

History of Cartography As Taught at UCSB †

History of Cartography Conference, Chicago, June 1993

Waldo Tobler

As background to my course at the University of California, Santa Barbara, I should inform you that my training is in geographical cartography, and my specialties are the subjects of map projections, mathematical and computer cartography, and analytical geographical modeling. I teach courses in all of these areas. My language competence is limited to western tongues.

During a ten week quarter I present twenty-five lectures in a once-a-year course called "History of Cartography". While at the University of Michigan I had the good fortune to audit the comparable course offered by the late Professor George Kish, and I use some slides from his set in my course. Beyond Professor Kish's lectures I have done considerable reading in the field, augmenting the slides from many books, and collecting facsimiles. I was able to spend two sabbatical periods traveling to over a dozen major libraries in the United States and Europe examining original manuscript maps. Our own university library subscribes to the major journals in the field, and the somewhat larger library at UCLA is not far distant. With these resources, and the increasingly available - as pointed out by Ruggles (1989) - books, exhibition catalogues, journal publications, facsimiles, and even video tapes it is possible to assemble sufficient materials for a creditable undergraduate course. There is to date no suitable (in the North American sense) textbook, and I produce an annual syllabus with readings, bibliography, glossary, gazetteer, sample maps, time lines, etc., as do many others teaching in the field. The course enrolls circa 35 students, 80% of whom are geography majors. The enrollment is enhanced by the fact that the course satisfies both an undergraduate writing requirement - I require book reports and a term paper - and the undergraduate requirement in world cultures. Without these inducements, which have positive and negative benefits, the enrollment would undoubtedly be more modest. Previous cartographic courses are not a prerequisite.

The history of cartography can be approached from several, overlapping, points of view, as detailed in the first table. My own approach is largely chronological, and a sample sequence of lectures is given in the second table. This clearly fits into the "Normal" category in Ruggles' taxonomy. Nevertheless, given my background and interests, some topics are emphasized more than others. I will try to give you an inkling of these.

Cartometric analysis of old maps has become relatively easy with the development of computers. Digitization of "landmark" coordinates, and their identification in modern terms is the normal prerequisite here. This can be used to solve the long-standing problem of estimating the scale of an old map (see appendix). The accuracy of tables given in old manuscripts also present interesting challenges. As an example consider the maps which might have been made by the Kosterneuburg monks in the 1400's using information comparable to that in the Brussels Distance Table. This can be used as a nice problem for students, as illustrated in the appendix. For California students the table needs to be converted into contemporary units, since they neither read Latin nor have any idea where the towns mentioned in the manuscript might be. One is then also led to a nice treatment of the history of surveying, plane tableing, triangulation, and the development of error analysis and adjustment. Ptolemy's *Geographia*, recently available again in English translation but also in many facsimiles, is well suited to detailed analysis since he already gives latitudes and longitudes; all one needs to do (sic!) is to identify the places. I

consider it somewhat of a cartographic scandal that 500 years of scholarship has not yielded better results in this regard. Another task made simpler by the development of computers is the estimation of the distortion on Portolan charts and medieval maps. What can be done in this area is illustrated in the viewgraphs. Or, given a birds eye view, the modern photogrammetrist might wish to calculate the coordinates in space above the earth which best represent the hypothetical viewing point, and the extent to which the depiction satisfies the laws of perspective.

An issue raised here is the extent to which students of the history of cartography should have training in cartography, especially in the analytical aspects, and whether they should be computer literate. If the answer to the latter question is yes, with what kinds of cartographic software should they have a familiarity - word processing does not count as cartographic software nor computer literacy. Should student exercises involve map analysis using mathematics and calculation?

One of the themes that I like to bring out is the usefulness, and appropriateness, of old maps for the study of the development of concepts in physical and urban geography. The quickest way to do this is to look at the depiction of mountains, and to a lesser extent rivers, over time. The geomorphological understanding was simply not there. In this regard one can contrast the paintings of Leonardo da Vinci with contemporary map makers works. Having brought in an artist, one can also contrast a view of Amsterdam by Jan Micker with two of the same city by Matthias Meran and by Rembrandt from the year 1640. To illustrate the growth of cities a set of slides of models from the City of Vienna Museum fit nicely into historical maps of the same city. And castles on old maps can be compared with the same on modern postcards. This provides *prima facie* graphic evidence of the veracity of many facets of old maps for students. Of course these are only a few examples from many possibilities.

An attractive aspect of the history of cartography is that it can involve themes from art and mathematics, geography and myth, culture and science; there's a bit here for everyone.

Citations:

R. Ruggles, "The Teaching of the History of Cartography", *International Cartographic Association report*, Budapest, 1989, 28pp.

Pelletier, Ormeling, Scharfe, Kadmon, Kretschmer, Woodward, & Hamelers, 'Teaching the History of Cartography', *Seminar Proceedings*, Uppsala, 1991, S2pp.

