



On the Relative Effects of Using Sector or Median Lines for Partitioning the Juridical Continental Shelf beyond 2000 Nautical Miles in the Arctic Ocean

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The combined Exclusive Economic Zones (EEZs) of the five coastal states bordering the Arctic Ocean (Canada, Greenland¹, Norway, Russia, USA) form an unbroken belt that encircles the entire Ocean, leaving a high seas enclave in the centre (Figure 1). It has been shown (Macnab et al, 2000) that upon implementation of Article 76 of the UN Convention on the Law of the Sea (UNCLOS), the five states among themselves could be in a position to share jurisdiction over resources of the seabed that underlie most of this enclave. This paper describes an analysis of two hypothetical scenarios for partitioning this jurisdiction among the five states, and compares how the choice of partition affects the sizes of the areas that would devolve to individual states.

This study was undertaken strictly for academic purposes, and its outcome is not intended to be prejudicial to the present or future interests of any of the five affected states. As of this writing, no coastal state anywhere in the world has established formally the outer limit of its zone of extended jurisdiction, but it can be confidently predicted that many will do so in the next few years - and when they do, a significant number will have to address the question of defining bilateral boundaries with neighbouring states. Arctic coastal states will similarly have to deal with this issue, however the situation in the polar region could be complicated by historically contrasting approaches to the definition of bilateral boundaries.

The Juridical Continental Shelf in the Arctic Ocean

Regional descriptions of the bathymetry of the Arctic Ocean and of the thickness of the underlying sediment are available in the public domain as numerical grids (Jakobsson et al, 2000; Jackson and Oakey, 1986). An analysis of these data sets was undertaken using a digital methodology that was developed specifically for the implementation of Article 76 of UNCLOS (van de Poll et al, 2000). The result (Macnab et al, 2000) demonstrated that most of the high seas in the Arctic Ocean could be underlain by the combined juridical continental shelves of the five coastal

¹ While this paper refers to the self-governing territory of Greenland as a coastal state, it should be noted that in most respects, Denmark maintains the right to exercise jurisdiction over the oceanic regions adjacent to Greenland. However, to maintain the geographic focus of the discussion, Greenland is identified throughout this text as the affected coastal state

