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Reconnaissance Marine Geophysical Survey for the Shallow Water Acoustics Program

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LONG-TERM GOALS

Provide geophysical and geological environmental characterization in support of Office of Naval Research shallow water acoustics experiments.

OBJECTIVES

Conduct a reconnaissance survey and offshore Panama City, Florida, in advance of the ONR shallow water acoustics reverberation experiment to be conducted there in 2013. Data collection will include CHIRP subbottom reflection and vibracoring.

APPROACH

The outer New Jersey shelf has, over the past 25+ years, evolved into a premier natural laboratory for Office of Naval Research efforts to understand the geology and the acoustic response of the seabed in shallow water environments. In great measure because of the large body of seabed information that exists in this region, the SWA06 program chose this locale for a combined low and mid frequency acoustics experiment, which was completed during summer, 2006. The SWA program sought to utilize these prior data related to the geology, geophysics and geoacoustics of the seabed, as well as new CHIRP reflection data collected in 2006 and coring samples collected in 2007, to establish an *a priori* structural/geoacoustic constraints of the seafloor and subsurface along the intended propagation pathways used in the experiment (Figure 1).

The successful integration of geological/geophysical/geoacoustic data into SW06 acoustic modeling efforts has led to recognition, expressed clearly at the recent SW06 workshop in Austin, that gathering such data should be considered an essential component of any forthcoming SWA experiment. Ideally, reconnaissance geophysical data will be collected well prior to the acoustic experiment in order to provide background data for planning purposes. During or after the experiment, additional data should be collected that directly supports the acoustic path geometries associated with the experiment.

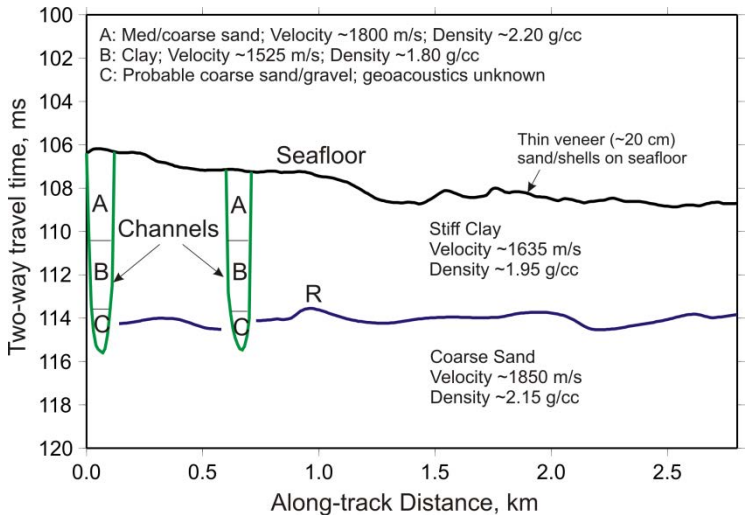

Figure 1. Cross section through New Jersey outer shelf geoacoustic stratigraphic model along propagation path utilized by George Frisk in his SW06 modeling work. Stratigraphic information is obtained from a 3-D interpolation of chirp-derived horizon interpretations. Geoacoustic information is derived from logged cores into the sedimentary units.

The ONR Ocean Acoustics program is planning a reverberation experiment offshore of Panama City, Florida, in 2013. Building on the New Jersey shelf work, my approach for this program is to collect reconnaissance CHIRP reflection data and sediment cores in 2011, analyze the data through 2012 to provide a basis for siting the reverberation experiment, and then follow up after the experiment with focused data collection at the locations eventually chosen for the experiment.

WORK COMPLETED

The reconnaissance CHIRP and coring survey was completed successfully in April, 2011 aboard the R/V Sharp (Fig. 2). The CHIRP data have been processed for fish depth, heave and layback. The CRIRP data have been fully interpreted. The vibracores have been split, photographed and sampled at 10-cm intervals for grain size analysis, which has also been completed.

