

# Longitude

To know the position of a place on «earth,» we need to know its position in «[latitude](#)» and longitude, that is to say its coordinates. In Jules Verne's well-known novel *Les enfants du Capitaine Grant*, the Captain's children have a document eaten away by sea water giving the coordinates of the place where the Captain has been shipwrecked. But while the latitude indication is legible, the longitude is not. In order to find their father, they will have to travel to the known degree of latitude, 37°11' South, and then undertake a tour round the world.

The height of the sun above the horizon at midday enables calculation of the distance from the Equator in degrees of latitude. This explains how, early in history, men were able to know their position in terms of latitude with ever-greater accuracy.

The problem of longitude was far more delicate. Determining longitude depends on having the ability to measure time without too much approximation. Longitude is a matter for astronomy and calculation, and the issue required techniques that were difficult to perfect.

The sun was the first clock. At the highest point in the sun's apparent daily course it is midday or noon, and indeed in some mountain ranges there are "south peaks" or "aiguilles du midi", summits above which, for the inhabitants of the valley, the sun passes in the middle of the day.

The rotation of the earth around its axis passing through the two poles means that at any point on a large circle the centre of which is the centre of the earth, it is midday at the same moment on one half of the circle extending from one pole to another, and midnight on the other symmetrical half. It is not the same sun time on any two of these circles, however close they might be: in Paris it is not the same time as in the Bois de Boulogne or the Bois de Vincennes, both on the outskirts of the city. If it is possible to accurately measure the difference in time between the moment when the sun reaches its highest point in one place and the moment when it is reached in another place, the angular distance between these two places can then be measured.

In other words, what is needed is a sufficiently accurate clock or chronometer. It is set to midday when in a first place the sun reaches the highest point in its apparent course (the local noon). In a second place, at the local noon, the difference in relation to midday in the first place is read on the chronometer.

The difference between the two midday readings then enables a simple calculation of the angular distance between the two points.

The crucial issue is to possess the clock, and this requires micro-mechanical techniques that were only really mastered from the 18th century. Up till then measurement of time was ensured using various systems such as the hourglass, the water clock, or huge pendulum clocks that were un-transportable and very inaccurate. Navigators measured distance covered by estimation, that is to say on the basis of the speed of the ship, which was itself calculated in rather imprecise manner. Calculations were affected by all sorts of factors, such as the speed of ocean currents, and in fact the sailors never really knew where they were in terms of longitude. This can be clearly seen from ancient maps. The positions given for places are relatively accurate for latitude, even at early dates, while enormous errors appear for longitude. This explains why numerous Pacific islands were discovered twice or even three times. A navigator would place an island on a map, and a few years later another navigator would "discover" an island, positioning it not at all in the same place. This generated conflict between French and English navigators who considered, in all good faith, that they had been the first to take possession of an island in the name of their king.

Before the 18th century, various methods of measurement had been suggested. Some were rather "hair-brained" schemes, such as the idea of anchoring pontoons every 600 miles across the Atlantic, and firing flares visible from a hundred miles. Other systems were more scientific, based on measurements of the stars or the moon, but they required exceedingly complex observations and calculations.

The challenge was to invent a clock that was not only accurate in ordinary conditions, but that, once it was embarked on a vessel,

would not be offset by the incessant and often abrupt movements of the sea and storms, nor by dilation and contraction of certain metal parts, since longitude needed to be measured in northerly and equatorial zones alike. It was not a distinguished scientist but a humble clock-maker, John Harrison, who built the first clock enabling calculation of longitude with an adequate degree of approximation. The first experiment took place on a voyage from London to Lisbon in 1735, and it yielded good results, but Harrison was the object of derision and rejection by the academics in the British Admiralty and the Board of Longitude that had been set up by the British government. These notables could not accept that a mere craftsman should have, by way of an assemblage of cogs and balance wheels, found the solution to a problem they were trying to find in the stars. For a long period poor Harrison was refused the payment promised to the person who would find a way of calculating longitude. Harrison, and later his son, spent many years perfecting their clocks, and reducing their size and weight (the first prototype weighed 75 pounds).

Today we are able to measure time to a billionth of a second, and in all events it is sufficient to listen to radio navigation bulletins or use GPS to know or calculate the latitude and longitude of a place.

There then remained one problem to be solved, and it was not scientific but purely political: the problem of the prime meridian.

The story of the calculation of longitude is told in detail in a fascinating little book, Longitude, by Dava Sobel (1995 for the edition in English, Fourth Estate Ltd), and for the French-language edition 1996 (J.C.Lattès)

## **Bibliographie**