

Tectonic Evolution and Hydrocarbon Exploration of a Multiply Overprinted Caledonian Continental Collision Zone in the German Baltic Sea

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ABSTRACT

The review of legacy data and the subsurface remapping of a ~4,000 km² area in the German Baltic Sea east of Rügen island are reported. The area was previously explored by Petrobaltic, a consortium between USSR, Poland, and GDR (1975–1990): ~8000 km of 2-D seismic were acquired and four deep offshore wells (G14, H2, H9, K5,) were drilled. The area is located in a complex tectonic setting. It straddles four superimposed basins created by Caledonian, Variscan, and Permian events. All four contain potential reservoirs. They are overlain by non-prospective Mesozoic sediments. The Caledonian crustal domain contains the collisional boundary between the Precambrian continents of Avalonia and Baltica. It hosts Ordovician turbidites of the accretionary prism (H2, H9) thrust northward onto the undeformed, starved Cambro-Ordovician foreland sequence on the Baltica shelf (G14). The Variscan Rhenohercynian basin contains Devonian continental clastic rocks associated with post-Caledonian rifting, covered by marine carbonates. These are overlain by Carboniferous marine carbonates and continental flysch related to the Variscan orogeny. The area also straddles the Gryfice graben (K5), a pull-apart basin linking the two branches of a 2000 km long, dextral-transtensional, Permian intracontinental rift. The graben hosts Late Carboniferous to Early Permian volcanic rocks and clastic sediments. Younger marine Zechstein carbonates and evaporites form the northern margin of the Northeast German Permian basin which record late Early Permian thermal sagging that prevailed to the Early Cretaceous. The prospectivity of the area was re-evaluated by integrating 3320 km of re-interpreted, reprocessed seismic data with well data and field analogs from onshore East Germany and Poland. As a result, prospectivity domains based on structure and sediment distribution were mapped. In particular, the areal extent of potential Devonian and Carboniferous reservoirs is much larger than mapped previously. It is shown that the historic wells were poorly placed and are not representative of the local prospectivity, and that undrilled structures with multiple, stacked targets exist in the area.