# Map projections used in selected portolan style maps including the Piri Reis map of 1513

*Jean-Pierre Lacroix & Robert Bywater*

*Ancient Cartography*

# Outline

- Introduction  & Methods
- Analysis of selected portolan maps
- Conclusions

# Introduction

- Marine charts from 13th to 16th century
- “The first true maps” (Beazley, 1904)
- “The outline ... for the Mediterranean was amazingly accurate.”
  “(the) majority opinion ... (is) that the portolan charts were projectionless or that any projection was accidental” (Campbell, 1987)

# Origin & construction unknown

"Whatever their antecedents might have been, these cannot be identified with any confidence today. ...
How was the prototype constructed and when?”

(Campbell, 1987)

# Aim

- **To investigate if portolan maps were constructed using one or more cartographic projections.**

# Portolan definition

- Although many portolan charts include compass roses, these were a later addition.

- We follow Max Eckerts's (1925) definition and define portolans as those which are

"rhumb line charts"

# Methods

1. trace shorelines

2. digitize tracings

| B | C |
|---|---|
| 22 | 13 |
| 23 | 12 |
| 24 | 11 |
| 25 | 12 |

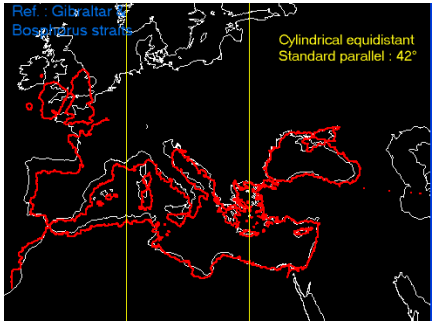
Spreadsheet

3. choose 2 features as "reference locations"

4. choose map projection

cylindrical equidistant (standard parallel 42°)

5. Computer-assisted superposition




6. assess superposition

ACCEPT

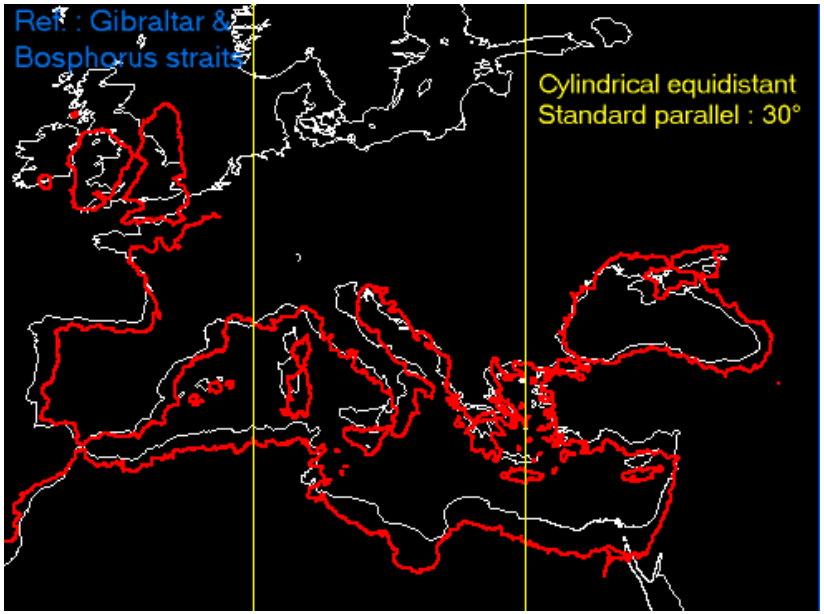
or

REJECT

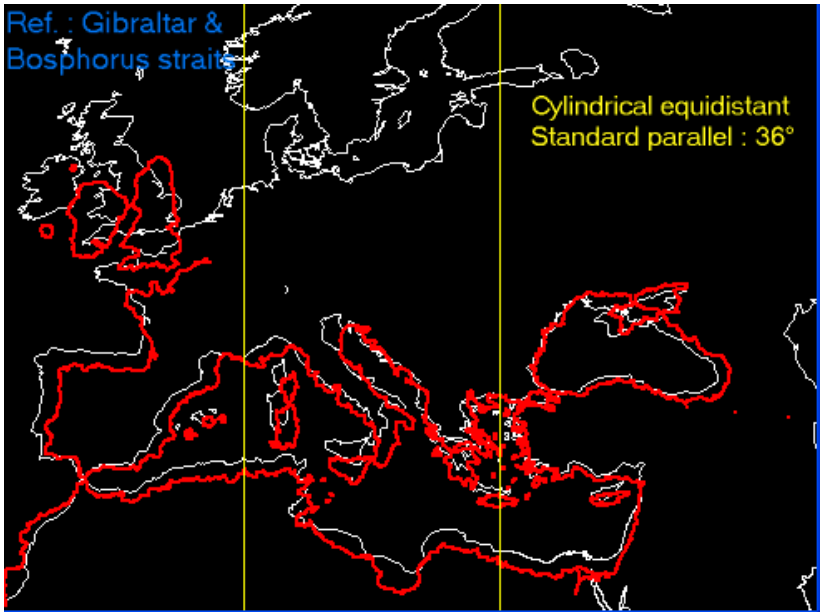
# Dulcert, 1339

# Equidistant cylindrical - Refs : Gibraltar & Bosphorus Straits

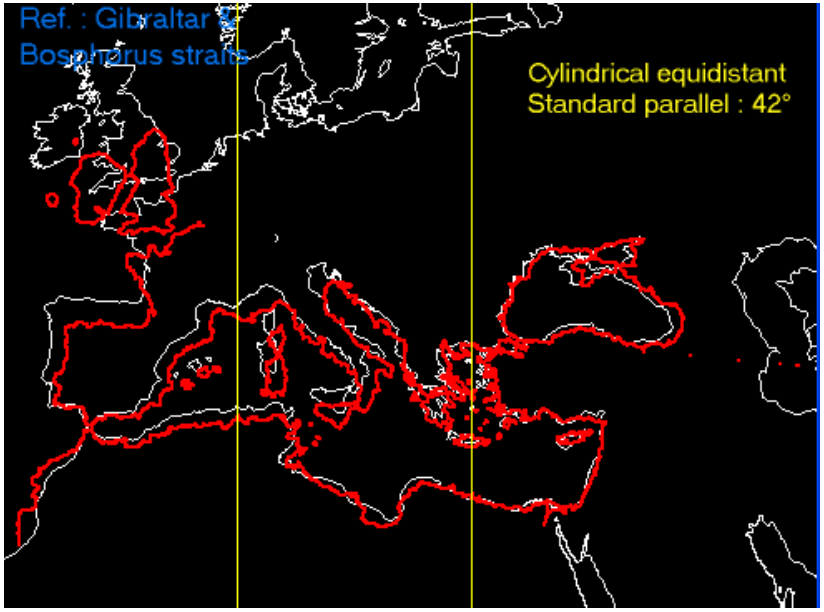
30º



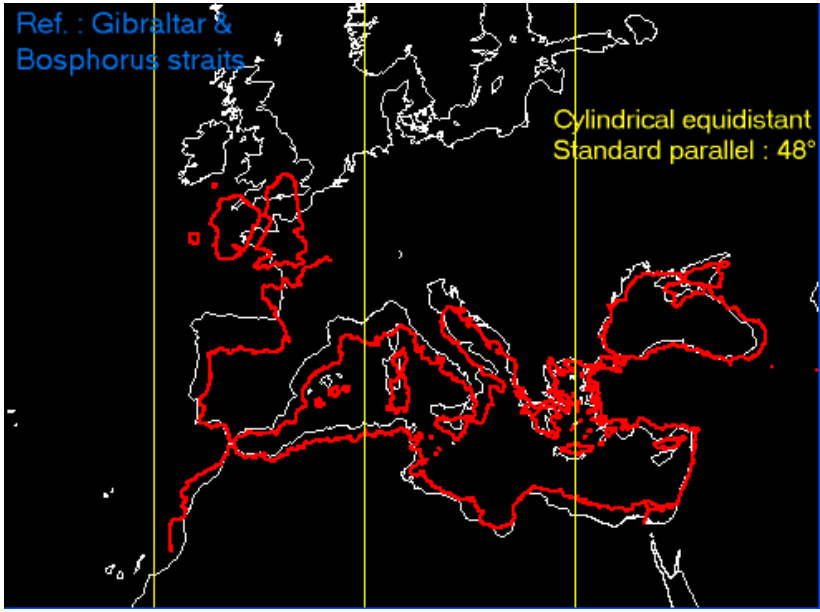

36º




42º

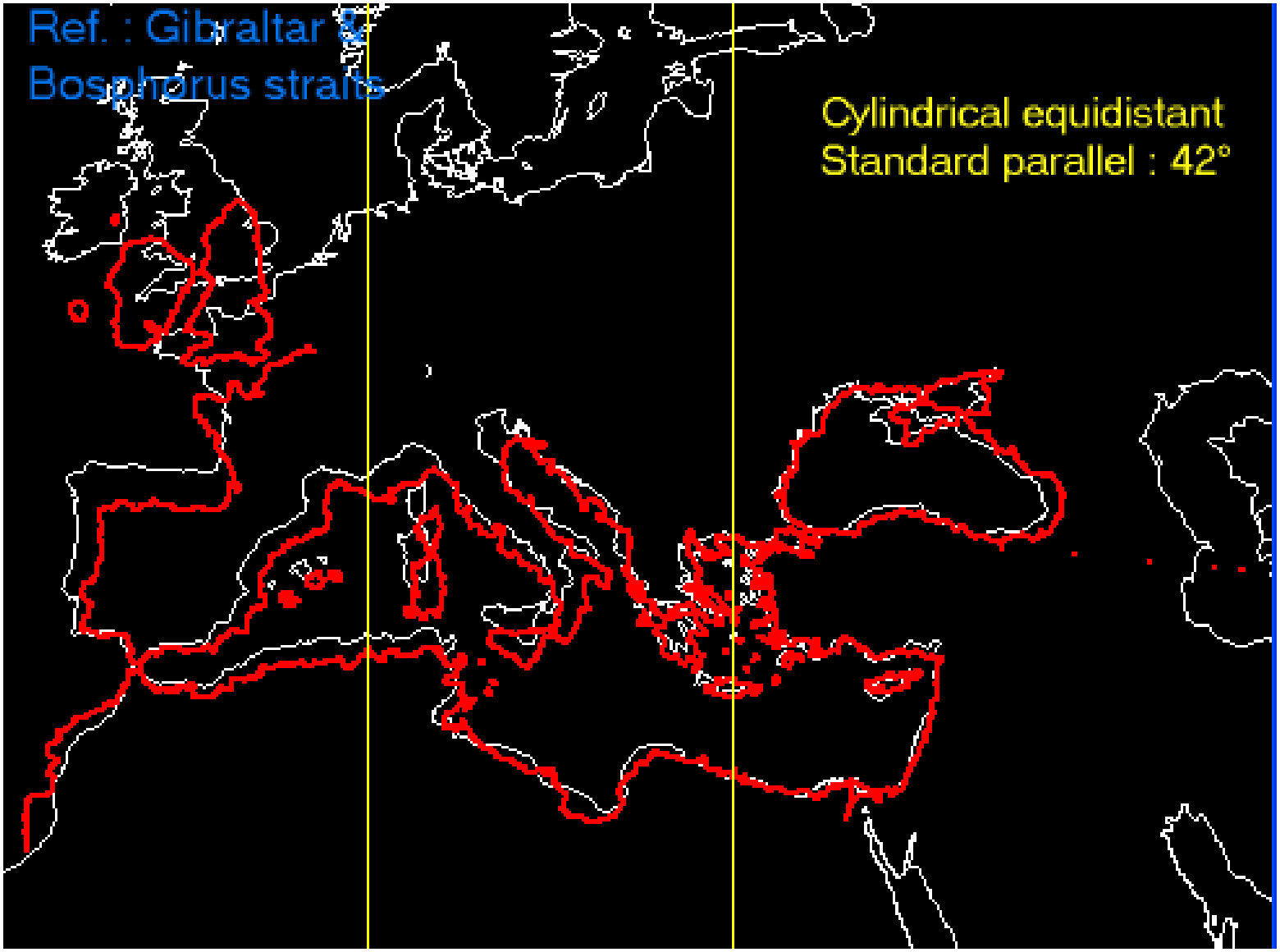



48º



# Equidistant cylindrical - Refs : Gibraltar & Bosphorus Straits

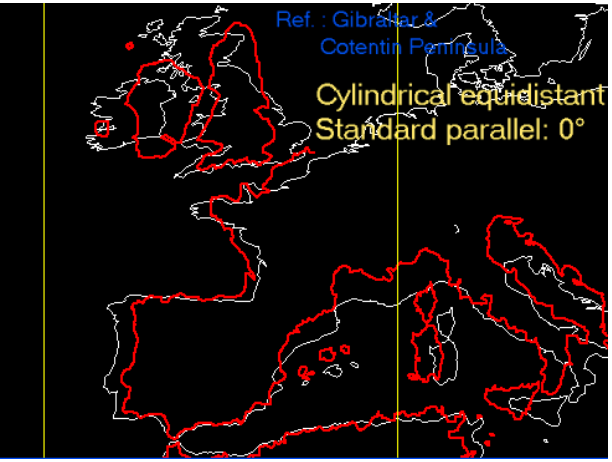
42º



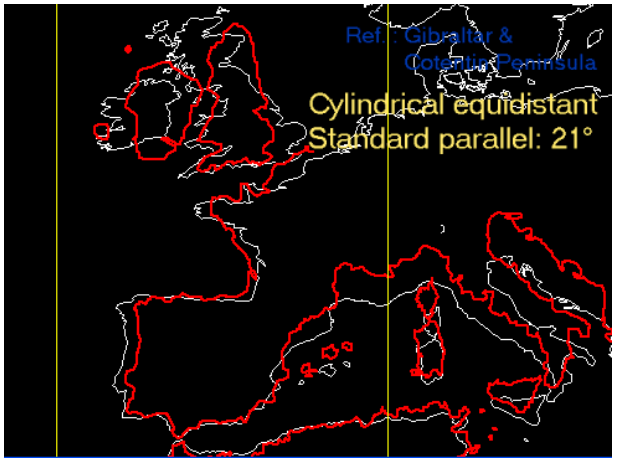
# Atlantic Zone

## Equidistant cylindrical - Refs : Gibraltar Strait & Cotentin Peninsula

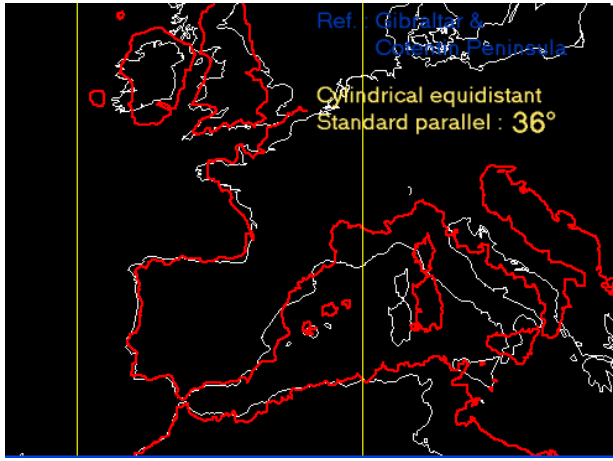
### 0º



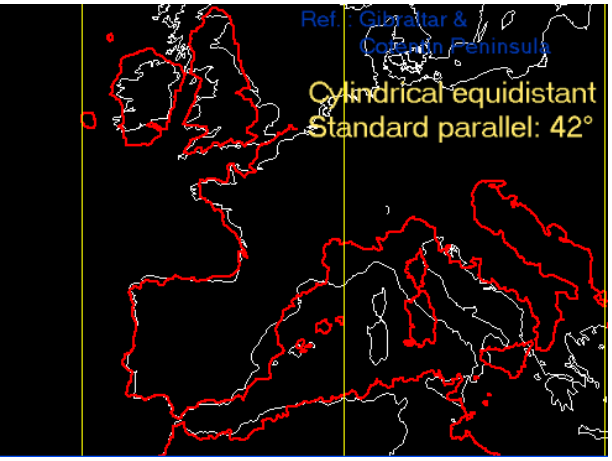

### 21º



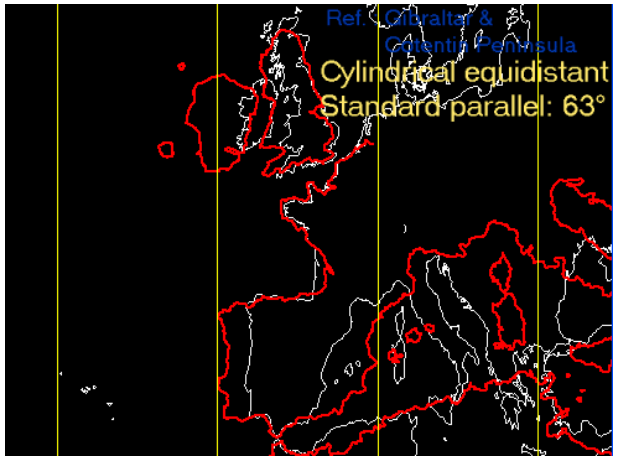

### 36º




### 42º



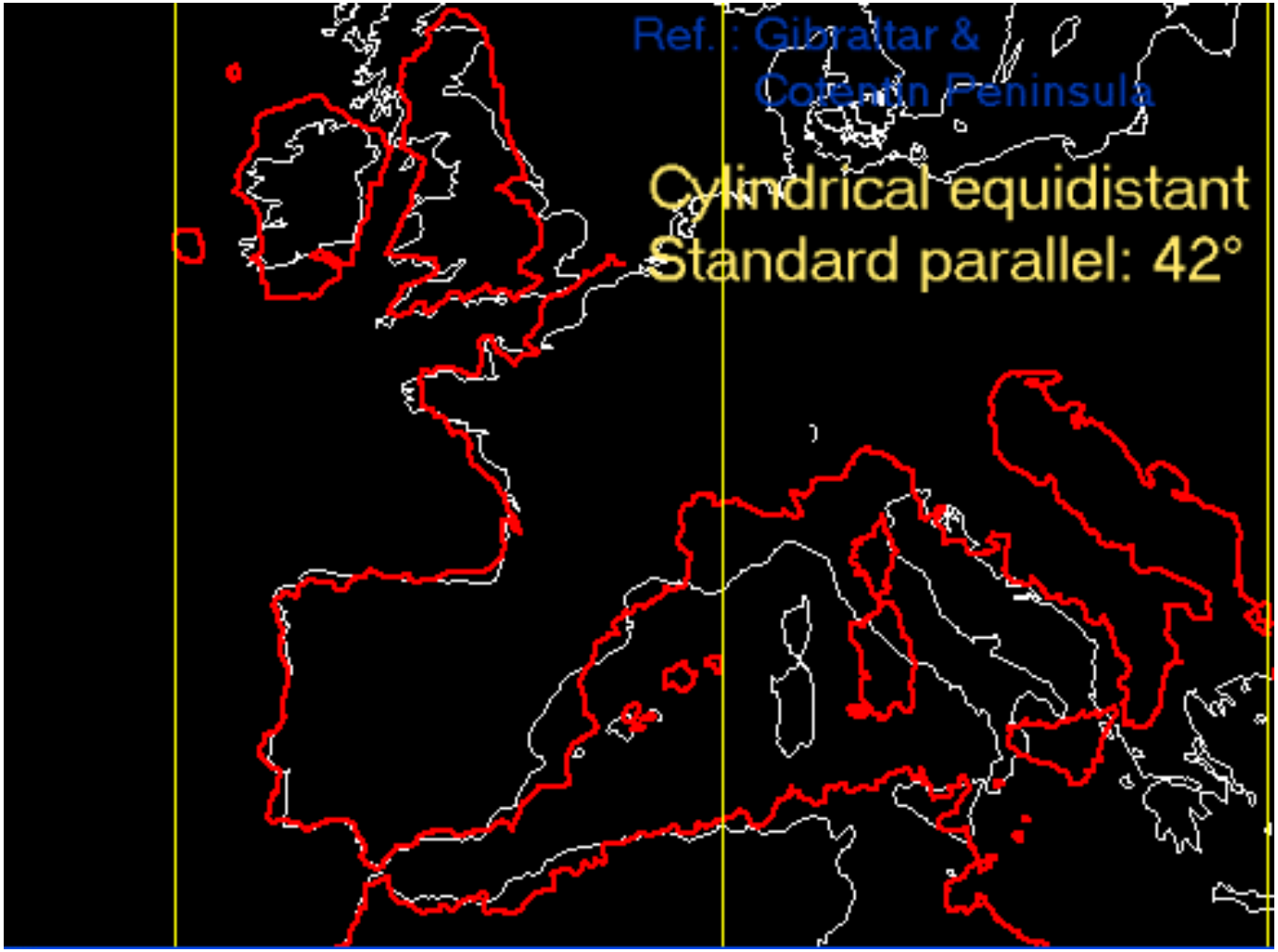

### 63º



# Atlantic Zone

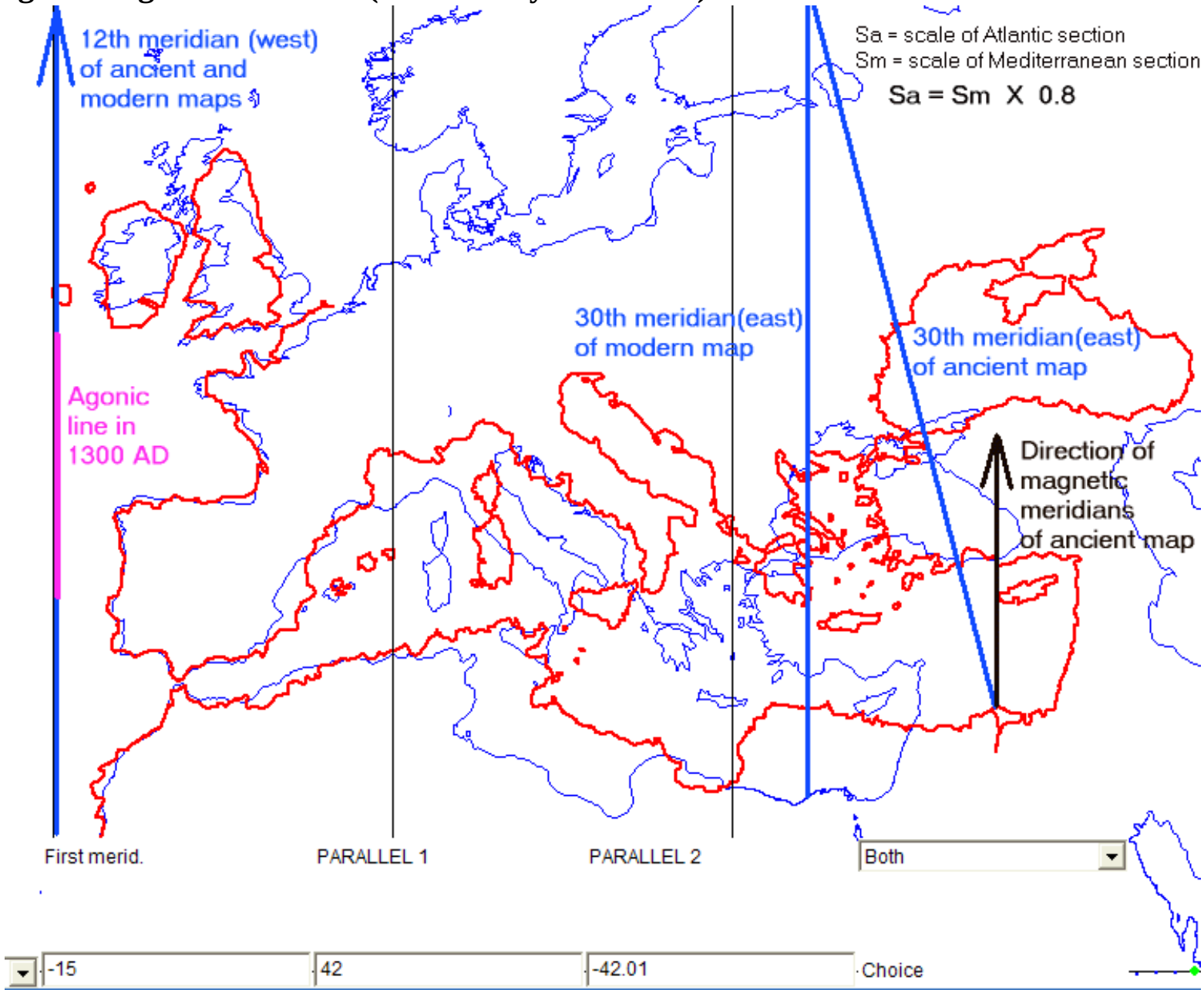
## Equidistant cylindrical - Refs : Gibraltar & Cotentin Peninsula

