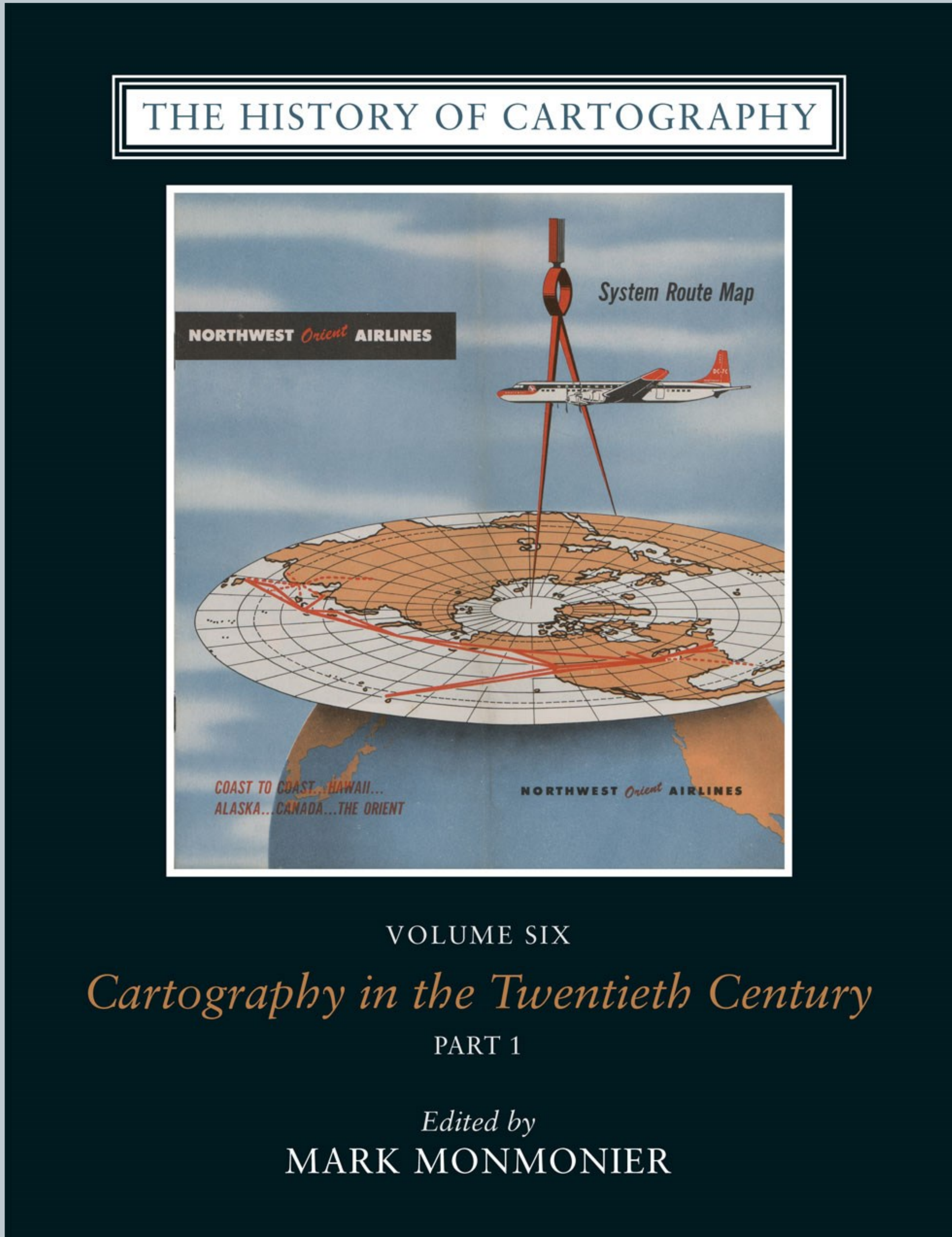


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# The History of Cartography, Volume 6

## *Cartography in the Twentieth Century*

Edited by Mark Monmonier

Maps tell us much more than merely how to get there from here. As one of the oldest forms of human communication, they express the many ways we attempt to understand the world. For more than thirty years, the *History of Cartography Project* has charted the course for scholarship on cartography. Filling nearly 7,000 pages and covering centuries of mapmaking, it's a spectacular celebration of the art and science of finding our way.

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The twentieth century is a pivotal period in map history. The transition from paper to digital led to previously unimaginable dynamic and interactive maps. Geographic information systems radically altered cartographic institutions and reduced the skill required to create maps. Satellite positioning and mobile communications revolutionized wayfinding. Volume 6 covers all of these changes, demonstrating the far-reaching effects of maps on science, technology, and society—and vice versa. Hundreds of expert contributors provide both original research. This definitive volume is a reference work of first resort for all who study and love maps.

***Mark Monmonier** is distinguished professor of geography at Syracuse University's Maxwell School of Citizenship and Public Affairs. He has been editor of* The American Cartographer *and president of the American Cartographic Association, and has served on advisory panels for the National Research Council and the U.S. Environmental Protection Agency.*

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***School Atlas.*** See Atlas: School Atlas

***Scientific Discovery and Cartography.*** Scientific discovery in this essay (in contrast to scientific discovery in physics, for example) refers to the finding of places on the earth or elsewhere in the universe; a place has not been discovered until it has been recorded in such a way that it can be visited or otherwise found again (Skelton 1958, 185). Discovery is typically done by deliberate exploration, although it may also include accidental discovery, which, as has been observed, often occurs when the discoverer is in the process of exploration, as, for example, Christopher Columbus's "discovery" of America in his attempt to reach Asia by a westward water route.

Methods of recording geographical discoveries include verbal description and lists of places, usually arranged alphabetically with coordinates, in gazetteers. Unlike these linear methods, maps, charts, and plans permit places to be seen in spatial relationship with other places in a global, regional, or local context (Monmonier and Schnell 1988, 1–7). Accordingly, maps (and similar devices) have been found to be efficient means of understanding relationships on the earth, parts of the earth, or other bodies (such as the moon [fig. 886] and the planets). As Marshall McLuhan observed, the map is one of a select group of communications media without which "the world of modern science and technology would hardly exist" (1964, 157–58). For this reason, maps are important not only in geography but also in archeology, astronomy, botany, geology, meteorology, and other spatially based sciences.

The surveying and mapping of the land and coasts has been undertaken since antiquity (Thrower 1999). By 1900, through the work of local, national, and colonial surveys, a large part of the land area of the earth was covered by general topographic maps. However, the resulting map series were uneven in quality and scale and varied in date. Areas not reached or mapped by the beginning of the twentieth century included the ice caps, centered on the North and South Poles, and the world's highest mountains, especially in Asia. The North Pole was claimed to have been reached by Frederick Cook (in 1908) and by Robert Peary and Matthew Henson (in 1909), and the South Pole was reached by Roald Amundsen and his party in 1911. Aerial reconnaissance followed, but in the case of the highest mountains on land, flight had preceded land ascent, which was not accomplished in the case of Mount Everest (the highest mountain on earth) until 1953 by Edmund Hillary and Tenzing Norgay. All of these events were a spur to mapmaking, but owing to world wars, which plagued the twentieth century, there was stagnation in some projects, while in others, such as maps for strategic purposes, there was greatly increased activity. Both of these trends are evident in the international multisheet map series at the scale of 1:1,000,000, the International Map of the World (IMW).

Although proposed in the last decade of the nineteenth century by Albrecht Penck, the earliest experimental sheets of the IMW were available only in the first decades of the twentieth century. Sovereign states were to be responsible for IMW sheets of their individual home countries and their colonies. A great setback came when the United States decided not to cooperate in this project. Even so, the private American Geographical Society of New York agreed to prepare all of the map sheets covering South and Central America, about one tenth of the total. Similarly, a large area of Asia called Greater India was mapped by the Survey of India, according to IMW specifications, which called for a modified polyconic projection. But by World War II the project was far from complete, and many of the sheets that had been made were out of date. Of the sheets in a projected complementary series of thematic maps, covering population, soils, geology, vegetation, and other distributions, very few were actually made.