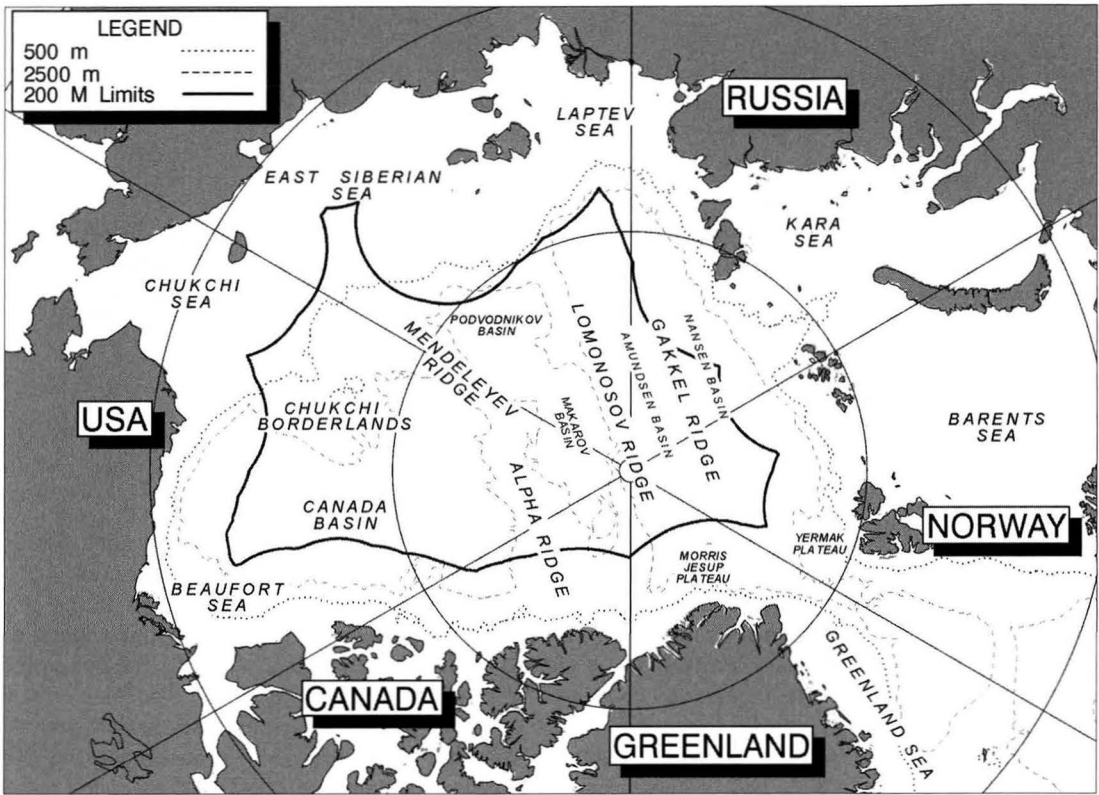


Figure 1: The Arctic Ocean: constituent seas, principal seabed features, and the conjoined 200 nautical mile limits that circumscribe the combined Exclusive Economic Zones of the surrounding coastal states. Isobaths derived from GEBCO Sheet 5.17 (Canadian Hydrographic Service, 1979)

states, with the exception of a small zone situated between the Chukchi Borderlands and the Alpha Ridge, and a larger one overlaying the Gakkel Ridge (Figure 2). According to the provisions of Article 76, the latter two zones appear to lie beyond the seabed jurisdiction of any coastal state.

It is worth noting here that the data sets from which these findings were derived are the products of ongoing collaborations between investigators in a number of Arctic and non-Arctic states. In some respects, the data sets are preliminary and incomplete, but there are continuing efforts at the international level to enhance them with new information that will support more authoritative determinations of the outer continental shelf limit. With that proviso, the limits shown in Figure 2 are believed to be a fair representation of the general situation, but they remain subject to revisions in detail, pending improvements to our knowledge of the bathymetric and geological nature of the seabed.

Between	Longitude	Remarks
Canada and Greenland	60°W	Shown on official Canadian charts
Greenland and Norway	1°E	Originating near midpoint of shortest line between Greenland and Spitsbergen (not a formal boundary)
Norway and Russia	32°4'30"E	Shown on official Russian charts
Russia and USA	168°58'37"W	1990 Agreement between USSR and USA
USA and Canada	141°W	Shown on official Canadian charts