42º

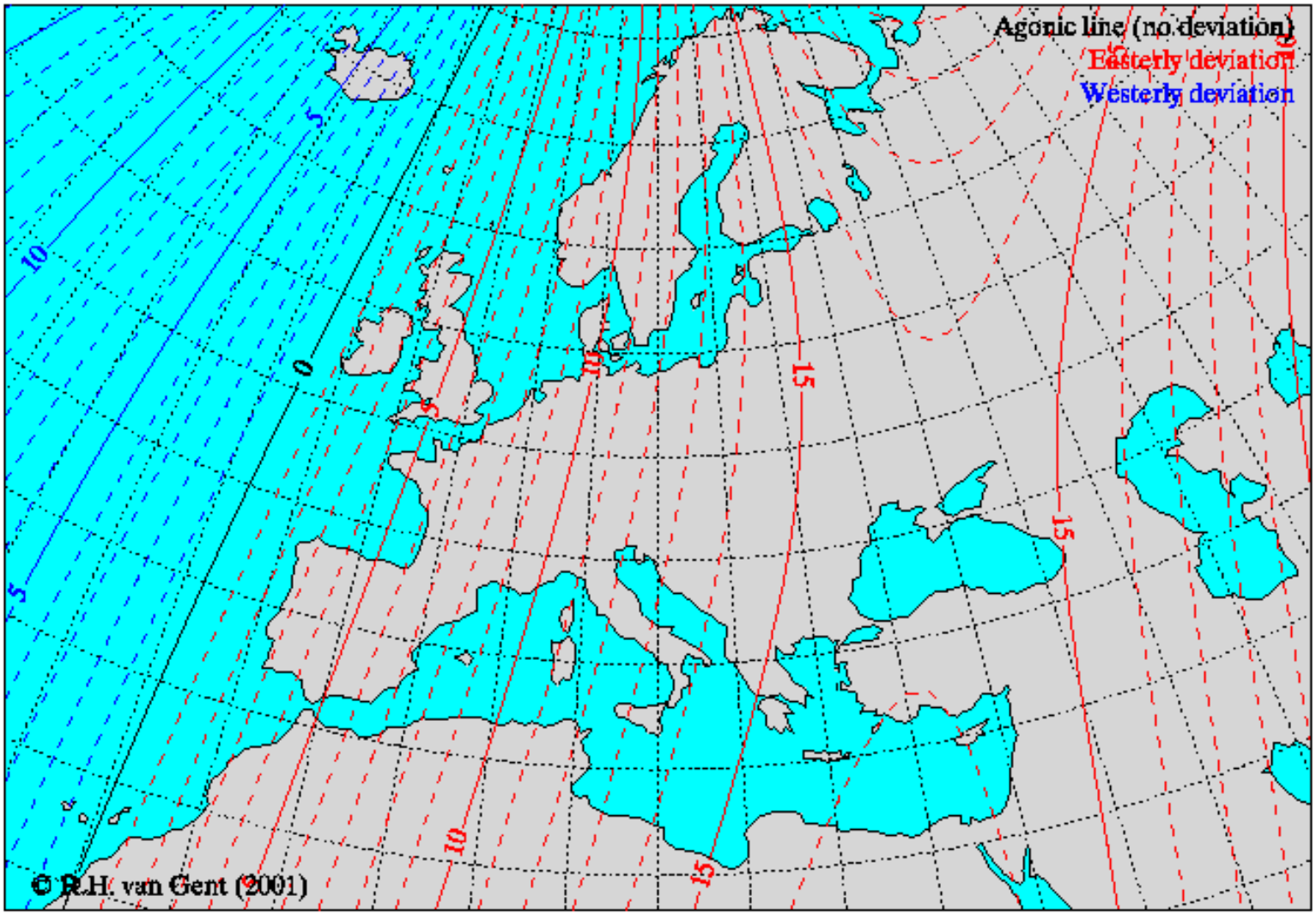



**Dulcert scale here is different = 0.8 of Mediterranean coast**

**With this portulano, a navigator can sail to a given point by placing the needle of the compass along the magnetic meridian (without any correction)**

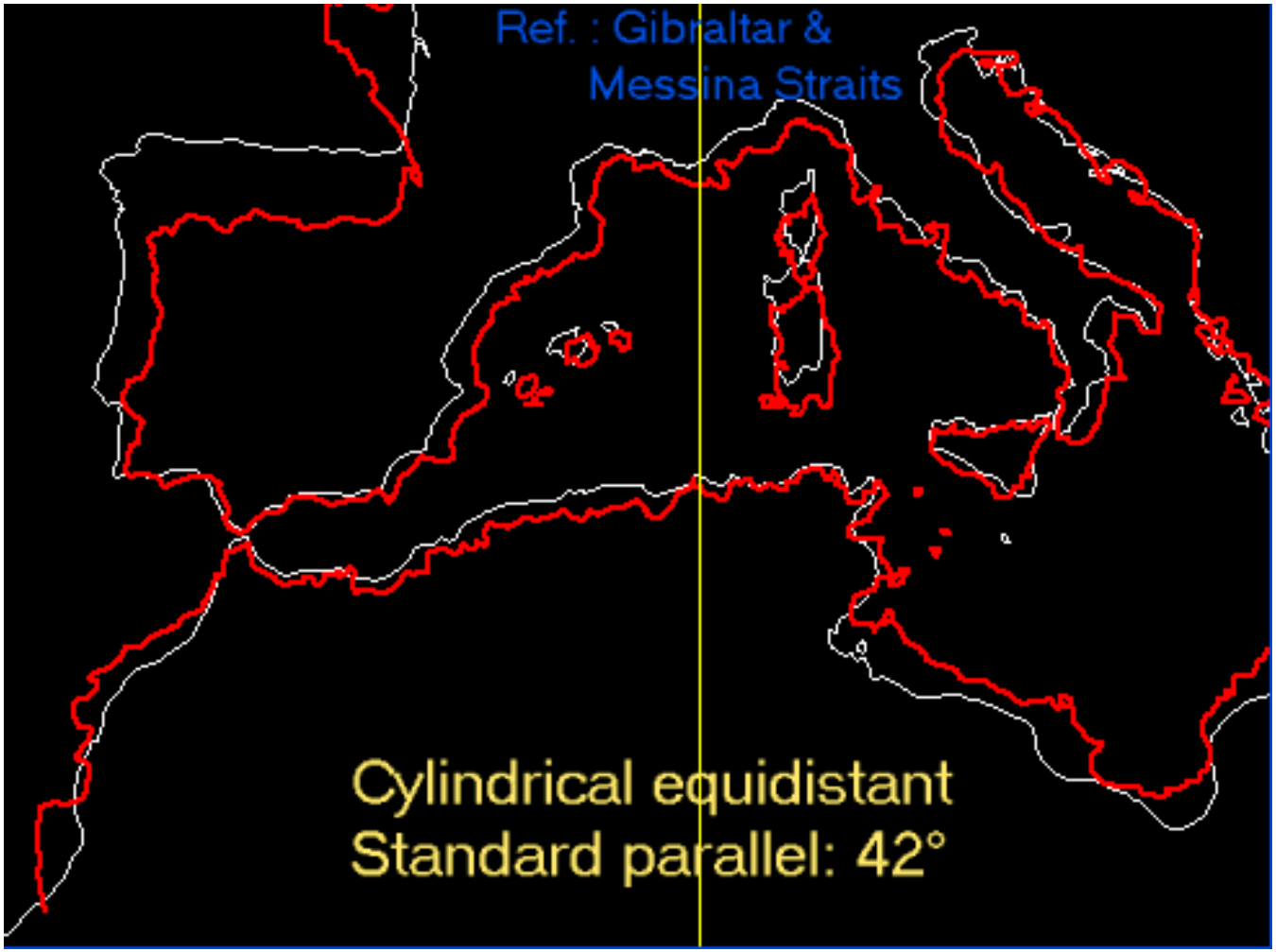


**The rotation explained by the difference of magnetic declination in 1300 AD**
**Model from R.H. van Gent (2001)**



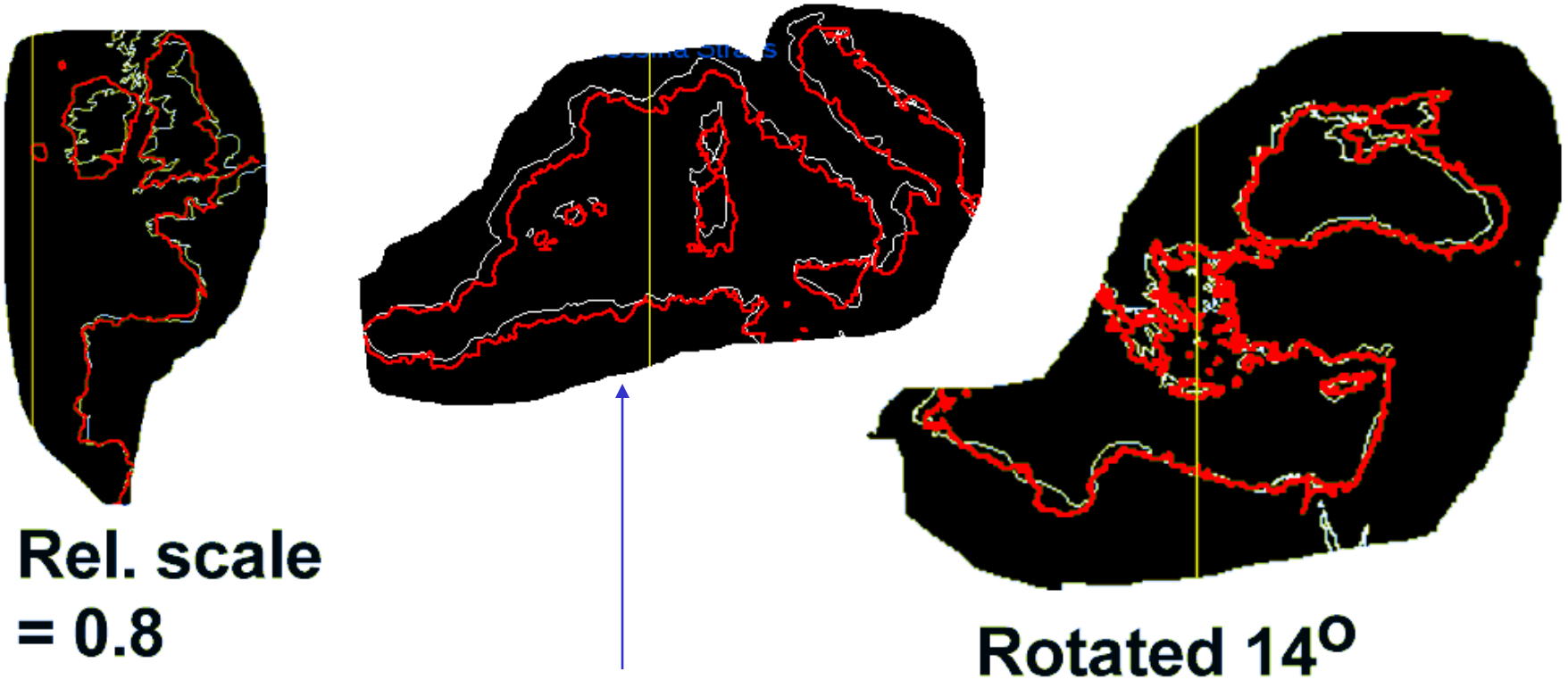
# Western Mediterranean Zone

## Equidistant cylindrical - Refs : Gibraltar Strait & Messina Strait



# Summary

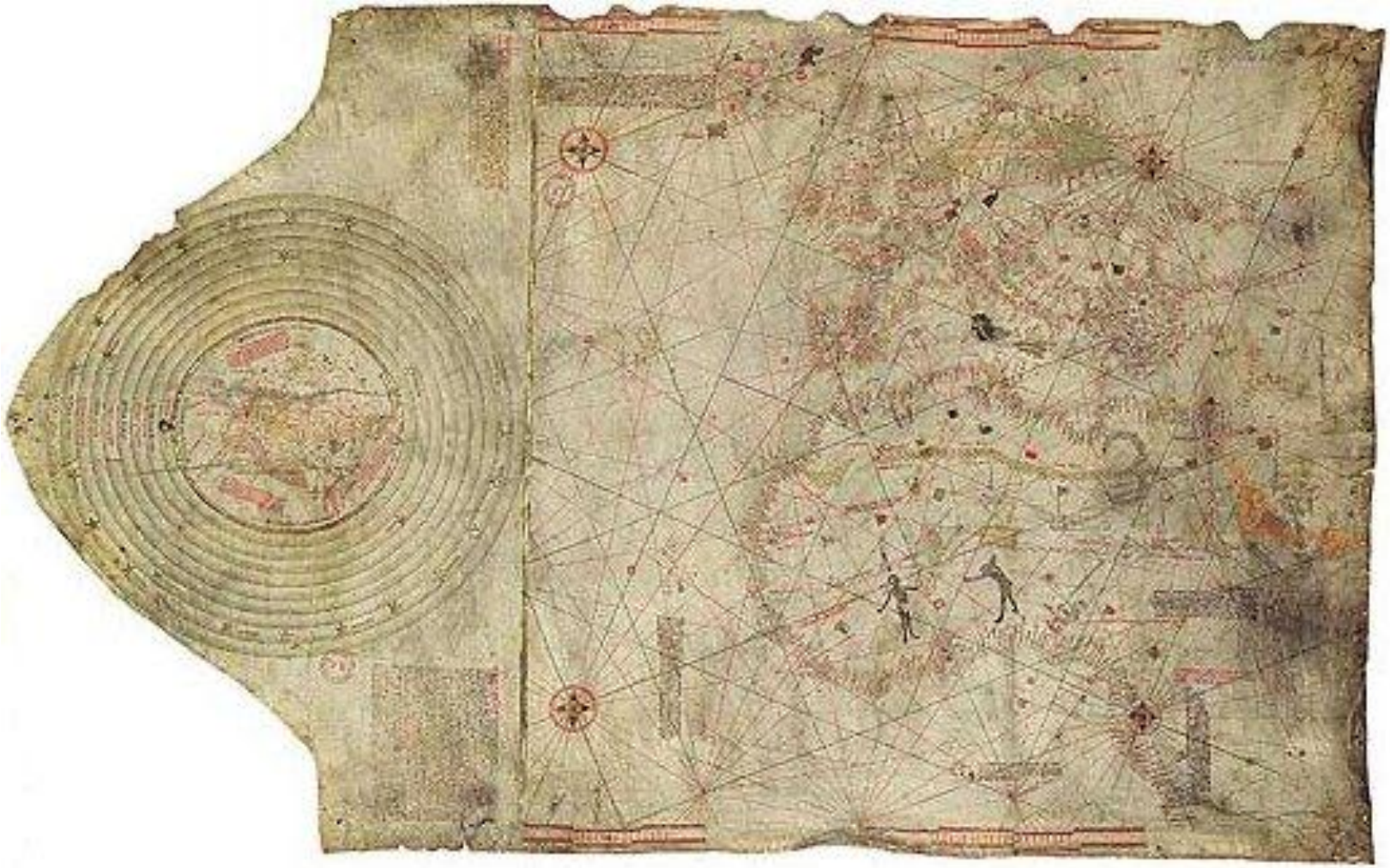
**Atlantic** **Western Mediterranean** **Eastern Mediterranean**



# Why is the relative scale of the Dulcert Atlantic coast = 0.8?

- We saw that the Eastern Mediterranean on the Dulcert was rotated because of the differences in the direction of magnetic north between the west and east Mediterranean.
- Why was the scale of the Atlantic coast = 0.8 of the scale of the Mediterranean?
- We will now examine the northern coasts of Africa on some other portolan maps.

# The “Columbus” map, circa 1492



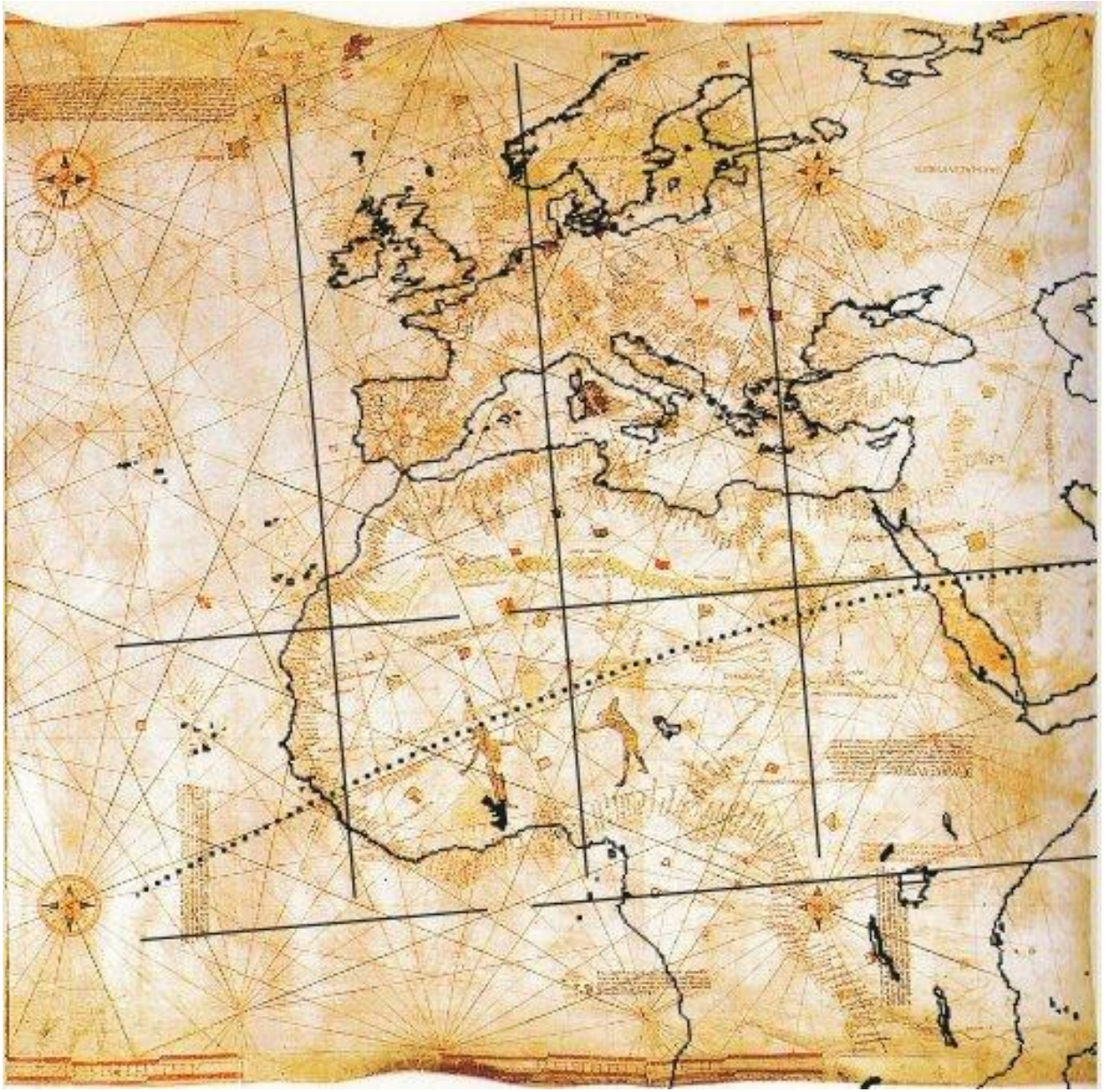
# “Columbus” map ~1492 : Equidistant cylindrical : 42º :

# Plate Carrée Projections

- The plate carrée is the only cylindrical projection the standard parallel of which is a great circle.

- In the “classical” plate carrée  the standard great circle is the equator.

