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Polar Hemispheres: The Overlooked Alternative to Nautical Planispheres in Renaissance Iberia

by Luis A. Robles Macias

Detail. World map in PAE projection dated 1524 that claims to be the work of "Juan Vespucci of Florence, pilot of the King of the Spains". Harvard Map Collection, Vespucci1524.

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From the Editor

You will see that the contents of this issue again cover the earliest to the most current period of the history of cartography, and the subjects take you around the world. That is the goal of the Society and the journal you are reading.

After returning from retirement to edit the past three issues, I am pleased to hand over future Editor duties to **Andrew Adamson**, who has closely followed my preparation of this issue. He is eager to continue the traditions of the journal, and, we expect, bring his own flavour to the journal. Yes, flavour—Andrew is British by birth. His 'day job' still involves international travel; no problem—I have found the editorship can easily be done from afar via the internet. The journal is in good hands.

I wish all our readers the best as I step back to emeritus status again. It is you, the membership, that keeps the journal alive with your contributions as writers, book reviewers, and saying YES when a call for help is issued. My sincere thanks to you all.

Cheers, and remember, without geography you are nowhere.

Tom

Polar Hemispheres: The Overlooked Alternative to Nautical Planispheres in Renaissance Iberia

By Luis A. Robles Macías

INTRODUCTION

The kingdoms of Portugal and Castile, in the Iberian Peninsula, were major centers of maritime exploration, trade and conquest throughout the 15th and 16th centuries. Nautical charts, also known as portolan charts, are the type of maps that typically comes to mind when discussing this historical context. Such charts were progressively expanded in geographical scope until covering the entire world in the form of rectangular nautical style planispheres.

This paper aims to draw attention to an entirely different tradition of world maps that coexisted with nautical planispheres in Renaissance Iberia. These other maps depicted the northern and southern hemispheres as circles centered on the poles, with explicit graticules of parallels and meridians. Surviving examples are rare, but numerous mentions of similar maps can be found in overlooked contemporary texts.

ENCISO'S TESTIMONY: TWO TYPES OF WORLD MAP

In 1519, in Seville, a book was published entitled *Suma de geographia* authored by Martín Fernández de Enciso.[1] The *Suma* blended a classical treatise of cosmography with a geographical description of the world, including a detailed account of the American shores explored by Spanish expeditions. While for the Old World Enciso largely recycled generic information from classical or medieval sources, for the New World he provided minute positional, nautical, and anthropological information.[2]

The *Suma*'s text mentions several times a world map, designated *figura en plano*, that was supposed to accompany it. However, no map has ever been found in the numerous surviving exemplars of the book, and this has opened a debate about the reasons for this absence.[3] I will not enter that debate here, but focus instead on a paragraph of the *Suma* in which Enciso describes not only the *figura en plano* but also a second type of world map, and succinctly compares the relative merits of both types.

The text in question is found between the *Suma*'s purely cosmographical chapters and the part devoted to descriptive geography [see **Figure 2**]. In it, Enciso first explains how the world is divided by the equator and a meridian into four equal parts called quadrants. Enciso then states that "charts could and should be made in this way, shaped as quadrants", so that they match the roundness of the sphere; but he immediately adds that he has personally opted for a different type of map, called "en plano por longitud [on a plane by longitude]". Enciso defends his choice based on two advantages of the latter maps: first, coastlines "are depicted joined"; and second, seamen "understand better on a plane" given that "seamen are not astrologers and, if one is, it is by accident".

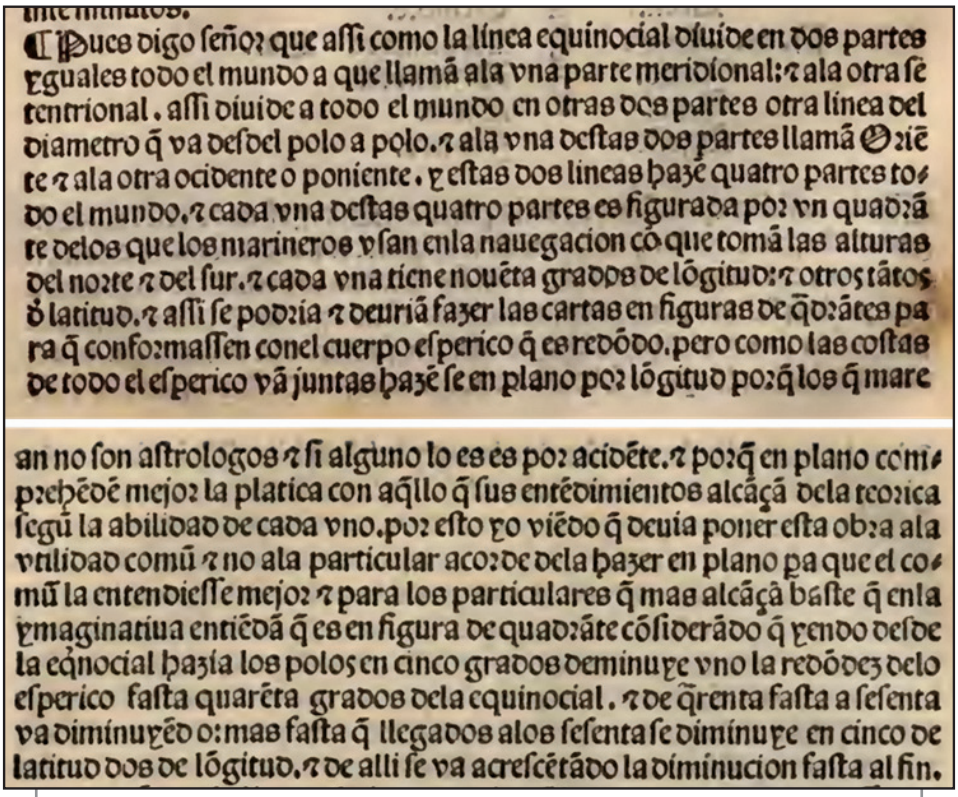
This paragraph has frequently been interpreted as the description of a single type of map, identified with the map presumably published by Enciso along with his *Suma*.[4] Specifically, the type of map that Enciso calls *en plano por longitud* has been deemed to be a nautical-style planisphere with horizontal parallels similar to those made contemporarily in Seville, starting with the unsigned Kunstmann IV of ca. 1519, the equally unsigned Salviati and Castiglione planispheres, and the world maps made by Juan Vespucci in 1526 [**Figure 1**] and Diego Ribero thereafter.

This was most likely the type of map that Enciso finally selected for the *Suma*, but it should be emphasized that the cited text describes not just one but two different types of world maps. This point was already made by Navarrete,[5] and is apparent from a simple linguistic analysis of Enciso's very long sentence. The conjunction "pero [but]" opposes how maps "could and should be done" with how Enciso actually decided to make his map. The comparative "mejor [better]" implies a difference of quality between the two types of maps that are being compared. And the phrase "a la utilidad comun y no a la particular" opposes two types of utility—common and individual—each of which Enciso associates with one or the other type of map. Furthermore, Enciso calls the two types of maps by clearly different names: *en plano por longitud* for the type he chooses, and *en figuras de quadrantes* for the one he praises but decides to discard.

WHAT IS A MAP *EN FIGURAS DE QUADRANTES*?

The method to draw a world map *en figuras de quadrantes* is very briefly outlined in the first lines of Enciso's

Figure 1. The world map signed by Juan Vespucci in Seville in 1526 and now kept at the Hispanic Society Museum and Library (HSML, New York City, NY) is a typical example of nautical-style planisphere (image courtesy of the HSML).



Pues digo señor que assi como la línea equinocial diuide en dos partes yguales todo el mundo a que llamã ala vna parte meridional: y ala otra septentrional. assi diuide a todo el mundo en otras dos partes otra linea del diametro q̃ va desde el polo a polo. y ala vna destas dos partes llamã Oriẽte y ala otra occidente o poniente. y estas dos lineas hazẽ quatro partes todo el mundo. y cada vna destas quatro partes es figurada por vn quadrãte delos que los marineros vsan enla nauegacion cõ que tomã las alturas del norte y del sur. y cada vna tiene nouẽta grados de lõgitud: y otros tãtos de latitud. y assi se podria y deuriã fazer las cartas en figuras de q̃drãtes para q̃ conformassen conel cuerpo esperico q̃ es redõdo. pero como las costas de todo el esperico vã juntas hazẽ se en plano por lõgitud porq̃ los q̃ mare an no son astrologos y si alguno lo es es por accidẽte. y porq̃ en plano comprehẽdẽ mejor la platica con aq̃llo q̃ sus entẽdimientos alcãçã dela teorica segũ la abilidad de cada vno. por esto yo viẽdo q̃ deuia poner esta obra ala vtilidad comũ y no ala particular acorde dela hazer en plano pa que el comũ la entendiesse mejor y para los particulares q̃ mas alcãçã baste q̃ enla ymaginatiua entiẽdã q̃ es en figura de quadrãte cõsiderãdo q̃ yendo desde la eq̃nocial hazia los polos en cinco grados deminuye vno la redõdez delo esperico fasta quarẽta grados dela equinocial. y de q̃renta fasta a sesenta va diminuyẽdo: mas fasta q̃ llegados alos sesenta se diminuye en cinco de latitud dos de lõgitud. y de alli se va acrescẽtãdo la diminucion fasta al fin.