W. Tobler, "Bidimensional Regression", *Geographical Analysis*, 26: 186-212, 1994.

† Pages 9-22 of F. Ormeling, & Y. Bouma, eds., *Seminar on the Teaching of the History of Cartography*, ICA Commission on the History of Cartography, Education and Training, University of Utrecht.

The mathematical appendix is not given here. It was badly mauled in the foregoing publication. It is available from the author under the title "The Scale Problem for Old Maps".

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HOW TO APPROACH THE TOPIC

History of Art - Geographic illustration; 'coffee table books; Lots of Slides, History of Science

Cumulative development (?) - Evolution of topographic, thematic maps;

History of Exploration - Voyages of discovery; Explorers maps

Nationalistically - History of map making in my country, region

The view from today - evaluation of accuracy, content

The view from yesterday - in the context of the times Maps as symbols, not to be taken literally

How to identify - The hobby market, collectors, investors (e.g. stamps). Watermarks, paper, printing techniques, styles of individuals

G. Ritzlin, ed., 1980, "World Directory of Dealers in Antiquarian Maps", Chicago, Chicago Map Society
Study dates back less than 200 years

Exotic (foreign) terms, impossible-to-pronounce names

Languages needed - Latin, ancient Greek, English, French, German, Italian, Spanish, Russian, Chinese, Japanese, Arabic, Portuguese, Babylonian Cuneiform, Egyptian hieroglyphics, etc.

Some Libraries to visit if you have a chance [GA 192/193]

J. Walter et al, eds., 1986, "World Directory of Map Collections", Munich, Saur [GA 192 W67]

D. Carrington, & R. Stephenson, eds., 1984, "Map Collections in the United States and Canada", 4th ed., Special libraries Assn.

Italy: Naples, Florence (Archivo di Stati, Laurenziana, Science) Rome (Vatican)

France: Biblioteque Nationale (Paris)

Austria: National Bibliotek (Vienna)

Germany: Munich; Nuremberg (Germanisches National Museum), Berlin

UK: British Library (London)

China: Xian (County Museum)

USA: Newberry (Chicago); LC (Washington); Huntington (Pasadena) AGS (Milwaukee); UCLA; Yale (Rare Book - Beinike); Clements (Ann Arbor), Brown (Minnesota); UCSB (Special Collections); UCLA

Exhibits and Facsimilies

Lectures

Geography 126 4 Units. Detail Outline. Subject to minor change. Spring 1990 MWF 11:00-11:50 3613 Ellison
Professor Tobler Office Hours: 5809 Ellison, 1:30-2:30 Tuesdays, or by appointment. Call 961-3831 or 961-3663.

(b) = book review (6 total) (e) = exercise (s) = slides

Apr 2 Mon	Introduction, Literature, study resources (e)
Apr 4 Wed	Pre-historic maps (s)
Apr 6 Fri	The Greek World (s, b)
Apr 9 Mon	Roman Surveyors (s)
Apr 11 Wed	Early Middle Ages (s)
Apr 13 Fri	Late Middle Ages (s, b)
Apr 16 Mon	Portolani (s)
Apr 18 Wed	Ptolemy (s, e)
Apr 20 Fri	Guest lecture (The flat world), (b)
Apr 23 Mon	Guest lecture
Apr 25 Wed	Surveying Instruments (s)
Apr 27 Fri	Surveying Adjustments (e, b)
Apr 30 Mon	Mercator (s)
May 2 Wed	Printing (s)
May 4 Fri	Globes and Atlases (s, b)
May 7 Mon	Explorers Maps (s)
May 9 Wed	The Orient (s)
May 11 Fri	Town plans (s,b) PAPER TOPIC DUE!
May 14 Mon	Special Collections visit
May 16 Wed	Special Collections visit
May 18 Fri	Geodesy (s)
May 21 Mon	Map Projections (s)
May 23 Wed	Topographic maps (s)
May 25 Fri	Thematic maps (s)
May 28 Mon	HOLIDAY - Memorial Day
May 30 Wed	Thematic maps (s)
Jun 1 Fri	North America (s)
Jun 4 Mon	20th Century (s)
Jun 6 Wed	Review. TERM PAPER DUE
Jun 11 Mon	Final Examination [25% of Grade] 3-6 PM

BOOKREVIEWS (30% of grade, 5% each) . Due as noted above. One to two pages, double spaced typed.

Deduction for tardiness. Complete bibliographic references; spelling and grammar count. First a description/paraphrase of contents; then your reaction. One or more books from G 80 to G 97 (inclusive) or one or more from GA 190 to GA 1681, and any from TA 501 A638 to TA 625 F52, or GA 101 153 (a whole volume), or by prior approval. For Journals a whole issue.

TERM PAPER (30% of grade) . Start early; Due 6 June

Double spaced typing, not exceeding ten text pages. Complete with bibliographic references, maps, scholarly standards. Topic is open, but should be approved by 11 May.

Book Reviews - DUE DATES! Term papers - DUE DATE Penalties for lateness

How to do a term paper:

Kate Turabian, 1976, "Students Guide for Writing College Papers", 3rd ed., U. Chicago.

