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Multi-scale petrophysical and geomechanical characterization of full core from the Groningen Field to understand mechanical stratigraphy and compaction behavior

Rob van Eijs (1), Sander Hol (2), Fons Marcelis (2), Gulfiia Ishmukhametova (1), Arjan van der Linden (2), Pedro Zuiderwijk (2), and Axel Makurat (2)

(1) Nederlandse Aardolie Maatschappij B.V., Petrophysics & Geomechanics, Schepersmaat 2, 9405 TA Assen, The Netherlands, (2) Shell Global Solutions International B.V., Rock & Fluid Science, Kessler Park 1, 2288 GS Rijswijk, The Netherlands

The Groningen gas field in The Netherlands is one of the largest onshore gas reserves known. Advancing production from the field has resulted in field-scale deformation with surface subsidence and accompanied local seismicity. Part of the deformation is associated with compaction of the Permian reservoir. While depletion-induced reservoir compaction is expected to be controlled locally by grain-scale physical mechanisms such as sub-critical cracking or particle re-arrangement and intergranular pressure solution creep, understanding of the intra-reservoir variability of these mechanisms is still limited, though crucial for predicting the coupling between production, rock deformation, and surface effects.

To aid an improved understanding of fundamental processes and scaling effects, approximately 200 meters of core over the reservoir section was taken from a well in the Groningen Field, drilled in July 2015 close to the village of Zeerijp. Using this material, we have performed detailed laboratory investigations and will continue to do so in significant numbers, to compare the results obtained with well- and field-scale observations. In this contribution, we present several exemplary mechanical data sets for the reservoir and caprock, and compare these data with well-scale petrophysical and mechanical information, notably sonic, scratch and visual geological details with the aim to arrive at a multi-scale description of petrophysical and geomechanical rock properties. Our first comparison reveals a strong contrast in compressibility and strength between the reservoir and caprock, as well as a contribution of inelastic strain to the total strain response of the tested rock samples. We will discuss the observed mechanical stratigraphy in considering regional and field scale deformation patterns.