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Barents Sea crustal architecture and basin development

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The Barents Sea continental shelf is characterized by a complex tectonic history and thus comprises a wide range of crustal and basin architectures that formed in response to different geological processes. Overlapping Paleozoic orogenies (Timanian, Caledonian, Uralian) preceded multiple rift episodes mainly affecting the western Barents Sea and eventual breakup with Greenland to the west and Lomonosov Ridge to the north. Recent work related to the PETROBAR and BarMod projects has provided new details on basin architecture, tectonic and thermal histories, stratigraphy, paleogeography, paleo-water depths and the role of the basement grain in the structuring of the Barents Sea basins.

The eastern Barents Sea comprises a wide and deep sag basin that formed by rapid subsidence in Late Permian-Early Triassic times, most likely in response to basin-forming mechanisms other than rifting. The deep East Barents Sea Basin was filled by thick uppermost Permian and Triassic sediments prograding westwards from uplifted source areas mainly in the SE (Urals).

In the western Barents Sea we find more typical rift basins formed in response to at least three major post-Caledonian rift phases: Carboniferous, Late Jurassic-Early Cretaceous, and Late Cretaceous-early Paleogene. The rifting activity migrated westwards through successive tectonic phases. Carboniferous rifting affected the entire western Barents Sea and gave rise to NE-SW to N-S trending horst and graben structures following a Caledonian basement grain. These structures were covered by a regional carbonate platform before renewed faulting affected the SW Barents Sea in Late Permian time. The major prograding system reached the western Barents Sea in earliest Triassic time gradually filling in a regional basin of considerable waterdepths. Late Jurassic-Early Cretaceous oblique extension and formation of the deep SW Barents Sea basins was linked to the North Atlantic-Arctic plate tectonic evolution.

Regional uplift associated with the Early Cretaceous High Arctic Large Igneous Province gave rise to a depositional system characterized by north to south progradation covering most of the Barents Sea. Volcanic extrusives are preserved in the northern Barents Sea, mainly on Franz Josef Land and eastern Svalbard, while intrusives are found widespread, particularly in the deep East Barents Sea Basin.

A Late Cretaceous-Early Paleogene mega-shear system along the western Barents Sea-Svalbard margin (De Geer Zone) linked rifting, breakup and initial opening of the Norwegian-Greenland Sea and the Arctic Eurasia Basin. Narrow pull-apart basins formed within this dominantly shear system, in particular at a releasing bend in the margin SW of Bjørnøya. A restraining bend SW of Svalbard gave rise to the transpressional Spitsbergen Fold-and-Thrust Belt.

Compressional structures of different styles are found widespread in the Barents Sea region. The nature and timing of these are difficult to constrain in many areas due to later uplift and erosion, but we expect that there are different causes and timing involved. At the western margin we see evidence of compressional deformation as young as Miocene in age.

The entire Barents Shelf was uplifted and eroded during Neogene time and thick fans of Plio-Pleistocene glacial sediments were formed in front of bathymetric troughs characteristic of both the western and northern Barents Sea. Most of the uplift is closely linked to the glacial erosion, but tectonic uplift occurred prior to the glaciations.