Deformable Plate Reconstructions Provide New Insights into the Structural Evolution of the North Atlantic between Ireland and Canada

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Abstract
A team of leading researchers from academia, government, and industry on both sides of the Atlantic has recently completed the first year of a two-year study to develop *A New Kinematic Plate Reconstruction of the North Atlantic between Ireland and Canada*. The project team, which is led by GeoArctic Ltd, includes researchers from Badley Geoscience Ltd., University College Dublin (UCD), Memorial University of Newfoundland (MUN), University of Liverpool, the Dublin Institute of Advanced Studies (DIAS), the Geological Survey of Canada (GSC), and others.

The plate kinematics of the North Atlantic Ocean has been well documented and there is general agreement that extension started in the Triassic and lasted until the Tertiary, with final separation between the Flemish Cap and Galicia Bank occurring in the Early Cretaceous and between Greenland and the Hatton Bank in the Palaeogene. Understanding the tectonic history of the conjugate margins of Newfoundland and Ireland is critical for evaluating their hydrocarbon potential and, as petroleum exploration has focused increasingly on deep-water continental margins in recent years, plate tectonic reconstructions are coming into their own as an important exploration tool. Current plate kinematic models for the North Atlantic are inadequate when it comes to understanding the pre-breakup history of the region and its influence on basin geometry. It is critical, therefore, that we better understand the pre-breakup history and employ plate reconstruction tools and techniques that are up to that challenge.

The current study benefits from the deformable plate reconstruction method developed by GeoArctic in the late 1990s (Whittaker et al, 2000) that eliminates many of the inherent short-comings found in rigid plate reconstructions. The method advances ideas first put forward by Srivastava and Verhoef (1992) for the removal of extension at plate margins. However, their earlier approach used a gross estimation of continental lithosphere extension (β factors) from the measurement of plate overlap, which did not accommodate lateral, depth-dependent, and time-dependent variations in the amount and direction of extension or movement in the vertical plane due to tectonic subsidence. Whittaker et al (2000) first describe a 4D deformable plate reconstruction that used as input β factors for key time intervals calculated from 3D tectonic subsidence maps. This method has since evolved to include the wide range of geological processes responsible for basin development as well as analytical techniques that include 2D or 3D gravity inversion, flexural backstripping and forward modelling in the calculation of vertical movement and lateral, depth-dependent, and time-dependent variations in the amount and direction of extension. For this study gravity inversion, flexural backstripping and forward modelling have been carried out by Badley Geoscience Ltd. (Roberts et al, 2011).

A robust deformable plate model may be used to accurately remove the effects of pre-breakup extension across conjugate margins thereby providing a means to better evaluate basin formation and evolution and takes into account the wide range of geological processes responsible for basin development. Ultimately, the ability to apply the deformable plate model to restore, not only the palaeo-position, but the pre-breakup geometry of basins, palaeogeography, structure, sediment source areas, and reservoir facies represents a major advance over rigid plate models in the evaluation of source rock and reservoir potential. The new kinematic model for the North Atlantic between Ireland and Canada resulting from this study will

provide us with an enhanced understanding of the major controls and mechanisms for basin formation and evolution in offshore Atlantic Ireland and Eastern Canada.

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Biography

Bridget Ady is a geologist with over 25 years experience in the field of computational and mathematical geology. She co-founded GeoArctic Ltd in 1996 where she has designed and developed deformable plate modelling and plate reconstruction techniques and software. She has worked as the plate modeller on plate reconstruction projects that include the Amerasia Basin, Baffin Bay, Labrador Sea, Barents Sea, North Atlantic and Indonesia.

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