Cenozoic tectonic framework of the Baffin Bay – Nares Strait region of Arctic Canada and Greenland

Gordon Neil Oakey
Geological Survey of Canada (Atlantic), 1 Challenger Drive, PO Box 1006, Dartmouth, NS, B2Y 4A2 <Goakey@nrcan.gc.ca>

During the Mesozoic and Cenozoic evolution of the North Atlantic rift system, the independent movement of the Greenland Plate resulted in a complex intraplate tectonic history between Canada and Greenland. In this study, a new plate kinematic model is presented for the Paleocene – Eocene motion of Greenland relative to Canada (North American Plate). The model is constrained by seafloor spreading magnetic anomalies in the Labrador Sea and the fracture zone geometry defined by satellite-derived gravity data over Baffin Bay. In the Nares Strait region between northern Greenland and Ellesmere Island, 175 km of NE-oriented sinistral motion is defined during the Paleocene followed by 250 km of northwestward convergence during the Eocene. The change in direction occurred during chron 24N (Lower Eocene). This new model is consistent with the different episodes of the Cenozoic Eurekan orogeny.

Marine magnetic data have been re-interpreted in context with the new kinematic model. Linear anomalies over central Baffin Bay are interpreted as Paleocene seafloor spreading anomalies. Over northern Baffin Bay, a new Eocene fracture zone is identified by a small amplitude linear anomaly parallel to the fracture zones defined by satellite-derived gravity. New aeromagnetic data were collected in the Nares Strait region as part of a Canadian-German research program to improve the details of the intraplate boundary. The northern Hall Basin survey identified a narrow magnetic anomaly that correlates with a fault-bounded (Tertiary) sedimentary basin onshore Judge Daly Promontory (Ellesmere Island). The basin is mapped offshore as an elongated NE-trending feature and is interpreted to be the transpressive (Eocene) plate boundary. The southern Kane Basin survey identified an offshore extension of a Proterozoic dyke which can be mapped westward from an outcrop on Greenland to the Ellesmere coast with no offset, suggesting that the plate boundary identified to the north does not extend as a continuous linear feature through Kane Basin and the Archean crustal block of SE Ellesmere Island is part of the Greenland Plate.

New gravity observations over Ellesmere Island and Axel Heiberg Island have been integrated with existing Canadian and Danish data sets to produce a comprehensive regional-scale compilation. A large amplitude gravity low crossing Nares Strait is cut obliquely by the frontal thrust of the Cenozoic Eurekan rogeny and corresponds with thick Paleozoic strata along the Franklinian margin rather than crustal thickening from the Eurekan orogeny. The gravity modeling also identifies substantial crustal thinning beneath the Lancaster Sound sedimentary basin, and is interpreted to be a failed rift-arm of the Eocene Baffin Bay spreading system. Calculations of crustal thickness suggest that as much as 40 km of extension occurred, enough to consider Ellesmere Island (and Devon Island) as a separate plate from North America during the Eocene. Also, the association of the basin development with the oceanic (volcanic) rift system implies that the strata (>6 km) are predominantly Eocene and a high heat flow is expected. As such, the tectonic framework provides critical constraints on potential development of petroleum systems.