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Plate tectonic constraints on the opening of the Arctic-North Atlantic deep-water gateway

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The Fram Strait between Svalbard and Greenland provides the only exchange of deep water masses between the Arctic and the North Atlantic oceans and is therefore important to European climate and ocean circulation. At the same time, the strait is made up of ridge segments and transform faults belonging to the Eurasian-North American plate boundary. The Gakkel Ridge to the north and the Knipovich Ridge to the south have been spreading since the Paleocene and the Eocene, respectively. However, seafloor spreading in the Fram Strait was delayed while the plate boundary here evolved as a predominantly transform boundary. For example, the West Spitsbergen fold-and-thrust belt was formed because of transpression between Svalbard and Greenland. We have investigated how plate tectonics may constrain the timing of the subsequent transition into rifting and seafloor spreading. First, we have interpreted the continent-ocean transition (COT) from all available seismic profiles offshore Svalbard and east Greenland. Beyond the profiles we have used the relation between crustal thickness and the Bouguer gravity anomaly as a proxy COT. Magnetic lineations are re-interpreted by modelling of the seafloor spreading along historical aero- and ship magnetic tracklines. We attain a refined Eocene-to-present opening model compatible with existing plate tectonic models of the Arctic and North Atlantic. The very earliest possibility for a deep-water connection would be the Eocene-Oligocene transition ($\sim$33 Ma) when relative plate motions between Svalbard and Greenland changed from strike-slip to spreading. However, magnetic anomaly 5B ($\sim$15 Ma) and possibly anomaly 6 ($\sim$20 Ma) are the oldest magnetic anomalies that can be traced continuously through the Fram Strait. Accordingly, there must have been a 13-18-m.y. rifting phase preceding the seafloor spreading, as indicated by post-Eocene downfaulting of basement terraces on the western Svalbard margin. During this period the Fram

Strait was probably shallow on the average. The deep-water connection may have been further delayed from the time of onset of seafloor spreading because of continental “bridges” across transform faults, the Hovgard ridge microcontinent, and the subsidence of young oceanic crust. If our model of 20-15 Ma opening is correct, it would be interesting to examine North Atlantic sediment cores for independent corroboration of the gateway opening.