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Thermal and maturity history of sedimentary rocks in the vicinity of salt structures – a numerical modelling study in the North German Basin

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Introduction

The central part of the North German Basin is characterised by a multitude of huge salt diapirs derived from Rotliegend and Zechstein salt. It is well known that the petrophysical properties of salt differ from those of other sedimentary rocks. In particular salt has a much higher thermal conductivity and therefore can significantly affect the temperature field in a sedimentary basin and thus influence the maturity of organic matter and the timing of hydrocarbon generation.

We analysed the influence of the salt diapir Büsum, located in the North German Basin, on the temperature and maturity distribution and evolution of the surrounding sedimentary rocks in a 3D numerical modelling study.

3D model

The 3D model is located in the central part of the North German Basin. It includes the salt diapir Büsum and its surrounding rim synclines (West Holstein Trough) and covers an area of about 780 km^2.

The 3D finite element model for the numerical simulations consists of 30 layers and 200 x 173 x 108 (x-, y-, z-direction) grid cells including the sedimentary sequence from Upper Rotliegend to the Quaternary. It is based on depth maps from the consortium RWE Dea AG and Wintershall AG, completed with depth maps from Baldschuhn et al. (2001).

The evolution of the salt diapir was modelled based on an unpublished 2D structural

modelling study. For lithology assignment the information of well reports and for calibration purposes temperature and vitrinite reflectance data of 5 wells were used. The simulations were performed with the PetroMod modelling software of IES GmbH, Aachen. For maturity calculations the Easy%Ro kinetics of Sweeney & Burnham (1990) was applied.

Results

The calculations show that the temperature and maturity isolines are definitely affected by the salt structure. Temperature above the diapir is up to 17˚C higher than at the same depth level in the outer parts of the rim syncline. In contrast the temperature at the flank of the salt diapir increases with distance from the salt structure. For example the temperature at a depth of 5000 m at a point located 7 km away from the salt diapir is about 12˚C higher than directly beneath the salt diapir. Underneath the salt overhang the temperature is reduced by up to 17˚C.

The highest maturity differences of about 0.2%VRr are found underneath the salt overhang.

References

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