

# Newfoundland Orphan Basin: key structural elements for the Northeast Atlantic opening

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The Newfoundland margin has demonstrated a high hydrocarbon potential with discoveries in the Flemish Pass and Jeanne d'Arc basins, which shared common characteristics with the Orphan Basin. The recent acquisition of a large amount of high quality seismic data shed new light on the prospectivity of the margin and allow addressing key information about the structural model for the northeast Atlantic opening.

The newly imaged 800 km-wide Orphan Basin, at the junction between the Newfoundland–Iberia and the Newfoundland–Irish rift systems, has recorded the long-lasting rifting processes active in the Northeast Atlantic region during the Mesozoic. The NW-SE Late Jurassic– Early Cretaceous (Neocomian) tectonic extension related to Newfoundland-Iberia rift system explains most of the structural evolution of the Orphan Basin and implies that up to 800 km of stretched continental lithosphere must be considered when studying the continental rifting processes between the Newfoundland and Iberia margins. The new structural analysis performed in the Orphan Basin allows for proposing a revised version of the Northeast Atlantic opening model.

The Northeast Atlantic region is characterized by Late Jurassic–Early Cretaceous extensive intracontinental rifting. Before extension, the Orphan Knoll, Porcupine High, Galicia Bank, Goban Spur, and Flemish Cap continental fragments formed a large, unstretched continental block. The western rift branch, passing through the Jeanne d'Arc, Orphan, South Porcupine, and Rockall basins, experienced several hyperextensional episodes without achieving continental breakup, whereas by the Late Aptian time the eastern branch ruptured through rift propagation between Newfoundland and Iberia.

The drastic tectonic stress change from NW-SE to NE-SW occurred at the end of the Early Cretaceous with only minor impact on the Orphan Basin (local tectonic inversion of relatively small intensity). Oblique rifting may predominate in the earliest phase of extension between Newfoundland and Northwest Europe (as recorded at the same time in the Equatorial Atlantic region). This stage ended in the Late Albian with continental breakup separating Newfoundland and Irish conjugate margins.

The study of the Orphan Basin demonstrated spatiotemporal dynamics of the Northeast Atlantic rifting controlled by: (i) the inherited structural fabric controlling the initial location and later segmentation of the margins, (ii) more than 65 Ma of extensional regime through successive rifting stages, and (iii) drastic changes of maximum horizontal stresses.