SHALLOW SEISMIC REFLECTION IN GLACIOTECTONIC HITHER HILLS, LONG ISLAND

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Glaciotectonics is responsible for a multitude of structural complications recognized across Long Island. Hither Hills, located on the south fork of Long Island, is one of many locations on Long Island that has been interpreted to have deformation associated with glaciotectonic processes (Bernard et al., 1997). Folding and faulting of sediments has been observed at outcrops in several locations within the Hither Hills region. However, outcrops on Long Island generally exhibit a transitory nature due to the inherent poor resistance of the unconsolidated sediments to weathering processes. Excavation in quarries, where many of these outcrops are observed, also plays a role in the fleeting nature of many of Long Islands outcrops. This transitory nature and the general scarcity of outcrops has prompted us to look for other methods to observe the structural complexities that exist due to glaciotectonic deformation in order to comprehend better the glaciotectonic nature of terrain in Hither Hills and on Long Island in general. In a preliminary study, a small-scale (12 channel) seismic refraction survey on a hill in the southwestern section of the Hither Hills region produced encouraging results (Figure 1a). Refractions from several layers indicates increasing velocity with depth. Forward and reverse refraction profiles from this preliminary survey also reveal differences in apparent velocities of these layers which is indicative of a dipping layer consistent with the expected orientation of a glaciotectonically produced thrust fault (Figure 1b). Based on these results, we have conducted a (60 channel) seismic reflection survey and additional seismic refraction surveys in an effort to image possible deformation in more detail. Although the data are still in the processing stage, initial results of this higher resolution survey indicate the presence of additional structural complexities not recognized in the earlier refraction survey. The reflection data presents some difficulties due to the weak and apparently complicated nature of the reflectors (Figure 2). This is likely due to both a probable small value of impedance contrast between lithological layers and the possibly very complex nature of these structures when viewed in such detail. The recent refraction survey displays variations in arrival times that indicate the possible presence of a fault offset or some lateral variation in velocity (Figure 3) not recognized in the earlier, small-scale refraction survey. Recognition of these kinds of features in glacially thrust terrain on Long Island is especially important for the development of accurate models of ground water flow. For example, thrusting and tilting of a glacial sediment column that includes aquitards (such as clays) could drastically redirect the flow of groundwater. Along the same lines, an accurate understanding of the structures and lithologies present in glacially thrust terrain has environmental significance for developing accurate models of contaminant plumes. Thirdly, a more detailed understanding of glacial thrust structures may help us comprehend better the nature of this example of a small-scale fold-and-thrust belt.

