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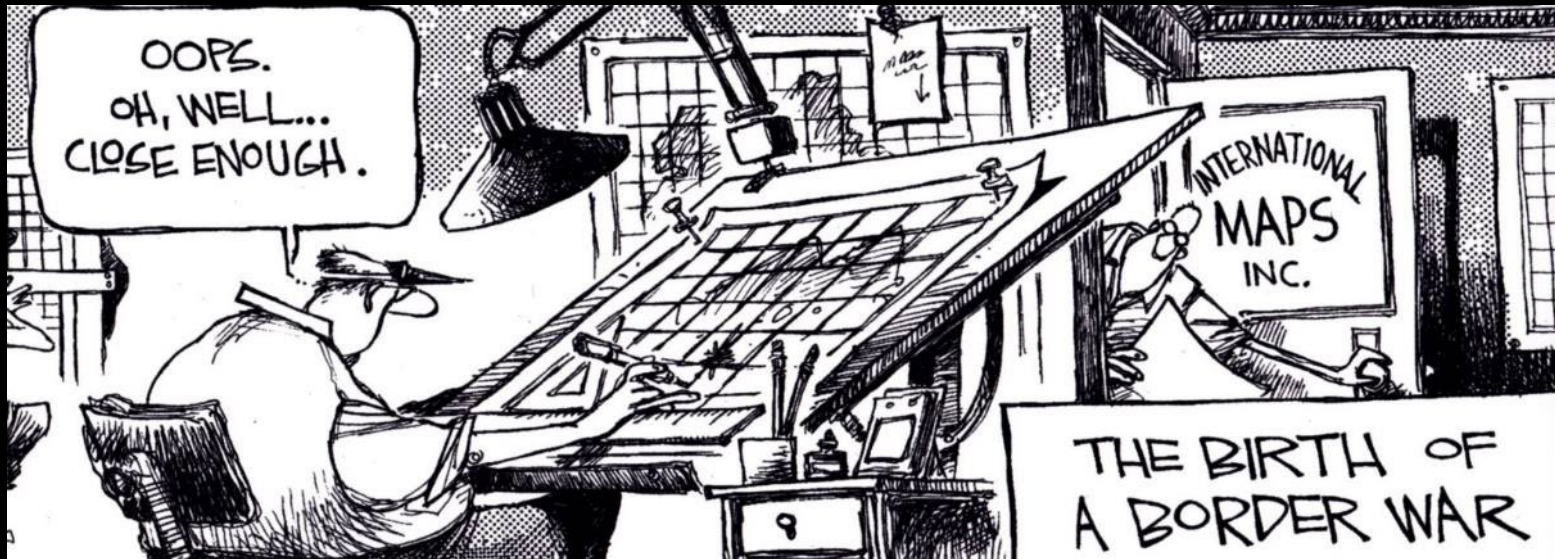
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Thank you.



# The role of the technical expert during negotiations



Martin Pratt

**bordermap** consulting

Geographical intelligence for international  
boundary-making and dispute resolution

# The importance of technical expertise

- Coastal geography is always central to the determination of an equitable solution in maritime boundary delimitation.
- Coastlines are complex and frequently unstable entities.
- Imprecise definition of international boundaries can lead to future disputes. Calculating positions and distances on the surface of the earth is not as straightforward as it may seem...
- Not many lawyers are expert geographers!

# Technical tasks in maritime delimitation

- Interpreting charts and remotely-sensed imagery
- Identifying relevant basepoints
- Determining relevant coastlines and the relevant area
- Constructing equidistance lines and other potential boundaries
- Determining coastline length & the general direction of the coast
- Evaluating proportionality
- Converting coordinates between geodetic reference systems
- Comparing the effect of using different types of ‘straight’ line
- Evaluating the effect of different vertical datums
- Field surveys
- Preparing illustrative maps

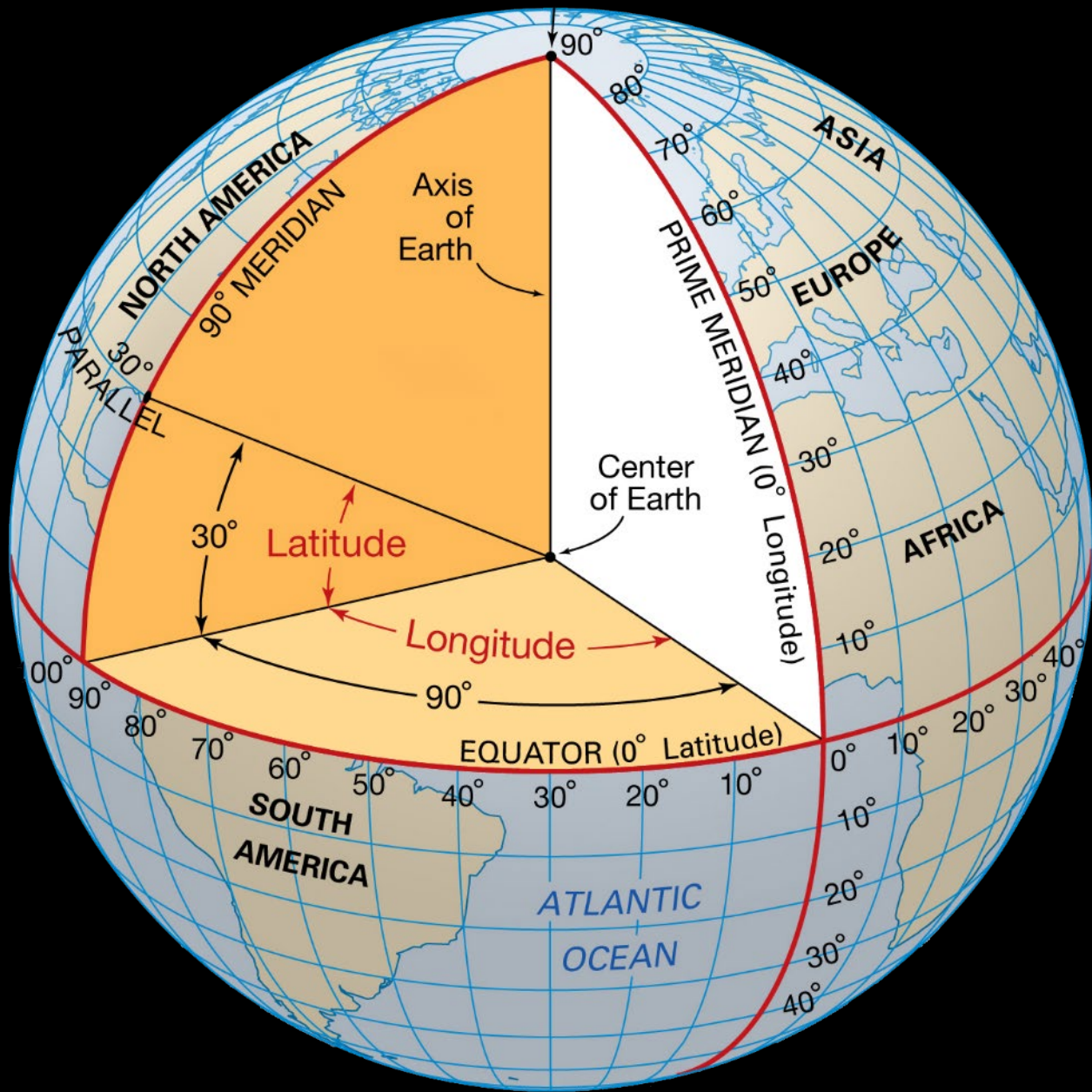
# A technical perspective on maritime delimitation

## Aim

- An equitable division of maritime space.
- The unambiguous definition of a line that can be located on the surface of the earth with sufficient accuracy for practical needs.

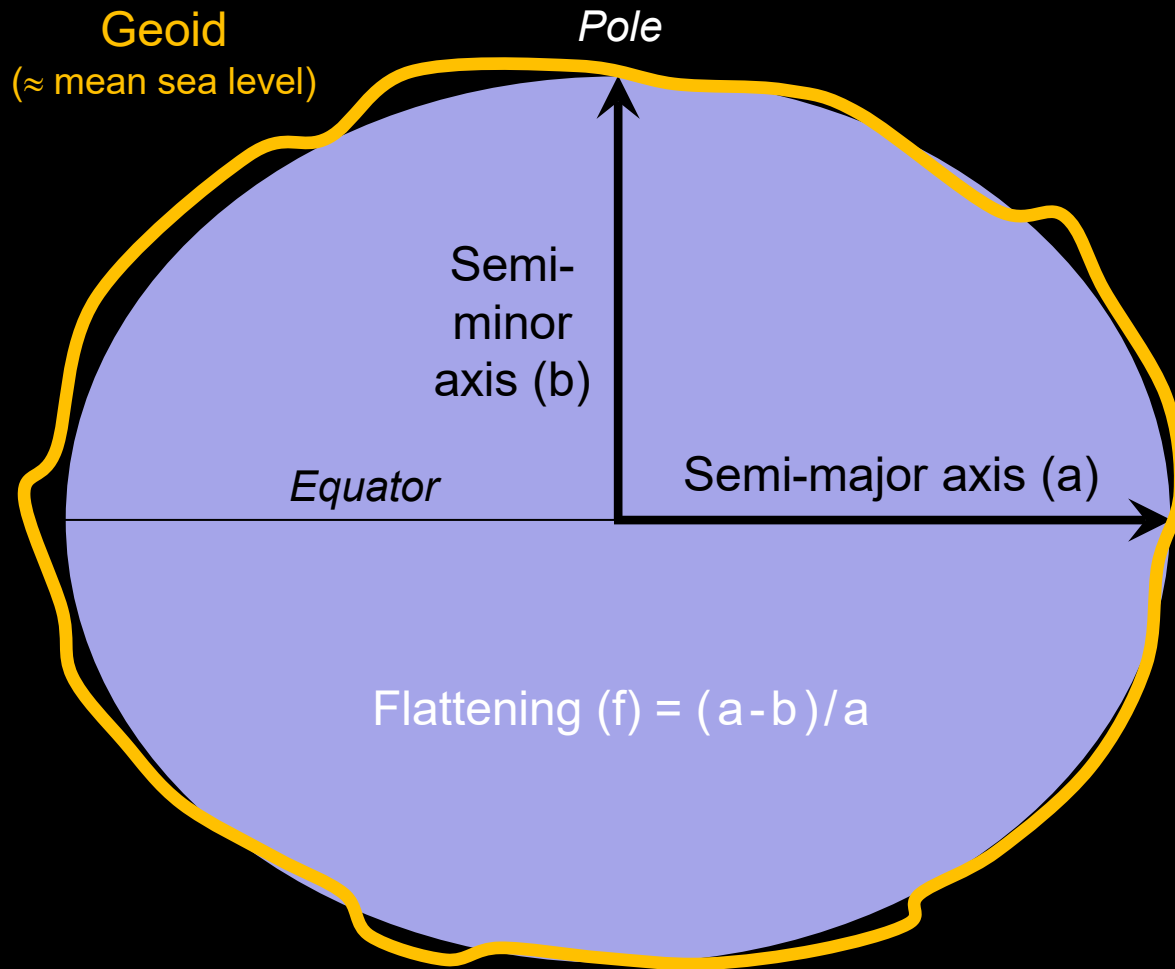
## Requirements

- Coordinates of turning points referred to an appropriate geodetic reference system (or systems).
- Definition of the nature of the lines connecting turning points.





# Modelling the earth: ellipsoids and datums



Local datums (origin at location on surface) e.g. NAD 27, Minna

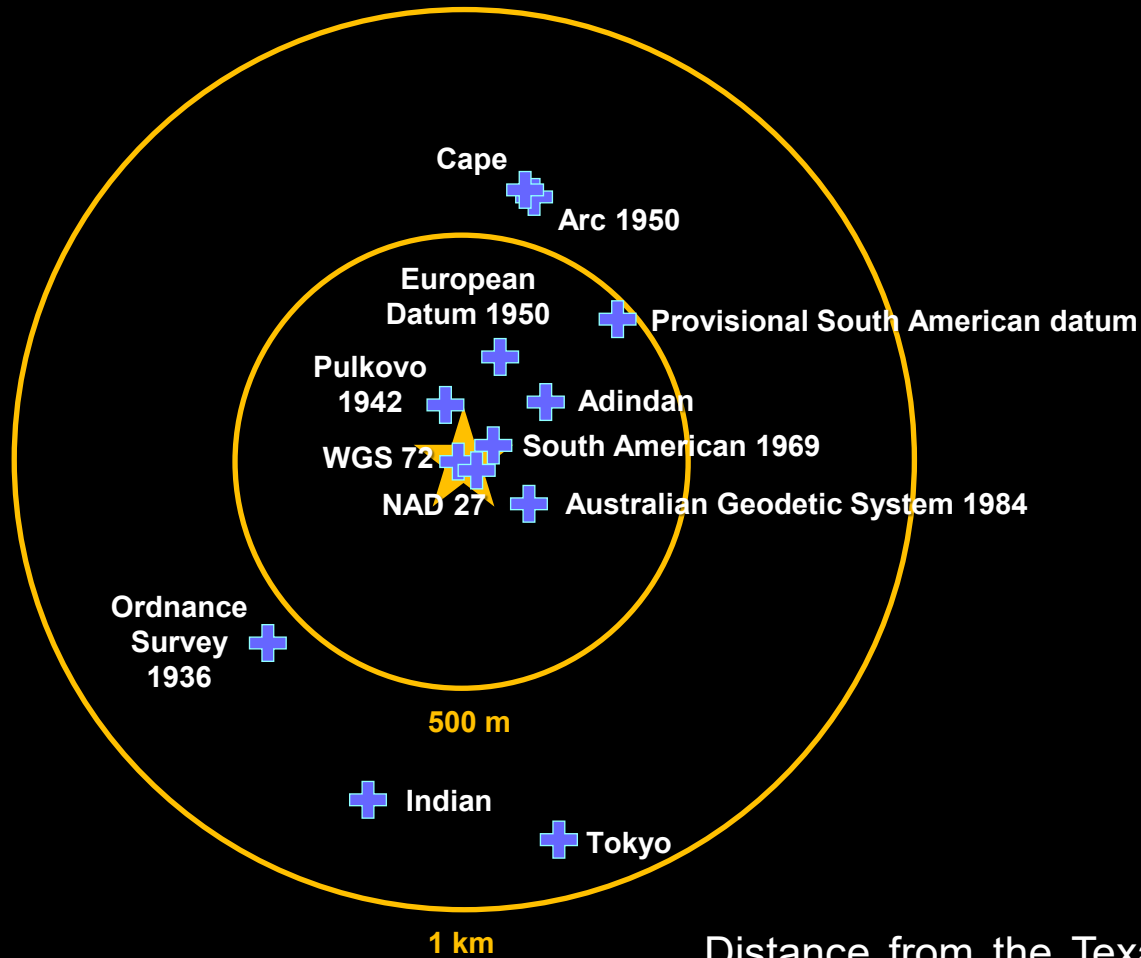
Geocentric datums (origin at earth's centre of mass) e.g. NAD 83, WGS 84



# Datums 101

- A geodetic datum is a mathematical model which describes the shape of the ellipsoid on which coordinates are measured.
- The latitude and longitude values of a point on the surface of the earth vary from datum to datum.

