

# **SOLUTION MINING RESEARCH INSTITUTE**

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**Meeting  
Paper**



## **Hydraulic Fracturing Stress Measurements in the Krummhörn Gas Storage Field, Northwestern Germany**

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# HYDRAULIC FRACTURING STRESS MEASUREMENTS IN THE KRUMMHÖRN GAS STORAGE FIELD; NORTHWESTERN GERMANY

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## Abstract

The Ruhrgas AG gas storage field Krummhörn is located near the North Sea harbour town of Emden, NW Germany. The present storage facility consists of 3 caverns leached in the Groothusen salt dome (Zechstein 2) at a depth between 1500 and 1800 meters. To investigate the structure of the salt dome with respect to a future increase of the storage capacity, 2 deep boreholes were drilled in 1994. In one of the boreholes, Krummhörn K 6, an extensive hydraulic fracturing test program was conducted for determination of the in-situ stress within the salt at depth, as the limiting input parameter for cavern design and storage pressure planning.

Using the MeSy wireline hydrofracturing technique where the double straddle packer unit is moved within the borehole on a standard borehole logging cable, a total of 11 hydrofrac tests were successfully carried out in the 8.5 inch diameter open hole between app. 1300 and 1800 m depth. Every test consisted of the initial fracturing cycle and several subsequent refrac cycles for reliable and precise determination of the shut-in pressure. Most of the frac cycles demonstrated distinct breakdown at fracture initiation and reproducible fracture re-opening pressure values, while determination of reliable shut-in pressure values required an extensive analysis of the pressure records. The analysis yields a well-documented shut-in pressure profile

$$P_{si}, \text{ MPa} = 29.38 + 0.0194 \cdot (z, \text{ m} - 1300)$$

or a shut-in pressure gradient of

$$dP_{si} / dz, \text{ MPa} / \text{ m} = 0.0221$$

for the depth between 1300 and 1720 m (TVD). The shut-in pressure profile is in good agreement with the vertical stress profile derived from various geophysical logs for the overburden density.