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Unravelling the characteristics of siliciclastic margin successions using multivariate statistical analysis of petrophysical data: IODP Expedition 313

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Downhole geophysical measurements and images allow the characterization of the lithology and physical properties of subsurface successions, thus making a powerful contribution to the evaluation of facies and sediment composition and to the recognition of key intervals and surfaces in siliciclastic successions. The mission-specific IODP Expedition 313 (May-July 2009) cored and logged sequences deposited on the New Jersey continental margin during the post-Eocene ice-house world.

Three boreholes were drilled to a composite total of 2065 m; 5800 m of wireline logging data were collected in these holes, and a suite of petrophysical measurements was completed on the 1310 m of recovered core. Continuous through-pipe spectral gamma ray logs were acquired in each borehole with magnetic susceptibility, resistivity, sonic and acoustic image logs obtained in open hole at key intervals and/or where borehole conditions allowed.

Analysis shows lateral and vertical changes in the physical properties of the sediments that enable us to distinguish depositional intervals at several scales ([U+F06D]m – tens of meters) (see also Lofi et al., this congress). Multivariate statistical analysis (iterative non-hierarchical cluster analysis) of the logs provides an objective assessment of the location of both subtle and major changes within and between intervals. The characteristic petrophysical responses can be used to infer characteristics of the sediments and pore fluids, and also reflect the varying diagenesis of the sequences. Some of these intervals correlate with the depositional sequences predicted from seismic reflection profile analysis and several depositional units are also evident in the logs at a higher resolution; these units may reflect changes in sediment supply, depositional environments and post-depositional diagenesis. Medium to high resolution acoustic images of the borehole walls reveal sedimentary characteristics even within intervals of low core recovery. The calibration of these datasets with the excellent core recovery in key intervals of each borehole will aid interpretation in intervals with incomplete core recovery, thereby contributing to one of the Expedition 313 aims to evaluate sequence stratigraphic facies models that predict depositional environments, sediment compositions, and stratal geometries in response to sea-level change.