Table 1: Sector Lines

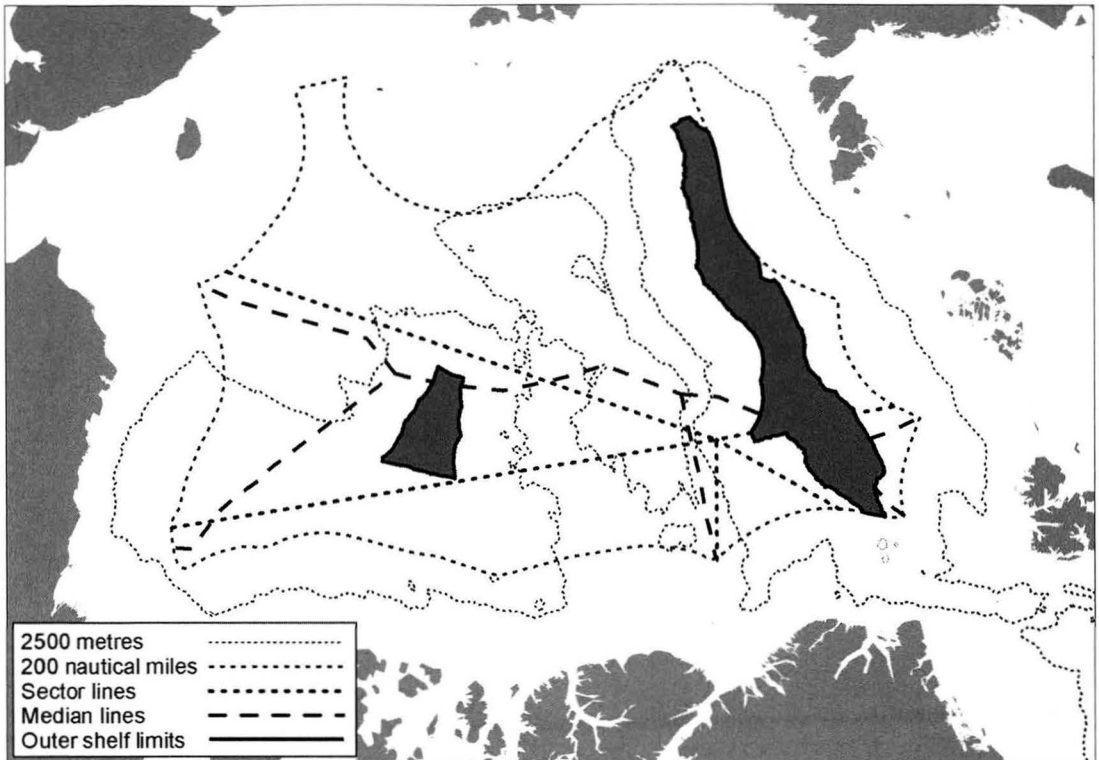


Figure 2: The combined juridical continental shelves of the five coastal states could potentially fill all of the Arctic Ocean beyond 200 nautical miles, except for the two grey-shaded zones that would lie beyond state jurisdiction. The sector and median lines shown here represent two hypothetical approaches for partitioning the combined continental shelves among the five coastal states

There is a general recognition of the potential for contention arising from overlapping continental shelf claims in the Arctic Ocean. At the same time, the view has emerged that some of the grounds for this contention could be reduced to a certain extent by developing among the Arctic states a common understanding of the bathymetric and geological factors that bear upon the implementation of Article 76. In the expectation that this approach would facilitate the consistent development of outer shelf limits, a pattern of informal co-operation has developed among international specialists who share a common interest in Arctic continental shelf delimitation (Macnab, 1999).

Partitioning the Juridical Continental Shelf

As a sequel to the investigation described above, an analysis has been undertaken to compare two possible approaches to partitioning the combined juridical continental shelves of the five coastal states in the Arctic Ocean. There is no question that additional approaches exist, but it was decided to restrict the present analysis to an evaluation of techniques that are strictly geometric. The first technique consists of dividing the high seas enclave by five sector lines that converge at the North Pole; the second entails the calculation of median lines between neighbouring states that are everywhere equidistant from selected territorial seas basepoints.

Sector lines

Pharand (1988) reviews the use of sector lines that converge upon the North Pole to define limits of national jurisdiction in the Arctic Ocean. Of the five coastal states, only Canada and Russia have demon-

