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IODP EXPEDITION 308: GULF OF MEXICO HYDROGEOLOGY SITE U1320 SUMMARY

Hole U1320A Latitude: 27º18.0809'N, Longitude: 94º23.2537'W
Hole U1320B Latitude: 27º18.0900'N, Longitude: 94º23.2514'W
Water depth: 1468.6 m

IODP Site U1320 is located near the center of Brazos Trinity Basin IV. The primary drilling objective at this site was to establish a reference section to determine the rock and fluid properties in a normally pressured basin. Secondary objectives included improving the age model for Brazos-Trinity Basin IV, and studying turbidite deposits. To achieve these objectives, Hole U1320A was continuously cored from the sea floor to a terminal depth of 299.6 mbsf. A MWD/LWD dedicated second hole (Hole U1320B) was then drilled to a terminal depth of 320 mbsf.

The lower part of the sedimentary succession pre-dating the younger basin fill is termed Lithostratigraphic Unit V in Hole U1320A. This sedimentary sequence is dominated by clay, with rare silt laminae often containing fragments of foraminifera. Most of the succession is intensely bioturbated. We interpreted Lithostratigraphic Unit V to represent hemipelagic sedimentation with a high influx of siliciclastic material, derived from either river plumes and/or very low density turbidity currents. Above Lithostratigraphic Unit V, Lithostratigraphic Unit IV is dominated by clay and represents the initial pulse of turbidite influx into the Brazos-Trinity Basin IV. Lithostratigraphic Unit III consists of a foraminifera-bearing, light-greenish gray clay that contains a volcanic ash layer (Y8), the product of the Los Chocoyos (Guatemala) eruption dated at 84 ka. Lithostratigraphic Unit II represents the main phase of basin filling and is defined by a 135-m thick succession of both sandy and muddy turbidites, and muddy slump/debris-flow deposits. The youngest Lithostratigraphic Unit I consists of a thin veneer of Holocene hemipelagic sediments. The overall basin fill succession shows a general upward increase in proportion of sand and thickness of turbidite packages. The cause of this increase is interpreted to result from: 1) lowering of sea level, and 2) progressive infill of the intra-slope basins upslope, favoring the bypass of sediment to Brazos-Trinity Basin IV.

Site U1320 yielded rare to abundant assemblages of calcareous microfossils spanning the late Pleistocene to Holocene, in Marine Oxygen Isotope Stages (MIS) 1 to 6. Tropical to subtropical species dominate the interglacial assemblages, whereas cool temperate species are more common in assemblages from glacial intervals. Intervals deposited during MIS 5 show no reworked nannofossils, indicating a quiet, open marine environment during sea level highstands. Frequent small, thin shelled benthic species of *Bolivina* and *Bulimina* are found in the lower part of Hole U1320A, suggesting that low-oxygen, nutrient-rich bottom conditions prevailed during MIS 6 in Brazos-Trinity Basin IV. Several tie points in magnetic susceptibility and NRM intensity could be correlated with MIS 3.1 to 5.5 for the upper onlapping basin fill, and contributed to the age model for Site U1320.

Results of physical properties analysis at Site U1320 suggest that progressive compaction and fluid expulsion were the main factors influencing the physical characteristics of the sediments. Lithostratigraphic Unit II is characterized by considerable scatter in porosity values (ranging from 36% to 71%). This is interpreted as variations in lithofacies, in particular the presence or absence of sandy intervals. At the bottom of Lithostratigraphic Unit III and top of Lithostratigraphic Unit IV (143 mbsf), porosities begin to increase rapidly

(maxima of 61%). Lithostratigraphic Unit V is characterized by a gradual decline in porosity with depth, reaching ~50% by ~299 mbsf. This porosity decrease is accompanied by increasing thermal conductivity, magnetic susceptibility and resistivity. Bulk density increases with depth, from 1.4 g/cm^3 at the sea floor to 2.0 g/cm^3 at 273 mbsf. Grain density variations are small (between 2.6-2.8 g/cm^3). Thermal conductivity increases with depth (from 1.1 to 1.3 W/(m·K)).

Chemical porewater data at site U1320A suggest rapid anaerobic degradation of organic matter through sequential oxidation fronts within shallow depths, whereas chemical changes at deeper sections of the hole point to diagenetic processes and/or deep-seated fluid flow. Rapid change in interstitial water profiles occurs at shallow depths within the upper part of Lithostratigraphic Unit II (top 40 mbsf). The decrease in SO_4, from approximately ambient seawater concentrations of 24.4 mM to a minimum of 0.5 mM at 21.5 mbsf, coincides with a concomitant increase in alkalinity from 4.77 to a maximum of 15.99 mM at 20 mbsf. Mn concentrations also decrease downhole to a minimum of 1.37 mM at 34.5 mbsf. Salinity and Ca, Mg, K, Li and Sr decrease with depth up to 40 mbsf. In Lithostratigraphic Unit V, a significant increase in Ca and Sr corresponding with a decrease in Li concentration takes place. Ba has its maximum concentration between 120-180 mbsf (Lithostratigraphic Units III and IV).

The average TOC content (0.53%) is consistent with the concentrations observed in Hole U1319A and is estimated to be primarily derived from algal material (average C/N = 4.21). Trends in TIC, TOC, N, C/N, and H data clearly correlate with seismic reflector surfaces R10 and R20. The highest concentration of methane (57,714.2 ppm) is observed at 122 mbsf. C_1/C_2 ratios are very high, suggesting a biogenic origin for the methane. Downcore profiles suggest two probable sources of biogenic gas, including shallow *in situ* production and possibly some migration from depth. The calculated Sulfate-Methane Interface (SMI) depth is 22 mbsf. The inverse correlation between sulfate and methane gradients suggests local methanogenesis; however, the low microbial biomass (1 x 10^6 cells ml^{-1}) cannot support the production of large amounts of methane.

Two deployments of the T2P probe were completed at Hole 1320A. The first deployment was at 126.3 mbsf (below Core 15X) and the second deployment was at 213.0 mbsf (below Core 24X). Both deployments used the tapered needle probe. The first deployment was completed with the drill bit ~1m from the bottom of the hole, and used the drill string to push the T2P into the formation. The deployment resulted in a slight bend to the needle probe and the pressure transducer on the shaft did not record data. However, pressure was recorded at the tip transducer. The second deployment was also completed with the drill bit 1 m above the bottom of the hole, but instead of using the pressure of the drill string, the tool string weight was used to insert the probe into the formation. All transducers performed well and the T2P was retrieved without damage. Both deployments recorded pressures that were slightly below hydrostatic. The temperature gradient between the two deployments based on recorded temperatures was 20 degrees C/km.

Logging operations showed that from seafloor to 177 mbsf, porosity, resistivity, and gamma ray logs clearly delineate series of interbedded sand and mud facies that correspond to Lithostratigraphic Unit II. Porosity decreases with depth from 87 % to ~45% at a total depth of 297 mbsf indicating compaction and potential fluid expulsion throughout the entire drilled interval. LWD resistivity images of the borehole show apparent breakouts at the bottom of the hole with an E-W orientation. These breakouts indicate a N-S maximum stress direction that could be attributed to high input of siliciclastic material derived from river plumes, turbidity currents, and/or slump deposits from the basin flanks.

All primary and secondary drilling objectives were accomplished at Site U1320. Drilling results, together with those from Site U1319, provided key information on the space-time evolution of sedimentary and geochemical systems at Brazos Trinity Basin IV, and on the range of variation for index physical properties in a normally pressured basin. We have also demonstrated the viability of the T2P probe deployments and acquired in-situ data on formation pressure and temperature.