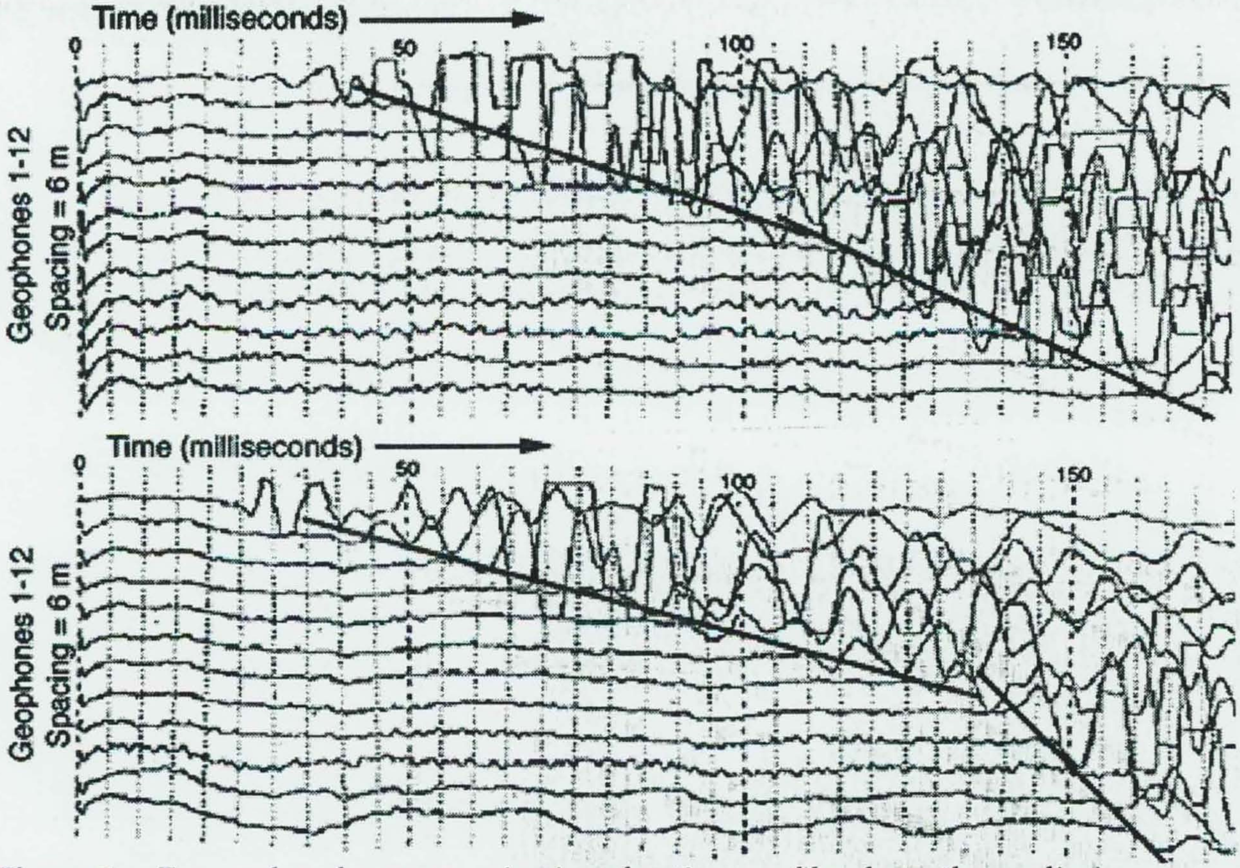

Figure 1a. Forward and reverse seismic refraction profiles from the preliminary survey along line B-B′. Sloping lines indicate first motion arrival times versus distance from the source which show increasing velocities with depth. Different apparent velocities between the forward and reverse profiles reveals the likely presence of a dipping layer.

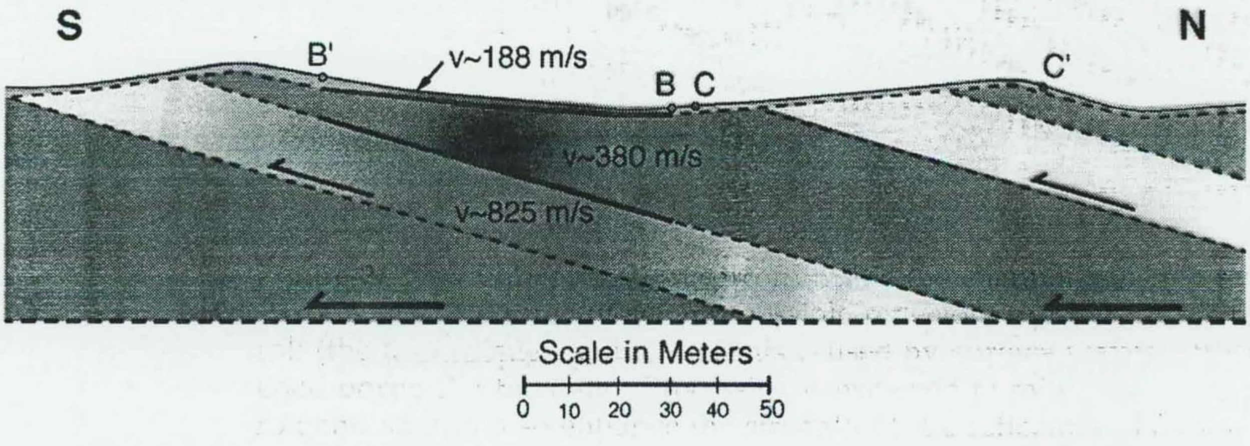

Figure 1b. Speculative structural interpretations of the observations in figure 1a. The areas that are shaded in the darker tones indicate regions which have been constrained by the refraction data. Other areas are extrapolated from this information.