Accordingly, another 1:1,000,000-scale project was proposed by the United States and its allies in World War II, the World Aeronautical Chart (WAC) series. A different projection (the Lambert conformal conic) and different symbolization were used for the WAC, and the coverage was quickly completed. At about the same time, the Soviet Union produced a global series of general map sheets, Karta Mira, at the scale of 1:2,500,000. In addition, individual countries produced thematic map sheets. Outstanding in this regard are the maps of the Land Utilization Survey of Britain at the scale of one inch to one mile. Through a diverse array of projects, most of earth's land areas were known and mapped by

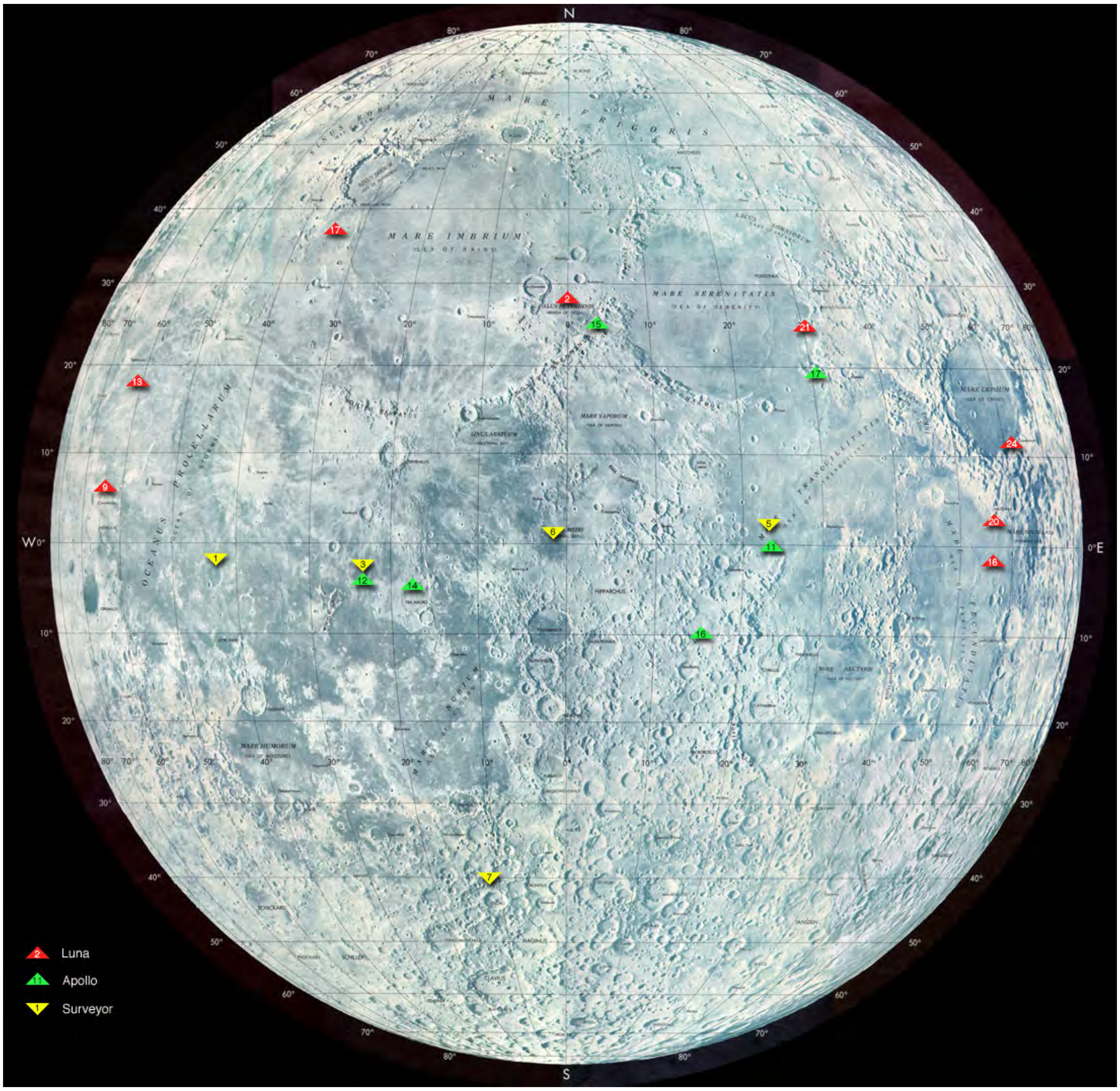


FIG. 886. LUNAR LANDING SITES MAP. Landing sites are shown for the Russian Luna missions (1959–76) and U.S. Apollo (1969–72) and Surveyor (1966–68) missions.

Image courtesy of NASA Goddard Space Flight Center.

the year 2000, at least topographically and at the reconnaissance level (Böhme 1989–93).

Complementary to this map coverage are images from aerial surveys, often made with the object of producing photographs for mapping purposes (Newhall 1969). The science of photogrammetry, quintessentially a twentieth-century development, involves the making of maps from photos, typically overlapping vertical air photos. Such maps can be made faster than by ground surveys and, ideally, with greater accuracy and richness of detail. The instrument that made this possible is the binocular stereoscope, in addition to further developments such as the multiplex stereoplotter. Aerial photos, sometimes as mosaic orthophotomaps, were occasionally printed on the backs of maps (and later as separate maps) for the same area, to show such qualities as the "texture" of the landscape. Even though these mosaics could be annotated, they did not take the place of more traditional maps for many users, because their rich detail required interpretation by specialists.

Continuous surveillance images from the U.S. Landsat program and ad hoc images from the French SPOT (Système Probatoire d'Observation de la Terre) (fig. 887) and other missions extended aerial mapping activity from the 1970s onward (Lillesand and Kiefer 2000, 373–469). Although valuable, such space images held limited possibilities for stereoscopy and therefore did not replace overlapping vertical aerial photos taken closer to

FIG. 887. LANDSAT THEMATIC MAPPER (TM) IMAGE, 1991. Created using visible and infrared portions of the spectrum showing the triangle of roads encircling the village of Shisar in southern Oman that suggested a possible location of the Lost City of Ubar. Size of the original: 19 × 18.4 cm. From *EOSAT Landsat Data Users Notes* 7, no. 3 (1992), cover.

the earth for primary topographic mapmaking. Because of advances made in the twentieth century, including global positioning systems (GPS) and other space programs, all parts of the land surface of the earth have now been imaged and mapped, and, in this sense, discovered scientifically. Individuals can make their own terrestrial discoveries with that most ubiquitous of cartographic products, the automobile road map, produced in millions of copies in many countries of the world and widely available in the twentieth century.

The oceans and the seas, except for the coastal areas, gave up their secrets grudgingly. During the Scientific Revolution of the seventeenth century and later, attempts were made to measure the depths of the ocean basins by plumb line, without conspicuous success. In 1768 Benjamin Franklin (in collaboration with his cousin Timothy Folger) had printed in a limited number the first chart showing the Gulf Stream, a warm-water surface current in the Atlantic, and later Alexander von Humboldt mapped the surface ocean currents, warm and cold, worldwide. During the first half of the nineteenth century the American Matthew Fontaine Maury greatly advanced maritime navigation with his wind and current charts. Later, after much discussion and dissension, the International Meridian Conference, held in Washington, D.C. in 1884, approved Greenwich, England, as the global prime meridian and the center of twenty-four hourly time zones around the earth, which was almost universally adopted in the twentieth century. This was a tribute to Britain's major role in global hydrographic surveys, a consequence of which was Charles Darwin's theory of organic evolution.