Kate Turabian, 1973, "A Manual for Writers of Term Papers, Theses, and Dissertations, 4th ed, U. Chicago
W. Strunk & E. White, "The Elements of Style"

J. Gibaldi, & W. Achert, 1988, MLA Handbook for Writers of Research Papers, 3rd ed. , NY.

EXERCISES (15% of grade) A few short, simple, exercises will be assigned

Mental Map, Coordinates - Old Maps of Africa - Nordenskiöld, Trilateration Distances

Ptolemy's coordinates (see power point presentation)

Introductory Lecture

Handout: Course sheet; Office hours; due dates; exam time; off days; references, terminology

This is a chronologically oriented description of the development of cartography, enriched by detailed treatment of particularly important topics. I will begin with a brief review of the source materials for the field, and then move to prehistoric maps and the Greek conception of the world. Next in sequence are Roman, then medieval maps, and portolani. The Renaissance and the rediscovery of Ptolemy's works introduce the voyages of exploration and printing technology, leading to the period of great atlases and the panoramic renditions of Da Vinci, Duerer, and Meran. Problems of the discovery of the longitude and of geometrical and physical geodesy then faced the French Academy and the Royal Society. This period also saw the important anamorphoses of Mercator, Lambert, and Gauss, and the development of the theory of the adjustment of observations. Contemporary topographic maps date from this time. More recent extensions include nautical and aeronautical charts and observations from ballons, airplanes, and satellites. Maps from the Far East, Africa. Of increasing importance is the relation of geographical maps to science and to statistics, depicting abstract themata and non-visual phenomena.

Many of the readings are available in the bookstore as a syllabus "History of Cartography" (1991), 181 pages
Read Skelton through during first week, and again during last week.

Reading in Brown. Preface and Chapters I & II by 6 April; Chap III by 13 April;
IV by the 20th, V by the 27th. Chap VI by 4 May, VII and VIII by

First Exercise: Homework Assignment: 'Mental Map' DUE NEXT MEETING

On an 8.5 x 11 inch blank piece of paper draw a map - from memory; don't use/copy any existing map. Do it neatly if you can, but there is no correct answer to this exercise. Include your name (on back is Ok) for credit. The map should be of one of the areas listed. Turn it in at the beginning of the next class meeting.

Areas from which to choose: a) the campus b) the United States c) the world

HANDOUTS (to come, or in syllabus)

Parchment, Papyrus

On the coloring of maps c 1700

Of Exactitude in Science - map scale 1658

G. Mercator

Map Examples from Ptolemy, to 1500

1500 BC Rock Carving

Hereford map (page size) / Henry of Mainz 1110 AD

Verzerrungsgitter der Schweiz, idem, Kanton Zurich, idem Mitchel map

New Yorkers View of USA

Portolan Makers

History of Maps (Raisz) several sheets

History of Cartography (single sheet - Tobler)

Editions of Ptolemy (two sides)

Map Catalogue of Ptolemy sheets (2 sides) Waldseemueller 1513

Ptolemy Mss Map

References to the history of cartography Geography 126 W. Tobler

Imago Mundi [GA 101 153]; The Map Collector [GA 300 M36] Acta Cartographia [GA 201 A1A3];

Map Collectors Circle [Z 6003 M3] Regular Cartographic Journals USA, UK, Canada; Geographical Magazine;

Books:

- L. Bagrow, 1985, History of Cartography, 2nd Ed., Cambridge, MIT press
- C. Bricken, & R. Tooley, 1979, Landmarks of Mapmaking, New York, Crowell GA 201 374 1977
- T. Campbell, 1982, The Earliest Printed Maps, Univ. of California, Berkeley
- C. Elliot, 1987, The City in Maps: Urban Mapping to 1900, The British library, London
- C. Harley, & D. Woodward, eds. 1987, The History of Cartography, Vol I, Chicago, U. Press
- P. Harvey, 1980, The History of Topographic Maps, London, Thames ~ Hudson GA 125 H37
- D. Jolly, Antique maps, sea charts, city views, celestial charts, & battle plans: Price and Record Handbook, Vol. 7, Brookline, Mass, 1989
- I. Kretschmer, J. Doerflinger, & F. Wawrik, eds., 1986, Lexikon zur Geschichte der Kartographie, 2 vols, Vienna, Deuticke GA 105 K35
- A. Modolski, 1984, Railroad Maps of North America: The First 100 Years, Washington DC, Library of Congress.
- C. Moreland, & D. Bannister, 1986, Antique Maps: A Collectors Handbook, 2nd ed., London, Longman
- A. Nordenskiöld, 1973, Facsimile Atlas to the Early History of Cartography, New York, Dover (Reprint) G 1025 N6 1961 Map Room
- J. Reps, 1984, Views and Viewmakers of America, Columbia, U. Missouri
- W. Ristow, 1985, American Maps and Mapmakers, Detroit, Wayne State U. GA 405 R57 1985
- A. Robinson, 1982, Early Thematic Mapping in the History of Cartography, Chicago, University Press GA 201 R63
- S. Schwartz, & R. Eherenberg, 1980, The Mapping of America, New York, Abrams
- R. Shirley, 1984, The Mapping of the World: Early Printed World Maps, London, Landmark Books
- R. Skelton, 1965, The Vineland Map and the Tartar Relation, New Haven, Yale U.
- M. Thompson, 1981, Maps for America, Washington DC, GPO
- H. Wallis, & A. Robinson, eds, 1987, Cartographical Innovations, St. Albans, Campfield Press.
- J. Wilford, 1981, The Map Makers, New York, Knopf. GA 105.3 WA9