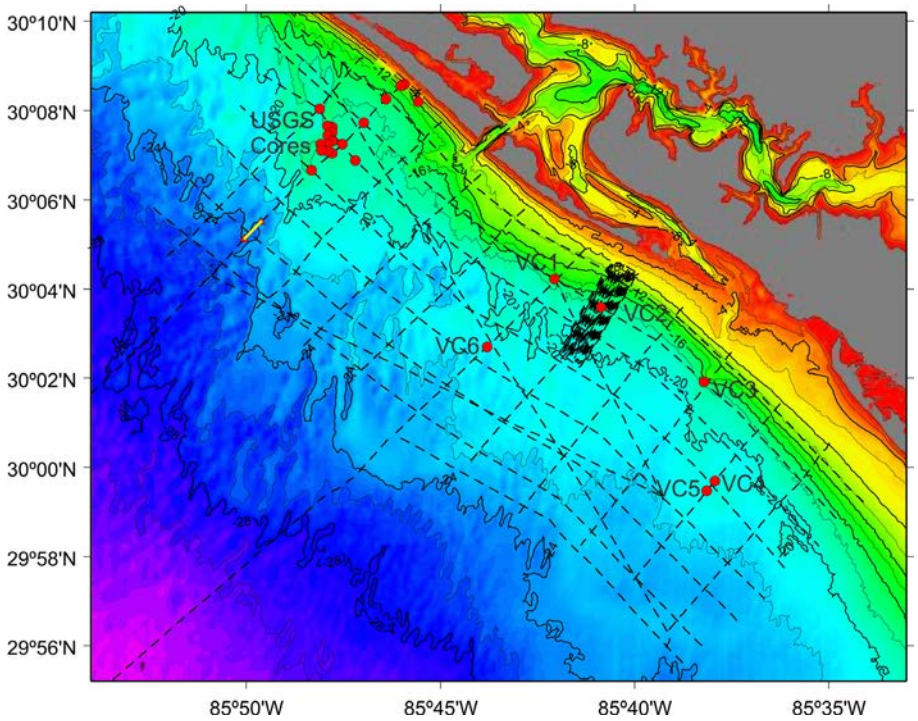

Figure 2. April, 2011 CHIRP track lines (dashed) overlain on regional bathymetry map offshore Panama City, Florida and St. Andrews Bay. April, 2011 vibracores (VC1-6) locations are also shown, as are prior cores collected by the USGS in the NW sector of the survey area

RESULTS

One of the cruise objectives was to locate a region of at least 3 m of sand for the acoustic experiment. A quick analysis of the regional grid survey on board lead us to locate vibracores VC1, VC2 and VC3 (Fig. 1) in spots that were likely thick sand targets. Core VC2 was our best penetration at 3 full meters of sandy sediment. Subsequently, we conducted a half day survey of densely-spaced track lines in the vicinity of VC2 (Figure 3). The results presented here are focused that region.

