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Biodegradation-controlled organic-inorganic interactions in a Jurassic oil reservoir: Heidrun field, Haltenbanken area (Norway)

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The Heidrun oilfield is located in the prolific petroleum province of the Haltenbanken region (Norwegian Sea). Heidrun is intensively segmented by faults into compartments containing oil with different degrees of alteration.

Post-filling alteration processes in the oil reservoir are reflected by inorganic geochemical and mineralogical features due to organic-inorganic interactions during biodegradation. To unravel these interactions, organic geochemical features are correlated with inorganic geochemical and mineralogical phenomena (mineral dissolution/precipitation) as well as isotopic signatures of carbonates along the recent oil-water contact (OWC) and in-reservoir cementation zones (potential paleo OWCs).

Sediment samples have been taken along today´s oil-water contacts and in-reservoir cementation zones from eight wells. The sample material covers three different sedimentary successions (Åre, Tilje and Ile Fm.).

All samples have been investigated by microscopy of thin sections, whole rock XRF and XRD. Selected samples were analysed by SEM, ESEM and microanalysis. Samples choosen for analysis of stable carbon and oxygen isotopes of carbonate have additionally been analysed for degradation features within patterns of saturated hydrocarbons.

Microscopy of thin sections together with SEM and ESEM investigations of OWC samples and cemented in-reservoir layers point to feldspar and quartz alteration which led to kaolinite blastesis as consequence of modified pH values. Few pyrite precipitations have been documented. Microanalysis of selected samples indicates that precipitated carbonate cements are pure calcite and carbonate solid solutions (Ca-Mg-Fe-Mn carbonate).

In summary, different biodegradation degrees led to changes of the hydrogeochemical conditions. These variations controlled the precipitation of pure calcite and/or carbonate solid solutions and indicate: less intensively biodegraded hydrocarbons co-occur with calcite, moderatly biodegraded hydrocarbons co-occur with carbonate solid solutions. Intensified biodegradation-controlled organic-inorganic interactions (degradation degree of hydrocarbons and the presence of carbonate phases) due to anaerobic bacterial fermentation are reflected by ^{13}C-enrichment in carbonate phases.