Other stuff in library

- Waldseemüller, 1507 & 1516 facsimiles, Fischer & von Wieser G 1025 w3 1968
- M. Destobmes, ed., Mappemondes AD 1200-1500, Amsterdam, N. Israel, 1964 GA 221 155 vl Waghenaer
 - G 1059 W3 S7 1584 (Thresoor der Zeevaerd) t
 - G 1059 W3 S7 1592a (Spiegel der Zeevaerd) t
- Sebastian Münster, Ptolemy, 1540 G 1005 G4 1540a
- O. Morrison, North America in Antique Maps 1440-1865, Athens (Ohio) Morrison, 1968. G 1105 M6 1968
- Ogilby's Road Maps of England and Wales, 1675 G 1808 0302 1971
- G. Schilder, Three world maps by Hoeye (1661), Blaeu (1607) & Visscher (1650) GA 300 S35 1981 Oversize
- E. L. Stevenson, Terrestrial and Celestial Globes, 1921. GA 260 S7 1971
- W. Ristow, American Maps and Mapmakers, Detroit, Wayne State University, 1985 (\$60) GA 405 R57 1985
- O. Muris & O. Saarmann, Der Globus im Wandel der Zeiten, Columbus, Berlin, 1961 GA 260 M8
- J. Reps, Views and Viewmakers of Urban America, U. Missouri, 1984
- Ptolemy Atlases: (G 1005.....)
 - Bologna 1477
 - Rome 1478
 - Florence 1482
 - Ulm 1482
 - Strassburg 1513
 - Basle 1540 (S. Münster)
 - Paris Manuscript <1500 (Geographie de Ptolemee)
 - Mercator Atlas
- Ortelius, Theatrum Orbis Terrarum, 1570 G 1006 T5 1570
- De Jode, Speculum Orbis Terrarum, 1578
- J. Wilford, The Mapmakers, New York, Knopf, 1981 GA 105.3 WA9

Sebastian Muenster, *Cosmography*, 1588 G 113 M75 1977
 S. Y. Ederton, *The Renaissance Rediscovery of Linear Perspective*, New York, Basic, (Chap VII)
 M. Thompson, *Maps for America*, GPO 1981, 265pp GA 405 T46
 J. McCrindle, *The Christian Topography of Cosmas, an Egyptian Monk*, Franklin reprint, New York, 1897, 385pp G 91 C67I3
 M. Vrij, *The World on Paper*, Amsterdam, Theatrum Orbis Terrarum Ltd, 1967 126 pp (exhibit catalogue - the library has a special, large, section devoted to exhibition catalogues)
 J. Speed, *Prospect of the World*, 1627
 Von Keere, *Germania Inferior*, 1851
 Nordenskiold, *Periplus* G 1025 N63 1897
 Nordenskiold, *Facsimile Atlas* G 1025 N6
 E. Klemp, ed., *America in Maps*, Holmes & Meier, New York, 1976 G 1100 A45 1976
 Berghaus, *Physikalischer Atlas*, vol. I & vol. II G 1019 B38 1852
 C. Moreland & D. Bannister, *Antique Maps: A Collectors Handbook*, London, Longmans, 1983 (\$51)
 D. Woodward, ed., 1975, *Five Centuries of Map Printing*, Chicago University Press

TEXT BOOKS No text is used in the course, but here would be some possibilities

L. Brown, 1949, *The Story of Maps*, Dover Reprint; (Librarian; covers Greek tradition)

B. Skelton, 1975, "Maps: A Historical Survey of their Study and Collecting" Illustrated edition, Chicago, U. Press (Collector, independant scholar)

Competing Books:

C. Crone, H. Wallis [Librarians] "Maps and their makers;

J. Wilford, [Journalist] "The Map Makers", 1981;

L. Bagrow, [Merchant] "History of Cartography";

Nordenskiold, [Explorer] "Periplus";

Robinson, Woodward [Geographers, Cartographers]

Some of these, and others, are on reserve

Some vocabulary for History of Cartography Geography 126 W. Tobler

Agrimensores Roman term for land measurers (mensores = surveyors)

Alidade A ruler used for the determination of direction with simple or telescopic sight

Apogee The point in the orbit of a satellite of the earth at the greatest distance from the center of the earth

Armillary sphere An old astronomical instrument composed of rings representing the positions of important circles of the celestial sphere

Astrolabe Instrument used to observe the positions of celestial bodies

Boustrophedonic As the ox ploughs. The Public Land Survey townships are laid out on a boustrophedonic grid. The stacks in the library are not, necessitating useless walking

Cartouche Ornate label on a map

Clepsydra Water clock

Codex Ancient hand written or printed book. Plural codices.