In spite of all these and other scientific advances, remarkably little was known about the deep oceans until the second half of the twentieth century (Ritchie 1992). Mapping of this so-called pelagic zone awaited the development of echo sounding, or sonar, largely in the post–World War II era. Sonar permits continuous traces, or profiles, to be made across the ocean floor while a ship is in progress. By this means the crust of the earth can be imaged remotely. From a great many such traces, accurate charts of the landforms of the ocean floor could be made for the first time. These charts revealed a variety of underwater forms, as great as those on dry land, including mountains higher than Everest, individual sea mounts (sometimes volcanoes), deep canyons, and broad plateaus and plains. Arguably the greatest discovery of earth science is the presence of midocean ridges rising from the floors of the major oceans. From these it is inferred that the present continents are spreading from a single (or perhaps two) original continents. Evidence of this is provided by several features, including the morphology of the coasts, as between Africa and Brazil, and the lithology of the (postulated) formerly connected coasts, including the same rock types with the same impurities. Major credit for the theory of continental displacement, or continental drift as it is now called, goes to the German earth scientist Alfred Wegener. Although the theory was not widely accepted until several decades after his death and is now regarded as perhaps the most important concept in modern geophysics, it challenged the previously held idea of a more static earth. Two geophysicists, the British Edward Crisp Bullard and the American W. Maurice Ewing, continued this line of research, and their work was popularized by the submarine cartography of Marie Tharp (fig. 888) as well as of Richard Edes Harrison. Harrison also produced maps of surface, intermediate, and abyssal currents, which further emphasized the true three-dimensional character of the ocean basins. Prior to the twentieth century, half of the surface of the moon was better known through telescopic observations than the earth's deep oceans, suggesting that most of the world has been discovered in the last half of the twentieth century (Thrower 1999, 172–73).

Air and space was the last frontier to be scientifically investigated and delineated, although, as in case of the land and oceans, there are precedents. Although the thin and fragile envelope of the atmosphere that surrounds the earth is ubiquitous, little was known about its nature until relatively modern times. In the seventeenth century, after an experiment observing decreasing barometric pressure with elevation, Evangelista Torricelli stated that "we live submerged at the bottom of a sea of air" (Shea 2003, 33). The climbing of higher mountains and the study of meteorology was further advanced in the nineteenth century, when the Prussian Alexander von Humboldt with the French medical doctor Aimé Bonpland made the highest recorded human ascent (in the Andes) to that time. Later, with acknowledgment to Edmond Halley, who had published an isogonic chart of the Atlantic Ocean over a century earlier (1701), Humboldt applied the same principle to meteorology (Robinson and Wallis 1967). This was a map of isotherms in part of the Northern Hemisphere, which is the bellwether of the use of isometric lines in meteorology; many others, including isohyets and isobars, were invented in the nineteenth and twentieth centuries. That the dynamic patterns of storms and fronts was first appreciated during the Crimean War (1853–56) (Monmonier 1999, 43–44) underscores how much progress has been made recently in this field.

One of the most widely used cartographic products in daily newspapers and on television screens is the weather map (Monmonier 1989, 112–24). Data are received from thousands of weather stations located around the world, often at airports. Transmissions are made, in abbreviated numerical form, by radio or telephone and plotted on

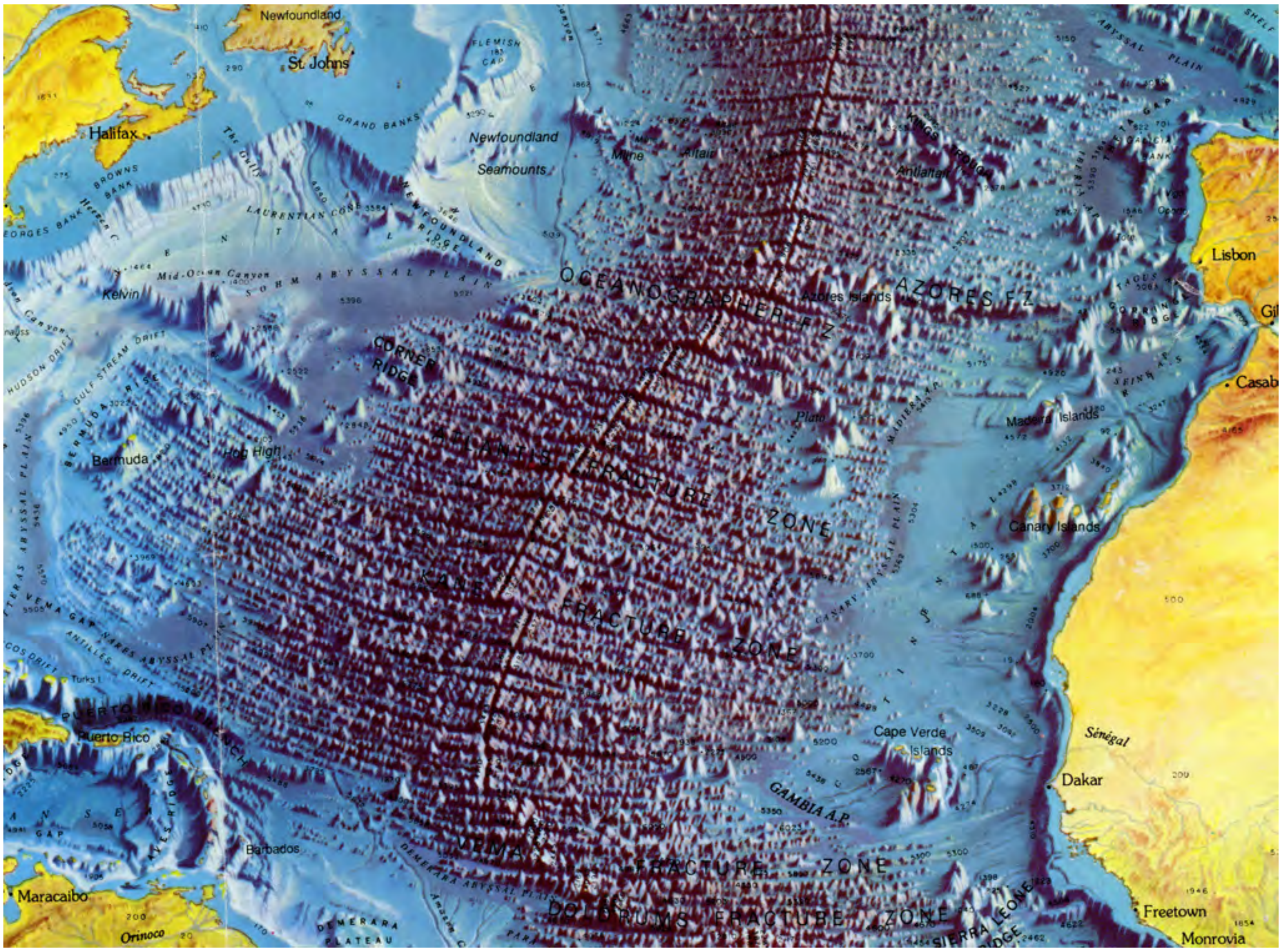


FIG. 888. DETAIL OF THE MID-ATLANTIC RIDGE FROM *WORLD OCEAN FLOOR*, BY BRUCE C. HEEZEN AND MARIE THARP, 1977. Size of the entire original: 108 × 189 cm; size of detail: ca. 23.6 × 31.5 cm. Image courtesy of the Arthur H. Robinson Map Library, University of Wisconsin–Madison.

maps. The symbolization on these maps includes arrows for wind directions, isobars for barometric pressure, and heavier lines for fronts, differentiated as warm, cold, or occluded. Areal symbols are used for precipitation with different symbols for rain and snow. Completed maps are produced photoelectrically and relayed to stations that have machines capable of reproducing the originals. A sequential series of weather maps can illustrate the passage of pressure cells and fronts, and the growth and dissipation of storms. The resulting images (as frequent as one every three hours) can be projected, sequentially, as time-lapse "movies." This is a step toward animated mapping, which has wide appeal and is of great utility in cartography (Thrower 1961; Campbell and Egbert 1990). Patterns can be appreciated in animation that are not immediately apparent by inspection of a series of static maps. Thousands of movies have been made in which maps appear, an increasing number with animation. For example, an animated map can use time, the fourth dimension, to show an explorer's progress across Africa. One of the most important discoveries in the realm of air and space is the jet stream, which separates air masses of different atmospheric pressure. High-flying aircraft are speeded up or slowed down, depending on the direction of travel, by this dynamic phenomenon that was not discovered until the jet aircraft age (second half of the twentieth century).

