Evidence for Permafrost on Long Island

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Permafrost or permanently frozen ground is soil or rock that remains below 0°C throughout the year. It forms when the temperature at the ground surface cools down sufficiently so the ground stays frozen throughout the summer. Permafrost usually has a surficial active layer that can support vegetation.

Long Island was formed during the last glacial maximum and its geomorphology is a result of glacial and proglacial processes. Permafrost is a common feature in proglacial areas today as well as in arctic regions where we can observe the formation of features characteristic for such environments such as patterned ground, ice wedges, involutions and others.

Previous work on loess on long island suggests the possibility that permafrost conditions persisted for several thousand years after the retreat of the Laurentian ice sheet (Kundic, 2005). However, little observational evidence of permafrost on Long Island at the end of the Wisconsinan has been documented. Evidence for such permafrost has been found just to the north of Long Island in Connecticut (for example Stone and Ashley, 1992)). We also know that permafrost conditions were present in New Jersey, Delaware and Pennsylvania (French et al., 2003; French et al., 2005; Lemcke and Nelson, 2004; Ridge et al., 1992; Walters, 1978). Ice wedge casts in coastal New Jersey were dated at 14,000-17,000 calendar years (French et al., 2005). Based upon this, there may have been permafrost on Long Island until at least 14 ka.

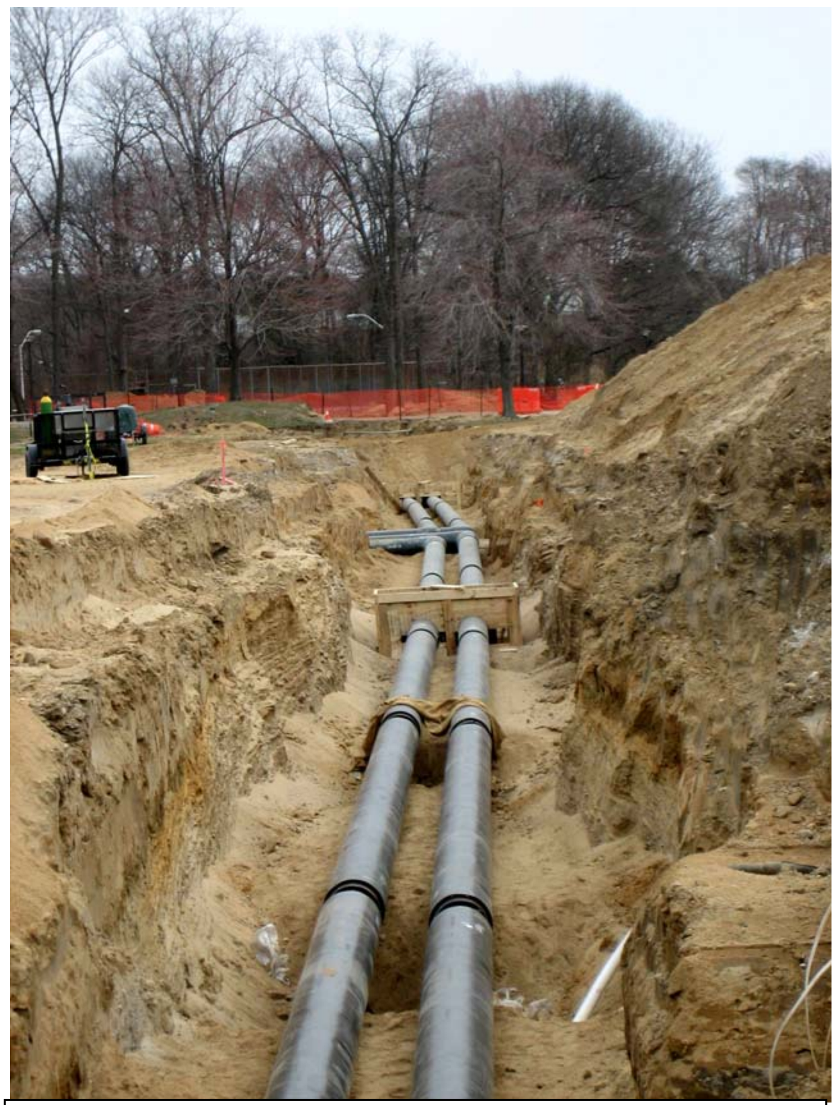

Figure 1. Trench on Stony Brook University campus

A recently dug, several-meter-deep trench on the Stony Brook University campus (Fig. 1) revealed involutions at greater than one meter depth. (Fig. 2). An involution occurs when sand sinks into saturated diamicton of lower density and diamicton ascends into the sand (Murton, 2001). Involutions are variable in size and can be a couple of meters in diameter.