Colophon An inscription placed at the end of a book or manuscript usually with facts pertaining to its production; an identifying device used by a printer or publisher often with the appearance of a heraldic symbol. From Greek: kolophon=summit, finishing touch.

Folio Book of large size. Today generally oversize, but smaller than 'elephant'. A leaf.

A sheet of paper folded once. Size of a piece of paper cut two from a sheet. About 1/2 of 27.5 by 22.125 inch sheet of paper.

Fresco Painting on freshly spread moist lime plaster with pigments suspended in a water vehicle. Same root as fresh"

Geodesy The field which involves determination of the size and shape of the earth.

Gouache Opaque watercolor paint

Gnomon An object that by the position or length of its shadow indicates the hour of the day, as a sundial.

Groma Roman survey instrument to lay out lines at right angles

Holograph Hand written manuscript

Itinerarium pictum Roman term for map

Obverse The front side

Octavo The size of book which results from folding a sheet of paper into eights.

	One quarter the size of a folio book. Also written as 8vo.
Oikoumene	The known inhabited world
Paper	A sheet of plant fibers laid down on a fine screen from a water suspension to form a felted mat.
Papyrus	Writing material made from the Cyperus Papyrus plant of the Nile delta. Cut strips pressed together. Plural papyri
Parchment	Skin of sheep or goat prepared for writing. Originated in Pergamum, a city in Asia Minor.
Periplus	Sailing directions. Plural Periploi
Provenance	Ownership history or origin, helpful in authentication
Quarto	The size of a book which results from folding a sheet of paper into fourths. One half the size of a folio book. Also written as 4to.
Rhumb line	Line of constant direction on sphere. Loxodrome.
Sexagesimal	Number system based on 60 [Babylonian] Used for time and degrees, i.e. latitude & longitude
Sidereal year	Time taken by earth to complete one orbit. 365d, 6h, 9m, 9.54s
State	Refers to the Printing history of a work, based on the condition of the plate
Synodic	Period between successive conjunctions of celestial bodies
Vat. Gr. 191	Manuscript described by location, language, catalog (or accession) number; specifically, the Greek manuscript # 191 in the Vatican library (Ptolemaic manuscript atlas)
Vellum	Fine lamb, kid, or calf skin prepared for writing or book binding. Same root as veal. A strong cream colored slightly rough paper.

Some ancient place names

Berytus	Beirut
Cappadocia	Roman name for Central Turkey
Gades	Cadiz
Hibernia	Ireland
Maeotis	Sea of Azov
Massalia	Marseilles
Pillars of Hercules	Straits of Gibraltar
Pontus Euxinus	Black Sea
Tanais	Don River
Taprobana	Sri Lanka (Ceylon)
Trapezus	Crimea
Zipangu	Japan

Second lecture

Prehistoric, indigenous
Mental maps: local, regional, world
Topologic, metric
Symbolic, way-finding

Slides

1. Quick: Draw the World
2. The San Franciscan
3. New Yorkers view
4. Texans view
5. Californians view
6. UCSB view (Chase Langford)
7. Mediterranean area
8. Catal Huyuk map, c 6200 BC Hasan Dag 38 08N 34 12 E
9. Kesslerloch, perhaps 5000 BC near Schaffhausen
10. Silver vase drawing, circa 3000 BC
11. Val Camonica, Oglio River, Northern Italy
12. Val Camonica map, c 1500 BC
13. Idem
14. Cuneiform tablet
15. Writing cuneiform
16. Babylonian fragment, c 2300 BC; Brown p. 38
17. Tablet fragment from Nippur
18. Babylonian world 700-200(?) BC; Brown p. 38
19. Wall painting; surveyors in Tomb of Amenophis IV, Thebes
- 20, 21. Gold mining in Sudan; Turin papyrus, c 1500 BC
22. Rajum Hani Stone, early AD
- 23, 24. Aztec map on Agave paper, post 1500 AD
- 25, 26. Glyphs
27. Tepetlaoztoc, Valley of Mexico, c 1500 AD
28. Eskimo map for Byrd, 1925 AD Eastern Greenland
- 29-32. Melanesian stick charts

References:

- M. Blakemore, 1981, From Way-finding to Map Making: the Spatial Information Fields of Aboriginal Peoples, *Progress in Human Geography* 5, 1; 1-24.
W. Davenport, 1960, Marshall Islands Navigational Charts”, *Imago Mundi*, 15, 19-26
J. Mellaart, Catal Huyuk, McGraw-Hill, N.Y., 1967
C. Smith, & G. Lewis, “Cartography in Prehistoric Europe and the Mediterranean”, pp. 43-101 of J. Harley, & D. Woodward, 1987, *The History of Cartography*, Vol. 1, University of Chicago Press, Chicago.

