Physiography of Nares Strait: importance to the origin of the Wegener Fault

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Nares Strait is a long, deep trough which, at its shoreline at least, is straight. Most theories of its origin are deduced from observations remote from the Strait and even those observations adjacent to the Strait were seldom if ever taken for the express purpose of elucidating its origin. Direct observations of the floor of the Strait are very scarce, yet without them the dilemma of movement or non-movement seems unresolvable. We have been able to map the gross physiography of the Strait and can deduce from it that the area has undergone compression along an approximately northwest–southeast axis.

In order to resolve the dilemma of motion or no motion along Nares Strait, we suggest that a post-Palaeozoic northward movement (50–100 km) of the Canadian Arctic Islands by the process of crustal thinning in Lancaster and Jones Sounds and in the Sverdrup Basin can, when combined with geologic/geometric uncertainties, account for the present-day relatively small observed net offset.

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The Nares Strait dilemma is a mapping problem; participants in the Nares Strait symposium have mapped and interpreted some phenomena which have a bearing on the nature of the feature itself or of earth processes and motions that may or may not have taken place along it. Carefully reasoned, internally consistent arguments starting from different measurements and based on different premises lead to conflicting conclusions, indicating that either the measurements are erroneous or irrelevant or that the premises on which the arguments rest are invalid. In this contribution we are concerned with the morphology of the Strait and its spatial relationships with the adjacent land and oceanic areas, and of course our measurements and premises are as fraught with dangers as are everyone else's.

The facts, absolute and unarguable, of this case are extremely few; there is a big trough between Greenland and Ellesmere Island (Fig. 1). We do not know what it is, how it got there or when it was formed. Those workers who have examined the geology of one or both sides, and we should emphasize that they are extremely few, have largely ignored the necessity for explaining the presence of the trough or have fallen into the trap they implicitly ascribe to others in that they have made assumptions as to the origin of Nares Strait based on scant or non-existent information. Alternatively those who ascribe an origin to the trough because conclusions they reach regarding the history of adjacent oceanic areas are otherwise untenable, seem to believe the trough offers no restrictions to their conjecture; the physical reality of Nares Strait enters their calculations not at all.

What does the trough look like? As stated earlier, we are dealing with a mapping problem and consequently our answer depends on the scale and area of investigation. Looked at from far enough away, Nares Strait would not exist at all, that is, there would be no break between Greenland and Ellesmere Island. But as we move closer, it would become apparent that Greenland and Ellesmere are separated by water; through this we may be tempted to draw a straight line, but closer inspection still would reveal that the straight line would only be a very rough approximation to the complex shape that now appears. To the man in the field, the trough looks very complicated indeed. The most important of these complications is that he finds that rather than looking down at the trough as we do when looking at a map, he is looking up at land surrounding him. The trough has an impressive vertical component. In cross-section we have two very dissected plateaux of about 1500 m elevation separated by a trough as deep as 800 m below sea level and from 25 to 100 kilometres wide (Fig. 2) Did material ever fill this void? If so, where is it now? Any possible mode of origin must answer these questions as well as satisfy all the relevant conditions outlined by other papers in this symposium and in the literature.

Assuming the trough to approximate a long, linear depression we must ask how such a physiographic fea-