# The impact of the choice of datum



Distance from the Texas Capital Dome of the WGS 84 coordinates of the dome referred to different datums

Original graphic: Peter H. Dana

# Datums 101

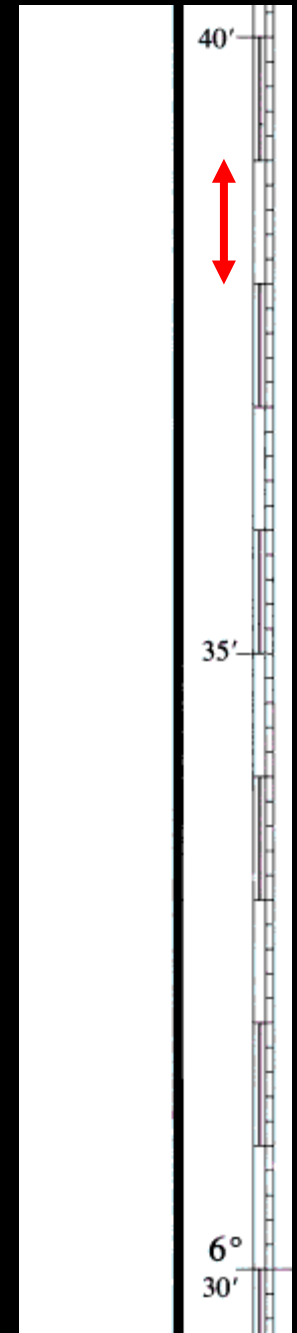
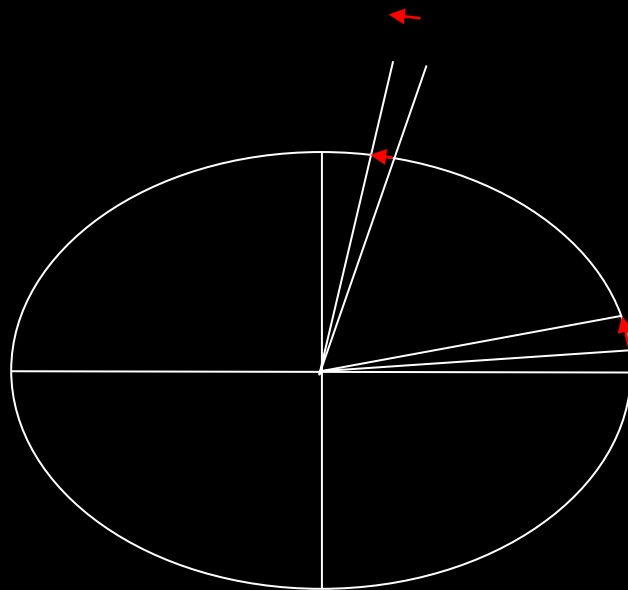
- A geodetic datum is a mathematical model which describes the shape of the ellipsoid on which coordinates are measured.
- The latitude and longitude values of a point on the surface of the earth vary from datum to datum.
- Unless a datum is specified, you cannot be certain which point on the surface of the earth to which a set of coordinates is referring.
- Using the wrong datum can create an error of several hundred metres.
- Positions referring to one datum can usually be converted to another datum, but you must know the original datum.

# Latitude, longitude and distance

1 sea mile = 1 minute (') of latitude. Length increases with distance from the equator

1 second (") of latitude = 1/60 minute = c.31 metres

1 international nautical mile (M / nm) = 1,852 metres

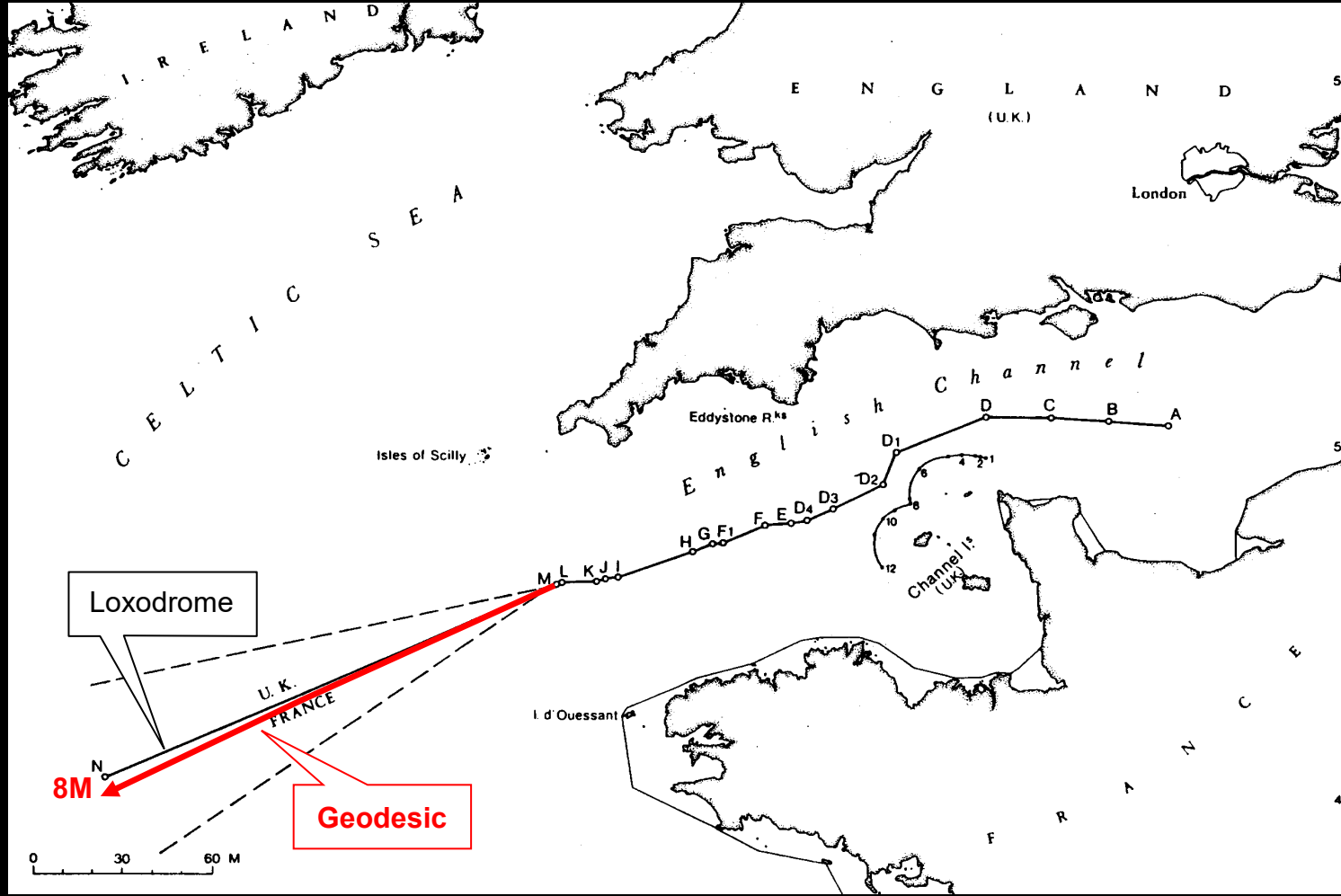


# 'Straight' lines: loxodromes and geodesics

- A straight line on Mercator projection map or chart represents a line of constant compass bearing known as a *loxodrome* or *rhumbe line*. This characteristic explains the use of the Mercator projection for most navigational charts.
- The line of shortest distance between two points on a spheroid is known as a *geodesic*. A geodesic plots as a curve on a Mercator projection chart.

# Significance of choice of line

France-UK maritime boundary arbitration, 1977



# Positional accuracy

Which is more accurate?

a)  $4^{\circ} 17' 18.445''$  N,  $8^{\circ} 21' 20.238''$  E

b)  $4^{\circ} 17' 18''$  N,  $8^{\circ} 21' 20''$  E

- Without a specified geodetic datum, coordinates are of limited use for jurisdictional purposes, no matter how 'accurate' they may appear.

# Positional accuracy

- 1 mm on a 1:250,000 scale chart = 250 m on ground.
- ‘Plottable error’ =  $\pm 50$  m at best.
- Pointless to quote coordinates with an accuracy of  $\pm 3$  cm (0.01 of a second) or even  $\pm 3$  m (0.1 of a second) if derived from a chart at 1:250,000 or smaller.

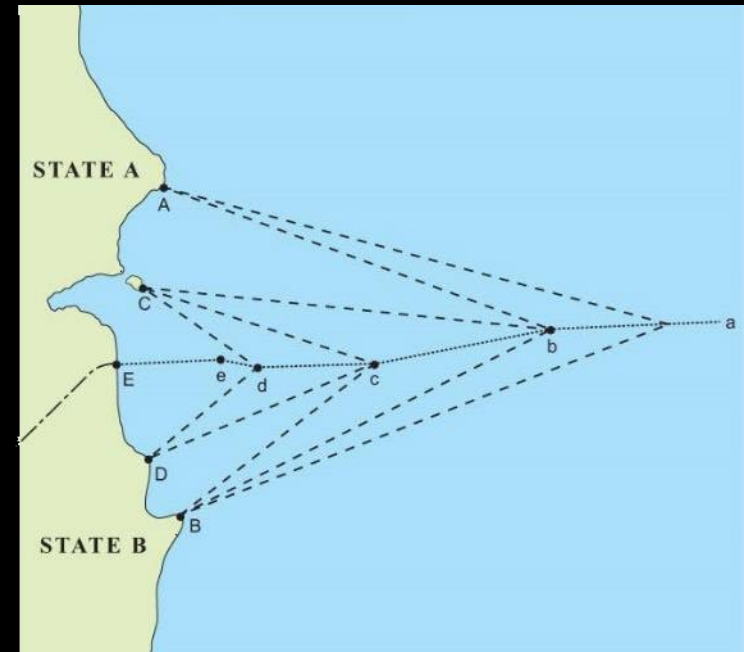
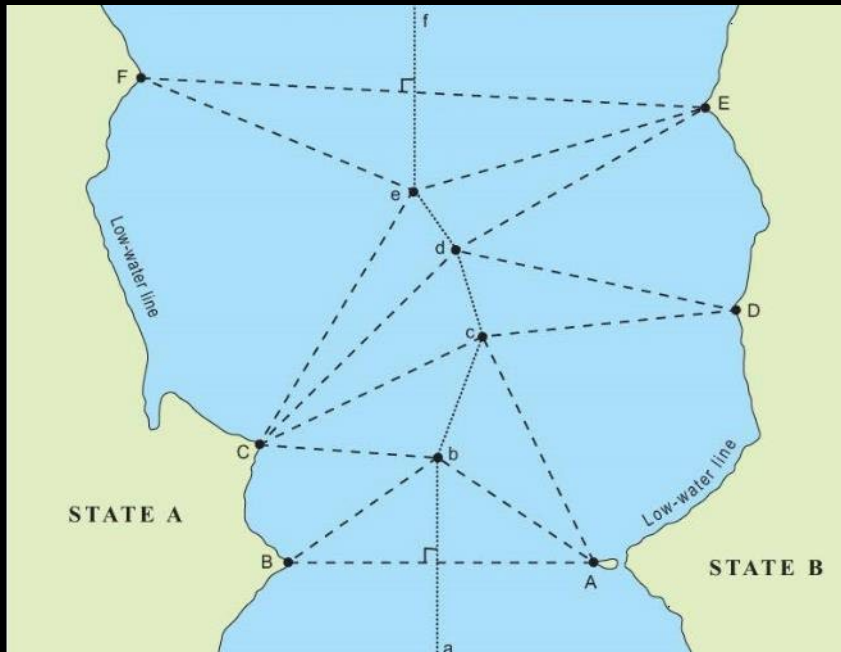


# The ICJ's three-stage methodology

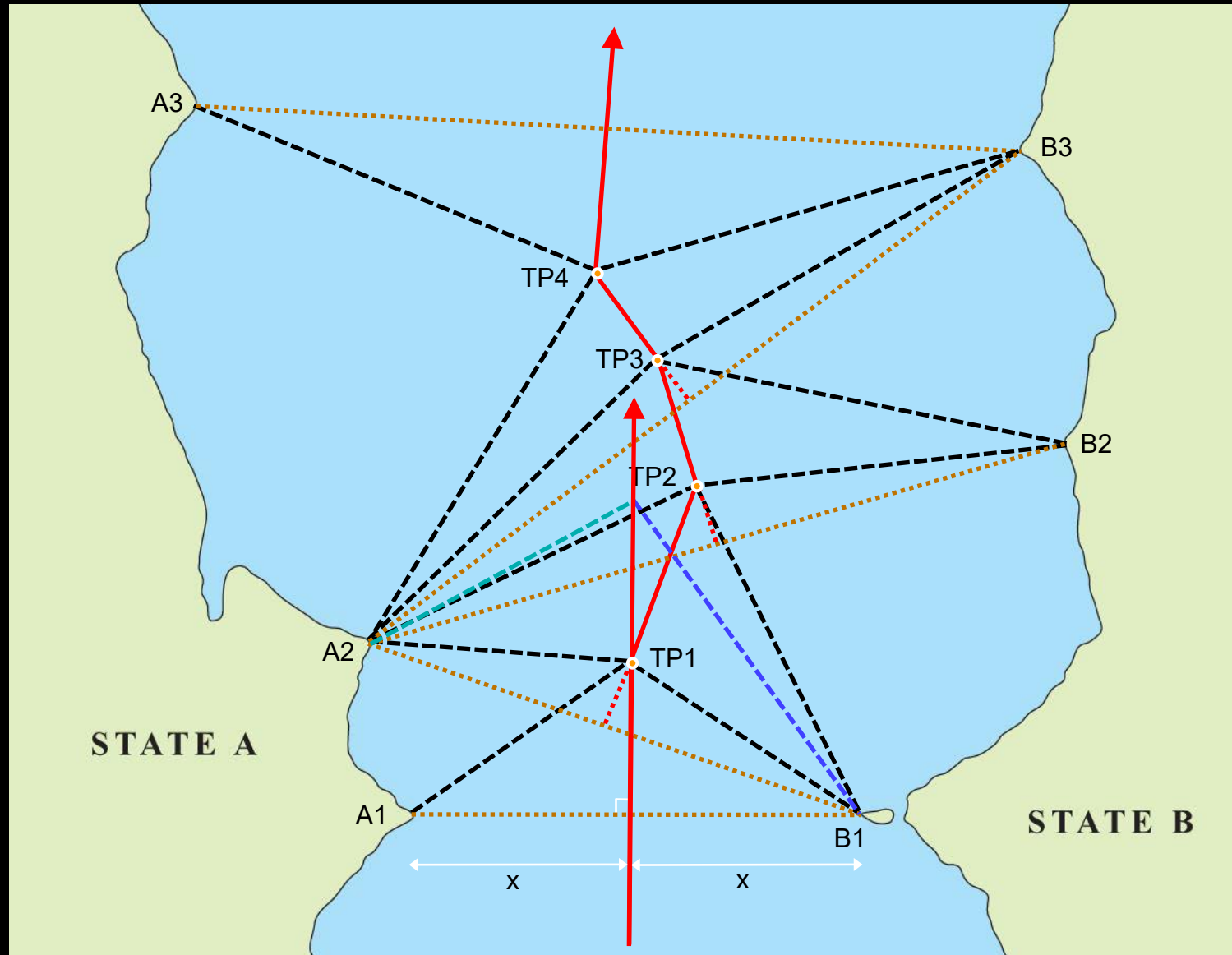
1. Construct a provisional equidistance line.
2. Consider whether any relevant circumstances justify adjustment of the provisional equidistance line to produce an equitable solution.
3. Confirm that no great disproportionality of maritime areas is evident by comparison to the ratio of coastal lengths.

