SOME NOTES ON EARLY IDEAS OF THE FORM AND SIZE OF THE EARTH: *A paper in Basic English read at the International Geographical Congress in Warszawa, by*

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I have put this short paper into Basic English because it is a form of English of which it is easy to get some knowledge very quickly and by which correct ideas can be given to those whose knowledge of the language is not great; it is therefore the form of English which is the best for an International Conference. Some facts about Basic English are given with a word-list of which distribution was made at the Congress. Copies may be had from the Orthological Institute.

IT is my purpose to put before the Congress some examples of geographical writings in the British Museum, London, which give us great help in getting a true idea of the geographical thought of early times. The time covered is from A.D. 900–1500.

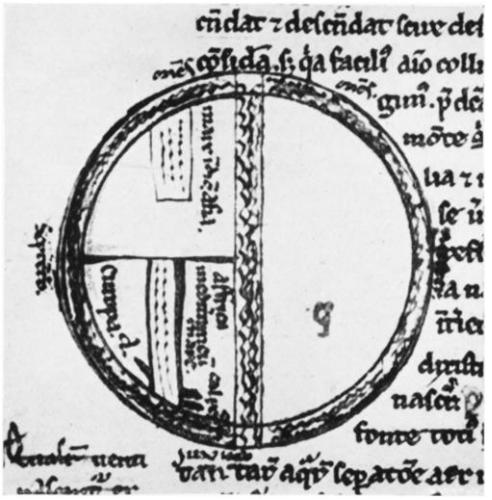
We are in error when we give overmuch attention to the writings of those foolish ones among early writers who said the Earth was flat. The reason why their views seem to us more important than they truly are is because they seem at first to be in agreement with the common maps of those days. On these maps were put only the lands and seas of which man had knowledge, around which a circle or square was made as an edge to the picture; but the best early writers put side by side with these maps a picture of the complete Earth ball, and only when we take a look at the two pictures together do we get a clear and true idea of the geographical teaching of those days.

Here for example is a copy of the Anglo-Saxon or Cotton Map of about A.D. 990, which has been very frequently printed [not given here]. The second picture (Plate 1), an outline of the Earth ball, is not frequently seen; but it was made to go with the first, which is simply the expansion of a part of it. In my 'Tudor Geography' I have printed two more such pictures which were put together in one geographical work, and which we have to keep together in our minds if we are to get true ideas. One gives the complete round Earth and the houses of the winds, the other gives only the part of which man had knowledge, that is to say the three great lands, Europe, Asia, and Africa, and the water round them, named Ocean. When a man of learning had the design to give an account of the theory of Earth knowledge, he put on his pages simply the outline picture of the Earth ball and not a map. Here are two examples, from works of about A.D. 1150 (Plates 2, 3).

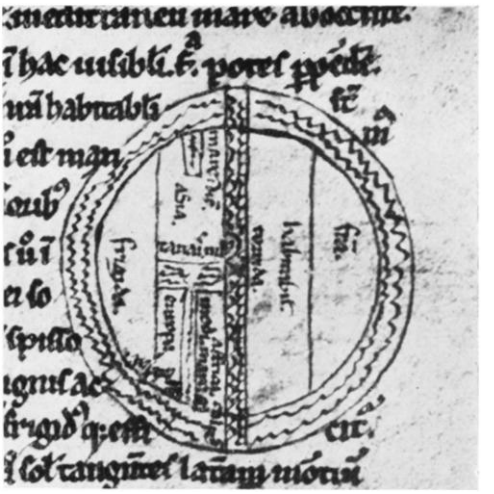
My fifth picture (Plate 4) is one which was designed for the purpose of making clear the facts about the way in which the shade of the Earth is seen on the moon (an eclipse), and the reason why it is seen from different parts of the Earth ball at different sun times. Cosmas Indicopleustes had no doubt seen such a picture, because he put one very like it in his noted book. He had, though, the purpose of making the idea of a round Earth seem false and foolish. I put the date of this picture at A.D. 1272. It is interesting, because of the use of the name Arym, a name taken from the Arab system of earth-knowledge.

