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Interpretation and significance of petrophysical boundaries in siliciclastic shelf margin successions: IODP Expedition 313

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Sedimentary successions on siliciclastic margins show heterogeneities at several scales ([U+F06D]m – tens of meters) that can be interpreted in terms of sequence stratigraphy (including depositional units, erosional surfaces, paleoenvironment), fluid content or diagenetic features. Such heterogeneities are often associated with changes in the physical properties of the sediment and can therefore be identified from downhole geophysical log responses, in borehole wall images and from core petrophysics measurements.

The mission-specific IODP Expedition 313 (May-July 2009) cored and logged three sites in New Jersey continental margin sediments. Continuous through-pipe spectral gamma ray logs were acquired in each borehole. Magnetic susceptibility, resistivity, sonic and acoustic image logs were obtained in open hole at key intervals and/or where borehole conditions allowed. A suite of petrophysical measurements (including density, magnetic susceptibility, resistivity, P-wave velocity and derived porosity) was also collected on the 1310 m of recovered core.

Preliminary interpretations of the above dataset allow identification of many surfaces and intervals less than a few m thick evidenced by a signal change in at least 3 petrophysical parameters (referred to here as petrophysical “events”). In this context, the objectives are to define their significance and to fit any characteristic petrophysical response to specific sedimentary heterogeneities (e.g. erosional surface, maximum flooding surface, lithological horizon, cemented horizon).

Here, we present a selection of key petrophysical events and, where cores have been recovered, we compare them to sedimentological data. Results show that these “events” often tie with sedimentological changes (diagenetic intervals are particularly well picked up) although in some cases no obvious correlation is observed. This suggests that the petrophysical approach may detect some subtle lithological or textural changes in the sedimentary succession. In a few cases, petrophysical events can be identified from logs where there is no recovered core, and understanding their significance is thus crucial.

Using the same data set, a multivariate statistical approach allows petrophysical intervals to be quantitatively distinguished (Inwood et al., this congress). Results from both approaches will be compared in order to apply the same principles to the study of siliciclastic margins elsewhere, in addition to contributing to our understanding of the key stratal surfaces on the New Jersey continental margin.