# Equidistance / median lines

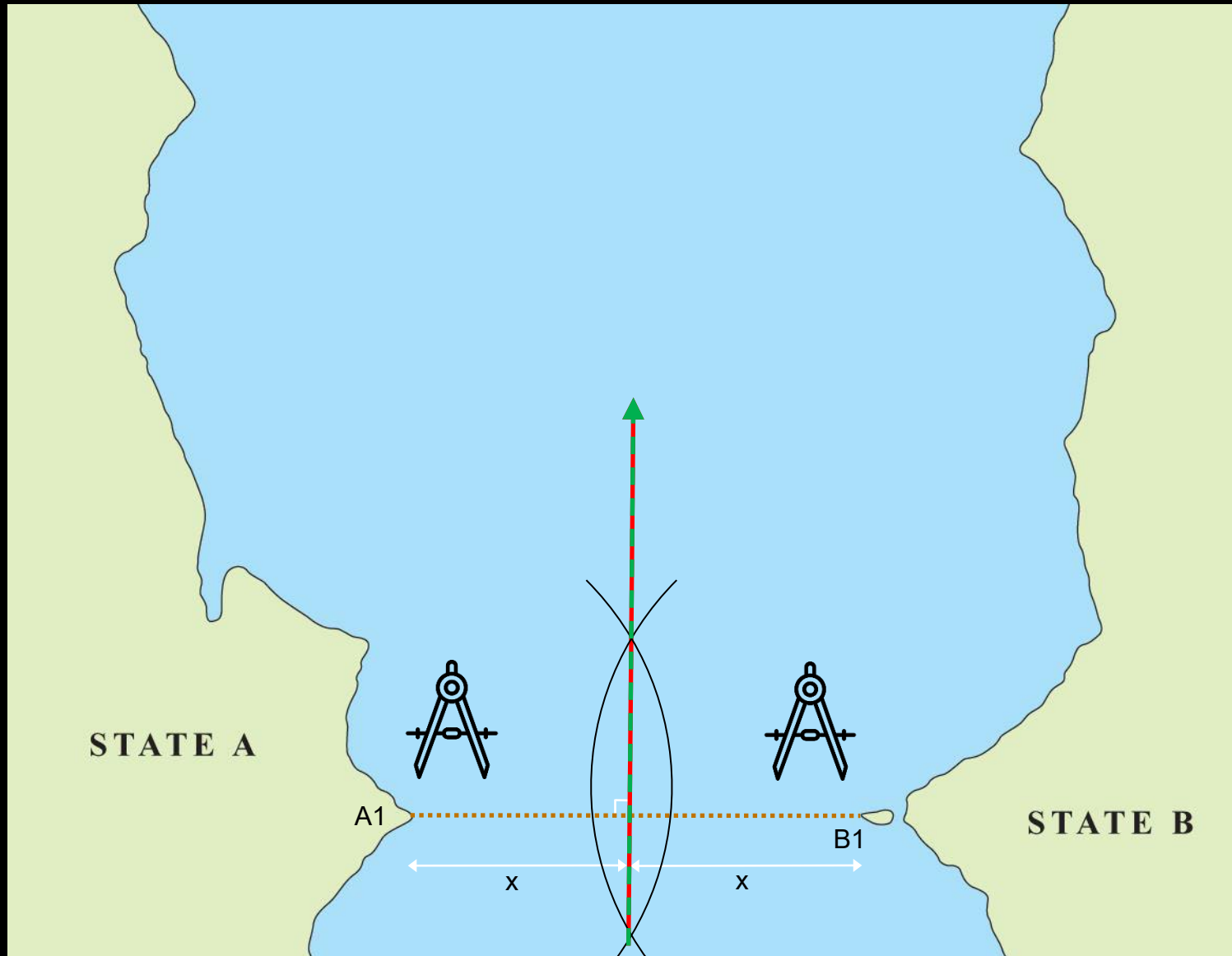
...the median line every point of which is equidistant from the nearest points on the baselines from which the breadth of the territorial seas of each of the two States is measured (UNCLOS, Article 15)



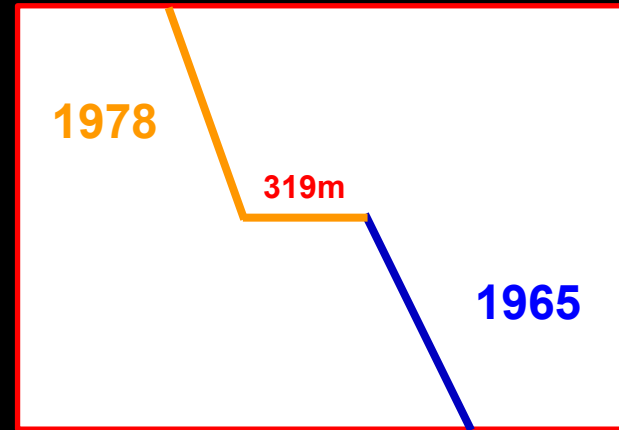
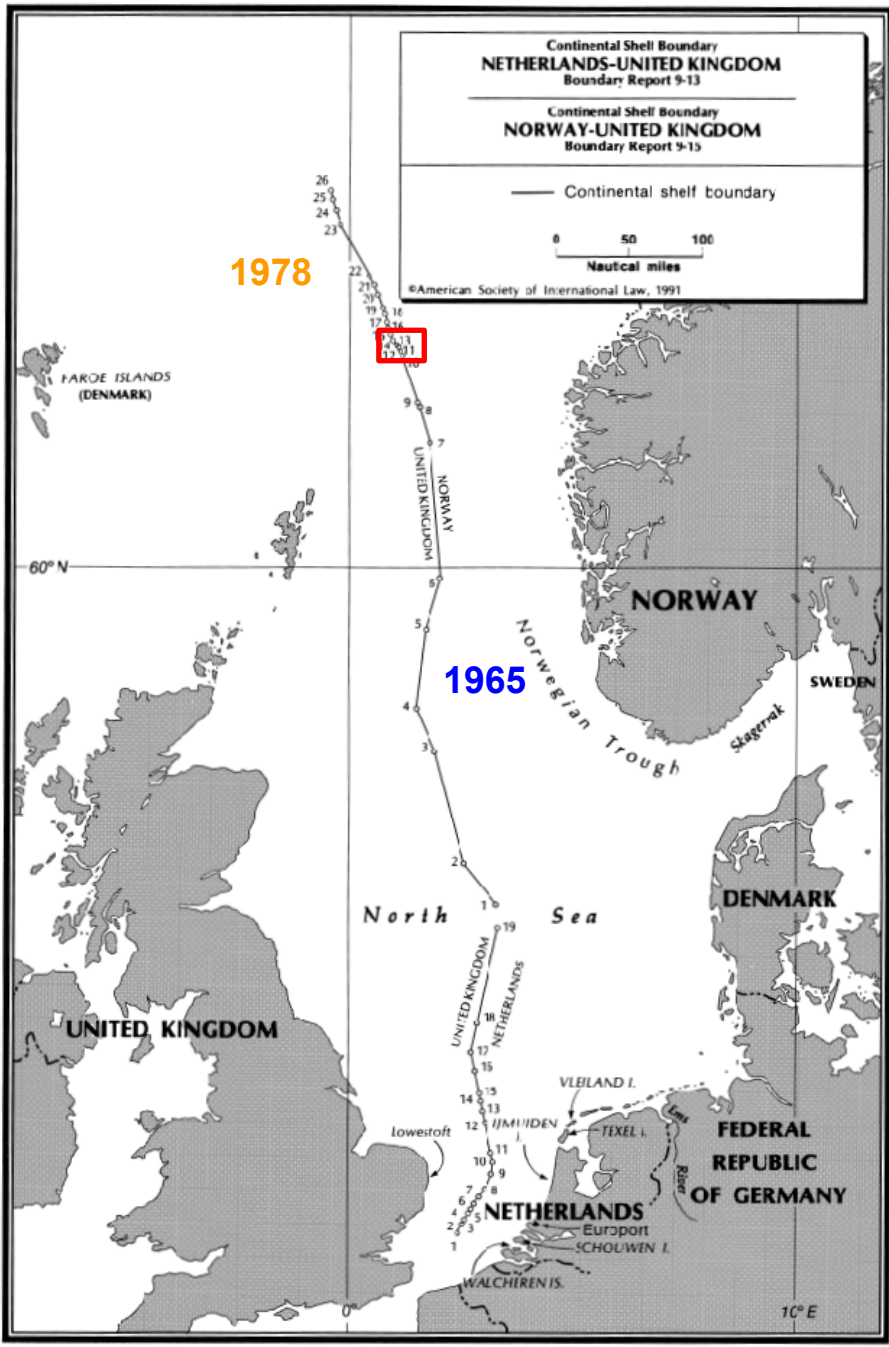
# Constructing an equidistance line



# Constructing an equidistance line



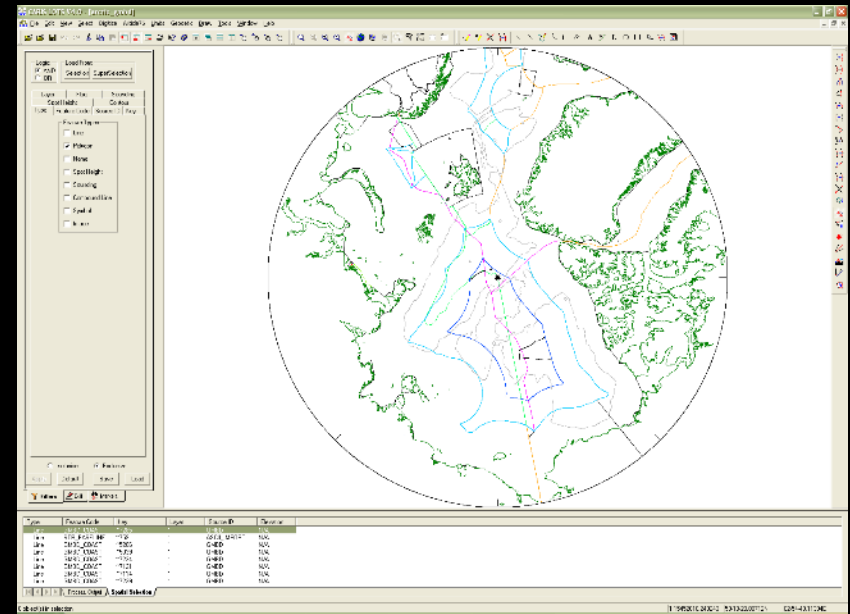
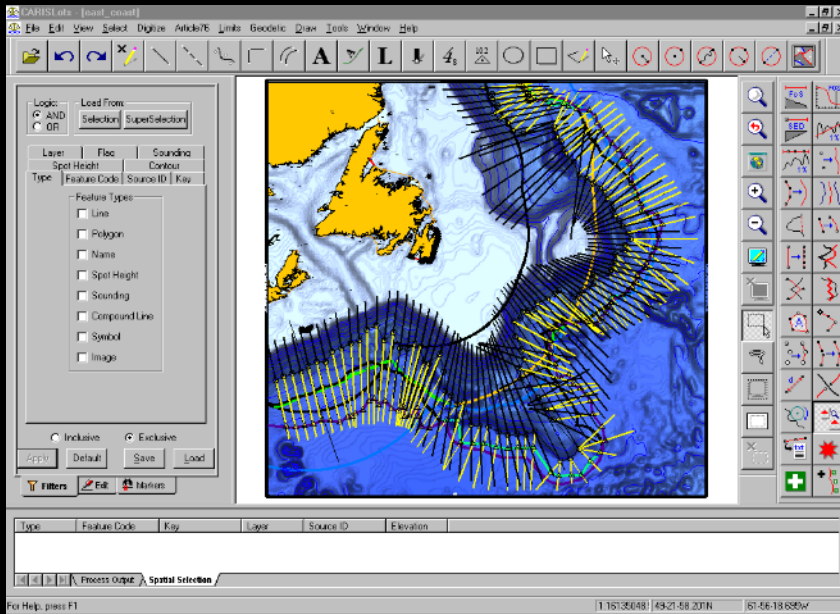
# Graphical v. computed equidistance lines Norway-UK (1965/1978)



# Tools for maritime boundary-making

LOTS Limits and Boundaries

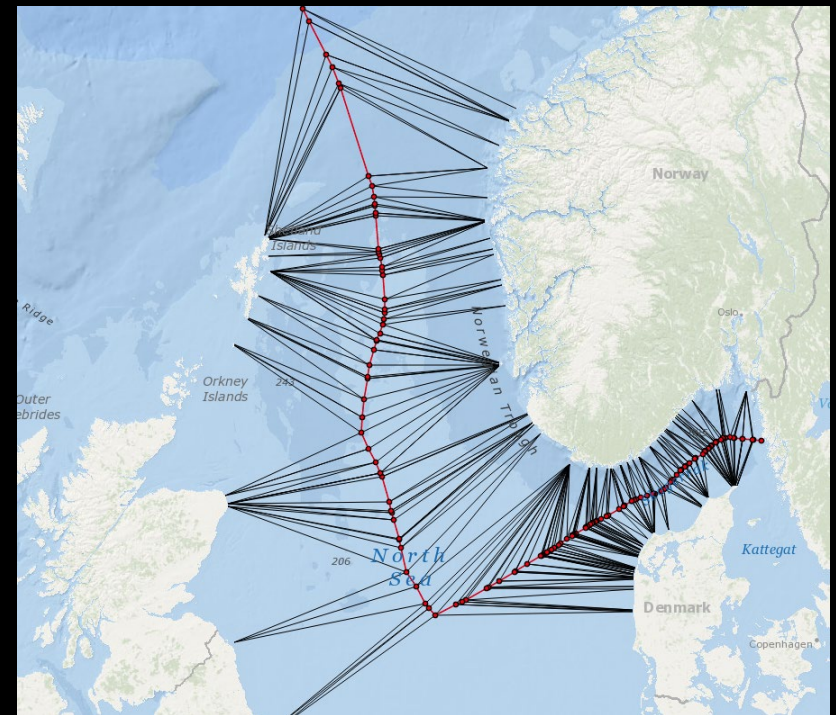
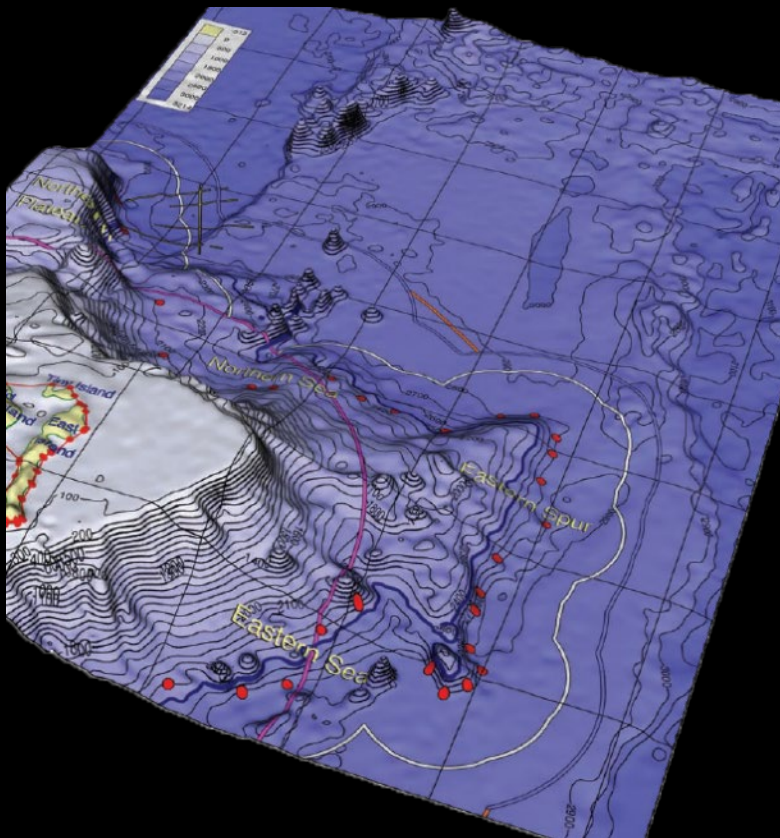
[www.teledynecaris.com/en/products/lots-limits-and-boundaries](http://www.teledynecaris.com/en/products/lots-limits-and-boundaries)