Figure 2. Paragraph of Enciso's Suma that describes two different types of world map. The 1519 edition has no page numbers; this text is found between the verso of folium [b ix] and the recto of folium [b x].

paragraph. He describes how the Earth can be sliced into four parts by cutting it along the equator and along one meridian. He then states that "each of these four parts is depicted by a quadrant of those that sailors use in navigation", adding that each of the four parts of the Earth measures 90 degrees in latitude and 90 in longitude. The instruments called quadrants in Enciso's time did span an angle of 90 degrees [**Figure 3**]. However, if

Figure 3. Left : The Earth split in four parts by the equator and a meridian. Right: An astronomer using a quadrant; Andrea Pisano and assistant, 1343–1348, Museo dell'Opera del Duomo, Florence.

one splits a sphere into four equal parts as indicated by Enciso, each of the resulting pieces measures 180 degrees in longitude, not 90. This apparent error was not corrected in later editions of the book.

Scattered across the cited paragraph, one can find additional clues regarding the aspect of a map *en figuras de quadrantes*. The first is that this map "conforms" well with the sphericity of the Earth, i.e. it somehow conveys the idea that our planet is round. Another clue is that the map does not ensure the continuity of contiguous coastlines, as one advantage of maps *en plano* is that coastlines "are depicted joined", without breaks. Finally, meridians seem to be drawn not as parallel lines but converging towards the poles; this is deduced from the final lines of the cited paragraph, in which Enciso provides a sketchy method to mentally convert his map *en plano* into one *en figura de quadrantes*.

The indications given by Enciso are of course not sufficient to draw a map. However, if one considers the types of world map in circulation in the first decades of the 16th century, only a few could match the above description. The idea of splitting the world in four quadrants, with discontinuities between them, rules out continuous shapes like rectangular, fan-like or oval world maps. Conveying the idea of a round planet suggests that the map involved circular shapes, rather than cordiform or other complicated geometries. All in all, the map shapes that tick all the boxes are only two: equatorial hemispheres, i.e. a circle for the western half of the Earth and another for the eastern half, with the equator a straight line; or polar azimuthal hemispheres, i.e. a circle each for the northern and southern halves, centered on the poles. In both cases, several variations would be possible, for example drawing the two hemispheres at equal or different scales; seen from inside or from outside; with different mathematical rules to plot parallels and meridians.… In particular for polar hemispheres, several "projections" can be defined depending on the spacing of parallels. If spacing is simply proportional to the difference of latitude, the projection is called "equidistant". If, on the contrary, parallels are spaced as if the observer were looking at them from the opposite pole of the sphere, the projection is called "stereographic".

Out of this set of theoretical possibilities, only the polar azimuthal equidistant (PAE) projection can be effectively connected to extant maps from the historical context in which the *Suma* was published. The only two world maps made in Seville in Enciso's time that are not nautical-style planispheres both use the PAE, namely:

1. **A Portuguese hemisphere in Istanbul**. Undated and unsigned manuscript preserved at Topkapı Palace [**Figure 4**]. The depicted southern hemisphere, in PAE projection, is the surviving half of a world map that originally consisted of both hemispheres. Scholars agree this map must have been drawn, or at least finished, in Portugal or in Seville around

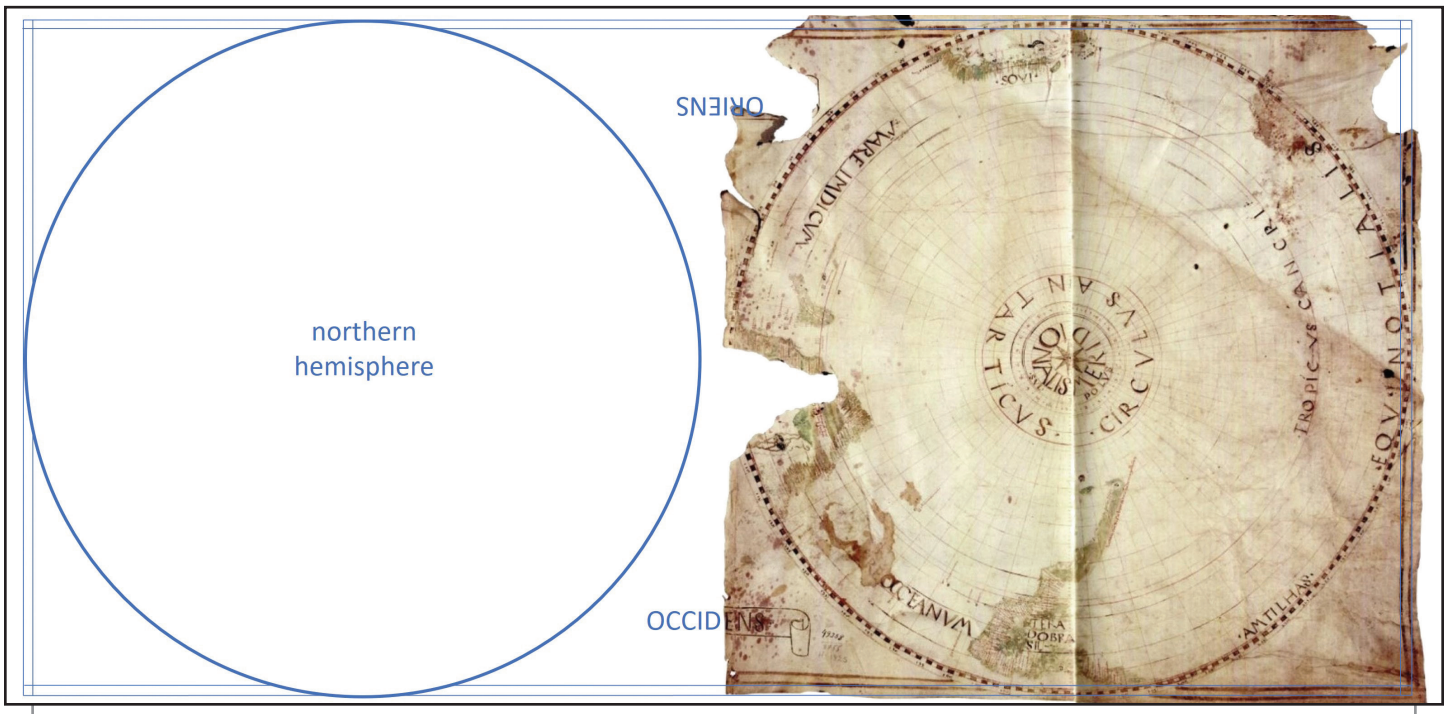


Figure 4. Anonymous PAE hemisphere in Istanbul (Topkapı Sarayı Müzesi Kütüphane, Hazine 1825) with a tentative reconstruction of the rest of the map.

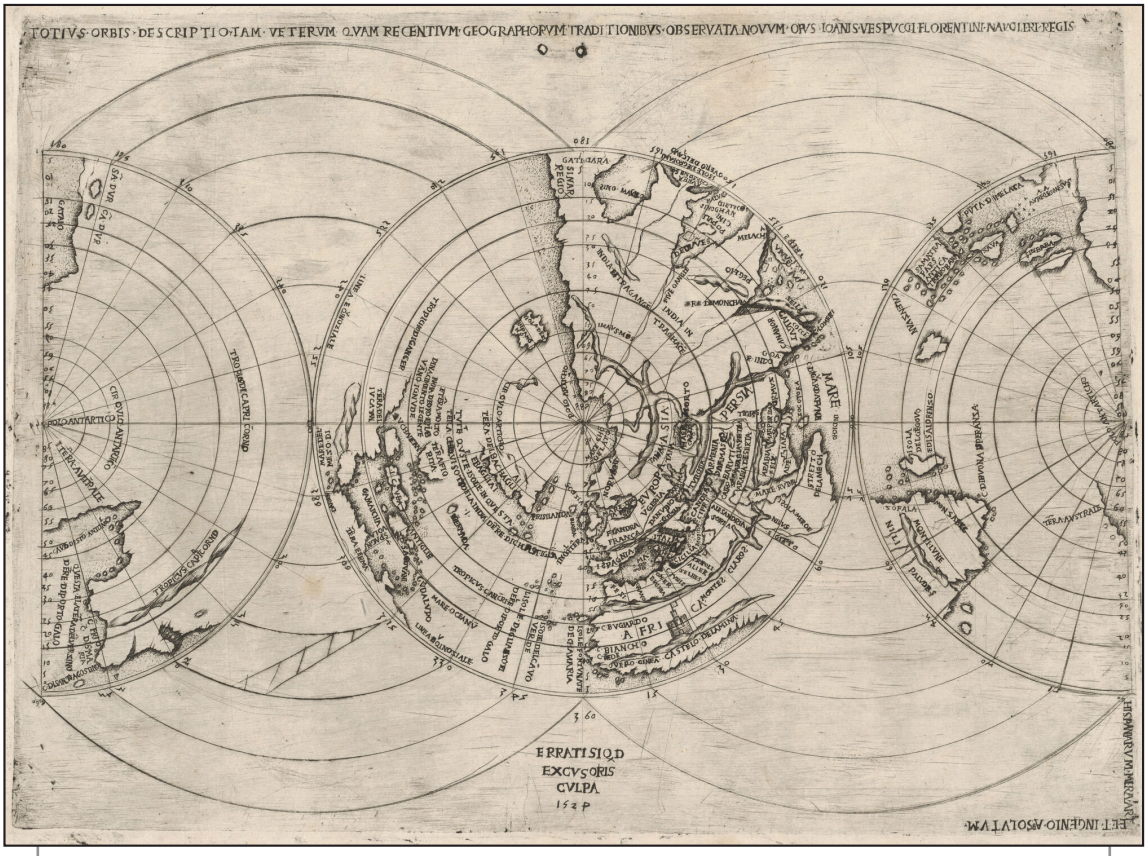


Figure 5. World map in PAE projection dated 1524 that claims to be the work of "Juan Vespucci of Florence, pilot of the King of the Spains". Harvard Map Collection, Vespucci1524.

