Opening of the North-Atlantic and Formation of the Jan Mayen Micro-Continent - Tectono-Thermal Modeling of a Dual Breakup System

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The Arctic Ocean is progressively moving back into the focus of academic research and industry exploration. Its complex geological history has created high-potential frontier area basins for exploration but poses a major challenge to basin modeling. Extensional tectonics, multiple breakup events with jumping ridge axes, magmatism, uplift, and erosion have left their fingerprints in the basins observed today. This study presents the results of comprehensive basin modeling of a transect spanning from East-Greenland to the Norwegian margin.

The key structural elements are the Greenland continental margin to the West, the Jan Mayen microcontinent in the center, and the Norwegian margin to the East. Multiple rifting events from Permian to Paleocene times have cumulated in breakup and opening of the North Atlantic. Breakup occurred first east of Jan Mayen in the early Eocene (~55Ma) and led to the separation of Jan Mayen and Greenland from Norway. Spreading jumped to the west of Jan Mayen in the late Eocene-early Oligocene (~30Ma) and Jan Mayen drifted away from the Greenland margin. In addition, a number of erosion and uplift events have affected the area. Jan Mayen was uplifted to or above sealevel and heavily eroded at ~30Ma. Suggested causes of this uplift include interaction with the Iceland plume and/or magmatic underplating. Likewise, the Greenland margin has been uplifted. Possible causes for this uplift include flexural unloading by grand scale glacial erosion and interaction with the Iceland plume.

A series of model realizations with a special focus on breakup, underplating as well as uplift and erosion have been performed with TECMOD2D. These reconstructions put bounds on likely structural and thermal evolutions. All realizations have been analyzed for their hydrocarbon potential with a focus on the maturity of inferred Jurassic source rocks beneath Jan Mayen. Key findings include that (1) differing seismic interpretations result in multiple possible evolution scenarios and uncertainties on the presence of Jurassic source rocks beneath Jan Mayen. (2) Multiple breakup events had first order control on the thermal evolution of the lithosphere. The Norwegian margins appear not to have reached thermal equilibrium from the 55Ma breakup event. (3) Erosion had strong effects on the thermal evolution of sediments at Jan Mayen. (4) Lateral heat flow from dual breakup had major control on Jan Mayen water depths but a lesser effect on hydrocarbon maturation.