Involutions are closely associated with permafrost and also thermokarst which can be described as a pitted land surface that forms as permafrost melts. Involutions form mainly at the thaw unconformity, where active and frozen layer meet. If involutions are less that 80 cm below surface, they could be a result of frost and heave actions. Deeper involutions are usually associated with degradation of permafrost and deformation of soft sediment during active layer deepening (Murton, 2001).

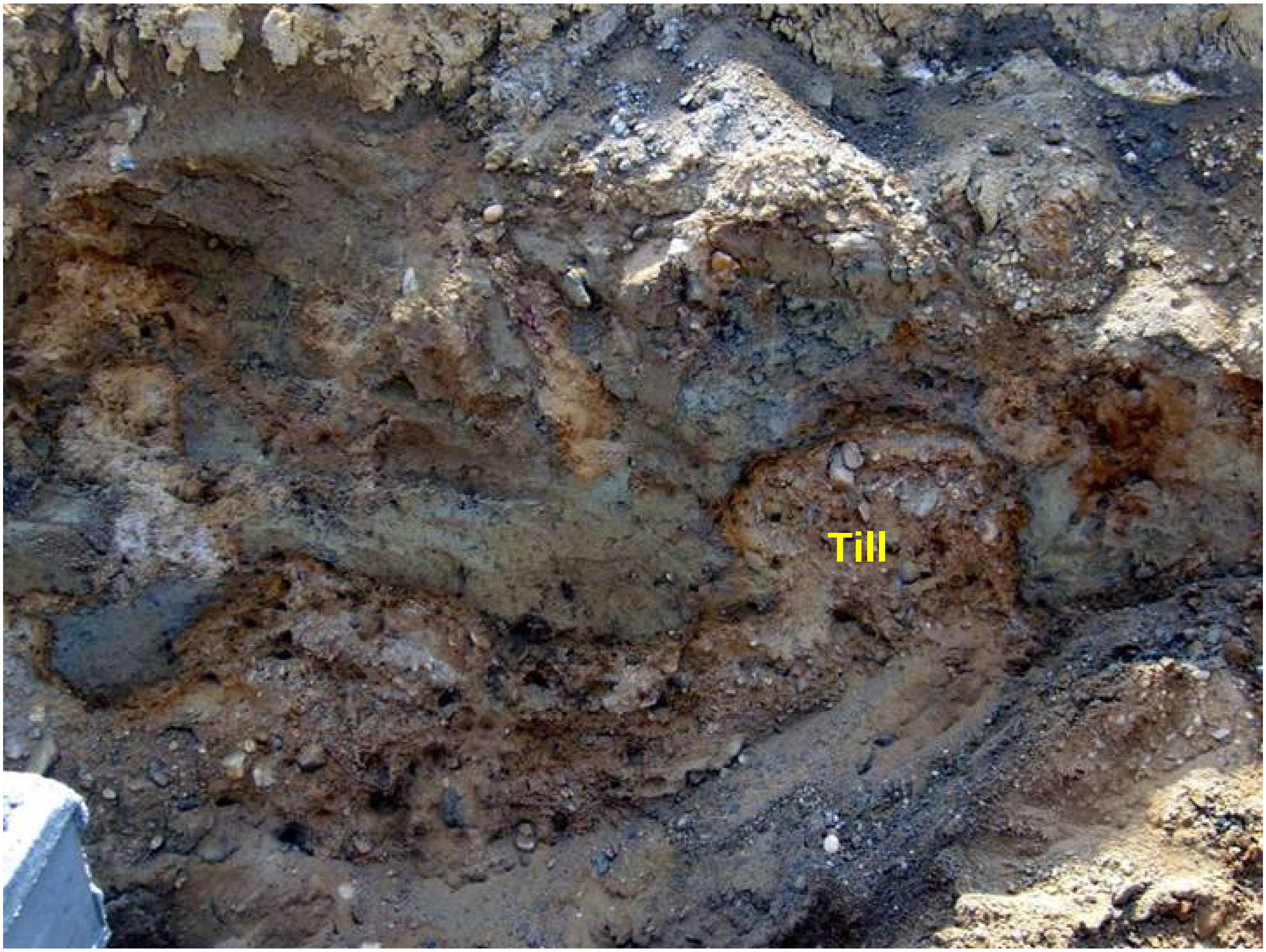

Figure 2 Involution showing till rising into sandy silt layer.