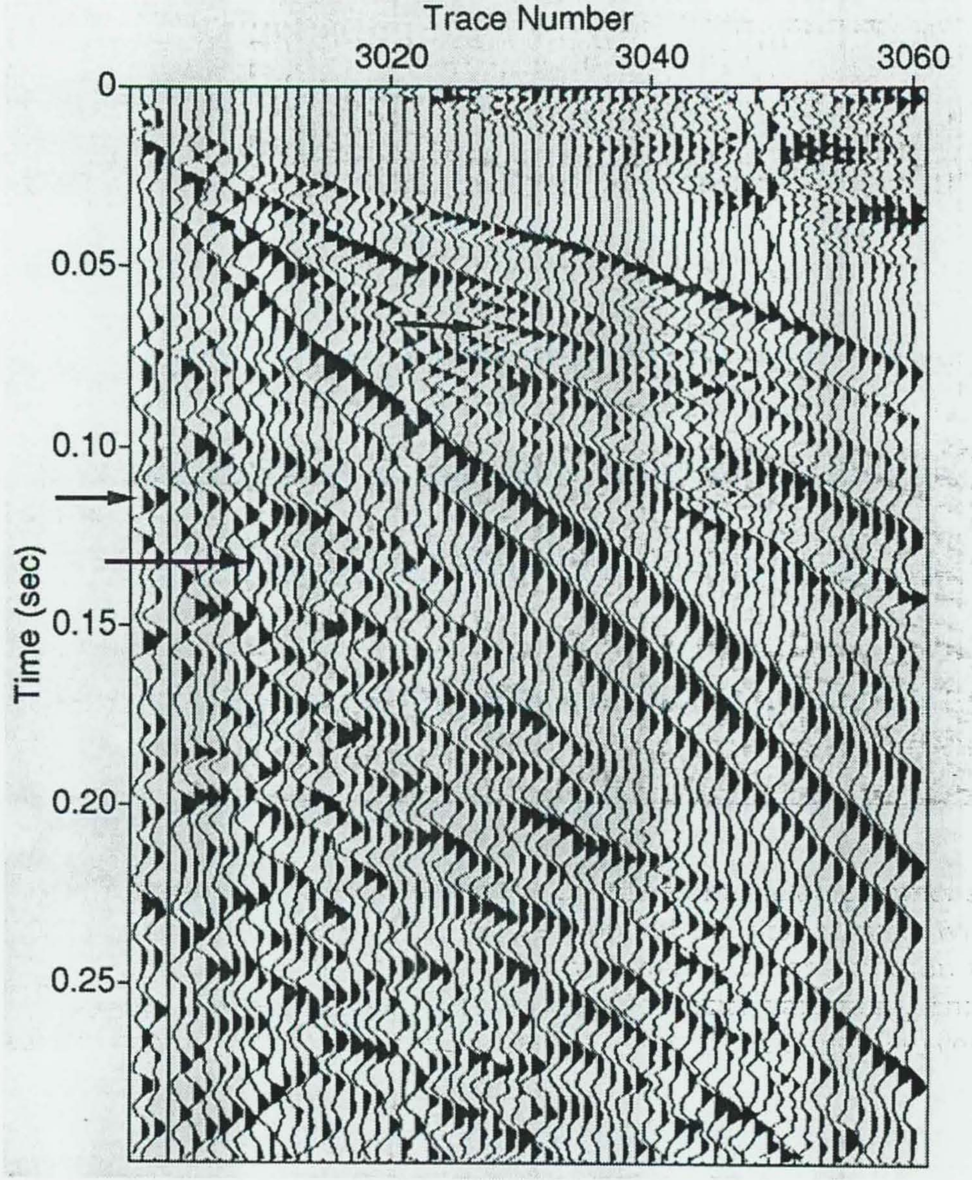

Figure 2. One unprocessed record from the (60 channel) seismic reflection survey. Arrows indicate three of several possible reflectors present in this record. Ground-roll (the low frequency linear events caused by surface waves) streams through a good portion of the data. Processing is expected to minimize the effects of ground-roll and should also enhance the strength of the reflectors. Possible reflectors exhibit complexities (deviation from the typical smooth hyperbolic curve) that might indicate presence of topography or structure on the subsurface layers.

