Wavelets - *Underwater Exploration: New UH Sonar and Seismic Capabilities*

By Anoop William, Robert Stewart, and Jiannan Wang, University of Houston

Figure 1: Bathymetric and side-scanning sonar rigged from the side of the research vessel Milan in Galveston Harbor during the 2014 Geophysics Field Camp.

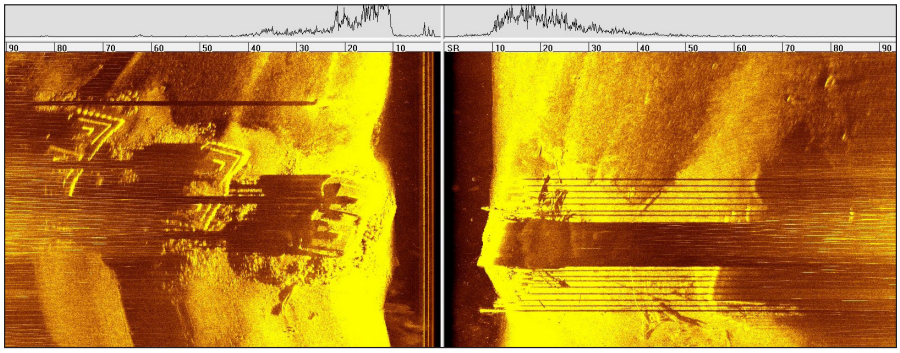

Figure 2: An echo image from the side-scanning sonar (EdgeTech 4600) along a traverse underneath the Pelican Island Causeway. The rectangular bridge footings in the channel are apparent. The top graph shows the energy of echo returns.

A nice advantage of practicing geophysics in Houston is proximity to the energy industry and the Gulf of Mexico. Many geophysical opportunities (and challenges) are found in the nearby offshore. The Allied Geophysical Laboratories (AGL) and geoscientists at the University of Houston have begun to introduce "hands-on" marine studies into our geophysics curriculum. While we have been undertaking land surveys and processing for some years, we are now beginning to acquire and analyze shallow marine data.

Initially we have been developing a shallow marine acquisition and processing capability. To do so, we have acquired some very fine equipment including:

- EdgeTech's 4600 wide-swath bathymetry and side-scanning sonar system operating at 540 kHz (***Figure 1***). An EdgeTech 3100 portable sub-bottom profiler operating at 2 - 16 kHz frequency
- Falmouth Scientific's HMS 620 "Bubble Gun" electromagnetic seismic source (boomer) pulsing over a band from 70 – 700 Hz
- A 24-channel MicroEel streamer from Geometrics.

We have also conducted several surveys in the last few months. The first survey was part of our annual Geophysics Field Camp operated this year out of Galveston. We next took the "chirp" or sub-bottom profiler to survey two lakes in Haiti as part of our SEG-supported Geoscientists Without Borders humanitarian program. Finally, in August 2014 we surveyed Clear Lake and Galveston Bay as a component of a field school taught in conjunction with Nautilus World.

Galveston Field Camp

During the 2014 UH Geophysics Field Camp in Galveston, we inaugurated our sub-bottom profiler (chirp system). We combined it on the research vessel Milan, with the bathymetry and side-scan sonar under the guidance of new UH geophysics professor, Dr. Will Sager. A side-scan sonar image, acquired while passing under the Pelican Island Causeway, shows the bridge's footings (***Figure 2***). We delivered the program via a collegial partnership with staff and facilities at Texas A&M University in Galveston.

Haiti Expedition 2014

In July of 2014 a team from UH used the sub-bottom profiler to acquire 100 km of high-resolution lines in Haiti (***Figure 3***).

With leadership from UH's Dr. Paul Mann, we surveyed over the 130 km^2 brackish Lake Azuei and 15 km^2 fresh-water Lake Mirogoane that both straddle the active trace of the Enquillo-Plantain Garden fault zone. Faults on or near this plate boundary region gave rise to the devastating 2010 earthquake. An example of the chirp data (***Figure 4***) show a bathymetric anomaly associated with the fault.

Figure 3: UH team attaching the sub-bottom sonar (chirp) to a lake vessel in Haiti in July 2014.

Wavelets continued on page 29.

Wavelets continued from page 28.