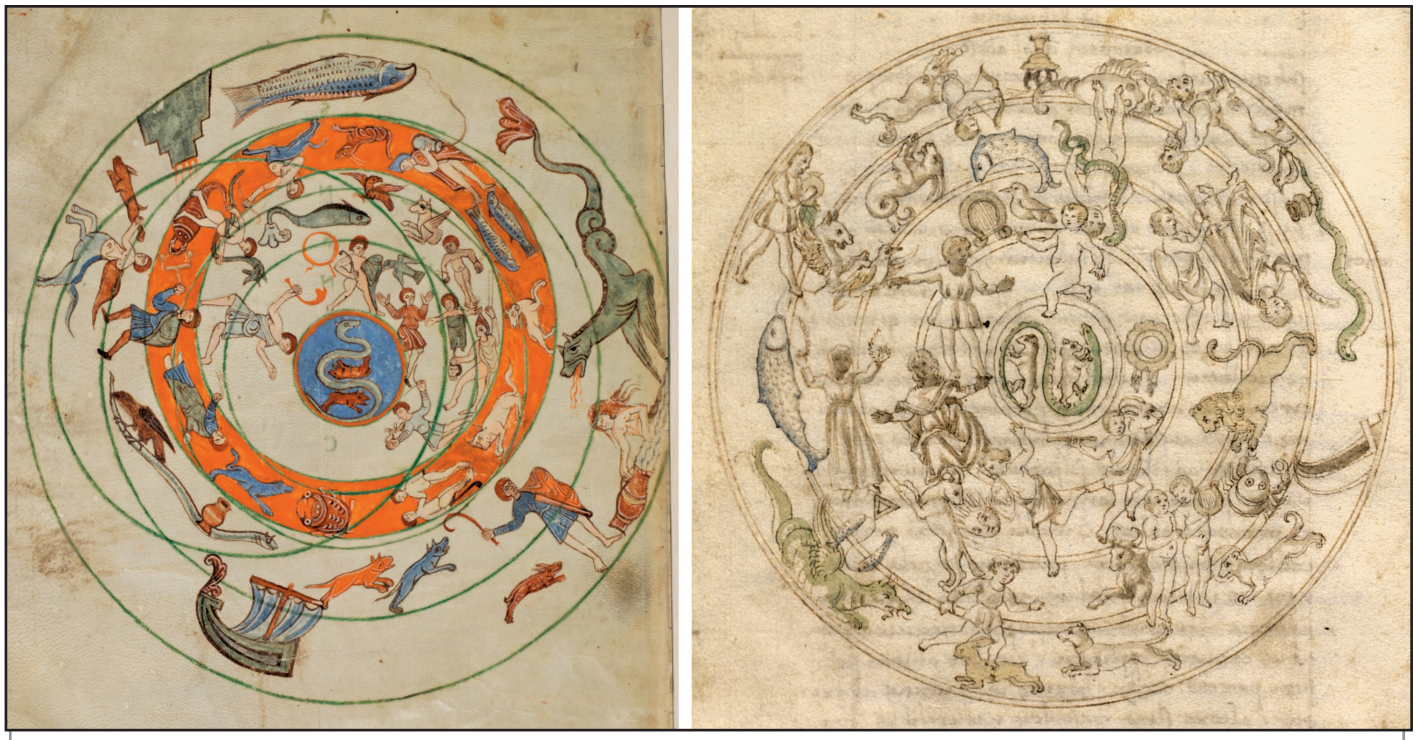


Figure 6. Medieval celestial planispheres built according to the PAE method. Left: early 11th century at Burgerbibliothek Bern cod. 88, f.11v (CC-BY-NC image). Right: ca. 1475 attributed to Giorgio Antonio Vespucci at Biblioteca Nazionale di Napoli, Ms XIV.D 37, f.2v.

1521–22, and have variously attributed it to Portuguese mapmakers Pedro Reinel,[6] Jorge Reinel,[7] or Estevão Gomes.[8]

2. **Juan Vespucci's printed world maps**. Likely published in Italy and known in three exemplars, all slightly different. One copy is dated 1524 **[Figure 5]**, and two of the copies claim their author to be Florence-born Juan Vespucci, who at the time was royal pilot at the Casa de la Contratación in Seville.[9] The northern hemisphere, drawn as a circle in PAE projection, occupies the center of the map while the southern hemisphere is split in two halves, each of which is located at one side of the composition.

Based on this, the hypothesis is hereby formulated that the maps *en figuras de quadrantes* described by Enciso were polar hemispheres in PAE projection. Their round shape immediately reminds the reader of the sphericity of the Earth. In Vespucci's case, the link to the concept of quadrant is even clearer given that the southern hemisphere is split in two halves, i.e. quadrants of the sphere. The explicit grids of latitude and longitude of these maps would have logically been favored by academic cosmographers, but their coastlines broken across hemispheres were counterintuitive for mariners, who naturally disliked them.

UNUSUAL BUT NOT UNIQUE

Moving the gaze beyond the Iberian Peninsula, a few other PAE maps have come down to us from Renaissance Europe. As stated in the classic references on the history of map projections,[10] the oldest extant PAE terrestrial maps are two hemispheres sketched by a University of Cologne student known as Glarean in 1510. Chart maker Vesconte Maggiolo produced almost simultaneously in Naples a fan-shaped map of the Atlantic that is conceptually a fragment of a PAE planisphere i.e., a circular representation of the entire world centered on the north pole. PAE hemispheres were later made by authors such as Battista Agnese, André Thevet or Guillaume Postel, while the closely related polar azimuthal stereographic (PAS) projection was used for world maps in several cosmography books.

Polar azimuthal projections had nevertheless been used for much longer for start charting. A celestial hemisphere dated 1426 has traditionally been identified as the oldest surviving PAE map of any type,[11] and a description of the PAE projection is already found in an Arabic treatise from around 1000 CE.[12] Furthermore, recent scholarship has found that the PAE was extensively used by

medieval astronomers even if they did not master all of its mathematical intricacies. Practically every surviving celestial hemisphere and planisphere from the 9th to the 15th centuries was built according to a rough PAE projection.[13] In particular, a celestial hemisphere from around 1475 attributed to Florentine humanist Giorgio Antonio Vespucci is in PAE projection **[Figure 6]**.[14] Giorgio Antonio was the uncle and teacher of Amerigo Vespucci, who may have thus become familiar with the PAE method in his youth and later transmitted it to his nephew Juan Vespucci or even used it himself, as we will see.

The early PAE terrestrial maps by Glarean, Maggiolo and possibly other precursors thus emerged in a context in which the PAE projection was commonplace for celestial maps. This same background may have enabled the simultaneous use of the PAE for world maps in Portugal and Spain. Which leads to the question: were polar azimuthal maps made in Iberia in addition to the two mentioned surviving examples? A close reading of contemporary texts about maps indicates that this was likely the case; four possible instances are studied in the following section.

