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## Applying the Test of Appurtenance Globally A New Inventory of Wide Margin States from Public Domain Data

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### Introduction

At the time of writing, only three Coastal States have submitted their proposed Continental Shelf limits to the Commission on the Limits of the Continental Shelf (CLCS); namely Russia, Australia and Brazil. (United Nations 2001; United Nations 2004; United Nations 2004). It is uncertain how many more are likely to do so, in part because not all Coastal States are aware that they may be eligible to do so. There is also a possibility that States who should be taking action to examine their outer limits are not doing so. Of course, Coastal States with conspicuously broad margins are well aware of the tasks ahead of them, and many are engaged in work that will see them delimiting their juridical Continental Shelves before 2009. However, some States may be at risk of not delimiting areas they are entitled to under the Convention. This situation may have arisen because of the complexity of the definition of a Continental Shelf under Article 76, poor understanding of seafloor physiography adjacent to the Coastal State, a seemingly intricate seafloor with features that do not lend themselves to the creation of a juridical Continental Shelf, and a readiness to believe published maps and lists which, possibly incorrectly, do not include the State involved.

This study attempts to clarify the situation somewhat by making measurements on public domain data using the CARIS LOTS software, using the definition of the Continental Shelf in Article 76 and the rules included in the CLCS Guidelines, (United Nations 1999) to determine which areas of the world ocean floor are worthy of further examination for their possible classification as juridical Continental Shelves.

The results of this study show that, applying the CLCS Guidelines' Test of Appurtenance to each of the 152 Coastal States (United Nations Table of Claims 2004) that are members of the United Nations, 65 Coastal States appear to meet the outlined criteria for the 'Test of Appurtenance.'

### New Requirements Imposed by the CLCS Guidelines

Article 76 of UNCLOS (United Nations 1983) defines the juridical continental shelf. It also requires States to submit their limits to the United Nations' Commission on the Limits of the Continental Shelf (CLCS) for their recommendation (McDorman 2002). The CLCS produced Guidelines (United Nations 1999) with the stated purpose of assisting States in their preparations. Between 1976, when Article 76 was finalised, and 1999

when the CLCS Guidelines were issued, a great many workers published interpretations of Article 76 and of the features required to be mapped. Based on these interpretations, other recent papers analysed particular geographic areas to see if possible claims existed. Two principal global coverage maps of possible Continental Shelf areas have appeared in print in recent years. One in colour comes from (Malakoff, 2002) with no information on how it was constructed. A black and white map in (Prescott, 2000) was based on a 1998 paper, i.e. one produced before the CLCS Guidelines were pub-

lished. Therefore, the test of appurtenance had not been defined at the time of publication of the two principal maps mentioned above.

However, with the issuance of the Guidelines in 1999, the world was apprised of the interpretation that the CLCS made of Article 76, which means that early interpretations of the number of States that can make a claim should be re-examined. Of particular relevance, the Guidelines contain two elements that had not been apparent in the literature until their publication; the first of these being