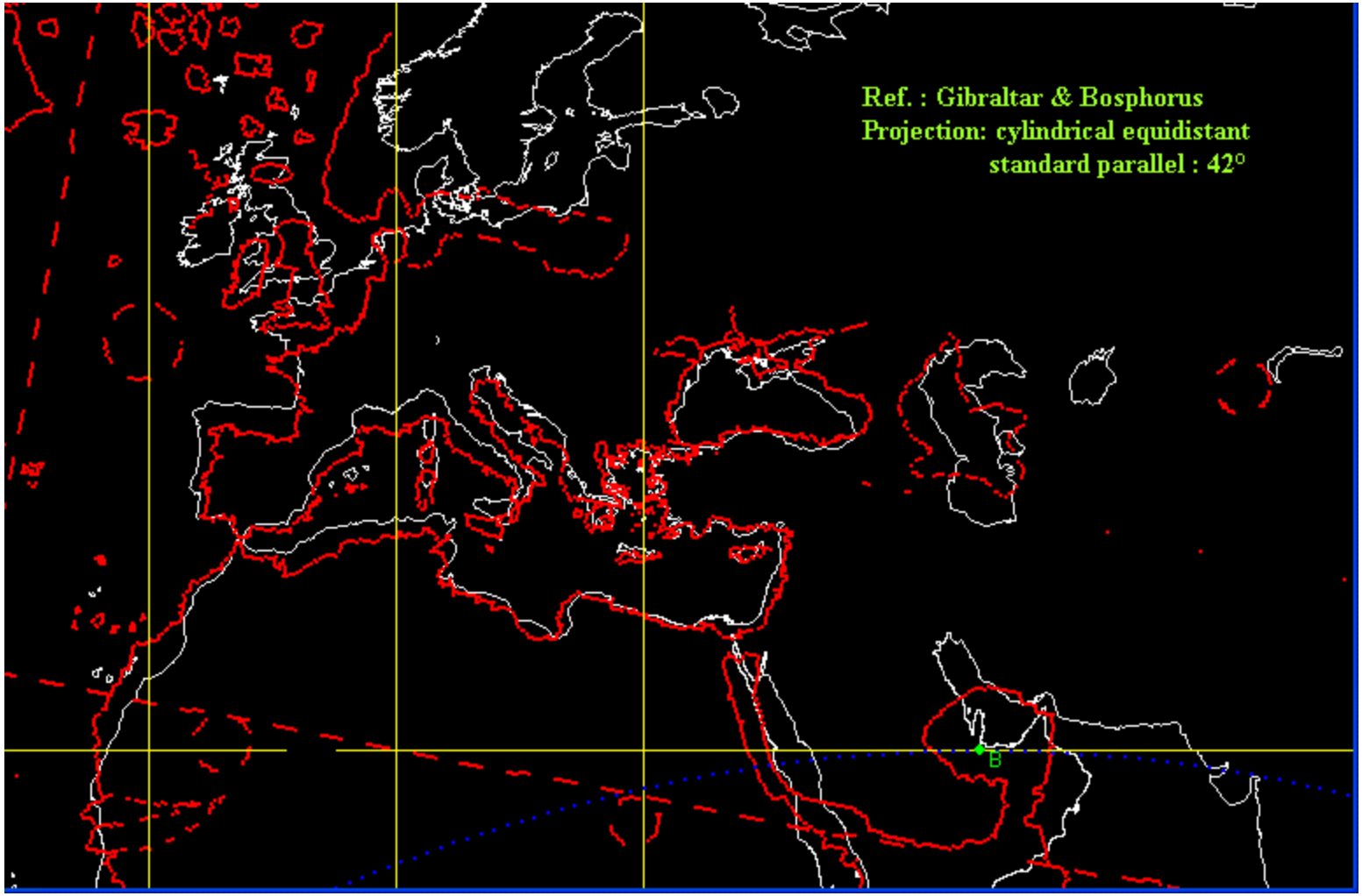
# “Columbus” map ~1492 : Plate carrée



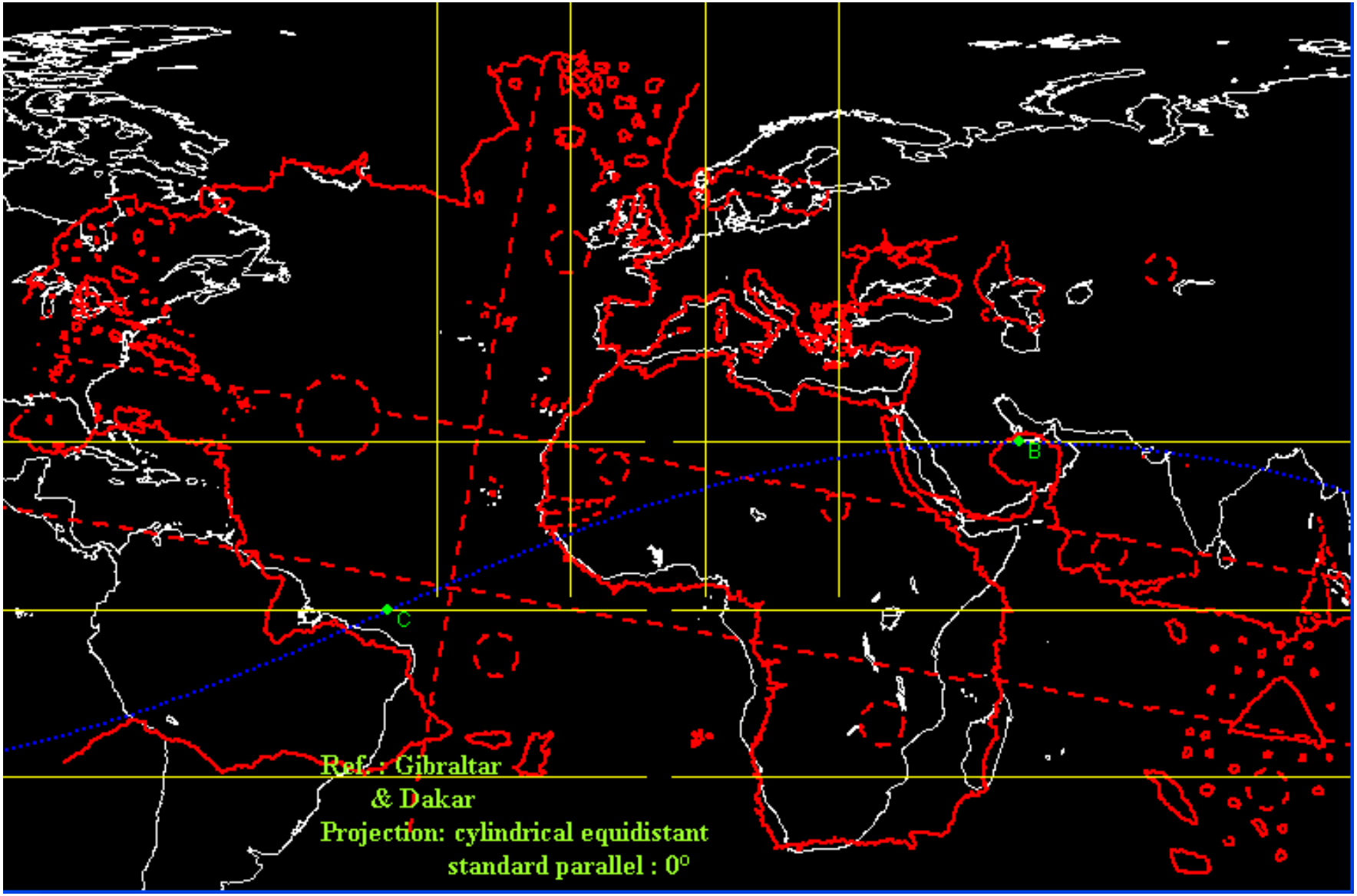
# Juan de la Cosa, 1500

# Juan de la Cosa 1500 :
# Equidistant cylindrical : Refs : Gibraltar & Bosphorus Straits

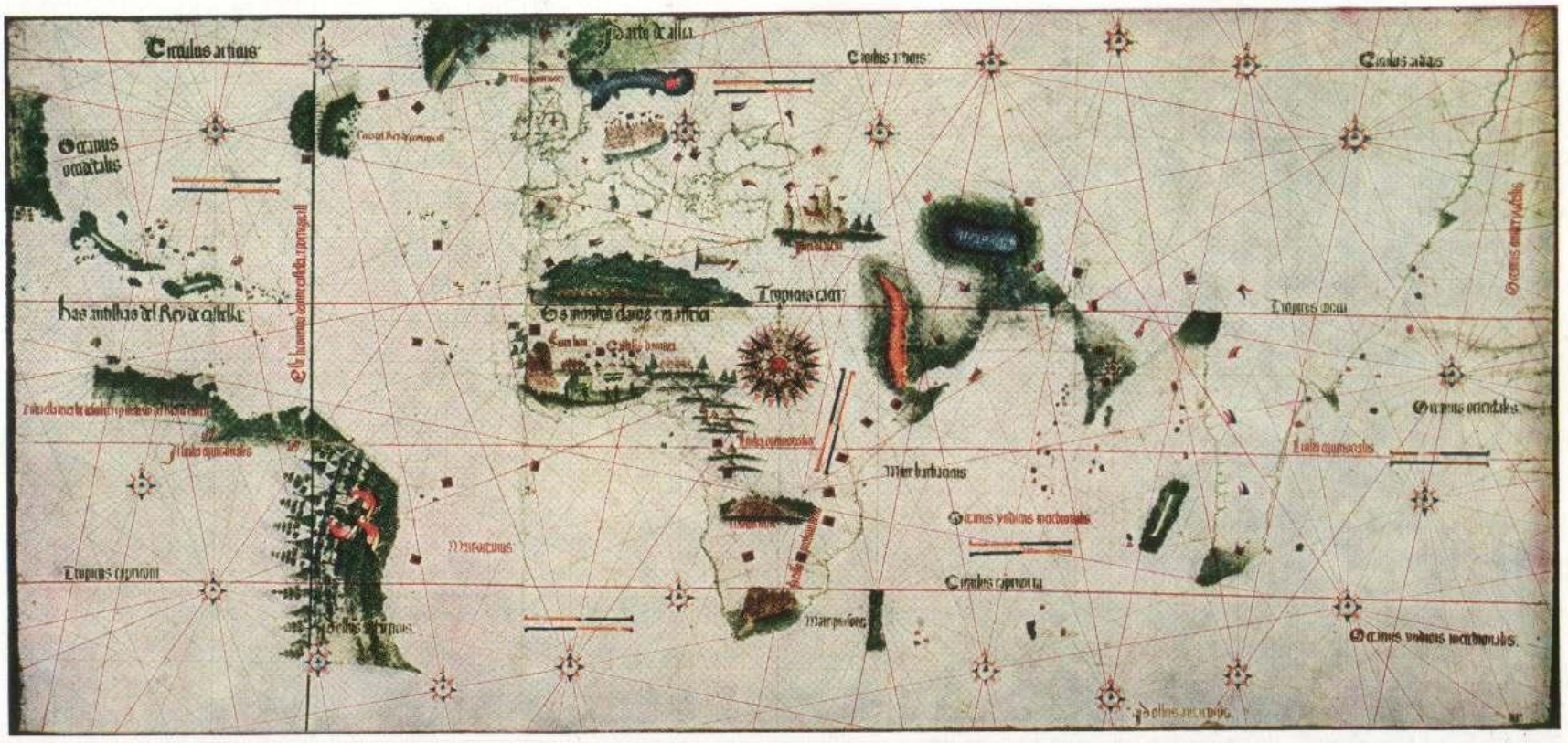
42º



# Juan de la Cosa 1500 : North & West Africa
# Plate carrée : Refs : Gibraltar & Dakar

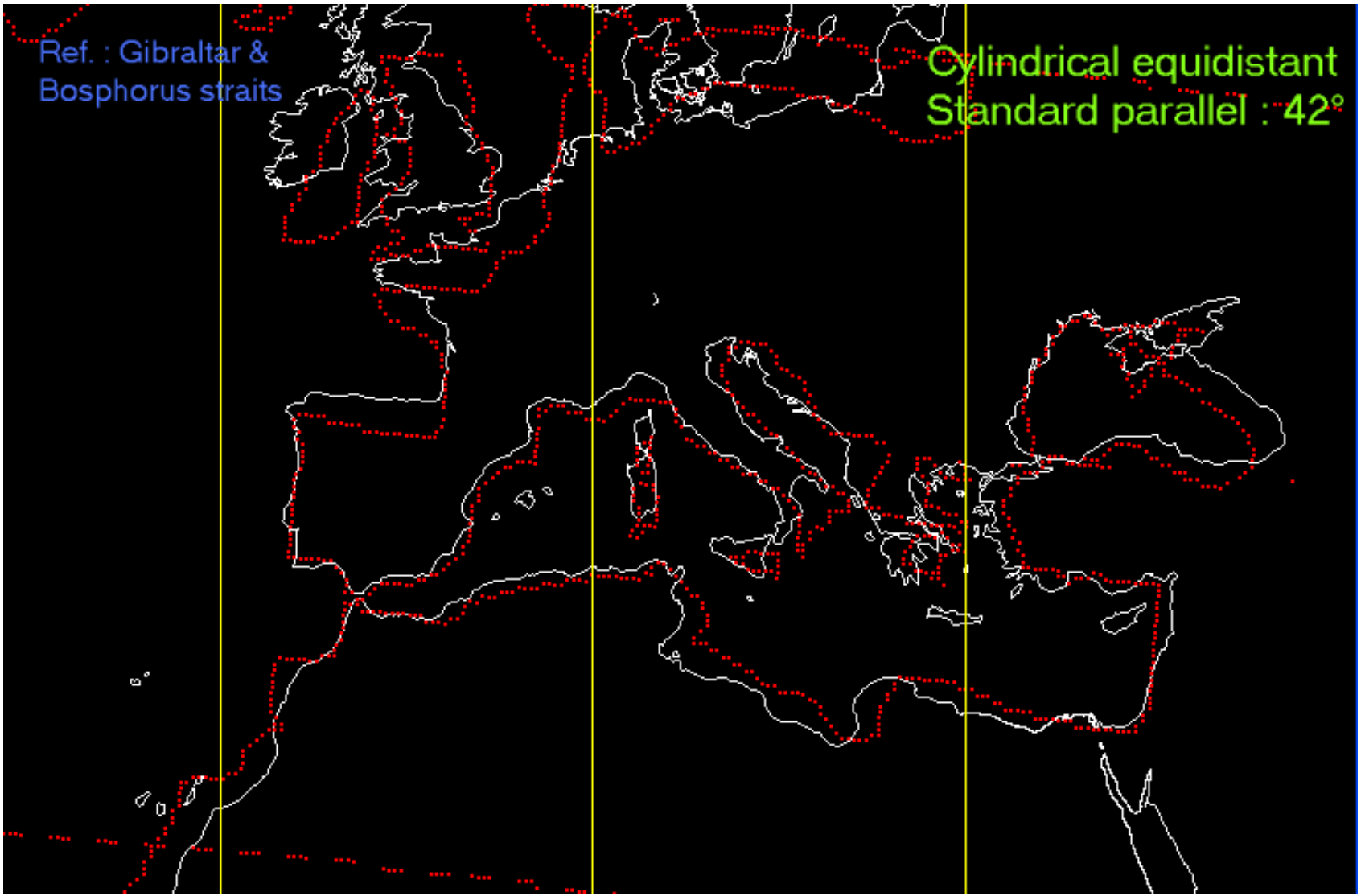


# Cantino, 1502



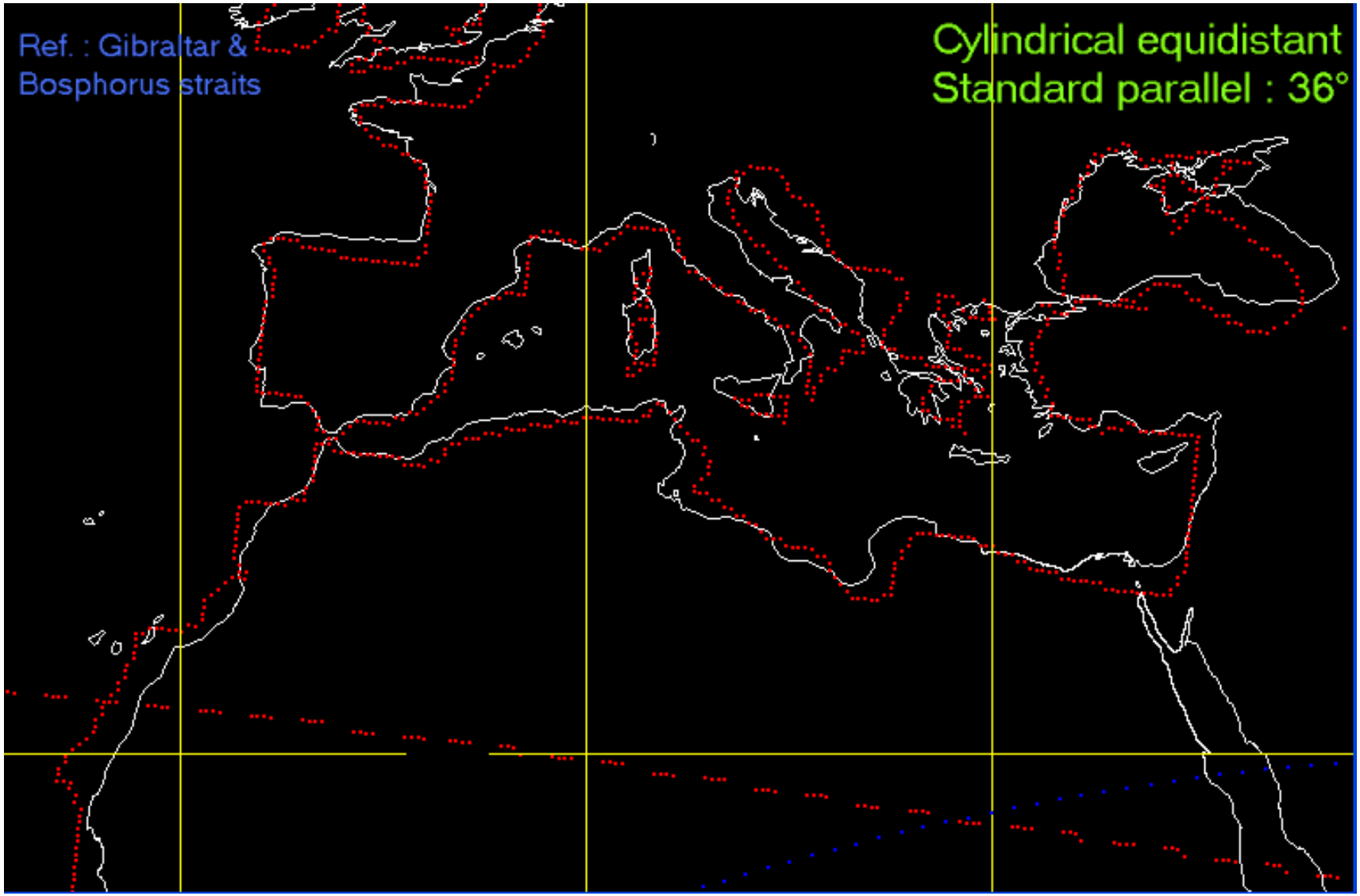
# Cantino, 1502 :
# Equidistant cylindrical Refs : Gibraltar & Bosphorus Straits

42º

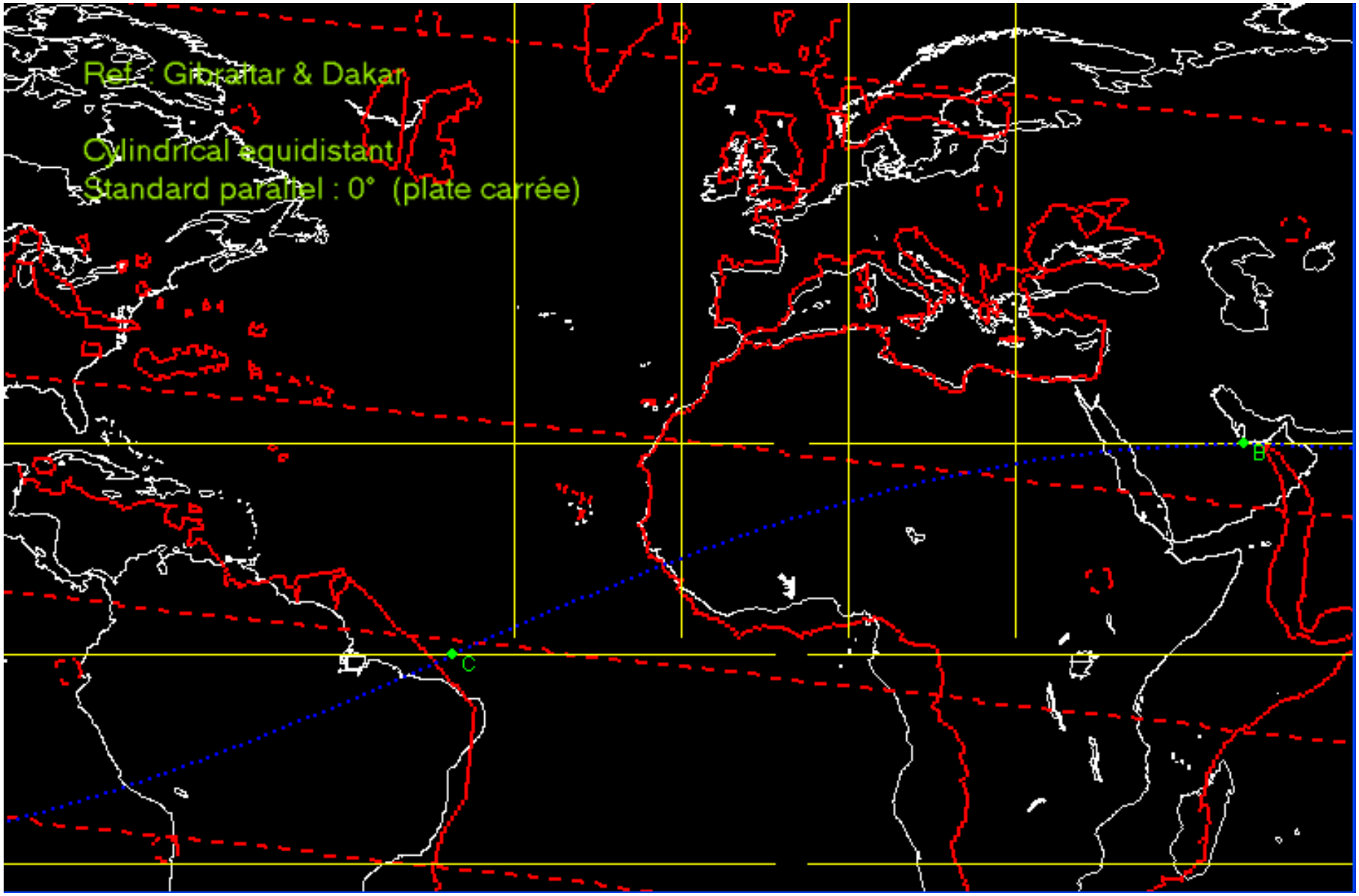


# Cantino, 1502 :
# Equidistant cylindrical Refs : Gibraltar & Bosphorus Straits

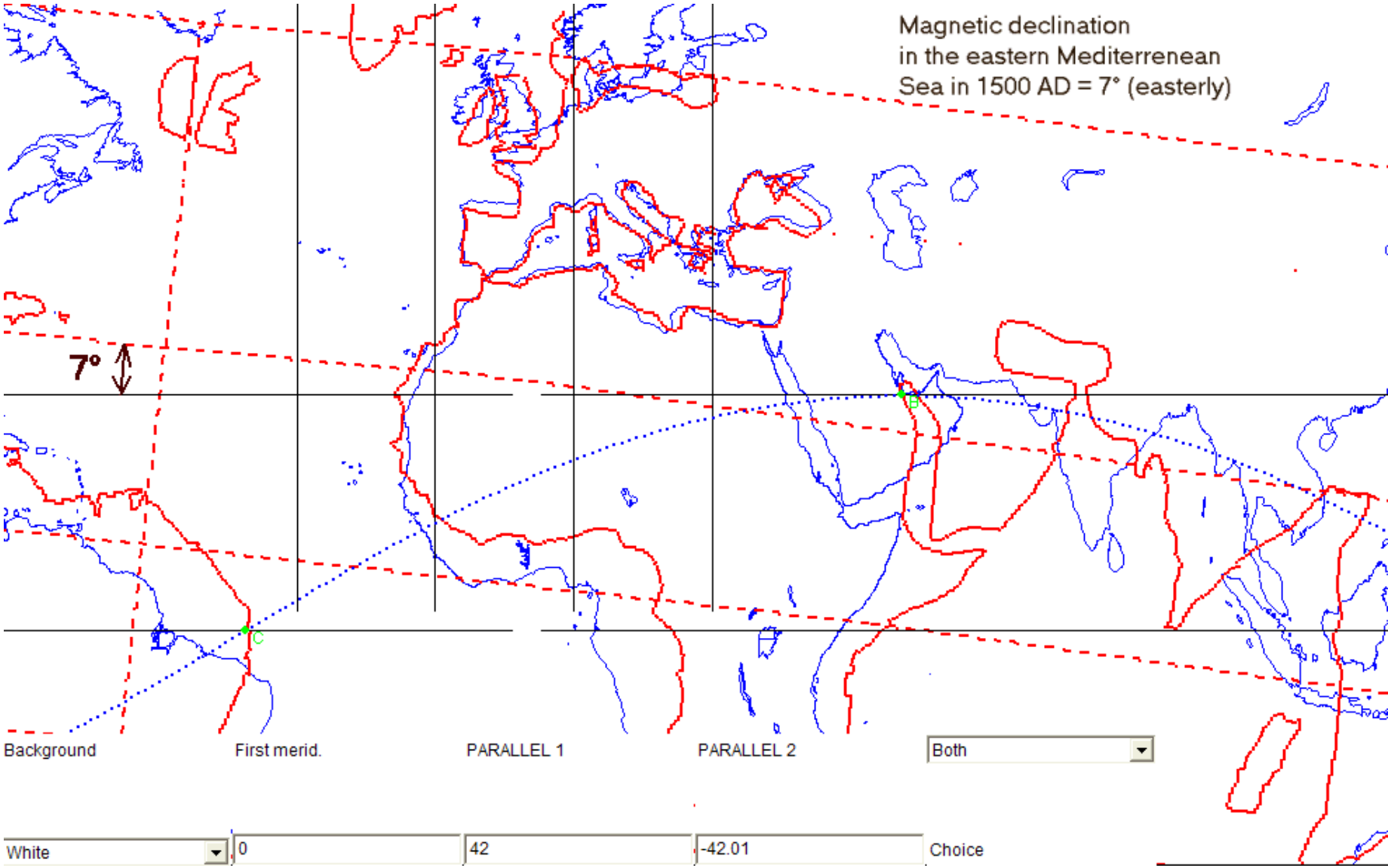
36º



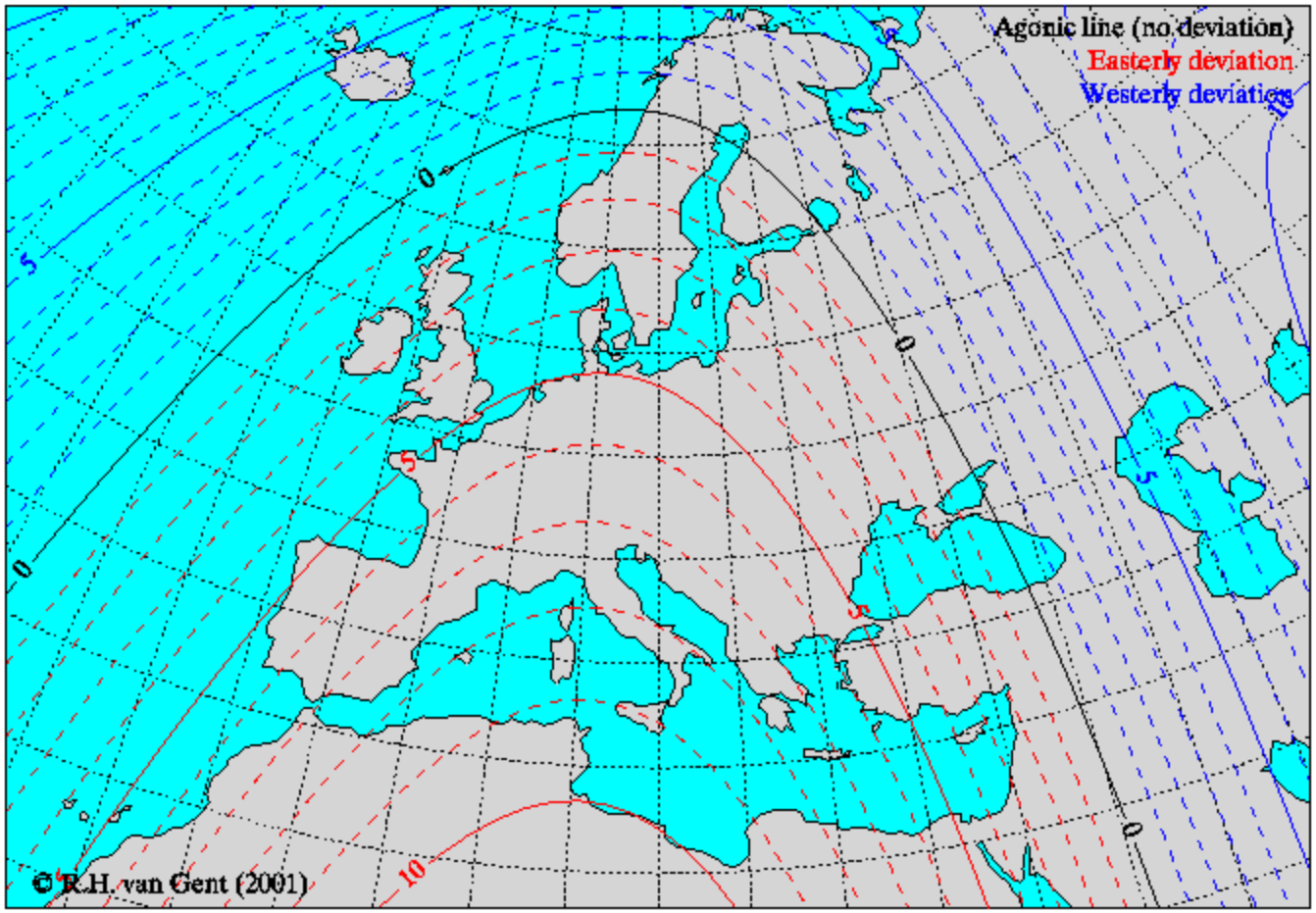
# Cantino, 1502 : North & West Africa
# Plate carrée : Refs : Gibraltar & Dakar