Authority	*Data*	*Stadium to Mile*	*Value given to Unit in Feet*	*Degree*	*Great Circle of Earth*
Eratosthenes ↓ Macrobius ↓ Sacrobosco	Circumference = 252,000 stadia 1° = 700 stadia	10	Itinerary stadium of 500 feet or 400 palmipes (short cubits)	70 miles	25,000 miles
↑ Italian and Portuguese Sea hand-books				70 miles $17\frac{1}{2}$ sea leagues	6300 leagues
MSS. of A.D. 900–1600		8	625 feet (St. Isidore)	$87\frac{1}{2}$ miles	31,500 miles
Ptolemy	Circumference = 180,000 stadia 1° = 500 stadia	8	625 feet	$62\frac{1}{2}$ miles	22,500 miles
Ananias Širacki (v. Mzik)		7	143 feet or $571\frac{3}{7}$ palmipes	$71\frac{3}{7}$ miles	
'Philosophia Mundi' and 'Imago Mundi' (1100–1400)		$8\frac{3}{4}$	$571\frac{3}{7}$ feet	$57\frac{1}{7}$ miles	20,520 miles
Renaissance Cosmographers		$8\frac{1}{3}$	600 feet	60 miles	21,600 miles
Spanish Sea hand-books		10	500 feet	$16\frac{2}{3}$ leagues	6000 leagues
Alfragan ↓ Climata of Sacrobosco	Circumference = 20,400 miles 1° = $56\frac{2}{3}$ miles		Miles of 4000 cubits or 6000 feet	$67\frac{2}{5}$ miles	24,480 miles
'Imago Mundi' of d'Ailly			Miles of 4000 short cubits or 5000 feet	$56\frac{2}{3}$ miles	20,400 miles
C. Columbus				$14\frac{1}{6}$ sea leagues	5100 leagues
Ibn Khordadhbeh	1° = 25 parasangs		Parasangs of 12,000 cubits or 3 miles	75 miles	
Albategni	Circumference = 240,000 stadia 1° = 600 stadia	10	400 cubits or 600 feet	60 miles	21,600 miles

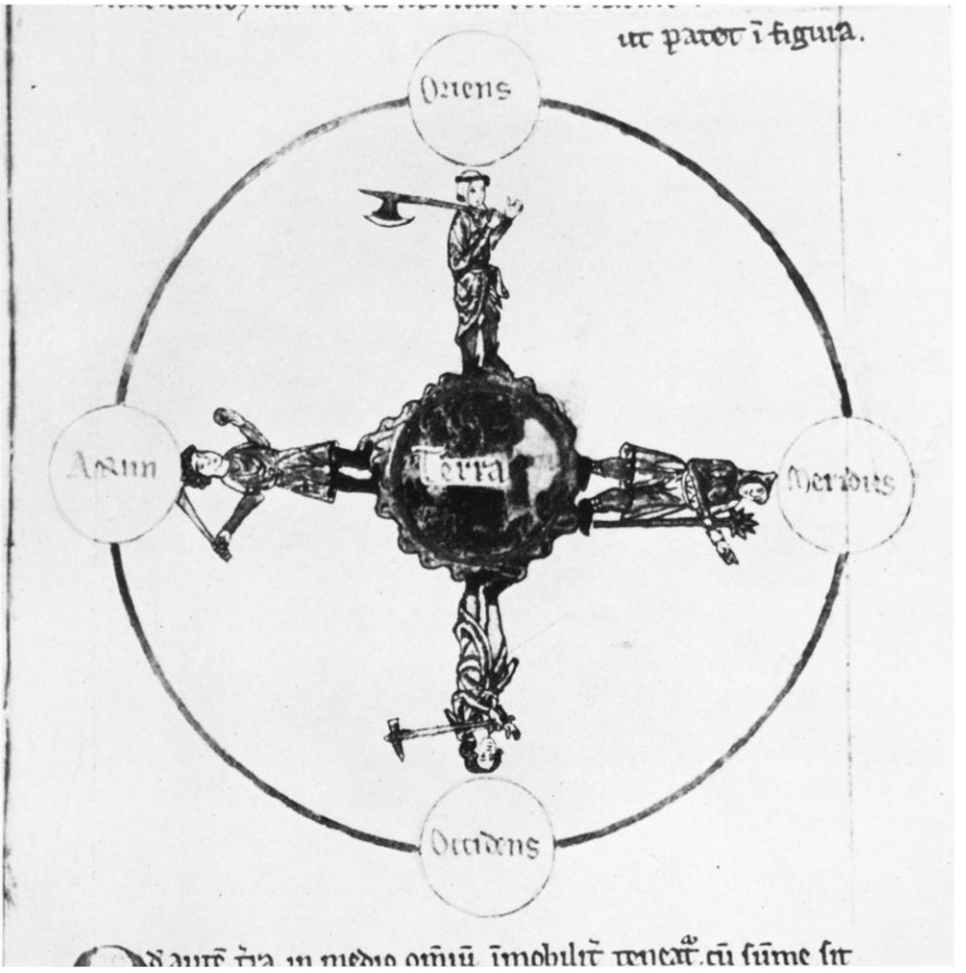
1. The Earth Ball (British Museum Cotton MSS. Tiberius BV.)



