

Petrography and diagenesis of Paleocene-Eocene sandstones in the Siri Canyon, Danish North Sea

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Introduction: Post-depositional remobilization and injection of sand are often seen in deepwater clastic systems and has been recently recognised as a significant modifier of deep-water sandstone geometry. Large-scale injection complexes have been interpreted in the Paleocene Siri Canyon near the Danish Central Graben of the North Sea hydrocarbon province from borehole data (Fig.1).

The emplacement of largescale injection complexes has been commonly recognized in the geological literature to seismic activity and consequent sand liquefaction.

However, as a result of very small differences in textural and compositional properties, and the lack of depositional structures often seen in deep-water sand, the distinction between "in situ" and injected or remobilised sands is indistinct.

Large scale heavy mineral sorting (in 10 m thick units) is observed in several reservoir units and has been interpreted to signify the depositional sorting.

Heavy mineral sorting does also occur in injected sands and a detailed understanding of this sorting process is essential when evaluating the origin of a sediment.

In his study we demonstrate an example of effective sorting of heavy minerals in a thin injected sand where the sorting is related to the flow patterns during injection.

Differences in sorting pattern of heavy minerals are suggested as a tool for petrographic /geochemical distinction between "in situ" sands and their related injected sands, particularly where potential primary structures are removed.

Studied glauconitic sandstones reservoir in the Siri Canyon are based on the investigation of the geochemical composition of the reservoir sand in cores and also petrographic investigations by optical microscope, scanning electron microscope (SEM) examinations and XRF analyses .

Depositional and remobilized sandstone units are identified in cores from the Paleocene sand-rich Cecilie-wells which provides this study with examples of heavy mineral sorting in depositional and remobilised sandstones.

The deposition and sorting of heavy mineral grains in these sediments is controlled mainly by grain size, shape and density (Fig.2).

Heavy minerals may be selectively concentrated during transport and deposition because of their high density.

Selective concentration of heavy minerals is thought to take place through a combination of sorting mechanisms, including settling velocity and differential transport and entrainment.

This study also presents the occurrence and compositional variation of the authigenic zeolites in the Siri Canyon sandstones, and discuss the physicochemical conditions which prevailed during formation of zeolites, pore water chemistry, composition of mineralogical precursors and the host sediments.

Studied zeolites in Siri Canyon have a hydrated aluminosilicate framework with varying amounts of alkali and alkaline earth metals.

Authigenic zeolites may be common in deep marine sediments, and in volcanoclastic deposits.

They are generally related to dissolution of siliceous fossils or diagenetic alteration of volcanic glass (Fig.3).

Authigenic zeolites are uncommon constituents in most sandstone.

However, authigenic zeolites are common in some of the glauconitic sandstones from the Siri Canyon, where it is generally associated with thick coatings of opal/microquartz on the detrital framework grains.

References:

[1]Hamberg, L., Dam, G., Wilhelmson, C. & Ottesen, T.G. (2005): Paleocene deep-marine sandstone plays in the Siri Canyon, offshore Denmark – southern Norway. In: Doré, A.G. & Vining, B.A. (eds): Petroleum geology: North-West Europe and global perspectives. Proceedings of the 6th petroleum geology conference, 1185–1198. London: Geological Society.

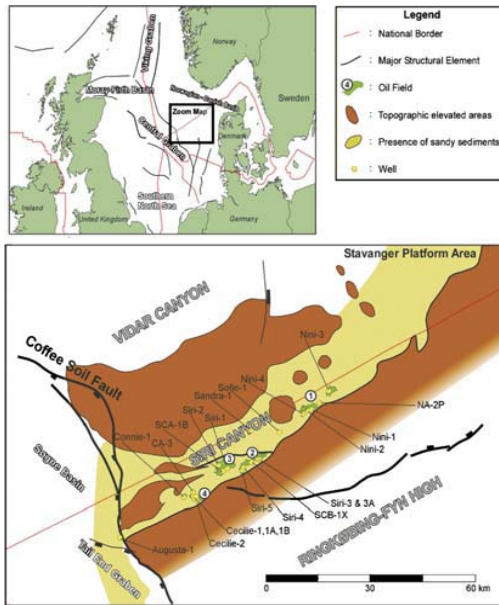


Fig.1. Paleocene-Lower Eocene Location map and schematic stratigraphy infill of the DanisNorth Sea and Siri Canyon. Taken from Hamberg, L. et al. (2005) ^[1]

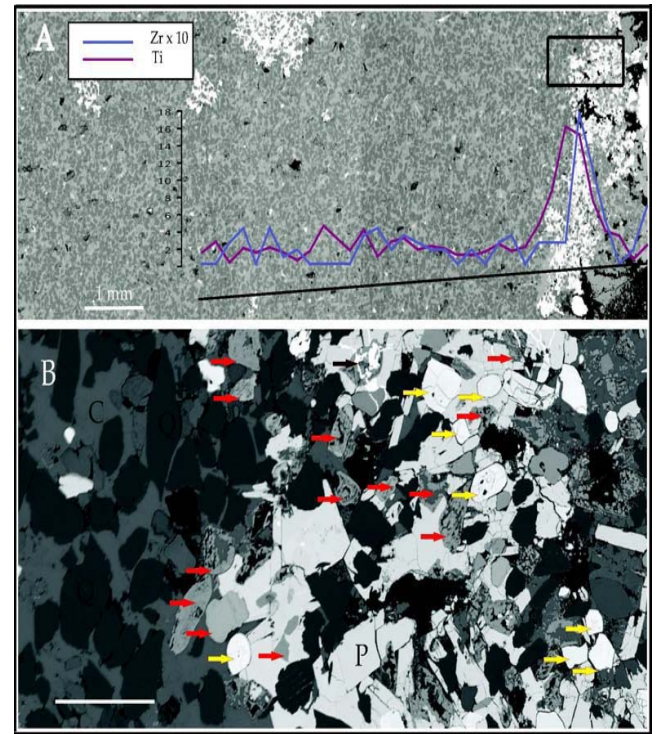


Fig.2. A Combined SEM-BSE micrograph of thin section (CE-2 2316.15m). EDAX-data along black line. Scale is 18W% for Ti, 1.8W% for Zr. White areas are cemented by pyrite. Black box indicates close up in B. B) SEM-BSE micrograph of HM laminae. Red arrows indicate Ti-rich mineral grains, yellow arrows indicate zircon grains. Q : quartz grain; C: calcite cement, P : pyrite; black arrow point to barite in fracture. Note that quartz grains in HM lamina are significantly smaller than quartz grains in host sediment.

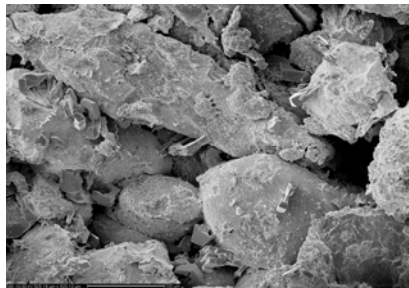
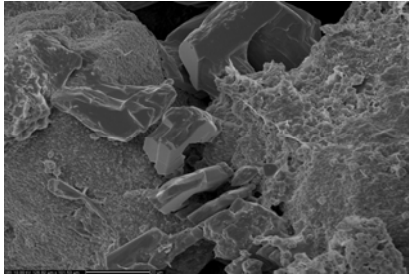


Fig.3. Predictive model of zeolite-mineralization is potentially applicable to other sandstone reservoirs with a volcanic ash component. Overall, recovery can be increased by recognizing specific zeolites and properly treating the wells with appropriate completion fluids to minimize formation damage and the resulting production loss.