# Cantino 1502 :
# Equidistant cylindrical 42º : Rotated 7º



# Magnetic declination in 1500 AD
# Model from R.H. van Gent (2001)

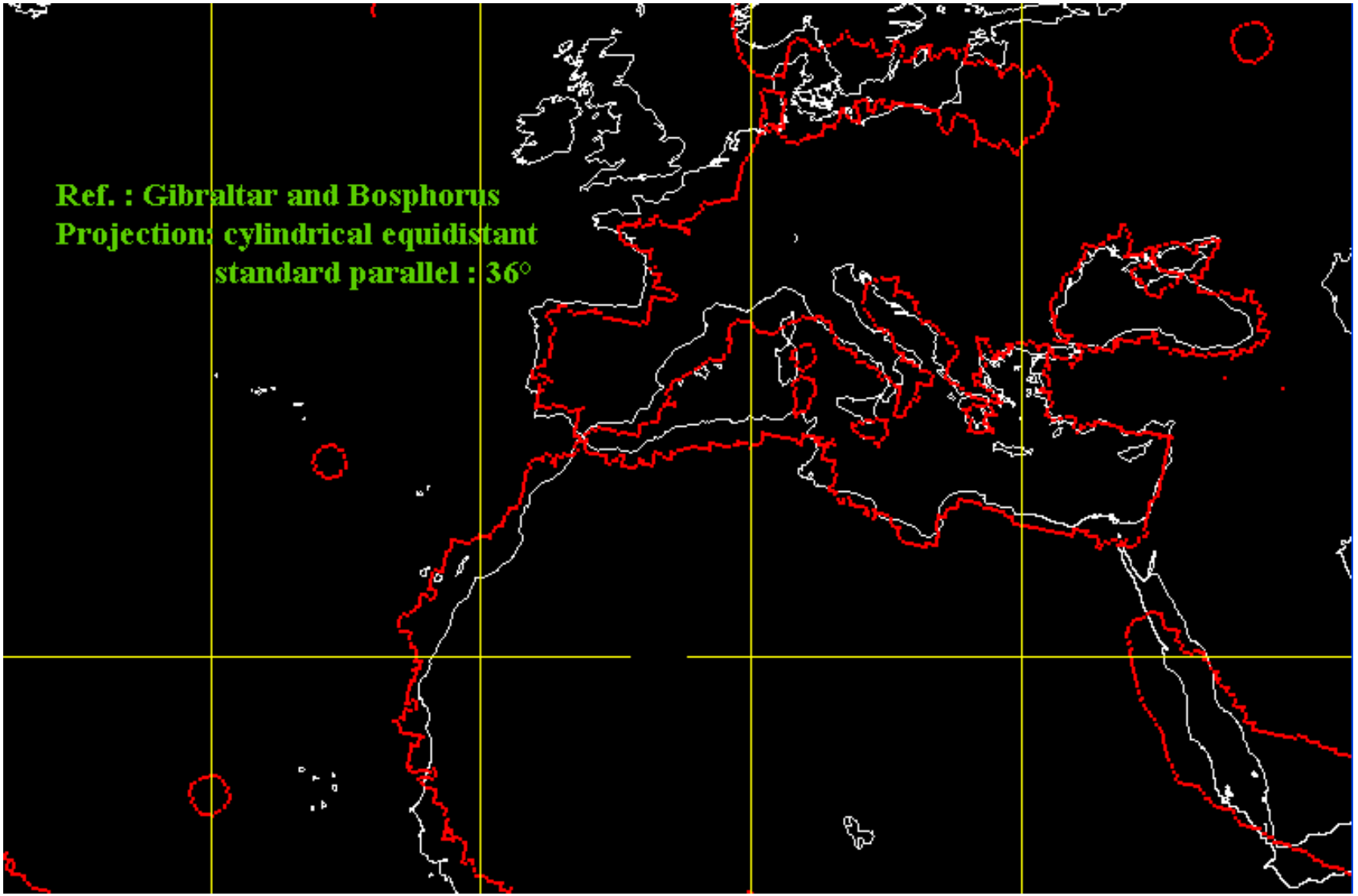


# Caveri, 1504-1505

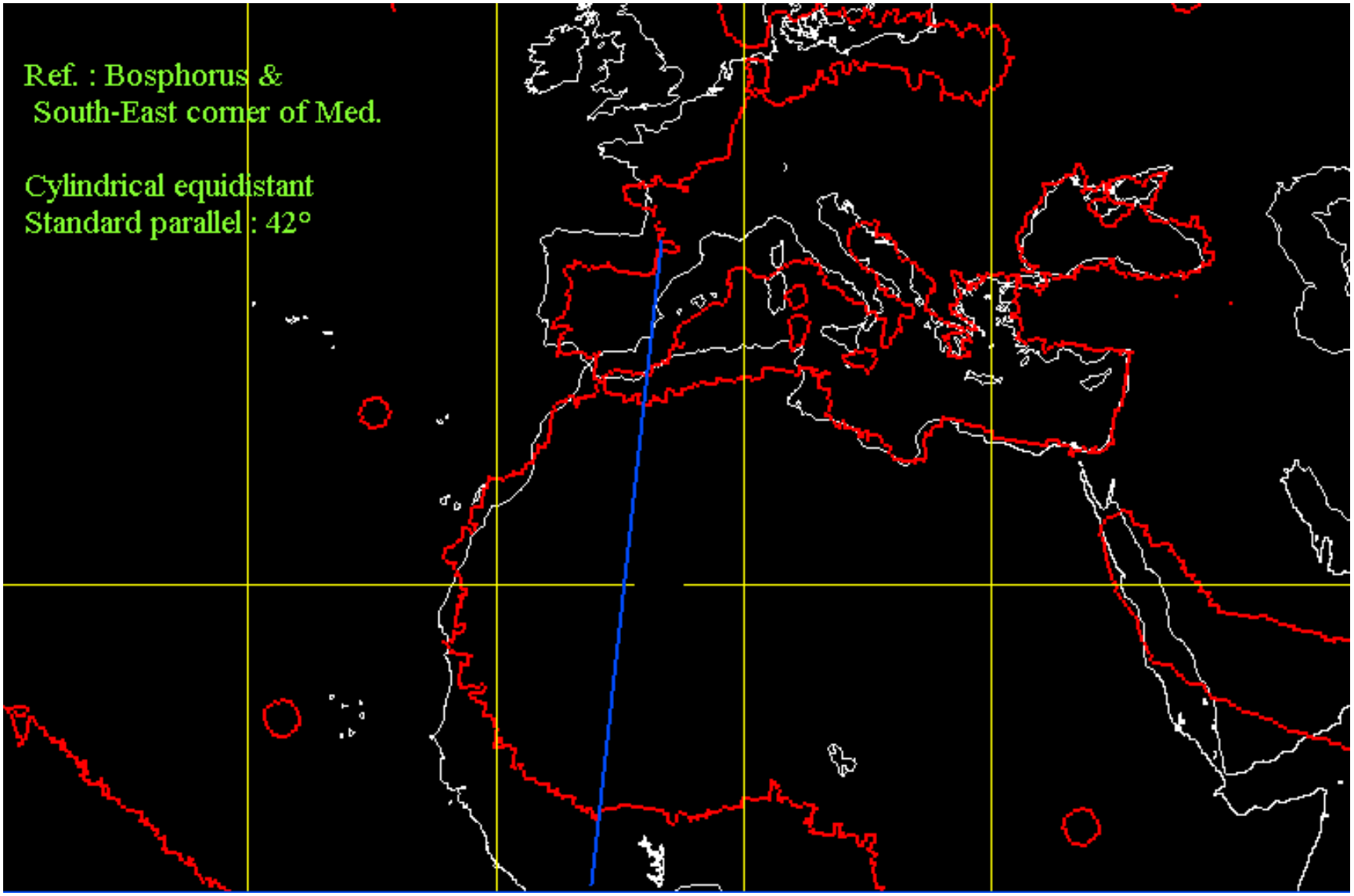
western hemisphere

# Caveri 1504-1505 :
# Equidistant cylindrical Refs : Gibraltar & Bosphorus Straits

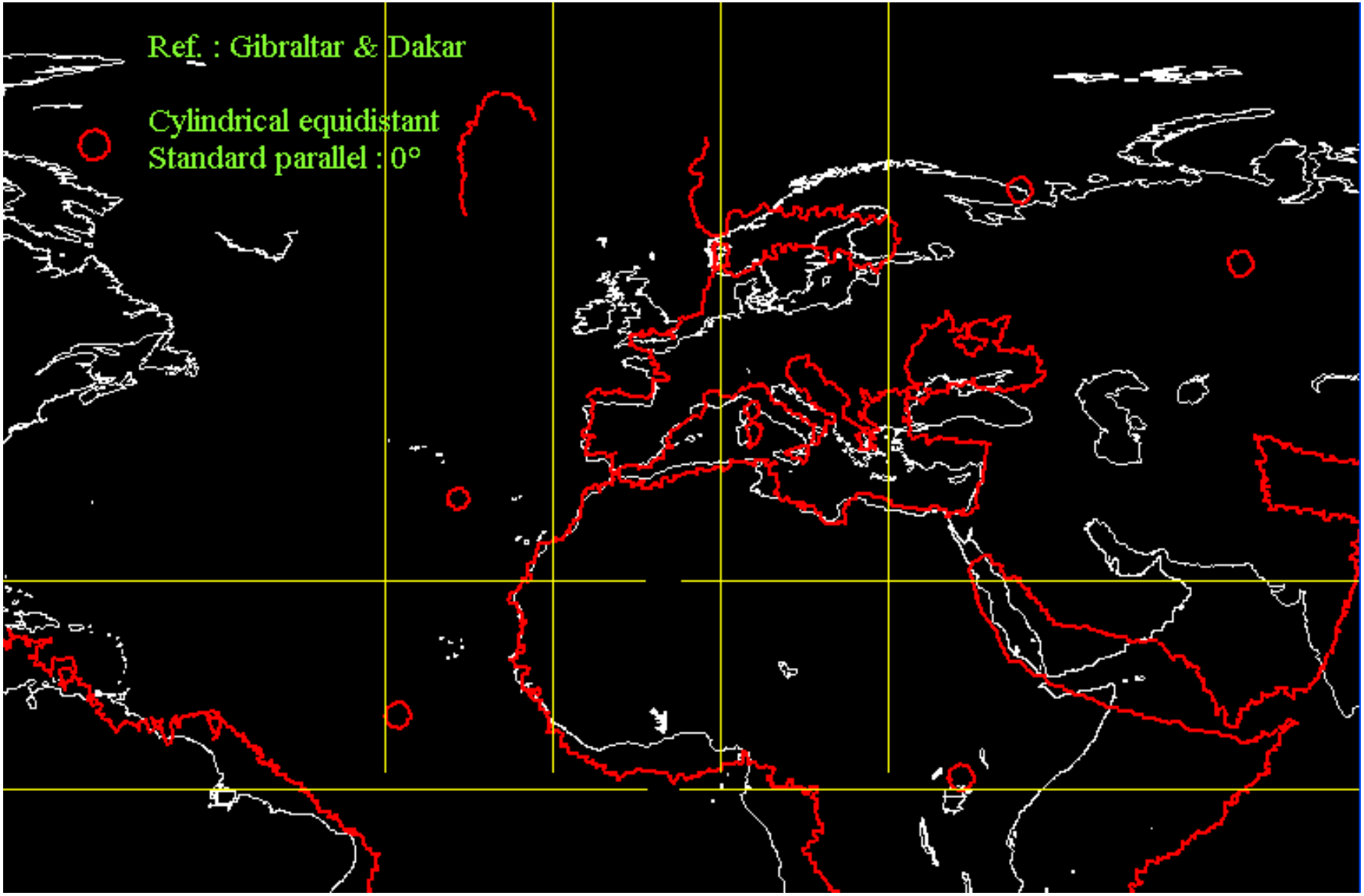
36º



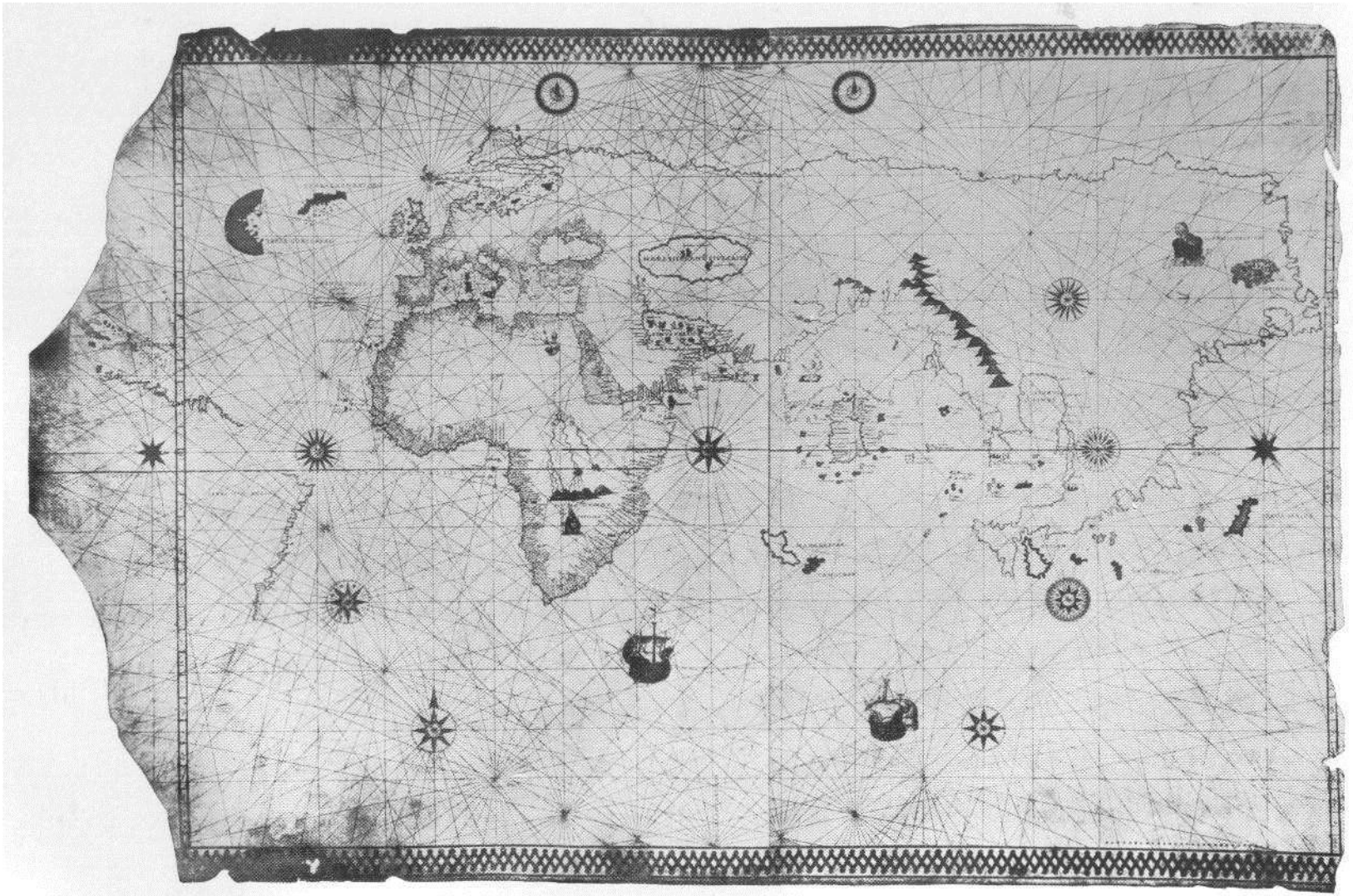
# Caveri 1504-1505 : Eastern Mediterranean Equidistant cylindrical Refs : Bosphorus and SE corner of Mediterranean



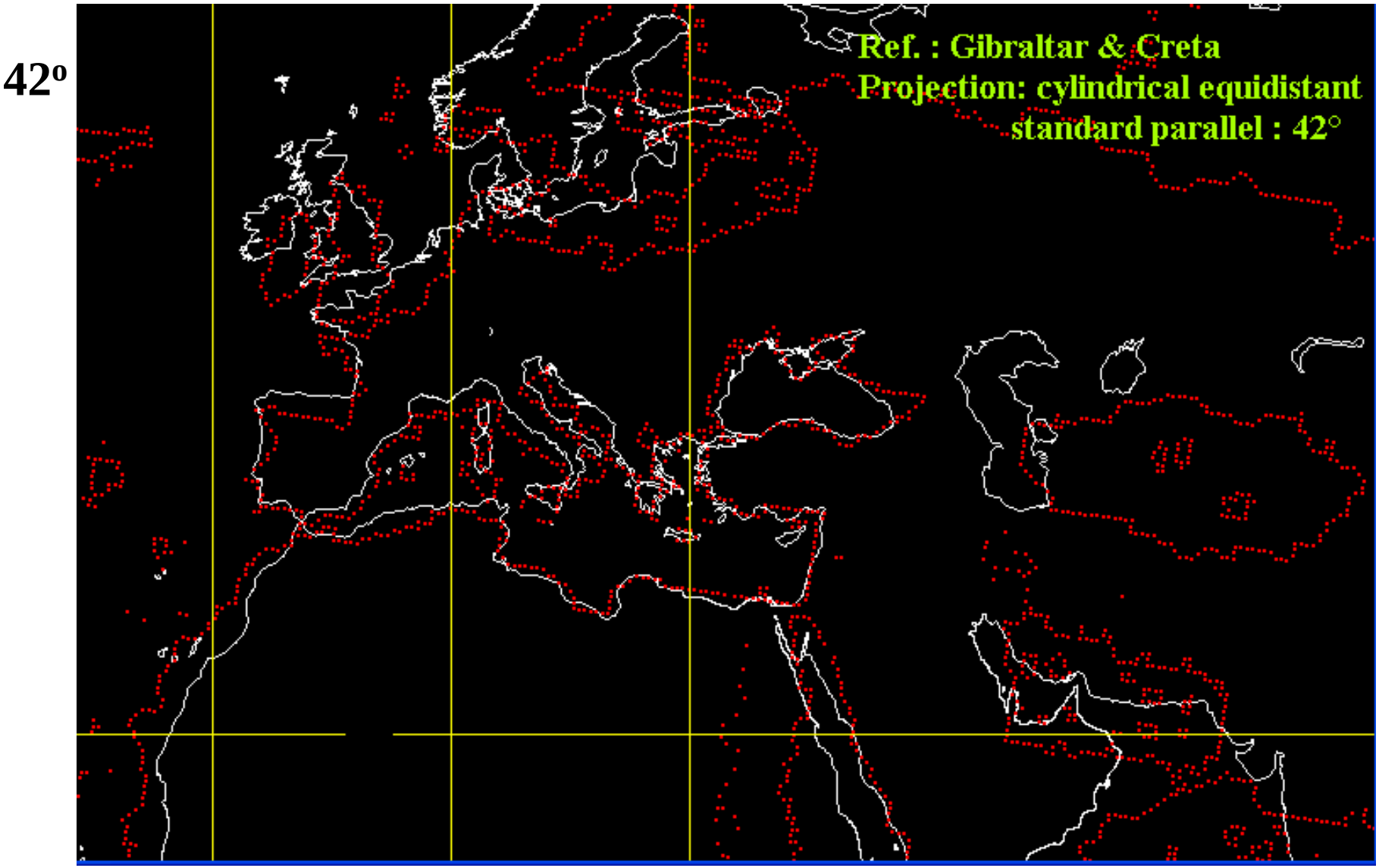
# Caveri 1504-1505 : North & West Africa
# Plate carrée  Refs : Gibraltar & Dakar



