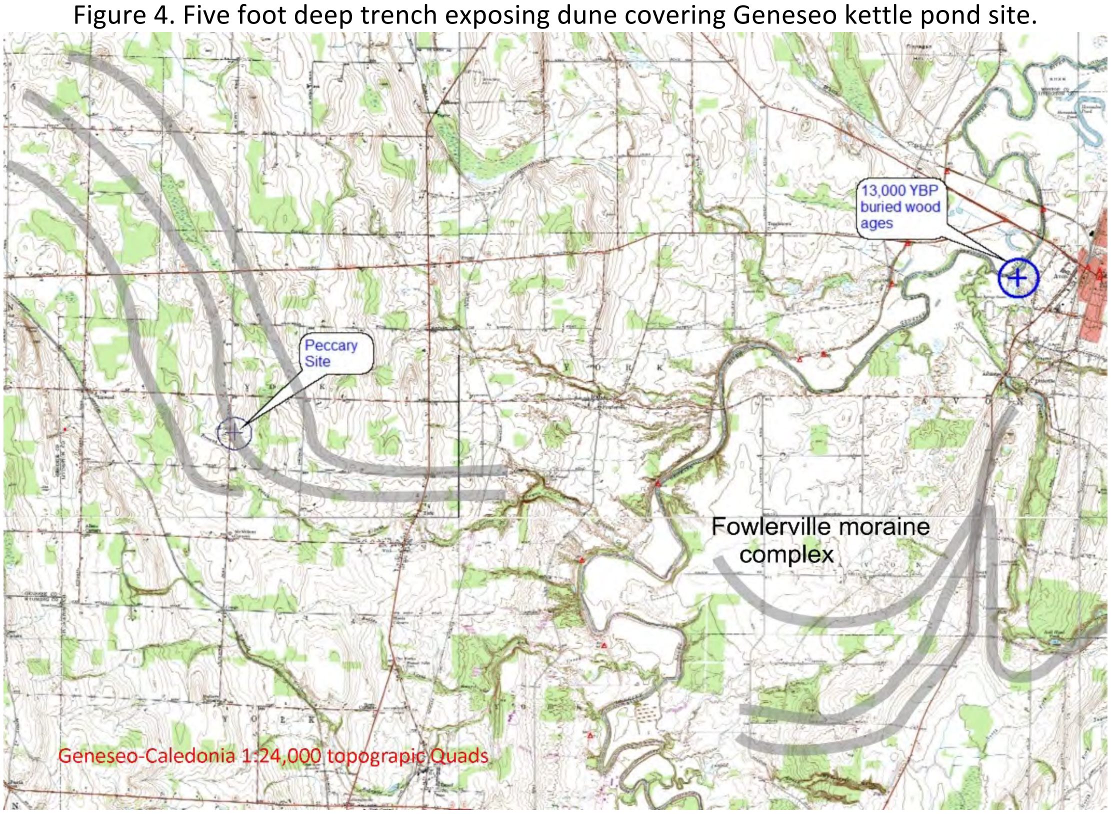

Figure 5. Fowlerville moraine complex with two dated sites; Avon at upper right edge.

