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Overpressure generation, temperatures and fluid flow in rapidly deposited Quaternary sediments: Ursa Basin, Gulf of Mexico

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Integrated Ocean Drilling Program (IODP) Expedition 308 was dedicated to the study of overpressure and fluid flow on the Gulf of Mexico continental slope. In the Ursa Basin Expedition 308 tested a flow model by examining how physical properties, pressure temperature, and pore fluid composition vary within low-permeability mudstones that overlie a permeable and overpressured aquifer. Penetrometer measurements, made at two sites, define the spatial variation in pressure and temperature in low permeability mudstones in the shallow sedimentary section. Sites U1322 and U1324 were located $\sim$10 km apart on an E-W transect traversing a clastic sediment prism of Quaternary age, and were drilled to 234 and 608 meters below seafloor, respectively. ? (fluid overpressure divided by hydrostatic effective stress) is approximately 0.6 in both locations (i.e. the pore pressure lies 60% of the way between hydrostatic and lithostatic). The overpressured section may begin at a shallower depth at Site U1322 than at Site U1324. The temperature gradients are linear, but is 25% greater at Site U1322 than at Site U1324. Thermal conductivities at the two locations are similar ($\sim$1.2 vs 1.15 W/m·K), implying a vertical conductive heat flow of $\sim$22 mW/m^2 at Site U1324 vs $\sim$30 mW/m^2 at Site U1322. Sedimentation is considerably faster at Site U1324 than at Site U1322 (10 vs. 3.8 mm/y). The similar overpressure gradients present at both sites in spite of the almost 3-fold difference in sedimentation rate imply a component of lateral flow between them: this flow increases the pressure at Site U1322 relative to a system with only vertical fluid migration. In the Blue Unit, composed of interbedded sheet sands and mudstones and underlying the Ursa mudstones, fluid overpressures

generated by rapid loading at Site U1322 may be partially dissipated by efficient lateral fluid migration. This provides an additional explanation for the elevated temperature gradient at Site U1322. Viewed on a basin scale, this pattern of lateral fluid flow may be the prime locator for cold seaps, mud volcanoes, and a trigger for repeated submarine landslides generating major mass transport deposits within the past 50000 years.