The case for major displacement along Nares Strait

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Johnson, G. L. & Srivastava, S. P. 1982. The case for major displacement along Nares Strait. – In: Dawes, P. R. & Kerr, J. W. (eds), Nares Strait and the drift of Greenland: a conflict in plate tectonics. – Meddr Grønland, Geosci. 8: 365–368.

Nares Strait is a prominent physiographic lineament between Greenland and Ellesmere Island, Canada. That it has attracted the attention of geologists, geophysicists and geomorphologists is attested to by this volume. This summary is based solely on those articles presented in the volume that suggest that lateral motion has occurred along Nares Strait; the amount of movement indicated for the Strait ranges from 200 to 320 km.

The Nares Strait dilemma is not yet resolved. Additional dedicated geophysical and geological investigations in the region surrounding Nares Strait will have to be undertaken before a satisfactory solution to the problem can be found. Hopefully, this volume will instigate such activities.

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Nares Strait, the linear seaway between Greenland and Ellesmere Island, has played an important role in continental drift studies of the Arctic ever since Taylor (1910) suggested it was the site of major transcurrent movement. However, land geologists and marine geophysicists have had a different outlook on the origin and significance of Nares Strait for a long time. This is further attested to by the data presented in this volume and by the two summary papers concluding the volume dealing with the cases for and against major movement along Nares Strait (cf. Dawes & Kerr, this volume). The difference in conclusions of the two summary papers is not because the two papers are in any way biased, but they tend to emphasize the differences in the approach to the problem by the two groups. Land geologists who have mapped the rock units on one or both sides of the Strait have maintained the view that Nares Strait is mainly a graben feature and little or no lateral displacement has taken place along it. Marine geophysicists, on the other hand, have regarded the Strait as a convenient lineament along which to slip the Greenland continental block to explain the evolution of the seas surrounding Greenland (e.g. Arctic Ocean, North Atlantic, Labrador Sea – Baffin Bay, Fig. 1). We agree that the geology of the land surrounding the Strait offers certain constraints for invoking lateral motion along it, but because the structural and lithological boundaries across it lack definite continuities different models involving movement up to 320 km of lateral displacement along it have been proposed by various workers.

The appropriate papers are summarized below in tabular form. Data outside those directly applicable to the problem of whether motion and how much motion occurred along Nares Strait are omitted from this summary. The selection is from a purely objective evaluation and apologies are due to any author who may feel slighted.

Authors	*Amount of displacement*	*Evidence*
Monahan, D. & Johnson, G. L.	240 km	1. Presence of a deep linear trough must be explained. 2. Land geologists can accept 50–100 km offset of marker beds, an additional 60–70 km can be accommodated by geometric uncertainties. 3. The remaining kilometres may be accommodated by post-Palaeozoic expansion of the Northwest Territories platelet by crustal thinning in Lancaster Sound and Jones Sound and in the Sverdrup Basin.