Review of homework exercise

North orientation, arrow; Scale of distances, areas
Symbol table, area symbols (water, forest); place names; elevation
Lat/lon graticule, color; sources; indication of accuracy.
Topologic/Metric, Rubber sheet geometry; inside outside, distance, direction, area
I will discuss these “mental” maps along with prehistoric and indigenous maps:
Local, regional, national.
Configuration, scale, orientation, position. Topological correctness: Neighbors, insidedness, adjacency, intersection, betweenness, Metrical accuracy: distance, direction, area, rmse, strain tensor
Content: Topo, thematic, symbols, style, color

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Exercise

See if you can best a 15th century Monk!

There are three parts to this. Each part counts one third.

Use 8.5 x 11 inch paper; graph paper is best. Neatness counts.

Do not use any data not given here, except what you know about Europe.

- 1) Prepare a map of city locations from the data given in the Brussels distance list, and describe how you did it.
- 2) Evaluate the accuracy of the map at each place, relative to the given data, and describe how you did this.
- 3) Evaluate the accuracy of the overall map, relative to the given data, i.e., use internal evidence, and describe how you did this.

De Wyennma ad Wratislaviam 48 miliaria. item 24 ad Olomuntz. Item 32 ad Budam. Item 80 ad Venecias. Item 44 ad Saltzburgh. Item 36 ad Pataviam. Item 36 ad Pragam. Item 96 ad Basileam.

De Saltzburgh ad Monacum 19 miliaria. Item 14 ad Pataviam. Item 24 ad Nurembergam.

De Patavia ad Pragem 32 miliaria. Item 18 ad Ratisponam.

De Ingelstat ad Augustam 9. Item 11 ad Monacum. Item 7 ad Freising.

De Nurenberg 27 miliaria ad Erfordiam. Item 35 ad Liptz. Item 54 ad Maidburg.

Item 74 ad Lubeck. Item 74 ad Wratislaviam. Item 100 ad Cracoviam. Item 36 ad Pragam. Item 68 ad Wyennam. Item 32 ad Pataviam. Item 14 ad Ratisponam.

Item 34 ad Saltzburg. Item 24 ad Monacum. Item 45 ad Basileam. Item 18 ad

Ulmam. Item 24 ad Heidelberg. Item 32 ad Magunicam. Item 28 ad Francfordiam super Mogano.

Item 60 ad Coloniam. Item 100 ad Parisius. Item 70 ad Jeng in Sabaudia. Item 20 ad Augustamn.

Item 13 ad Ingelstat.

From: Brussels, Bibliotheque Royale, MS.Inv. 1022-1047, f. 205v, col 2. Written ca. 1440 A.D. by Paulus de Gherisheim. Slightly edited from Durand, 1952.

Hint. There are Latin dictionaries in the library, but the following are pretty obvious:

de = from, ad = to, miliaria = miles, item = also, or the same, super = above

Exercise: travel time distances. Due: _____

There are three parts to this. Each part counts one third. Use 8.5 x 11 inch paper for the map. Graph paper is best. Neatness counts. This is information similar to what might have been available in the middle ages. Of course these cities did not exist and such speeds were not possible.

Do not use any data not given here.

- 1) Prepare a map from the given data, and describe how you did it.
- 2) Evaluate the accuracy of the map at each place, relative to the given data.
- 3) Evaluate the accuracy of the overall map, relative to the given data; i.e., use internal evidence

From Saint Louis it's 5.4 hours to Chicago and 12.2 hours to Dallas.

San Francisco is 15 hours from Seattle, 6.8 from Santa Barbara, and 7.2 from Los Angeles, and it's 33 to Dallas, 39.2 to Chicago, 23.2 to Denver.

Miami is 24.2 hours from New York City, 12.6 hours from Atlanta, and 25.1 from Dallas.

From Atlanta to Washinton DC is 11.9 hours; to New Orleans is 8.8; to New York City is 16.2.

From New Orleans it's 9.7 hours to Dallas and 16.3 to Miami.

Washington DC is 4.6 hours from New York City, 24.3 from Dallas, 30.6 from Denver, and 19.7 from Miami.

Philadelphia is 1.9 hours, and Boston is 4.3 hours from New York.

Milwaukee is 20.6 hours from Boston, 6.2 hours from Minneapolis, and 1.9 hours from Chicago, 36.2 from Seattle.

Los Angeles is 26.6 hours from Dallas and 37 from Chicago.

Denver is 16.4 hours from Dallas, 18.6 hours from Chicago, and 18.4 from Los Angeles.

Dallas is 14.6 hours from Atlanta.

Boston is 18.7 hours from Chicago and from Chicago to New York City is 15 hours.

Chicago is 37.7 .hours from Seattle and 13.7 from Washington D.C.

These data are for driving times averaging 50 miles per hour, and do not include stops for meals, etc., but assume use of the quickest route.