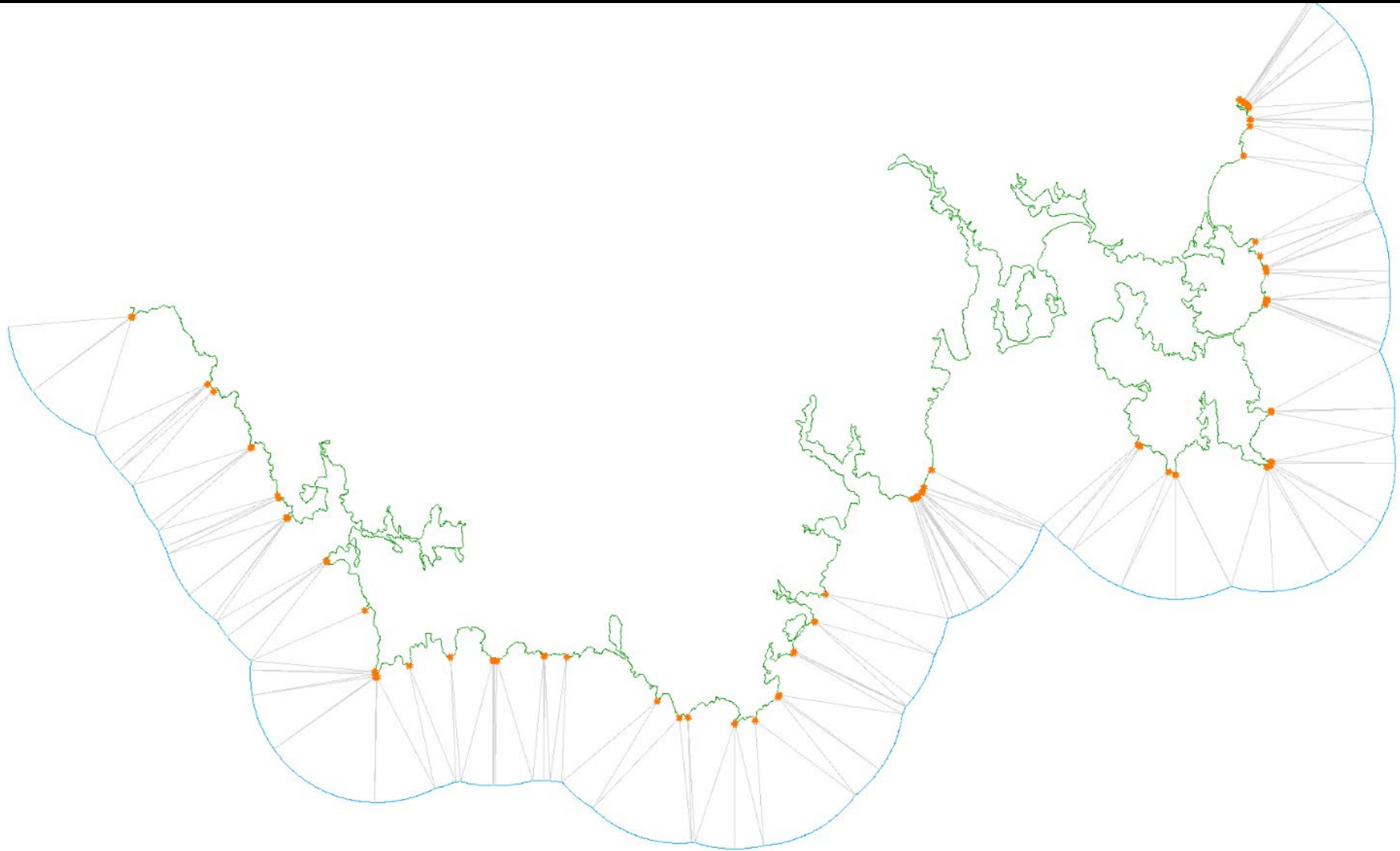
# Tools for maritime boundary-making

## Geocap Shelf / Maritime Limits and Boundaries for ArcGIS

[www.geocap.no/article/martime-limits-and-boundaries-for-arcgis](http://www.geocap.no/article/martime-limits-and-boundaries-for-arcgis)



# Generating limits and measuring coastlines

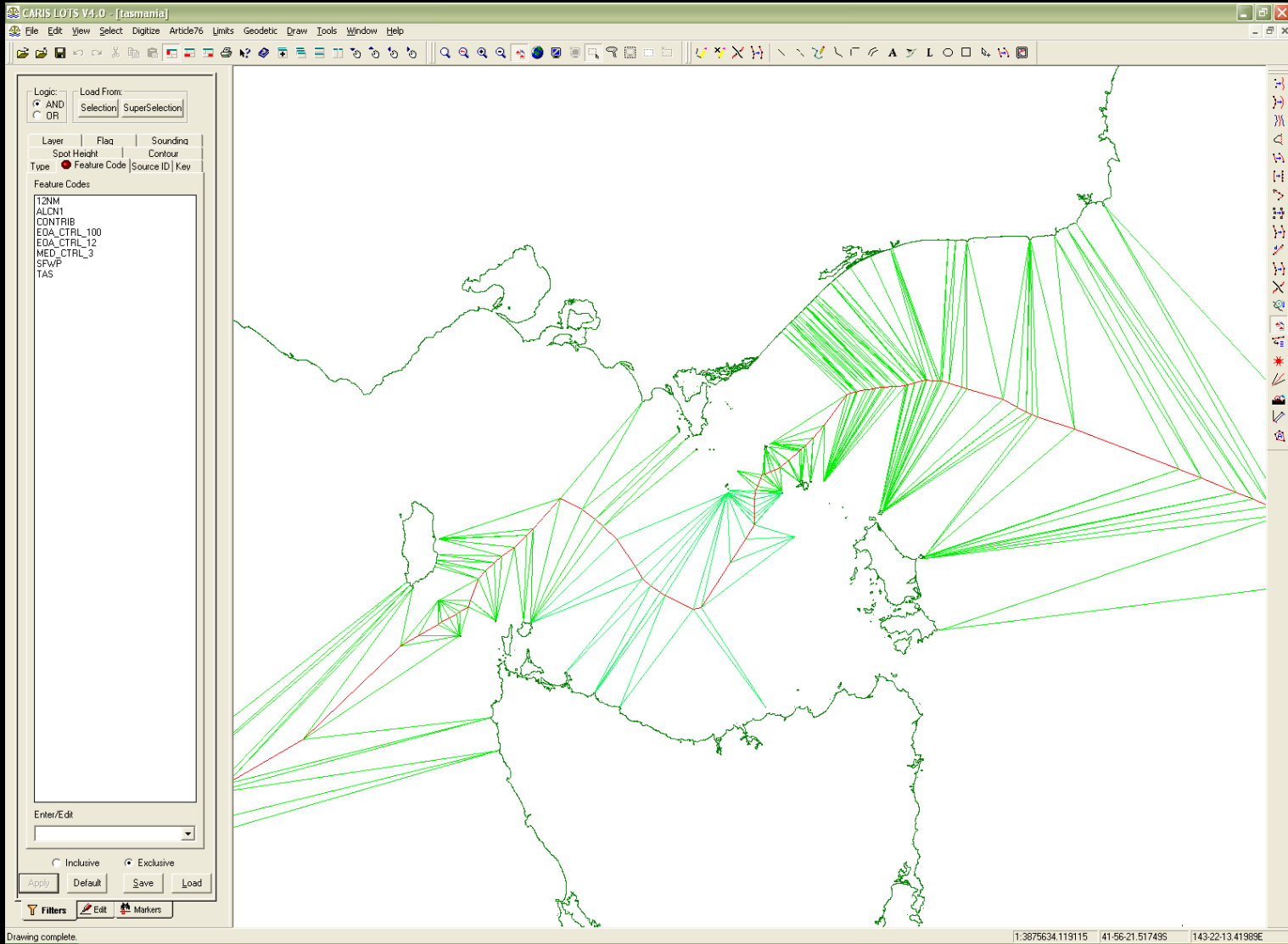




# Generating limits and measuring coastlines



# Computing equidistance lines



# Calculating 'half-effect'

The screenshot shows the CARISLOTS V4.0 software interface. The main window displays a map of Jamaica with a green boundary. A dialog box is open on the left side, titled "Load From", with options for "AND" and "OR". The dialog box also has tabs for "Layer", "Flag", and "Sounding", and a "Type" dropdown set to "Feature Code". A list of "Feature Codes" is shown, including "AWFF LINE" and "CONTRIB". Below the list is an "Enter/Edit" field. At the bottom of the dialog box, there are "Inclusive" and "Exclusive" radio buttons, and buttons for "Apply", "Default", "Save", and "Load".

At the bottom of the software window, there is a table with the following columns: Type, Feature Code, Key, Layer, Source ID, and Elevation. The table is currently empty.

The status bar at the bottom of the window shows "Drawing complete." on the left, and coordinates "1:1580187.195512", "17:29:28.06275N", and "74:57:52.31966W" on the right.

# Calculating 'half-effect'

The screenshot displays the CARISLOTS V4.0 software interface. The main window shows a map with a green coastline and a complex network of black lines. A red line is highlighted within the network. The interface includes a menu bar, a toolbar, a left-hand panel with selection options, and a bottom status bar.

**Left Panel:**

- Logic:  AND  OR
- Load From: Selection | SuperSelection
- Layer: | Flag: | Sounding: |
- Spot Height: | Contour: |
- Type:  Feature Code |  Source ID |  Key
- Feature Codes: CONTRIB
- Enter/Edit: [Dropdown]
- Inclusive  Exclusive
- Buttons: Apply, Default, Save, Load
- Filters: [Icon] Edit [Icon] Maskers

**Bottom Panel:**

Type	Feature Code	Key	Layer	Source ID	Elevation
Line	AWPP LINE	12214	0	DEFAULT	N/A

Process Output: Spatial Selection

1 object(s) in selection.

1:1580187.195512 18-11-04.12178N 74-31-43.15151W

# Calculating 'half-effect'

The screenshot displays the CARISLOTS V4.0 software interface. The main window shows a map with a green boundary and a complex network of black lines. The left-hand control panel includes a 'Logic' section with 'AND' and 'OR' options, a 'Load From' section with 'Selection' and 'SuperSelection' options, and a 'Feature Codes' section with a list containing 'CONTRIB' and 'FULL'. The bottom status bar shows a table with the following data:

Type	Feature Code	Key	Layer	Source ID	Elevation
Line	AWPP LINE	12218	0	DEFAULT	N/A

The status bar also includes navigation controls and the text '1 object(s) in [Click here to begin]'. The bottom right corner of the window displays coordinates: 1:1580187.195512, 16:53:07.13604N, and 74-48-41.01560W.

# Calculating 'half-effect'

The screenshot displays the CARISLOTS V4.0 software interface. The main window shows a map with two distinct outlines: a green one on the left and a black one on the right. The interface includes a menu bar at the top with options like File, Edit, View, Select, Digitize, Article76, Limits, Geodetic, Draw, Tools, Window, and Help. Below the menu is a toolbar with various icons for navigation and editing. On the left side, there is a control panel with the following sections:

- Logic:** AND (selected), OR, Selection, SuperSelection
- Layer:** Flag, Sounding
- Spot Height:** Contour
- Type:** Feature Code (selected), Source ID, Key
- Feature Codes:** A list box containing 'CONTRIB' and 'MEDIAN\_CTRL'.
- Enter/Edit:** A dropdown menu.
- Inclusive/Exclusive:** Radio buttons for Inclusive and Exclusive (Exclusive is selected).
- Buttons:** Apply, Default, Save, Load.
- Filters:** Edit, Maskers.

At the bottom of the interface, there is a table with the following columns: Type, Feature Code, Key, Layer, Source ID, Elevation. The table is currently empty. Below the table, there are navigation buttons and a status bar that reads 'Process Output' and 'Spatial Selection'. The bottom-most status bar shows 'Drawing complete.', 'Microsoft Excel - Consultancy ledger.xls [Compatibility Mode]', and coordinates: '1:1580187.195512 16:51:18.88542N 76:43:09.15493W'.

# Calculating 'half-effect'

The screenshot displays the CARISLOTS V4.0 software interface. The main window shows a map with a green coastline and a dense red line representing a survey track. The interface includes a menu bar (File, Edit, View, Select, Digitize, Article76, Limits, Geodetic, Draw, Tools, Window, Help), a toolbar, and a left-hand control panel. The control panel has sections for Logic (AND/OR), Layer, Flag, Sounding, Spot Height, Contour, Type (Feature Code/Source ID/Key), Feature Codes (CONTRIB), and Inclusive/Exclusive selection options. A table at the bottom shows the selected feature details.