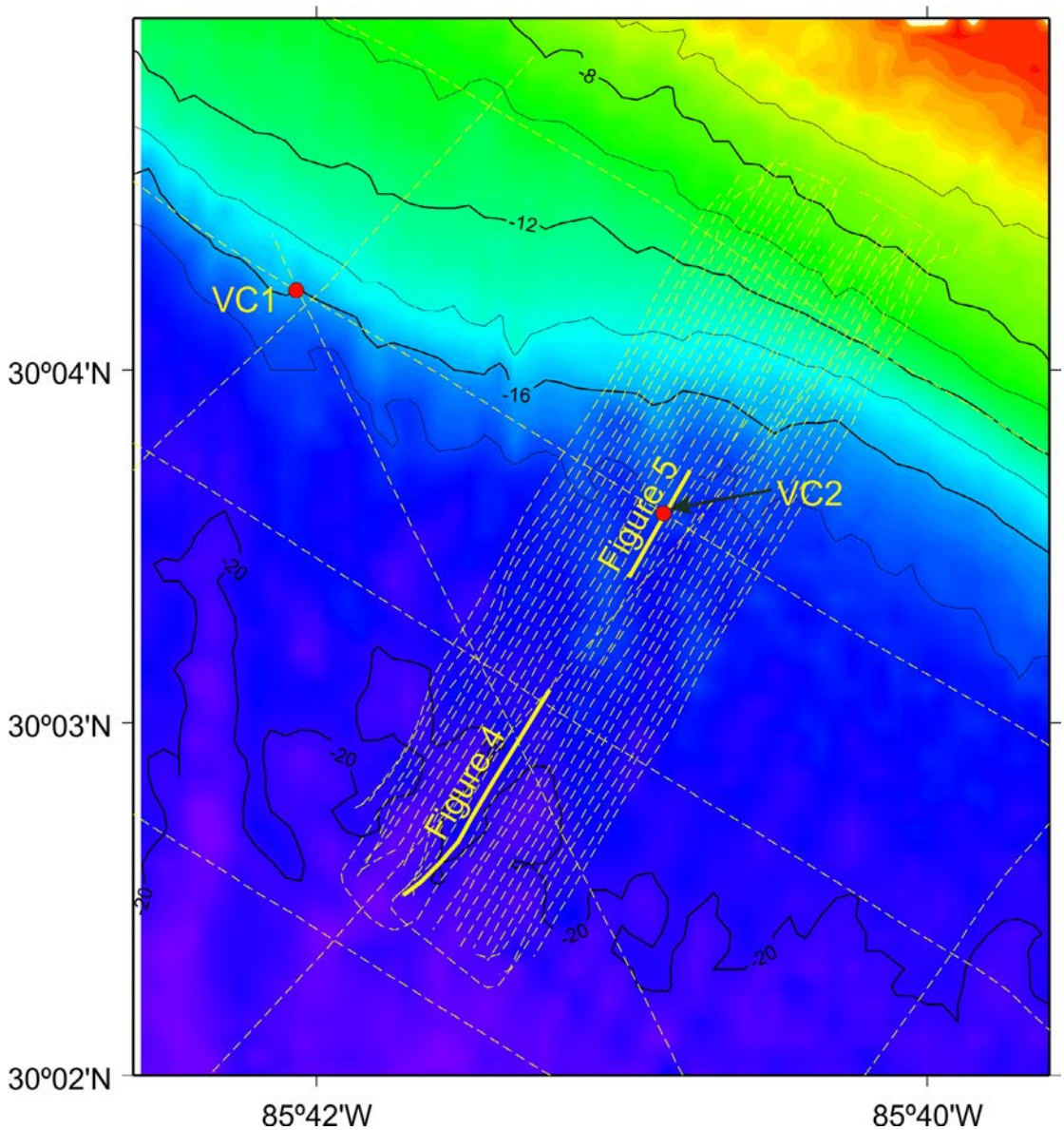

Figure 3. Densely-spaced (~50-m separation) chirp track lines (yellow dashed) in the vicinity of vibracore VC2. Locations of segments displayed in Figures 4 and 5 are identified. Bathymetric contours in meters.

Figure 4 displays a CHIRP data line that demonstrates the primary stratigraphic elements of the region. The deeper strata on the left side of the image consist of what I interpret as a buried river or estuarine channel that has been filled by layered estuarine sediments. These strata are capped by a reflector that I interpret as the base of the sand sheet (see discussion of core VC2 below). The "Sand Base" reflector is only intermittently present, best expressed where buried channels/estuarine strata are present beneath it, but must be inferred in other areas between buried channels. Above the "Sand Base" is a shallow reflector that is also very intermittently in evidence, but can be recognized as the base of the sand ridges as it commonly outcrops at the low point of swales between the ridges.

