

# Influence of inversion tectonics on the formation of the Bramberge oil field, Northern Germany

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**Abstract:** The Bramberge oil field is one of the three major petroleum accumulations in Germany. The field is located on the western margin of the inverted Lower Saxony Basin and belongs to the so-called Emsland Petroleum Province. Since its development in 1958, the field contributed approximately 6.9 % of Germany's crude oil production (and additional 5.8 % Vn of Germany's oil-associated natural gas). Despite its outstanding economic importance the formation of the Bramberge petroleum accumulation is still a matter of discussion. The aim of this study was to improve the understanding of the formation of the Bramberge oil field with special emphasis on the inversion related structural development and associated organic matter maturation. The work was conducted by means of organic geochemical analysis of fluid and rock samples from the oil field and by finite element modelling of a 2D seismic section applying the PetroMod 2D software package (Integrated Exploration Systems, Aachen).

The Bramberge field is underlain by an oil prone Mesozoic sequence including two possible source rocks, the Lower Jurassic Posidonia Shale and the Lower Cretaceous Wealden Paper Shale, both to be found in advantageous bituminous facies and thicknesses. Biomarker and isotope geochemical data point towards a petroleum generation in the Wealden Paper Shale with an admixture of secondary oil associated gas.

Burial history of the Mesozoic sediments was determined with a major phase of subsidence until Late Cretaceous times followed by a short inversion movement leading to an uplift of formerly deeply buried sediments southeast of the recent field.

Maturation of the Wealden Paper Shale took place as early as in the Early Cretaceous but for the most part during deep burial prior to the Late Cretaceous inversion and in the Hesepe area to some extent in the Tertiary. The maturity of the Wealden Paper Shale today is in the range of 0.55–0.90 %Rr. The Posidonia Shale reached the oil window as early as Early Cretaceous times and expelled some additional natural gas during maximum burial. Because maturation peaked just before the inversion, Mesozoic sediments underneath the field display a maturity inversion today. Migration of Wealden derived oil into the reservoir occurred already prior to the inversion. By comparing the modelled reservoir pore space saturation prior and past the inversion, it becomes obvious that the reservoir had been predominantly filled up already prior to inversion. During slight Tertiary burial Wealden oil migrated again into the Lower Cretaceous reservoir horizon. Therefore, the Bramberge oil accumulation had been created already prior to Late Cretaceous inversion, however its final filling took place during the Eocene.

**Kurzfassung:** Die Erdöllagerstätte Bramberge befindet sich am Westrand des Niedersächsischen Beckens und wird geologisch zur emsländischen Erdölprovinz gerechnet. Seit seiner Erschließung 1958 produzierte das Feld etwa 6,9 % der bundesdeutschen Gesamtproduktion. Damit gehört das Feld Bramberge zu den drei bedeutendsten Erdöllagerstätten Deutschlands. Trotz seiner herausragenden wirtschaftlichen Bedeutung ist die Genese des Feldes Bramberge bisher nicht hinreichend untersucht worden. Unterhalb der Lagerstätte kommen sowohl die Papierschiefer des Wealden als auch der Posidonienschiefer des Lias in großer Mächtigkeit und in günstiger bituminöser Fazies vor. Biomarker und isotopengeochemische Daten deuten auf eine Ölbildung in den Papierschiefern des Wealden mit Gaszumischungen aus dem Posidonienschiefer hin.

Ziel der vorliegenden Studie war es, die strukturelle Entwicklung und Wärmeﬂussgeschichte im Gebiet des Feldes Bramberge sowie die Migration des Erdöls in die Lagerstätte mit Hilfe der Programmgruppe PetroMod 2D (Integrated Exploration Systems, Aachen) zu modellieren. Es konnte gezeigt werden, dass die Restrukturierungen während der oberkretazischen Inversion zu einer Reifeinversion der betroffenen Sedimente geführt haben, da die Reifung der organischen Substanz bereits vor der Inversion weitgehend abgeschlossen war. In der

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