# King-Hamy, post 1502

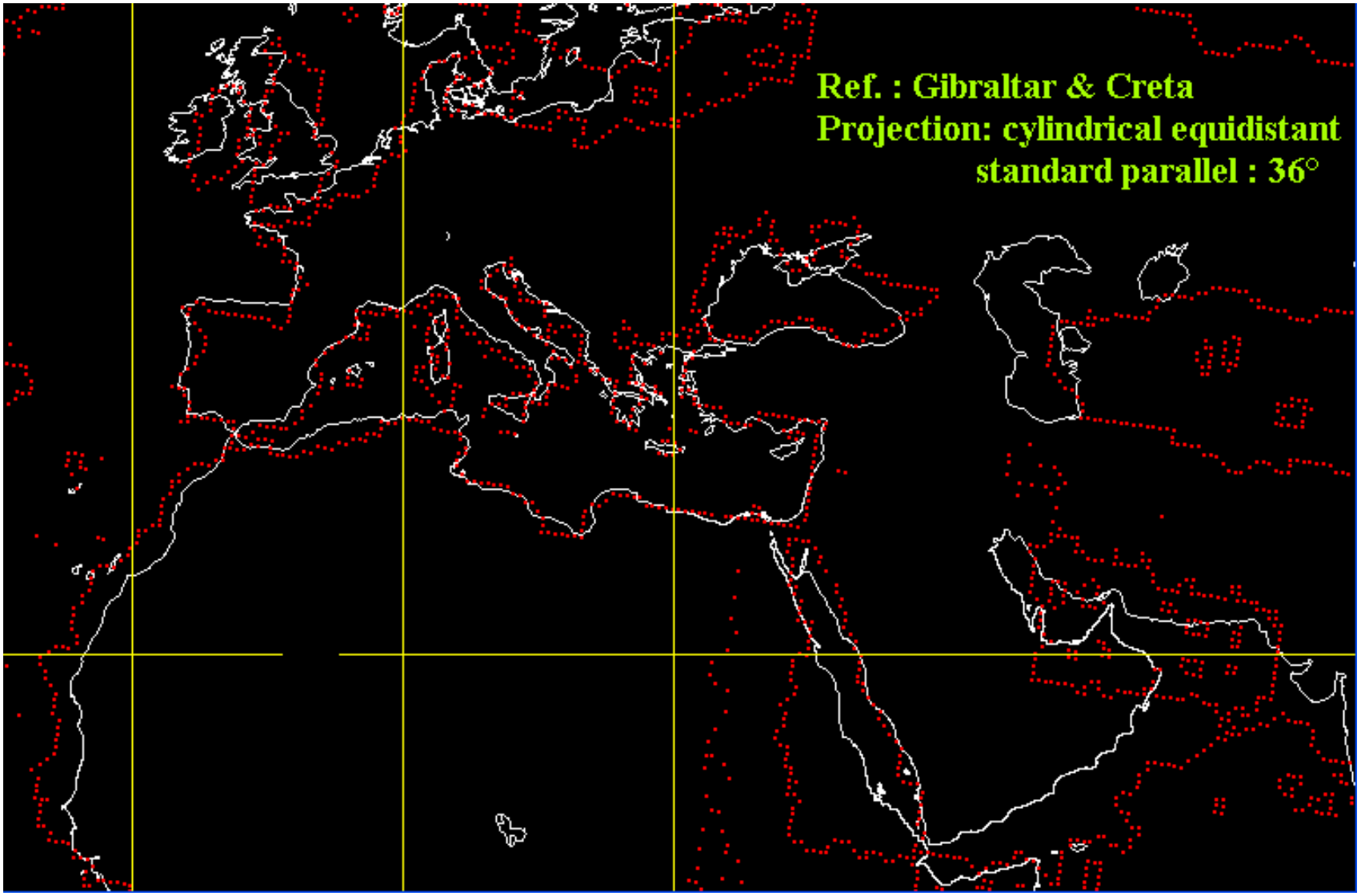


**King-Hamy, post 1502 :**
**Equidistant cylindrical : Refs : Gibraltar & Crete**

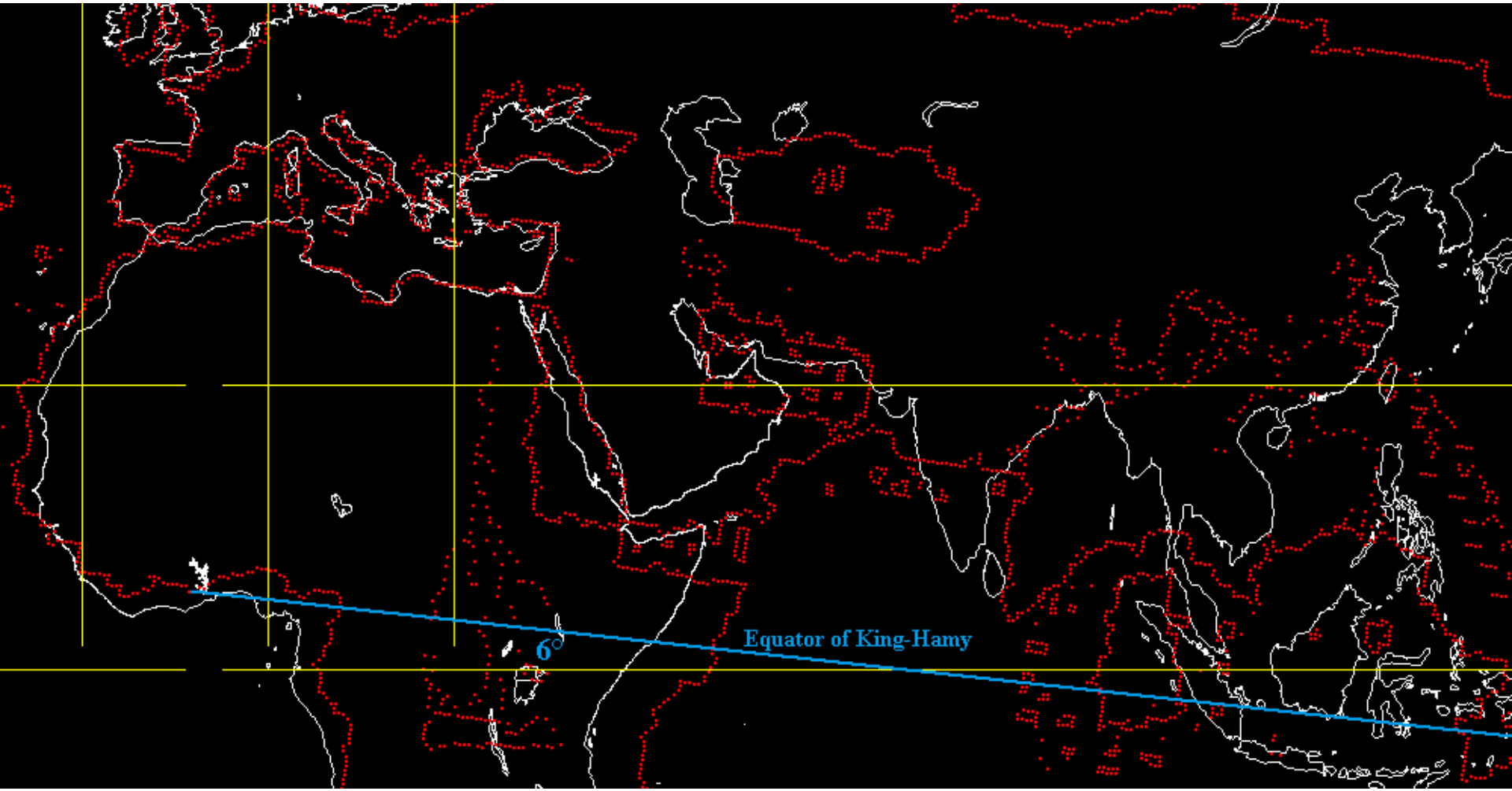


**King-Hamy post 1502 :**
**Equidistant cylindrical : Refs : Gibraltar & Crete**

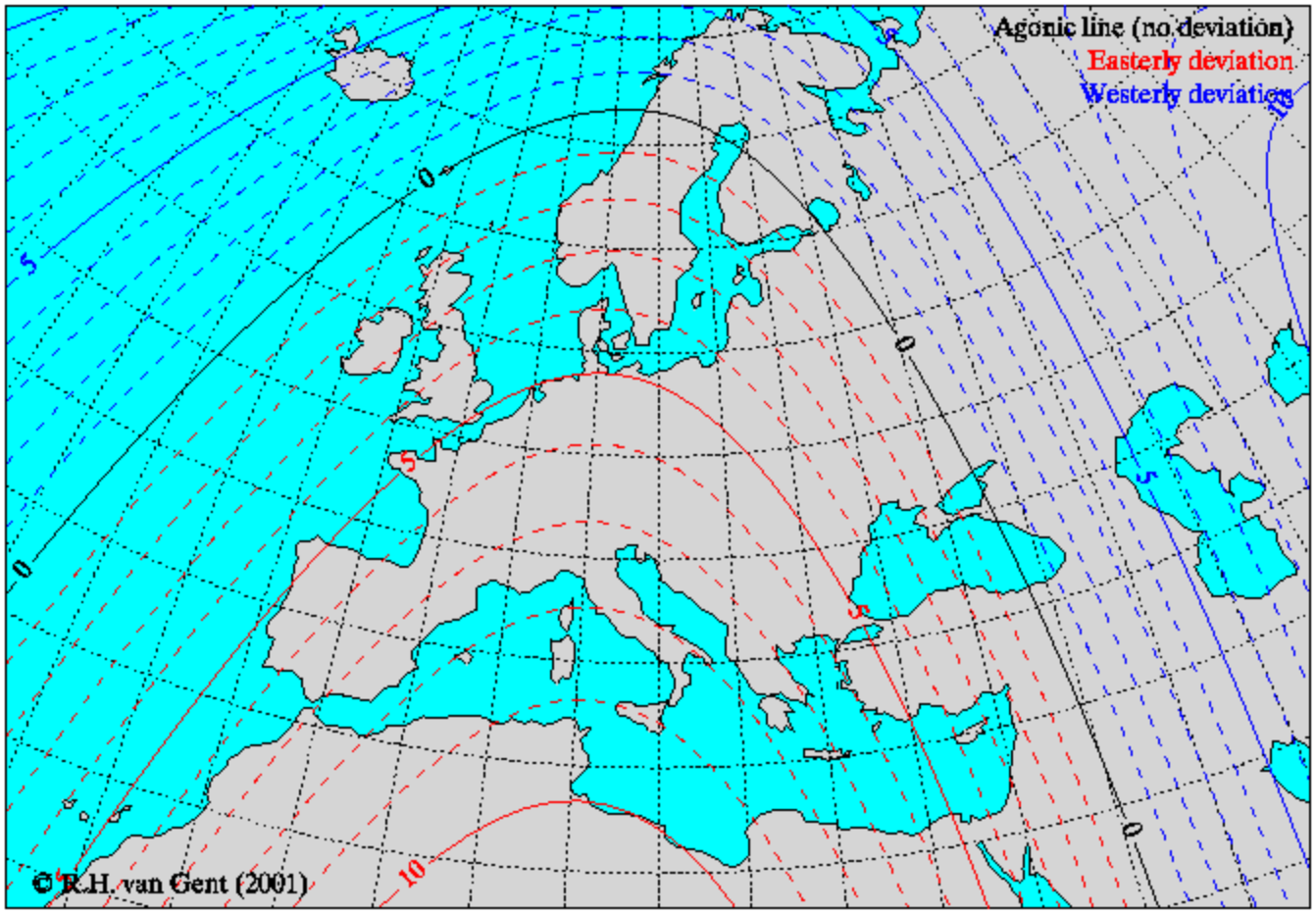
**36º**



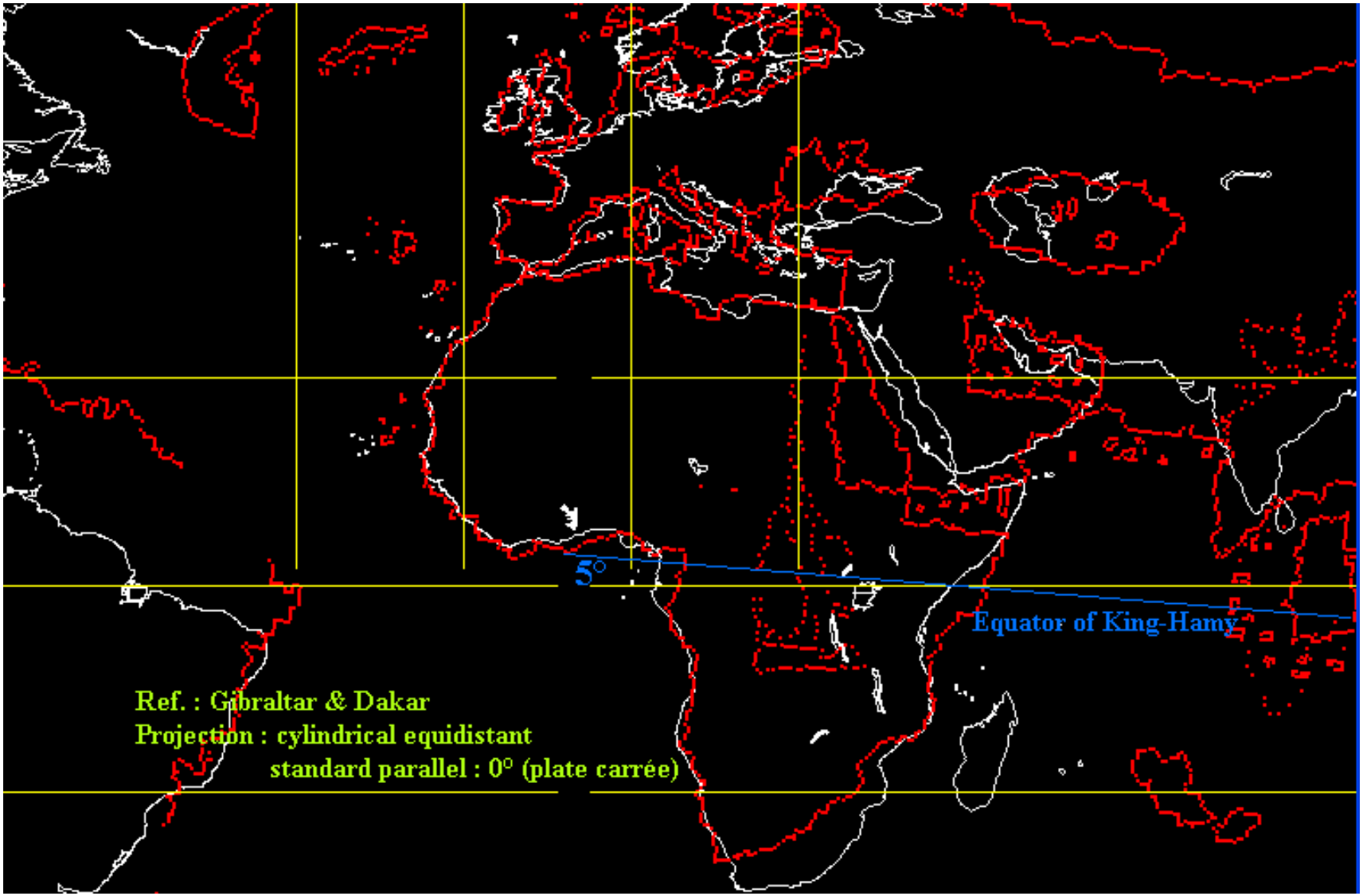
# King-Hamy post 1502 :
# Equidistant cylindrical 36º : Rotated 6º



# Magnetic declination in 1500 AD
# Model from R.H. van Gent (2001)



# King-Hamy post 1502 :West Africa
# Plate carrée : Refs : Gibraltar & Dakar



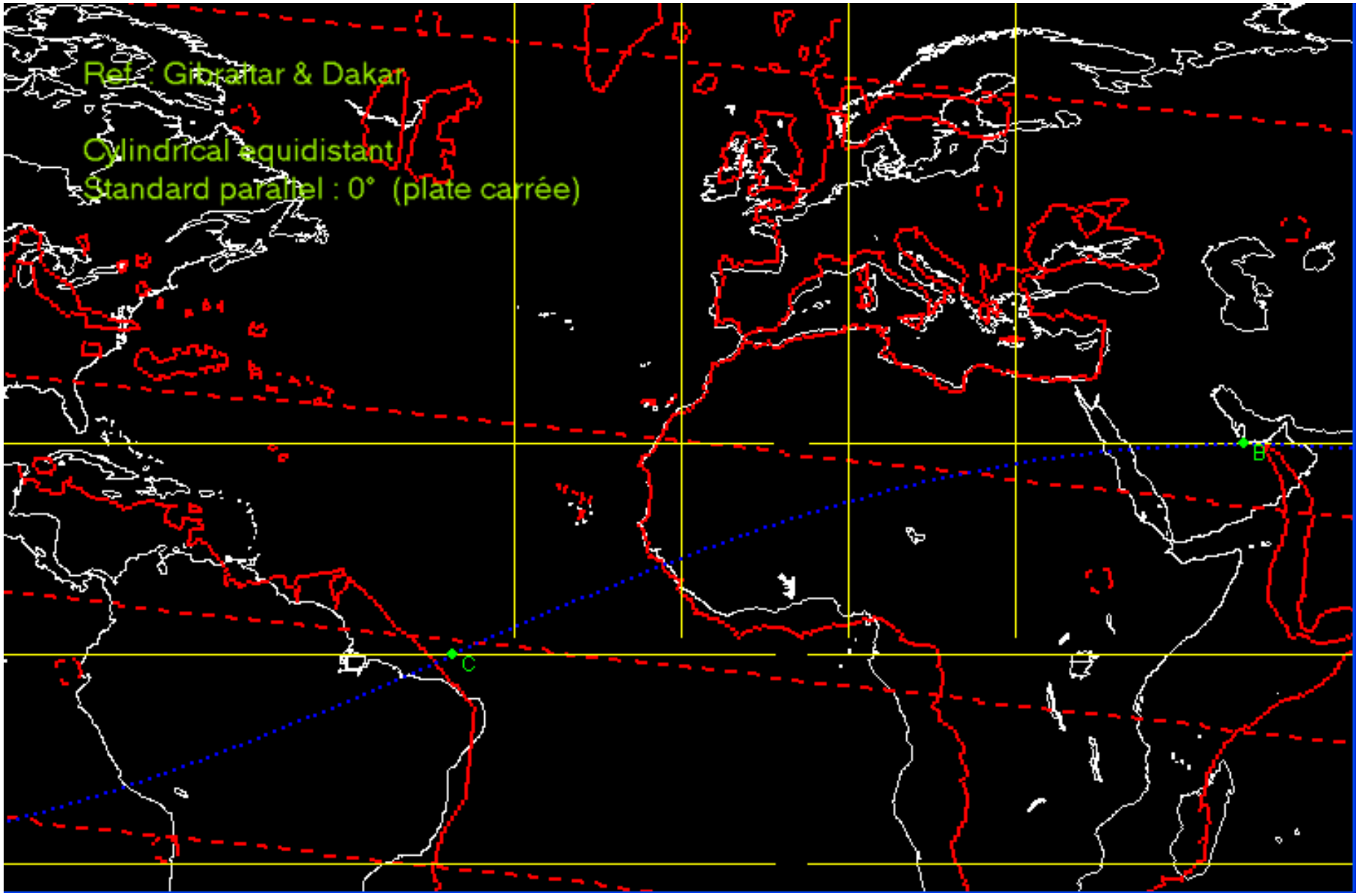
# Summary

- **On some (probably most) Mediterranean portolanos, there appears to be a virtual line between Greece and the Gulf of Sidra where separate east and west sections were probably joined together.**
- **The Mediterranean coast of Africa appears OK on both cylindrical (42º or 36º) and most plate carrée projections.**
- **The Strait of Gibraltar lies at 36ºN and we note that cos (36º) = 0.8.**

- **We conclude that the African coastline of the Mediterranean (derived from a plate carrée) was compiled with Mediterranean portolan charts built with a standard parallel between 36º and 42º.**
- **As a result, the Atlantic shorelines on these portolan plate carrée maps were rescaled to circa 0.8 (compared to the scales of the Mediterranean shorelines.)**
- **Later cartographers probably used similar methods but with other Mediterranean portolanos (also cylindricals but probably with a 42º standard parallel).**

# Equatorial and Southern Africa

# Cantino, 1502 : North & West Africa
# Plate carrée : Refs : Gibraltar & Dakar



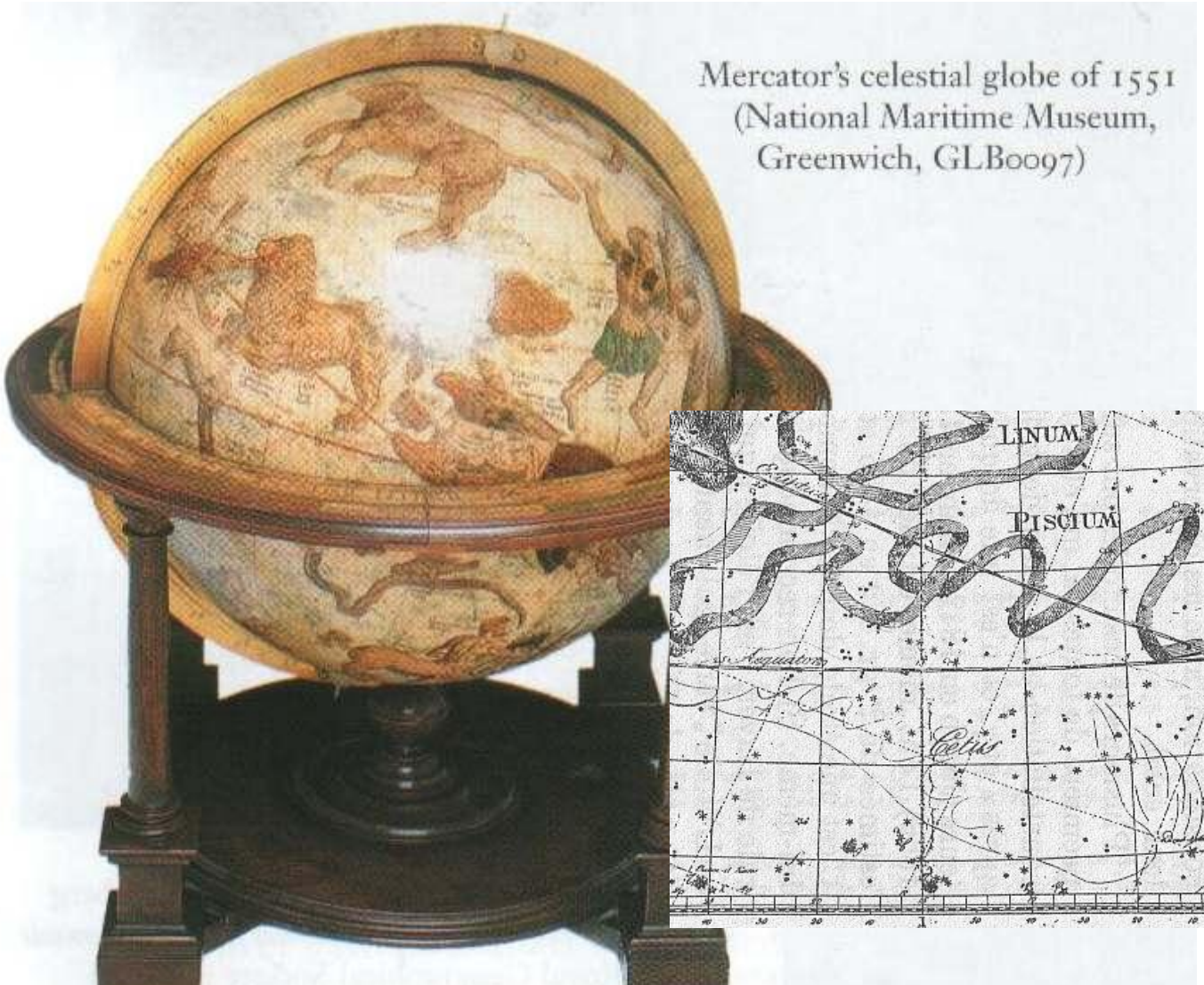
# Other Plate Carrée Projections

- In a transverse plate carrée, the standard circle is a meridian.

- If the standard great circle is not either the equator nor a meridian then it is termed an oblique plate carrée.

# Celestial Ecliptic

**Mercator**



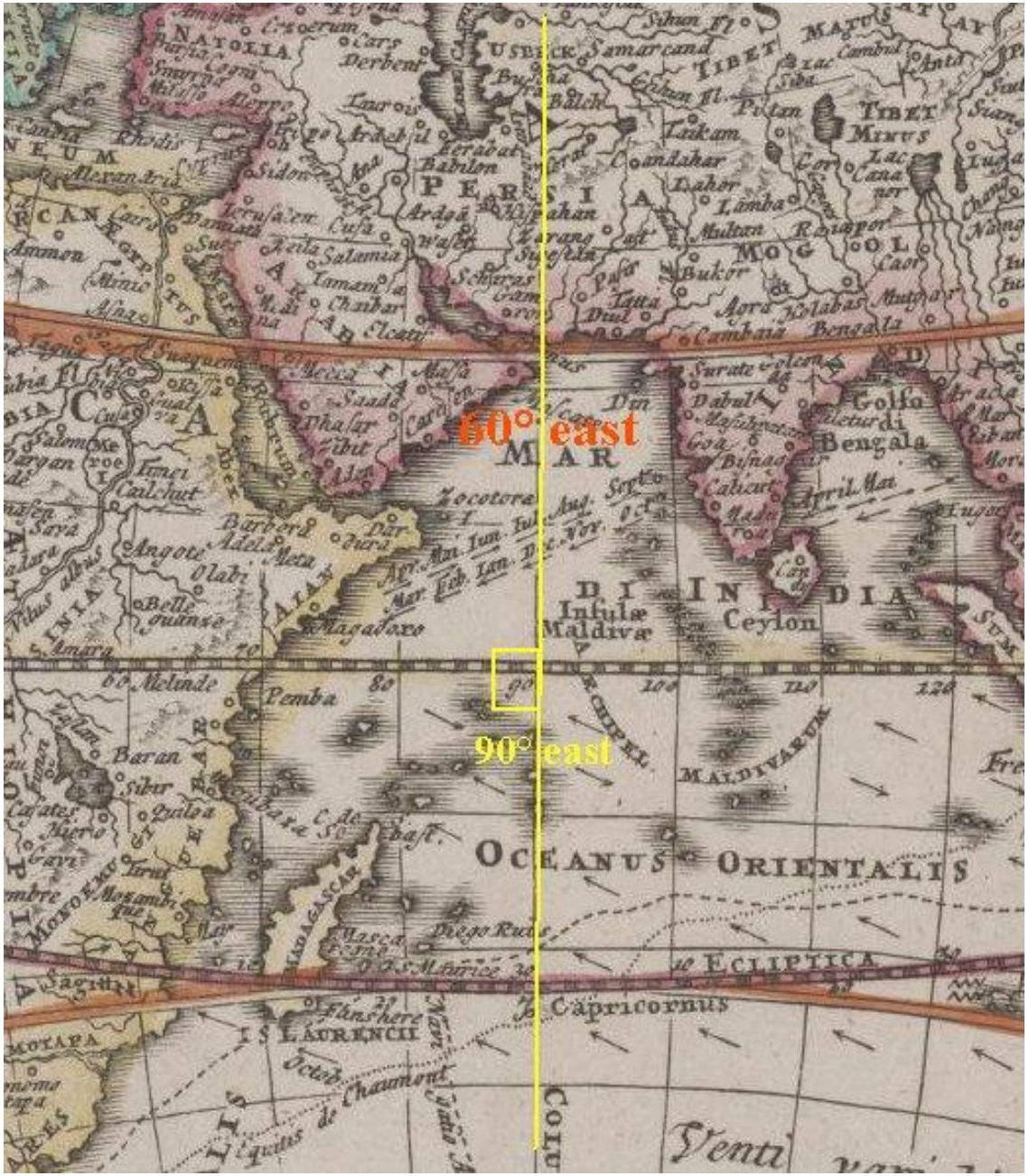
Mercator's celestial globe of 1551 (National Maritime Museum, Greenwich, GLB0097)

**Bode's Celestial Atlas**

# Terrestrial Ecliptic


**Hendicus Hondius 1630**


**Gerard Valck, 1686**




# Homann, 1720

**Solsticial line through Gulf of Oman**

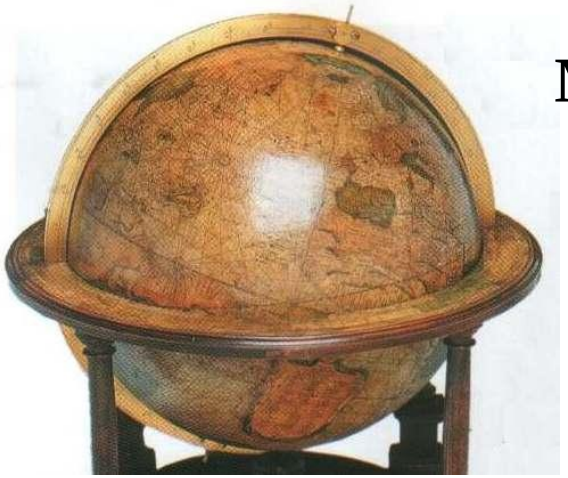
**(60°E longitude)**

# Oblique plate carrée - 1

- The terrestrial ecliptic is a great circle making with the equator an angle equal to the obliquity of the celestial ecliptic.
- In antiquity the obliquity was accepted to be about $24^{o}$.
- One can produce an oblique plate carrée projection using a terrestrial ecliptic as the standard great circle.