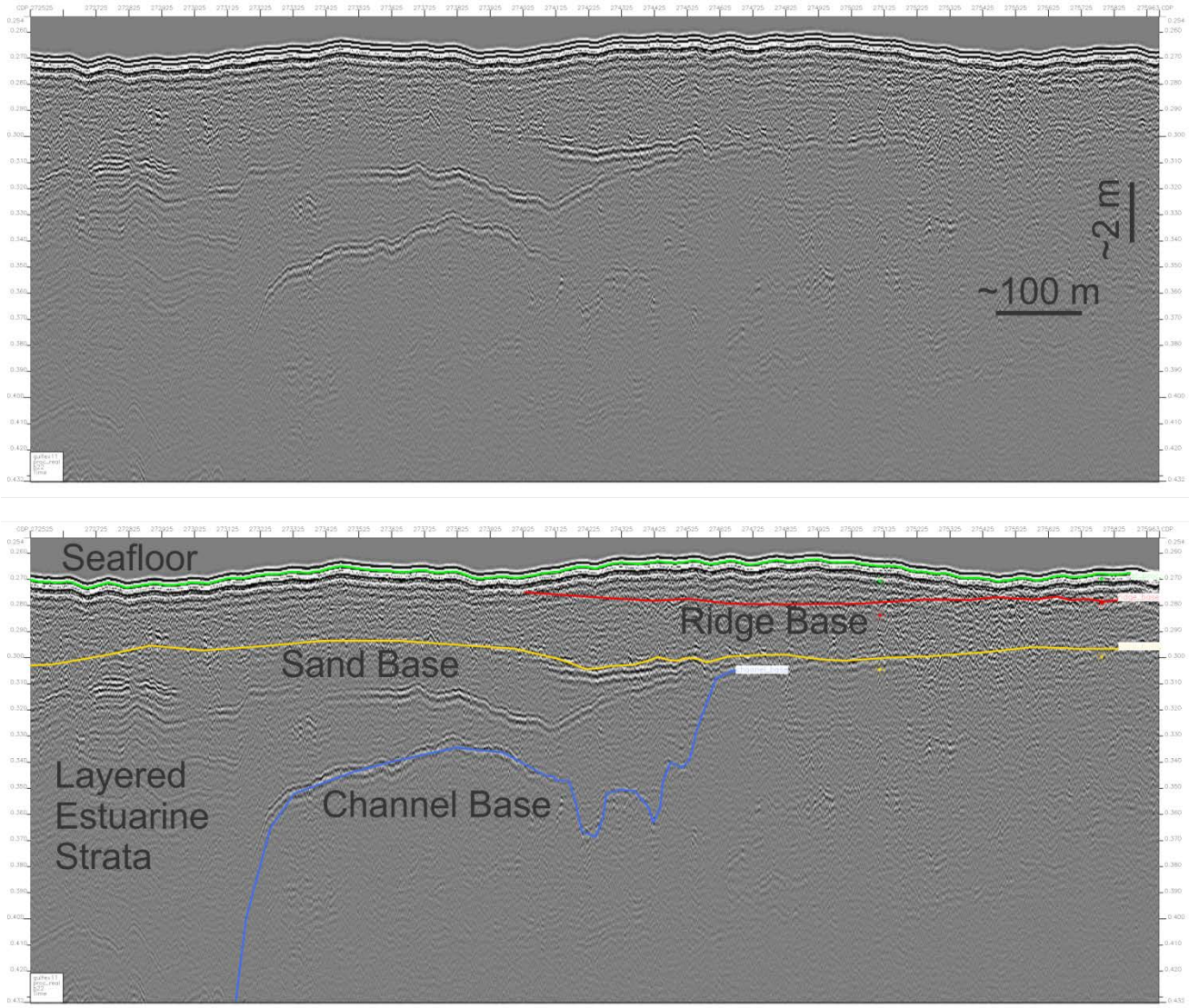

Figure 4. Uninterpreted (top) and interpreted (bottom) CHIRP section demonstrating primary stratigraphic elements of the shallow subsurface. Location shown in Figure 3.

Figure 5 displays a CHIRP data line that intersects the location of core VC2. Here the “Channel Base” horizon is much shallower, indicating tributaries rather than main channels. The “Sand Base” reflector is not observed, but is inferred based on continuity with the reflector where it is visible (as in Figure 4), and by truncation at the tops of the Channel Bse reflector. On the other hand, the “Ridge Base” reflector is clearly evident at the VC2 site, outcropping to the left in the swale adjecent to the sand ridge. At 3 m of penetration, core VC2 penetrated the “Ridge Base” reflector, but did not quite reach the “Sand Base” horizon.