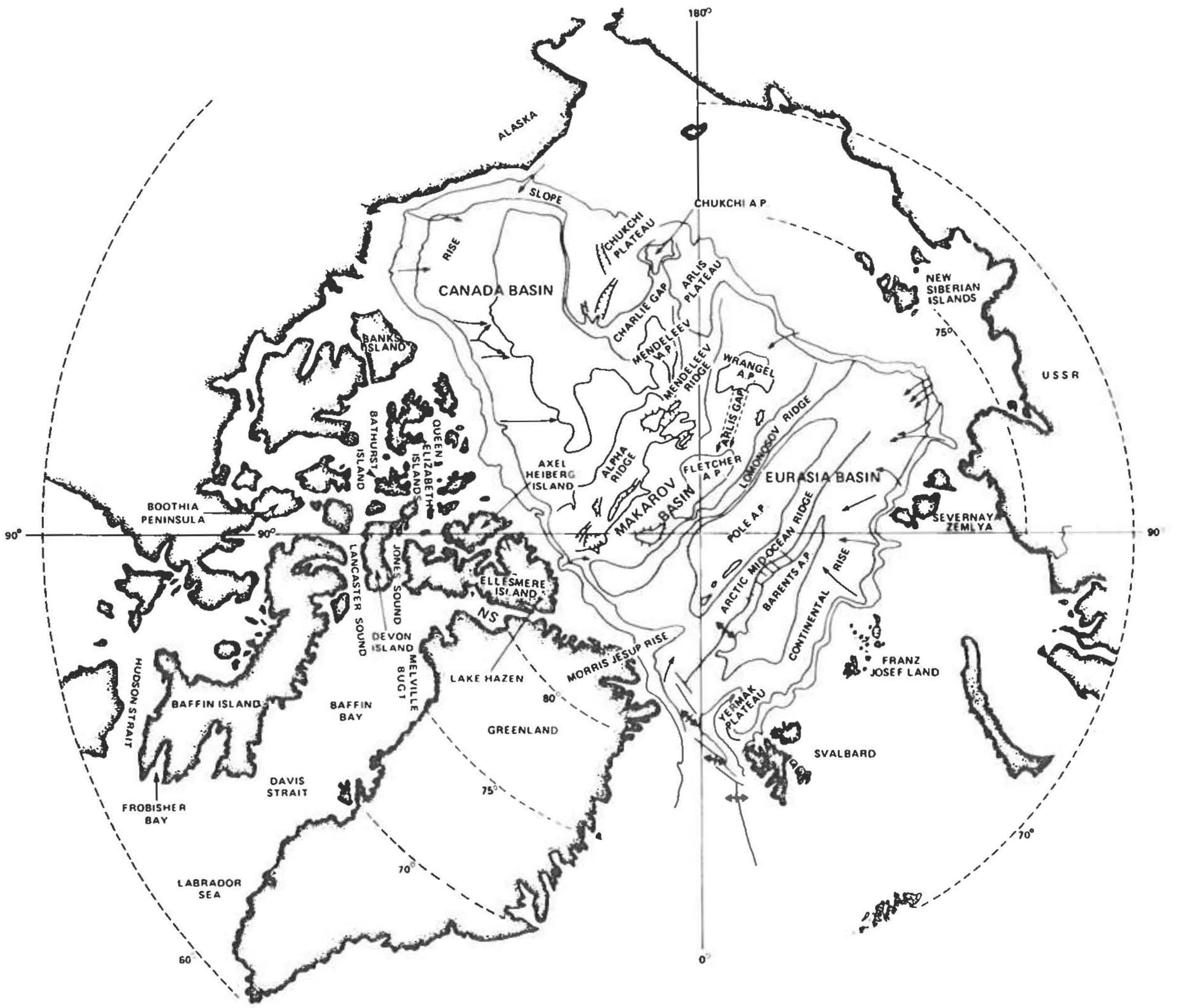


Fig. 1. Index map of the oceanic and continental regions adjacent to Nares Strait (NS).

ture could form. Firstly, assume it was formed in a continuous landmass, that is, no drift occurred, then, (Fig. 3b) erosion could have preferentially removed material to form the trough; compression, extension or upwarp of the crust could cause a graben to form (Fig. 3c). Compression could have caused the crust to buckle or down warp. Secondly, assume that the trough formed in a continuous landmass but allow the landmass to be fractured by a plate tectonic event, then (Fig. 3e) a transform fault (wrench fault) could have cut the crust; this would have to include either a component of drift transverse to the fault to open up the trough (Fig. 3f, 1) or, failing that, be followed by lateral erosion away from the fault trace (Fig. 3f, 2). Rifting apart of the two sides of the trough due to rotation of Greenland counterclockwise relative to Ellesmere Island (Fig. 3g) or rifting without rotation, that is, a straight pull apart between Greenland and Ellesmere Island (Fig. 3d), could also have occurred. Thirdly, we could suppose that Greenland and Ellesmere Island currently rest on plates that are drifting towards one another, their proximity at present forming a trough. We thus have eight possibilities, some of which have had adherents in the literature (see Kerr 1980), some of which apparently have been ignored, but all of which warrant some attention especially in view of our current state of ignorance of Nares Strait.

It is sobering to put our ignorance into perspective by considering approaches taken to similar problems in the past. Consider, for example, the San Andreas Fault. There is a strong resemblance between the objectives of this volume and that addressed by two symposia on a similar and related theme, namely the magnitude of movements along the San Andreas Fault. Forty papers (Dickinson & Grantz 1968) followed by 50 papers (Kovach & Nur 1973), addressed the problems of

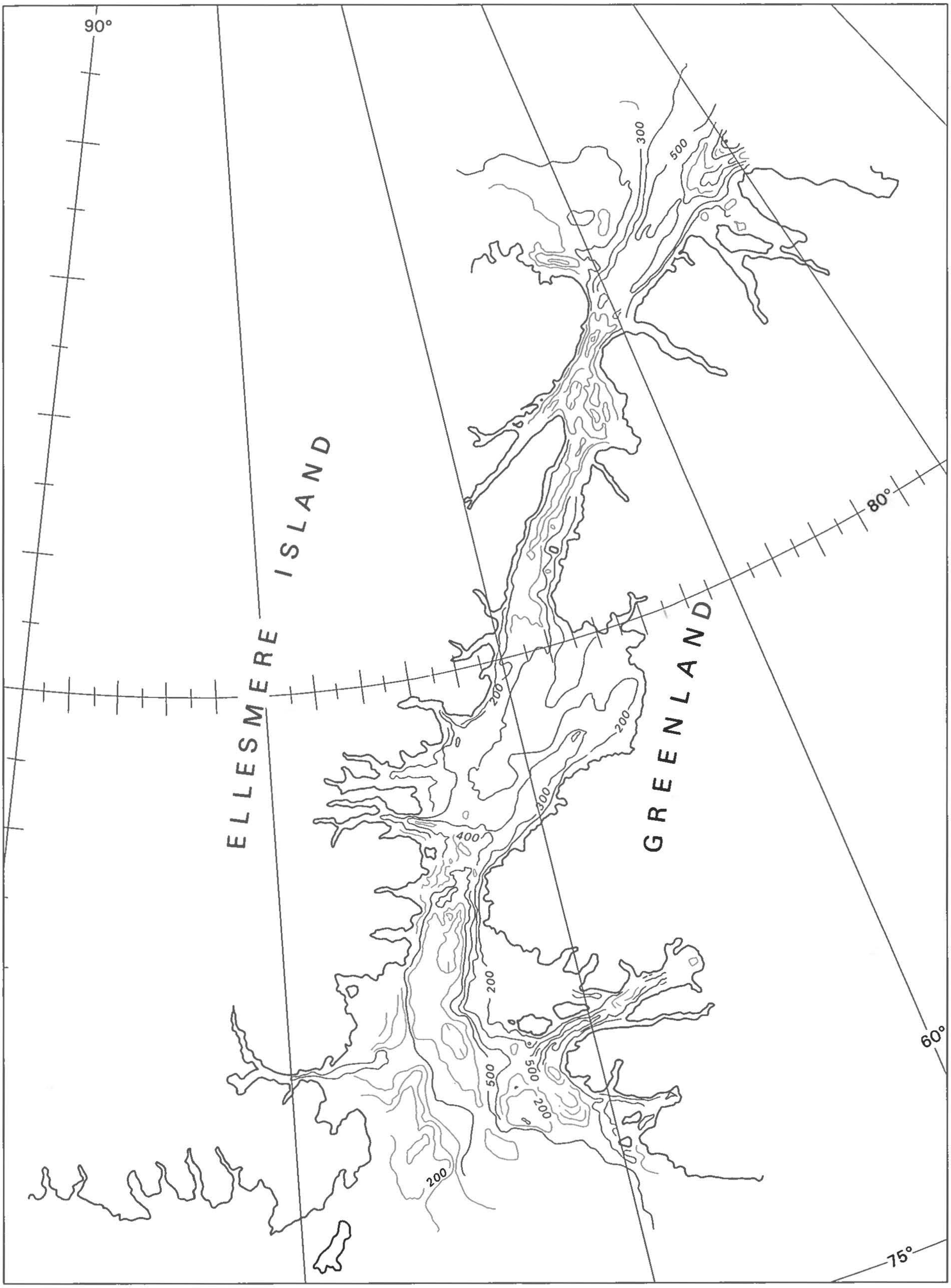


Fig. 2. Bathymetry of Nares Strait (after Johnson et al. 1979). Depths are in metres.