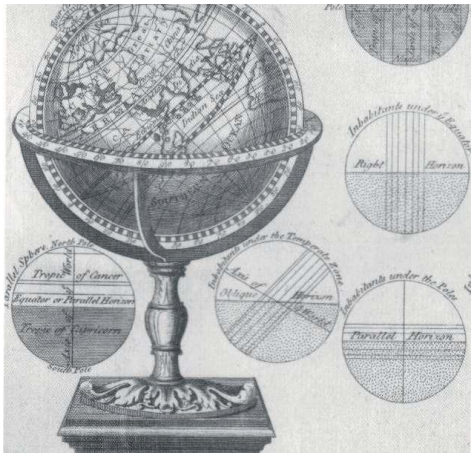
# Oblique plate carrée - 2

- **The intersection of the terrestrial ecliptics with the equator (the "equinoxes") of Hondius and Homann occurs at 30°W. and 150°E.**
- **Similar intersections are seen on Mercator's globe of 1541 & a globe from the late 16th century.**



**Mercator, 1541**

**late 16th century**



- **The Finaeus (1532) and Mercator (1538) cordiform maps have a standard meridian practically running along the "solsticial" line of the terrestrial ecliptic.**

# Cantino, 1502 : Oblique plate carrée,

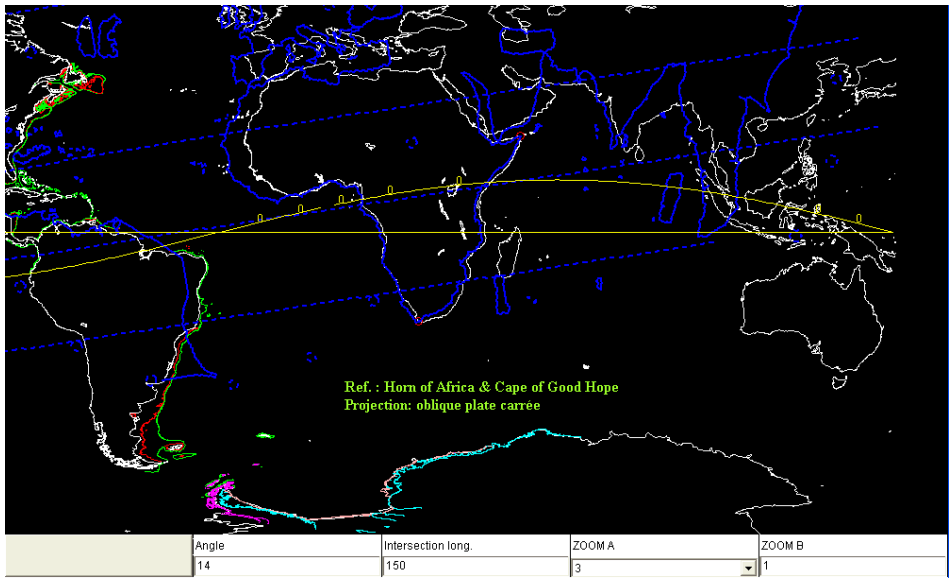
**Equator crossings :**
**30ºW & 150ºE**

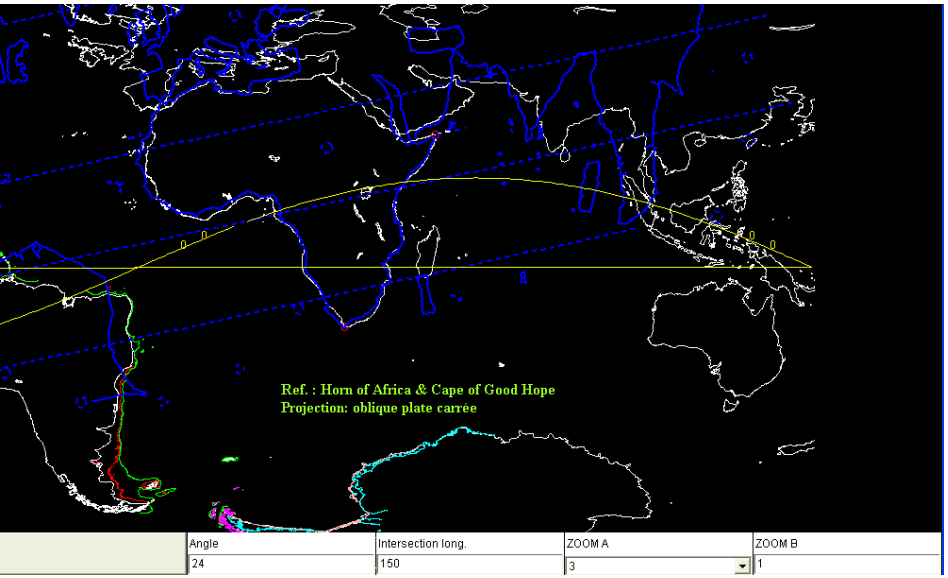
**Obliquity angle :**

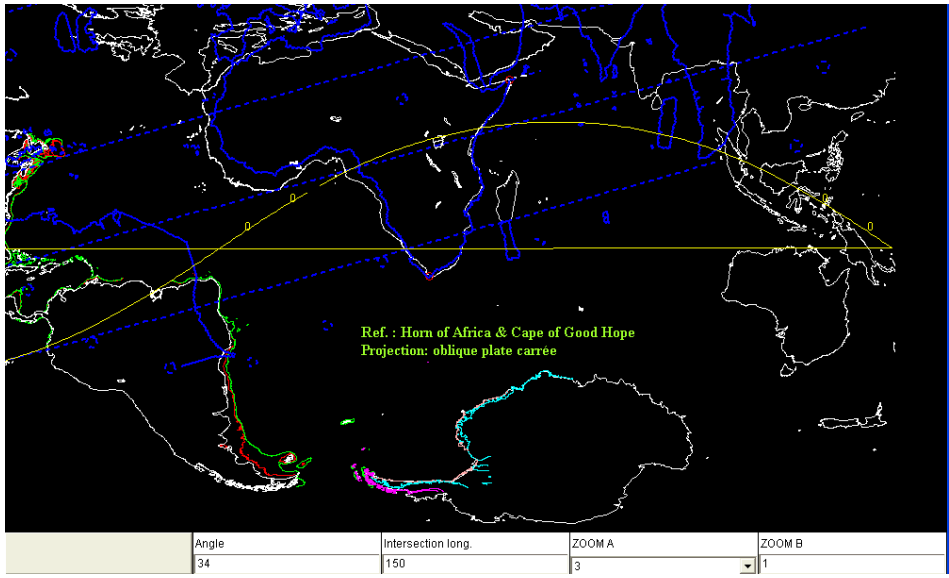
**14º** →

**24º** ↓

**34º** ↘



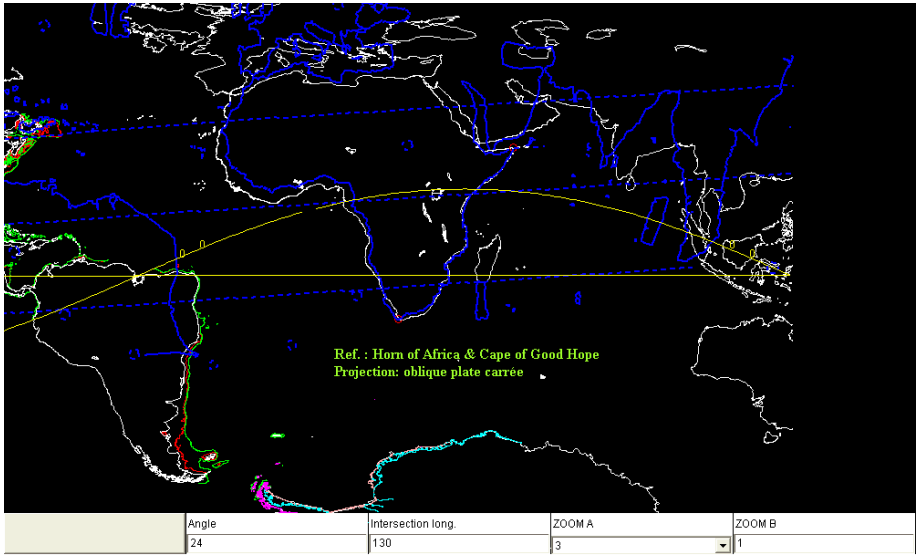
# Cantino, 1502 : Oblique plate carrée,

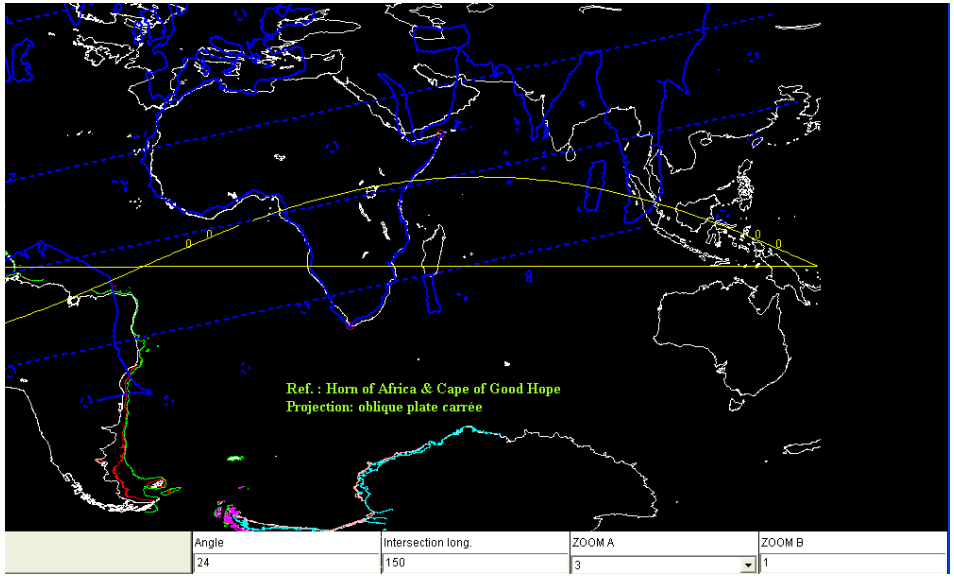
**Obliquity angle : 24º**

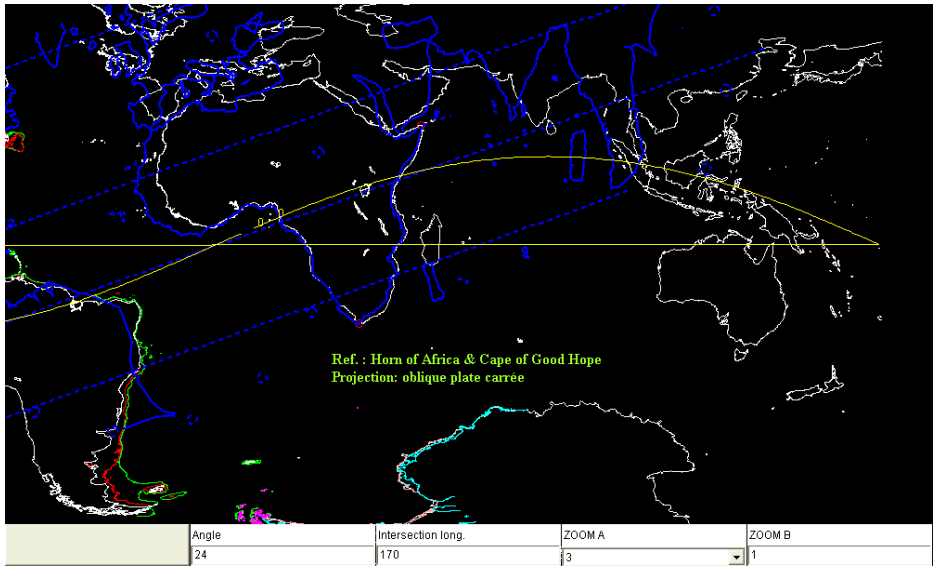
**Equator crossings :**

**50ºW & 130ºE**

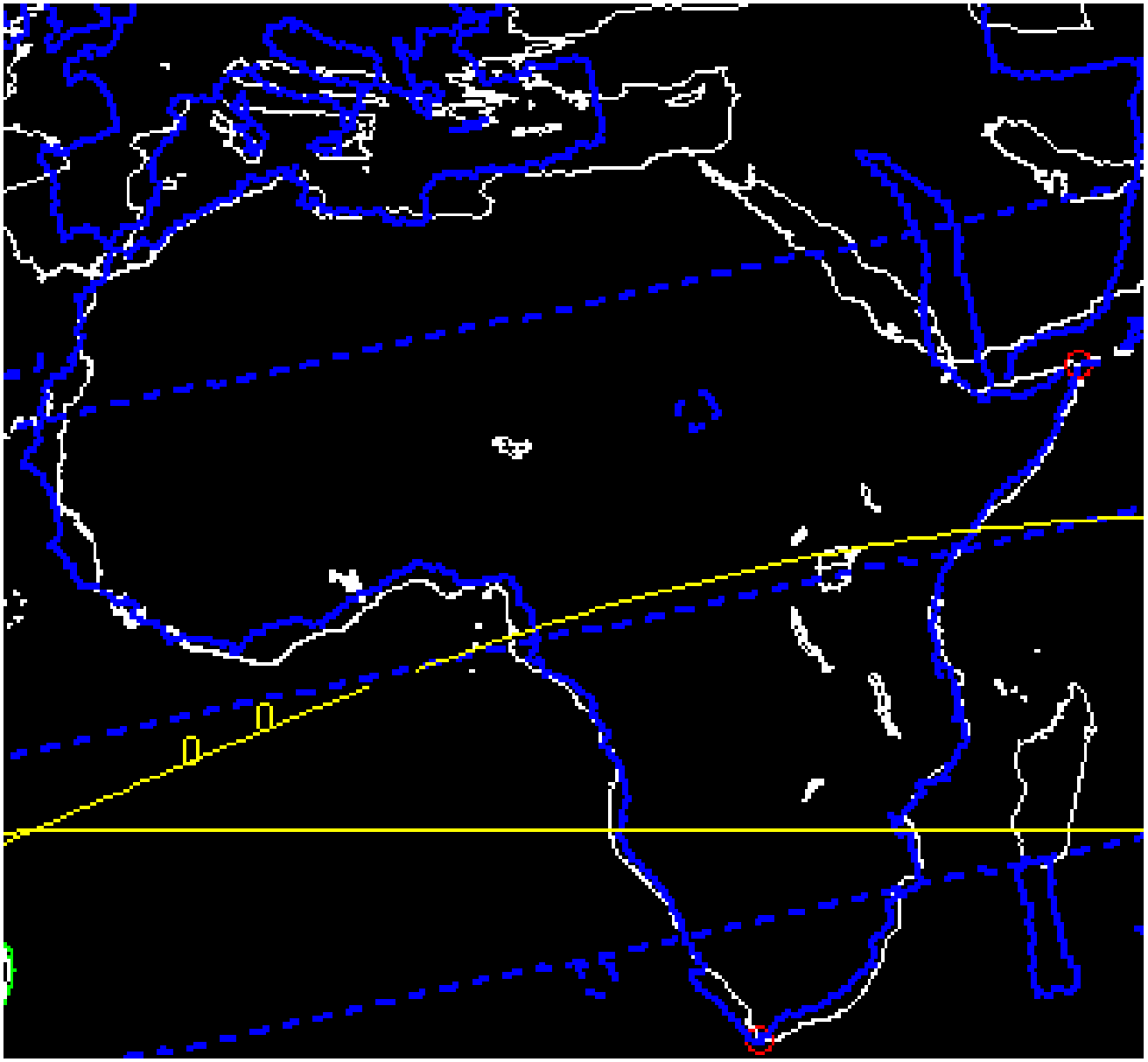
**30ºW & 150ºE** **10ºW & 170ºE**



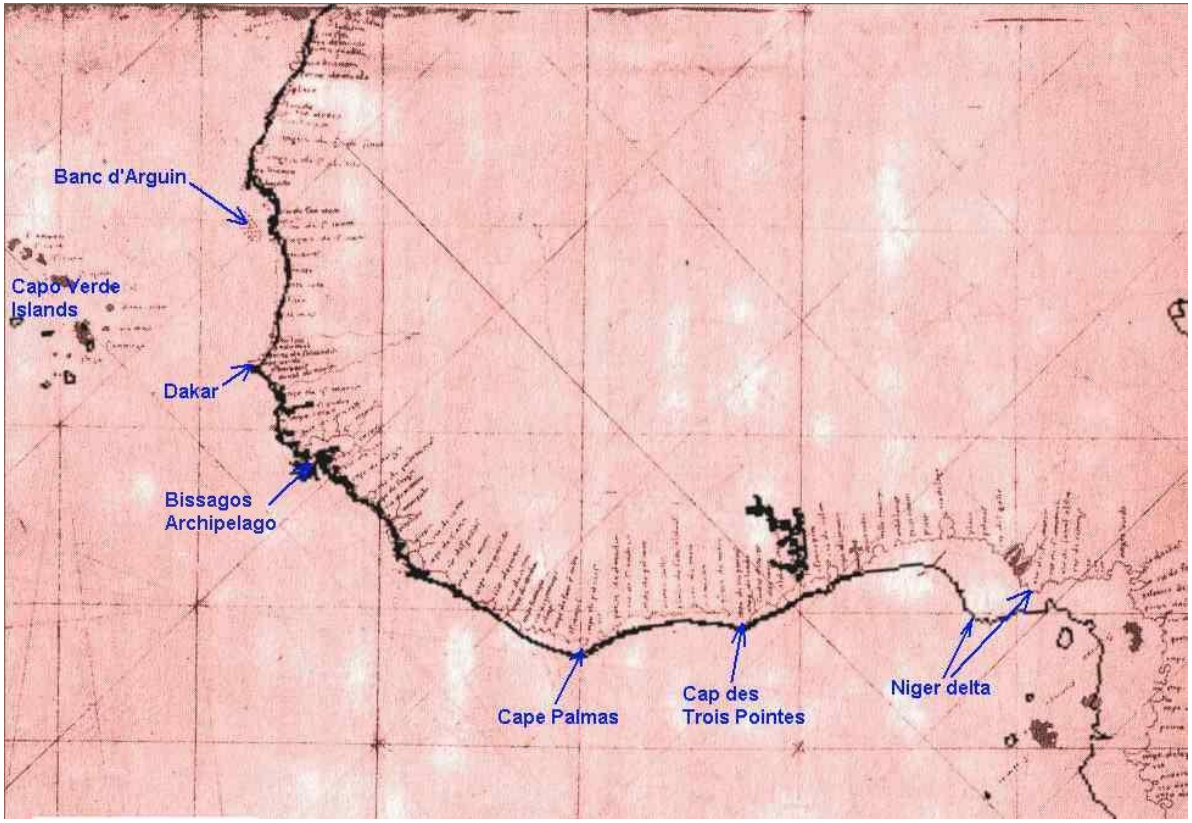



# Cantino, 1502 : Equatorial & Southern Africa
# Oblique plate carrée, Refs : Horn of Africa & Cape of Good Hope



# “Venetian, 1484 : West Africa

# Plate carrée



# “Venetian, 1484 : Equatorial West Africa

**Oblique plate carrée**

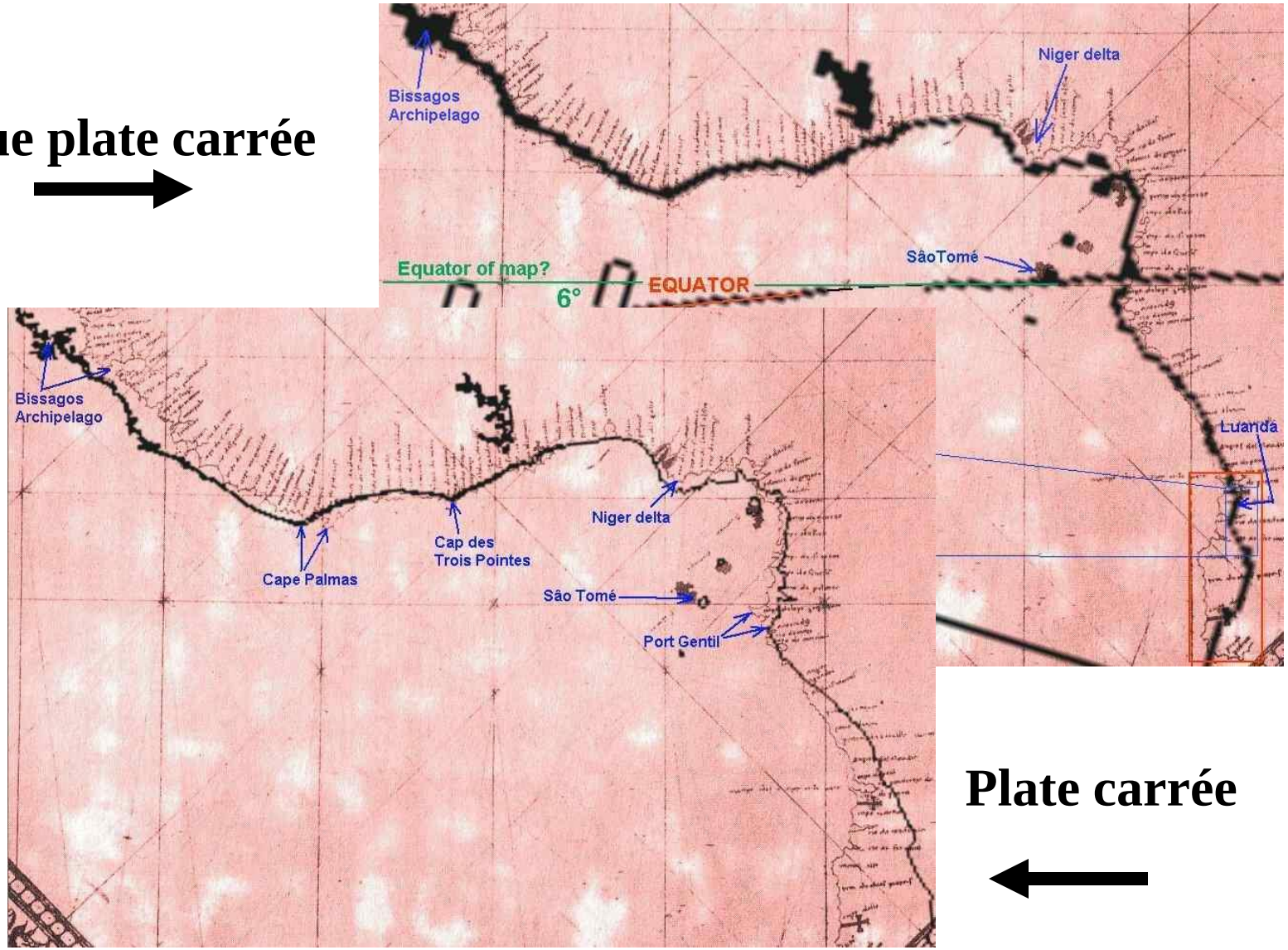
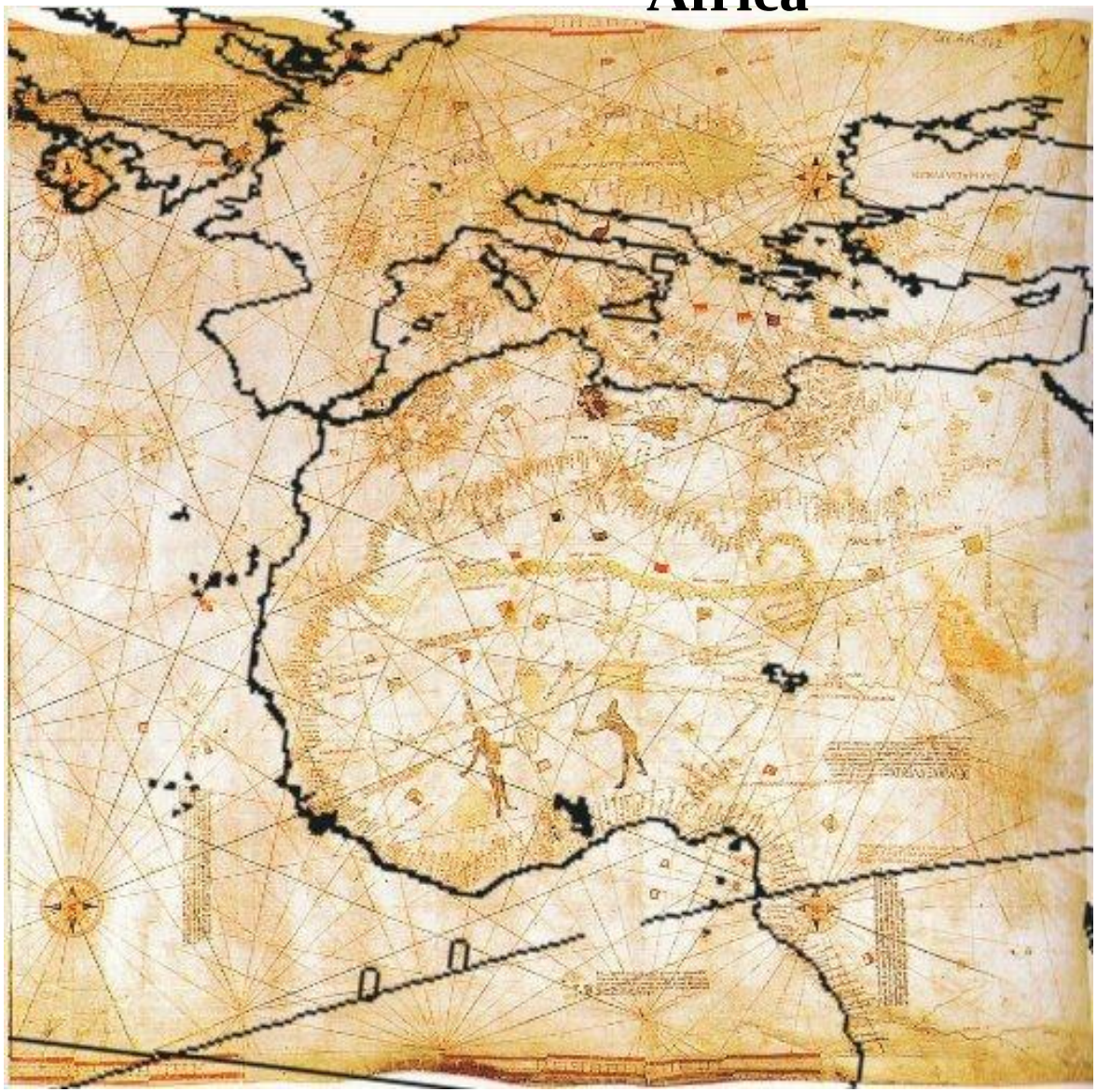