Type	Feature Code	Key	Layer	Source ID	Elevation
Line	AWPP LINE	112138	0	DEFAULT	N/A

Process Output: Spatial Selection

1 object(s) in selection. 1:1580187.195512 17-10-29 37992N 73-51-47.38683W

# Calculating 'half-effect'

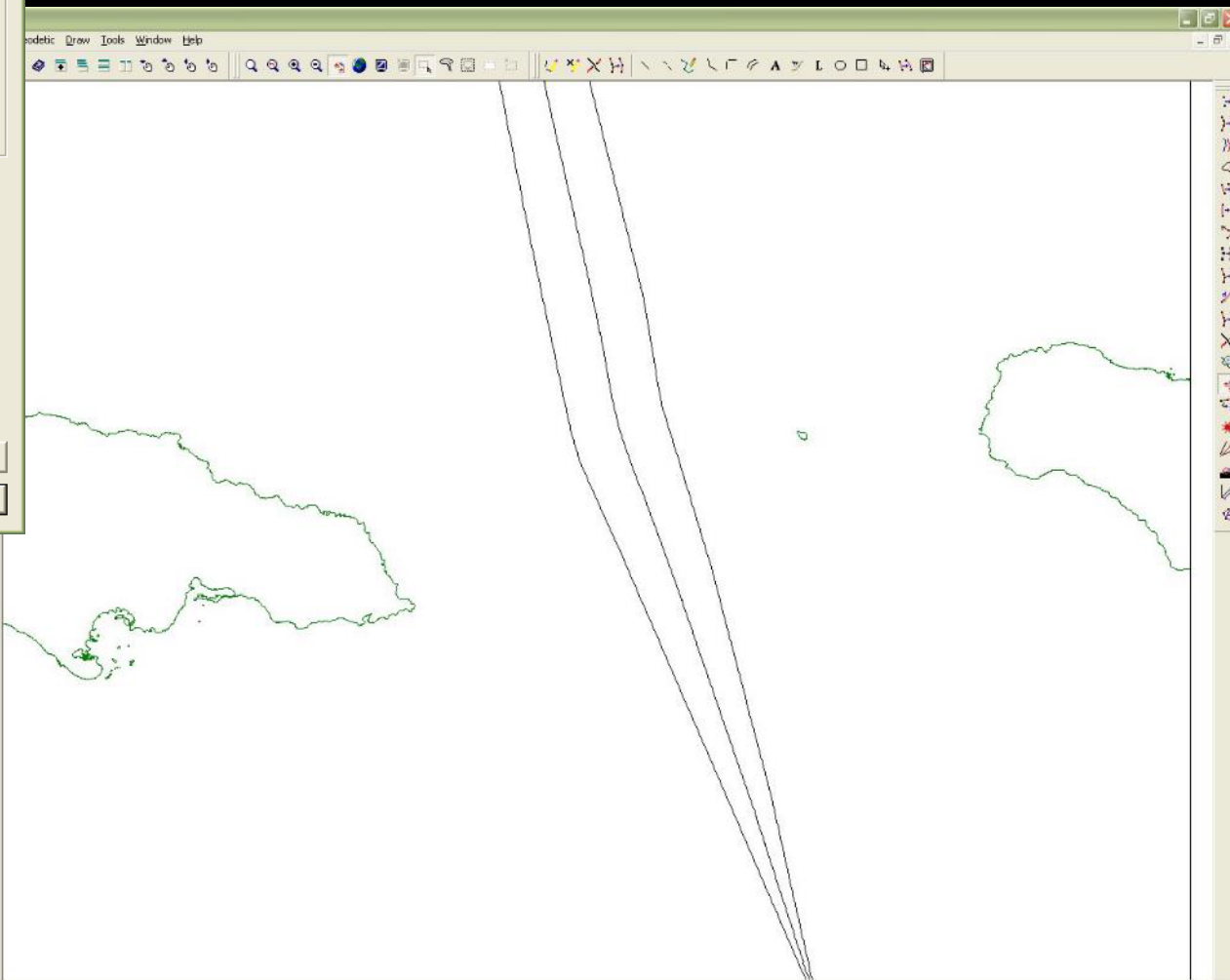
**Equidistant Line Generation** [X]

Selection 1  
0 Points  
[Select Points]  
Weight: 3  
 Straight Baseline  
 Reverse the direction of the line.  
 Show Control Lines

Selection 2  
0 Points  
[Select Points]  
Weight: 2  
 Straight Baseline  
 Add Points  
 Add Lines  
 Points and Lines

Limit Distance  
Limit: 200  
In fill: 10  
Units: Nautical Miles

Report File:  
[ ] [Browse]  
[Cancel] [OK]



Type	Feature Code	Key	Layer	Source ID	Elevation

Process Output: Spatial Selection

Drawing complete. 1:1580187.195512 17:52:00.09314N 74-50-43.66095W



# Calculating 'half-effect'

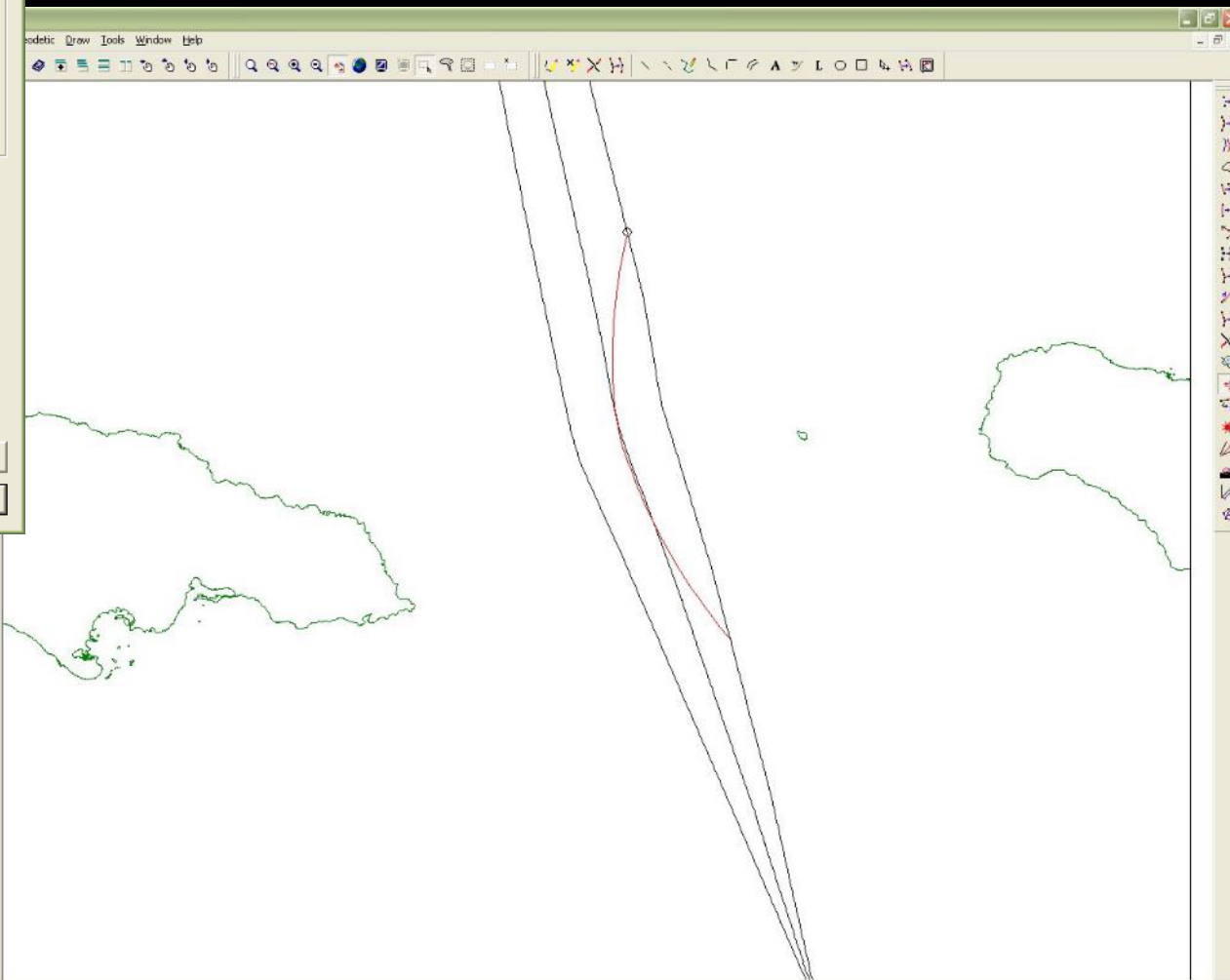
**Equidistant Line Generation** [X]

Selection 1  
0 Points  
[Select Points]  
Weight: 3  
 Straight Baseline  
 Reverse the direction of the line.  
 Show Control Lines

Selection 2  
0 Points  
[Select Points]  
Weight: 2  
 Straight Baseline  
 Add Points  
 Add Lines  
 Points and Lines

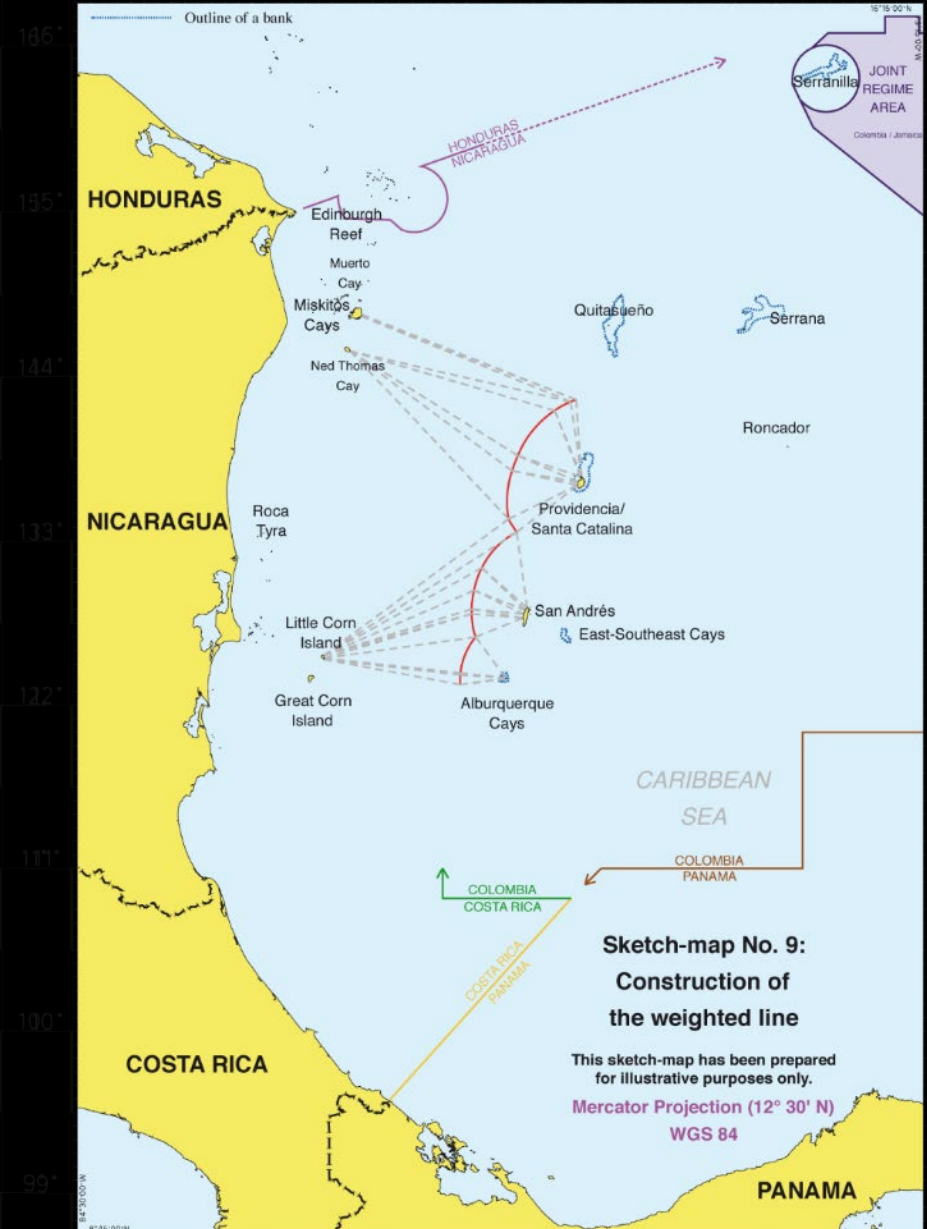
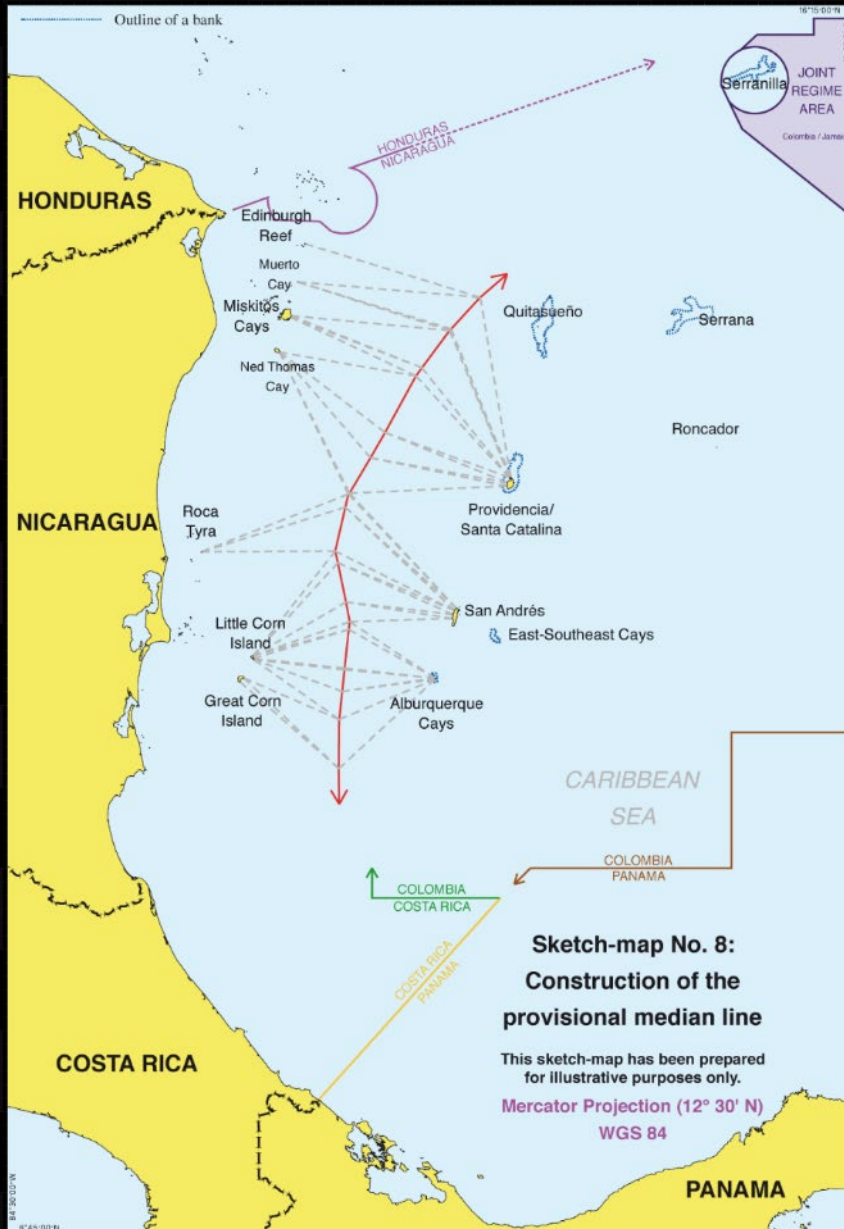
Limit Distance  
Limit: 200  
In fill: 10  
Units: Nautical Miles

Report File:  
[ ] [Browse]  
[Cancel] [OK]



Type	Feature Code	Key	Layer	Source ID	Elevation
Line	AWPP LINE	11242	0	DEFAULT	N/A

# Weighted equidistance: Nicaragua v. Colombia (2012)



## **WARNING: Garbage In, Garbage Out...**

- Limits and equidistance lines generated by software are only useful if the baselines from which they are constructed are sufficiently accurate for the needs of the relevant state or states.