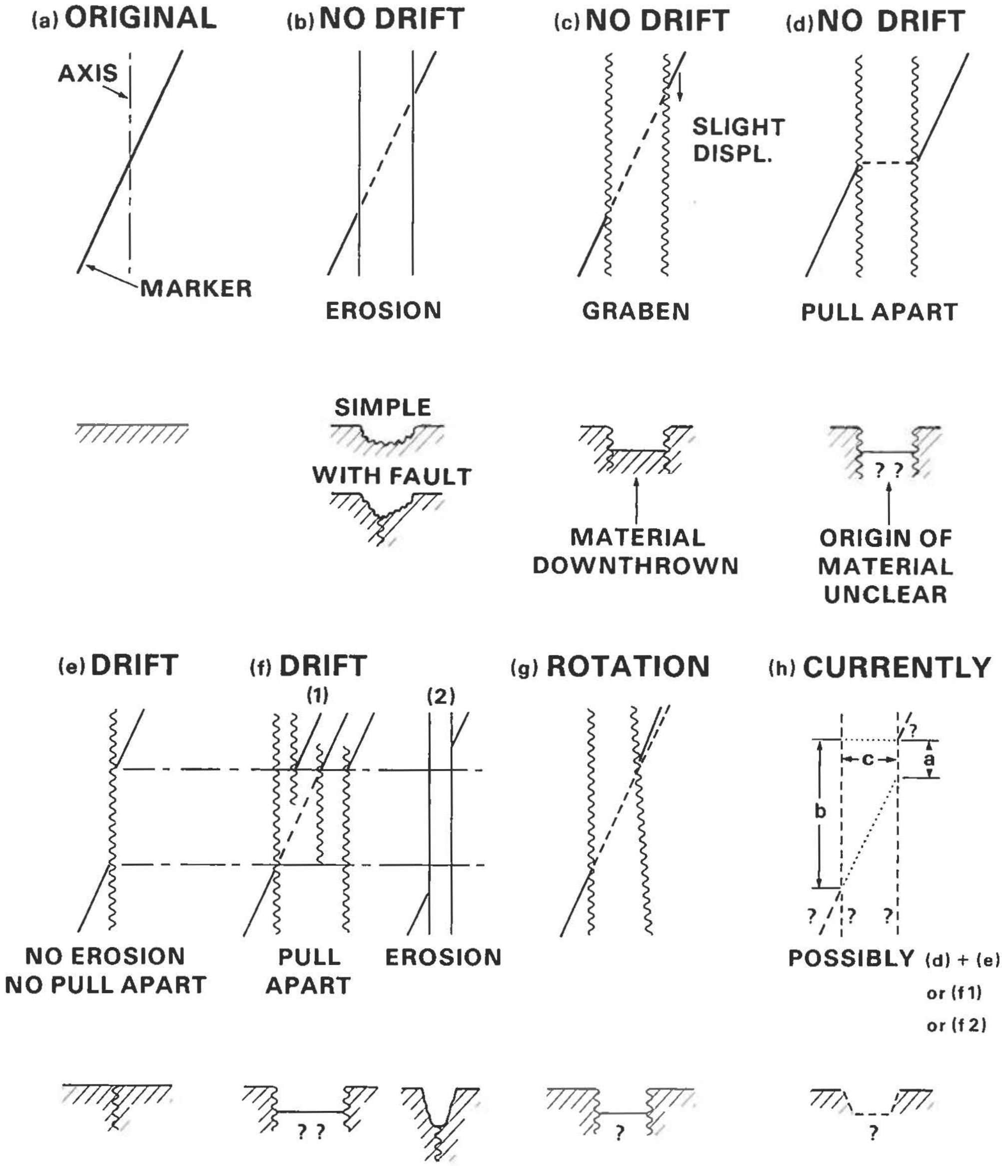


Fig. 3. Diagrammatic representation of several modes of origin of Nares Strait. Upper portion of each diagram is a plan view, lower portion a cross-section. The marker shown intersects Nares Strait at 30° which is approximately representative of many markers mapped along the Strait. (a) shows one possibility for the original configuration before the Strait was formed. This assumes that the Strait was formed in a single continental plate although the possibility that Greenland and Ellesmere Island have never been part of the same plate cannot be ignored, (b) shows a simple case of preferential erosion, (c) shows a simple graben, (d) shows faulting followed by separation between each side, (e) shows simple drift along a fault axis, (f) shows drift followed by separation (1) or by erosion (2). Note that in (1), depending on the amount of separation, geometry similar to that in (b), (c) and (d) could be produced, (g) shows the case for slight rotational separation and (h) shows the situation as currently mapped by some workers, for some markers. Assuming no vertical movements, this could have arisen from some combination of (d) and (e) or from (f). In such a case, minimum drift is 'a', maximum 'b' and uncertainty 'a–b'.

movement along the San Andreas Fault, a feature that is: a) clearly a fault; b) clearly has had strike-slip movement along it; c) conveniently outcrops on land for over 800 km; d) does not form an international boundary; e) is readily accessible and f) has a strong, fault trace derived topographic expression. These produced only a plethora of contradictory estimates of movement ranging from 45 yards to 450 km. We, on the other hand, are attempting to elucidate a feature: a) whose nature is not clearly established, that is, we do not know that it is a fault; b) may or may not be the product of strike-slip movement; c) is inconveniently covered with sea-water or ice; d) forms an international boundary adding to the already logistically difficult location; e) is not only inaccessible but hides some of the relevant geology under permanent ice caps or yearly snowfall and f) has a most enigmatic topographic expression. Should the San Andreas Fault not seem an apt enough model, consider the Great Glen Fault in Scotland which has a mere 160 kilometres of outcrop. A summary by Harris et al. (1978) indicates that this fault has reportedly suffered sinistral shifts of between 104 and 224 kilometres, or dextral shifts of between 29 and 160 kilometres, depending on whose field evidence is accepted. These examples are cited to point out the extreme difficulty in determining or refuting strike-slip movement of any sort on the ground. We are faced with a far more difficult situation in that we do not even know whether Nares Strait represents the surface expression of strike-slip movement.

