Geophysical Insights Into the Origin of 'The Wall', a Glaciotectonic Feature on the Stony Brook Campus

Dan M. Davis, James Farrell, Jazmin Inoa, Harrison Last,
Gregory Swirson, Yuan (Sunni) Tang, and Gene Zagorsky
all at: Dept. of Geosciences, Stony Brook University, Stony Brook, NY

Stony Brook University sits atop the Harbor Hill Moraine. One of the more enigmatic geomorphological features on the campus is a curved hill of about 15 m relief, known locally as 'The Wall'. It is part of the northern extent of a wedge-shaped region of undulating elevated terrain bounded on the south by the southern edge of the moraine and widening to the west from its eastern tip near Terryville, through southern South Setauket, to the western end of the Stony Brook campus where its north-south extent reaches about 1300 m.

During the fall of 2012, we conducted a combined GPR (ground-penetrating radar) and resistivity survey of The Wall. Previous such surveys have proved useful in highlighting the structure of features such as the structure of the moraine, a hill formed by a crevasse near the front of the glacier, and the interface between the moraine and the outwash.

In this survey, the main transect was a 97 m long line, roughly north-south, running up the northern face of The Wall. Along that that line, we conducted a pair 94m long resistivity surveys with over 500 quadrupoles each, one using a dipole-dipole sequence and the other using a Wenner-Schlumberger sequence. Of these, the former is most sensitive to horizontal contrasts in resistivity, but relatively insensitive to vertical contrasts; the latter is moderately sensitive to both (Loke, 2001). Along that same main transect we collected a series of GPR survey lines with a high resolution (shallow penetration) 500 MHz antenna set, and a lower resolution (deep penetration) 100 MHz antenna set, along with intermediate-frequency 200 MHz data. We also collected GPR data on two other lines, one running near the base of the slope and another cutting diagonally across it. We carried out detailed topographic surveys in order to be able to topo-correct both the resistivity and the GPR data.

Before this study, we recognized that there were at least three viable alternative explanations for The Wall.

One possible explanation for this topographically high area is the direct result of folding – the topographic relief of The Wall might reflect stratigraphic relief from a fault-cored fold such as a fault-propagation or fault-bend fold (Suppe, 1983). There is precedent for such a possibility on Long Island: previous geophysical work on the campus of Suffolk County Community College in collaboration with S. Tvalia is highly suggestive of such a mechanism for the generation of the topography in that part of the Ronkonkoma moraine. In such a case (our initially preferred model) we would expect to see dipping (about 20°) beds that roughly parallel the slope of the wall, corresponding to the ramp zone of the fault-bend fold. To the north, we would expect nearly horizontal beds (over the upper flat) and then, to the south, steeply southward dipping beds, corresponding to the hanging wall cutoff zone.

A second alternative model was that the hill could be a fluid-eroded remnant of topography that was once more laterally extensive. In such a case, we would expect to find truncated sedimentary layering without a capping diamict.

A third model is a hybrid of the first two – that The Wall is the remnant footwall of the ramp and upper-flat zones of a glacial overthrust. In this case, we would expect to find relatively undisturbed sediments capped by a diamict – the basal till of the overthrusting ice sheet eroded sediment and transported it to the south.

Our results quite clearly favor this third model. Layering in glacial sediments is often subtle at best, particularly as imaged using GPR, but much of the high terrain south of The Wall shows distinct sedimentary layering, much of it with an apparent dip of about 6° to the south, to a depth of about 10 m. Below that depth, the signal is more chaotic, but there are some distinct reflecting layers 15-20m below the surface that are nearly horizontal. Throughout the hill, the top 2 m or so shows numerous diffraction hyperbolae, indicative of boulders and cobbles. That, in turn, indicates the presence of a capping diamict.

The resistivity data (both dipole-dipole and Wenner-Schlumberger) are entirely consistent with this result. Below a very shallow zone of moderate (consistent with soil) the next 2 m or so generally have a resistivity about an order of magnitude higher that the sediments below. This is as expected for a layer, such as diamict, with a high volumetric fraction of large clasts.

We conclude, therefore, that The Wall is most likely the result of a ramp in the forward advance of the glacier. The diffraction hyperbolae and high resistivity near the surface likely indicate a capping diamict – a basal till tracing the ramp and upper flat for the glacial thrusting. The removed sediment would then have been deposited somewhere to the south and the ice – the bulk of the hanging wall - would have melted away.