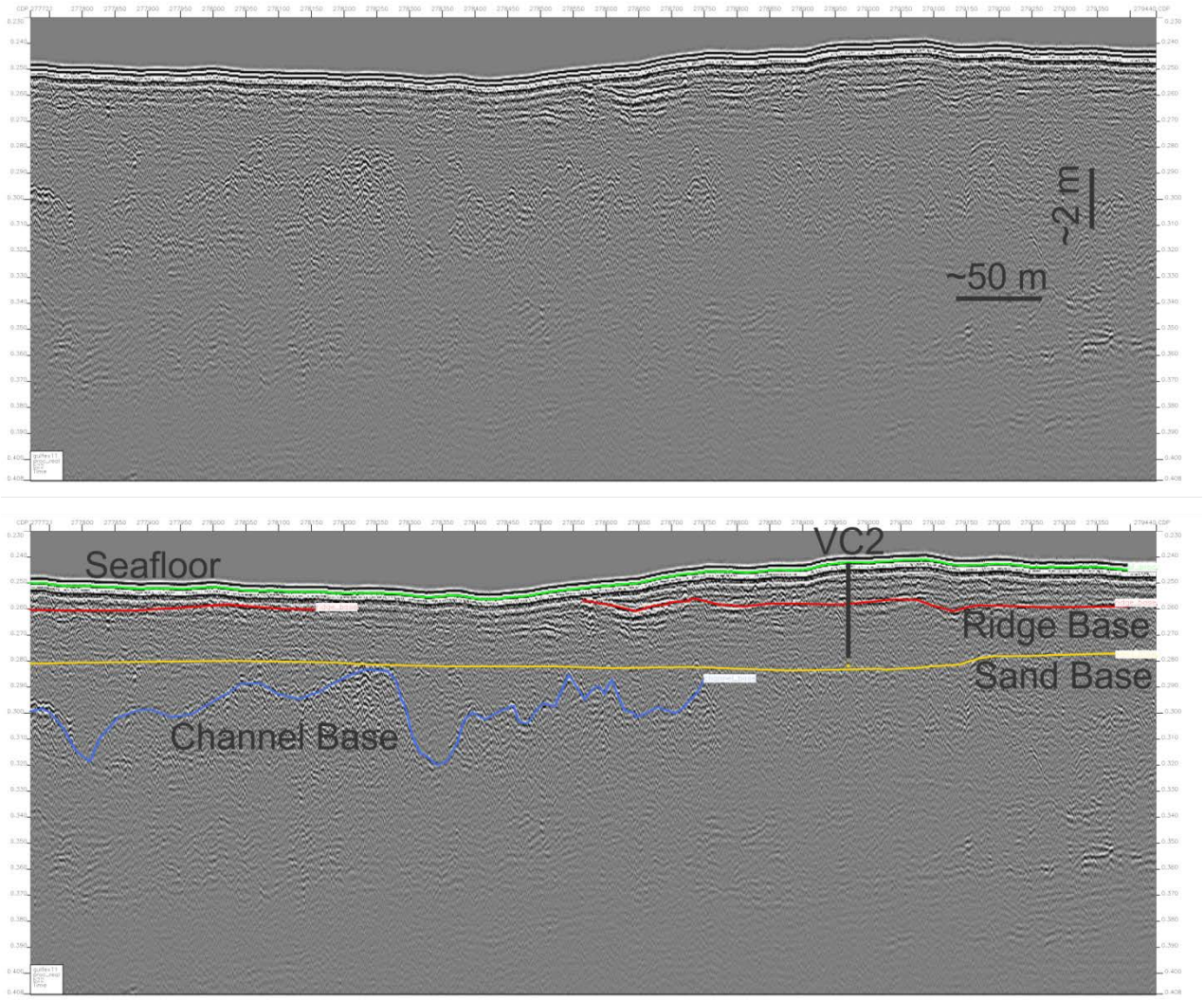

Figure 5. Uninterpreted (top) and interpreted (bottom) CHIRP section demonstrating primary stratigraphic elements of the shallow subsurface in the vicinity of core VC2. The depth of penetration of VC2 is indicated by the vertical black line on the bottom panel.

Figure 6 displays composite photographs of the split core VC2. A ~0.5-m shelly unit separates two zones of medium-to-coarse sand. The top of the shelly unit, at ~1.1-1.2 mbsf, correlates to the "Ridge Base" reflector. The upper sandy unit is well winnowed of fine material, and contains more shell hash. The lower sandy unit contains a greater fraction of fine grains (up to 10% in some samples), has less shell hash, but does contain some woody debris. I interpret the shell layer as the transgressive ravinement surface separating barrier sands below from marine sands above. Barrier sands are deposited atop estuarine sediments by the transgression of the shoreface. Assuming this interpretation is correct, what is somewhat remarkable at this location is the widespread preservation of barrier sands. For example, just NW of this site, in the vicinity of the USGS cores (Fig. 1), there is no distinction between the Ridge Base and Sand Base: the base of the sand ridges lies at the top of the buried channels and, hence, barrier sands were not preserved after transgressive ravinement. Likewise, our investigations on the NJ shelf indicated that barrier sands could only have been preserved in the buried river channels, if at all.