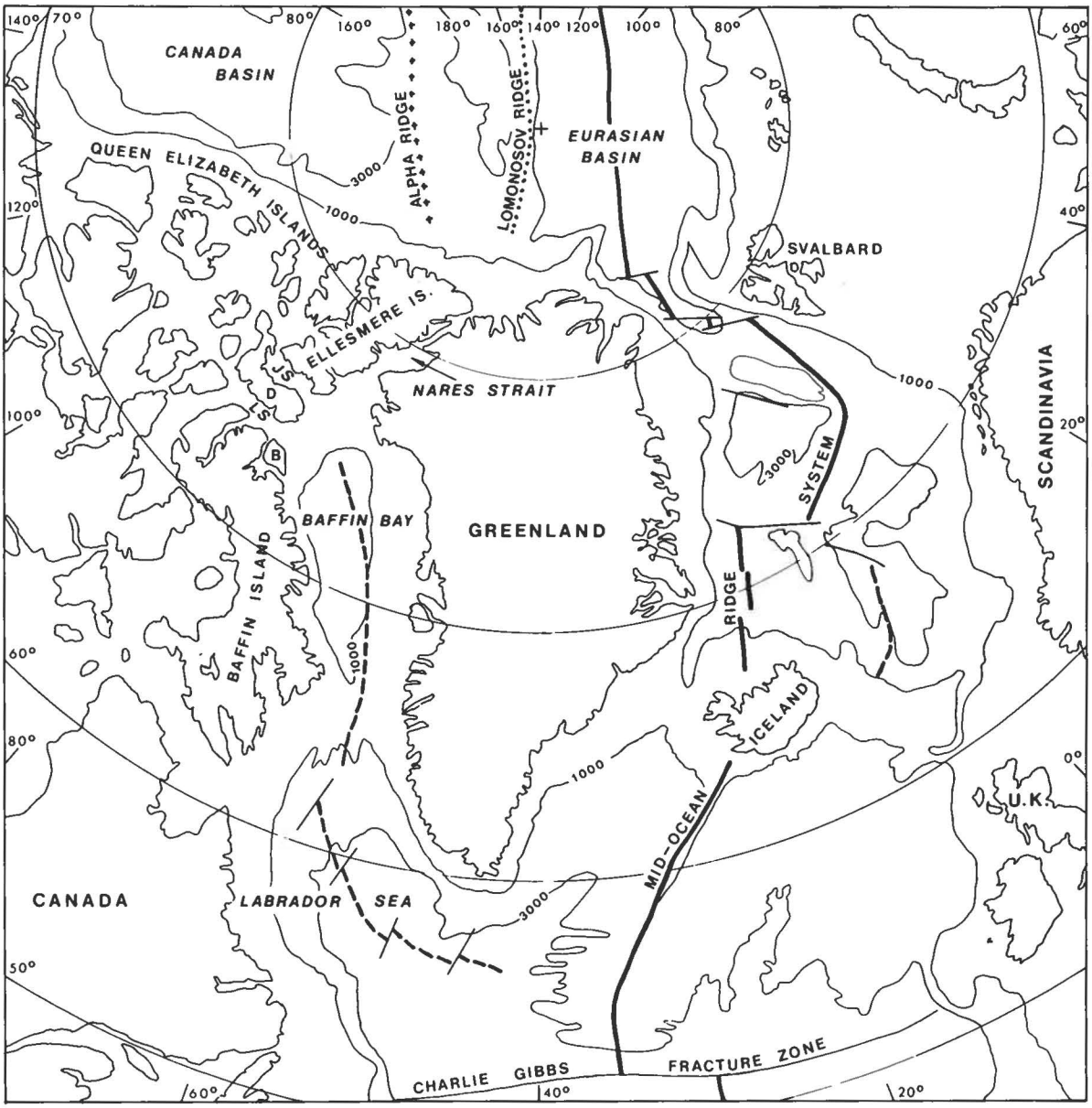

Fig. 1. Index map showing the setting of Nares Strait in the North Atlantic – Arctic Ocean system. J = Judge Daly Promontory, JS = Jones Sound, D = Devon Island, LS = Lancaster Sound, B = Bylot Island. Heavy full lines = active spreading centres, dashed lines = extinct spreading centres, dotted line = ridge of continental origin, line of crosses = ridge of uncertain origin, thin full lines = fracture zones. Bathymetry is in metres.

Authors	*Amount of displacement*	*Evidence*
Mayr, U. & de Vries, C. D. S.	not determined	Late Eocene to early Miocene sinistral strike-slip movement of 19 km parallel to Nares Strait is suggested from the Judge Daly fault zone on the western landward boundary (Ellesmere Island).
Peirce, J. W.	320 km	1. Stratigraphic evidence on Bylot Island of a mid-Cretaceous and younger graben. First phase of the