One of the oldest traditions in scientific cartography is the study and use of map projections fundamental to an understanding of global relationships and discoveries. The tradition has interested some of the greatest minds in the past, from Hipparchus to Carl Friedrich Gauss. Three noteworthy twentieth-century cartographers who have contributed significantly to this field are J. Paul Goode, R. Buckminster Fuller, and John Parr Snyder. In 1923 Goode grafted lower-latitude parts of the sinusoidal projection (0°–40° N and S) onto poleward parts of the Mollweide (40°–90° N and S) to make the homolosine projection, resulting in an equal-area (equivalent) projection with the best features of both of its pre-twentieth-century ancestors. To further improve the shapes of the outlines of the continents, Goode interrupted the projection. Fuller invented the Dymaxion projection (see fig. 739), originally a cuboctahedron and later popularized as a icosahedron whereby he covered the globe with twenty equilateral triangles with a constant scale along their edges; it can be folded into a solid, globelike figure. Later, the Space Oblique Mercator (SOM) projection was proposed by Alden P. Colvocoresses and developed by Snyder, who calculated the necessary formulas to take into account earth rotation in respect to the changing ground tracks of Landsat orbits (Snyder 1993, 188–89, 196–98, 269–70). By 1964, Howard T. Fisher had developed SYMAP, a computer program that produces statistical maps using alphanumeric printers.

Twentieth-century cartographers have been the great beneficiaries of a legacy going back millennia. They are, indeed, as Isaac Newton (who postulated that the earth is an oblate spheroid) said of himself in 1676, "standing on the shoulders of giants."

NORMAN J. W. THROWER

SEE ALSO: Antarctica; Biogeography and Cartography; Climate Map; Figure of the Earth; Epidemiological Map; Geography and Cartography; Geologic Map; Geophysics and Cartography; Meteorology and Cartography; Oceanography and Cartography; Tharp, Marie

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***Scribing.*** Scribing of photographic negatives, also termed negative scribing, first became popular for map production in the 1950s, although conceived over a century earlier. Scribing involves removal of selected portions of actinically opaque coating from a transparent base layer with a sharp point or blade. Also known as the *cliché-verre* (glass-plate) technique, scribing on glass in England and France dates from 1839, the year of photography's invention (Nadeau 1989–90, 1:69–70, 2:372, 381). "Scribing" originally meant outlining wood- and metalworking patterns with sharp tools. Such patterns were duplicated photographically from scribed glass negatives in England during the 1880s (Woodward 1966, 58).

By 1900 scribing on glass had been used experimentally for maps in various European countries. Glass is ideally transparent, hard, and dimensionally stable, but fragile. Nevertheless, glass scribing was adopted after 1900 for topographic map production in several countries, including the Netherlands East Indies in 1927 (figs. 889 and 890) and the Soviet Union in 1937 (Koeman 1975, 153–54). Some mapmaking organizations revised master negatives by opaquing portions needing revision and scribing corrections in their place (Sachs 1952, 11).

General adoption of scribing in cartography came with improved materials and tools. In 1913 negative scribing on a flexible supporting material was suggested, but suitable transparent materials were not available (British patent 1143, 15 January 1913). By midcentury a number of new materials had been tried. Town plans of Zurich, Switzerland, were scribed in 1933 on coated Zellon, a noncombustible safety glass made from cellulose acetate (Koeman 1975, 154). Alternatives were thermally set plastic, vinyl, and polyester film (polyethylene terephthalate, patented 1941). The latter's toughness, flexibility, and dimensional stability soon made it the favored base material, although vinyl continued in use for ongoing projects (Moore 1975, 1–2).

Developing a good scribe coating was more difficult: transparent (for tracing a guide image) yet actinically opaque (for exposing press plates), soft and nonabrasive

# R

***Race, Maps and the Social Construction of.*** The cartographic construction of race refers to the concept that maps and mapping actively create and reproduce race and racial knowledges. Although maps create many different knowledges, those that sustain or create race are particularly important as they undergird projects as diverse as colonialism, redlining, territorialization, and indigeneity.

A racialized territory is a space that a particular race is thought to occupy. The idea that humans can be assigned to a small number of distinct populations was popularized by Carl von Linné (Linnæus), whose mid-eighteenth century *Systema Naturæ* (10th ed.) was highly influential. Linné set out four natural racial categories: blue-eyed white Europeans, kinky-haired black Africans, greedy yellow Asians, and stubborn but free red Native Americans. (These descriptions are those of Linné.)

Twentieth-century race maps extend the nineteenth-century practice of mapping particular kinds of people constituted as populations. By the mid-nineteenth century multiple forms of mapping were in use, including isarithmic, choropleth, and dasymetric maps. Maps were made of race, ethnicity, education, crime, longevity, language, religion, birth and death rates, and age of first marriage. These subjects were of concern as "moral statistics," deemed useful in discerning how best the modern state should be governed.

In the twentieth century there have been at least three ways of thinking about race:

1. Race as essence. In the early twentieth century race was something that was *in* individuals. It was heavily influenced by Mendelian genetics and the "one-drop" rule. Race is in an individual.
2. Race as geographical populations. Individuals are part of a race that occupies or originated in specific territories. An individual is in a race.
3. Modern genetics, with a focus on genetic distinctiveness (however tiny) of groups of people.

Maps that derive from race-based data sources such as the census have had to confront changing official definitions, inclusions, and exclusions. Since the U.S. Census was first collected in 1790 the number and definition of races has changed frequently (table 44).

Racial identity had become more fractured in the United States over time with just four categories in the first census and fifteen by the end of the twentieth century. Conversely some categories have been dropped (Aleut, Eskimo, Hindu, Mulatto) in tune with changing understandings of race and ethnicity. These changes were often politically motivated. The superintendent of the 1870 and 1880 U.S. Census, economist and statistician Francis Amasa Walker, explicitly remodeled its data collection to track what he saw as worrying immigration trends (Hannah 2000). For the first time the Census Bureau published maps of its results and sent the resulting atlas to thousands of schools.

Use of racial categories that can be mapped lay uneasily not only with changing concepts of race, but also with the politics of race. During the early twentieth century geographers and geographical institutions such as the American Geographical Society (AGS) played a significant role in promoting racial and eugenicist views. These were often part of a narrative of the threat of immigration from populations considered unhealthy, degenerate, or otherwise undesirable. For instance, the Harvard geographer and climatologist Robert DeCourcy Ward, president of the Association of American Geographers in 1917, was a eugenicist and cofounder of Boston's Immigration Restriction League. Ward favored immigration laws with exclusions that were "biological" and not socioeconomic (Ward 1922), such as the United States' quota-based 1924 Johnson-Reed Immigration Act. The act limited each country's immigration to 2 percent of their U.S. population in the 1890 census

Table 44. Changing categories of race in the American census at selected dates. Adapted from Nobles 2000, tables 1 and 2, and the 2000 U.S. Census form

| Date of Census | Racial and ethnic categories used |
|---|---|
| 1790 | Free White Males, Free White Females; All Other Free Persons; Slaves |
| 1890 | White, Black, Mulatto, Quadroon, Octoroon, Chinese, Japanese, Indian |
| 1900 | White, Black, Chinese, Japanese, Indian |
| 1910 | White, Black, Mulatto, Chinese, Japanese, Indian, Other (+ write in) |
| 1930 | White, Negro, Mexican, Indian, Chinese, Japanese, Filipino, Hindu, Korean, Other races, spell out in full |
| 1960 | White, Negro, American-Indian, Japanese, Chinese, Filipino, Hawaiian, Part-Hawaiian, Aleut, Eskimo, etc. |
| 1980 | White, Negro or Black, Japanese, Chinese, Filipino, Korean, Vietnamese, Indian (Amer.), Asian, Indian, Hawaiian, Guamanian, Samoan, Eskimo, Aleut, Other (specify) |
| 2000[1] | Spanish/Hispanic/Latino (Mexican, Mexican Am., Chicano; Puerto Rican; Cuban; other); White; Black, African Am., or Negro; American Indian or Alaska Native; Asian Indian; Chinese; Filipino; Japanese; Korean; Vietnamese; Other Asian; Native Hawaiian; Guamanian or Chamorro; Samoan; Other Pacific Islander; Some other race |

[1]The 2000 census was the first to allow respondents to select more than one racial category and to combine this with the Spanish/Hispanic/Latino category.

