Bed-Scale Clay Distribution in Deep-Water Sandstones and the Implications for Reservoir Quality

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ABSTRACT

Detrital clay is considered a major factor driving flow behavior, bed-scale heterogeneity and reservoir quality in sediment gravity flow deposits. Quantifying and accounting for the details of the clay distribution at high-resolution vertically within single event beds and laterally towards bed pinch-outs remains a significant challenge. High-resolution XRF core scanners have been widely used to capture continuous compositional trends in shallow sediment cores and offer some promise with rock cores, although to date there has been only very limited use of this technology in the deeper subsurface. The Ross Sandstone Formation in western Ireland is a useful prototype succession to explore the value of elemental profiling in that it comprises a simple bimodal mix of dominantly quartz-rich sand and clay. Recent Statoil-funded behind-outcrop coring in the Ross has identified a wide range of bed types, including conventional turbidites, hybrid event beds (HEBs) and mass-transport deposits. The bed mix and character of the HEBs is similar to other systems including outboard Paleocene Wilcox sandstones in the Gulf of Mexico. Vertical XRF profiling of key bed types shows that Si and K are useful textural proxies for silt/sand grains and clay and/or mica respectively, and Ca for diagenetic overprinting. The elemental profiles have been calibrated using whole-rock ICP-AES on core plugs and the profiles have linked to high-resolution spectral gamma logs in the boreholes. The data give new insight into subtle but systematic vertical compositional trends that reflect differential settling of coarser quartz sand and silt in arresting suspensions and fluid muds, fractionation of micas, and textural interfaces reflecting internal shear and partitioning of the flows. Lateral trends are being addressed at basal Ross level where turbidites and outsized hybrid event beds can be traced up to 18 km obliquely down-dip. The profiling is revealing strong lateral textural fractionation of platy grains, organic particles, clay and micas. The elemental data has also helped identify vertical changes in sediment composition and sand input across the Ross Formation as whole; early sandstones are coarser grained, have lower gamma, lower K and higher Si than younger parts of the Ross confirming that the deep-water part of the succession comprises at least two distinct systems.