Shear-Wave Velocity Anomalies (60 m/s) and High Vp/Vs Ratios (>16) at Shallow Depths (0-5m) Below a Distressed Artificial Levee, Marrero, Louisiana, USA

Lorenzo, Juan M.[1]; Hicks, Jason [1]; Vera, Emilio E.[2] (1) Department of Geology and Geophysics, Louisiana State University, Baton Rouge, LA. (2) Departamento de Geofisica, Universidad de Chile, Santiago, Chile.

A growing societal need exists for scientific involvement in the study of coastal protection systems, which can be addressed by near-surface seismic methods. Both deep- and near-surface hydrogeologic processes can contribute to the structural failure of artificial earthen levees.

Recently, attempts have been made at using seismic geophysical methods to develop a proxy for engineering shear strength, by mapping changes in the transmission velocity of shear waves (Vs) through artificial levees. In the absence of electromagnetic methods, Vp/Vs ratios can be used as good indicators of variations in the fluid (water, and air or gas) saturation. Cone penetration borehole tests measure the resistance of the soil to penetration of the cone tip and its frictional sliding that can be correlated to sediment types and seismic physical properties.

A distressed section of an artificial earthen levee, suitable for seismic investigation, lies ~15 km S of the city of New Orleans, Louisiana, USA. Cracks, ~10 cm wide, ~30 cm deep, up to ~100 m in length, and arcuate in plan view, exist along the crest at two sites.

Between September 2007 and February 2008, we collect both seismic reflection and refraction, horizontally polarized, shear (S) and compressional wave (P) data in pseudo-walk-away tests for the upper 30 m of the subsurface along the protected (west) side of the earthen levee, and within 30 m of its crest. One profile lies parallel to the damaged levee crest and, for reference, two profiles run parallel to undamaged portions of the levee.

We integrate P-velocity (Vp) and S-velocity (Vs) maps, sedimentary environment interpretations, and cone-penetrometer-derived-sediment/soil and laboratory-derived physical properties from 10 test sites along the levee crest. We interpret zones of (1) high fluid concentration and perhaps seepage, (2) high-organic content, and (3) variable soil shear strength as a function of sediment facies.

Predicted shear modulus minima correlate with interpreted zones of, high-organic- and undercomapcted, clay-rich sediments. We interpret that despite nominal full soil saturation, small, in-situ intergranular free gas maintains Vp/Vs ratios low. However, Vp/Vs ratios reach values > 16 near saturated gas-free sands, atop a sand- rich buried delta lobe (2000 - 4000 yr) at ~5 m depth under the distressed portion of the earthen artificial levee.