Surveying Lecture: W. Tobler[†]

Land Surveying involves measuring:

Distance, Direction, Time; Gravity (geodesy)

Egypt, Babylon, Roman agrimensores

Using instruments:

Rulers (rods, chains, tapes, way wisers, electronic waves) for distances

Sextants, alidades, transits, theodelites for angles

Compasses, sextants, astronomic tables for directions

Clocks for time

Gravimeters, satellites for gravity

Plane table - circa 1600 - advantage: no math needed; airphoto

Telescope ~ 1609 advantage: improves aiming for angles

Theodelite

Vernier- finer readings from instruments

Measurements give the location of things:

- 1) Configuration (relative positions, using angles or distance)
- 2) Scale (size of configuration, using at least one distance)
- 3) Orientation (north, using stars & time)
- 4) Position (location on earth relative to Greenwich, Ecuator)

These INDEPENDANT properties can be illustrated by triangles.

The principle measurements in land surveying are:

- 1) Triangulation - angle measurements + baseline 1550-1950
Trigonometry - developed 1450- 1650
Logarithms 1588-1620; later slide rules, mechanical calculators
- 2) Trilateration - distances measured - before 1450 and after 1950
- 3) Traverse distance & direction, (open, closed); compass
- 4) Leveling
- 5) Geodetic surveying involves the shape of the earth in 3 dimensions

SURVEYING

Every measurement is, to some extent, wrong!

Need to estimate the magnitude of the errors.

Thus: redundant (extra, repeated) measurements + adjustments.

Multiple measurements + averaging; back-azimuths.

Two dimensionality → two measurements for each position.

The SURFACE of the earth is two-dimensional! Maps preserve two dimensionality.

Measurements are made on the surface of the earth.

Latitude and longitude are defined by two measurements.

A third measurement is redundant. Avoided prior to circa 1810.

Redundant measurements result in inconsistencies, and

these provide a method for estimating accuracy.

- 1) Make measurements
- 2) Estimate error
- 3) Adjust observations
- 4) Give precision with answer

Root mean square error, error ellipses, residual errors Bowditch method of adjustment, trilateration adjustment Method of Least squares

[†]See: W. Tobler, 1996, "A Graphical Introduction to Survey Adjustment", *Cartographica*, pages, 33-42

Geography 126 Special Collections visit
Items to be examined May 11 & 13 1987 (11 - 11:50 AM)

Manuscript Bible (in vault)
Cresques Portolan Atlas (Grossjean facsimile), 1375
Braun & Hogenberg, Civitatas Orbis Terrarum
Joan Blaeu Grand Atlas, 1665
Portugaliae Monumenta Cartographia (Cortesao & DaMota)
Nueremberg Chronicles, 1493
Adrian Wilson, 1978, The Making of the Nueremberg Chronicle, Adam
Cooks Voyages (maps and engravings)
Van Keulen Atlas
Kitchen Atlas, 1773
J. Leighly, California as an Island
J. Wheat & C. Brun, Maps and charts published in America before 1800

Maps (including John Maximus collection) by:

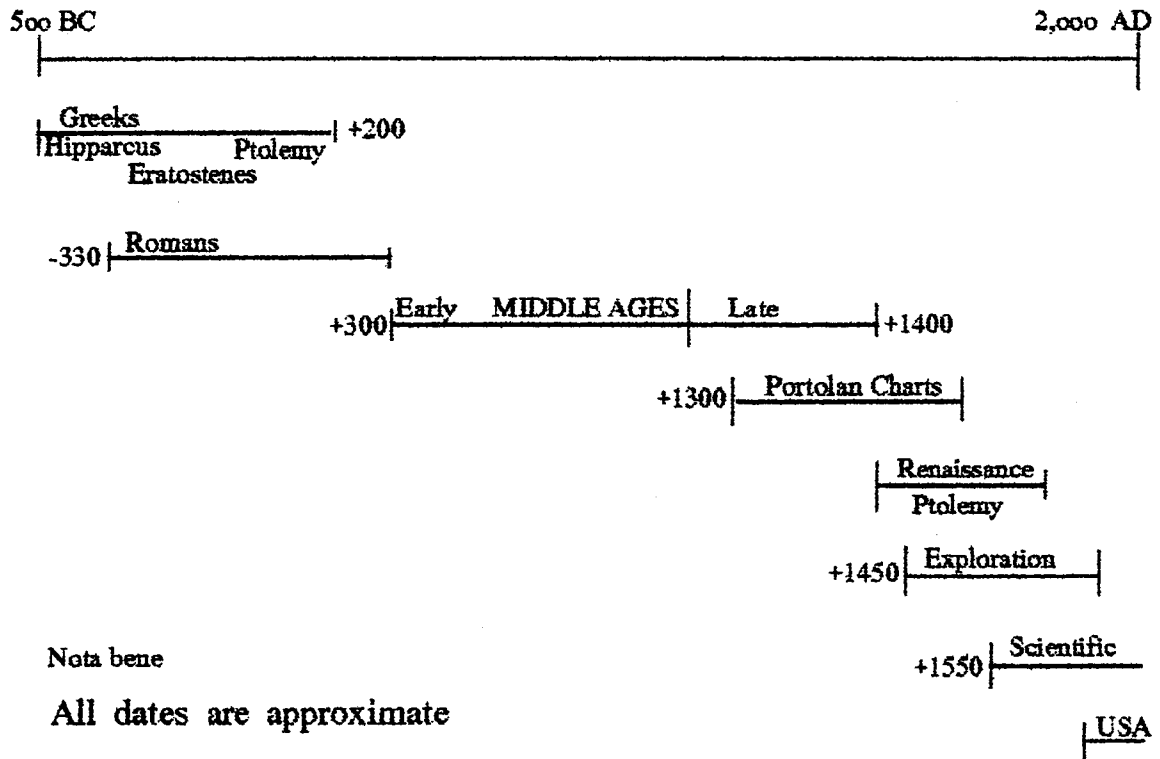
Blaeu	Hondius	Mercator	Anville	Arrowsmith
Cook	DelIsle	Ortelius	Sanson	Waldseemueller
Bonne	Coronelli	Tanners North America		

