STRESS REGIMES – IMPORTANT CONTROLS ON LEAKAGE MECHANISMS?

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Leakage of pore fluids from hydrocarbon reservoirs may have a severe impact on hydrocarbon column heights. Since faults and fractures often act as conduits for fluid flow in the subsurface, they are also commonly considered as major leakage pathways for hydrocarbons. The generation of faults and fractures is controlled by the effective rock stress. Accordingly, a study which aimed to investigate the relationship between stress regimes and leakage mechanisms was initiated, motivated by the belief that evaluation and prediction of the stress history could possibly aid in prognosing hydrocarbon entrapment.

The hydrocarbon occurrences in different overpressured hydrocarbon provinces offshore Norway were studied. These provinces have experienced different geological histories and variable amounts of hydrocarbon leakage. Since all these areas have been exposed to fairly recent hydrocarbon charge, the work focused on relatively recent geological events that may have influenced the stress history. In addition, pore pressures and retention capacities were analyzed to facilitate the analysis of effective stress variations.

Areas which have undergone recent crustal flexuring were found to have higher retention capacities and more extensive hydrocarbon leakage than areas with less recent tectonic activity. This increased tendency for hydrocarbon leakage is explained by shear failure at the trap crests, induced by elevated pore pressures, stress anisotropy and rapid stress changes due to the flexuring. This conclusion agrees well with the observed variations of retention capacities in the study area, as pore pressures in locations with significant stress anisotropy do not reach as high values as is observed in areas with a more homogeneous stress state.

It is suggested that sedimentary basins that have experienced recent crustal flexuring may in general be more exposed to hydrocarbon leakage from overpressured traps than basins with a more relaxed recent stress history. It is therefore recommended that sealing analysis should include basinwide analysis of recent tectonic history, assisted by analysis of retention capacity characteristics.