This evidence of the extreme difficulty in dealing with major earth movements in the field is again symptomatic of the problems of scale in relating field observations to major crustal deformation. The high number of hypotheses and magnitudes of movements advocated on other similar features indicates their extreme complexity. A hypothesis that explains one portion of a feature of this nature may not be adequate or appropriate in other sectors of its length. In Nares Strait, very, very few people have traversed its entire length looking for a unifying hypothesis that would explain the many manifestations of this complicated feature.

One could then consider the measurements made in the oceans surrounding the Strait. Here again we are extremely ignorant. The best way of illustrating this is to refer to the papers by Grant (1980, this volume) in which he presents a composite diagram showing 16 different positions for Greenland as reported in the literature mainly based on measurements made at sea pertaining to plate tectonics. Not all of the 16 positions can be correct. None of the 16 reconstructions he cited nor any of the others that could have also been included that we have been able to find in the literature deal with the problem of showing what the Strait itself is, although it is presumed to be a transform fault by most marine geologists and geophysicists.

We thus find two polarizations, almost ideologies of approach, neither of which has had the direct objective of studying the origin of the trough. The efforts of land based geologists have been directed towards elucidating the formations which occur on one side or on the other side of the Strait; they have largely ignored, and continued to ignore throughout the symposium, modes of origin for the Strait. Several of them have discussed their work with their colleagues working on the opposite side of the Strait and decided on the basis of these discussions that they are mapping equivalent formations. This is still not conclusive evidence that drift did or did not occur, since equivalent formations can be mapped on either side of the Atlantic Ocean to name one example. Conclusions of no drift seem to be a manifestation of the Law of Parsimony; since there is no reason to invoke drift in explaining the geology, it is not invoked.

The alternative philosophical approach is based on marine geophysical observations some distance removed from the Strait. These observations, primarily magnetic lineations and oceanic crustal velocities, were first interpreted in the Atlantic Ocean as manifestations of sea-floor spreading. Subsequently, similar observations were interpreted in the Labrador Sea and in Baffin Bay to mean that Greenland and the North American landmass separated from one another by such a process. This interpretation, and it is not a necessary interpretation since the Atlantic could have opened without displacing Greenland, requires that there be relative movement between Greenland and some part of the Canadian Arctic; this movement, on maps at least, is most easily accommodated along Nares Strait. The literature pertaining to the geology surrounding Nares Strait has not been abundant, and certainly not been conclusive, and to marine geophysicists it has not offered sufficient constraints to deter them from moving Greenland relative to Ellesmere Island. This too is an application of the Law of Parsimony; since there is no reason not to move Greenland, move it.

This situation of having two contrary schools of thought is a natural, healthy one, from which will come a new third viewpoint that will be closer to explaining how Nares Strait was actually formed. Such a third view will only come through attempting to synthesize what each school has to contribute.

Geometric considerations

Let us examine the geometry of the situation starting from the totally unsubstantiated assumption that Greenland and Ellesmere Island have contributed through mutual interaction to form Nares Strait. How would drift along Nares Strait manifest itself under the many possible circumstances that could have taken place? Fig. 3a shows diagrammatically the axis of an incipient Nares Strait together with a geological marker or boundary intersecting the axis at 30°, which approximates the situation in at least the northern portion of the Strait. Not all markers intersect the Strait at 30°, but it seems that those best mapped do so. Note the totally unfounded assumption that the marker is straight. Fig. 3b shows one possible origin for Nares Strait in which simple erosion focused on the Strait for some unknown reason, possibly along some type of fault, created a trough with no relative movement between Greenland and Ellesmere Island. The marker remains linear. Should Nares Strait be a graben, then as