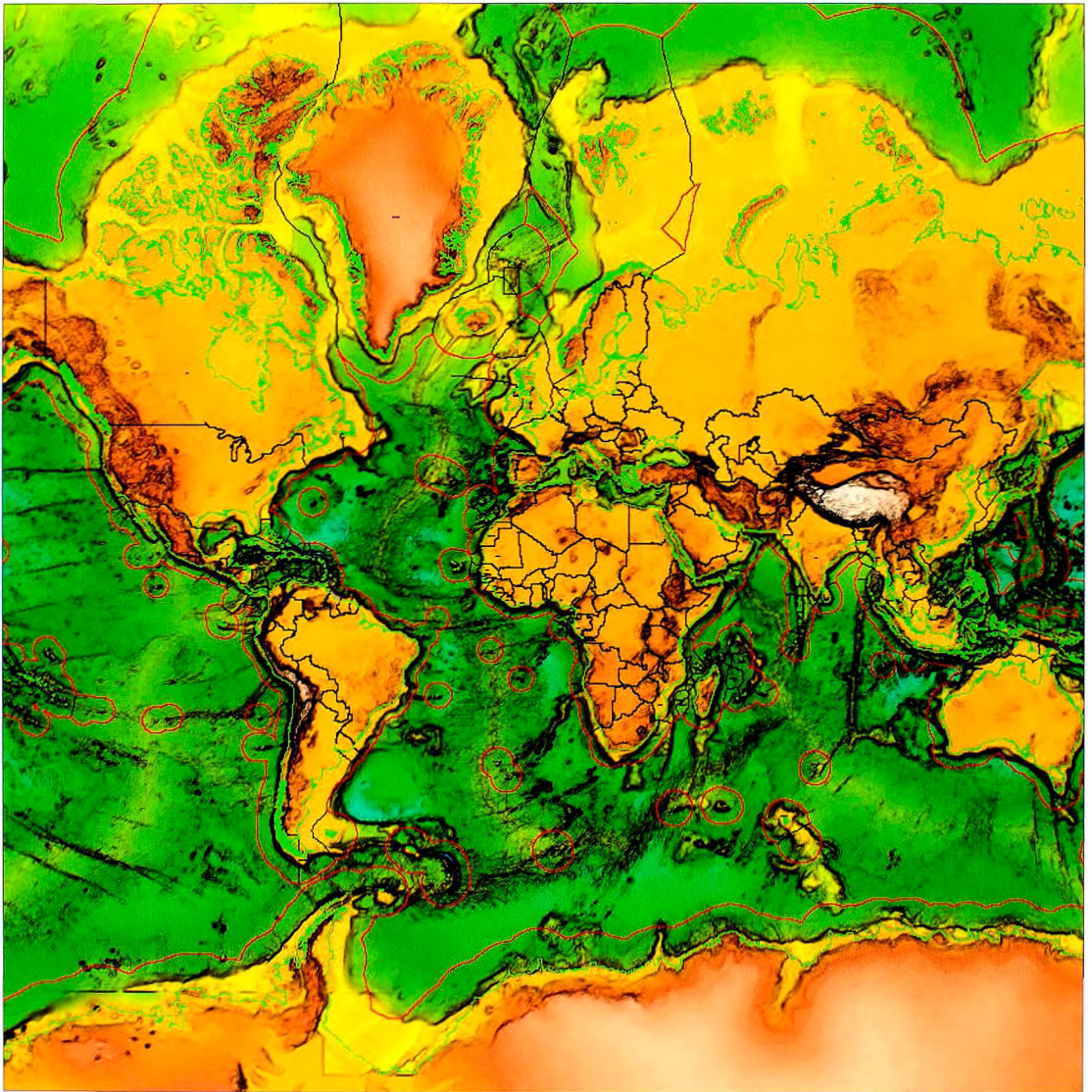


Figure 1: This diagram details the global coverage of the shaded-relief Etopo2 raster bathymetric dataset, with the world Coastlines (green lines) and each Coastal State's individual 200 mile limit (red lines) that was examined in the global study area. All 152 Coastal States were considered in the tables that follow in this paper.

the requirement that Continental Shelves have to meet the 'test of appurtenance.' Meeting this test includes the new requirement to map 'the region defined as the base of the continental slope.'

### Test of Appurtenance

The Test of Appurtenance is prescribed by the CLCS as a means of determining whether or not an area of seafloor is a 'natural prolongation' of a Coastal State. The Test of Appurtenance is described in the Guidelines (Paragraph 2.2.8.) as: *If either the line delineated at a distance of 60 nautical miles from the foot of the continental slope, or the line delineated at a distance where the thickness of sedimentary rocks is at least 1 per cent of*

*the shortest distance from such point to the foot of the slope, or both, extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured, then a coastal State is entitled to delineate the outer limits of the continental shelf as prescribed by the provisions contained in article 76, paragraphs 4 to 10.*

Note that whether or not a particular piece of seafloor meets the Test of Appurtenance cannot be determined without carrying out at least a preliminary investigation. If the region in which a Foot of the Slope is located is 140 nm or more from a baseline, then a distance formula line (FOS+60nm) 60 nm from that FOS, or a sediment 1% thickness line that extends beyond 200 nm can reveal whether the area is likely to meet the Test of Appurtenance. Until a

REGION	WORLD STATES	TEST OF APPURTENANCE (A) (PASSES)	TEST OF APPURTENANCE (B) (PHYSICALLY MEETS CRITERIA)
NORTH AMERICA (Incl. Caribbean)	23	4	2
SOUTH AMERICA	10	6	2
EUROPE	32	8	0
AFRICA	38	10	14
ASIA	33	4	10
OCEANIA	16	2	3
NON-COASTAL STATES	41	N/A	N/A
TOTALS	193	34	31

Figure 2: Results of the Global Study, when applying the criteria for the Test of appurtenance.