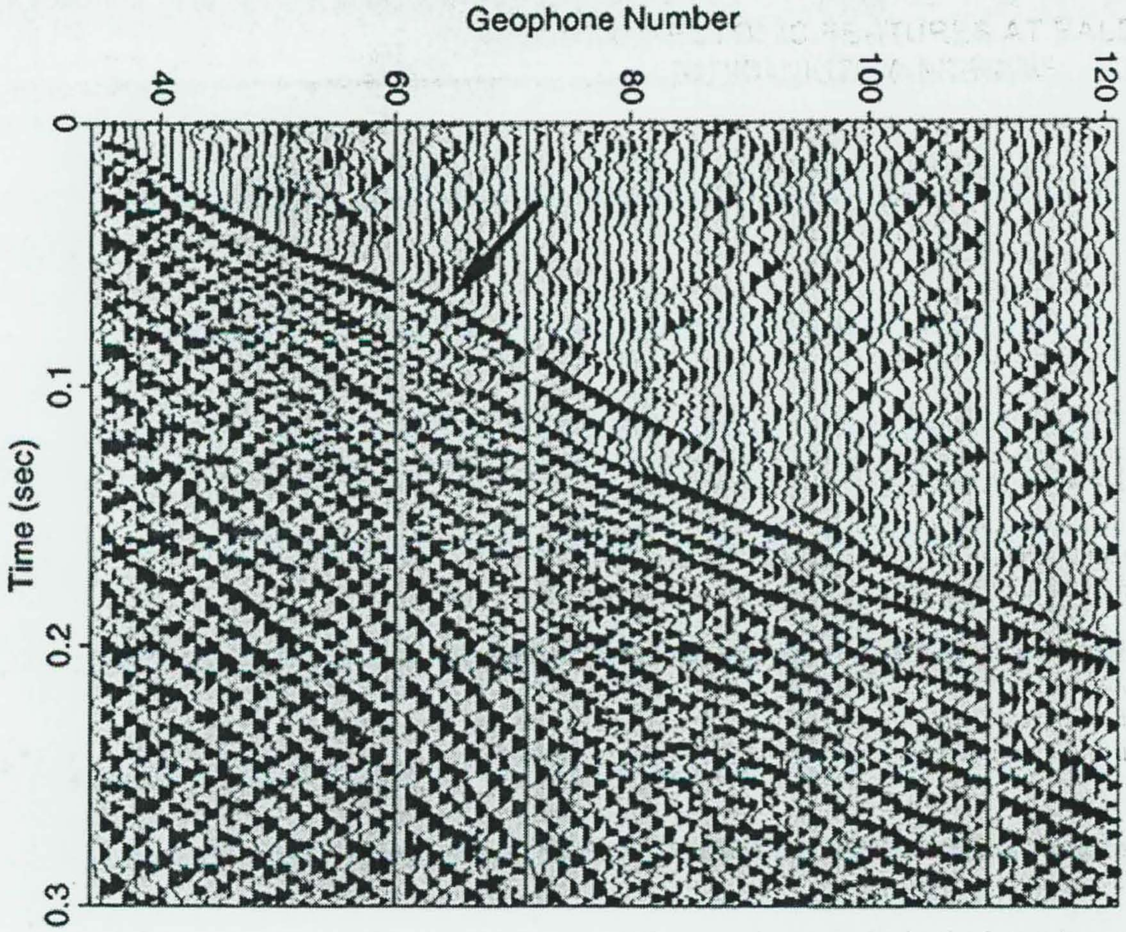

Figure 3. Seismic refraction profile from the 60 channel survey. The arrow indicates an inflection in the slope of the first arrivals which shows an apparent *decrease* in the seismic velocity at depth, an observation typical of a vertically offset fault or some other kind of lateral velocity variation. This data set displays complexities not imaged in the initial (12 channel) survey shown in figure 1a.

References

Bernard, M. B., D. M. Davis, S. S. B. Haq and D. M. Mutter (1997) Glaciotectonic origin of Terrain, Hither Hills, Long Island: A preliminary study, Geology of Long Island and Metropolitan New York, 34-37.