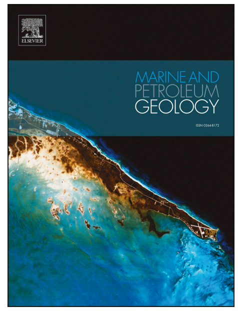

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EROSION AND PONDING OF THUNDER HORSE DEEPWATER TURBIDITES BY MASS TRANSPORT COMPLEXES IN MISSISSIPPI CANYON BASED ON IMAGE LOG SEDIMENTOLOGY

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ABSTRACT

Mass transport complexes are often associated with deepwater turbidite reservoirs, but typical subsurface data sets are of insufficient resolution or coverage to determine if and how the mass transport complexes have an impact on reservoir architecture. We present a case study of integrated, high resolution data (core, image logs, and seismic) from Thunder Horse, one of the largest deepwater oil and gas discoveries in the Gulf of Mexico, to illustrate how mass transport complexes can both compartmentalize and pond reservoirs. The key data type enabling these conclusions are image logs, which reveal erosive mass transport complexes whose emplacement removed the upper portion of one of the Thunder Horse sandstone reservoirs on the northwest side of the asset and resedimented the sand as multiple smaller compartments.

Stacked seafloor landslide deposits interbedded with turbidite sandstone reservoirs are herein characterized in detail from image logs at Thunder Horse, located in lower Mississippi Canyon. Dips from bedding boundaries on image logs in the sandstone reservoirs show little variation in structural tilt (< 20°), indicating continuous deposition by high density turbidity currents prior to major structural deformation, and are thus the best proxy for regional structural dip. In contrast, dips in 85% of all mudrocks in this area show widely varying dip magnitude and azimuth over small and large scales, and are interpreted as having been deposited by slumps, slides, and folds, building up to form mass transport complexes. Only very rarely (2% of strata) do we observe mudrock dips that are conformable to the regional dip and strike.

Unconformable bedding contacts at the tops of the sandstone reservoirs in northern Thunder Horse suggest scouring and erosion, whereas basal sandstone contacts are in conformance with overall structural dip, suggesting amalgamation. On seismic data, the mass transport complexes stack and mound together, forming a paleo-topographic high with at least 30 m of relief. Core acquired in this mudrock-dominated deposit reveals convoluted and folded bedding capped by 0.5 m of highly bioturbated marl that is interpreted as a *Glossifungites* hiatal surface. The implication is that the mass transport complexes formed a topographic obstacle that diverted subsequent debris and turbidite flows, and later created localized ponding and thickening of the overlying reservoir. Thus, mass transport complexes were found to both erode and augment sandstone reservoirs. Biostratigraphic dating of the two reservoirs brackets their deposition as occurring in <400,000 years during the Serravalian, Middle Miocene, probably as a result of the Harang shelf failure.

As a case study this type of integrated, high resolution data has wide applicability to other deepwater, sub-salt reservoirs, as improved structural and depositional interpretations inform reservoir performance and impact future well plans. Further, recognition of mass transport complexes as agents of reservoir compartmentalization and sandstone ponding allow for more accurate reserve estimation.

Keywords: image logs, turbidites, mass transport complexes, Gulf of Mexico, Middle Miocene, Mississippi Canyon