(which restricted Southern and Eastern Europeans and Jews) and banned Asian immigration altogether. It remained in effect until 1965.

Racial mappings blended biological, territorial, and sociodemographic factors in varying degrees. Economist William Zebina Ripley's influential book *The Races of Europe* (1899) was one of the more biological approaches. Ripley, who taught at Columbia, Massachusetts Institute of Technology, and Harvard, proposed a tripartite racial classification for Europe, which was taken up by anthropogeographers such as H. J. Fleure, Thomas Griffith Taylor, and Ellsworth Huntington (Winlow 2006). The three European races—Teutonic, Alpine, and Mediterranean—could be distinguished anthropometrically by head shape, nigrescence and brunetness (measures of pigmentation), and stature (fig. 777). These measures of physical structure fit well with a suite of measures aimed at assessing intellectual development, including the intelligence quotient (IQ) test.

Another highly influential book that utilized anthropometric cartography was Madison Grant's racist *The Passing of the Great Race* (1916), which had gone through four editions by 1921. Grant, a lawyer and amateur anthropologist, was a longtime councilor of the AGS. He had published his theories in the organization's *Geographical Review*, and the AGS drafted the maps in his book. Drawing on Ripley, Grant adopted a similar tripartite division of Europe into Nordic (superior), Alpine, and Mediterranean races (fig. 778). Grant's racial divisions were both biological and territorial, and he drew on a number of geographical sources for his maps, including Ripley, Jean Brunhes, Jovan Cvijić, Eugene Van Cleef, B. C. Wallis, and Leon Dominian. Grant also used his race science to inform his political activities: he was vice president of the Immigration Restriction League, and he provided his maps and statistics to help pass a 1924 Virginia race law as well as the 1924 Immigration Act.

Pre–World War II understandings of race, and the maps that created and sustained racialized territories, varied with the racial theories of their authors. Two of these theories are race science (eugenics) and racial essence (the one-drop rule). Although some authors (Nobles 2000) see these as historically sequential (with race science predominating during the nineteenth and early twentieth centuries and the one-drop rule persisting until the postwar period), to a large degree they were contemporaneous.

Race science, or eugenics, explicitly draws on the mapping of populations understood as identifiable races distributed over discrete territories. For many, these racial divisions were biological, while for others populations could be geographically located by a mix of biology and sociocultural indicators such as religion and language. Geographers, anthropologists, paleontologists, and biologists contributed to race science, which by 1914 had become mainstream science, funded by major institutions, and taught at forty-four major universities (Black 2003, 75).

The center of eugenic research was the Eugenics Record Office (ERO), located in Cold Springs, New York, and headed by Charles Benedict Davenport and Harry Hamilton Laughlin. Together with Grant, Davenport developed a series of questions that were filled out by his fieldworkers in interviews with American families and, during World War I, with new recruits. Wartime data, and specifically the U.S. Army Alpha test of written comprehension, which was used to assess intelligence, provided large-scale data on Americans. Princeton psychologist Carl C. Brigham later modified the

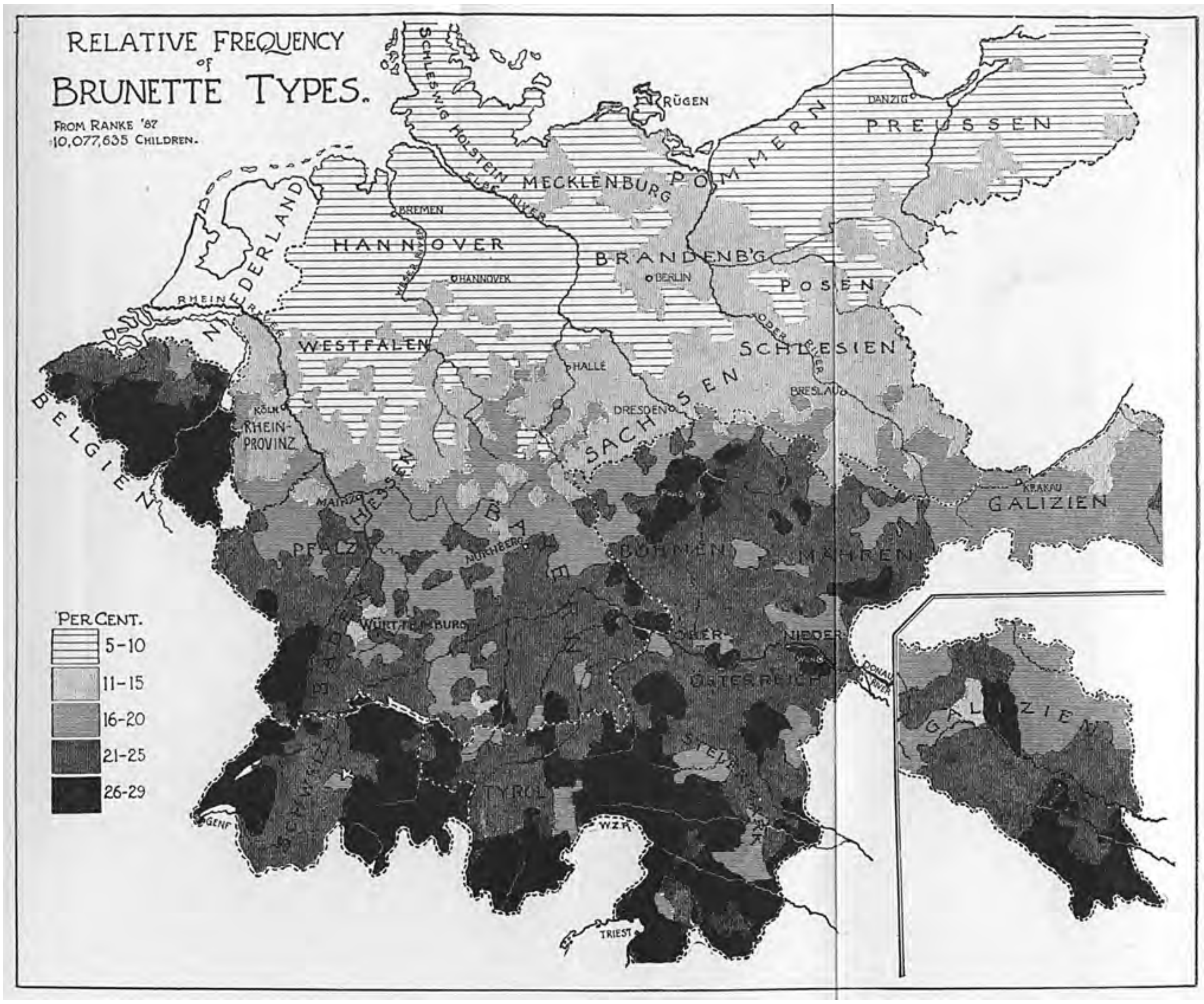


FIG. 777. WILLIAM ZEBINA RIPLEY, *RELATIVE FREQUENCY OF BRUNETTE TYPES* FOR GERMANY, 1899. Size of the original: 16.6 × 20.2 cm. From Ripley 1899, facing 222.