2. Outline picture of the Earth Ball (British Museum, Arundel MSS. 377)



3. Another picture of the Earth Ball (slightly enlarged) from the same MS.



4. Man on the Earth Ball (British Museum, Egerton MSS. 843)

In the Arab system the town or island of Arym was at the top (or cupola) of the Earth ball, but here it is put in the place of Septentrio or North.

My sixth picture [not given here] is taken from a group of maps and outlines which were made at St. Albans, England, about 1250–1260, by or for the noted writer of histories, Matthew Paris. What gives it interest is the fact that it is representative of the change from the Greek and Latin wind system to the new system that came into use with the north-pointing needle (*i.e.* compass). The old winds of Aristotle's day were eight in number, which with the later addition of the four points, north, south, east, and west, made twelve. The new winds, as given in this picture, were sixteen in number, and because English ship-men got their knowledge of the new way of sailing "by needle and stone" from their French brothers, the new names were at first, as you can see, in French. It is clear from the outline picture at which we are looking that the map-makers of St. Albans had knowledge that the Earth was round like an orange, but if we saw only the maps of Matthew Paris we would have no idea of this.

Here, on the other hand (Plate 5), is a picture by a writer who was not a man of learning. He has got mixed in his ideas, and he puts together a map of the three lands, Europe, Asia, and Africa, but puts above Asia the circles of air, fire, and water which in the system of Ptolemy had their true places about the Earth ball.

I come now to the ideas of the writers of these same times on the *size* of the Earth ball. The ideas which they had were taken from the writings of others in earlier times; they did not themselves make new measurements. Three values or measurements were commonly used, those of Eratosthenes, Ptolemy, and Alfragan. It is clear that some writers had knowledge of only one of these three, but others had knowledge of them all, and so had to make a decision as to which was right. But it was also possible to get an agreement between the three values by making an adjustment of the units used, and this was done by some writers.

I have put in table form a simple statement as to all the different values given to one degree of a great circle of the Earth which I have noted in early writings, and I have given some ideas of the adjustments possible because of the unlike values of the stadium which were in use.

