Tectonic models for natural stress, exhumation and temperature in shale gas basin

Publieke samenvatting / Public summary

Summary

This project redefined the crustal structure and early tectonic history of the Southern North Sea and the subsurface of the Netherlands. A new tectonic and structural basement map based on the paleo-tectonic restoration of the Avalonia micro-plate (including the southern North Sea and the Netherlands) has profound implications for the evolution of Mesozoic sedimentary basins. One of the eye-catching outcomes of this research was the lower Dinantian age of the Dutch Central Graben and its important role in the distribution of Paleozoic extension acting as a strike slip zone. Instead of defining the Dutch Central Graben as part of the Avalonian crust, the new interpretation – as a remnant Caledonian accretionary wedge – suggests that the graben formed along a detachment reactivating the contact between the accretionary wedge and the underlying ancient Baltica margin. This new interpretation means that the formation and evolution of the graben is not only controlled by the mechanics of continental extension (pure-or simple-shear rifting), but also by rheology of the major inherited Paleozoic thrusting contact between the major continental units.

Background

Avalonia is one of the few regions where the initial Mid-Paleozoic basin structure is still recognisable, largely intact, and well-studied. Its kinematics and dynamics remain, however, largely unknown, in

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particular in view of the successive late Paleozoic to recent evolution of the basin. Consequently, the importance of the mid-Palaeozoic tectonic evolution and structural controls are often overlooked and poorly understood in basin studies.

Project objective

This paper reassesses the importance of Mid-Palaeozoic tectonics on the subsequent sedimentary basin evolution of north-western Europe. To this end, it analyses the dynamics of early Variscan extension in Avalonia, based on the integration and re-evaluation of available geophysical and geological data from lithosphere to basin scales. Using a revised crustal map of the Thor suture zone, the paper presents a new paleo-tectonic reconstruction and tectonic scenario for the Devonian-Carboniferous rifting. These findings are key for a better understanding of long-lived tectonic segmentation and post-rifting deformation phases.

Project results

The paper’s findings indicate that the structural grain of many crustal-fault-dominated sedimentary basin structures, such as the North Sea Central Graben, were created in the early Carboniferous. Consequently, the main basement structuration of northwest Europe was completed before the Variscan orogeny and successive post-Variscan extension and inversion phases reactivated the existing basement structures without creating major new fault groups. Incorporation of the Paleozoic structural grain allows for a consistent tectonic framework for the Mesozoic, contributing to fundamental understanding of basin evolution. From the tectonic framework analysis, Avalonia stands out as a fine example of long-lived lithosphere memory, spanning over 350 My of structural control in geodynamic evolution.

This final report contains the results as published in the journals Geology and Marine and Petroleum Geology. The continuation of the project was guaranteed in the form of two new TKI projects: “Tectonic models II: The Dutch Central Graben and

its margins” and “RiFa – Rise and Fall", the role of thermal uplift in the formation of Jurassic basins in the Dutch subsurface” that were to start in early 2018.

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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