

The Consequences of Hyperextension on Deep Water Basins: Examples From the North Atlantic and Circum-Arctic

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ABSTRACT

Over the past decade, hyperextension has become increasingly recognized as a common extensional process on continental margins worldwide. Increased deep-water exploration has resulted in new research, seismic data and modelling techniques that have provided new insights into the structural evolution of these hyperextended margins. Palinspastic deformable-margin plate reconstruction methods can help to quantify the amount, direction and timing of hyperextension and to restore margins to their pre-rift configuration. These reconstructions show that, in many areas, rifting and hyperextension are the primary processes responsible for extremely thinned continental crust where stretching factors (beta) reach 3 or more. Such extreme crustal stretching requires that we reevaluate hyperextended margins in terms of its consequences on thermal subsidence, basin architecture, and flexural uplift. During extension the amount of stretching of the continental crust generally increases from the hinge line, which marks the transition from undeformed to deformed crust, to the distal parts of the margin where maximum stretching occurs. This causes a corresponding change in facies and palaeogeography across the margin, variations in subsidence and basin margin uplift, and has consequences for heat flow and hydrocarbon maturity. The evolution and depositional history of the emerging deep-water provinces of the North Atlantic and circum-Arctic, including the Labrador Sea, Porcupine, Rockall and Orphan Basins and the southwest Barents Shelf, are discussed in light of what we now know about hyperextended margins. The ability to quantify and restore the history of crustal extension across these margins using palinspastic deformable-margin plate reconstructions provides us with restored structural profiles and backstripped 3D structural models. These models help give us a clearer understanding of the relationship between hyperextension and sedimentary basin evolution. Hyperextended margins can easily be misinterpreted, but when their possible consequences are fully understood they can provide us with potential new petroleum plays.