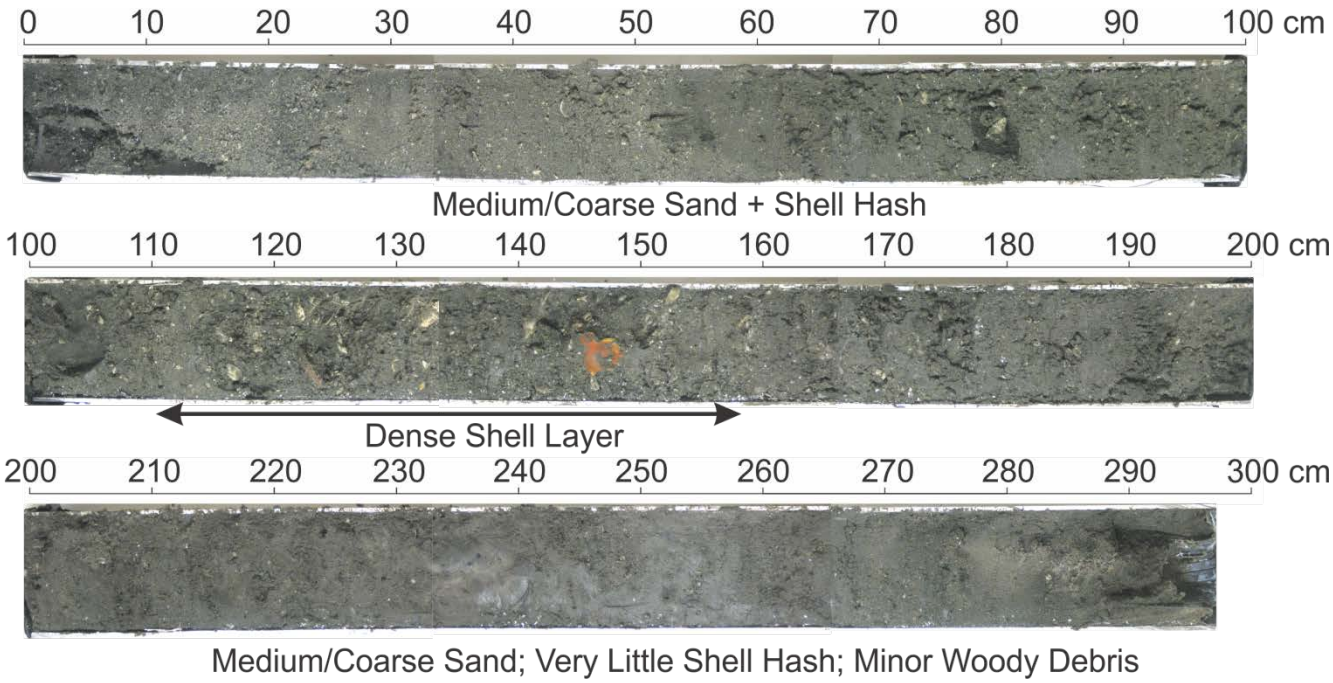

Figure 6. Composite photograph of split core VC2.

Figure 7 displays structure maps for the three reflectors identified above within the focus survey area, and Figure 8 displays the same for the full survey area. The Ridge Base is limited by the pattern of oblique sand ridges in the region. The Sand Base reflector is uniformally present beneath the seafloor although, again, much of this is inferred by the limits of the tops of the channels. The landward limit of the horizon is likely a detection issue as it gets buried by the shoreface sands. The "Channel Base" horizon displays a clear fluvial character among the smaller, tributary channels. The larger channel to the south of the survey box was only partially sampled, but shows some evidence of strong meandering of the channel thalweg.

Figure 9 shows an enlargement of the Channel Base horizon with speculative interpretation for the pathways of the buried river channels.