POSSIBLE MENTIONS OF POLAR HEMISPHERES OR PLANISPHERES IN RENAISSANCE IBERIAN SOURCES

Jaime Ferrer, 1495

After signing the Treaty of Tordesillas in 1494, one of the experts consulted by the Catholic Monarchs was Catalan cosmographer Jaime Ferrer de Blanes.[15] Upon receiving the royal request, Ferrer answered on 27 January 1495 with a letter that was posthumously published fifty years later in a collection of his correspondence.[16] He informed that:[17]

> (…) and therefore, very high and most serene Sovereigns, I have examined (the subject) to the extent of my humble understanding, although late, and not so soon as I had wished, on account of a slight illness; and therefore I send to your Highnesses, by a man of mine, a figure of the world on a large scale on which may be seen the two hemispheres, to wit, our Arctic and the opposite Antarctic one. And likewise you will see the equinoctial circle and the two tropics of the declination of the sun, and the seven climates, and each one of these circles put in its proper place as in the *treatise on the sphere* and in the *situ orbis* learned men direct and divide into degrees.
>
> And, in order that the distance may more clearly be seen of the said three hundred and seventy leagues and how far they extend in a westerly line starting from the said Cape Verde, I have intersected the said distance from pole to pole with red lines, which at the equator are twenty-three degrees apart, and with acute angles, the said lines correspond to the poles of the earth in this figure: [see **Figure 7**]. and all that is crossed by yellow lines will be what belongs to the most illustrious King of Portugal, turning in the direction of the Antarctic pole. And this distance of sea completes the said three hundred and seventy leagues which are, as I said above, twenty-three degrees starting from Cape Verde in a westerly line.
>
> And if in connection with this decision (treaty of partition) your Highnesses should command that I should go thither[18] I will, of my great and obedient love, certainly go at my own expense and without any pay. (…)

As can be seen, Ferrer sent to the Court a world map and emphasized that both the North and South hemispheres could be seen on it. In addition, he included in the letter a figure to clarify his explanation. However, the version of this figure published by the editor of Ferrer's letters was a rather cryptic sketch. To further complicate the interpretation of the figure by later historians, Martín Fernández de Navarrete modified the sketch in his own edition of the text, as shown below.

Ferrer's world map was not just a sketch but a separate, stand-alone document. This is quite certain given the Monarchs' reply to Ferrer's letter one month later, acknowledging receipt not only of Ferrer's letter but also of "la escriptura" that he had sent along with it.[19] The choice of the word "escriptura" in this letter also suggests that the cartographic work that Ferrer sent to the Court was a two-dimensional drawing rather than a three-dimensional object like a globe or an armillary sphere.

Ferrer eventually appeared before the Catholic Monarchs. In August he was in Burgos, where he wrote a letter to Christopher Columbus at the Queen's request.[20] At some unspecified date, but probably while still at the Court, Ferrer composed a *parecer* i.e. a formal opinion on the demarcation of the Line of Tordesillas.[21] In it, he again mentioned what seems to be a world map in two hemispheres, perhaps the same map sent in 1495 or another version drawn later on.

Jaime Ferrer's main biographers have paid relatively little attention to the nature of his *forma mundi*. Both José María Millás Vallicrosa and Josep Llorenç simply called it "a world map".[22] Ricardo Cerezo assumed that Ferrer built his map on a "proyección trapeciforme modificada [modified trapezoidal projection]" without explaining how that would be compatible with the sketch in the 1545 edition of Ferrer's letter.[23] José María García Redondo has recently attempted to connect Ferrer's world map to

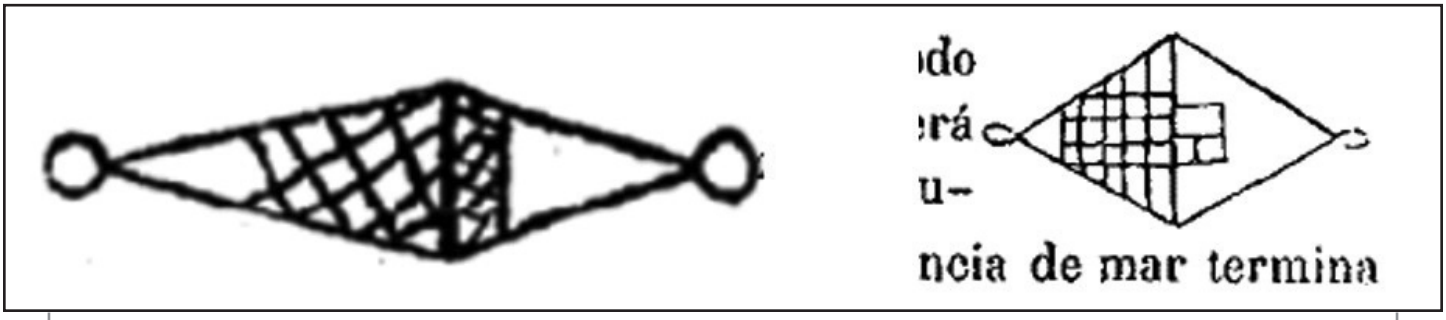


Figure 7. Left: Figure of Ferrer's 25 January 1495 letter, as published in 1545 (reproduced from Llorenç i Blat, "Les Sentències Catòliques," 74). Right: the same sketch deformed by Martín Fernández de Navarrete (Viajes, II, 98).

nautical cartography, imagining it as a sailing chart with some kind of "westward extension".[24] Adam Szászdi, on his side, interpreted it as a globe because of Ferrer's phrase "una forma mundi en figura spérica",[25] ignoring the word "escriptura" used in the royal letter of February 1495 to refer to the work sent by Ferrer.

A close reading of the texts leaves little doubt that Ferrer's *forma mundi* was a two-dimensional map, and his insistence in representing the world "in figura extensa" covering both hemispheres implies that the map showed the entire surface of the Earth, including the southern latitudes that were often omitted in Ptolemaic world maps. Furthermore, the fact that Ferrer stated that he was plotting the equator and the tropics on the map "by degrees" makes one think that it must have been built according to latitudes and longitudes, rather than to the principles of traditional nautical charting.

Ferrer could have adopted many different shapes for his world map, for example rectangular, trapezoidal, oval or as two separate circular hemispheres. The latter option seems the most likely due to three reasons:

1. Ferrer's emphasis on showing "the two hemispheres" rather than a generic term for the entire world.
2. Ferrer's use of the word "circle" to designate the equator, tropics and climes, which are indeed circular in polar azimuthal maps.
3. The familiarity of late medieval cosmographers with polar azimuthal projections.

A way to test the hypothesis that Ferrer's *forma mundi* was a set of polar azimuthal hemispheres is to incorporate the rest of the elements that he described in his letter and compare the result with the sketch published in the 1545 edition of his correspondence. The red lines he drew "from pole to pole" would be straight meridians in a polar azimuthal world map, indeed forming "acute angles" of 23 degrees at each pole, as Ferrer observes. The space between these two red meridians, which is the territory beyond the Cape Verde meridian that the King of Portugal had secured in Tordesillas, was filled in with yellow lines in Ferrer's map. The scheme in Figure 8 gathers all the information provided so far to reconstruct Ferrer's map. It turns out that, if the hemispheres are drawn adjacent to each other and with the orientation shown in the scheme, the central part of the image strongly resembles the 1545 diagram. This tends to corroborate the hypothesis that Ferrer's world map consisted of two PAE hemispheres and provides a reasonable interpretation of a sketch that had so far defied deciphering.

This would mean that polar azimuthal maps were produced in the Iberian Peninsula since at least 1495, fifteen years before Glarean. How widely they circulated is not known. Ferrer wrote that he was leaving his *forma mundi* at the Court together with this *parecer*. Even though there is no trace of either document in Spanish archives, there is no reason to doubt Ferrer's word as at least the *parecer* was preserved somewhere and eventually published in print.

Amerigo Vespucci, 1500

In a letter written on 18 July 1500 in Seville, Amerigo Vespucci promised to send two cartographic works to Lorenzo di Pierfrancesco de' Medici in Florence: one of them was a "carta in figura piana [chart in plane figure]" and the other an "apamondo in corpo sperico [world map in spherical body]" similar to one he had recently made for the Spanish king.[26] To this day, the interpretation of this text has been that Amerigo had built a terrestrial globe for the Catholic Monarchs and promised to send another globe, along with a flat map, to Florence.[27]

However, what Vespucci wrote was that he intended to send "dua figure [two figures]". The word *figura* might denote a three-dimensional image like a statue but its first and most obvious meaning is that of a drawing, a painting, a two-dimensional depiction. Furthermore, it is now well understood that in Renaissance Florence the