In addition to involutions the section has exposed stream deposits. The deposits are composed of layered well sorted sand with lenses of coarse sand and gravel and silt. Gravel layers do not show imbrication. The layered sand is sharply cut and overlain by fine sand that shows involution at some places (Fig 3) therefore indicating that this was the boundary between active and frozen layer in permafrost.

There are several thrust faults that cut the layered sand (Fig. 4). The fault zones are composed of a mixture of sand and coarse gravel. Frozen gravel isles competent than frozen sand, silt and clay in that order. The gravel is imbricated in the fault zone (Fig. 5) suggesting that it was less competent. If the fault had occurred in unfrozen sediment, finer grain sediments might be expected in the fault zone.

Figure 3 Involution of layered sand into the fine sand above. The pipe is about 2 inches in diameter

Figure 4. Thrust fault in layered sand in trench. The cobble-rich material above the faulted layers is anthropogenic.

Figure 5. Close up of thrust fault showing imbricated gravel in fault zone

The trench on SUNYSB Campus has uncovered interesting features. While no evidence of the presence of permafrost after the retreat of the ice sheet was reported on Long Island, we know that it has persisted south of Long Island for several thousand years after the retreat (French et al., 2005). Presence of permafrost is very likely to influence the depositional environment at the edge of the ice sheet by delaying the melting of the leftover buried ice and therefore delaying the formation of the topography. It would also influence the development of vegetation and movement of the sediment. This discovery is not definite proof of the presence of continuous permafrost, and it does not provides a time frame for the possible permafrost. But it has uncovered features that are closely associated with permafrost conditions. Therefore, the presence of permafrost needs to be considered when interpreting proglacial features on Long Island

References Cited

French, H. M., Demitroff, M., and Forman, S. L. (2003). Evidence for late-pleistocene permafrost in the New Jersey Pine Barrens (Latitude 39 degrees N), Eastern USA. *Permafrost and Periglacial Processes* **14,** 259-274.

French, H. M., Demitroff, M., and Forman, S. L. (2005). Evidence for Late-Pleistocene Thermokarst in the New Jersey Pine Barrens (Latitude 39 deg. N), Eastern USA. *Permafrost and Periglacial Processes* **16,** 173-186.

Kundic, V. (2005). "Age and provenance of Long Island loess." Unpublished Master Thesis thesis, SUNY in Stony Brook.

Lemcke, M. D., and Nelson, F. E. (2004). Cryogenic sediment-filled wedges, northern Delaware, USA. *Permafrost and Periglacial Processes* **15,** 319-326.

Murton, J. B. (2001). Thermokarst sediments and sedimentary structures, Tuktoyaktuk Coastlands, western Arctic Canada. *Global and Planetary Change* **28,** 175-192.

Ridge, J. C., Evenson, E. B., and Sevon, W. D. (1992). A Model of Late Quaternary Landscape Development in the Delaware Valley, New-Jersey and Pennsylvania. *Geomorphology* **4,** 319-345.

Stone, J. R., and Ashley, G. M. (1992). Ice-wedge casts, pingo scars and drainage of glacial Lake Hitchcck, Trip A-7. *In* "Guidebook for fieldtrips in the Connecticut Valley region of Massachusetts and adjecent States, New England Intercollegiate Geological Conference 84th Annual Meeting, Amherst, Mass., Oct. 9-11,1992: University of Massachusetts, Geology and Geography Contribution 66." (P. Robinson, and B. J.B., Eds.), pp. 305-331, Amherst, Mass.

Walters, J. C. (1978). Polygonal Patterned Ground in Central New-Jersey. *Quaternary Research* **10,** 42-54.