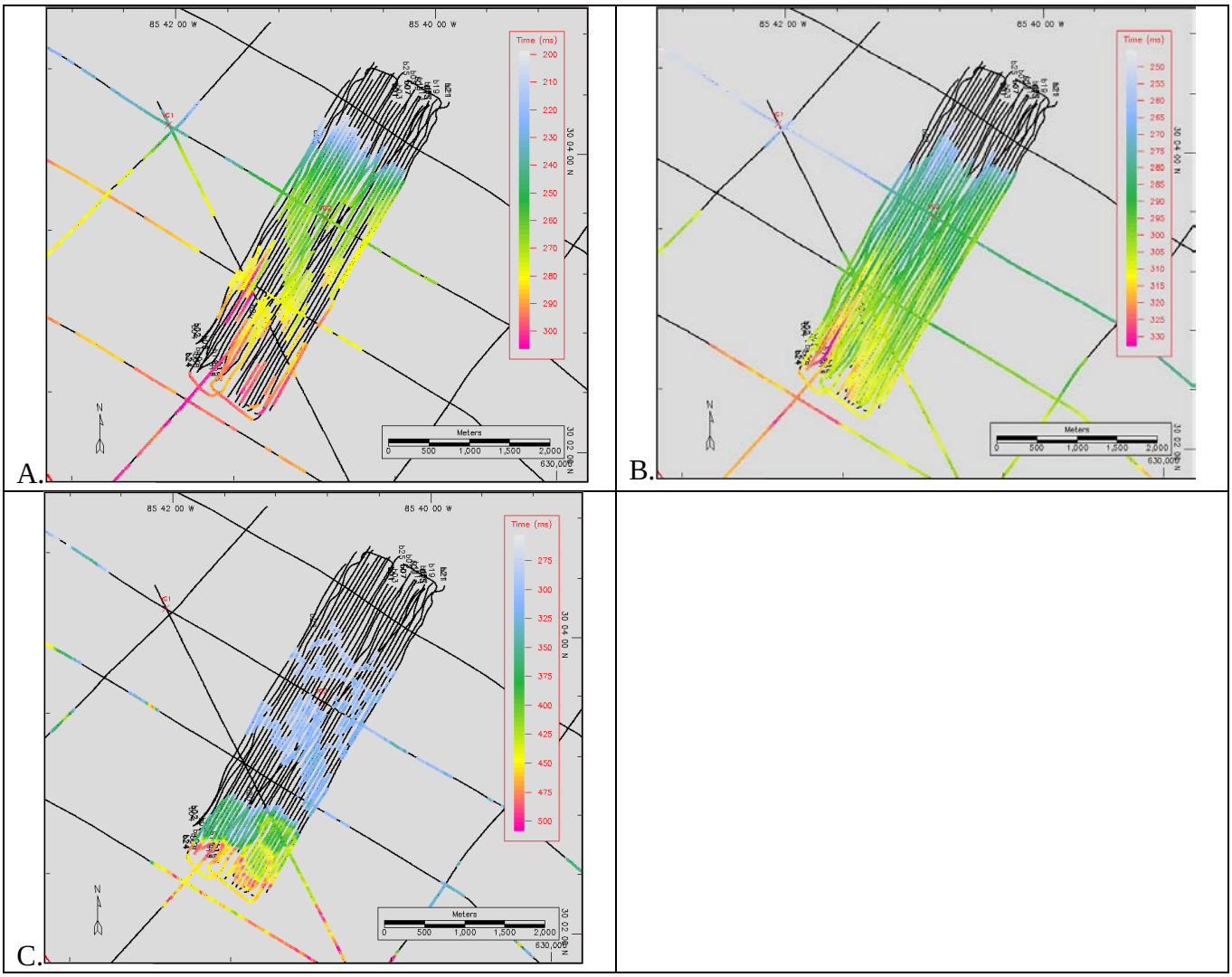

Figure 7. Structure maps within the focus survey area for the three primary reflections identified in Figure 4: (A) Ridge Base, (B) Sand Base, and (C) Channel Base. Note fluvial patterns in Channel Base reflector.

IMPACT/APPLICATIONS

The results of this work will be instrumental first in choosing a location for the TREX13 ONR shallow water acoustic reverberation experiment, and secondly for applications of acoustic modeling efforts to the experimental data.

RELATED PROJECTS

This work is closely related to the ONR Shallow Water ’06 program, where geological and geophysical site characterization were utilized in numerous efforts to model results of various acoustic experiments.