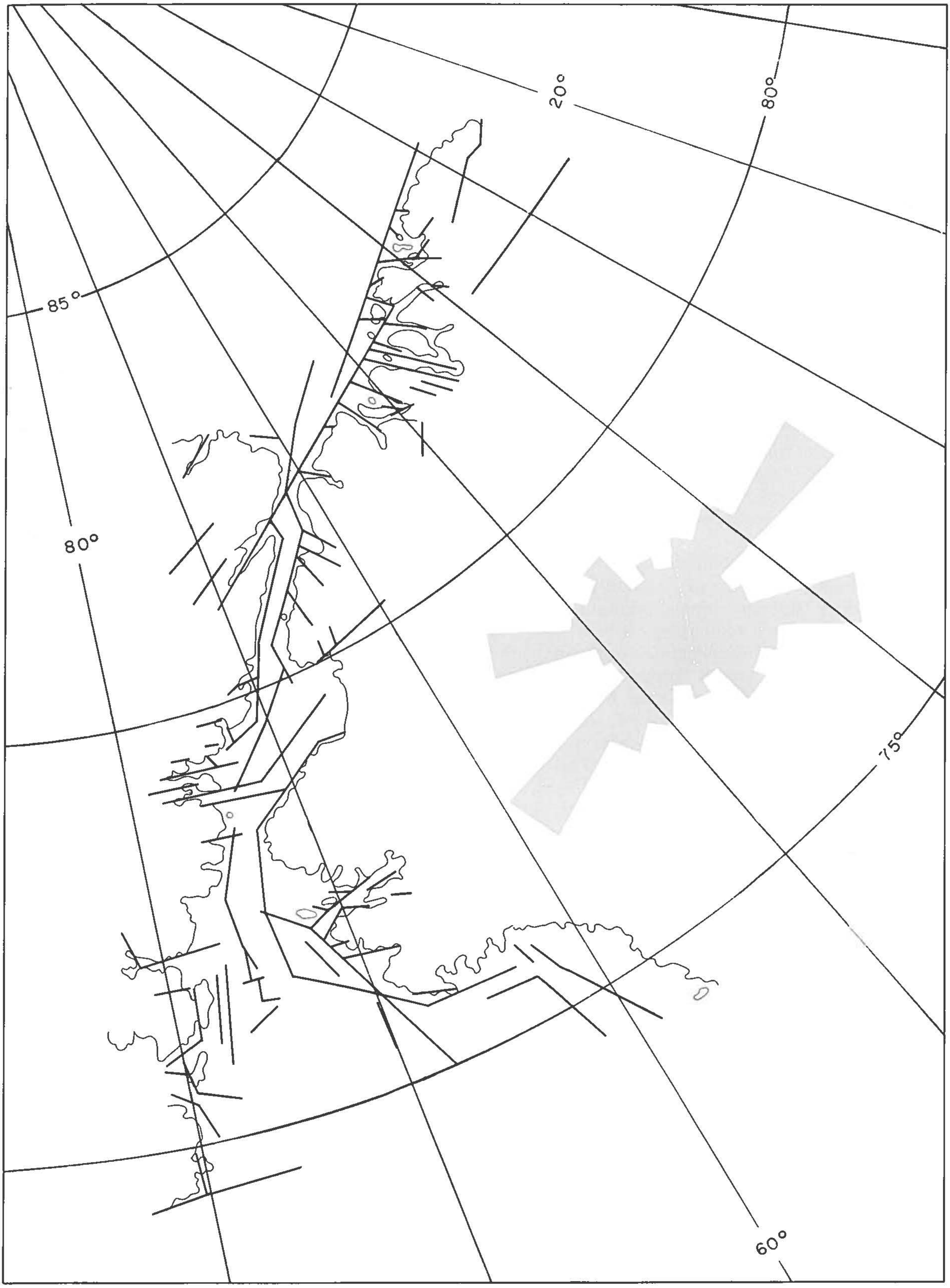
Fig. 3c indicates, there would be a very slight displacement of the marker and the material flooring the trough should be similar to that on the adjacent land. Next, as in Fig. 3d, we assume that there has been no drift but that Greenland and Ellesmere Island have pulled apart from one another. In this case the origin of the material flooring the trough would be unclear and the marker would be displaced significantly from its otherwise linear configuration. Turning to situations in which drift did occur, Fig. 3e shows displacement of the marker which would occur with merely strike-slip movements along the axis. This is meant to be read in conjunction with Fig. 3f in which drift accompanied by pull apart or by erosion has taken place. Note that with pull apart it is entirely possible to arrive at marker configurations similar to those in Figs 3b or 3c in which no drift occurred. Pulling apart even further would produce confusing situations somewhere between the configuration shown in Figs 3c and 3d. Again the nature of the material forming the floor of the trough would be unknown. Not to be ignored is the possibility that Greenland rotated counter-clockwise relative to Ellesmere Island as shown in Fig. 3g. It is possible from the geometry of the Strait itself to postulate rotations of about 3¹/₂° and such rotation would be virtually undetectable with the present configuration of markers.

The situation shown in Fig. 3h is that currently mapped by many workers. It shows a strait of unknown origin whose sides were formed in some as yet unresolved fashion and with geological markers displaced away from an extension of one another. If this configuration is correct, and if the situation has not been confused by vertical movements, then this situation could have only been caused by some combination of events which has to include those portrayed in Figs 3e and 3f. That is, some drift must have occurred for the mapped marker to be displaced by some amount. It is most useful to attach some approximate numbers to this diagram to determine the limits that any one marker can provide. We know from Fig. 3h that at least the amount of drift shown by 'a', can have taken place and possibly the amount shown by 'b'. The difference between 'a' and 'b' is therefore the amount of uncertainty in any measurements or estimates of drift based on geologic markers on either side of the Strait. If the Strait is 30 kilometres wide and the angle of intersection between the marker and the Strait is 25°, then the zone of uncertainty is about 65 km long: a 30° intersection gives 52 km and a 35° intersection gives 42 km. This slop could worsen to about 107 km if the width of the Strait were 50 km and the angle of intersection 25° and diminish to only 4 km if the Strait were 25 km wide and the angle of intersection 50°. It seems safe therefore to consider that there is approximately 50 km of slop inherent in the geometry of any measurement. This is a limit on the resolution of any movement that may or may not have taken place along the Strait. Unless evidence is presented that will substantiate or refute opening perpendicular to the axis of the Strait, drift less than approximately 50 km cannot be detected.

In the above it was assumed that the geological marker was not only straight, but clearly agreed upon. This is certainly not the case. Dawes (1973) discusses the many problems of deciding which boundaries should be safely correlated across the Strait and it is those very problems that attracted some participants to this conference. Part of the problem arises from the different interpretation of subdivisions used by those workers who advocate the geosynclinal model, but a more basic problem arises from the actual tectonic differences on each side of the Strait. Dawes (1973) reviews the fact that folding differs on either side of the Strait in that axial planes of folds dip north in Ellesmere Island and south in Greenland. This is not at all unexpected provided that the Strait is a major tectonic feature; textbooks on structural geology written twenty or thirty years ago are replete with descriptions of what were then called wrench faults, on either side of which folding directions changed in a manner very similar to that described in the region of Nares Strait. This is usually attributed to compression and is consistent with the pattern of linear scarps summarized in Fig. 4. Fig. 4 shows the trace of the scarps, together with a rose diagram in which length and sense of scarps have been weighted and assembled using a method suggested by Scheidegger (1979). This pattern clearly supports compression along a NW–SE axis.