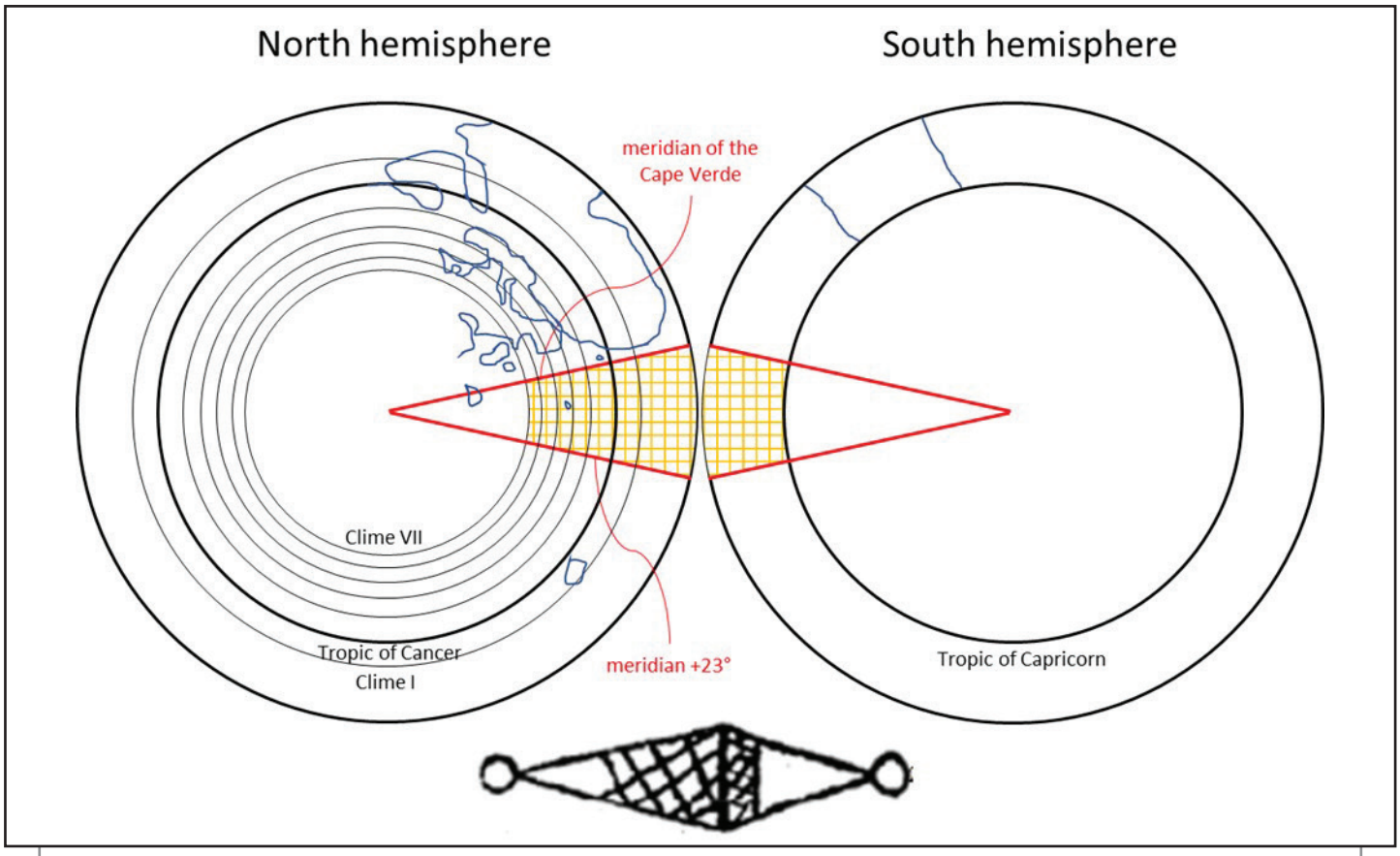


Figure 8. My reconstruction of Ferrer's map of 1495, assuming a polar azimuthal equidistant projection. The sketch published in 1545 is included for comparison. Coastlines are purely speculative and have been drawn for orientation only.

word "sphere" was not only applied to globes but also, and more frequently, to two-dimensional world maps, for instance in descriptions like "painted sphere in quadro" or "image of a large sphere in cloth".[28]

Vespucci's *apamondo in corpo sperico* may thus well have been a two-dimensional map rather than a globe. The name given to the map suggests that, contrary to the *carta in figura piana*, it depicted the Earth in a way that immediately evoked its spherical shape. This in turn opens the possibility that the *corpo sperico* was a set of polar azimuthal hemispheres. As we have seen, the Florentine may have learnt the rudiments of astronomy with his uncle Giorgio Antonio on a PAE planisphere. He may also have seen at the Court the PAE world map drawn by Jaime Ferrer a few years earlier. It is thus plausible that Vespucci was familiar with the PAE, even though there is no sufficient evidence to determine the exact form of the maps he made for King Ferdinand and for Lorenzo de' Medici.

Luís do Rego, ca. 1545

In a letter without date but certainly written between 1545 and 1548 in India, the Portuguese Luís do Rego informed his king about a cartographic work he had made.[29] This letter has so far only been published in full in Portuguese. The only fragment translated into English and French, with different interpretations, is precisely the paragraph in which Rego first mentions this work:

> I decided to make a *corpo redomdo em prayno* [literally "round body on a plane"] where our navigation is shown together with that of Fernan Magellan without missing one league […] and this *corpo praino* [literally "plane body"] made without a missing league, may be used for navigation purposes as any other chart (and) on it, you clearly see that the Moluccas are in your hemisphere.

Armando Cortesão, who was the first scholar to comment this letter, hesitated to interpret Rego's "corpo redondo" either as a planisphere or as a globe.[30] Marcel Destombes mentioned Rego's letter in his article about the Portuguese PAE hemisphere in Topkapı, translating "corpo redondo em prayno" as "sphere made in the form of a plan" and "corpo praino" as "plane sphere".[31] This

suggests that Destombes considered Rego's work to have been a two-dimensional map but he did not develop his opinion further. Francisco Contente Domingues, decades later, opted for interpreting it as a globe whereas Dejanirah Couto translated "corpo redondo em prayno" into French as "planisphère".[32]

In fact, the non-translated rest of the letter contains key information that helps understand what kind of cartographical work Rego made, or actually works in plural because the first realization is that he made two, not just one. In effect, he had drawn a first *corpo redomdo* according to a terrestrial module of 17½ leagues per degree but later, following indications from the local Portuguese governor, Rego started to make a second one—not yet finished when he wrote his letter—with a slightly smaller module of 16½ leagues.

Rego's first *corpo redomdo* must have spanned the entire world or at least a large part of it because it encompassed Portugal, Germany, Brazil, all of Africa, India, China and the Moluccas. For the second one, Rego describes it as covering the 360 degrees of the Earth's circumference, in a round shape. Rego called this second work by the same term *corpo redomdo* but also used the word "carta [chart]" to refer to it.

In his letter, Rego repeatedly compares his works to what he called old charts ("cartas velhas"), stressing that they were useful for navigation like any other chart. At one point, three pilots reportedly asked Rego to plot the usual Portuguese routes around Africa on his first *corpo redondo* and they found that Rego's rhumbs and latitudes matched well with those indicated in old charts. Rego observes that this surprised the pilots.

TABLE 1: BEARINGS REPORTED BY LUÍS DO REGO.

From	To	Bearing
Lisbon	The Moluccas	NE by N
The Moluccas	Lisbon	NNW
Lisbon	Goa	NE by N
Goa	Lisbon	NW by N

There is one technical set of data in the letter that helps determine the type of work that Rego designed: the bearings between Lisbon and the Moluccas and between Lisbon and Goa [**Table 1**]. Rego must have measured these bearings on his first *corpo redomdo*, as he also lists the regions crossed by the lines drawn between these pairs of locations.

Figure 9 and **Figure 10** below compare Rego's data with the azimuths that would be read on a sphere

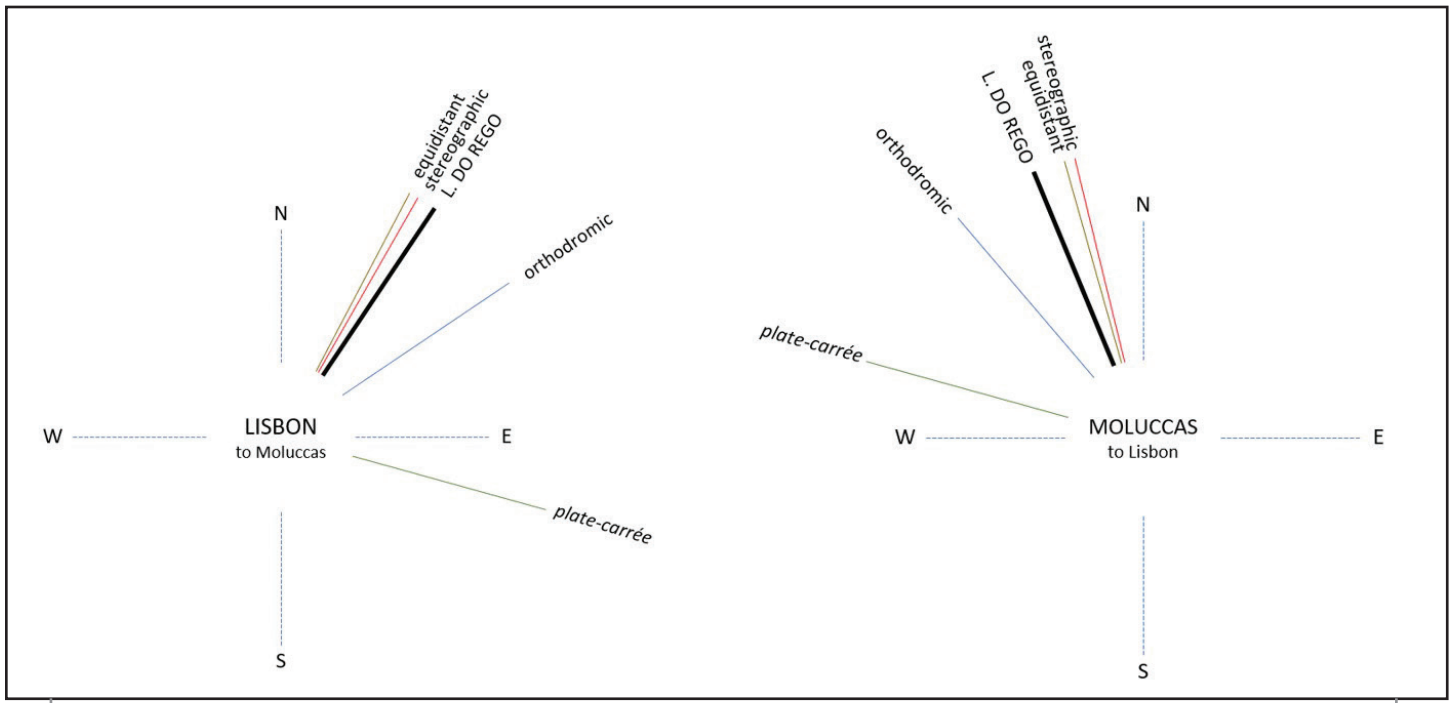


Figure 9. Bearings from Lisbon to Ternate island (Moluccas), and vice versa, as reported by Luis do Rego (thick black line) and as measured on four types of cartographic work: nautical planisphere (plate-carrée), sphere (orthodromic line), polar azimuthal equidistant projection and polar azimuthal stereographic projection.