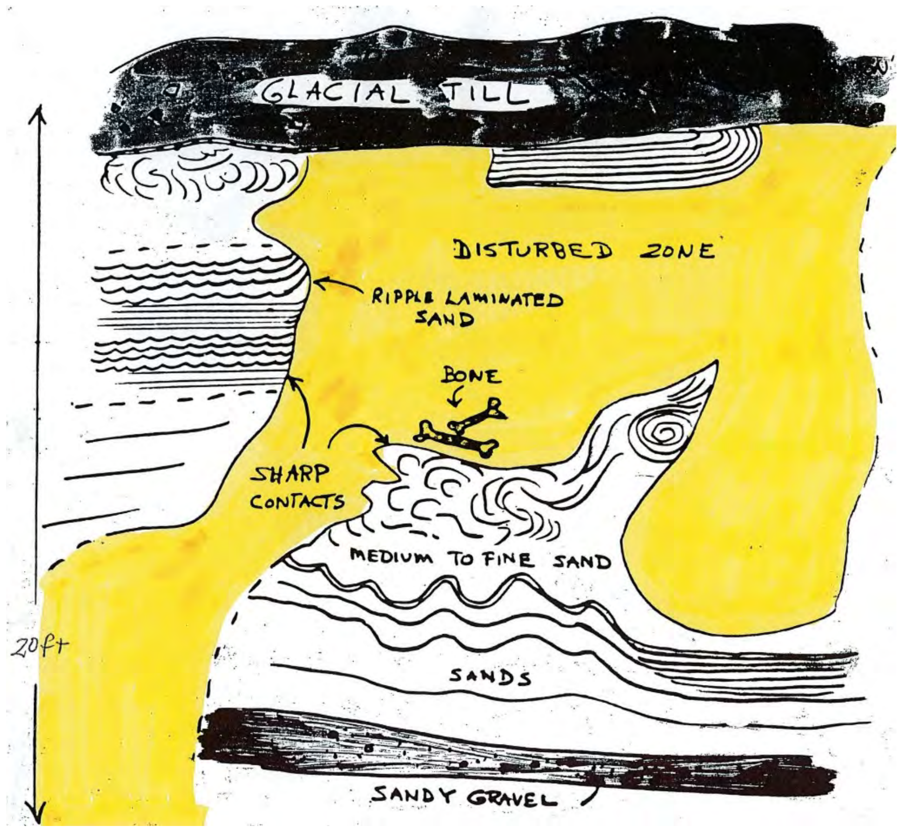

Figure 6. Original field sketch of peccary skeleton quicksand burial site near Linwood, NY.

Figure 7. Contact between completely liquefied sand above (at trowel) and less fluidized but disrupted sand layers at base of peccary burial (bones), as sketched near center of Figure 6.

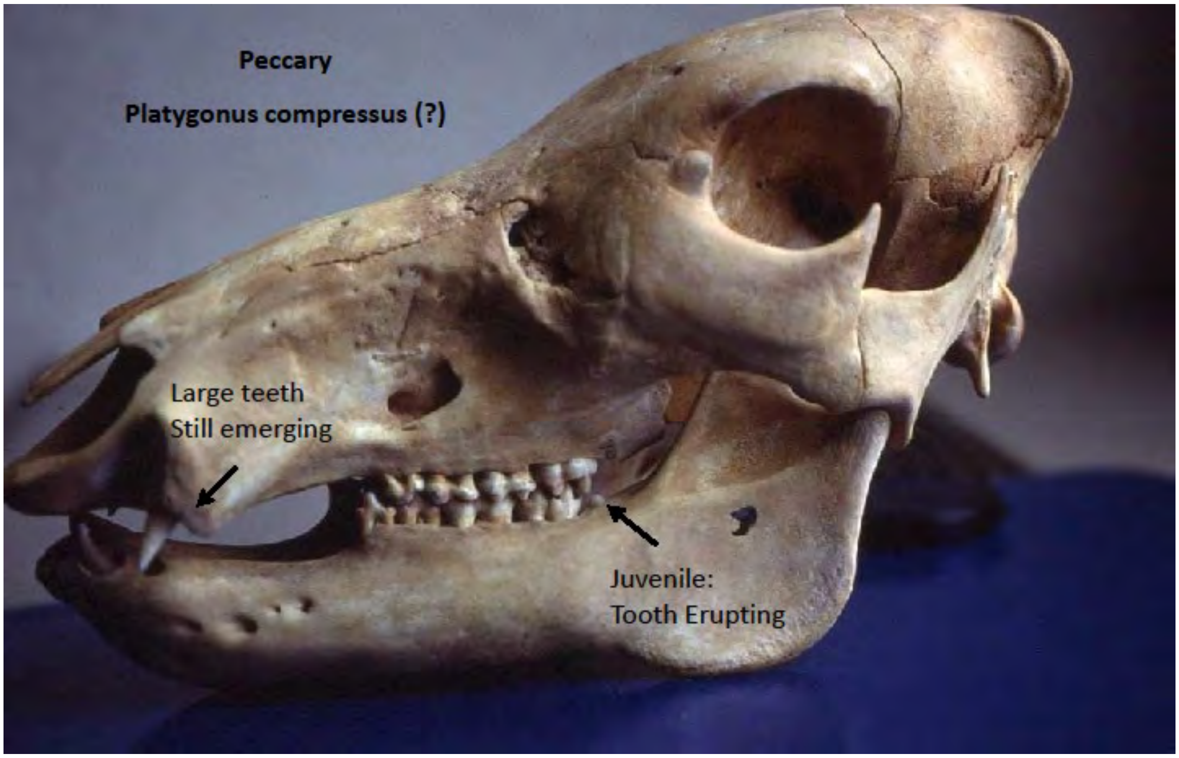

Figure 8. Juvenile peccary skull showing excellent preservation and tooth-tusk eruption stages.


