Shallow gas mapping on NCS – From Geological understanding to climate impact

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Increased focus on GHG emissions have resulted in focus on subsea well associated and naturally occurring methane seeps. As a response to this Equinor initiated a project in 2019 to map out and quantify impact from well associated gas seeps (WAGS) and natural occurring gas seeps (NOGS) on the NCS. To understand the dynamic behavior of shallow gas migration in the subsurface and the associate risk picture Equinor have performed regional interpretation of quaternary sediments distribution, regional assemble of shallow gas anomalies, reclassification of shallow gas from more than 1500 exploration wells, summarised seep operations from both natural and well associated seeps.

Norwegian sea: Naust contains shallow gas on several intervals (High risk areas), some areas with observed natural seeps, gas migrated along the clinoforms and accumulates on the topsets (Figure B). Natural seeps are observed on the seabed where clinoforms intersect with it or where shallow

detachment surfaces occur (Figure A). Chemical analysis indicate biogenic origin from the Naust shallow gas.

Horda- platform: No natural seeps observed–few wells with observed shallow gas, some areas with potential shallow gas amplitudes. A lot of pockmarks could indicate the gas have migrated out after the last glaciation

Tampen area: A lot of natural seeps. Dynamic system where shallow gas migrates along the clinoforms and accumulates in shallow sediments on the Tampen spur. This area is defined as the Tampen blanking zone where seismic imaging of the shallow sediments is very poor.

Southern north sea: Several intervals with shallow gas (From Utsira to seabed). Natural seeps have been observed on seabed where tunnel valleys erode down to gas bearing horizons (e.g. Crenulate)

Equinor has utilized multibeam echosounder data (MBES) from site surveys and ROV inspections to detect seeps. Seep observation can be related to poor isolation of naturally occurring shallow gas layers or very shallow accumulations of biogenic gas (right below seabed where the wellhead is cut).

There have not been observed gas seeps from deep reservoirs in chemical analysis indicating breach of reservoir well barriers.

The inspected NOGS (95) typically had rates *in situ* ranging from <0,01 l/min to 0,02 l/min. Many of the NOMS inspected (~80%) had rates below what is possible to detect with ROV, but can be detected with MBES.

All new site survey has water column data that enable detection of gas seeps. The data do not enable source identification. This would require chemical analysis of the gas (incl isotope signature).

Further work will be performed together with through WELLFATE/Influse (NFR – Project) to assess the rate and dynamic behavior of the observed seeps. Equinor is also looking into prospectively for some of these structures.

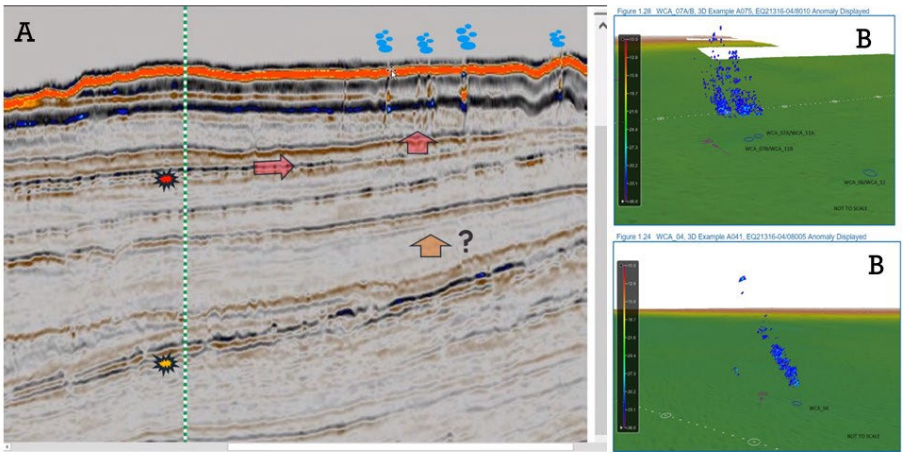

Figure: A: Seismic section section showing natural migration of shallow gas from source layer to seabed in the Norwegian sea. B: Multibeam Echosounder (MBES) used to document natural and well associated seeps on seabed.

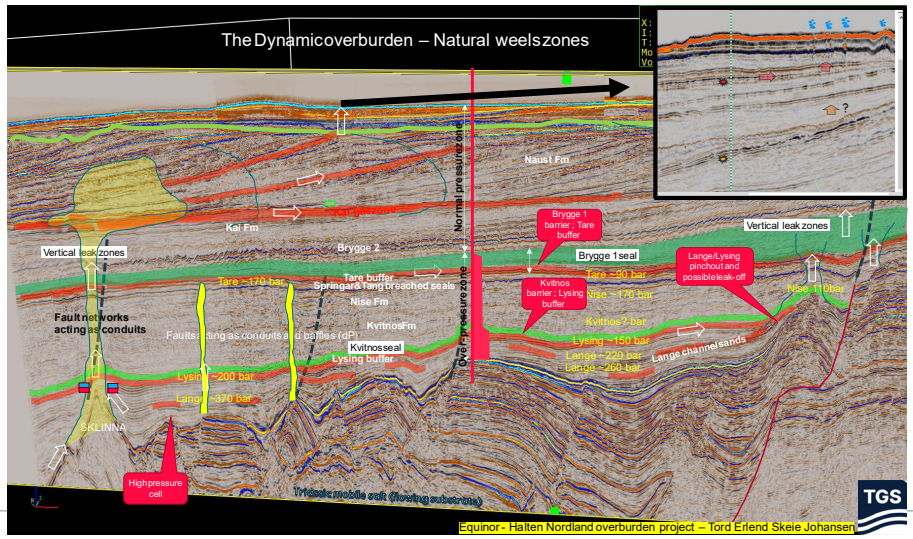

Figure: B: The Dynamic overburden – Natural weeks zones. Overburden is in most cases a dynamic dynamic flow/pressure system – that may change in field life lifetime. Good regional overburden dynamic knowledge is necessary to understand seabed observations.

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