NORTH AMERICA		SOUTH AMERICA		EUROPE	
Antigua & Barbuda		Argentina	A	Albania	
Bahamas		Brazil	A	Belgium	
Barbados	A	Chile		Bosnia & Herzegovina	
Belize		Colombia		Bulgaria	
Canada	A	Ecuador	A	Croatia	
Costa Rica	B	Guyana	A	Cyprus	
Cuba		Peru	B	Denmark	A
Dominica		Suriname	A	DNMK (Greenland)	
Dominican Republic		Uruguay	A	DNMK (Faroe Islands)	
El Salvador		Venezuela	B	Estonia	
Grenada				Finland	
Guatemala				France	A
Haiti				FR (Martinique)	
Honduras				FR (Saint Pierre and Miquelon)	
Jamaica				FR (Guadeloupe)	
Mexico	A			FR (French Guiana)	
Nicaragua				FR (Reunion)	
Panama				FR (Wallis and Futuna)	
Saint Kitts & Nevis				FR (Tromelin)	
Saint Lucia				FR (Glorioso)	
Saint Vincent and the Grenadines				FR (Juan De Nova)	
Trinidad and Tobago	B			FR (Europa)	
United States of America	A			FR (Clipperton Islands)	
USA (Puerto Rico)				FR (Mayotte)	
USA (US Virgin Islands)				FR (French Polynesia)	
USA (American Samoa)				FR (New Caledonia)	
USA (Guam)				Georgia	
USA (Johnston Atoll)				Germany	
USA (Palmyra Atoll)				Greece	
USA (Midway Island)				Iceland	A
USA (Wake Island)				Ireland	A
USA (Jarvis Island)				Italy	
USA (Kingman Reef)				Latvia	
USA (Howard Island)				Lithuania	
USA (Baker Island)				Malta	
USA (Northern Marianas)				Monaco	
USA (Navassa Island)				Netherlands	
				Norway	A
				NO (Jan Mayen)	
				NO (Svalbard)	
				Poland	
				PortugalL	A
				Romania	
				Serbia & Montenegro	
				Slovenia	
				Spain	A
				Sweden	
				Turkey	
				Ukraine	
				United Kingdom	A
				UK (Bermuda)	
				UK (Pitcairn)	
				UK (South Georgia)	
				UK (South Sandwich Islands)	
				UK (British Indian Ocean Terr.)	
				UK (British Virgin Islands)	
				UK (Anguilla)	
				UK (Cayman Islands)	
				UK (Monseerrat)	
				UK (St. Helena)	
				UK (Turks and Caicos Islands)	
				UK (Falkland Islands)	

Figure 3: Results when applying the criteria for the Test of Appurtenance in the CARIS LOTS software for six regions of the world.

AFRICA		ASIA		OCEANIA		NON-COASTAL STATES
Algeria		Bahrain		Australia	A	Afghanistan
Angola	A	Bangladesh	B	Cook Islands		Andorra
Benin	B	Brunei Darussalam		Fiji	B	Armenia
Cameroon		Cambodia		Kiribati		Austria
Cape Verde		China	B	Marshall Islands		Azerbaijan
Comoros		Dem. People's Republic of Korea		Micronesia (Federated States of)		Belarus
Congo	B	India	A	FSM (Caroline Islands)		Bhutan
Cote d'Ivoire		Indonesia	B	FSM (Marianas Islands)		Bolivia
Dem. Republic of Congo		Iran		Nauru		Botswana
Djibouti		Iraq		New Zealand	A	Burkina Faso
Egypt		Israel		NZ (Tokelau)		Burundi
Equatorial Guinea		Japan	A	Nieu		Central African Republic
Eritrea		Jordan		Palau		Chad
Gabon	B	Kuwait		Papua New Guinea	B	Czech Republic
Gambia	B	Lebanon		Samoa		Ethiopia
Ghana	B	Malaysia	B	Solomon Islands	B	Hungary
Guinea	A	Maldives	B	Tonga		Kazakhstan
Guinea-Bissau	A	Myanmar	B	Tuvalu		Kyrgyzstan
Kenya	B	Oman		Vanuatu		Lao People's Democratic Republic
Liberia	B	Pakistan	A			Lesotho
Libya		Philippines	B			Liechtenstein
Madagascar	A	Qatar				Luxemborg
Mauritania	B	Republic of Korea				Malawi
Mauritius	B	Russian Federation	A			Mali
Morocco (Western Sahara)	B	Saudi Arabia				Mongolia
Mozambique	A	Singapore				Nepal
Namibia	A	Sri Lanka	B			Niger
Nigeria	A	Syrian Arab Republic				Paraguay
Sao Tome & Principe		Thailand				Republic of Moldova
Senegal	A	Timor-Leste				Rwanda
Seychelles	B	United Arab Emirates				San Marino
Sierra Leone	B	Vietnam	B			Slovakia
Somalia	A	Yemen	B			Swaziland
South Africa	A					Switzerland
Sudan						Tajikistan
Togo	B					Republic of Macedonia
Tunisia						Turkmenistan
United Republic of Tanzania	B					Uganda
						Uzbekistan
						Zambia
						Zimbabwe

with the individual classification of A (Passes) and B (Physically meets criteria) for the Test of Appurtenance.

Coastal State has performed this test, it cannot know whether or not to proceed with investigating a potential juridical Continental Shelf.

