June 20, 2005

IODP EXPEDITION 308: GULF OF MEXICO HYDROGEOLOGY
SITE U1319 SUMMARY

Hole U1319A Latitude: 27º 15.9751'N, Longitude: 94º 24.1908'W
Hole U1319B Latitude: 27º 15.9857'N, Longitude: 94º 24.1908'W
Water depth: 1430.6 m

IODP Site U1319 is located on the southern flank of Brazos Trinity Basin IV. The primary 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 establishing an age model for Brazos-Trinity Basin IV and studying turbidite deposits. To achieve these objectives, Hole U1319A was continuously cored from the sea floor to a terminal depth of 157.5 mbsf. A MWD/LWD dedicated hole (Hole U1319B) was then drilled to a terminal depth of 180 mbsf.

Site U1319 is located at the edge of the basin. As a result, the turbidite succession is condensed relative to that at the basin center. Nevertheless, a detailed record of turbidite deposition is present, which can be correlated to the basin center. Six lithostratigraphic units were recognized: Unit I (Holocene drape), Unit II (turbidites and debris flows), Unit III (hemipelagic sediments), Unit IV (distal turbidites), Unit V (hemipelagic sediments), and Unit VI (very distal turbidites mixed with hemipelagic sediments). Unit 5 was deposited prior to the formation of the Brazos Trinity IV basin and all overlying sediments were deposited within it. Ash layer Y8, a regional stratigraphic marker dated at 84 ka, was recovered in Unit III. Hemipelagic units I and V are interpreted to have been deposited during eustatic high stands at the present and at 125 ka, respectively.

Rare to abundant assemblages of well preserved microfossils, spanning the late Pleistocene to Holocene period (marine oxygen isotope stages 1 to 6), were recovered. Tropical to subtropical species dominate the interglacial assemblages, whereas cool-temperate species are more common in assemblages from glacial intervals. The absence of reworked Cretaceous to Neogene nannofossils in the lower part of Hole 1319A (Units III and V) points to quiet, open marine environments. Moderately abundant benthic foraminifera in the upper ~30 m of the hole indicate a low-oxygen, high-nutrient environment.

Bulk density, measured both on the MST track and on discreet samples, increases with depth from approximately 1.3 to 2.0 g/cc, reflecting compaction. Core resistivity, derived from the multi-sensor track (MST), increases with depth to approximately 60 mbsf and thereafter remains constant. Undrained shear strength data show a general increase with depth as a result of increasing vertical effective stress and sediment consolidation. The trend is relatively smooth from the seafloor to about 80 mbsf; beneath 80 mbsf there is a sharp increase in undrained shear strengh. The maximum peak strength recorded was 89 KPa. Ratios between the peak and undrained shear strengths show that the clays encountered at Site U1319 have a low sensitivity.

Interstitial water chemistry shows large variations in alkalinity from 2.95 to 19.45 mM, with a downhole concave profile and a rapid increase to its maximum at 15 mbsf. The pH shows a similar concave depth profile, but with a maximum at ~30 mbsf. Sulfate concentrations in interstitial water show rapid downhole depletion with a sulfate-methane interface at 15 mbsf. The ionic concentrations of dissolved Mn show a similar depletion trend to the sulfate

concentration, whereas dissolved Ba, B and Si show a concave downward profile similar to the alkalinity and pH. The sharp porewater chemistry changes at shallow sub-seafloor depths suggest rapid anaerobic degradation of organic matter through sequential redox reactions within the first 15 m.

Average total organic carbon content is relatively low for Gulf of Mexico sediments (0.75%), but these values are consistent with the relatively low microbial biomass encountered (the maximum cell density observed was 1 x 10^6 cells ml^{-1}). Inorganic carbon concentration is highly variable throughout the hole, ranging from 0.87 to 4.08% (10.44 to 48.96% $CaCO_3$). The average C/N ratio in the sediment was 3.77, suggesting either that algal material is the predominant source of organic matter, or that the presence of inorganic nitrogen (such as ammonia) artificially lowers C/N ratios. The C/N maximum of 5.92 is coincident with the bottom of the sulfate reduction zone. The lack of any pentane (C2) in headspace samples suggests that the relatively large quantities (up to 11,310 ppm) of methane detected are of biogenic, not thermogenic origin.

Two deployments of the T2P (temperature two pressure) probe were completed at Hole U1319A. The first deployment was at 1388 mbsl (41.6 m above sea floor), and provided a successful pressure test that demonstrated that the tool could successfully pass through the lockable flapper valve (LFV) of the bottom hole assembly (BHA). Measured fluid pressure (13.76 MPa) was slightly below hydrostatic (13.94 MPa), and the recorded water temperature was 4.9^{0}C. A second T2P deployment at 80.5 mbsf recorded 1 m of penetration into the sediment. After 30 minutes, the tip pressure was at 15.49 MPa and the shaft pressure at 15.95 MPA; hydrostatic pressure was 15.19 MPa, and Formation temperature was 7.3^{0}C. Because of the non-vertical penetration of the T2P into the sediment, the tip of the tool was bent.

LWD/MWD operations were completed in Hole U1319B to 180 mbsf with data coverage by all LWD/MWD tools over the interval cored in Hole U1319A (0-157.5 mbsf). From the seafloor to 180 mbsf, the following trends were observed: gamma ray increased from 45 to 75 API, deep button resistivity increased from 0.6 to 1.8 ohm-m, porosity decreased from 75 to 50%, and bulk density increased from 1.4 to 2.0 g/cm^3. These data suggest a normal compaction trend in the clay-rich section of U1319. Deviations from this trend occur at 25 mbsf, where the gamma ray shows a step decrease (top of Unit III, foraminifera-rich clay), from 30.5-31.5 mbsf where gamma ray increased (onset of fine lamina of sand, Unit IV), and from 78-93 mbsf where bulk density decreased (consistent with physical properties observed in the cores).

Drilling objectives at Site U1319 were fully accomplished. The almost continuous coring, lithostratigraphic, biostratigraphic and logging record make Site U1319 an important reference location for the study of sediment compaction. We were struck by the stiffness of the deeper hemipelagic sediments and we look forward to comparing these properties with mudstones of the Ursa Basin. The low thermal gradient (~20 deg/km) was also striking. Finally, the ability to detect individual units within the first 30 mbsf allowed us to date and describe these turbidite deposits.