# The normal baseline

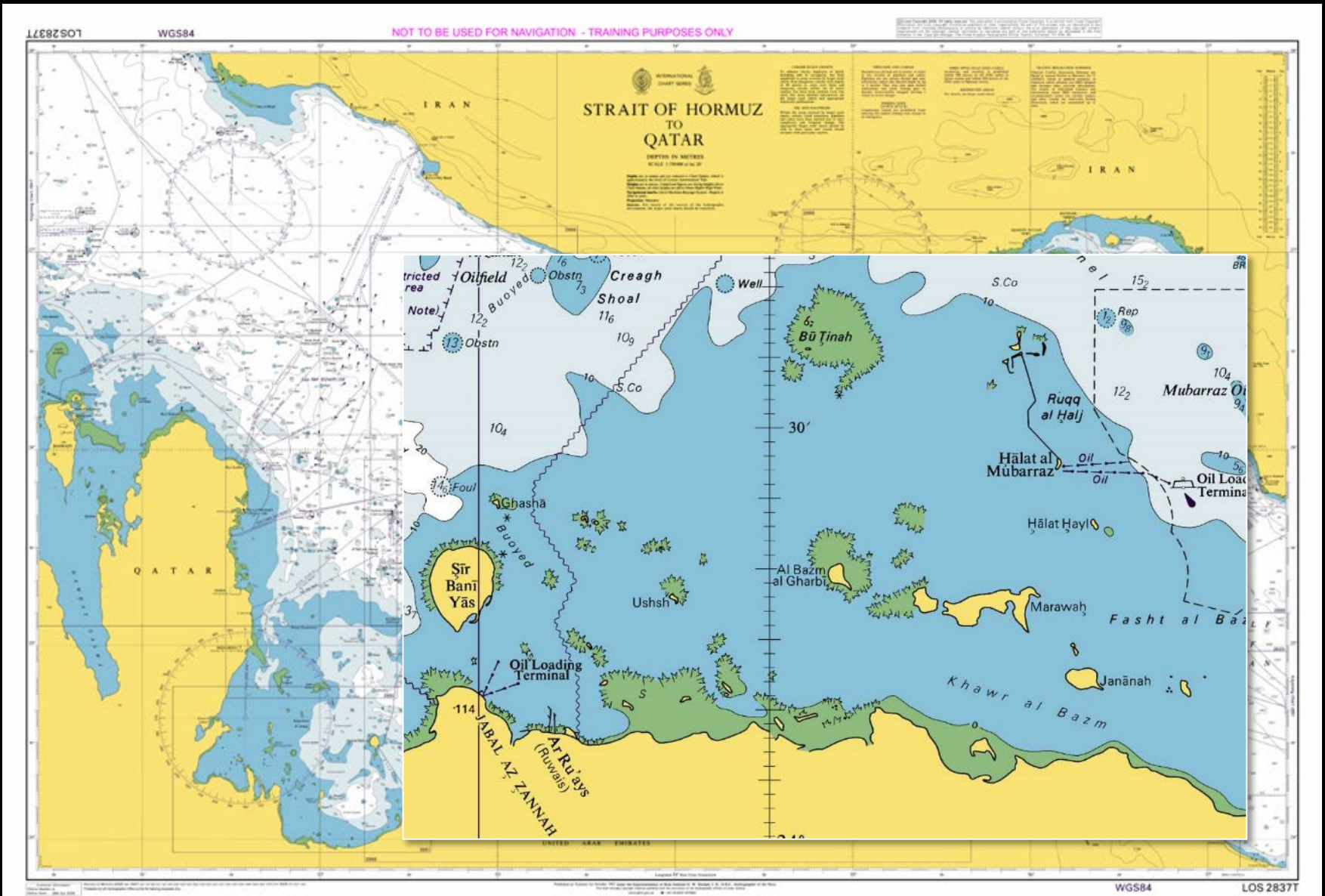
## UNCLOS Article 5

Except where otherwise provided in this Convention, the normal baseline for measuring the breadth of the territorial sea is the **low-water line along the coast as marked on large-scale charts officially recognized by the coastal State.**

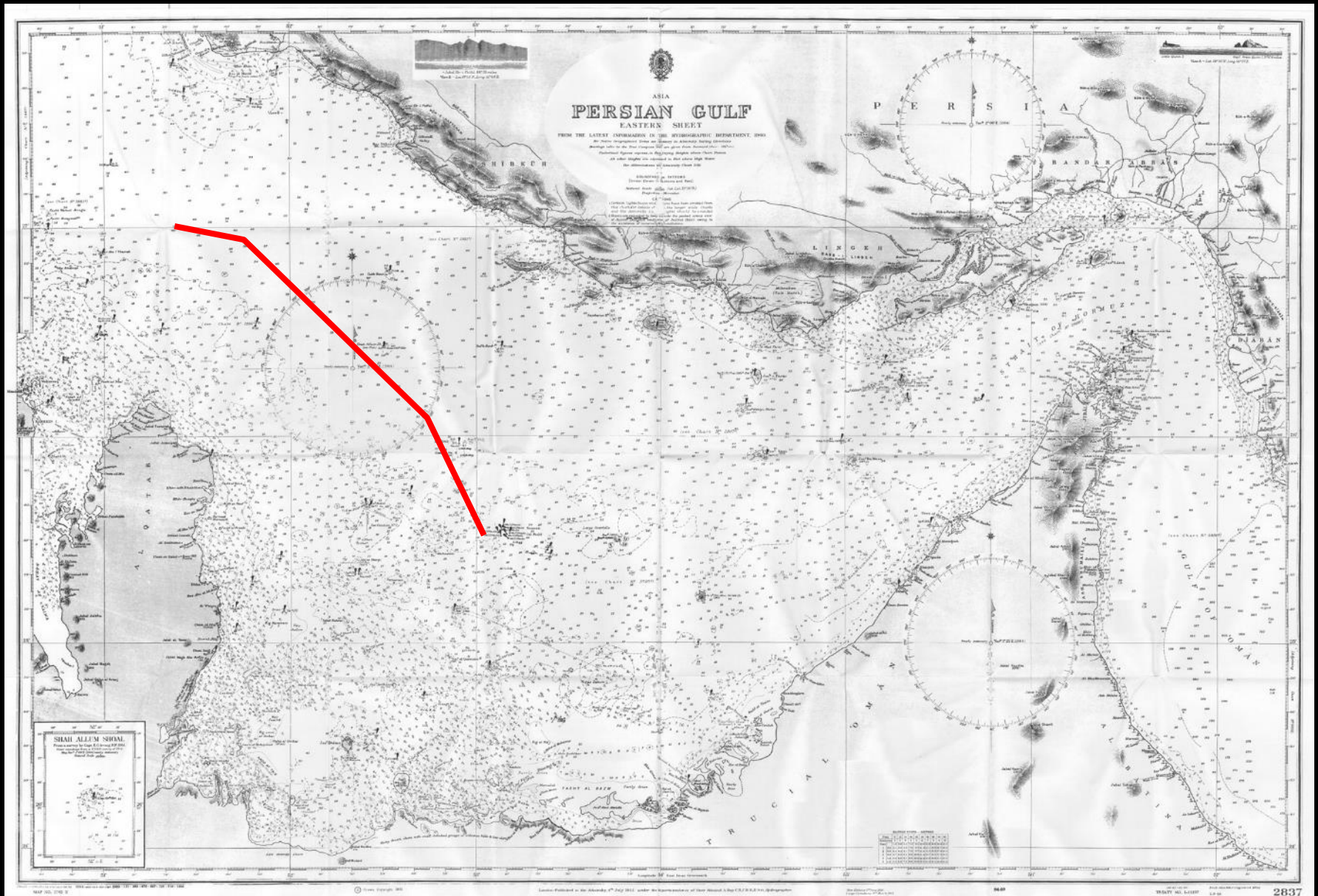
# Vertical datums

- Vertical datum: baseline for measuring land height and water depth.
- Chart datum: the low-water line depicted on a chart (height = zero).
- No internationally-agreed chart datum but Lowest Astronomical Tide recommended by International Hydrographic Organisation.
- Also:
  - Mean Low Water Springs
  - Lower Low Water Large Tides
  - Mean Lower Low Water
  - Lowest Low Water Spring Tide
- Two charts of the same area with different vertical datums will show different low-water lines. This can create problems in agreeing the alignment of the equidistance line.