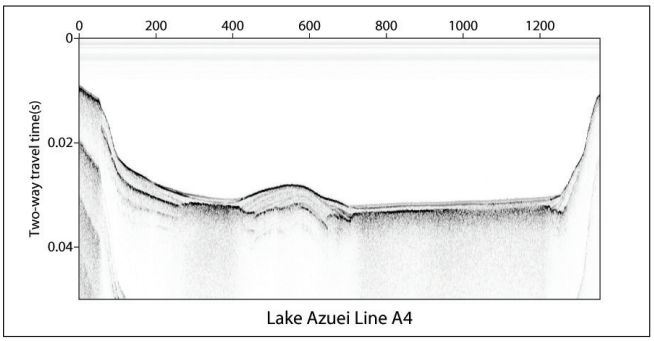

Figure 4: An example of the chirp data show an active anticline that is deforming Holocene lake sediments in Lake Azuei along with active strands of the Enriquillo fault zone.

Nautilus Industry Course

Closer to home, AGL has partnered with a major geoscience education provider (Nautilus World) to deliver seismic acquisition training for industry professionals. This five-day school was dedicated to giving hands-on experience in various land and marine seismic exploration techniques. Students from a range of countries including Ireland, Germany, Ghana, and UAE thrived in the program and managed to survive the Gulf Coast's August humidity. A highlight of the course was conducting sonar (***Figure 5***) and seismic lines from Clear Lake to Galveston Bay - past the restaurants of Kemah.

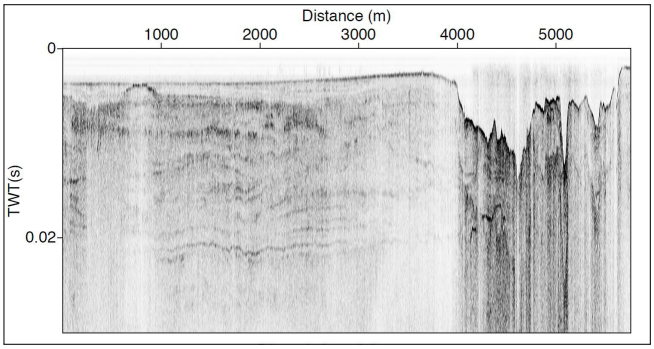

Figure 5: Sub-bottom sonar image from a Clear Lake transect. The two-way time of events (0.02s) indicates subsurface depths of up to about 15m.

We rigged one of the local boats with arms to support the sonar and seismic sources (***Figure 6***), as well as two hydrophone streamers.

The boomer was fired every second and produced reflections down to about 100 ms, or about 75 m below the lake bottom (***Figure 7***). We look forward to further processing and interpreting all of these new data!

Summary

UH and the Allied Geophysical Lab are expanding our geophysical capabilities to include marine surveying.

Figure 6: The boomer seismic source rigged from the side of a "Party Boat" out of South Shore Harbor near Kemah. Streamers (hydrophone cables) were attached on arms from the vessel's stern.

This is both for research and educational purposes. UH currently has a very large undergraduate geophysics cohort (some 130 students) and a similar number of graduate students. To our knowledge, this makes it the largest university geophysics program in the world outside of China. Via marine surveying (and other initiatives), we are looking to keep our program vibrant and useful to students, in both industry and the university. In addition, by having our own acquisition systems, we can undertake research projects to advance marine analysis and coastal understanding.

Acknowledgements

A special thanks to Li Chang and Ady Geda from the Allied Geophysical Laboratories for their assistance in all facets of our geophysical surveying. We appreciate the staff at Texas A&M University, Galveston; Haiti Bureau of Mines and Energy; South Shore Harbor, League City; and Nautilus World for their generous help with logistics.

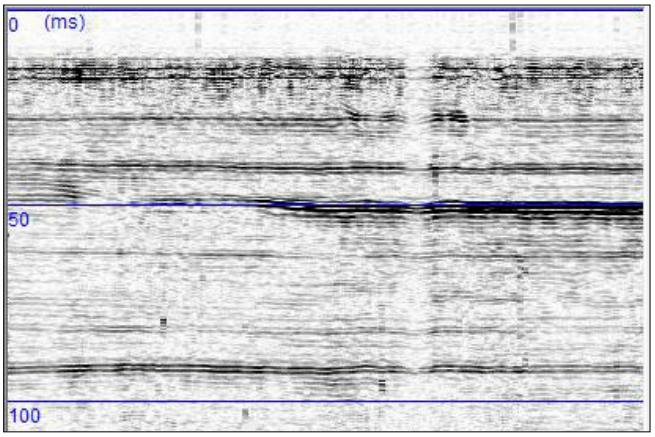

Figure 7: Raw boomer seismic data from the Clear Lake transect. We can see reflections down to 100 ms (about 75 m).