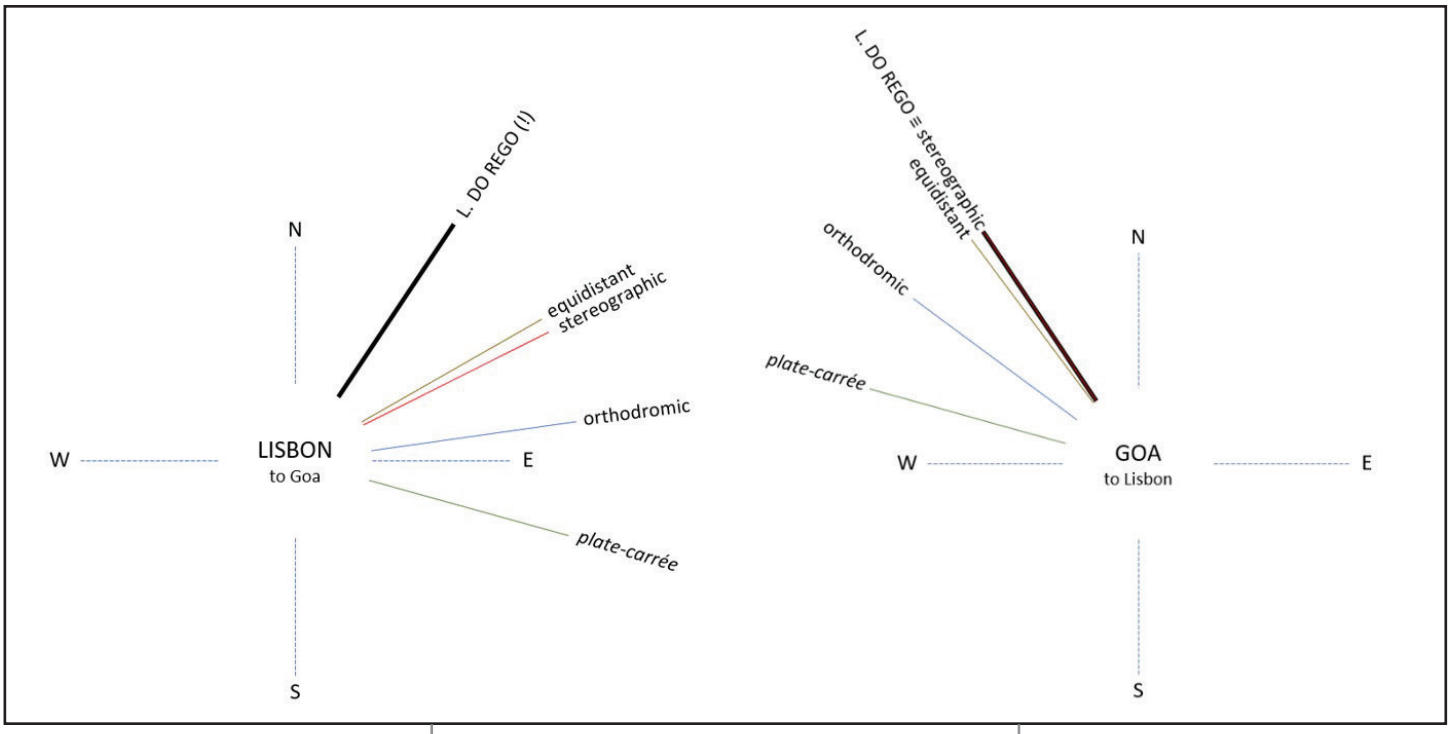


Figure 10. Idem from Lisbon to Goa, and vice versa.

(orthodromic i.e. trajectory along a great circle), on a nautical style planisphere (equated to a *plate carrée* projection), on a PAE hemisphere or planisphere and on a PAS hemisphere or planisphere.

It turns out that Rego's azimuth readings between Lisbon and the Moluccas are entirely incompatible with a *plate carrée* and, on the contrary, are quite close to the stereographic and equidistant projections, with discrepancies of only 4 and 6 degrees respectively. The orthodromic line is off by more than a *quarta* i.e. 11¼ degrees.

Doing the same calculations for the bearing from Goa to Lisbon results in an exact match with the stereographic projection, and the equidistant is very close to it (only 3 degrees' difference). On the other hand, the orthodromic is totally off in this case, by a full 20 degrees. Finally, looking at the data from Lisbon to Goa reveals that Rego's reported bearing is completely erroneous, probably because he mistakenly copied for Goa the same bearing as for the Moluccas.

It should be noted that the azimuths depicted in the figures are based on accurate coordinates for every location, but the results are numerically robust against variations of several degrees in these coordinates.

It can be concluded that Rego's *corpo redomdo* was neither a nautical planisphere nor a sphere. The *corpo*'s round shape and the fact that it depicted the 360 degrees of longitude leads one to think of a polar azimuthal map. In principle this could be either a set of two hemispheres or a full planisphere in a single circle. Based on Rego's account that he measured rhumbs on the *corpo* from Mozambique and the Comoros, in the southern hemisphere, to Cape Comorin in India, which lies north of the equator, a full planisphere looks more likely. The pilots' unfamiliarity with Rego's map is easy to understand if it was a polar azimuthal planisphere. The projection of such planisphere may have been stereographic or equidistant; both are compatible with Rego's reported bearings.

Sebastian Cabot, 1553

Sebastian Cabot sent Emperor Charles V from London a world map that may have consisted of two polar azimuthal hemispheres. Cabot had been appointed pilot major by this monarch in 1518 but in his old age Cabot deserted Spain for England. With the ascent of Queen Mary to the English throne and her subsequent alliance with her cousin Charles V, Cabot tried to ingratiate himself again with the Emperor.[33] In a letter written in November 1553, Cabot revealed an alleged Franco-English plot to invade Peru and announced he was sending the Emperor two "figures", one of which was a world map "divided by the equator":[34]

> The same Francisco de Urista also takes with him to show to your Majesty two figures which are: a

> mappe monde divided by the equator, from which your Majesty can see the causes of the variation of the needle with the pole, and the reasons why it moves back straight towards the north or south pole; the other figure shows how to take the longitude on whatever parallel a man happens to be. The results of both these the said Francisco de Urista will relate to your Majesty as I have here instructed him fully about them, and as he is skilled in the art of navigation, he is alright for that. In regard to the sea-chart which the said Francisco de Urista has, I have written to your Majesty before about it, that it is of importance to your service, and I also gave a relation in my own handwriting to Juan Esquefe, your ambassador, to send it to your Majesty. From what I am told, it is in the possession of Secretary Eraso. To it I refer you, and I assert that the chart will be of great service to your Majesty in reference to the division line agreed upon between the royal crown of Spain and Portugal for the reasons set forth in my relation.

In the letter Cabot mentions another map to which he refers as a "carta de marear [sea-chart]". The distinction between this sea-chart and the previously mentioned world map "divided by the equator" suggests that the latter had not been drawn as a nautical chart but by another method—possibly based on a grid of latitude and longitude.

Polar azimuthal projections are not the only way to draw a map of the world divided by the equator. An alternative used in the 16th century is the double-cordiform world map, first published by Oronce Finé in 1531 and emulated by Gerard Mercator in 1538, where each hemisphere is drawn as a heart instead of as a circle. Another example of division by the equator is Guillaume Le Testu's world map of 1566 where the two hemispheres are separately developed in an unusual projection.[35] However, I personally doubt that Cabot would have opted for any of these complicated shapes because the goal of his map was to let Charles V "see the causes of the variation of the needle". It was a didactic work, aimed at a non-specialist, and therefore its geometry should have been as easy to understand as possible. Circular hemispheres in PAE projection would be a more logical choice for that.