Figure 9. Upwelling of glacial meltwater at glacier margin, illustrative of potential quicksand mechanism. Photo by Gordon King, Lost Coast, Alaska.

Figure 10. Similar quicksand structures at ice marginal outwash site 5 miles SW of Albion, NY.

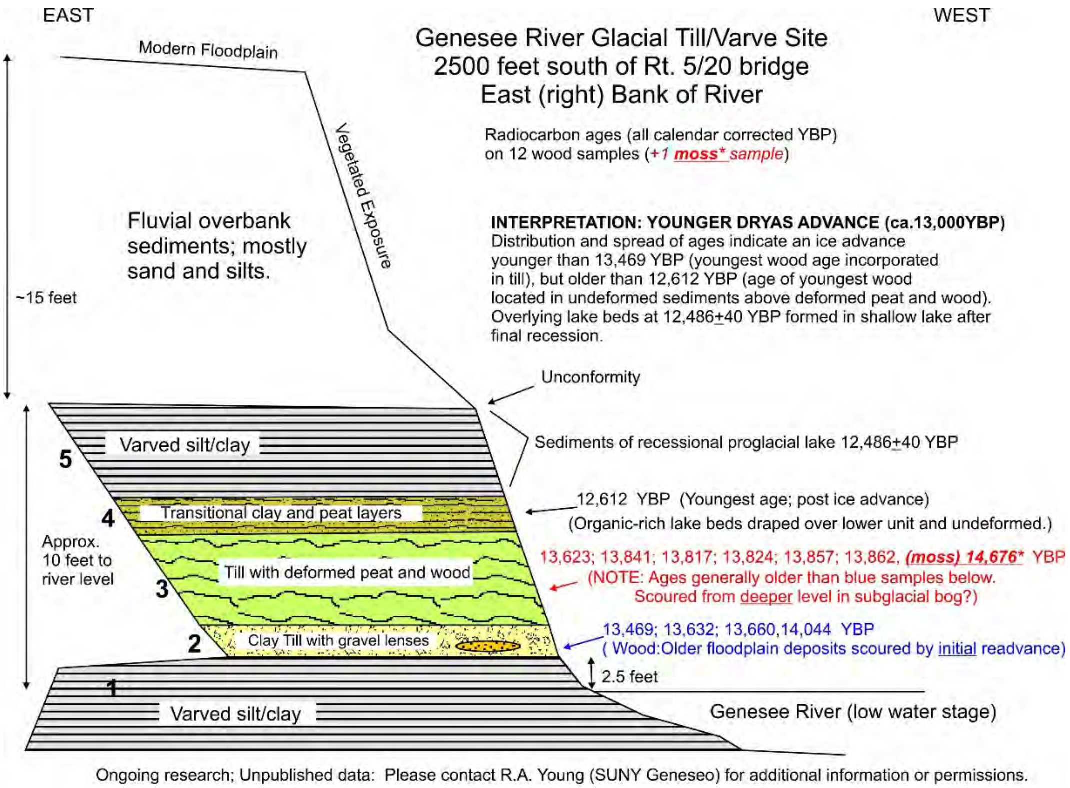

Figure 11. Radiocarbon age profile for stratigraphic section at Genesee River site near Avon, NY.


Figure 12. Unexcavated glacial till and varve site of Fig. 11, east bank, Genesee River, Avon, NY.