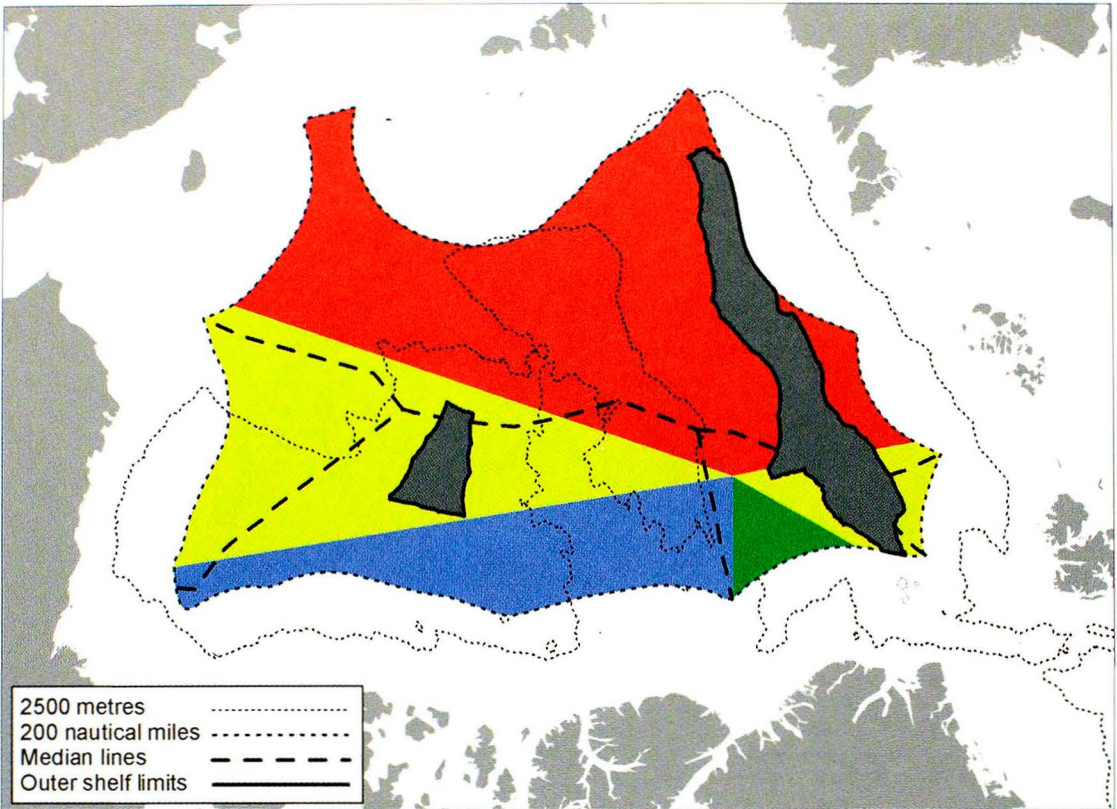


Figure 3: Juridical continental shelves beyond 200 nautical miles, showing hypothetical partitions as coloured polygons bounded by sector lines, i.e. meridians of longitude that converge at the North Pole

strated a historic adherence to the sector principle, whereas Greenland, Norway, and the USA have not. For the purposes of the present analysis, sector lines were selected in accordance with the criteria outlined in Table 1. These are illustrated in Figure 2 by straight lines that consist of short dashes.

Median lines

In general terms, a median line is defined by a succession of points that are equidistant from the coastlines of adjacent or opposite states. The methodology for their construction has been described by several authors (e.g. Kapoor and Kerr, 1986). The median lines examined in this particular analysis were developed from the same basepoints that were employed by Macnab and Carrera (1996). They are shown in Figure 2 as segmented lines that consist of long dashes.

Bilateral boundaries in the Exclusive Economic Zones of the Arctic Ocean

A related issue is the demarcation of the bilateral boundaries between the Exclusive Economic Zones of adjacent or opposite states in the Arctic. In principle, two such boundaries, i.e. Canada and the USA, and Norway and Russia, originate at points where land boundaries intersect the coastline, whence they extend seaward to the 200 nautical mile limit. Presumably, the three remaining boundaries, i.e. Canada-Greenland, Greenland-Norway, and Russia-USA, must originate or pass through points that are situated in ocean straits, whence they too extend to the 200 nautical mile limit.

A review of the status and configuration of bilateral EEZ boundaries is beyond the scope of this study, and the reader is referred to Oude Elferink (in press) for details. It suffices to say, however, that some of these boundaries remain in dispute, and that their ultimate resolution could impact the determination of extended boundaries by fixing, for instance, the start points of their prolongations beyond 200 nautical miles.

