Temporal Scales of Mass Transport on the Mississippi River Delta Front, from Results of a New Regional Survey

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Abstract

The Mississippi River Delta Front (MRDF) is an apron of rapidly depositing and weakly consolidated sediment extending from the subaerial portions of the Birdsfoot Delta of the Mississippi River. Over the past 40 years, the first geological survey of the MRDF was undertaken in 2017, led by LSU, BOEM, and USGS scientists. Twenty-eight piston cores collected seaward of distributaries of the Delta, up to 8.9 m in length, were analyzed (using a Geotek multi-sensor core logger) for resistivity, magnetic susceptibility, and density are compared with CHIRP subbottom seismic data. Additional analyses of sediment fabrics (X-radiography), radionuclide geochronology (210Pb, 137Cs) are ongoing and will help determine stratigraphic return period in sedimentary structures and the presence of deformation features associated with mass transport of sediment within mud gullies. Key morphological elements include (1) gullies, seafloor depressions in water depths of ~5-70 m transporting mudflows downslope, forming (2) positive relief mudflow lobes between ~50-200 m water depths, which evolve over poorly constrained temporal and spatial scales, varying in bedding distribution relative to gully proximity. Cores consist of sediments with weak bedding, majority clay to silt composition with variable organic material and infrequent bioturbation. Observed undulation and discontinuities in density profiles occurring 0.7-2.0 m into the seabed in gullies, are not present outside of the gullies. Recent work by our team demonstrated that undulations in density profiles correspond to flood deposits, preserved at seasonal scales. In addition, our team has identified short-term deposition rates of ~0.1 cm/day, and longer-term

sedimentation rates of 1.3-8 cm/yr within the upper ~2 m of the seabed, via radioisotope geochronology. However, bathymetric analysis has shown overall gully deepening of ~1 m/yr during the same time period. To elucidate, geochronological analysis of deeper cores is ongoing to gain a more detailed understanding of governing and attendant processes. If discontinuities in core density profiles represent the lower depth boundaries of mass-transport events, using our preliminary accretion rates we estimate a frequency of landslide events of a minimum return periods of ~9 years. Three temporal scales of seabed sedimentation are evident: seasonal deposition by river flood events and related storm/cold front reworking of annual flood deposits; rapid sediment slumping and annual-scale creep-like mass transport that produces bathymetric deepening (~1 m/y) in gullies, with detachment planes likely below 2 m in the seabed; deposition of mudflow deposits >0.7 m thick in gullies, over decadal timescales.