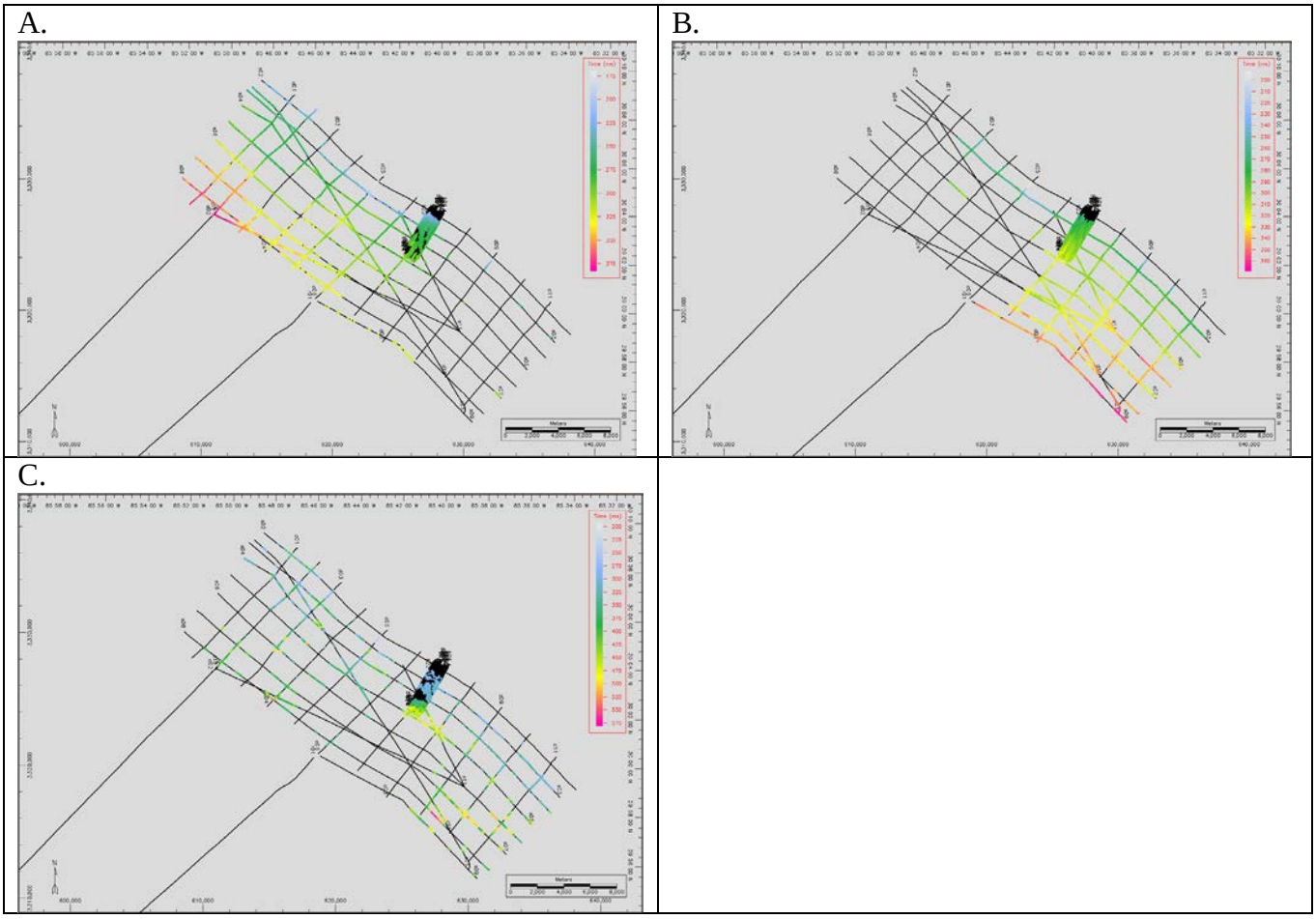

Figure 8. Structure maps over the full survey area for the three primary reflections identified in Figure 4: (A) Ridge Base, (B) Sand Base, and (C) Channel Base.

Figure 9: Channel Base structure map with speculative rendering of buried river channel pathways (dashed lines).