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Tectonic heat flow during the Permo-Carboniferous orogenic collapse: constraints from tectonic models and a maturity trend analysis based on the examples of the Friesland Platform

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The Southern Permian Basin outline is well defined by Late Permian to Early Jurassic sediments of considerable thickness, whose stratigraphy can be well correlated over the basin.

Late Permian to Early Jurassic tectonic subsidence curves across different parts of the basin are typical for a Permian to Early Triassic extensional stage that is followed by thermal subsidence. However, a purely extensional basin modelling of this area is extremely problematic: active faulting during this time is 'minor' and it occurs only in restricted areas of well defined graben structures such as the Gluckstadt Trough, the Horn Graben and the Polish Trough. Recent studies have shown that the broad saucer shape of the basin can be related to the destabilization and collapse of the Variscan orogeny (Van Wees et al., 2000; Ziegler et al., 2006). This geodynamic setting can have significant effects on basin modelling as it is marked by an anomalously high thermal attenuation in the subcrustal mantle causing elevated heat flows.

The present-day Friesland Platform shows very shallow depth for the Carboniferous sediments (1500-2000 m) and it has not experienced higher burial depths during its history. As a result, this area is in ideal condition to study Permo-Carboniferous temperature events because these trends are not overlain by more recent events. The well that is studied in this paper is situated at the southwestern margin of the Friesland Platform, on the border to the Texel-IJsselmeer High. This area experienced extensive erosion of Upper Carboniferous sediments during the uplift phase at the Permo-Carboniferous border ($\sim$1000 m). Vitrinite reflectance values from the remaining Carboniferous sediments suggest a high temperature event during the history of the well.

The results of the modelling show that the best-fit for the heat flow, in agreement with the anomalous maturity depth for the well, is marked by a sharply elevated heat flow at the permo-Carboniferous. This is clearly consistent with the concept of the orogenic collapse. However, higher temperatures than those predicted by the tectonic lithosphere scale model are required to calibrate the maturity predictions to the well data. According to van Bergen & Sissingh (2007), magmatic rocks of Permo-Carboniferous age were found in several wells on the southern Friesland Platform. It is therefore possible to assume that a magmatic event took place at that time that further increased the heat flow, resulting in very high temperatures and maturities for the Carboniferous rocks.

We will discuss through this example the importance of the magmatism in the early stage of the Southern Permian Basin evolution and the implications for the hydrocarbon generation in central Europe.