It was on the authority of Macrobius, of whose writings in Latin every man of learning had knowledge, that the value or measure of Eratosthenes was made so widely current. Sacrobosco, an Englishman, and a student of Robert of Lincoln, was one of the men who, about A.D. 1250, made use of Macrobius, and as a result put the value of 700 stadia to a degree in his book. Most men made use of Sacrobosco's book, named 'De Sphaera,' and from it the early Portuguese shipmen, such as Vasco da Gama, got the value of a degree, which they put at $17\frac{1}{2}$ sea-leagues. But Sacrobosco was also a reader of Alfragan, and for the extent of the seven *climata* of the Earth ball he made use of Alfragan's measures, in units of miles. Was this an unconscious error, or was it his opinion that the two values of Eratosthenes and Alfragan were not unlike? In a number of old writings there is a statement that Alfragan's mile was of 4000 cubits, which is equal to 6000 feet (very nearly) if they are great cubits, but to only 5000 feet (very nearly) if they are small cubits. Most

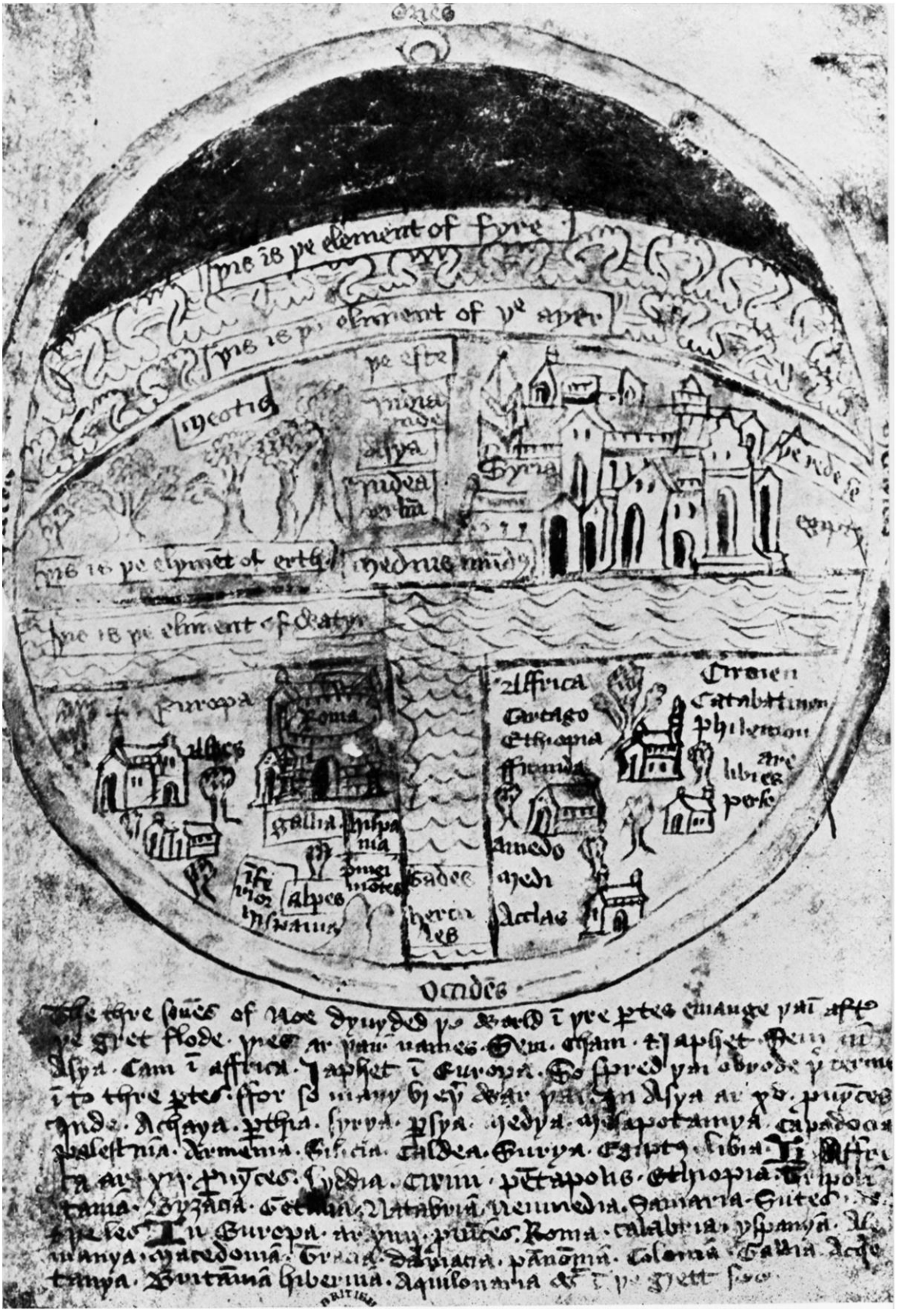
writers took them to be great cubits, and this gives to Alfragan's degree a value of 68 Roman miles, or very nearly the value of the Eratosthenes-Macrobius degree of 700 stadia, which is 70 miles. It should be noted that early Italian ship-men and Portulan chart-makers made use of the value of a degree of 70 miles (about A.D. 1300).

