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

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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
3. choose 2 features as “reference locations”
4. choose map projection
5. Computer-assisted superposition
6. assess superposition

ACCEPT or REJECT

cylindrical equidistant (standard parallel 42°)
Dulcert, 1339
Equidistant cylindrical - Refs: Gibraltar & Bosphorus Straits

- Standard parallel: 30°
- Standard parallel: 36°
- Standard parallel: 42°
- Standard parallel: 48°
Equidistant cylindrical - Refs: Gibraltar & Bosphorus Straits

Ref.: Gibraltar & Bosphorus Straits

Cylindrical equidistant
Standard parallel: 42°
Atlantic Zone

Equidistant cylindrical - Refs: Gibraltar Strait & Cotentin Peninsula

0°

21°

36°

42°

63°
Atlantic Zone

Equidistant cylindrical - Refs: Gibraltar & Cotentin Peninsula

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)

Magnetic declination for 1300.0 Model = HHK (1998)
Western Mediterranean Zone
Equidistant cylindrical - Refs: Gibraltar Strait & Messina Strait
Summary

Atlantic  Western Mediterranean  Eastern Mediterranean

Rel. scale = 0.8

Orientation of the western part
Scale of the eastern part

Rotated 14°
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 : 42° :
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

Ref.: Gibraltar & Bosphorus
Projection: cylindrical equidistant
standard parallel: 42°
Juan de la Cosa 1500: North & West Africa
Plate carrée: Refs: Gibraltar & Dakar

Projection: cylindrical equidistant
standard parallel: 0°
Cantino, 1502
Cantino, 1502:
Equidistant cylindrical Refs: Gibraltar & Bosphorus Straits

Ref.: Gibraltar & Bosphorus Straits

Cylindrical equidistant
Standard parallel: 42°
Cantino, 1502:
Equidistant cylindrical Refs: Gibraltar & Bosphorus Straits
Cantino, 1502 : North & West Africa
Plate carrée : Refs : Gibraltar & Dakar
Cantino 1502:
Equidistant cylindrical 42°: Rotated 7°

Magnetic declination in the eastern Mediterranean Sea in 1500 AD = 7° (easterly)
Magnetic declination in 1500 AD
Model from R.H. van Gent (2001)

Magnetic declination for 1500.0    Model = HHK (1998)
Caveri, 1504-1505

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

Ref.: Gibraltar and Bosphorus
Projection: cylindrical equidistant
standard parallel: 36°
Caveri 1504-1505: Eastern Mediterranean
Equidistant cylindrical Refs: Bosphorus and SE corner of Mediterranean

Ref.: Bosphorus & South-East corner of Med.
Cylindrical equidistant
Standard parallel: 42°
Caveri 1504-1505: North & West Africa
Plate carrée  Refs: Gibraltar & Dakar

Ref.: Gibraltar & Dakar

Cylindrical equidistant
Standard parallel: 0°
King-Hamy, post 1502
King-Hamy, post 1502:
Equidistant cylindrical: Refs: Gibraltar & Crete
King-Hamy post 1502:
Equidistant cylindrical: Refs: Gibraltar & Crete

36°

Ref.: Gibraltar & Creta
Projection: cylindrical equidistant
standard parallel: 36°
King-Hamy post 1502:
Equidistant cylindrical 36°: Rotated 6°
Magnetic declination in 1500 AD
Model from R.H. van Gent (2001)

Magnetic declination for 1500.0   Model = HHK (1998)
King-Hamy post 1502 : West Africa
Plate carrée : Refs : Gibraltar & Dakar

Ref. : Gibraltar & Dakar
Projection : cylindrical equidistant
standard parallel : 0° (plate carrée)
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 (42° or 36°) and most plate carrée projections.

• The Strait of Gibraltar lies at 36°N and we note that \( \cos (36^\circ) = 0.8 \).
• 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 36° and 42°.

• 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 42° standard parallel).
Equatorial and Southern Africa
Cantino, 1502: North & West Africa
Plate carrée: Refs: Gibraltar & Dakar

Cylindrical equidistant
Standard parallel: 0° (plate carrée)
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

Solstitial line through Gulf of Oman

(60°E longitude)
• 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°.

• One can produce an oblique plate carrée projection using a terrestrial ecliptic as the standard great circle.
• The intersection of the terrestrial ecliptics with the equator (the “equinoxes”) of Hondius and Homann occurs at $30^\circ W.$ and $150^\circ E.$

• Similar intersections are seen on Mercator’s globe of 1541 & a globe from the late 16th century.

• The Finaeus (1532) and Mercator (1538) cordiform maps have a standard meridian practically running along the “solstitial” line of the terrestrial ecliptic.
Cantino, 1502: Oblique plate carrée,

Equator crossings: $30^\circ$W & $150^\circ$E

Obliquity angle: $14^\circ$

$24^\circ$ $34^\circ$
Cantino, 1502: Oblique plate carrée,

Obliquity angle: $24^\circ$

Equator crossings:
- $50^\circ W$ & $130^\circ E$
- $30^\circ W$ & $150^\circ E$
- $10^\circ W$ & $170^\circ E$
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

dedicación de Agustín Millares Carlo y
estudio preliminar de LEWIS HANKE

I

FONDO DE CULTURA ECONOMICA
México - Buenos Aires
Columbus's opinion: it was 750 leagues from the island of Ferro in the Canaries to the Indies.
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 Queen Maud Land (B)
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.