Testing sequence stratigraphic models through high-resolution 3D seismic imaging of Miocene foresets on the New Jersey shallow shelf, USA

MASOUD AALI[1], MLADEN NEDIMOVIC[1], GREGORY MOUNTAIN[2], GRAIG S. FULTHORPE[3], JAMES AUSTIN[3], BILL RICHARDS[1], AND NEIL WATSON[1]

1. Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4J1, Canada
2. Department of Earth and Planetary Sciences, Rutgers University, Piscataway, New Jersey 08854, USA
3. Jackson School of Geosciences, University of Texas at Austin, Austin, Texas 78712, USA

The New Jersey margin is considered a classic example of a rifted margin. Because of its stable tectonic history, smooth thermal subsidence, and consistent deltaic sediment loading since Miocene, it has become a pre-eminent area for investigating the effects of global sea-level change and very well studied for that purpose since 1988. This was done most intensively by IODP Expedition 313 in April-July 2009, where three boreholes continuously cored much of the Miocene section, collecting extensive data from multiple clinoform topsets, foresets, and toesets previously imaged on a 140 km shelf-to-slope 2D seismic line. Subsequent to Expedition 313, a high-resolution P-Cable 3D seismic survey (11 x 50 km) was acquired in 2015 (Research Cruise MGL1510).

In this paper, we present preliminary results from this 3D survey by integrating three interpretation approaches in a 3D geocellular model: quantitative geophysics (P-wave velocity, density, clay volume); attribute analysis (surface, interval and volume attributes); and seismic stratigraphy (depositional sequences interpreted using objective geometric criteria). The estimated clay volume consistently shows an inferred coarsening-upward signature in each progradational sequence. Attribute displays derived from reflection amplitude are hampered by small time shifts in the cross-line (margin parallel) direction at the edges of each sail line. These shifts may be related to uncertainty in streamer positioning. Nevertheless, the reflection amplitude attribute displays are effective in rendering polygonal fault systems formed in stressed hemipelagic sediments within the toes of clinoforms.

Approximately sixty surfaces and depositional units have been recognized and interpreted by loop-tying within the 3D seismic volume, enhancing the framework previously published using 2D data. Depositional units are characterized by bounding reflections and stratal terminations, and the relative position of forestepping, upstepping, backstepping, and downstepping parasequences enable the interpretation of systems tracts. The data set is currently being reprocessed with the goal of ameliorating the time shift problem.

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