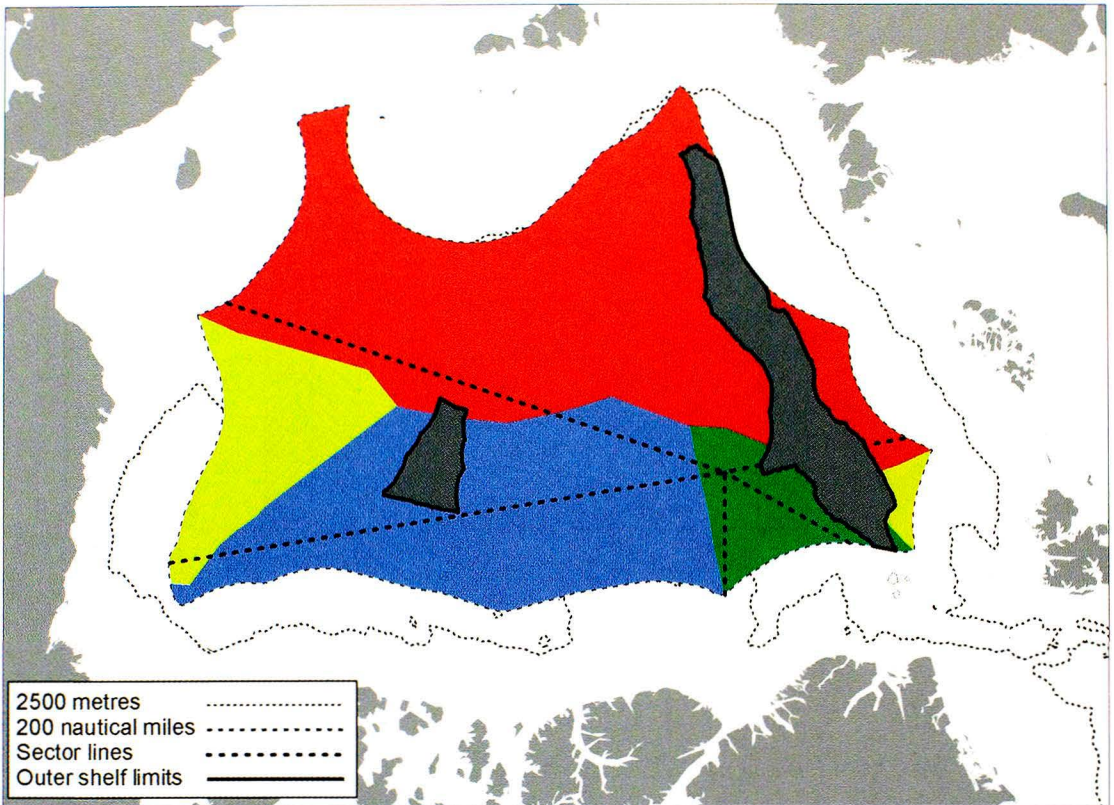


Figure 4: Juridical continental shelves beyond 200 nautical miles, showing hypothetical partitions as coloured polygons bounded by median lines, i.e. lines everywhere equidistant from the territorial seas baselines of adjacent or opposite states

Areas enclosed by sector and median lines

Figures 3 and 4 compare the hypothetical outcomes of partitioning the juridical continental shelf beyond 200 nautical miles by sector and median lines. For each set of partitions, the sizes of the enclosed areas were computed and listed in Table 2 for quantitative comparison. The same values are illustrated in the bar graph of Figure 5.

Country	Median Area, sq. km.	Sector Area, sq. km.	Median - Sector*	Difference in Percent*
Canada	799071	444754	354317	80
Greenland	161169	71576	89593	125
Norway	25825	62186	-36361	-58
Russia	1226258	1205255	21003	1.7
USA	283970	712522	-428552	-60
Totals	2496293	2496293		

* Positive/negative value: median partition is larger/smaller than the sector partition.