# Navigational charts



# Navigational charts: Iran-Qatar (1969)

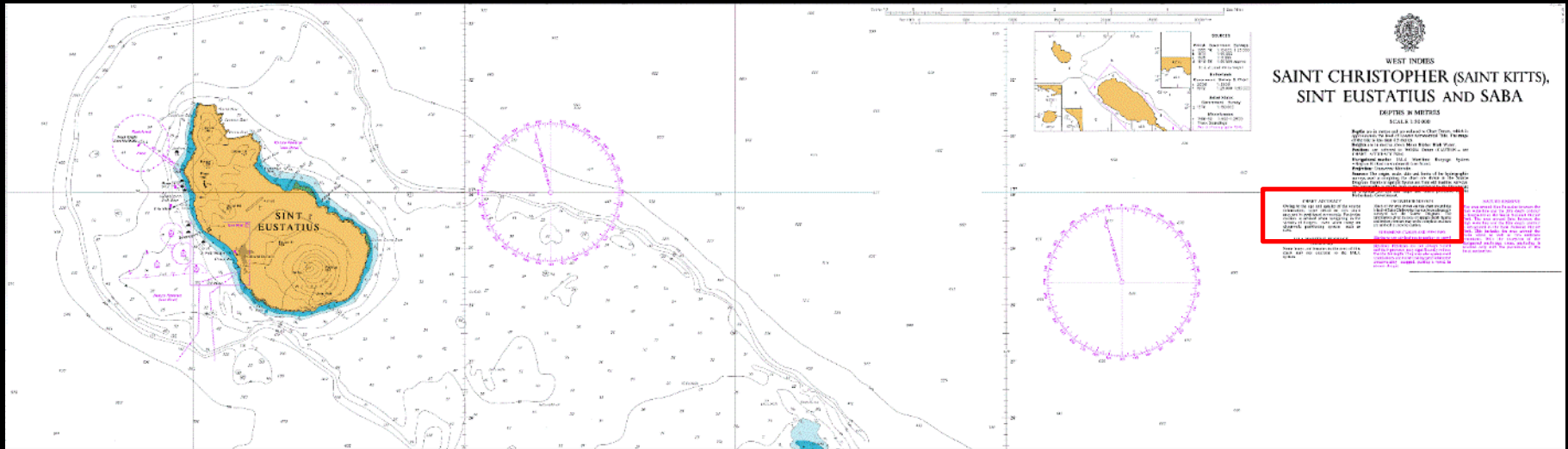


# Positional inaccuracies in old charts





# Positional inaccuracies in modern charts

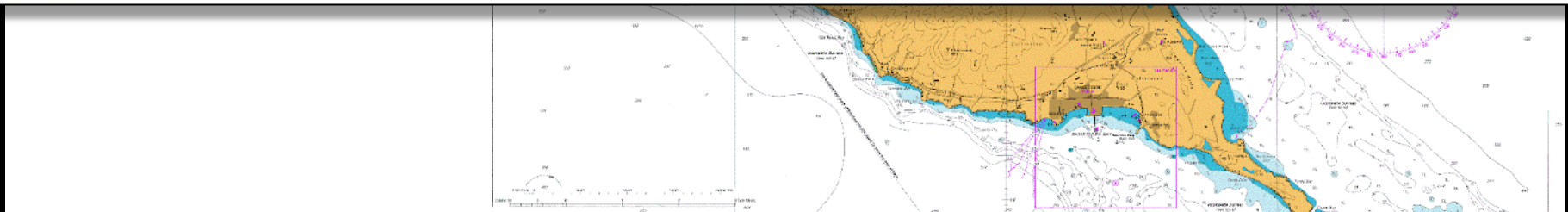


## CHART ACCURACY

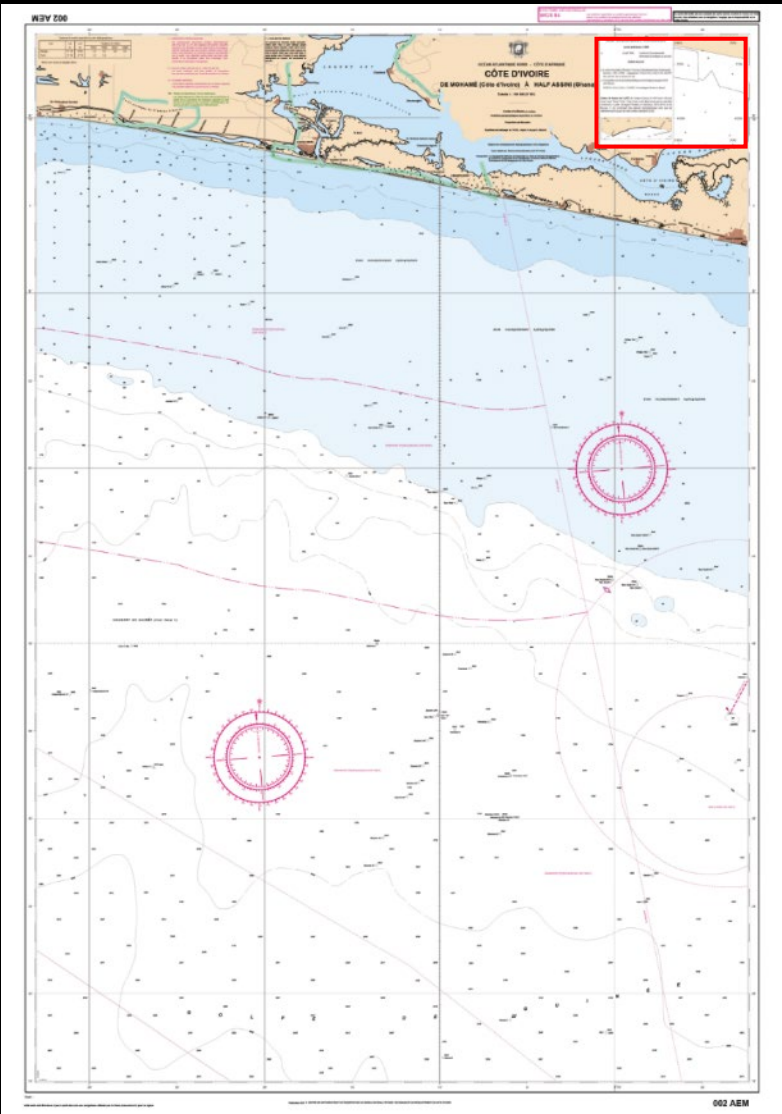
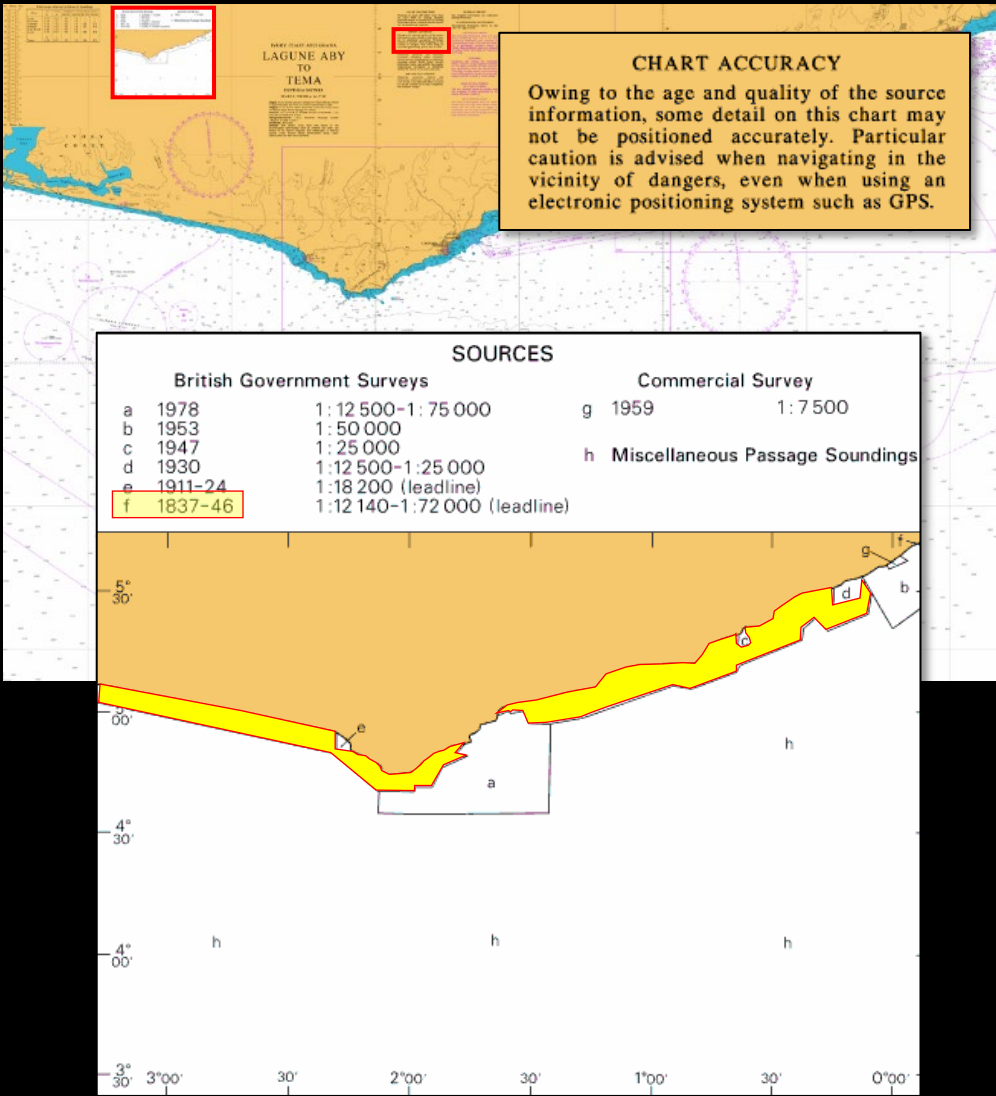
Owing to the age and quality of the source information, some detail on this chart may not be positioned accurately. Particular caution is advised when navigating in the vicinity of dangers, even when using an electronic positioning system such as GPS.

## INCOMPLETE SURVEYS

Much of the area shown on this chart around the island of Saint Christopher has not been adequately surveyed (see the Source Diagram). The information given in areas of upright depth figures and broken contours may not be complete; mariners are advised to exercise caution.



