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## Claudius Ptolemaeus (Ptolemy): Representation, Understanding, and Mathematical Labeling of the Spherical Earth

By Ben Sprague

*Background* Claudius Ptolemaeus, better known as Ptolemy (circa 100–178 AD) made many important contributions to geography and spatial thought. A Greek by descent, he was a native of Alexandria in Egypt, and became known as the most wise and learned man of his time. Although little is known about Ptolemy's life, he wrote on many topics, including geography, astrology, musical theory, optics, physics, and astronomy.

*Innovation* Ptolemy's work in astronomy and geography have made him famous for the ages, despite the fact that many of his theories were in the following centuries proven wrong or changed. Ptolemy collected, analyzed, and presented geographical knowledge so that it could be preserved and perfected by future generations. These ideas include expressing locations by longitude and latitude, representing a spherical earth on a flat surface, and developing the first equal area map projection. Ptolemy's accomplishments reflect his understanding of spatial relationships among places on earth and of the Earth's spatial relationships to other celestial bodies.

Ptolemy's most famous written works are the *Almagest*, a textbook of astronomy in which, among other things, he laid the foundations of modern trigonometry; the *Tetrabiblos*, a compendium of astrology and geography; and *Geographica* (his guide to "Geography"), which compiled and summarized much of the geographic information accumulated by the Greeks and Romans up to that time.

*Geographica*, a work of seven volumes, the standard geography textbook until the 15th century, transmitted a vast amount of topographical detail to Renaissance scholars, profoundly influencing their conception of the world. Containing instructions for drawing maps of the entire "oikoumene" (inhabited world), *Geographica* was what we would now call an atlas. It included a world map, 26 regional maps, and 67 maps of smaller areas. They illustrated three

different methods for projecting the Earth's surface on a map (an equal area projection, a stereographic projection, and a conic projection), the calculation of coordinate locations for some eight thousand places on the Earth, and the development of concepts of geographical latitude and longitude (Figure 1). Through his publications, Ptolemy dominated European cartography for nearly a century and inspired explorers like Christopher Columbus to test the spatial boundaries of the world.

Ptolemy suggested that people remap his data, and in Book I of *Geographica* he offers advice on how to draw maps. Later in *Geographica*, Ptolemy explains how to calculate the location of a place by using longitude and latitude, and how to represent the entire world on a flat map. Copies and reprints of Ptolemy's world maps made up the majority of navigation and factual maps for centuries to come, providing the base information for early European explorers. Ptolemy also standardized the orientation of maps, with North at the top and East on the left, thereby placing the known world in the upper left, a standard that remains to this day.

His ability to take in and understand the incredible amount of information developed before his time, add to it, and synthesis it into a map or a book of maps changed how people understood, perceived, and represented the world.

Today, we still use some of Ptolemy's original theories and debate the same problems that he faced. Longitude and latitude are still used to determine precise location on Earth. The equal-area projection, though updated substantially since Ptolemy's time, remains a fundamental tool for representing geographical distributions, and scholars continue to debate the best means of portraying a spherical Earth on a flat surface.

It is useful to speculate on how Ptolemy's work has influenced social understandings and the thinking and methodologies of the social sciences. His cartographic ideas provided a spatial framework for organizing and portraying information about the known world, allowing social thinkers to better understand the space in which different societies function. The first world atlas and the ideas of longitude and latitude facilitated a more accurate understanding of how societies work in space and compare to each other spatially. Furthermore, they encouraged speculation on possible relationships between social development and physical environments.

The concept of the equal area map projection may be the most important of Ptolemy's contributions to the social sciences—providing for the mapping and display of distributional information (e.g., population, resources, and cultural, geological, archaeological, historical, and phenomena) that is not biased by area distortions typical of some other projection methods. The display of data in an equal-area format allows for the visualization and analysis of spatial patterns for

anomalies and trends, tasks that are central to many issues in spatial social science and that are critical to the fair representation of information to the general public.

While Claudius Ptolemy helped bring geography to the forefront of scientific thought, his contributions influenced a broad range of disciplines to the importance of accuracy in locational measures and to the need for an equal-area perspective in evaluating spatial relationships among diverse phenomena and in making geographical comparisons.

Figure 1: This is an early map of the world constructed using map making techniques developed by Ptolemy. Note the organization with crisscrossing lines of latitude and longitude.



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