Table 2: Approximate surface areas of partitions defined by median and sector boundaries

Results of the Analysis

Partitions bounded by sector or median lines display considerable variation in the areas that they enclose. In relative terms, Table 2 shows that the choice between the sector or median approach has the least

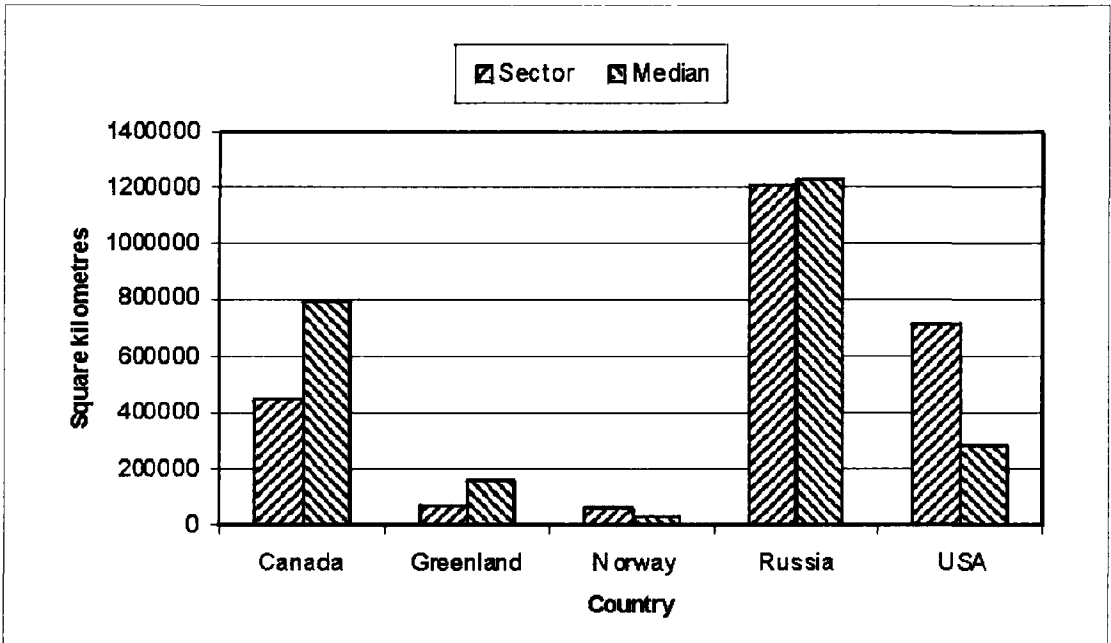


Figure 5: Approximate sizes of continental shelf partitions bounded by sector and median lines, for the five coastal states that surround the Arctic Ocean

impact on the size of the Russian partition (1.7%), and the greatest impact on the Greenland partition (125%). The relative sizes of the Canadian, Norwegian, and US partitions change by significant amounts (80%, 58%, 60%). In absolute terms, the variations range from a low of 21,003 square kilometres for the Russian partition, to 428,552 square kilometres for the US partition.

As can be readily perceived from an examination of Figures 3 and 4, the transition between sector and median boundaries is accommodated through a series of mutual adjustments between neighbouring partitions. This process is especially noticeable between the USA and Canada, where the largest (in absolute terms) area exchange occurs. While the areas affected are smaller than for the USA and Canada, Norway and Greenland experience a significant exchange in relative terms. Table 3 illustrates the effects of these accommodations by showing changes in the rankings of the coastal states, according to the sizes of their respective sector and median partitions.