The first step in performing the Test of Appurtenance is to find the Foot of the Slope. Although exceptionally the Foot of the Slope may not have a surface expression on the seafloor (evidence to the contrary), it will 'normally' occur as maximum change in gradient at the foot of the slope. Before the exact location where maximum change occurs can be determined, the Commission requires 'The identification of the region defined as the base of the continental slope.'

### Physical Measurements

Unlike an individual Coastal State which will perform a thorough analysis of detailed data to map the Foot of the Slope, we used coarse public domain data to perform an overview of the entire earth. This type of data is suitable for preliminary desktop studies. At our scale of investigation, the Foot of the Slope and Base of the Slope can be considered coincident. Using the CARIS LOTS software (van de Poll, Monahan et al. 2001), profiles were constructed and examined to determine the presence and location of the 'Base of the Continental Slope'. A systematic approach was taken to perform individual Tests of Appurtenance for each Coastal State around the world. The same data sources for bathymetry (3,800m x 3,800m spaced Etopo2) and sediment thickness (5,000mx5,000m Sediment) (both data sources from the National Geophysical Data Center (NGDC)) were used for each Coastal State. The bathymetric results were projected seaward 60 nautical miles to produce the 'Distance Formula Line.' The Sediment Thickness global dataset was used to yield the position of the place where sediment thickness is equal to 1% of the distance from the foot of the slope. Where the seaward-most position of either of these results was seaward of the 200 mile limit line for the individual Coastal State, the area was judged to have passed the Test of Appurtenance.

### Political Considerations

In the vast majority of cases, a profile could be constructed along an unobstructed straight line from a Coastal State to oceanic depths. Applying the Test

of Appurtenance to such a profile produced unambiguous results: either the conditions of the Test of Appurtenance were met or they were not. Where they were met, these States were assigned the letter 'A' in Figure 3. However, in some cases this situation is complicated by the presence of political boundaries between neighbouring states lying across the possible straight line path of a profile that could physically connect a state with the deep ocean. Where these bilateral boundaries interfere with the Test of Appurtenance and are known to be finalised (according to the latest maritime boundary treaties available on the United Nations website at date of writing) the Test of Appurtenance was not applied. On the other hand, there are boundaries between States that have not yet been resolved: prediction of how these boundaries will be resolved is beyond the scope of this paper. Therefore, States meeting the physical requirements for the Test of Appurtenance, but with unresolved bilateral boundaries that may have an effect on their claims, were assigned the letter 'B' in Figure 3. Letters were only assigned to the 152 Coastal States identified in the United Nations Table of Claims (2004). Their territories and dependencies were analysed but were not separately classified in our results table.

### Results

The details of our findings for our Global 'Test of Appurtenance' study are described in Figure 2. The world has been classified into six separate regions (see Table 2 for all 152 Coastal States and 41 Non-Coastal States). Figure 1 shows the scope of the study area, where Test of Appurtenance was systematically performed.

Findings at this scale of investigation are not detailed enough to allow actual delineation, of course, but can indicate where closer investigation should be carried out.

### Conclusions

#### **The 'Test of Appurtenance' Is Not Always Straightforward to Apply**

Although the Test of Appurtenance appears straightforward, there are some situations where an unresolved bilateral boundary might complicate its application.

## Data and Resolution

This study takes only a preliminary look at the world at a very small scale. Public domain data sources are adequate for this, but more closely-spaced data will be required for more detailed study. Most Coastal States will eventually undertake multibeam echo sounding surveys of their continental slopes as part of their search for a Foot of the Slope. Sediment thickness data is sparse, and effort will be required to obtain more. Monahan and Wells (2002), point out that horizontal uncertainty for location of Foot of the Slope and sediment thickness could be 1000s of meters, even with a good data set.

## Unresolved Boundaries

Unresolved boundaries or boundaries in dispute within the EEZ may be preventing some Coastal States from examining their potential juridical Continental Shelves. Because the outcome of such boundary placement is a major uncertainty, such States may be advised to apply the Test of Appurtenance as if they were not obstructed from access to the Foot of the Slope.

## Summary

A global scale application of the Test of Appurtenance has allowed a refinement in the number of States who may be able to delineate a juridical Continental Shelf under Article 76 of UNCLOS. Our results show that 65 States may be in a position to establish a juridical Continental Shelf. This number may change as higher resolution data is applied to this type of analysis. The data sets publicly available at time of writing allow investigation of the Foot of the Slope as the maximum change in gradient (bathymetric sources): consequently, there may also be further States that use the evidence to the contrary clause (geological and geophysical sources) to establish their Foot of the Slope. The consideration of evidence to the contrary was beyond the scope of this paper and therefore was not considered in the tabulated results.

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