The continuity of geological features across the Strait, which leads some workers to the conclusion that little or no drift has occurred, paradoxically led others in the nineteen-sixties to believe in drift between, say, North America and Europe. The apparent continuity of similar features across a body of water argues that they were once contiguous and since, as we have shown above, in Nares Strait neither continuity nor geometry offers any degree of rigidity, we feel that the case of non-drift is definitely not proven. Nor, however, is the case for drift. Although there are several models of the Arctic Ocean, Atlantic Ocean and Baffin Bay opening, none has any direct evidence from within the Strait itself. Until extensive geophysical work examines the floor of the Strait neither case can be definitively proven.

Fig. 4. 'Scarp' lineations in Nares Strait. Straight lines are scarp traces. Rose diagram represents an assemblage of lineations as percentage of total length of lineations compiled after a method suggested by Scheidegger (1979). The pattern shown could be interpreted as manifestation of compression along a NW–SE axis.


20°
80°
85°
80°
75°
60°

Geologic history of the Northwest Territories

Next we will go on to discuss briefly the history of the adjacent regions and present a hypothesis which might help to resolve the Nares Strait dilemma.

Kerr (1981) has related the Canadian Northwest Territories (NWT) to oceanic spreading in the Arctic and sub-Arctic. This study, based on a somewhat more refined history of sea-floor spreading in the Arctic is built upon his pioneering study. Our summary is contained in Table 1 with appropriate bibliographic references.

Kerr notes that initial fragmentation of the Precambrian and Palaeozoic core commenced in latest Devonian or early Mississippian time when the Sverdrup Basin first commenced receiving sediment. We consider this, the earliest event, as an abortive spreading centre which remained active until rifting was replaced by general subsidence as sediment continued to pour in. Faunal evidence (presence of circum-Arctic Upper Palaeozoic fauna) suggests that at least shallow waterways were present and indeed perhaps one occupied the suture from which Alaska was rifted away from the Canadian Arctic.

In the early Cretaceous a tensional regime fractured the crust, causing subsidence of the Sverdrup Basin into which the thick Isachsen Formation sandstone was deposited. This coincided with active sea-floor spreading in the Canada Basin which might be assumed to be the cause of the regional tension. Concomitant volcanism occurred with local basalt flows in the Isachsen Formation of northwest Axel Heiberg Island, while faulting and folding occurred in the Wandel Sea Basin of northern Greenland and in Svalbard (Dawes & Peel 1981).

The Eurekan rifting episode commenced in the late Cretaceous (Campanian–Maastrichtian time) as evidenced by sea-floor spreading in Labrador Sea/Baffin Bay as Greenland separated from North America. At this time, the faults and fault-controlled channels in the southeastern rift system formed. The Lancaster aulacogen is the most spectacular of these features. To the northwest, the Boreal orogeny resulted in regional uplift and erosion of the broad intra-basin arches in latest Cretaceous and early Tertiary. In the late Cretaceous there apparently was rifting in the southeast and northwest with little or none in the region between. The Canadian Arctic Islands region was subjected to two rifting events. The Boreal rifting episode caused uplift of the Pearya geanticline and Sverdrup rim. In the Paleocene and Eocene (65–45 m.y.), the crust of the Archipelago was extended by creation of large grabens and uplift of arches (Balkwill & Bustin 1978). Minor volcanism is recorded by the single basalt flow on Bathurst Island and farther southeast by the well-known early Tertiary volcanism on Baffin Island (Trettin et al. 1972). We suggest the uplift related to the doming and initiation of sea-floor spreading in the Fletcher Abyssal Plain region which commenced in the Campanian and ended in the mid-Eocene (Taylor et al. 1981). The main volcanic episode occurred in eastern Axel Heiberg Island at this time (75 m.y.) and comprises over 250 m of basalt flows — the Strand Fiord Formation (Trettin et al. 1972).

The Eurekan deformation reached its climatic phase in mid-Tertiary time (middle Eocene to early Miocene). During this stage, sea-floor spreading slowed and stopped in Baffin Bay, and the rifts were propagated farther northwest. The advance of the rifts northwestward into the Queen Elizabeth Islands was impeded by the preexisting structural trends, some of which were transverse to their paths and deflected their propagation. The Lancaster aulacogen was then further deflected southwestward by the Boothia Uplift.

Mid-Tertiary compressive deformation of the northeast NWT may be related to cessation of Baffin Bay spreading together with pressure from Greenland exerted by the Norwegian–Greenland spreading centre as Greenland affixed itself to the American plate. Pressure was perhaps applied northwestwards by Greenland across Nares Strait. Some support for this is found in the pattern of linear scarps, both onshore and underwater, in the Nares Strait region. Fig. 4 shows the trace of the scarps, which clearly supports compression along a NW–SE axis. In the Miocene there was some rejuvenated uplift of the NWT which might relate to an increase in the spreading rate of the Nansen Ridge (Vogt et al. 1979a).

Triple junctions

A common world-wide characteristic of graben systems is the occurrence of trilete patterns where three potential spreading ridges diverge to form rift, rift, rift or RRR junctions (McKenzie & Morgan 1969). Nonoceanic examples include the trilete systems of the North Sea, Gulf of Suez and Benue Valley (Whiteman et al. 1975). The RRR junctions are postulated to be generated by thermal expansion of the crust as a result of a "plume" or hot spot in the mantle (Morgan 1971, 1972). The hypothesis holds that updoming with con-

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Table 1.
Numbers in parenthesis refer to references cited as follows: (1) Balkwill (1978), (2) Dawes (1976), (3) Harland (1973), (4) Sweeney et al. (1978a), (5) Srivastava (1978), (6) Taylor (1978), (7) Harland (1969), (8) Vogt et al. (1979a), (9) Bally (1976), (10) Johnson et al. (1979), (11) Feden et al. (1979), (12) Churkin et al. (1979), (13) Kerr (1980), (14) Kerr (1981), (15) Trettin et al. (1972), (16) Brooks (1979), (17) Vogt et al. (1979b), (18) Hinz et al. (1979), (19) Newman et al. (1977).

