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Opening of the northern North Atlantic and formation of the sheared western Barents Sea-Svalbard and NE Greenland margins

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Late Cretaceous-Paleocene rifting and subsequent breakup and initial seafloor spreading in the Norwegian-Greenland Sea was linked to the Arctic Eurasia Basin by a regional megashear zone. The western Barents Sea-Svalbard margin developed along this zone and consists of five main segments: (1) A sheared margin along the Senja Fracture Zone (70 - 72 30 N), (2) a rifted margin SW of Bjørnøya associated with volcanism (72 30 - 74 30 N), (3) a sheared margin along the southern Hornsund Fault Zone (74 30 - 76 N), (4) an initially sheared and later rifted margin west of Svalbard between Sørkapp and Kongsfjorden (76 - 79 N), and (5) a complex sheared and rifted margin along NW Svalbard and SW Yermak Plateau associated with volcanism (79 - 81 N). Each segment is characterized by distinct crustal properties, structural and magmatic styles, and history of vertical motion. The first-order crustal structure along the margin and its tectonic development is mainly the result of three controlling parameters: (1) the pre-breakup structure, (2) the geometry of the plate boundary at opening and (3) the direction of relative plate motion. The interplay between these parameters gave rise to striking differences in the structural development of the different margin segments. Detailed mapping using seismic, gravity and magnetic data show that each of the regional margin segments is composed of a series of short rift and shear segments.

The continent-ocean transition (COT) is mapped from seismic profiles and the relation between crustal thickness and mantle Bouguer anomalies. The western Barents Sea-Svalbard margin is covered by an extensive seismic database and here the COT is confined within a narrow zone (10-20 km) at the sheared margin segments but is

more obscure and partly masked by volcanics at the rifted margin segments. Only a few seismic lines are available from the conjugate NE Greenland margin so the COT here is mainly constrained by the strong gradient in the mantle Bouguer anomalies. The new COT location indicates that the distinct segmentation of the western Barents Sea-Svalbard margin is mirrored on the conjugate NE Greenland margin. A refined location of the COT around the Hovgård and Greenland ridges is also provided.

Plate tectonic reconstructions based on the new COT and identified seafloor spreading anomalies, spreading axes and fracture zones, have been used to study the oblique opening of the northernmost NE Atlantic and the evolution of the conjugate margins. They also place constraints on the opening of the Fram Strait deep-water gateway linking the Atlantic and Arctic ocean between Svalbard and NE Greenland. A pre-condition for gateway opening was the change from strike-slip to oblique extension between Svalbard and NE Greenland at the Eocene-Oligocene transition (33.3 Ma). A continuous corridor of immature seafloor spreading formed by Chron 5B times (14.8 Ma) indicates up to about 18 Myr of extensive pre-drift crustal thinning. The gateway may have been further delayed until the presentday seafloor spreading regime was established at Chron 5 times (9.8 Ma). The age of the gateway agrees with the regional sedimentary record of Late Cenozoic deep-water exchange and climatic cooling.