Authors	*Amount of displacement*	*Evidence*
		Eurekan orogeny created by counter-clockwise rotation of Greenland and Ellesmere Island resulting in crustal shortening of the Sverdrup Basin. 2. Sea-floor spreading in Baffin Bay caused Greenland to move left-laterally some 320 km; during the mid-Oligocene Greenland and Ellesmere Island moved northwest 40–50 km (main phase Eurekan orogeny).
Newman, P. H. (a & b)	200–300 km	1. Geophysical measurements near the southern end of Nares Strait indicate it to be a fault bounded feature, filled with sediments to the north and basalt to the south. 2. Correlation of the structural boundary between deformed and undeformed rocks at the margin of the mid-Palaeozoic fold belt of northern Ellesmere Island and Greenland. 3. Correlation of Proterozoic successions and asymmetrical graben systems of Bylot Island – northern Baffin Island and North-West Greenland. 4. Nares Strait may be one arm of a triple junction (with Baffin Bay and Lancaster Sound) along which transform motion occurred.
Menzies, A. W.	about 240 km	Geophysical observations in the Labrador Sea and Baffin Bay show that these regions were formed by sea-floor spreading, thus requiring large strike-slip movement along Nares Strait, unless the Canadian Arctic Islands are assumed to be a platelet.
Kovacs, L. C.	250 km	1. Depth to magnetic source indicates that Nares Strait extends ~325 km as a deep structural lineament parallel to the northern coast of Greenland. 2. Offset of basement highs with characteristic magnetic signatures on either side and perpendicular to Nares Strait (Wegener Fault) indicates a 250 km movement during the Tertiary opening of Baffin Bay.
Keen, C. E. & Peirce, J. W.	about 250 km	1. Crustal extension, mantle upwelling and magmatic intrusion, considered as mechanisms for the formation of Baffin Bay, cannot satisfactorily match the available data from the Bay. Thus Baffin Bay formed by conventional sea-floor spreading requiring large strike-slip movement along Nares Strait. 2. If no more than 25 km of sinistral strike-slip movement has occurred along Nares Strait, possibilities which need serious consideration are: a) Wegener Fault is a zone, not a single feature and therefore motion may be taken up over a larger area. b) Lateral motion might be accommodated by extension of continental lithosphere in northern Baffin Bay and/or by compression within the Sverdrup Basin.

Author	*Amount of displacement*	*Evidence*
Srivastava, S. P. & Falconer, R. K. H.	about 250 km	1. Substantial movement required by kinematics of North Atlantic as a whole. 2. Alternative is that motion was accommodated by folding and faulting within the Northwest Territories and/or shear within Greenland. However, evidence of events of this magnitude is lacking for the present.

Conclusion

Nares Strait is a prominent physiographic lineament between Greenland and Ellesmere Island which has attracted the attention of many geologists, geomorphologists and geophysicists. To the reader of this volume it will be quickly apparent that there is a considerable diversity of opinion as to the amount of movement, if any, on Nares Strait, from none at all to as large as 320 km. This is because of the criteria used in deciphering motion or no motion along this lineament. When one looks at a small region of the Strait, either geologically or geophysically, the answer invariably comes out that little or no lateral motion has taken place in this region. On the other hand, significant lateral motions are suggested along the Strait when one considers large-scale tectonic developments of the surrounding regions (e.g. papers by Monahan & Johnson, Peirce, Menzies, Srivastava & Falconer).

In general, the mobilists adhere to the concept of sea-floor spreading in which large parts of the present oceanic regions were formed due to the separation of the plates (Fig. 1). The second tenet, which is not so universally adhered to, is that the plates behave in a rigid manner. Non-rigidity within the Greenland or northern part of the North American plates would help to alleviate the problem of large lateral motion along Nares Strait, but it may not be acceptable to all land geologists. We hope the number of articles presented in this volume will give readers a chance to assess what is known of the Nares Strait region and the problems one faces in trying to explain the evolution of the oceanic regions surrounding Greenland and at the same time maintaining the continuity of the geological boundaries across Nares Strait. Ideally, this volume will lead to a more rigorous examination of geology and geophysics surrounding Nares Strait by all earth scientists to decide what additional work is needed to solve the Nares Strait enigma.

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