Table 1. Summary of relevant events in the formation of the Arctic region (after Monahan & Johnson 1980).

	m.y.	ARCTIC OCEAN	CANADIAN ARCTIC ARCHIPELAGO	BAFFIN BAY LABRADOR SEA	NORTHERN GREENLAND	SVALBARD (SPITSBERGEN)
Miocene	0		Rejuvenated uplift of some arches (13)			
	20		Compressive folding and faulting of eastern Sverdrup Basin (19)		Uplift east coast Greenland (16)	Flood basalts (17)
Oligocene		Spreading between Spitsbergen and Greenland (11)	Banks Island extensional	Spreading ceases in Baffin Bay (5)	Thrust faulting	Volcanism (17)
Eocene	40	Rifting between Spitsbergen and Greenland (17)	Lancaster aulacogen active		Separation of Greenland and Spitsbergen (11)	West coast folding and faulting (3)
			Nares Strait rift (13, 14)			
		Eurasian Basin opens (Arctic mid-Ocean Ridge) (8)	Volcanism Bathurst Island (15)	Baffin Bay spreading starts Volcanism (5, 18)	Norwegian Sea opens (17)	
Paleocene	60	Siberia Abyssal Plain opens (6)	Boreal rifting - uplift of Pearya geanticline, Sverdrup rim and arches	Northern Labrador Sea spreading (5)	Kap Washington volcanism (2) Basic dykes (2)	
Cretaceous			Parry Channel opens (1, 13)			
	80		Volcanism Axel Heiberg Island (15)	Southern Labrador Sea opens (5)		Dolerites cutting Cretaceous basalts (3)
			Regional uplift and erosion			
	100		Volcanism	Initial rifting (18)		
			Faulting in Sverdrup Basin (13)			
			Diabase dyke swarm (20)	Volcanism (18)		
	120		Volcanism Axel Heiberg I. (1, 15)		Faulting and folding Wandel Sea Basin (2)	Faulting and folding (7)
		Canada Basin forms (1, 4, 8, 10, 12)	Banks Basin forms as rifted basin connected to Sverdrup Basin. Probable abortive rift (9)			
Jurassic	140					
	160					
	180	Probable early rifting				
Triassic	200					
	220					
Palaeozoic	240					
			Sverdrup Basin receives first sediment (330 m.y.). Probable abortive rift. Rifting replaced by general subsidence as sedimentation continues (1, 9)			

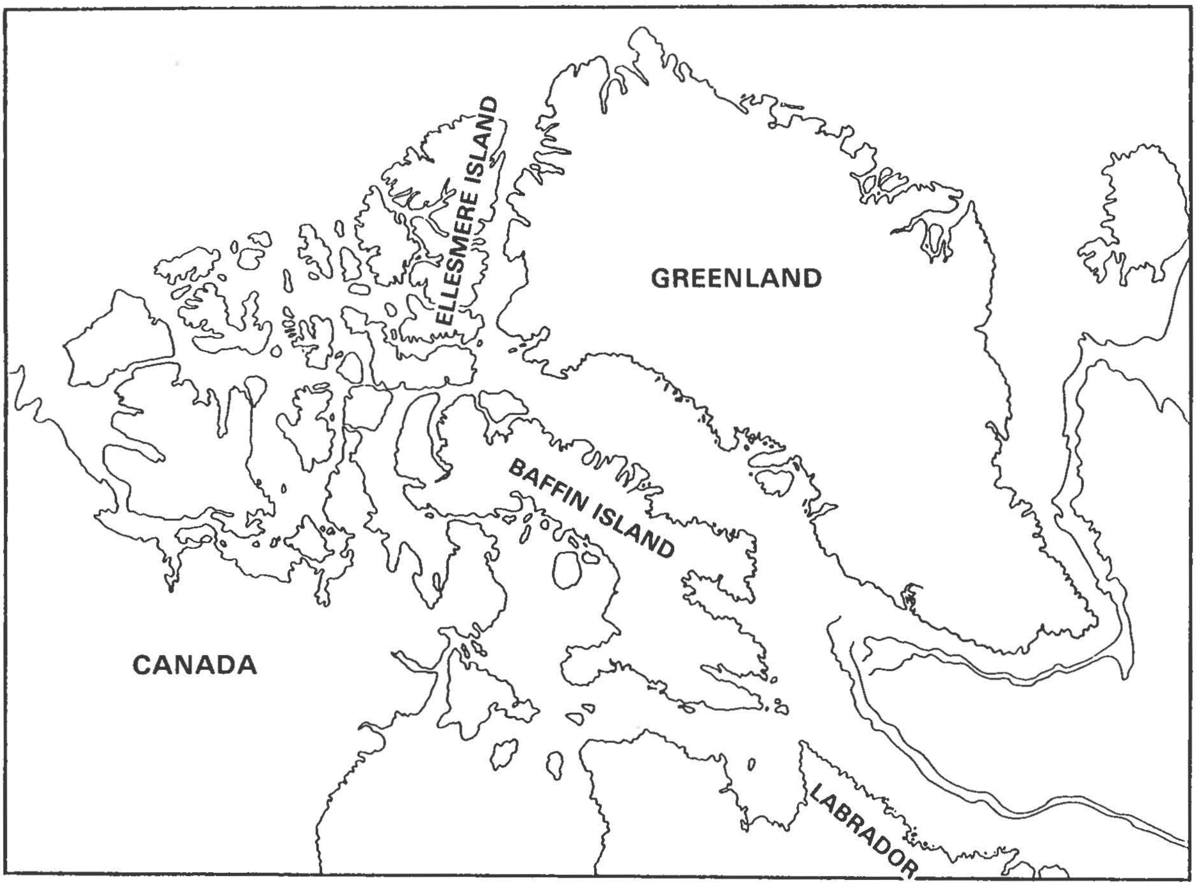

Fig. 5. Suggested late Palaeozoic reconstruction of the landmasses around Nares Strait showing Lancaster Sound and Jones Sound closed.

sequent thinning of the Earth's crust by subcrustal thermal erosion occurs over the thermal anomaly. Subsequent to the doming, crustal separation may occur with sea-floor spreading and the generation of new ocean crust. The trilete rifting may represent a least work configuration. Morgan (1972) has postulated that plume centres are responsible for the initial split of the Atlantic and other oceans. In the case of the North Sea and other continental examples, extensional faulting may occur; however there is no physical separation of the lithospheric plate. These have been referred to as "failed arms" by Brooks (1973) in describing a trilete pattern in East Greenland.