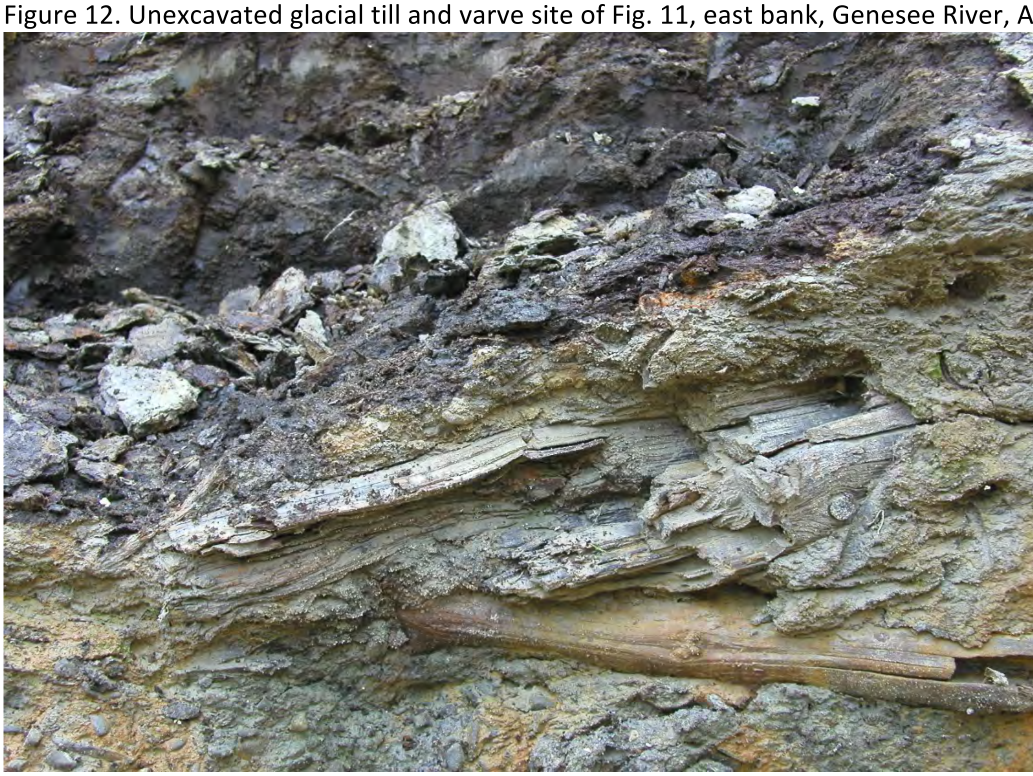
Figure 13. Logs (6" dia.) stripped of bark and limbs in glacial till, Genesee River bank, Avon, NY.

Figure 14. Close-up of unit 3 (gray till) and 4 (clay & peat) as on Figure 11 (Scale under #7 is 2”).

