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3D seismic, geochemical and biostratigraphical analysis of Paleogene remobilized sand in the Norwegian-Danish Basin

Katrine Juul Andresen, Ole Rønø Clausen, Claus Heilmann-Clausen, and Henrik Friis
Aarhus University, Department of Geoscience, Aarhus C, Denmark (katrine.andresen@geo.au.dk)

This study describes remobilized Paleogene sand occurring on the hanging-wall segment north of the major D-1 normal fault in the Norwegian-Danish Basin, eastern North Sea. The remobilized sand is observed on 3D seismic data in fine-grained Eocene host-strata as cross-cutting reflections with a typical tabular, V-shaped or wing-like geometry in the seismic cross-sections and a pronounced jack-up of the overlying succession onto which onlap can be observed. In map view the remobilized sand in certain areas have a channel-like appearance. The seismic observations indicate that the sand has a remobilized origin which may be partly depositional. Particularly the observed wings and jack-up on the seismic cross-sections indicate remobilization which potentially could be generated by two different processes: a) remobilization of depositional channel sand resulting in the formation of injected wings along the sides of the channel, or b) injection of remobilized sand from the deeper Paleocene strata causing jack-up and typically V-shaped intrusions. Injection of Paleocene sand into Eocene host strata is a well-known phenomenon from the nearby Paleogene Siri Canyon located c. 15 km north of the study area.
In order to acquire more information about the intrusions a geochemical study and a detailed biostratigraphical dating of cuttings and sidewall core samples from the Floki-1 well was carried out. The Floki-1 well penetrates the remobilized sand and was drilled to test an apparent 4-way closure on prospect Eocene sand which by then was interpreted to be 100 % depositional.
The geochemical study of the samples from the sand identified the Floki-sandstone as a very fine grained sand and silt with a matrix of very angular silt grains. The sand does not contain clays. The matrix appears to have formed by crushing of the sand grains. Thus, heavy minerals appear to have disintegrated by crushing but still most parts of the mineral grain is found together. Glauconite grains are strongly smeared. The sorting pattern, and the angular shape of silt sized matrix grains, and the intense shearing and deformation of glauconite grains indicates that the sand may have been injected under high pressure, resulting in massive crushing of detrital grains.
The age dating mainly includes dinocysts analysis from seven sidewall core samples and nine cutting samples above, within and below the sand. It is expected that the sand should either be of Eocene age probably revealing a depositional origin with subsequent remobilization to the sides (process a), or a Paleocene age revealing injection from the deeper strata (process b).
In order to address all observations, a potential model of generation may include elements of depositional sand combined with up-, downward and/or lateral injection which could have been facilitated by intense activity in the nearby D-1 fault.
The study highlights the importance of interdisciplinary approaches in the interpretation of complex geological features formed by several geological processes and mechanisms.