It seems possible that Baffin Bay, Lancaster Sound and the Nares Strait lineament are trilete rifts consequent to a "plume" or thermal anomaly which became active in northern Baffin Bay during the late Cretaceous–Paleocene time. This idea is not unique and several authors have briefly alluded to the possibility (Burke 1976).

In the late Cretaceous, doming affected extensive areas of the eastern Canadian Arctic Islands and northern Greenland (Trettin et al. 1972). It is postulated that some of the uplift resulted from a plume centred northeast of Lancaster Sound. This uplift led to rifting of the crust at several places (e.g. Frobisher Bay). It seems likely that the initial pattern was a rift or graben along the continental margin of Greenland (the Melville Bugt graben). Fig. 5 shows our postulated late Palaeozoic arrangement of the landmasses with Nares Strait, Lancaster Sound and Baffin Bay forming the trilete pattern. The latter contained at least a limited spreading axis while the two former are "failed arms".

No basic igneous rocks of proven Cretaceous–Tertiary age are known in the northern Baffin Bay region, but Paleocene basalts have been reported near Lake Hazen, northeastern Ellesmere Island (Christie 1964). In this regard northern Baffin Bay may be similar to the North Sea where basaltic rocks are obscured by sediment cover (Ziegler 1978).

Arctic Ocean

The Eurasia Basin is well demarcated by magnetic anomalies which date the separation of the Yermak Plateau and Morris Jesup Rise at anomaly 13 (38 m.y., Heirtzler et al. 1968, Feden et al. 1979) and the separation of the Lomonosov Ridge from Eurasia at or before anomaly 24 time (57 m.y., LaBrecque et al. 1977, Vogt et al. 1979b). However, following the suggestion of Taylor et al. (1981), that there are spreading anomalies between the Lomonosov and Alpha Ridges, we favour a continental origin for the Alpha Ridge (Johnson et al. 1978).

The date of the presumed rifting of the Alpha Ridge from the Lomonosov Ridge is uncertain. It might coincide with the initial rifting between Greenland and North America which according to Srivastava (1978) started during late Cretaceous and continued through anomaly 32 (75 m.y., Heirtzler et al. 1968). Anomaly 32 is the oldest anomaly that can be identified in the Labrador Sea (Srivastava 1978), and therefore is a favorable time to rift Alpha Ridge from the Eurasian continental margin. Srivastava's pole of opening at anomaly 32 time was located at 70.80°N, 150.93°E which allows the Arctic to be under a condition of tensional tectonic stress. Taylor et al. (1981) suggest that this spreading episode commenced in the late Cretaceous (anomaly 34/80 m.y.) and continued until mid-Eocene (anomaly 19/47 m.y., Heirtzler et al. 1968).

Palaeomagnetic data and evidence from regional structural and stratigraphic relationships in northern Alaska presented by Newman et al. (1977) suggest that the rotation of the Arctic Alaskan plate away from the Canadian Arctic Archipelago to create the Canada Basin began during the late Jurassic or earliest opening of the North Atlantic Ocean (Sweeney et al. 1978a, b). Rotation may have been followed by southward translation of the entire rotated block away from the Alpha–Mendeleev Ridge. The inception of rotation may have been as early as the Triassic (Newman et al. 1977, Sweeney et al. 1978 a, b), but no direct evidence of faulting of this age is seen in northern Alaska. Based on aeromagnetic data Taylor et al. (1981) have dated this spreading episode as occurring between 153 m.y. and 127 m.y. (Upper Jurassic – Lower Cretaceous). The spreading history thus indicates that with concurrent spreading in the Nansen Basin, Makarov Basin and Baffin Bay, Nares Strait would serve as a transform fault with a triple junction in northern Baffin Bay as well as at the northern end of Nares Strait.

Conclusion

Did Nares Strait act as a transform fault? Present reconstructions (Srivastava 1978, Srivastava & Falconer, this volume) show a northward movement of Greenland relative to Ellesmere Island by a left-lateral motion along Nares Strait of 250 km. We have previously noted that there can be a geometric ambiguity of 60–70 km. Some land geologists generally allow for 25–100 km of offset (Christie et al. 1981). Assuming the maximum, this still leaves a minimum of 80 km unaccounted for. We suggest this amount and possibly more can be accounted for by post-Palaeozoic extension or continental thinning in the Canadian Arctic. This would be similar to the continental "thinning or stretching" suggested for the North Sea grabens by Sclater & Christie (1980). This would have the effect of shifting the original Palaeozoic marker beds of Ellesmere Island to the north, therefore this motion can be subtracted from the unresolved 80 km. The width of Lancaster Sound is 75 km, Jones Sound is 40 km and the Sverdrup Basin has apparently been under tension since the late Palaeozoic with perhaps another 50 km of extension (Table 1). Therefore our hypothesis to resolve the dilemma of motion or no motion along Nares Strait is as follows: During the late Palaeozoic the continental fragments were arranged as shown in Fig. 5. As indicated by Srivastava 1978) Greenland generally moved to the NE some 250 km. The geometry of the situation indicates a 60–100 km ambiguity (Fig. 3). Some land geologists can tolerate a 50–100 km offset (Christie et al. 1981). We suggest the remaining kilometres were accommodated by the expansion of the NWT platelet by the process of crustal thinning in Lancaster and Jones Sounds and in the Sverdrup Basin.

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