Diagenesis and reservoir quality evolution of palaeocene deep-water, marine sandstones, the Shetland-Faroes Basin, British continental shelf


Abstract

The Palaeocene, deep-water marine sandstones recovered from six wells in the Shetland-Faroes Basin represent lowstand, transgressive and highstand systems tract turbiditic sediments. Mineralogic, petrographic, and geochemical analyses of these siliciclastics are used to decipher and discuss the diagenetic alterations and subsequent reservoir quality evolution. The Middle-Upper Palaeocene sandstones (subarkoses to arkoses) from the Shetland-Faroes Basin, British continental shelf are submarine turbiditic deposits that are cemented predominantly by carbonates, quartz and clay minerals. Carbonate cements (intergranular and grain replacive calcite, siderite, ferroan dolomite and ankerite) are of eogenetic and mesogenetic origins. The eogenetic alterations have been mediated by marine, meteoric and mixed marine/meteoric porewaters and resulted mainly in the precipitation of calcite ($\delta^{18}O_{V-PDB}=-10.9\%$ and $-3.8\%$), trace amounts of non-ferroan dolomite, siderite ($\delta^{18}O_{V-PDB}=-14.4\%$ to $-0.6\%$), as well as smectite and kaolinite in the lowstand systems tract (LST) and highstand systems tract (HST) turbiditic sandstone below the sequence boundary. Minor eogenetic siderite has precipitated between expanded and kaolinitized micas, primarily biotite. The mesogenetic alterations are interpreted to have been mediated by evolved marine porewaters and resulted in the precipitation of calcite ($\delta^{18}O_{V-PDB}=-12.9\%$ to $-7.8\%$) and Fe-dolomite/ankerite ($\delta^{18}O_{V-PDB}=-12.1\%$ to $-6.3\%$) at temperatures of $50–140$ and $60–140$ °C, respectively.

Quartz overgrowths and outgrowth, which post- and pre-date the mesogenetic carbonate cements is more common in the LST and TST of distal turbiditic sandstone. Discrete quartz cement, which is closely associated with illite and chlorite, is the final diagenetic phase. The clay minerals include intergranular and grain replacive eogenetic kaolinite, smectite and mesogenetic illite and chlorite. Kaolinite has been subjected to mesogenetic replacement by dickite. The K-feldspar and plagioclase grains have been albitized. Dissolution of calcite cement and of framework grain (feldspar, volcanic fragments and mud intraclasts) has resulted in a considerable enhancement of reservoir quality.