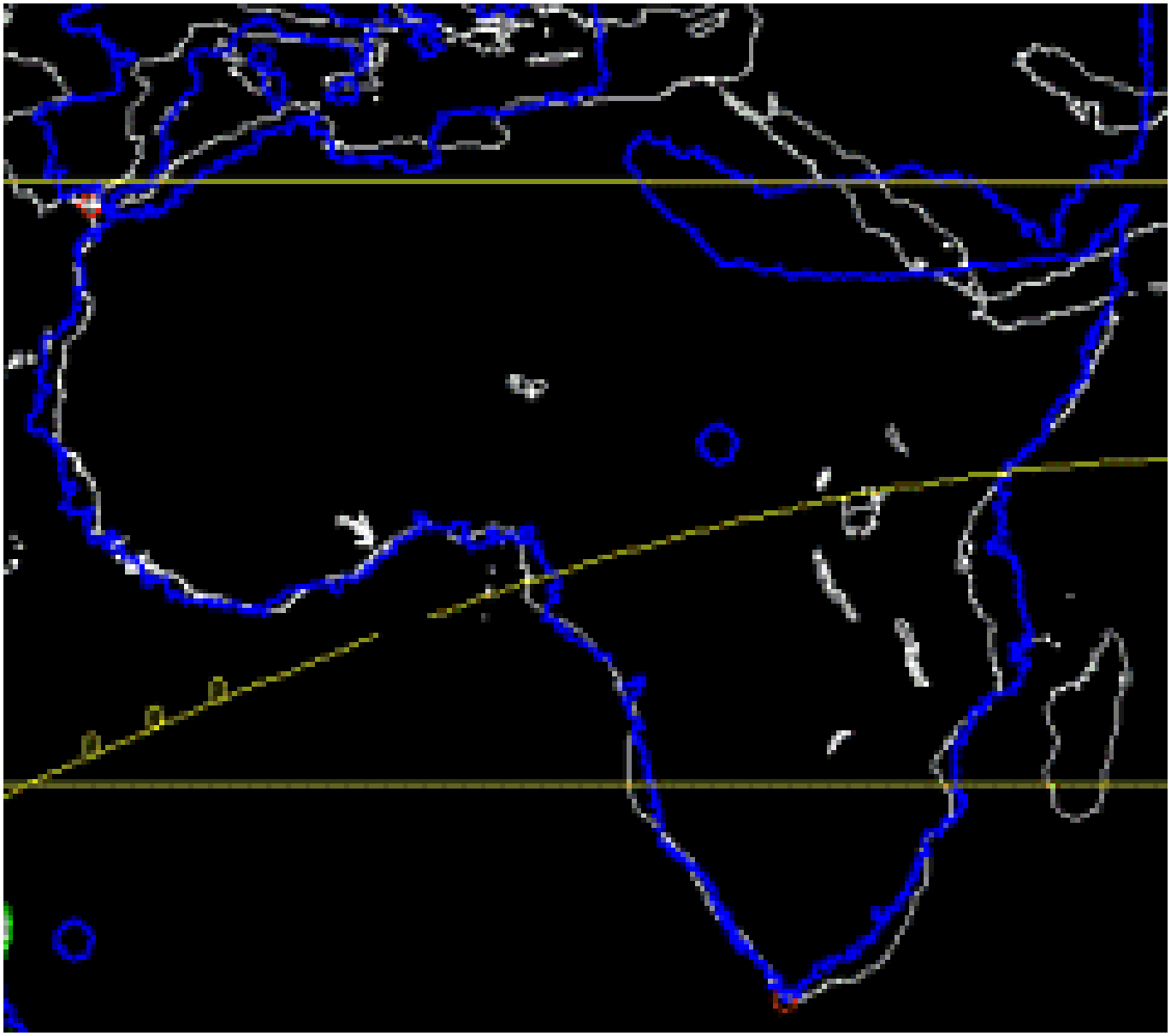

**Plate carrée**

# “Columbus” map, 1492 : Equatorial West Africa

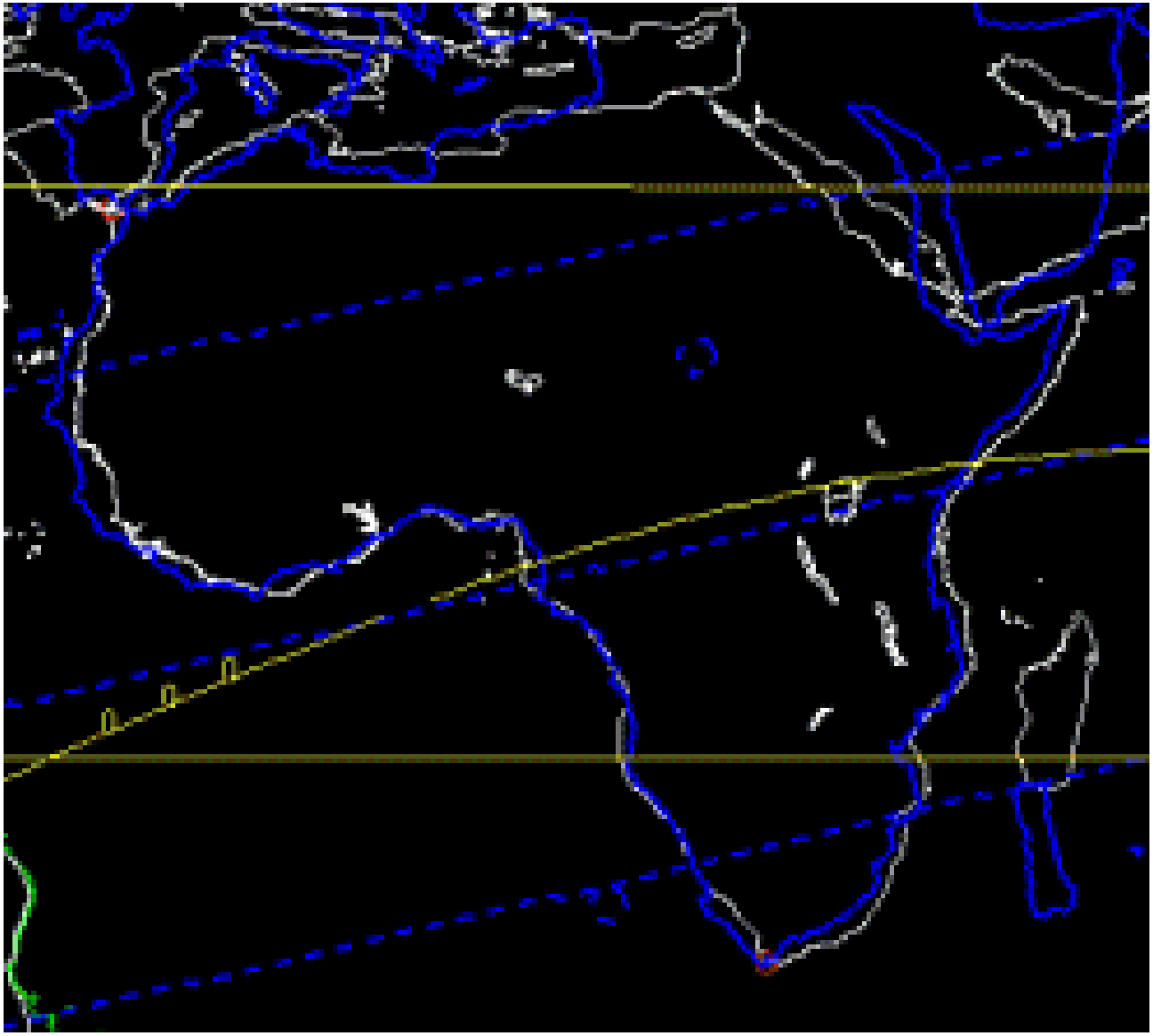


**Oblique plate carrée**

# Caveri, 1504-1505 : Equatorial & Southern Africa
# Oblique plate carrée, Refs : Strait of Gibraltar & Cape of Good Hope



# Cantino, 1502 : Equatorial & Southern Africa
# Oblique plate carrée, Refs : Strait of Gibraltar & Cape of Good Hope



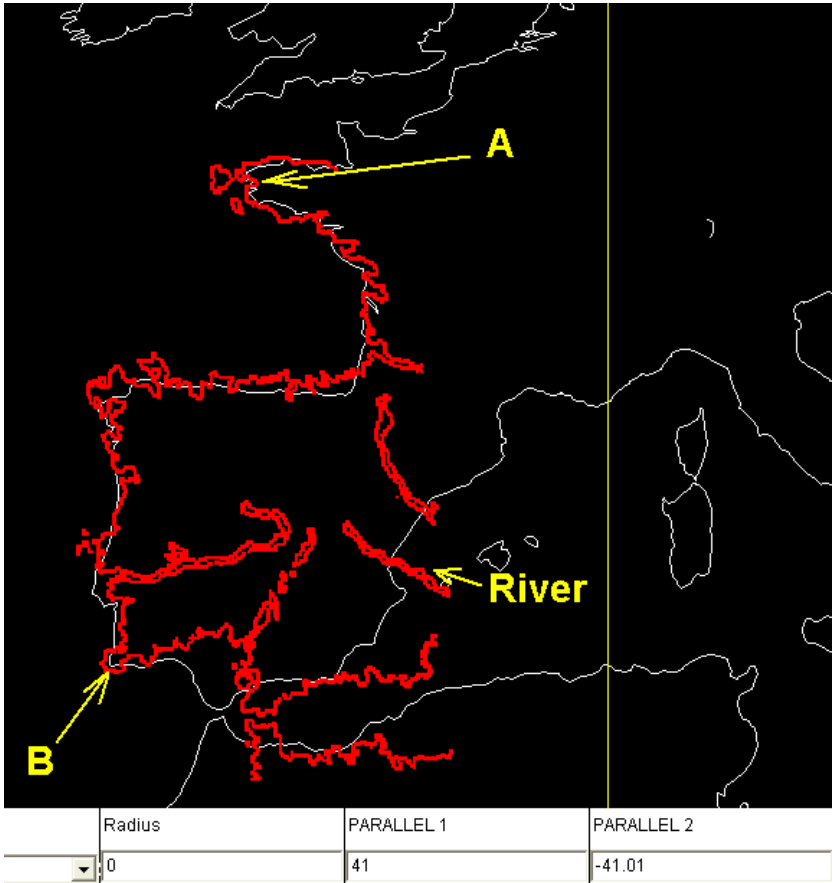
**SUMMARY:**

- Oblique plate carrée was a term used by Snyder (1993) for a projection said to be invented for geographical use in the 20th Century.
- We however conclude that it has been **re-invented** as some Renaissance portolan charts of the late 15th Century and early 16th Century appear to depict equatorial and southern Africa on an **oblique plate carrée projection**.
- The precision of southern Africa on the Cantino (1502) suggests that it was unlikely to result from the sailing of Vasco da Gama (who returned to Lisbon in August of 1499).

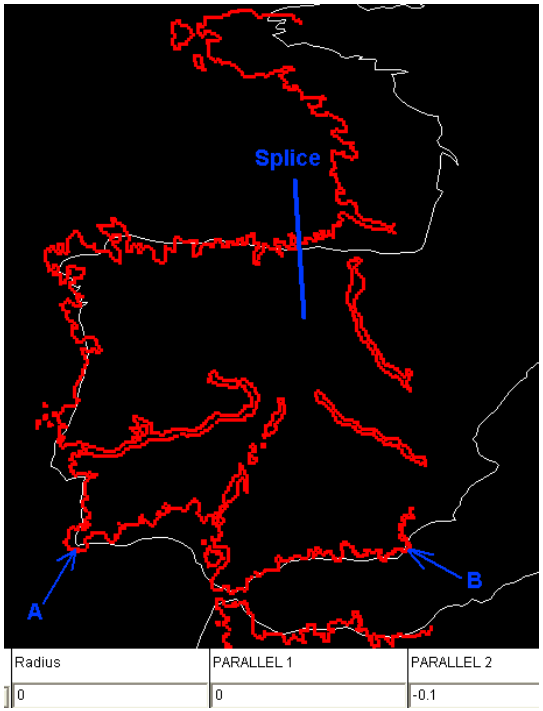
# Piri Reis, 1513

# Spain & Portugal

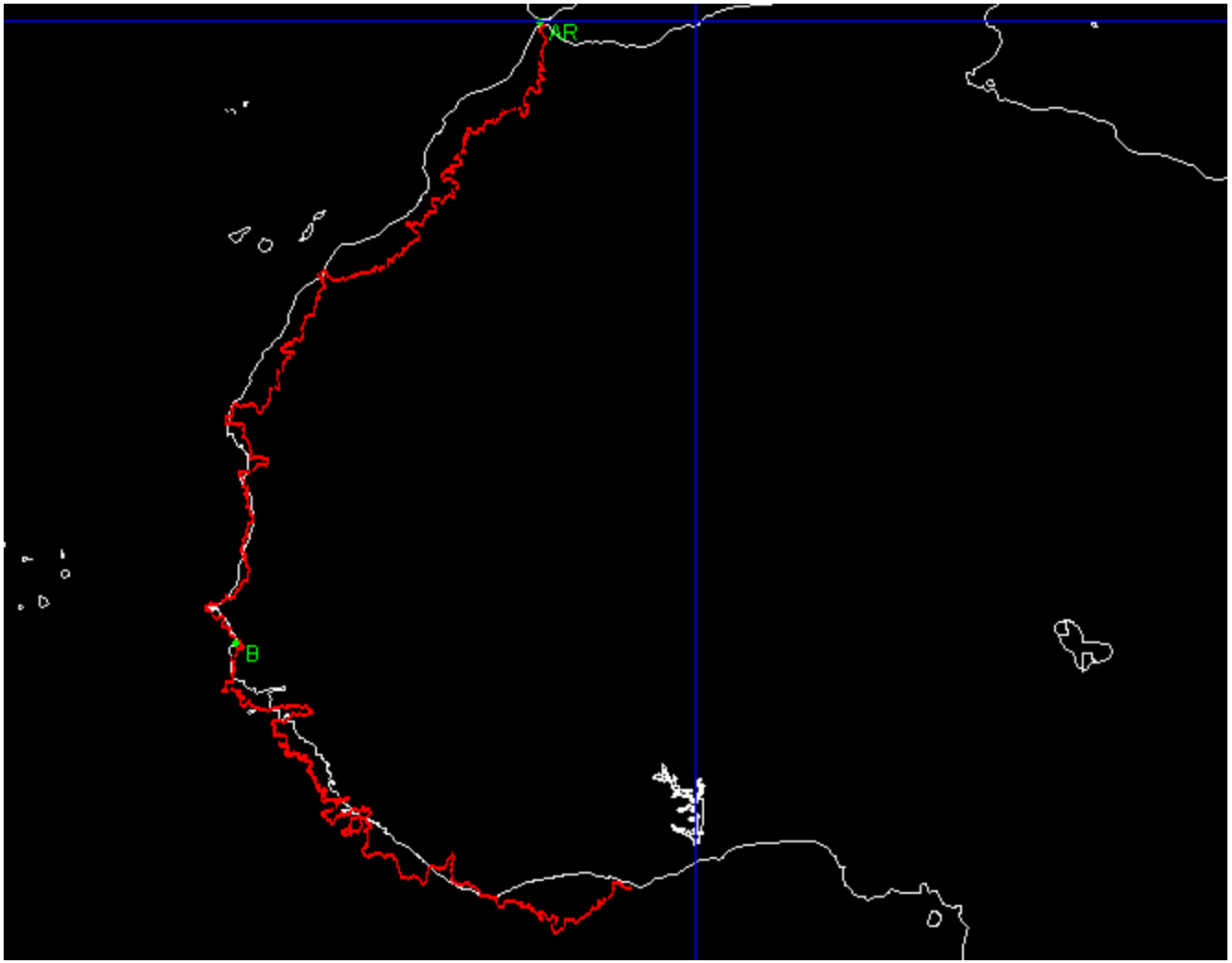
**Equidistant cylindrical**
**standard parallel: 42°**
**Correct between the two A & B**
**Impies a join probably on**
**southern coast west of Gibraltar**




**Same zone on a plate carrée.**
**Correct between the A & B**
**and on the western coast.**
**Join on northern coast?**

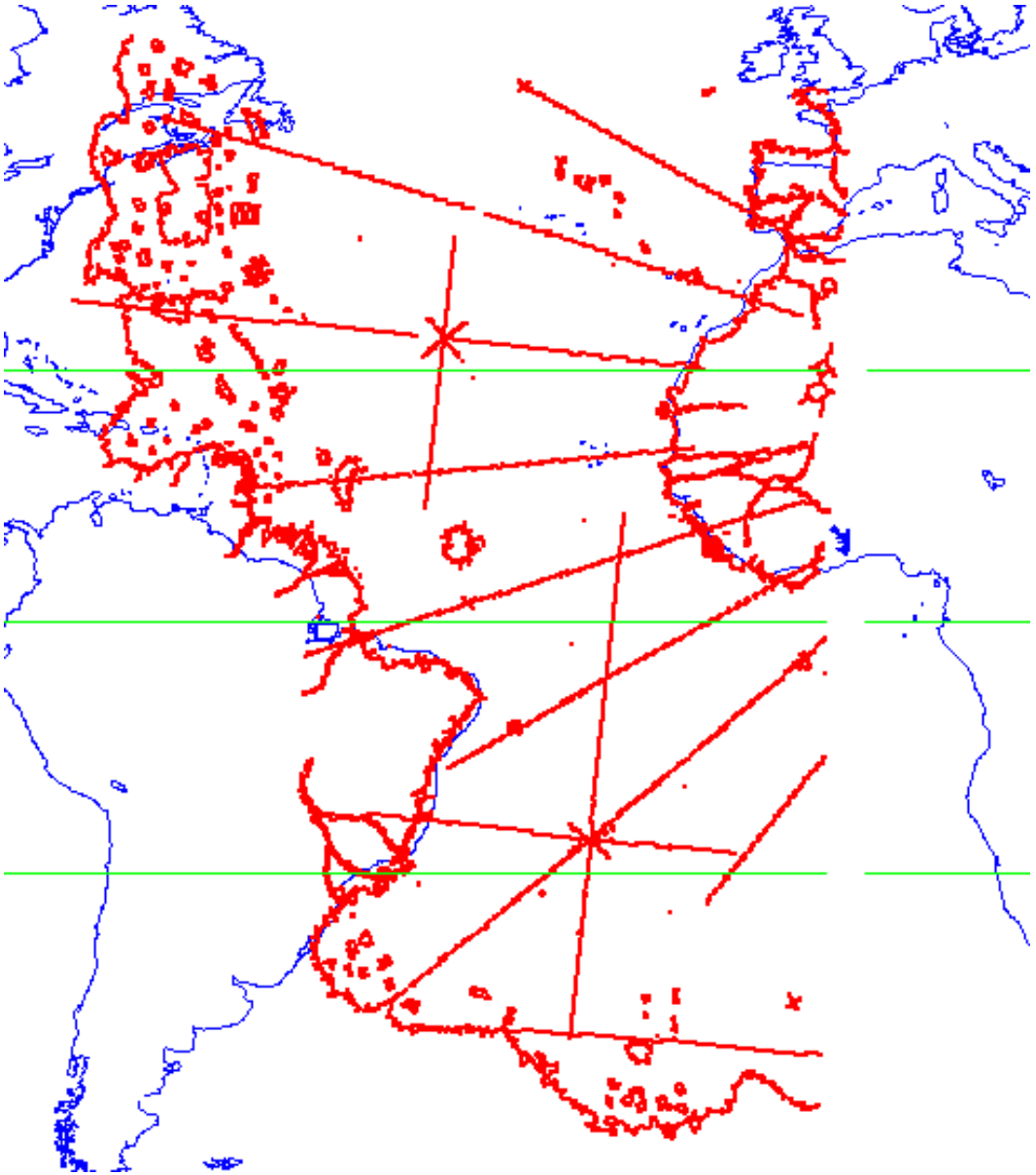


**Piri Reis, 1513 :**
**Plate carrée : Refs : Strait of Gibraltar & Gambia River.**



**Piri Reis, 1513 :**

**Plate carrée, Refs : Gibraltar & Gambia River mouth**



**The coasts and islands on this map are taken from Columbus's map.**

**Piri Reis, 1513**

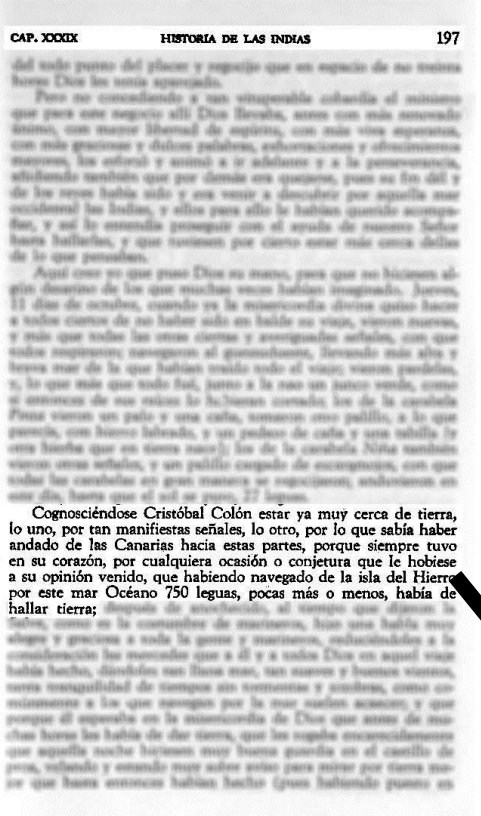
# HISTORIA de las INDIAS, *por*

## *Fray Bartolome de las Casas*

*edición de* Agustín Millares Carlo y
*estudio preliminar de* Lewis Hanke

I

FONDO DE CULTURA ECONOMICA
México - Buenos Aires



CAP. XXXIX HISTORIA DE LAS INDIAS 197

Cognosciéndose Cristóbal Colón estar ya muy cerca de tierra, lo uno, por tan manifiestas señales, lo otro, por lo que sabía haber andado de las Canarias hacia estas partes, porque siempre tuvo en su corazón, por cualquiera ocasión o conjetura que le hobiese a su opinión venido, que habiendo navegado de la isla del Hierro por este mar Océano 750 leguas, pocas más o menos, había de hallar tierra;

