University cluster fracture connectivity in heterogeneous rocks

Publieke samenvatting / Public summary

Summary

Improving gas productivity from unconventional sources like shale requires finding ways to improve the nano-micro scale pore network present in the shales. Promoting pore connectivity within the shale matrix accelerates the transport of gas from matrix to either natural or induced fractures. This project investigated whether it would be possible to employ the stress-strain-sorption behaviour and mechanical damage characteristics of gas shales, alongside fracturing, to achieve the desired increase in matrix permeability. The full report summarises the work done in project year 4 on the swelling and shrinkage behaviour of the Posidonia Shale and Whitby Mudstone and the permeability of these rocks.

The study concluded that the fastest fluid pathway and permeability through the Whitby Mudstone can probably be found in the areas with a less compacted matrix between silt-sized grains or where the matrix is most damaged when fractures are induced. Taking a residence time of fluid in the matrix of something in the order of less than one year, mechanically induced fractures could improve this by two orders of magnitude when circumstances favour fracturing.

Background

The swelling of clays has important implications for drilling operations and can cause wellbore instability. The magnitude of the influence of the

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swelling clays varies and depends on the mineralogy and the texture of the rock, hence the type of clay minerals present and their distribution within the rock. The composition of the fluids present also plays a role. The fluids used in drilling oil and gas wells – especially water – can encourage clay swelling and have a largely negative impact on the drilling process, significantly increasing well construction costs. Removing the water from the mud rock could potentially shrink the rock and increase the matrix permeability.

Project objective

This study focused on the swelling and shrinkage of the naturally occurring Posidonia shale mudstone and Whitby Mudstone, which are possible unconventional sources for oil and gas in the Netherlands and the UK respectively.

Project results

The study found that the Whitby Mudstone is a matrix rich rock with silt-sized grain floating within the matrix. The porosity of the Whitby Mudstone is less than 8% and varies in 2D, where lower 2D porosity values result in lower 3D porosity values and less well-connected pore networks in that parts of the rock.

Permeability depends on both the microstructure of the sample and its microstructural complexity, which is an interplay of porosity and mineralogy, and the exact arrangement of the silt-sized grains (grain boundaries), pores and possible micro fractures at different scales. Methods used to measure permeability pointed towards low undamaged matrix permeability values of 1.10-20 m2, where permeability was confining pressure and direction dependent. The highest permeability improvement using direct shear experiments was when the maximum stress made a 65° angle to the bedding. This improved the matrix permeability from 10-20 m2 to 10-18 m2 at 30MPa confining pressure, and so also decreased the residence time of fluids in the matrix by two orders of magnitude.

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De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.
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