Whatever the nature of their boundaries, the partitions of two coastal states are divided into sub-partitions by virtue of the location and configuration of the zone that overlays the Gakkel Ridge and which is beyond coastal state jurisdiction. Whether bounded by sector or median lines, the Russian partition is divided into a large sub-partition that is adjacent to the East Siberian and Chukchi Shelves, and a much smaller one next to the Barents and Kara Shelves (Figures 3 and 4). When bounded by sector lines, the Norwegian partition on the one hand is divided into two similarly-sized sub-partitions that bracket the near extremity of the Gakkel

Rank	Partition defined by sector lines	Partition defined by median lines
1	Russia	Russia
2	Canada	USA
3	USA	Canada
4	Greenland	Greenland
5	Norway	Norway

Table 3: Comparative rankings of partition sizes, in descending order

zone (Figure 3). When bounded by median lines, the Greenland partition on the other hand is divided into two sub-partitions that bracket the same zone, but in a highly asymmetric fashion (Figure 4).

Conclusion

This investigation has shown that the choice of sector or median lines for defining partition boundaries beyond 200 nautical miles in the Arctic Ocean could have a significant impact on the sizes of the resulting partitions, thereby affecting the dimensions of the zones of extended seabed jurisdiction. Clearly this could have important resource implications for coastal states that border upon the Arctic Ocean.

Under present circumstances, it is not clear whether or how a total solution could be achieved throughout the region. Presumably this would entail some sort of multilateral approach, in light of difficulties that could be anticipated in the implementation of strictly bilateral agreements that did not take into account the interests of other states. In any case, affected states that embarked upon a process of devising and implementing specific solutions would likely find their tasks much easier if they achieved some level of mutual understanding on at least three issues, not necessarily in the following order: (1) the definition of bilateral boundaries that separate their respective EEZs; (2) the formal implementation of Article 76 of UNCLOS in co-operation with adjacent states; and (3) the choice of technique for constructing continental shelf partitions beyond 200 nautical miles.

The foregoing suggests that it could be some time before a regional solution is fully realised - as of this writing, only two states (Norway and Russia) have ratified UNCLOS, and are engaged in the process of implementing Article 76. The remaining three states (Canada, Denmark on behalf of Greenland, and the USA) have yet to ratify UNCLOS, and when they do, each will have ten years in hand for dealing with the continental shelf issue. Meanwhile, bilateral EEZ boundaries remain unresolved in some places, depriving negotiators of 'anchor points' for partition boundaries beyond 200 nautical miles.

Even if most or all of these questions could be resolved to the mutual satisfaction of the affected parties, the partitioning of the juridical continental shelf beyond 200 nautical miles could remain a moot question until advancing technology and the pressure of the marketplace render it feasible to exploit the resources that lie upon or below the seabed, and which are currently inaccessible beneath the permanent ice cover of the Arctic Ocean. Until then, issues of jurisdiction may not receive a great deal of attention. However, such a deferral could provide an excellent opportunity to build upon the scientific and technical collaborations that have emerged in that area so far, with a view to developing an integrated, regional approach that takes into account the interests of all Arctic coastal states.

Acknowledgements and Disclaimer

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Biography

Paul Neto holds a Bachelor of Environmental Studies (BES) degree in Geography, which he received from the University of Waterloo, Waterloo, ON, Canada. Currently, working as a technical consultant/developer with CARIS based in Fredericton, NB, Canada, as part of the CARIS LOTS (Law of the Sea) team, Paul has extensive experience in implementing and advising on geospatial solutions and data processing. His latest work involved distributed data technologies for incorporating disparate spatial data over the Internet.

Robert van de Poll holds a Bachelor of Science Degree in Geology, which he received from Memorial University in St John's, NFLD, Canada. He is currently completing his Master of Science Degree in Engineering in the Department of Geodesy and Geomatics at the University of New Brunswick in Fredericton, NB, Canada. Robert has extensive experience as a practising Geologist, working in both Industry and Government. He has spent the past ten past years at CARIS based in Fredericton, NB, Canada. In addition to being the Geoscience Co-ordinator at CARIS, he is the Product Manager of the newly developed CARIS LOTS (Law of the Sea) software product. His Research thesis topic for his Masters degree deals specifically with CARIS LOTS.