Ptolemy's measure of a degree was used in an important group of writings of which the 'Imago Mundi' of St. Honorius and the 'Philosophia Mundi' of William of Conches are representative. In all these writings we get the statement that the great circle of the Earth is "180,000 stadia, which is equal to 20,520 miles." This relation of the stadium to a mile is not the one in general use at a later day. These very early writers made use of the value $8\frac{3}{4}$ stadia (nearly) to the mile. We have no knowledge of such a stadium, but a stadium of 7 to the mile is often recorded. The relation $8\frac{3}{4}$ to 7 is as 5 to 4, and this is the relation of the palmipes or small cubit to the foot (see Table). We have here possibly an error caused by mixed units. But this error gives a measure of the great circle which seems to come near to that of Alfragan, namely 20,520 in place of 20,400 miles.

Those who took St. Isidore as their authority made use of the stadium of 8 to the mile. Five hundred stadia divided by 8 gave $62\frac{1}{2}$ miles for the degree of Ptolemy, a value which we get in very early unprinted and printed copies of Ptolemy's maps. A short time later the stadium of $8\frac{1}{3}$ to the mile (noted by Strabo) was very generally taken in the place of the stadium of 8 to the mile. Five hundred stadia divided by $8\frac{1}{3}$ gave a degree of 60 miles, which made the next division into minutes and seconds very simple.

Cardinal Pierre d'Ailly in his 'Imago Mundi,' a work which was based on a number of earlier writings such as those of St. Honorius and Sacrobosco, makes an attempt at an adjustment of the different measures of the degree. A like attempt is made in a work in Latin by an unnamed writer of which I made the discovery in the British Museum, and which has never been printed. This writer says: "Ptolemy's degree is 500 stadia of 400 cubits, which is 71 miles and three stadia taking 7 stadia to a mile. Alfragan's degree is 56 miles in miles of 4000 cubits. Albategni's degree is 600 stadia, or 75 miles. The degree of Theodosius (*i.e.* Macrobius) is 700 stadia, or 87 miles and 4 stadia. If we take a common measure for Ptolemy and Alfragan, *i.e.* 5 feet make a pace, 125 paces make a stadium, and 8 stadia make a mile, then Ptolemy's degree is 480 stadia or 60 miles. And the great circle of the earth is 21,000 miles." (The working is as follows: 1 stadium of 400 cubits=600 feet; 1 stadium of 125 paces=625 feet. As 625 : 600 so is 500 : 480). He goes on: "Alfragan's degree is 537 stadia and 75 paces, which is 67 miles and 1 stadium and 75 paces. And the great circle of the earth is 24,192 miles. That of Albategni is 27,000 miles. That of Theodosius is 31,500 miles. That of Aristotle is 24,000 miles."

I do not make the suggestion that these early writers were correct in their reasoning about the value of a degree. It is my desire to make clear what were their opinions and beliefs, and what arguments they used. Only if we have a true knowledge of their ways of thought can our reading of their works be free from error.



5. The Map and the Earth Ball mixed (*British Museum Add. MSS. 37,049*)

The minaret of the mosque of Muhammad ibn Malikshah

The minaret of the mosque of Sirhân