History of Cartography

Time Line



Expanded



Nota bene

All dates are approximate

Sources on Arabic maps

Thrower, Norman (1996), *Maps and Civilization*, University of Chicago Press, Chicago, 326 pp., paper, ISBN 0-226-79972-7 A general introduction to the history of cartography.

Harley, J., & Woodward, David, eds. (1992), *Cartography in the Traditional Islamic and South Asian Societies*, Volume 2, Book 1 of *The History of Cartography*, University of Chicago Press, Chicago, 579 pp.

Kamal, Youssouf, (1926-1951), *Monumenta cartographica Africae et Aegypti*, Five volumes in 16 parts, Cairo. (Also facsimile edition 1987 from Frankfurt), in French, UCLA has a copy.

Kish, George, ed., (1978), *A Source Book in Geography*, Harvard University Press, Cambridge, 453 pp. Translated commentaries on geography from 625 BC to 1870 AD. Muslim Geography in given on pp. 199-235.

Ahmad, Maqbul, (1960-) articles on “Kharita” (4:1077-1083), and I~Djughrafiya U (2:575-578), in *The Encyclopaedia of Islam*, new ed., Brill, Leiden

Miller, Konrad, (1926-1931), *Mappae ababicae: Arabische Welt- und Laenderkarten des 9.-13. Jahrhunderts.*, Six volumes, Stuttgart. In German, UCLA has a copy.

Nasr, Seyyed, (1976), *Islamic Science: An Illustrated Study*, World of Islam Festival Publishing, Kent, 273 pp.

WORKS OF PTOLEMY IN ARABIC

ALMAGEST — Kitab AL-MAJISTI (OR AL~MIJISTI)

- 1 An early Syriac version (lost)
- 2 A version by al-Hasan ibn Quraysh made at the request of al-Ma'mun (r. 198-218/813-33) (lost)
- 3 Another version made for al-Ma'mun by al-Hajjaj ibn Matar al-Häsib and Sarjun ibn Hillya al-Rumi, completed in 212/827-28 (extant)
- 4 A version made for the vizier Abu al-Saqr Isma'il ibn Bulbul by Ishaq ibn Hunayn, completed 266-77/879-90 (lost)
- 5 A revision of Ishaq ibn Hunayn's translation by Thäbit ibn Qurrah (d. 288/901) (lost)

HANDY TABLES — KITAB AL-QANUN FI'ILM AL-NUJUM

WA-HISABIHA WA-QISMAT AJZA'IHA WA-TA'DILIHA (THEON'S REVISED VERSION)

- 1 A version by 'Ayyub and Sim'an ibn Sayyar al-Kabuli made for Mubammad ibn Khälid ibn Yahya bin Barmak, ca. 200/815-16 (lost)

PLANETARY HYPOTHESES — Kitab AL-IQTISAS or KITAB AL-MANSHURAT

- 1 Anonymous version corrected by Thabit ibn Qurrah (extant)

TETRABIBLOS — KITAB AL~ARBA'AH

- 1 A version by Abu Yahy al-Bitriq, perhaps made during the reign of al-Mansur (136-58/754-75)
- 2 A version by Ibrähim al-Salt, apparently made ca. 200/815-16
- 3 A revision of Ibrähim al-Salt's version by Hunayn ibn Ishaq

GEOGRAPHY — KITAB JAGHRAFIYAH FI AL~MA'UR WA-SIFAT AL-ARD

- 1 A version made either by or for Abu Yusuf Ya'qub ibn Ishaq al-Kindi (d. ca. 260/874) (lost)
- 2 A version that was either translated or simply corrected by Ibn Khurradadbi, probably completed between 232/846-7 and 272/885-6 (lost)
- 3 A version by Thait ibn Qurrah (d. 288/901)