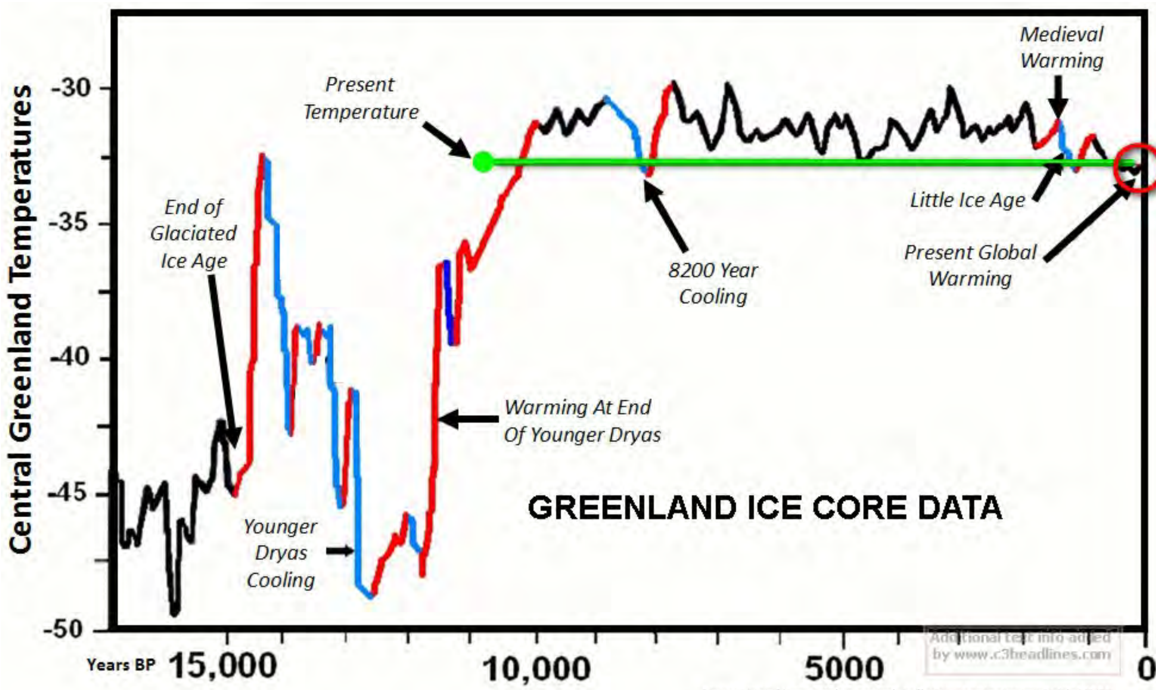

Figure 15. Diagram from Esterbrook (online posting), showing the major temperature oscillations during the past 15,000 years (YBP) as determined from the GISP2 and other studies. Source: https://wattsupwiththat.com/2012/06/19/the-intriguing-problem-of-the-younger-dryas.

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GISP2, Greenland Ice Sheet Project, The Greenland Ice Sheet Project (GISP) was a decade-long project to drill ice cores in Greenland that involved scientists and funding agencies from Denmark, Switzerland and the United States. Besides the U.S. National Science Foundation (NSF), funding was provided by the Swiss National Science Foundation and the Danish Commission for Scientific Research in Greenland. The ice cores provide a proxy archive of temperature and atmospheric constituents that help to understand past climate variations. Website, http://www.gisp2.sr.unh.edu/

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NOTE: Previously unpublished ^{14}C lab results are the subject of a longer article in preparation for a peer-reviewed journal, so only calendar corrected ages are presented for unpublished ages in this brief workshop summary.

Preliminary results for two OSL samples from the dunes in Figure 4 are included in Table 1. These two ages overlap in the 14.2 to 13.4 ka range using their respective "average and standard" errors, or from 13.1 to 12.9 ka using their "weighted average" errors. These results suggest that the dunes were formed by possible katabatic wind activity associated with the Younger Dryas event, thus accounting for the underlying organics to have accumulated in the interval following withdrawal of the ice from the Valley Heads position.

Table 1: Summary of OSL dating results from extracted from sediment, sample locations, radioisotope concentrations, moisture contents, total dose-rates, D_E estimates and optical ages.

Sample number	Location (°N/°W)	Altituc e (m asl)	Depth (cm)	U[a] (ppm)	Th[a] (ppm)	K[a] (%)	Rb[a] (ppm)	Cosm c[b, c] (Gy/k a)	Dose-rate[b, d] (Gy/ka)	n[e]	Weighed mean equivalent dose[f] (Gy)	Average equivalent dose[g] (Gy)	OSL Age[f,h] (ka)	OSL Age[g,h] (ka)
A- DUNE	42.8080/ 77.7513	308	152	1.1	3.5	1.3	37	0.19± 0.02	1.80±0.12	29	24.95± 0.32	26.67± 1.88	13.8±0.9	14.8±1.4
B- DUNE	42.8080/ 77.7513	308	152	1.4	4.2	1.4	42	0.19± 0.03	2.03±0.13	26	25.01± 0.35	26.76± 1.17	12.3±0.8	13.2±1.0

[a] Elemental concentrations from NAA of whole sediment measured at Activation Laboratories Limited Ancaster, Ontario Canada. Uncertainty taken as ±10%.

[b] Estimated fractional day water content for whole sediment is taken as 10% and with an uncertainty of ± 5%.

[c] Estimated contribution to dose-rate from cosmic rays calculated according to Prescott and Hutton (1994). Uncertainty taken as ±10%.

[d] Total dose-rate from beta, gamma and cosmic components. Beta attenuation factors for U, Th and K compositions incorporating grain size factors from Mejdahl (1979). Beta attenuation factor for Rb is taken as 0.75 (cf. Adamiec and Aitken, 1998). Factors utilized to convert elemental concentrations to beta and gamma dose-rates from Adamiec and Aitken (1998) and beta and gamma components attenuated for moisture content.

[e] Number of replicated equivalent dose (D_E) successfully measured determined from replicated single-aliquot regenerative-dose method (SAR; Murray and Wintle, 2000). These are based on recuperation error of < 10%.

[f] Weighted average for equivalent doses (D_E) of all aliquots. The uncertainty includes an uncertainty from beta source estimated of ±5%.

[g] Average and standard error for equivalent doses (D_E) of all aliquots. The uncertainty includes an uncertainty from beta source estimated of ±5%.

[h] Uncertainty incorporate all random and systematic errors, including dose rates errors and uncertainty for the D_E.