COMPARATIVE GPR STUDY OF PLEISTOCENE AND MODERN PARABOLIC DUNES, LONG ISLAND

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Long Island has two remarkable sets of parabolic dunes – the Grandifolia dunes of the north shore which formed proglacially in the latest Pleistocene, and the modern Walking Dunes on the south fork. Ground-penetrating radar (GPR) imaging the subsurface has made it possible to study these two ecologically sensitive sites in great detail without causing environmental damage.

The Grandifolia dunes trend south-southeast, with their relief stabilized by an ancient dwarf beech forest. A ridge we studied consists of a roughly 12 m thick layer of aeolian sand atop glacial till. Internal bed geometry is consistent with deposition in response to glacier-dominated prevailing winds blowing from the NNW. With sea level much lower at that time, such a wind would lead to accumulation of sand from across the dry, glacially reworked, and friable sediment of present-day Long Island Sound. These dunes provide a revealing window into conditions on Long Island during the latest phases of the last glaciation. The Walking Dunes of Hither Hills are modern parabolic dunes, actively overrunning a forest. GPR reveals numerous small buried trees within an internal structure characteristic of parabolic dunes. Varying orientations of imaged bedding planes illustrate complexities in the growth histories of these dunes. GPR imaging below the base of the dunes shows evidence of reworked glacial sediments and past erosional surfaces below present-day sea level. Aerial images dating back to 1930 allow us to track the motion of the youngest of these dunes, which currently migrate at rates of 1 to 3 m/yr. High-frequency (high resolution) 3-D GPR imaging on the crest of the most rapidly evolving of these dunes reveals a complex, asymmetrical pattern of growth, characterized by changing slip surface orientations and migration of the main blow-out. The older dunes are stabilized to varying degrees by vegetation. Like their Pleistocene analogs, the Walking Dunes grow in response to prevailing N to NW wind, though the modern dunes apparently feed upon the mobilization of shoreline-eroded glacial sediments by winds channeled between offshore islands. The presence of other parabolic dune forms, to the west, across Napeague Bay, suggests that the Walking Dune system may have once been part of larger dune field at a time when sea level was lower.

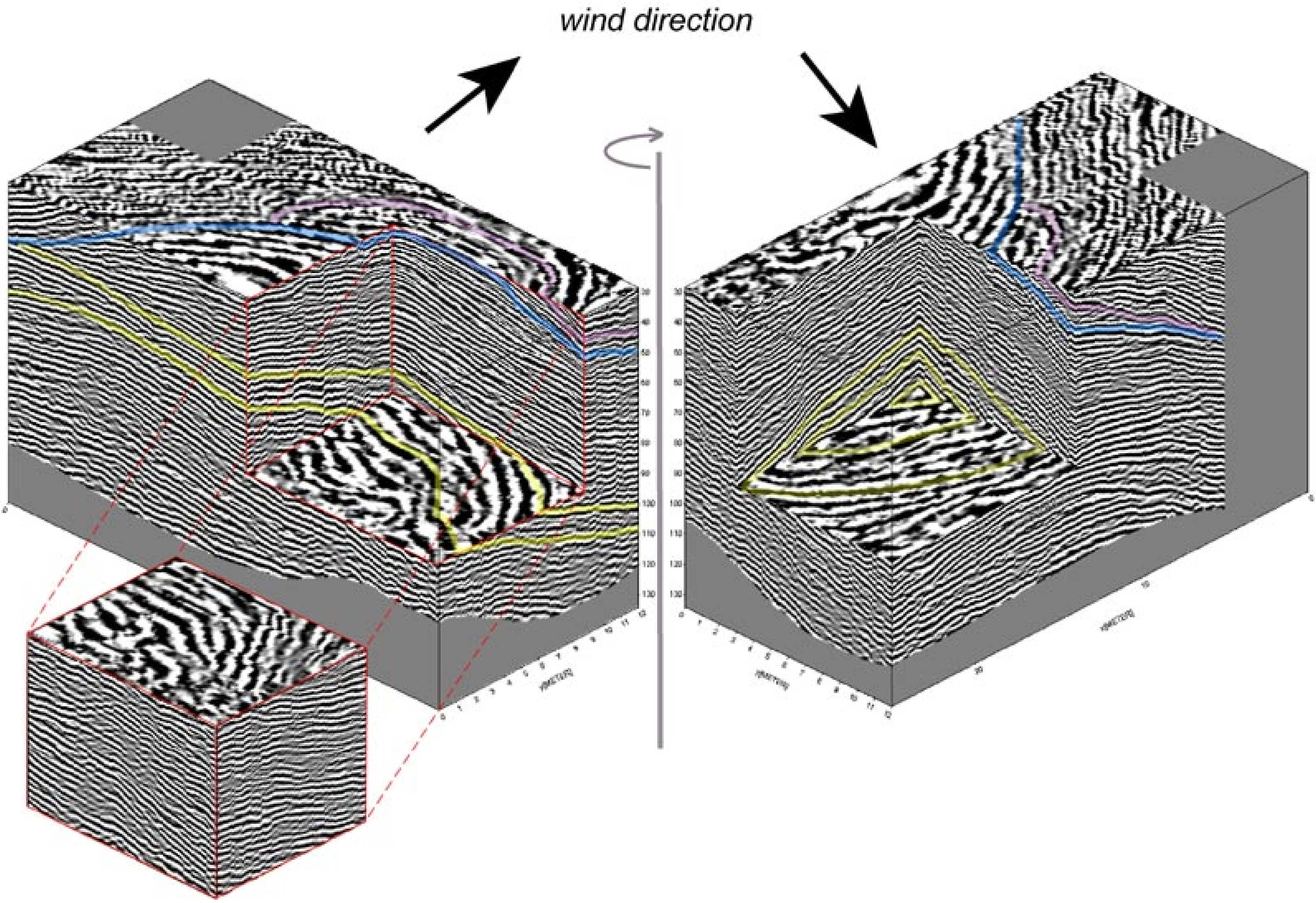

Figure 1.   3D radargrams from 61 parallel lines run on the crest of a parabolic dune. 3D imaging allows viewing of internal dune stratigraphy from multiple angles and time slices within the 3D radargram as shown by the radargrams above. The larger image on the left is looking downwind and the image on the right is looking upwind. Another unique feature of the 3D radargram is the ability to cut in from a cornerpoint to reveal internal structure along orthogonal planes of the cut out. The cut corner reveals internal structure from deeper within the dune. Note the consistency of reflectors along each face of the cube, as well as across edges and into adjacent faces. This shows how remarkably continuous these reflectors (due to slip surfaces) are along strike. These beds become cross stratified as the migrating blow-out deposits new slip faces radially as depositional lobes which are at differing angles to pre-existing strata.

Highlighted in this 3D radargram are some key features of the dune stratigraphy visible only through 3D GPR imaging.   Highlighted in yellow are reflectors (beds) which are continuous across several face and edges of the radargram. Represented in blue and purple are cross stratified slipfaces which reflect a migration of the blowout.