Furthermore, there exists a testimony by someone who saw a map that could be Cabot's and described it as "round", which suggests that it indeed consisted of two hemispheres. This eyewitness was Pedro Ruiz de Villegas, the Emperor's *cosmógrafo mayor*, who took part at the Junta of Badajoz-Elvas of 1524 and at the evaluation of Peter Apian's method for the measurement of longitude in 1554.[36] In an undated text included by Andrés García de Céspedes, *cosmógrafo mayor de Indias*, in one of his books,[37] Villegas listed a large number of maps, globes, tables of coordinates and itineraries that he claimed to have checked to prove that the Moluccas belonged to Spain rather than Portugal. The importance of Villegas's list is that almost all the cited cartographic works have disappeared and for many of them this is the only known mention of their existence.[38] Villegas used the words *poma* (apple) and *globillo* (small globe) to designate terrestrial globes, of which he cited three. For maps he employed the common terms *carta* and *padrón*, except in two specific cases:

- "un Mapa en globo, que fue del Rey de Napoles don Alonso"
- "otro Mapa en plano, en figura redonda, hecha en Londres"

The "Mapa en globo" of King Alfonso of Naples may have been anything. On the other hand, the map made in London cannot have been a globe, given that the designation "en plano" stresses its flatness; and it must certainly have had a round shape, as indicated by "figura redonda". References to mapmaking in England before 1550 are rather scarce,[39] and no English circular world map from that period has come down to us except for medieval mappae mundi, on which Villegas would have had much trouble to measure longitudes. This makes it tempting to identify the map made in London seen by Villegas with the one sent from that city by Sebastian Cabot in 1553. It would be natural for Villegas to be asked, as *cosmógrafo mayor*, to interpret and explain the maps received at the Court from their Venetian would-be spy in London.

CONCLUSIONS

Nautical style planispheres have traditionally been considered practically the only form of world map made at the Casa de la Contratación, and in general in Renaissance Iberia. On the contrary, a brief and often misinterpreted paragraph of Martín Fernandez de Enciso's *Suma de geographia* attests that Sevillian mapmakers were simultaneously conversant in another tradition, one which drew the world in the form of circular polar azimuthal hemispheres or planispheres graduated in latitude and longitude. This construction method had long been used by astronomers and was starting to be applied to terrestrial mapmaking across Europe. Enciso praised polar azimuthal maps because they reminded of the spherical form of the Earth and were favored by cosmographers; but mariners found them less intuitive than nautical style planispheres, which eventually became predominant in Seville.

While more than 300 nautical style planispheres, charts and atlases from Spain and Portugal are extant,[40] the only survivors from the non-nautical "polar azimuthal"

Iberian tradition are a Portuguese hemisphere in Istanbul and Juan Vespucci's printed world maps. Both had so far been considered outliers or anomalies.[41] Nevertheless, contemporary texts document the probable production of other polar azimuthal world maps in Iberia since at least 1495. Their authors often mastered both nautical charts and polar maps and used each type according to the map's aims.

These findings dovetail well with the observation made by recent scholarship that, later in the 16th century, nautical and Ptolemaic cartographic paradigms coexisted in Spanish institutions.[42] The start of that coexistence can now be traced back to the late 15th century.

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Luis A. Robles Macías is the winner of the **2023 DR. WALTER W. RISTOW PRIZE FOR ACADEMIC ACHIEVEMENT IN THE HISTORY OF CARTOGRAPHY**. Luis obtained his engineering degree at the University of Seville and a Master of Science at the Institut Français du Pétrole (France) and McGill University (Canada) in 2001. He has since pursued a professional career in clean energy that has taken him to France, California, and Belgium. In parallel Luis became interested in the mathematical aspects of old maps and in the circulation of geographical knowledge in the Renaissance, which resulted in several academic publications. He eventually embarked on a PhD in History at the Université Libre de Bruxelles (Belgium), devoted to the life and works of sixteenth-century mapmaker Juan Vespucci. He successfully defended his thesis in January 2024. Luis has been a scientific advisor to the MEDEA-Chart European research project on portolan charts and since 2020 is the editor of *Maps in History*, the magazine of the Brussels Map Circle.

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ENDNOTES

1 Martin Fernández de Enciso, *Suma de geographia q[ue] trata de todas las partidas & provincias del mundo: en especial delas indias, & trata largame[n]te del arte del marear: juntame[n]te con la espera en roma[n]ce: con el regimie[n]to del sol & del norte: nueuamente hecha* (Seville: Jacobo Cro[m]berger, 1519). Reprinted in 1530 and in 1546.

2 Enciso's first well-documented biography was authored by Martín Fernández de Navarrete, *Disertacion sobre la historia de la náutica, y de las ciencias matemáticas que han contribuido á sus progresos entre los Españoles* (Madrid: Imprenta de la viuda de Calero, 1846), 141–47, https://books.google.be/books?id=51u7eUMAmI4C. The first modern complete edition of the *Suma* was published by Mariano Cuesta Domingo, *Suma de geographia; el bachiller Martín Fernández de Enciso* (Madrid: Museo Naval, 1987). For a critical view of Enciso's work, see Antonio Sánchez Martínez, "Cartografía en lengua romance: Las cartas de marear en los regimientos y manuales españoles sobre el arte y la ciencia de navegar", *Boletín de la Real Sociedad Geográfica*, no. 146 (2010): 161–88.

3 Several scholars have blamed the disappearance of the map on Spanish censorpship: Cuesta Domingo, *Suma de geographia*, 42–43. Amando Melón y Ruiz de Gordejuela, *El primer manual español de Geografía* (Murcia: Universidad de Murcia, 1961), *https://digitum.um.es/digitum/bitstream/10201/21743/1/01%20El%20primer%20Manual%20espanol%20de%20Geografia.pdf*. Others have warned against the facile argument of secrecy: Julio F. Guillén, "Un mapamundi grabado de 1519, desaparecido", *Boletín de la Real Academia de la Historia* 167, no. II (September 1970): 9–13.

4 A recent case is José María García Redondo, *Cartografía e imperio: el Padrón Real y la representación del Nuevo Mundo*, Colección Pictura Mundi (Aranjuez: Ediciones Doce Calles, 2018), 144.

5 Fernández de Navarrete, *Disertacion sobre la historia de la náutica*, 143.

6 Marcel Destombes, "L'hémisphère austral en 1524: une carte de Pedro Reinel à Istanbul", in *Comptes Rendus du Congrès International de Geographie Amsterdam 1938*, vol. 2 (E.J. Brill, 1938), 175–84; Marcel Destombes, "The Chart of Magellan", *Imago Mundi* 12, no. 1 (1955): 65–88. This hemisphere was brought by the Portuguese delegation to the Junta of Badajoz-Elvas of 1524 and was the copy of a map made by Pedro Reinel in 1521 or shortly before, according to Joaquim Alves Gaspar and Šima Krtalić, *A Cartografia de Magalhães/The Cartography of Magellan* (Tradisom, 2023), 150–63.

7 Armando Cortesão and A. Teixeira da Mota, *Portugaliae monumenta cartographica*, vol. 1 (Lisboa: [Imprensa Nacional Casa da Moeda], 1960), 39–41.

8 Luis Miguel Benito Fraile, "Esteban Gómez, piloto de la Casa de la Contratación de las Indias", *Revista de Estudios Colombinos*, no. 13 (June 2017): 69–86, *https://dialnet.unirioja.es/descarga/articulo/6153636.pdf*.

9 For a recent overview of maps made by the Vespucci family, see Chet Van Duzer, "New Insights on the

Maps of the Vespuccis: Giorgio Antonio, Amerigo, and Giovanni", in *Shores of Vespucci: a historical research of Amerigo Vespucci's life and contexts*, ed. Angelo Cattaneo y Francisco Contente Domingues, Passagem, Vol. 12 (Berlin: Peter Lang, 2018), 73–85.

10 Johannes Keuning, "The history of geographical map projections until 1600", *Imago Mundi*, no. 12 (1955): 1–24; John P. Snyder, *Flattening the Earth: Two Thousand Years of Map Projections* (University of Chicago Press, 1993); John P. Snyder, "Map projections in the Renaissance", in *Cartography in the European Renaissance*, ed. David Woodward, vol. 3, The History of Cartography (University of Chicago Press, 2007), 2, *https://press.uchicago.edu/books/HOC/HOC_V3_Pt1/HOC_VOLUME3_Part1_chapter10.pdf*.

11 Biblioteca Apostolica Vaticana, codex Palatinus lat. 1368, ff.63v-44r. Richard Uhden, "An Equidistant and a Trapezoidal Projection of the Early Fifteenth Century", *Imago Mundi* 2, no. 1 (January 1937): 8-8.

12 In a 14th-century manuscript copy of Abu Rayhan al-Biruni's *al-Athar al-Baqqiya 'an al-Qorun al-Khaliyya*. Edinburgh University Library, MS Arab 161. English translation in C. Edward Sachau, trad., *The Chronology of Ancient Nations: An English Version of the Arabic Text of the Athâr-Ul-Bâkiya of Albîrûnî, Or "Vestiges of the Past" Collected and Reduced to Writing by the Author in A.H. 390–1, A.D. 1000* (London: Oriental Translation Fund of Great Britain & Ireland, 1879), *https://books.google.be/books?id=pFIEAAAAIAAJ*.

13 Elly Dekker, *Illustrating the Phaenomena: Celestial Cartography in Antiquity and the Middle Ages* (Oxford: Oxford University Press, 2013), chapter 3. Dekker prefers to speak of a PAE "method" of construction rather than "projection".