# Ghana-Côte d'Ivoire: comparison between charts A002 and BA1383

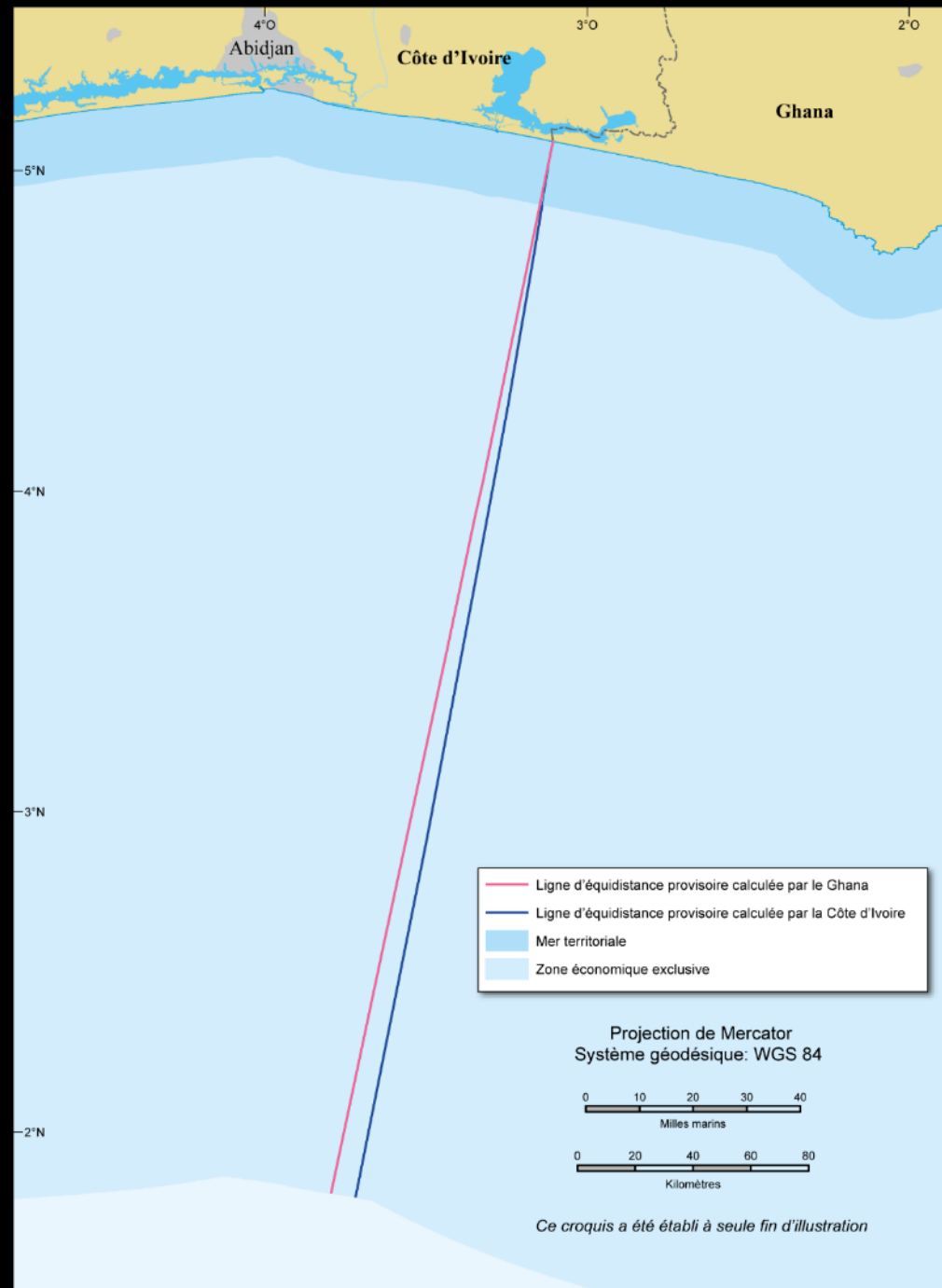


## Ghana-Côte d'Ivoire:

### Comparison between the low-water line on charts A 002 and 1383

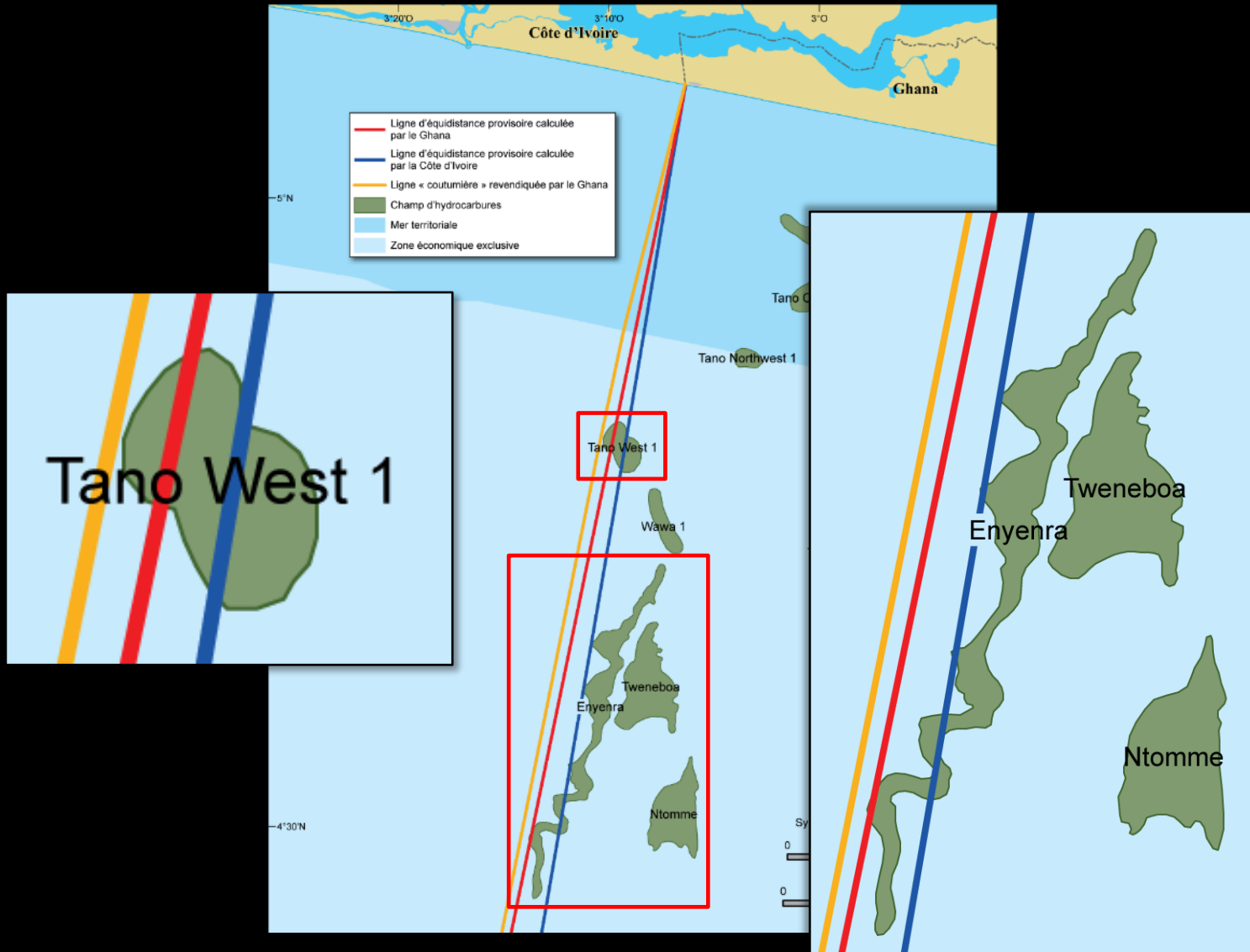


# Ghana-Côte d'Ivoire: The parties' provisional equidistance lines

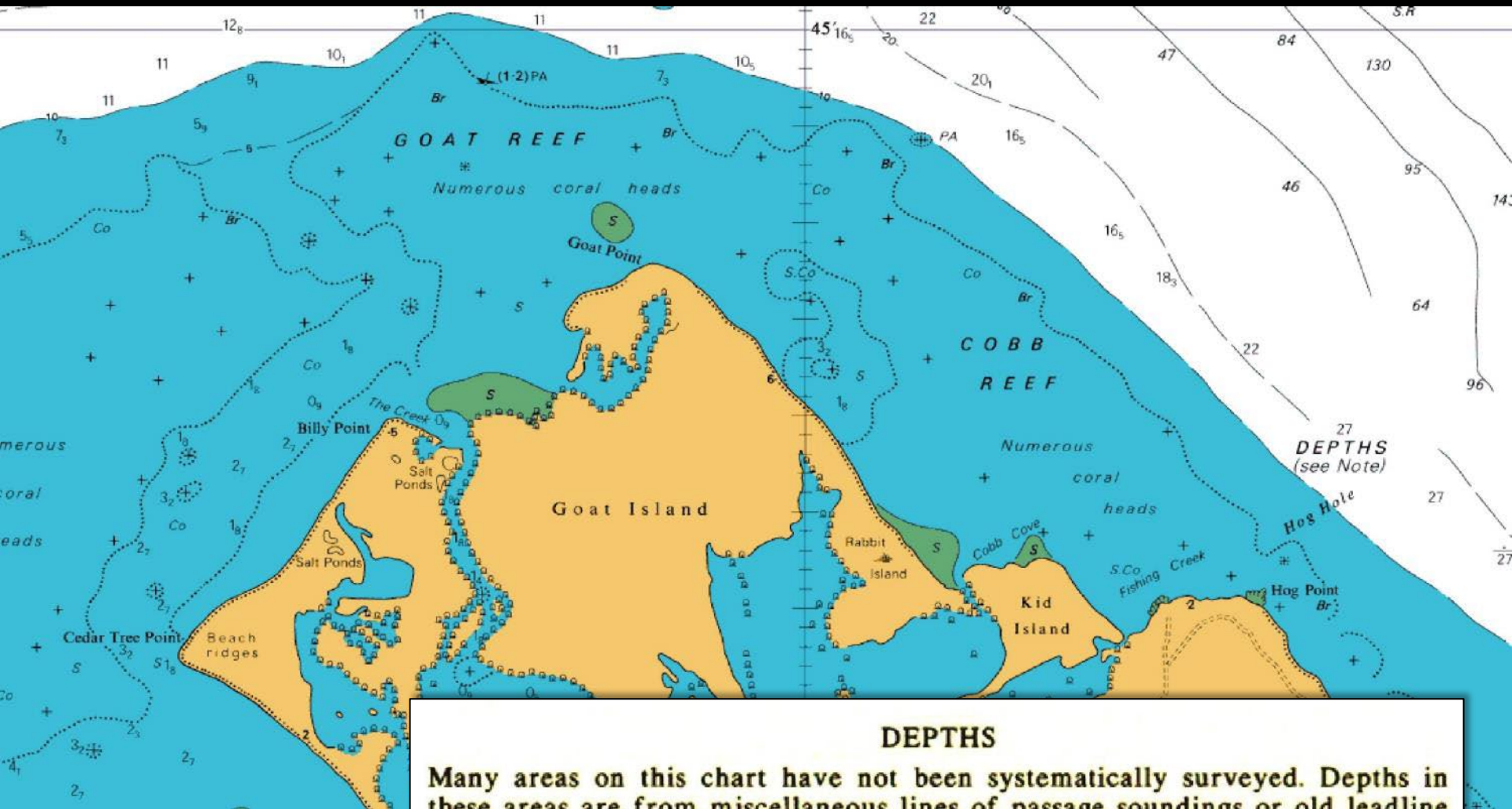


# Ghana-Côte d'Ivoire:

## The concrete effects of the provisional equidistance line



# Identifying the low-water line



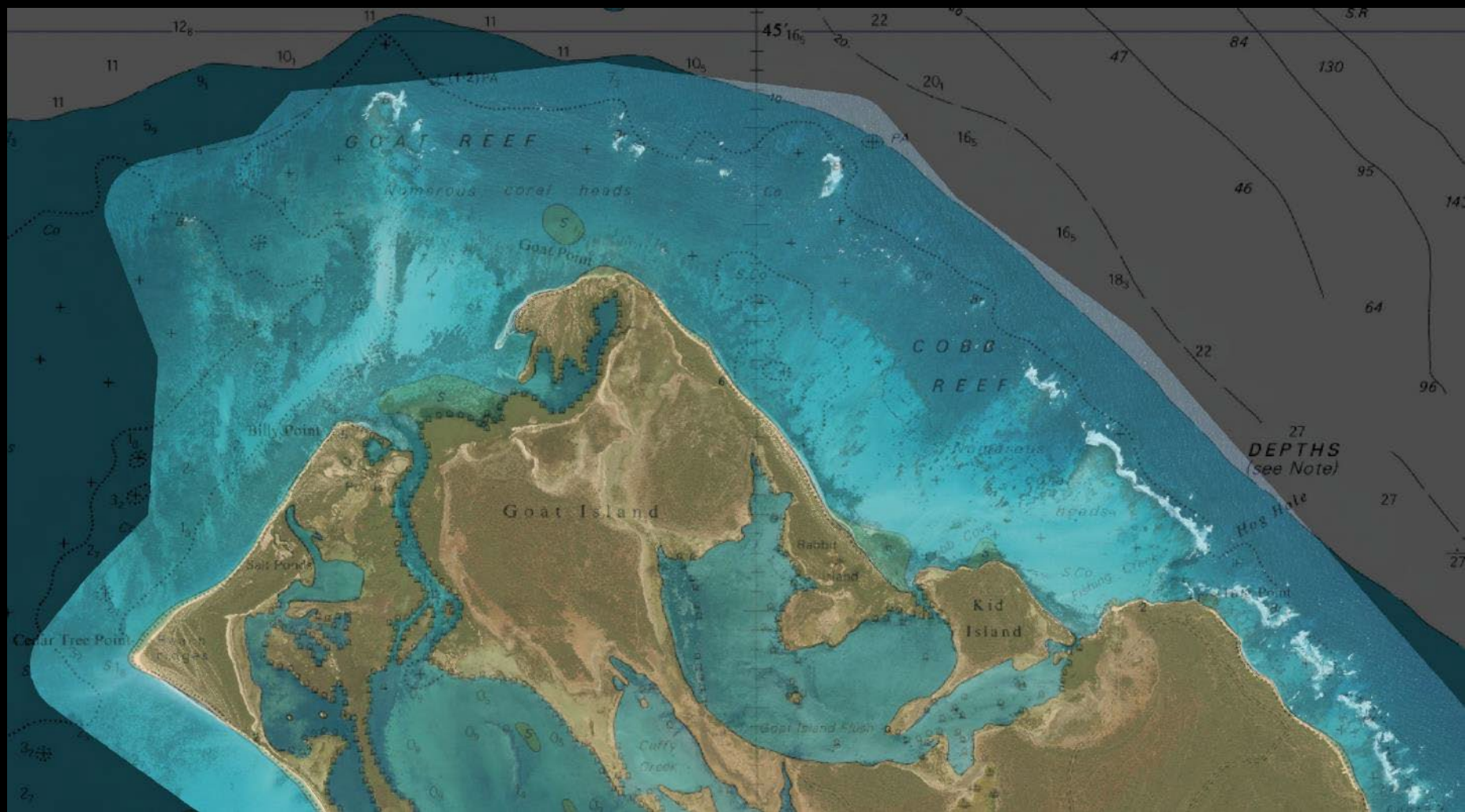
## DEPTHS

Many areas on this chart have not been systematically surveyed. Depths in these areas are from miscellaneous lines of passage soundings or old leadline surveys. Uncharted dangers may exist, including coral heads, which may uncover, and are liable to exist anywhere within the area of the fringing reefs. For further details see the Source Diagram.

# Identifying the low-water line

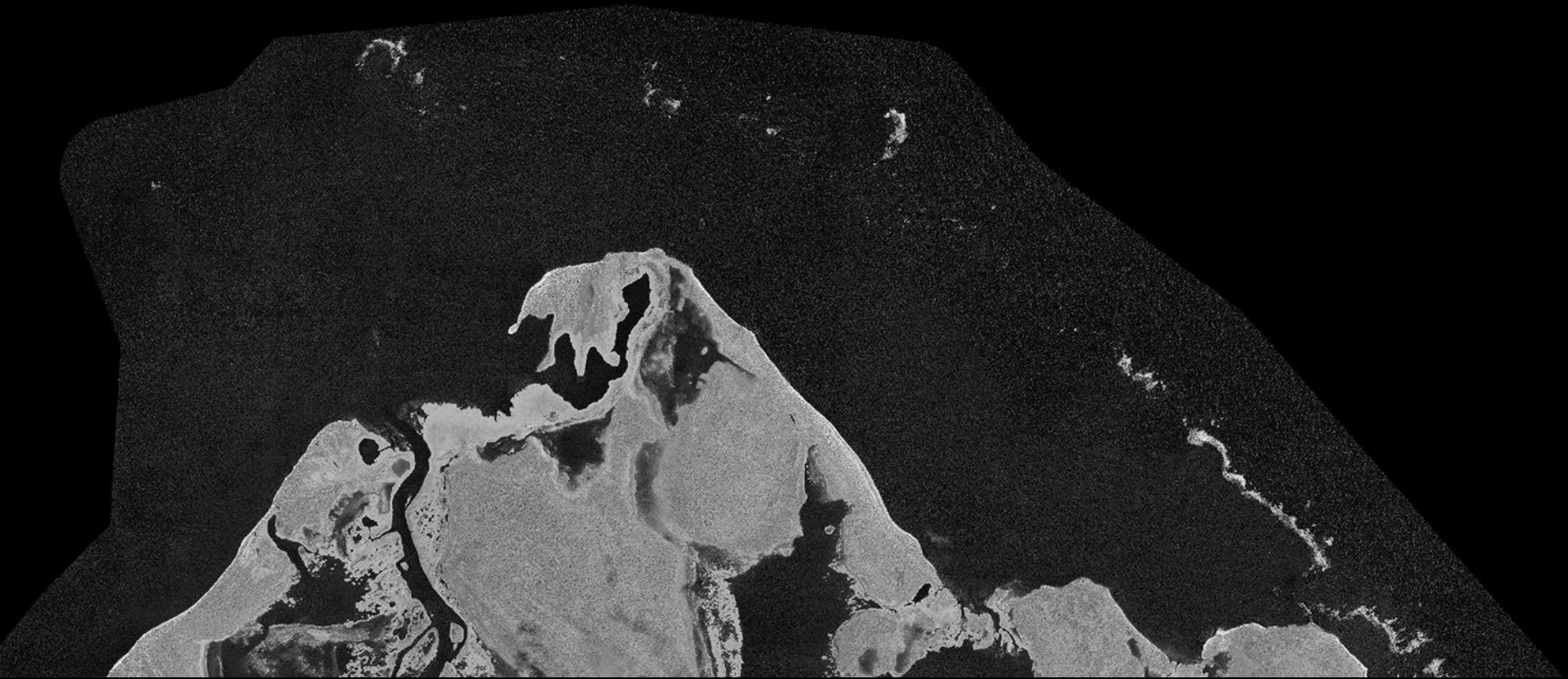


# Identifying the low-water line





# Identifying the low-water line



# Satellite imagery for baseline identification

## Pros and cons

- Inexpensive
- Up-to-date (+ historical archive from 1970s)
- Near global coverage
- No mobilisation required
- Resolution up to 15 cm per pixel
- Reasonably accurate reference to WGS84 without ground control
  
- Rarely acquired at low water
- Water penetration only in clear water, and difficult to interpret even then
- Contestable as definition of normal baseline?

# WorldView

## 0.3 metre pixel resolution



# Satellite imagery for baseline identification

## Pros and cons

- Inexpensive
- Up-to-date (+ historical archive from 1970s)
- Near global coverage
- No mobilisation required
- Resolution up to 0.3 m per pixel
- Reasonably accurate reference to WGS84 without ground control
  
- Rarely acquired at low water
- Water penetration only in clear water, and difficult to interpret even then
- Contestable as definition of normal baseline?

## South China Sea arbitrations tribunal's conclusions on satellite imagery evidence

326. As the Philippines correctly notes, satellite imagery is most beneficial when used in conjunction with other evidence, and the Tribunal considers that satellite imagery may be able to disprove the existence of large sand cays or features where the area in question clearly covers with water across a series of images. Additionally, the more far-reaching conclusions advanced by the Philippines regarding the (non-)existence of small sand cays or rocks could perhaps be established with very high-resolution stereoscopic imagery, taken at or near high tide, with in-person observations of tidal conditions taken at a nearby location.

**Absent such information, however, the Tribunal does not believe that the majority of the conclusions it has been asked to reach concerning the status of features as above or below water at high tide can be drawn on the basis of satellite evidence alone.**

**Bringing the landscape to life: Google Earth etc.**



# Bringing the landscape to life: Google Earth etc.



© 2020 Google LLC. All rights reserved. Imagery © 2020 Google LLC. Data © 2020 Google LLC, U.S. Navy, NGA, GEBCO

Google Earth

Imagery Date: 3/26/2020 5:28:05:07:891 N 114:13:04:22 E elev: 7m eye alt: 125 m

1985

# Bringing the landscape to life: Google Earth etc.



Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2022 TerraMetrics  
Image © 2022 Maxar Technologies  
Image © 2022 CNES / Airbus

Google Earth

Imagery Date: 12/27/2019 13°54'13.22" N 124°23'50.91" E elev: 0 m eye alt: 1.25 km



# Using Google Earth to monitor coastline change

## Ganges Delta, September 2009 v December 2013



# Field surveys to identify low-water line



# Field surveys to identify low-water line

Nicaragua v. Colombia, "QS32"



## QS 32:

14° 22' 07.2"N;  
81° 08' 31.5"W

Coral 1.505 meters  
above MSL.

Time 10:25

Date 1 Dec 09

Note the white guano  
on the rock indicating  
that it is above water  
at all times.

# Technical support: recommendations

- Identify the kinds of technical expertise that will be required as early as possible, and involve appropriate technical experts throughout the negotiation process.
- Have a technical expert present at all negotiation sessions.
- Allow technical experts to talk and exchange data.
- Be sensitive to time and cost requirements for technical tasks.

# Resources for maritime boundary technicians

- A Manual on Technical Aspects of the United Nations Convention on the Law of the Sea, 5<sup>th</sup> edition

[http://www.iho.int/iho\\_pubs/CB/C\\_51/C\\_51\\_Ed500\\_062014.pdf](http://www.iho.int/iho_pubs/CB/C_51/C_51_Ed500_062014.pdf)

[http://www.iho.int/iho\\_pubs/CB/C\\_51\\_ANIMATIONS/List%20of%20Animation%20for%20TALOS%202012\\_URL%27s\\_120911.pdf](http://www.iho.int/iho_pubs/CB/C_51_ANIMATIONS/List%20of%20Animation%20for%20TALOS%202012_URL%27s_120911.pdf)

- Developments in the Technical Determination of Maritime Space: Charts, Datums, Baselines, Maritime Zones and Limits

<https://www.dur.ac.uk/ibru/publications/view/?id=242>

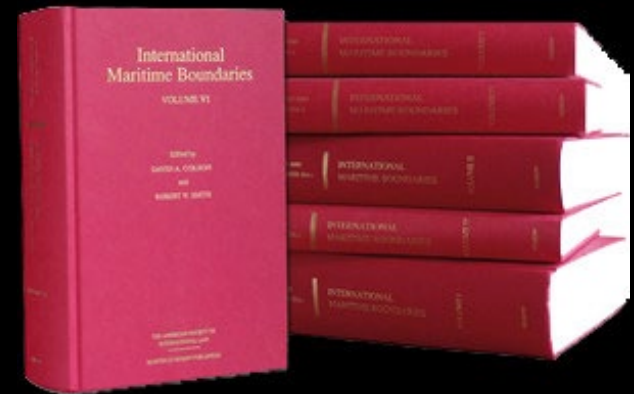
- Developments in the Technical Determination of Maritime Space: Delimitation, Dispute Resolution, Geographical Information Systems and the Role of the Technical Expert

<https://www.dur.ac.uk/ibru/publications/view/?id=243>

# Resources for maritime boundary technicians

- *International Maritime Boundaries*

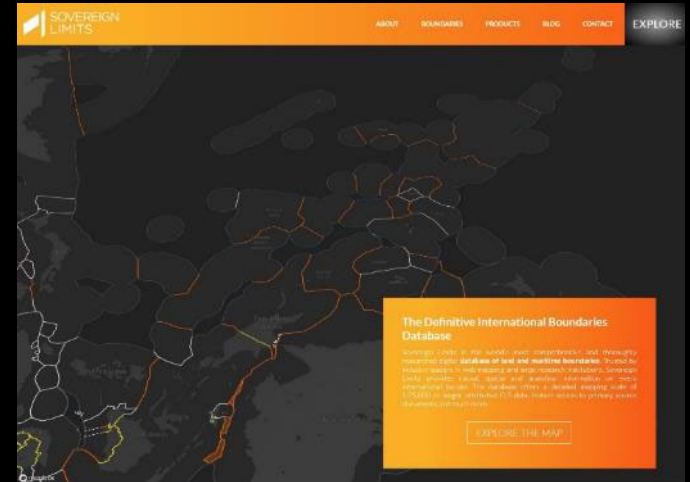
- American Society of International Law project
- 8 volumes, 5,813 pages
- Treaty texts, illustrative maps and in-depth analysis
- Global and regional review essays in volumes 1 & 5
- Examination of considerations
  - Political, strategic & historical
  - Economic & environmental
  - Geographic
  - Islands, rocks, reefs & low-tide elevations
  - Baselines
  - Geological & geomorphological
  - Method of delimitation
  - **Technical**



- **Online version:** [referenceworks.brillonline.com/browse/international-maritime-boundaries](https://referenceworks.brillonline.com/browse/international-maritime-boundaries)  
(US\$6,786 for outright purchase; annual subscription available)

# Resources for maritime boundary technicians

- *Sovereign Limits*
  - Online interactive geodatabase
  - Boundary briefs and maps (\$)
  - GIS dataset available for purchase (\$\$\$)
  - sovereignlimits.com



- *Marineregions.org*
  - Free online / downloadable GIS dataset
  - www.marineregions.org



# Thank you!



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**bordermap** consulting

Geographical intelligence for international  
boundary-making and dispute resolution