Army Alpha test into a college entrance exam known as the Scholastic Aptitude Test (SAT). There were some who spoke out against this practice. Walter Lippmann, journalist and founder of the *New Republic*, called these measures "quackery" (Black 2003, 84), and anthropologist Franz Boas argued that variation was due to cultural and historical circumstance. Nevertheless, eugenic data collection efforts, including maps, continued to influence policy by, for example, helping to pass forced sterilization laws in dozens of states. Davenport's research also helped inform German race theories even after World War I (Spiro 2009).

Both Lippmann and Davenport were involved in another huge effort to determine human territorial distributions during and after World War I. Known as the Inquiry, it had been founded in 1917 by President Woodrow Wilson and his right-hand man Colonel Edward Mandell House (Gelfand 1963). Headquartered in the AGS offices in New York City at the suggestion of its director, Isaiah Bowman, the Inquiry was a semisecret academic think tank that was effectively charged with determining America's foreign policy after the war. To do this it hired dozens of geographers, historians, geologists, and economists. During 1917–18 it produced a document known as the Black Book, which mapped the most desirable (to U.S. interests) territory of every European country. Lippmann and Bowman helped House draft Wilson's Fourteen Points, which later were cited by the Germans in their armistice agreement (Smith 2003). The Inquiry's mapping efforts run into the hundreds and included physical, cultural, linguistic, religious, and politically contested areas. They also

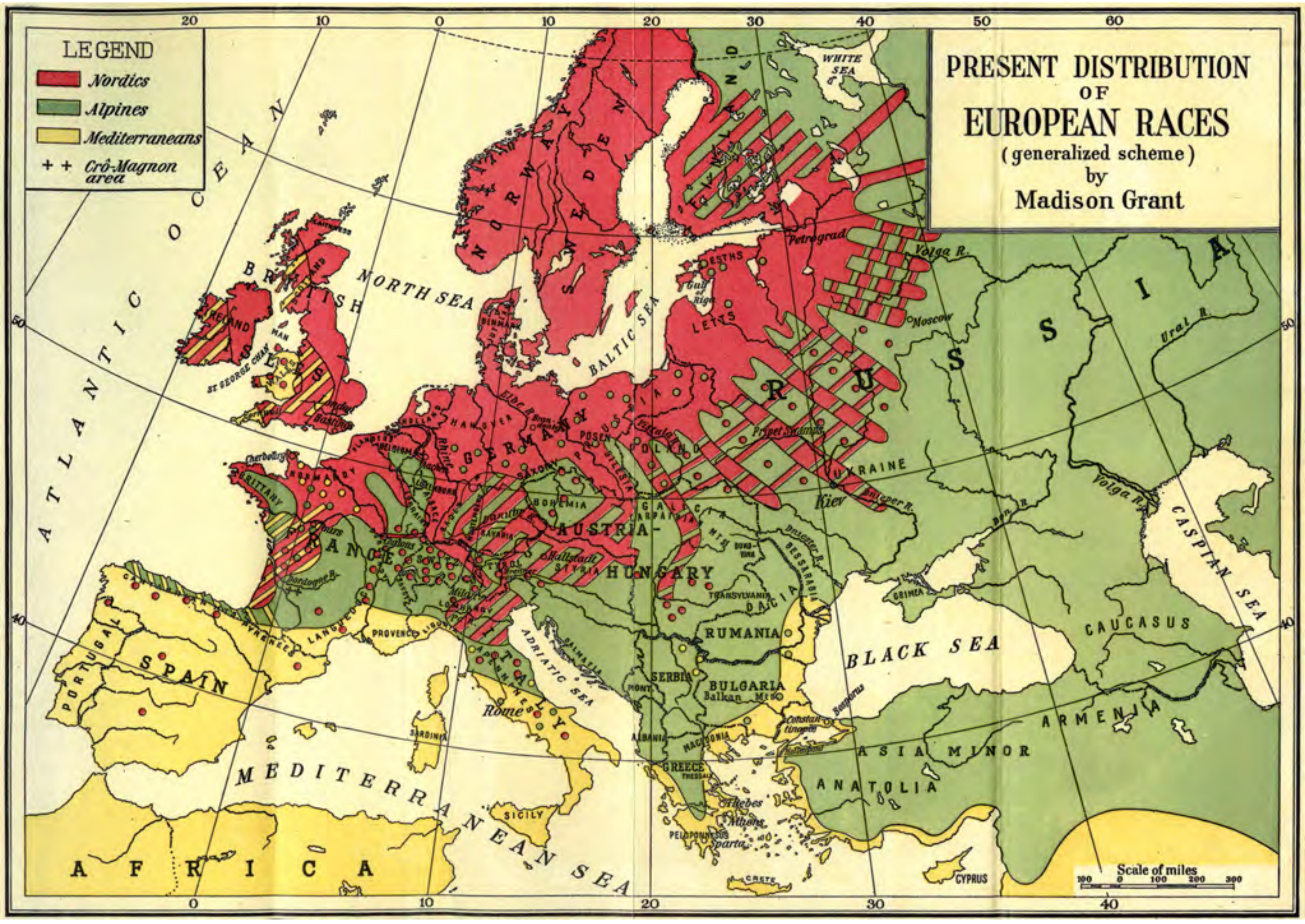


FIG. 778. MADISON GRANT'S *PRESENT DISTRIBUTION OF EUROPEAN RACES*, 1916.

Size of the original: 20.3 × 28.9 cm. From Grant 1916.

collected published maps, which were added to the AGS collection; many of these were later taken to Paris for the Peace Conference.

Instead of adopting a biological model of race, the Inquiry chose a more eclectic approach that nevertheless identified clear "zones of civilization," as the Serbian geographer Jovan Cvijić had put it. Cvijić donated his complex manuscript map of these zones to the AGS library (fig. 779). Geographer Leon Dominian, a member of both the AGS and the Inquiry, attempted to show the relation between language and nationality with a view to settling political boundaries in his book *The Frontiers of Language and Nationality in Europe* (1917).

The president took with him to the Peace Conference a core group of Inquiry men, who were salted through the critical territorial commissions that drew up the boundaries of postwar Europe. The chief cartographer was Mark Sylvester William Jefferson, Bowman's old professor. Jefferson's diary provides an exhilarating account of the day-to-day challenges of providing maps to the conference. Many of these reveal the struggle behind the scenes to determine the new political frontiers, which were highly contested by all parties. The Inquiry's position, and that of the United States, frequently prevailed because of its reputation for "scientific boundaries."

Race was clearly a factor in the proliferation of redlining in the 1930s and 1940s. Redlining occurs when a mortgage company refuses mortgages to certain neighborhoods, often by literally drawing red lines on maps around risky areas (it became illegal in 1968). For example, the Home Owners' Loan Corporation mapped 239 U.S. cities between 1935 and 1940, and it has been shown that controlling for building quality, these maps were determined largely by race (Hillier 2005).

Between the wars, the preference for biological (Mendelian) accounts of race was increasingly challenged by cultural, historical, and behavioral explanations of race. Biology did not disappear; the ERO continued its activities until 1939. Bowman's influential political geography text, *The New World* (four editions, 1921–28),


FIG. 779. JOVAN CVIJIĆ'S MANUSCRIPT MAP OF BALKAN ETHNICITY, 1918.

Image courtesy of the American Geographical Society Library, University of Wisconsin–Milwaukee Libraries.

included maps of the postwar world as comprising "kinds of people" who occupied territories with often contested lines of division. These were not races in the sense of continent-wide groupings, but Bowman's maps did group people into territories.

Post–World War II understandings of race differ in three distinct ways. In 1950, in the aftermath of Nazi practices of "racial hygiene," the United Nations Educational, Scientific and Cultural Organization (UNESCO) issued a statement on race that downplayed race's basis in biology. Writers have increasingly eschewed a biological basis for race, while maintaining the reality of race as a lived experience. In 1972 this position received further support from evolutionary biologist Richard C. Lewontin (1972), who showed that genetic differences *between* racial groups was far smaller (6.3 percent of variation) than that observable within a race but *among* local groups (85.4 percent of variation). Thus in anthropology it became more common to talk about "populations" rather than races. Where race has continued as a topic in geography, it has become predominantly used in studies of racial discrimination, especially after the emergence of more politically informed theories and concerns of social justice from the 1970s onward.