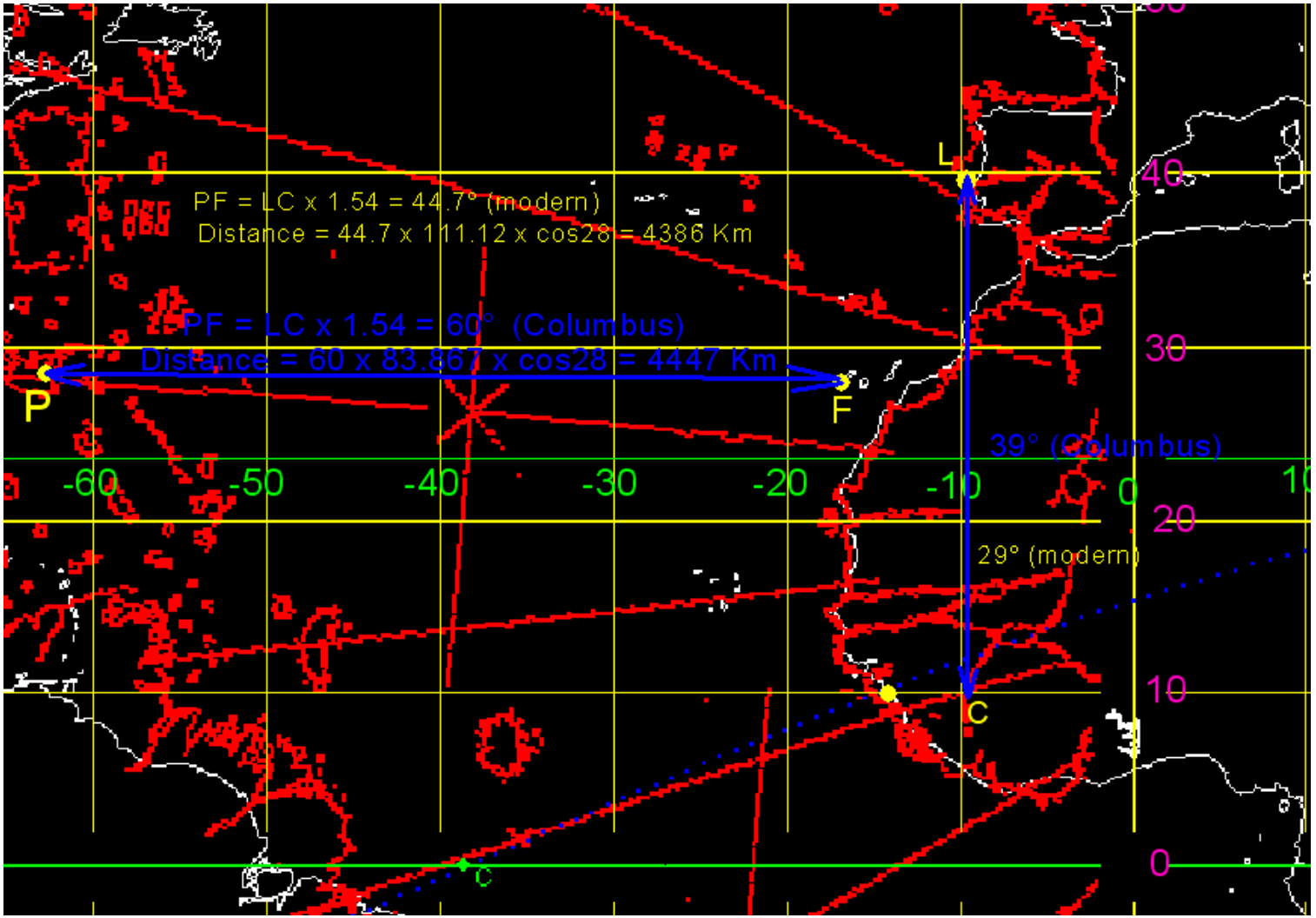
**Columbus's opinion : it was 750 leagues from the island of Ferro in the Caneries to the Indies.**

Cognosciéndose Cristóbal Colón estar ya muy cerca de tierra, lo uno, por tan manifiestas señales, lo otro, por lo que sabía haber andado de las Canarias hacia estas partes, porque siempre tuvo en su corazón, por cualquiera ocasión o conjetura que le hobiese a su opinión venido, que habiendo navegado de la isla del Hierro por este mar Océano 750 leguas, pocas más o menos, había de hallar tierra;

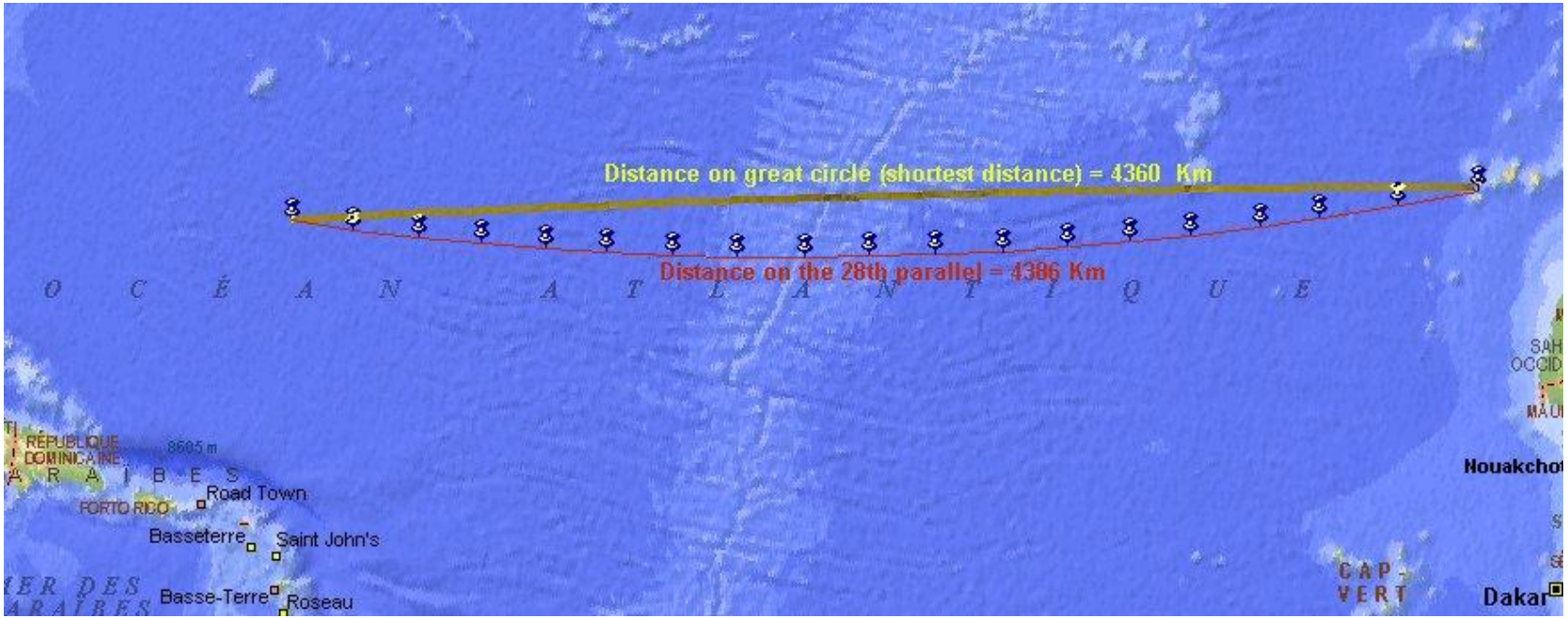
**Columbus, Ferro to Asia based on distance Lisbon (L) to Conakry (C)**

**= 750 leagues = 4447 Km**

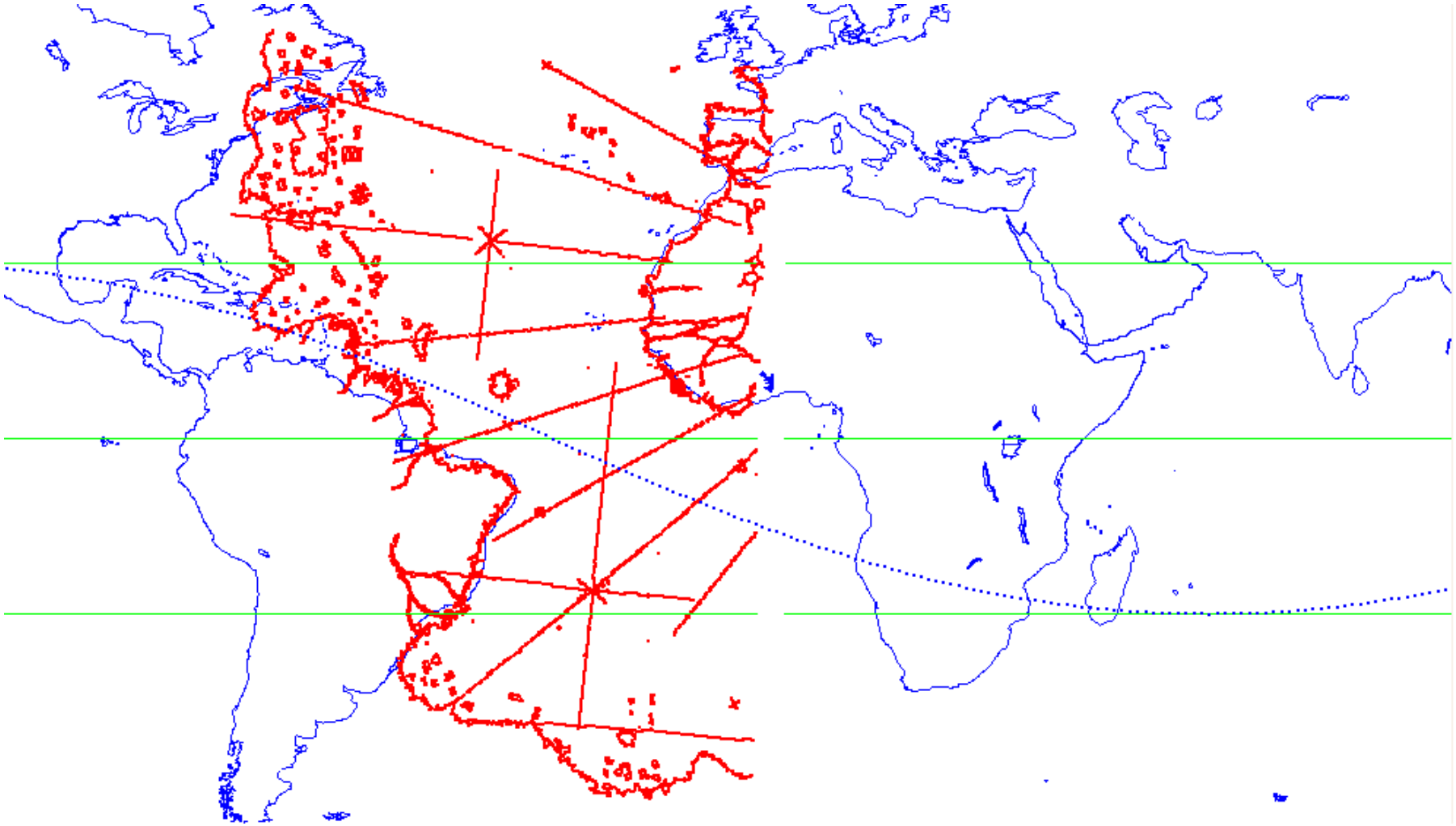
**Ferro to island P (on plate carrée) = 4386 Km (modern calculation)**



**The distance calculated on the map (constant bearing) = 4386km**
**The shortest distance however, the great circle distance**
**= 4360km, (26 km shorter)**



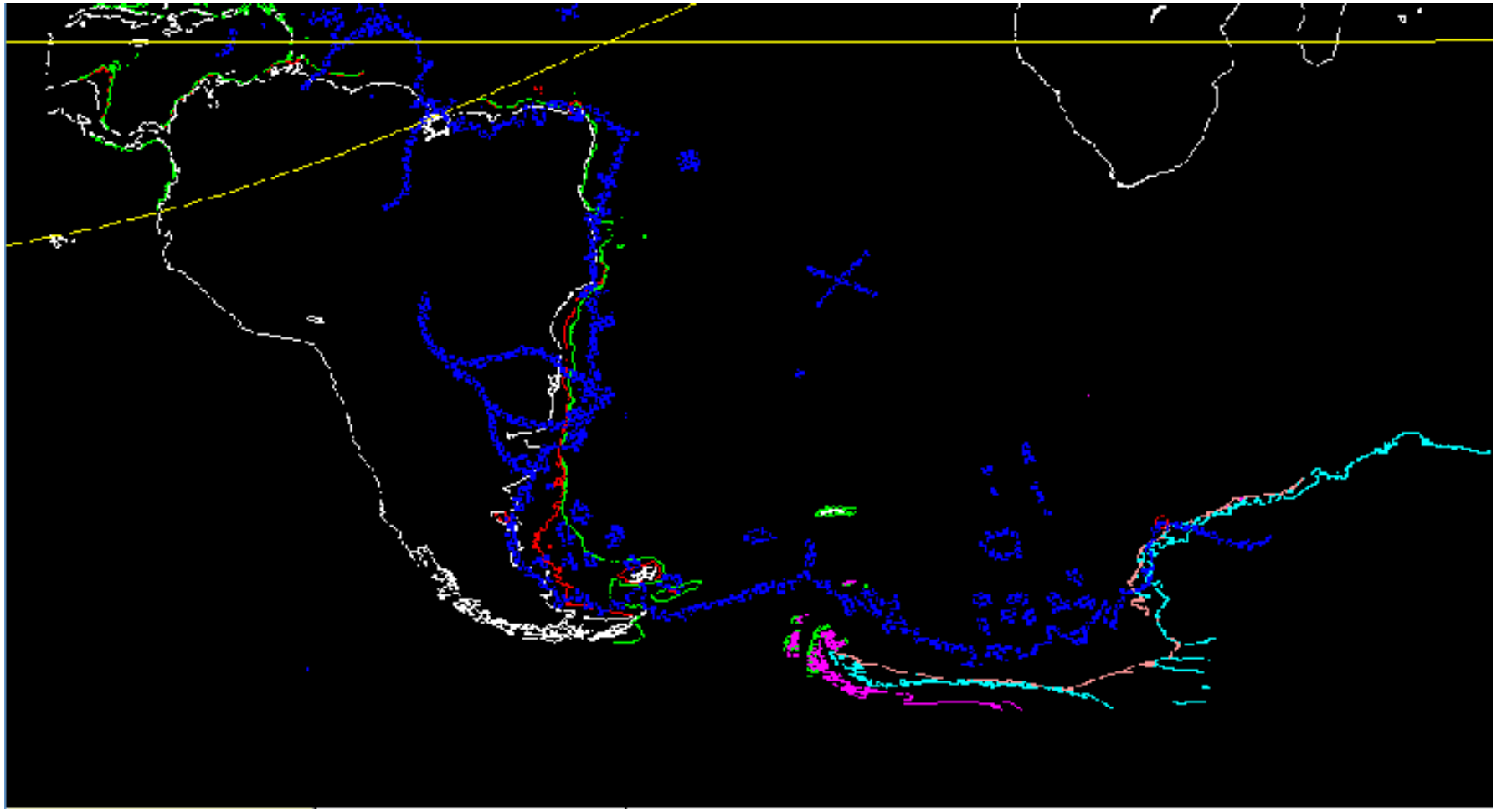
**Piri Reis, 1513 :**
**Plate carrée, Refs : Gibraltar & Gambia River mouth**

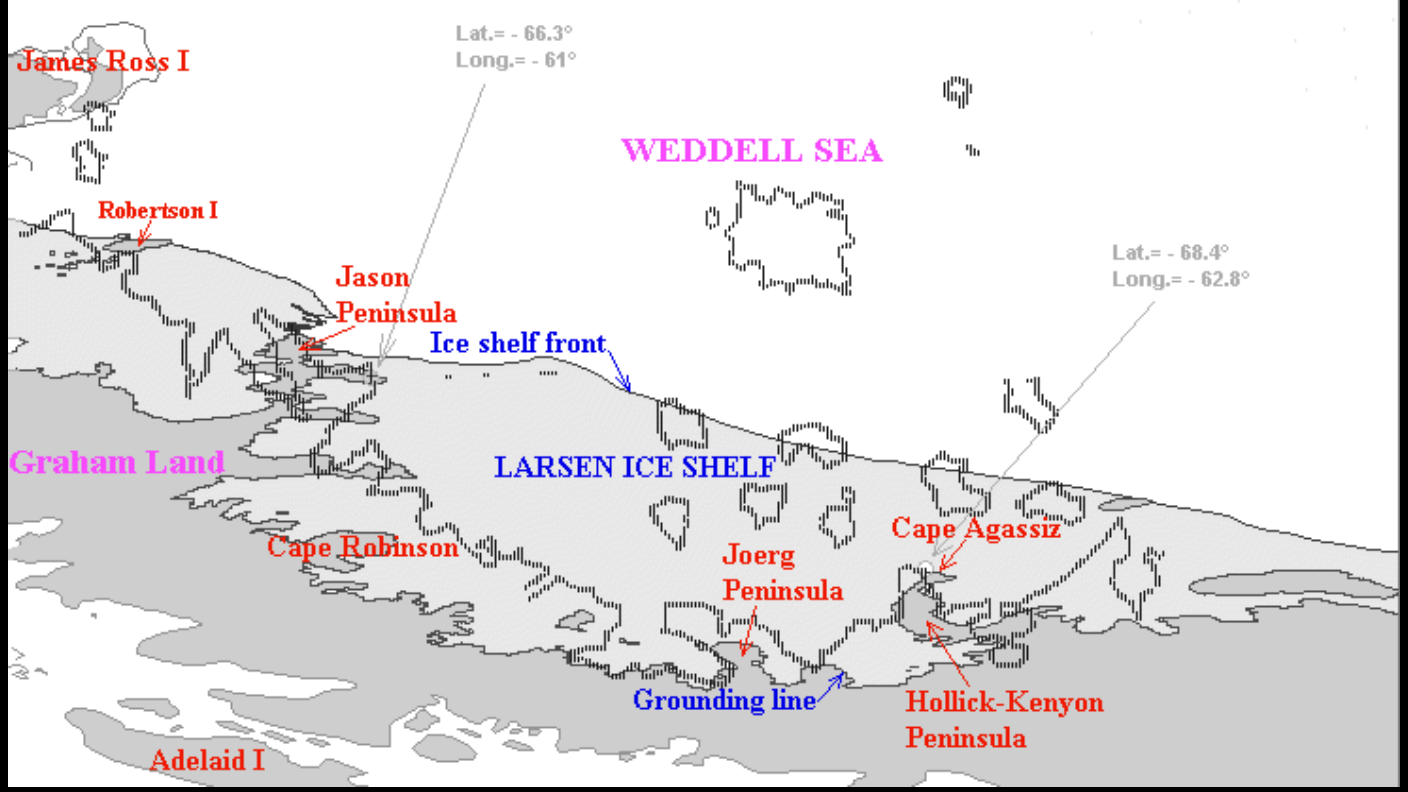


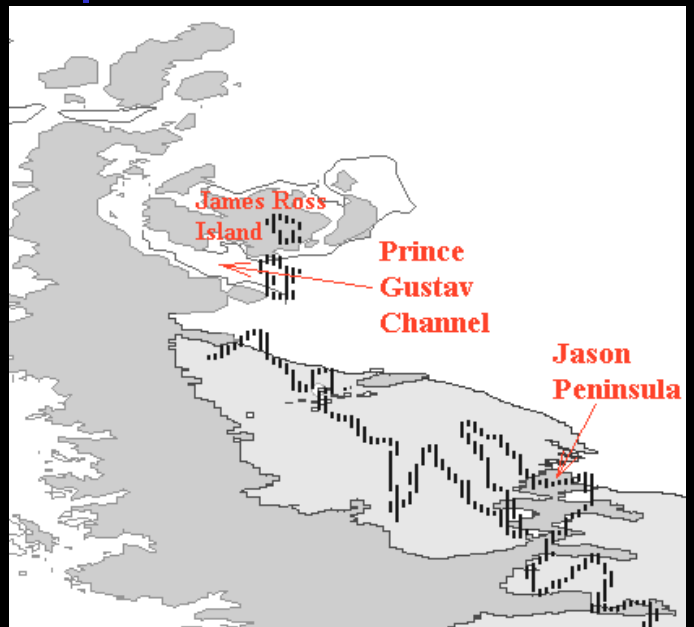
**Southern Lands**

**oblique plate carrée projection**

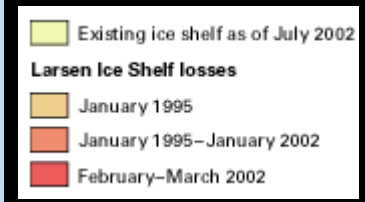
**Refs: Cape San Roque (A) & Northwest QueenMaud Land (B)**




James Ross I
Lat.= - 66.3°
Long.= - 61°
WEDDELL SEA
Robertson I
Jason
Peninsula
Ice shelf front
Lat.= - 68.4°
Long.= - 62.8°
Graham Land
LARSEN ICE SHELF
Cape Agassiz
Cape Robinson
Joerg
Peninsula
Grounding line
Hollick-Kenyon
Peninsula
Adelaid I


James Ross
Island
Prince
Gustav
Channel
Jason
Peninsula


Larsen A
Ice Shelf
Sea I Nunataks
Anvers
Island
GRAHAM LAND
Larsen B
Ice Shelf
Jason
Peninsula
Weddell
Sea
0 20 40 60 mi
0 40 80 km


Existing ice shelf as of July 2002
Larsen Ice Shelf losses
January 1995
January 1995–January 2002
February–March 2002

# Summary

- **The North Atlantic of Piri Reis is a plate carrée projection and the distance between Ferro and Asia on his 1513 map equates to 750 leagues (using the *Italian nautical mile*).**
- **Columbus's view of a 750 league separation between Ferro and Asia was determined by the map he used.**
- **It is reasonable to conclude that Piri Reis on his 1513 map reproduced the width of his North Atlantic from the map of Columbus.**

- **The Southern Atlantic is an oblique plate carrée projection.**
- **The whole of the eastern seaboard of South America (south of the Amazon) is depicted on the map.**
- **The "Southern Continent" on the 1513 Piri Reis map we suggest is a depiction of the shorelines of the Weddell Sea.**
- **We suggest that some shoreline features were those present on the eastern side of the Antarctic Peninsula when the Larsen Ice Shelves had partially disintegrated.**

# CONCLUSIONS

- **1. Our investigations of several portolan maps have indicated that these are not “projectionless”.**
- **2. Portolan maps were compositions derived from several source maps with differing projections :**
  **Mediterranean - equidistant cylindricals**
  **West Africa - plate carrée**
  **Southern Areas - oblique plate carrée**
- **3. The corollary is that the source maps for the portolans had good precision in their cartography, not only of the Mediterranean but also elsewhere (when assessed using the correct projections).**

- **4. Portolan maps evolved not only by place names (Campbell) but also by geographical alterations consequent to spatial and temporal variations in magnetic declination.**
- **5. The source maps must have depicted (most of) Africa, southern South America and probably parts of the Antarctic Peninsula.**
- **6. We suggest that the portolan source maps were likely to have originated prior to the Middle Ages.**