

Reservoir quality of GOM Louisiana Miocene shelf sandstones: Clay coatings are the key

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Miocene Louisiana shelf sandstones were deposited in a variety of shelf environments including distributary channels, fluvial point bars, and shoreface environments. These reservoirs are presently at temperatures exceeding 150 C, and exhibit higher risk due to porosity reduction. A regional study was conducted to assess reservoir quality uncertainty using basin modelling and sandstone petrography.

Rocks exhibit a negative correlation between porosity and quartz cement. Additionally, clay coatings are present in varying quantities and where prevalent inhibit quartz cementation. Wells penetrating highly bioturbated facies contain clay coatings which range up to 65% grain coat completeness. These coatings are more complete than those found in other adjacent non-bioturbated deltaic depositional facies.

The origin of the higher grain coat completeness in the shoreface sands is not clear, but is thought to be related to biological cycling of detrital clay and detrital sand grains in the depositional system. Textures suggest that these clay coatings are not diagenetic in origin as clays are often arranged parallel to grain boundaries, and it is suggested that detrital clays were applied to the grains during biological cycling. From these detrital coatings, chlorite-like authigenic coatings grow perpendicular to the substrate and may enhance the original detrital coats. Clay mineralogical detail reveals the coatings contain dominantly R2 illite/smectite/vermiculite with chlorite and illite.

Acid-base properties of 2:1 clays: The role of electrostatics

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Clays are highly anisotropic and electrically charged aluminosilicate minerals. Their acid-base properties are due to the protonation of aluminol and silanol groups on the edges of the particles. The 2:1 clays are characterized by isomorphous substitutions within the crystal lattice, which result in permanent negative charge expressed at the basal surfaces of the platelets. According to the amount and localization of the substitutions, these clays display a great variety of chemical and physical properties. The influence of the charge anisotropy of 2:1 clays on their phase behaviour, and the interplay of the structural- and protonable charge, are still a matter of debate.

We present a theoretical and experimental investigation of the titratable charge of 2:1 clays with various structural charge (σ_b): pyrophyllite ($\sigma_b = 0 \text{ e. nm}^{-2}$), montmorillonite ($\sigma_b = -0.7 \text{ e. nm}^{-2}$) and illite ($\sigma_b = -1.2 \text{ e. nm}^{-2}$). The calculations were carried out using a Monte Carlo method in the Grand Canonical ensemble and in the framework of the primitive model. The clay particle was modeled as a hexagonal platelet, with an 'ideal' crystal structure. The only fitting parameters used are the intrinsic equilibrium constants for the protonation/deprotonation reactions of the broken-bond sites on the lateral faces. Simulations are found to give a satisfactory description of the acid-base titration of 2:1 clays without any additional fitting parameter. In particular, combining the electrostatics from the crystal substitutions with the protonation constants, the simulations satisfactorily catch the shift in the point of zero net proton charge (PZNPC) of 2:1 clays according to the ionic strength, in good qualitative agreement with experimental observations following the sequence: pyrophyllite < montmorillonite < illite.