Second, writers have generally adopted a geographically continuous notion of human variation, rather than discrete, bordered territories. These geographical continuities are known as clines in anthropology, after a proposal by the biologist Julian Huxley in 1938. Components of human variation became increasingly mapped as gradations across space with changing environmental conditions or genetic drift (changing frequencies of genes within a population). Population geneticists such as L. L. Cavalli-Sforza and Lewontin included many such cline maps in their studies.

Third, race and ethnicity were increasingly understood as part of a cultural-geographic-historical complex, rather than as a single dominating variable. And as the early twentieth century racial purists such as Ward and Grant feared, immigration and global migration have undermined the notion of isolated races.

These three factors meant that maps of races in the prewar sense of geographically bounded territories fell out of favor, to be replaced by clines and emphasis on race as a perceived category. However, many maps still adopt a territorially discrete perspective, often using choropleth maps. Atlases of the 2000 U.S. Census, for example, mapped race in these terms (Brewer and Suchan 2001). The Census Bureau's use of race-based data has been challenged, even where individuals choose their own racial category. In France, for instance, the collection of such data is now banned because it reproduces racial categories.

In the past few decades, maps of race or ethnicity have become a topic of study itself in political geography, sociology, and anthropology. With the advent of critical approaches in cartography (Winlow 2006), mapping by and of indigenous peoples emerged as a significant focus. Such counter-mappings have explicitly considered how indigenous peoples, who have traditionally been the subject of mapping, can map themselves (Wainwright and Bryan 2009). Geographer Bernard Nietschmann, who called this strategy "map or be mapped," explicitly recognized the relations of power to the production of knowledge and vice versa (Bryan 2009, 24 n.2).

The closing years of the century witnessed attempts to bring back biological explanations of race. The sociologist Troy Duster (2005) described this as the biological "reinscription" of race. Much of this biological reinscription comes from the biological and medical communities, including human genetic research. The Genographic Project collected DNA samples from indigenous groups across the world in order to map human diversity and offered genome kits for sale to the public. Launched in 2005 by the National Geographic Society and IBM, the project is an extension of late-twentieth-century gene-mapping projects such as the Human Genome Diversity Project (HGDP). Both the Genographic Project and HGDP have attracted criticism for their reification of racial categories. Many scholars now therefore favor accounts of human variation as the result of the interaction between nature and culture. Nevertheless, race is likely to play a continued role in social policy—and thus in the generation of maps—as long as it remains a significant correlate of inequalities.

JEREMY W. CRAMPTON

SEE ALSO: American Geographical Society; Colonial and Imperial Cartography; Indigenous Peoples and Western Cartography; Paris Peace Conference (1919); Persuasive Cartography; Redlining; U.S. Census Bureau

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FIG. 918. *DISTRIBUTION OF THE POPULATION: 1900*, IN THE UNITED STATES.
Size of the original: 22 × 33 cm. From *Statistical Atlas: Prepared under the Supervision of Henry Gannett, Geographer of the Twelfth Census* (Washington, D.C.: United States Census Office, 1903), pl. 13. Image courtesy of the David Rumsey Map Collection.

The early innovators of these basic map types set the stage for the lexicon of visual language and graphic ingenuity that made its dramatic debut in the national mapping programs and statistical bureaus of Europe and the United States in the late nineteenth century. These new forms of statistical graphics introduced statisticians, administrators, planners, and social scientists to the important geographic revelations hidden within numerical census tables and text-laden reports. Within a relatively short time, graphic statistics became a universal language (Funkhouser 1938, 331).

At the beginning of the twentieth century, statistical thinking in the United States began to change, and there was an obvious shift both in appearance and enthusiasm for statistical graphics from 1900 to 1930. There was a pronounced shift toward theoretical models and experimentation in statistical graphics, yet results were generally inconclusive and contradictory and yielded few innovations (Fienberg 1979, 176; Beniger and Robyn 1978, 6–9).

Cartography as an academic discipline was taught at some institutions in Europe by 1902, but was not a commonly taught discipline in the United States at the time. The high cost of statistical atlas production reduced national programs in the United States and in Europe. U.S. statistical atlases produced by the Census Bureau between 1900 and 1920 were reduced in size and color folios (fig. 918). The last major statistical atlases in Europe were the Swiss contributions in 1897 and 1914.

A transition was also taking place in the national statistical agencies. In the United States, several statistical agencies grew and prospered, and data poured out of federal statistical offices, guiding developments in tariffs and taxation, immigration policy, disabilities, labor relations, and many more areas (Anderson 2010, 157). Yet there were problems in consistency, standardization, and coordination, as well as manpower shortages. Statistical systems worldwide needed to address explosive issues such as immigration and the dramatic growth of cities. Federal mapping efforts introduced the dot map in U.S. Department of Agriculture publications in 1903, reflecting a new concern with the productivity of Ameri-

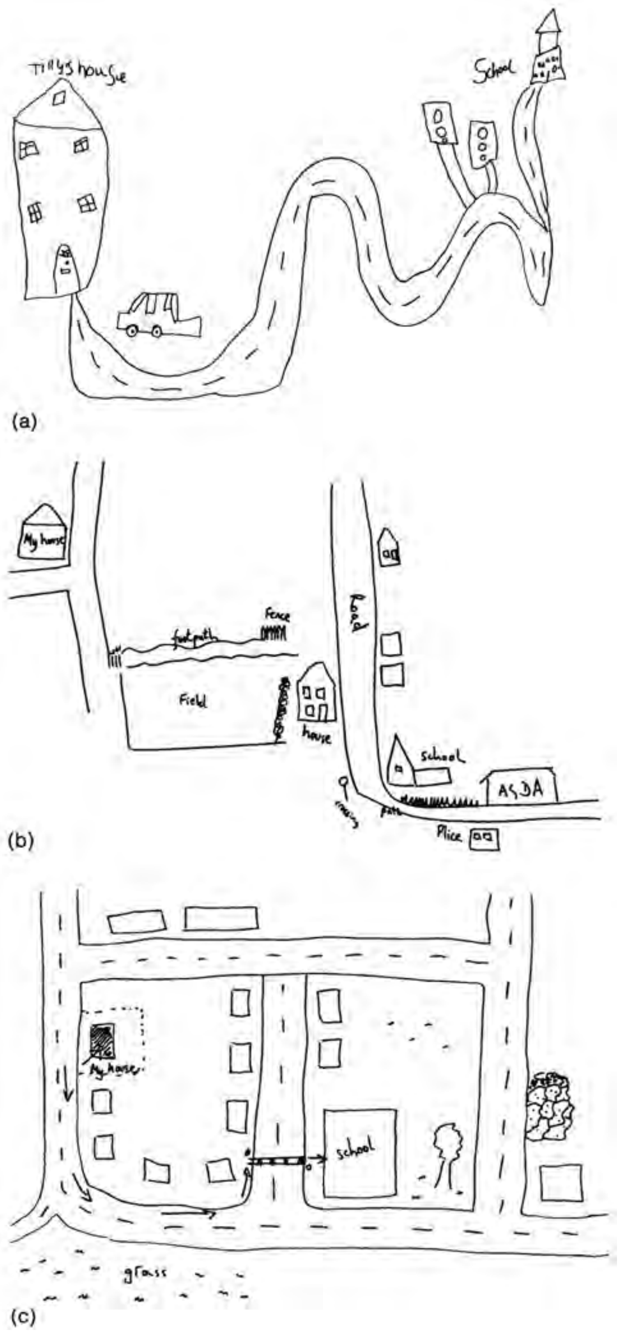


FIG. 138. LARGE-SCALE EXAMPLES OF CHILDREN'S JOURNEYS FROM SCHOOL TO HOME. Examples mapped by children show the three stages through which children generally evolve as they learn to master technical mapping conventions for depicting their environment: (a) pictorial (generally under eight years old); (b) hybrid form combining pictorial and plan (generally between eight and ten years old); (c) plan (generally over ten years old).
From Wiegand 2006, 49 (fig. 6.1). Reproduced by permission of Taylor & Francis Books U.K.

in Canada and the United Kingdom replicated the correlation between greater mobility, defined as free range, and increased accuracy in mapping their neighborhood (Wiegand 2006, 46).