14 Biblioteca Nazionale di Napoli, Ms XIV.D 37. The attribution to Vespucci was proposed by Albinia C. De la Mare, "The Library of Francesco Sassetti (1421-90)", in *Cultural Aspects of the Italian Renaissance : Essays in Honour of Paul Oskar Kristeller*, ed. Cecil H. Clough (Manchester/New York: Manchester University Press/A.F. Zambelli, 1976), 160-201; M. D. Reeve, "Some Astronomical Manuscripts", *The Classical Quarterly* 30, no. 2 (December 1980): n. 21.

15 In a first letter, dated 15 August 1494 in Segovia, King Ferdinand asked his lieutenant general in Catalonia, Juan de Lanuza, to consult with expert "marineros, cosmografos y stroligos [sailors, cosmographers and astrologers]"; transcribed in Josep Llorenç i Blat, "Les Sentències catòliques del diví poeta Dant (1545) de Jaume Ferrer de Blanes. Edició crítica, estudi i contextualització biogràfica i literària" (Universitat de Girona, 2014), 87–88, *http://dugi-doc.udg.edu:8080/bitstream/handle/10256/9815/tjlb.pdf?sequence=5*. In a later letter, dated 24 September in Madrid, the King specifically ordered Lanuza to send Jaime Ferrer de Blanes to the Court; extant fragment transcribed in Llorenç i Blat, 88. Separate messages were sent elsewhere, including one to the University of Salamanca on 30 July 1494, preserved at Archivo General de Simancas, Libro 1º de cédulas, f.85r.

16 *Sentencias catholicas del divi poeta Dant florentí compilades per lo prudentissim mossen Iaume Ferrer de Blanes* (Barcelona: Rafael Ferrer, 1545). Most documents were transcribed in Martín Fernández de Navarrete, *Colección de los viages y descubrimientos que hicieron por mar los españoles desde fines del siglo XV: con varios documentos inéditos concernientes á la historia de la marina castellana y de los establecimientos españoles en Indias*, vol. 2 (Madrid: Imprenta Real, 1825), 97–105, *https://books.google.be/books?id=bfFFYNhCcBEC*. See the critical edition by Llorenç i Blat, "Les Sentències Catòliques". In particular the transcription of this letter is in pages 238–39.

17 Translation adapted from Samuel Edward Dawson, *The Lines of Demarcation of Pope Alexander VI and the Treaty of Tordesillas A.D. 1493 and 1494*, J. Hope&Sons, vol. V, section II, Transactions of the Royal Society of Canada, Second Series (Ottawa, 1899), 541, *https://archive.org/details/linesofdemarcati00daws*.

18 Dawson inserted here "(to Cape Verde)" but I think that Ferrrer's "aquí" meant any town or city in the kingdoms of Castile or Aragon where the Court were residing at that moment, where he could indeed travel without much expense, rather than the faraway islands of Cape Verde.

19 Letter dated 28 February 1495 in Madrid. I reproduce the transcription in Llorenç i Blat, "Les Sentències Catòliques", 240.

20 Transcription in Llorenç i Blat, 247–50.

21 Llorenç i Blat, 241–46.

22 José Mª Millás Vallicrosa, "El cosmógrafo Jaime Ferrer de Blanes", in *Estudios sobre historia de la ciencia española* (Barcelona: CSIC, 1949), 455–78; Llorenç i Blat, "Les Sentències Catòliques", 91.

23 Ricardo Cerezo Martínez, *La cartografía náutica española en los siglos XIV, XV y XVI* (Madrid: Consejo Superior de Investigaciones Científicas, 1994), 176.

24 García Redondo, *Cartografía e imperio*, 167–69.

25 Adám Szászdi Nagy, "La Legua de Tordesillas y sus antecedentes", in *Os descobrimentos portugueses no século XV* (II Simpósio de História Marítima, Lisboa: Academia de Marinha, 1994), 271-300.

26 Luciano Formisano, *Letters from a New World: Amerigo Vespucci's Discovery of America*, trad. David Jacobson (New York: Marsilio, 1992), 17.

27 Most recently in Van Duzer, "New Insights on the Maps of the Vespuccis: Giorgio Antonio, Amerigo, and Giovanni"; Alida C. Metcalf, *Mapping an Atlantic world, circa 1500* (Baltimore: Johns Hopkins University Press, 2020), 34. The only differing opinion I have seen is Gyula Pápay's identification of Amerigo's *corpo sperico* with the woodcut equatorial hemisphere that accompanies the Rostock 1505 edition of *Mundus novus* published under Amerigo's name. Gyula Pápay, "Amerigo Vespucci's Contribution to the Modernization of Cartographic Representation", *KN – Journal of Cartography and Geographic Information*, 2020.

28 "Those maps titled spera could be globes, circular maps, or even armillary spheres; unfortunately the terminology in the inventories was often vague. (...) Of the thirteen spheres in the Florentine inventories, nine were either listed as 'painted' or titled 'a quadro,' strongly indicating that the majority of the spheres were world maps or globes." Genevieve Carlton, *Worldly consumers: the demand for maps in Renaissance Italy* (Chicago: University of Chicago Press, 2015), 92–93.

29 Arquivo Nacional Torre do Tombo, Gavetas, 18-2-49. The first transcription of this letter was published by Sousa Viterbo, *Trabalhos náuticos dos Portuguezes nos séculos XVI e XVII* (Lisboa: Typographia da Academia Real das Sciencias, 1898), 255–58.

30 "um planisferio (?) o poma (?)" Armando Cortesão, *Cartografia e cartógrafos portugueses dos séculos XV e XVI* (Lisboa: Seara nova, 1935), II, 205–6.

31 Destombes, "The Chart of Magellan".

32 Respectively Luís de Albuquerque, ed., *Dicionário de História dos Descobrimentos Portugueses* (Caminho, 1994), II, 937 and Dejanirah Couto, "Autour du globe ? La carte Hazine n11825 de la bibliothèque du Palais de Topkapi, Istanbul", *CFC*, no. 216 (Juin de 2013): 119–33.

33 Henry Harrisse, "Sébastien Cabot, pilote-major de Charles-Quint (1512–1547)", *Revue Historique* 102, no. 1 (1909): 1–16; Joyce Lorimer, *English and Irish Settlement on the River Amazon, 1550–1646* (London: Hakluyt Society, 1989), 1–9.

34 A contemporary copy of the letter has been preserved at Archivo General de Simancas, EST,LEG,808,107. Transcription in *Colección de documentos inéditos para la historia de España* III (Madrid: Imprenta de la viuda de Calero, 1843), 512–514, which gives the date as 15 November 1554 but from related documents it is clear that Cabot must have written the letter the previous year; see José Toribio Medina Zavala, *El veneciano Sebastián Caboto al servicio de España* (Santiago de Chile: Universidad de Chile, 1908), 411–12, *https://archive.org/details/elvenecianosebas01medirich*; Lorimer, *English and Irish Settlement on the River Amazon, 1550–1646*, 127.
English translation adapted with minor modifications from Charles Deane, "The Voyages of the Cabots", in *Narrative and Critical History of America*, ed. Justin Winsor, vol. 3, 8 vols. (Boston and New York: Houghton, Mifflin, 1886), 1–58, *http://www.gutenberg.org/files/50987/50987-h/50987-h.htm*.

35 Bibliothèque nationale de France, GE AA-625 (RES).

36 Mariano Cuesta Domingo, *Alonso de Santa Cruz y su obra cosmográfica*, vol. 1, Tierra nueva e cielo nuevo 8 (CSIC, 1983), 101; Mariano Esteban Piñeiro, "Esquivel. Un ejemplo de la ciencia aplicada en la España del Siglo de Oro", in *La Universidad Complutense cisneriana: impulso filosofico, cientifico y literario, siglos XVI y XVII*, ed. Luis Jiménez Moreno (Madrid: Editorial Complutense, 1996), 261-84.

37 Andrés García de Céspedes, *Regimiento de Navegación* (Madrid: Juan de la Cuesta, 1606), part II, 145r–149r. *https://bvpb.mcu.es/es/consulta/registro.cmd?id=406740*.

38 Transcription, translation and commentary of Pedro Ruiz de Villegas's list in Luis A. Robles Macías, "Las fuentes de un cosmógrafo castellano del siglo XVI", *Historia y Mapas*, 6 June 2012. https://historiaymapas.wordpress.com/2012/06/06/las-fuentes-de-un-cosmografo-castellano-del-siglo-xvi/.

39 Sarah Tyacke, "Chartmaking in England and Its Context, 1500–1660", in *Cartography in the European Renaissance*, ed. David Woodward, vol. 3, The History of Cartography (University of Chicago Press, 2007), 1729, *https://press.uchicago.edu/books/HOC/HOC_V3_Pt2/HOC_VOLUME3_Part2_chapter58.pdf*.

40 The latest edition (March 2021) of Dick Pflederer's *Census of Portolan Charts & Atlases* lists 328 such items.

41 Ricardo Cerezo speculated that PAE maps might have been invented specifically for Magellan's expedition. *La cartografía náutica española*, 171.

42 García Redondo, *Cartografía e imperio*, 373.