In the mid-1990s Wiegand and others undertook several studies in the United Kingdom to evaluate children's understanding of the configuration of the earth's landmarks based on previous exposure to maps in school atlases. Researchers employed the free recall method for drawing country and world maps (Wiegand 2006, 69–74). The children's maps revealed an Anglocentric bias, depicting the British Isles most accurately while exaggerating the size of Europe and underestimating the size of Asia and Scandinavia. Students were better at showing location and size than shape in world maps. Their maps displayed a systematic distortion, also common in adult sketch maps, by centering city locations and aligning continents according to vertical and horizontal lines. Other researchers found student's freehand sketch maps useful for identifying the blind spots, biases, and misconceptions in students' mental pictures of the world (figs. 139 and 140).

The question whether children's sketch maps improve with increased opportunities for travel and media exposure was the focus of an international study conducted with ten-year-old children from eight European and American countries. The results of the free map drawing exercises supported previous findings of gender differences in map quality resulting partly from different levels of experience and exposure. Schools could mitigate such disparities by incorporating virtual travel experiences on the Internet (Schmeinck and Thurston 2007).

Based in part on Lev Vygotskiy's cooperative learning model, educators undertook collaborative mapping projects with favorable results. Teamwork to produce large-scale maps increased the cognitive demand on the participants by requiring explanation or justification of their ideas during the mapping process. The group dynamic also encouraged students to set their own standards for completing and evaluating the task (Leinhardt, Stainton, and Bausmith 1998). In some communities collaborative mapping supported the research of urban planners and designers who enlisted children to map spaces and hidden environments in their neighborhood (Halseth and Doddridge 2000).

Issues of cartographic literacy and children's relationship with maps received official recognition in 1995 when the International Cartographic Association (ICA) formed its Cartography and Children Working Group, with the mandate of introducing children to the power of maps. Four years later it became the Children's Commission. In 1993 the ICA had successfully created a biennial international map competition for students under fifteen (later sixteen) years of age. Titled "Children Map the by Westgard in 1911 became one of the first sets of strip maps published by the AAA. Rishel's many pathfinding expeditions under the auspices of the *Salt Lake Tribune* yielded a popular guide, *Rishel's Routes*. When the Lincoln Highway Association (LHA) completed its work blazing and marking on the most renowned of early transcontinental highways in 1915, linking New York to San Francisco, the press fanfare was accompanied by the publication of the route guide, intended to support navigation of the route (Hokanson 1988). Hundreds of associations like the LHA were formed in the 1910s and early 1920s to promote the marking, improvement, and promotion of specific transcontinental and regional routes. Most made some effort to mark their routes, often in affiliation with local authorities and motor clubs. While a few published elaborate route guides, many offered little more than small-scale maps showing the general course of the route. These maps, for example those published by the National Highways Association, often showed the routes as bold lines, in the manner of railroad maps, conveying a sense that the highways were capable of supporting rapid cross-country travel (fig. 855). Yet most of these routes were highways in name only. They were inconsistently marked on the ground, almost entirely unpaved, and nearly impassable in many stretches.

The growing commitment of state, provincial, and federal authorities to the development of a continental system of trunk highways with uniform marking and designation during the 1920s coincided with a dramatic

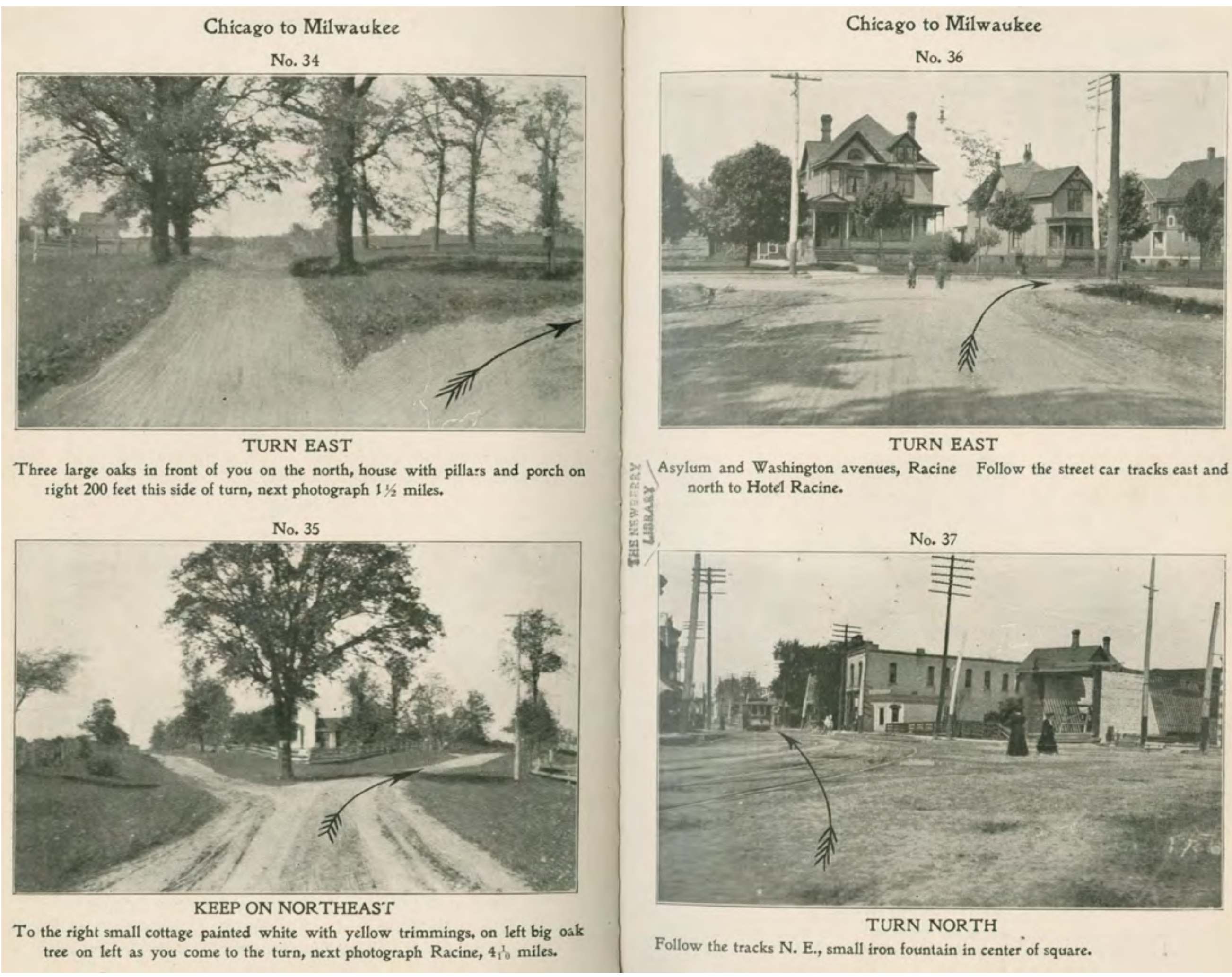


FIG. 854. PHOTOGRAPHS WITH DRIVING DIRECTIONS, PORTION OF CHICAGO TO MILWAUKEE ROUTE, 1905. Size of the original: 20 × 24 cm. From H. Sargent Michaels, *Photographic Runs, Series A: Chicago to Milwaukee* (Chicago: H. Sargent Michaels, 1905), photographs 34–37. Image courtesy of the Newberry Library, Chicago.