

Survey techniques of land and sky reveal Japan's location in the world

With a map in hand, you can journey to anywhere. A map is a reassuring companion that tells you where you are and how you can reach destinations even in unknown locations. Though many are familiar with the fact that the first map of Japan was the great achievement of Inoh Tadataka (1745-1818), few are aware that it was created during the Edo Period.

It was around 1800 that Tadataka began his survey across the nation. There were of course maps created by other survey engineers before him, but those maps only drew the general shapes of the areas of different domains. In comparison, the map by Tadataka covered the entire nation and even included longitude and latitude coordinates. The special feature of this map, now called the "Inoh Map," was that it revealed where Japan was located in the world.

The first step in the survey method used for the Inoh Map was to measure distance between one spot and another. Instead of the measuring tape we use today, Tadataka employed various instruments to measure distances, including a ken-nawa (*ken** rope), a *tessa* to compensate for the stretch properties of the ken-nawa, and a ken-zao (*ken** pole) to measure short distances. This was followed by azimuth orientation to determine the positional relationship between the survey spots. For this purpose, two compass-like instruments were used: a *han-en hoiban* and a *tsue-saki hoiban*, a device that kept the pelorus level even when the rod was tilted. After completing the measurements of distances and orientation, Tadataka made corrections to the details to enhance accuracy using such methods as *mikaeri sokuryo* (collateral survey) and *zenpo kokai-ho* (forward intersection). Tadataka was deeply

committed to survey accuracy and contributed to improving the precision of the survey instruments of the time as well. He was also the first man in Japan to apply astronomical observations in map making, allowing him to calculate longitude and latitude coordinates for confirming the location of a spot on the Earth, further lessening the error margin of the survey data.

The topography of areas surveyed were not always flat, therefore the survey methods needed to change accordingly. For instance, to survey the steep cliffs of rias along the coast, Tadataka used a boat to extend the ken-nawa between survey spots. When surveying a slope, he measured the slope angle with a *shogengi*, the azimuth direction with a pelorus, and then the distance of the slope itself was measured with the ken-nawa. From the data obtained, he calculated the horizontal distance using trigonometric functions.

The Inoh Map based on the actual survey was highly regarded in Europe because of its picture-like beauty in addition to its accuracy. It also laid the foundation for map making in Japan from the Meiji Era onward. Today, the survey methods employed have changed and the instruments and equipment used are more advanced, so we cannot fairly compare the accuracy of a present-day map with Inoh's. However, the principles and logic still remain basically the same.

Tadataka patiently pursued the survey of the land and the sky for about 17 years and completed the map of the country. It is true that survey techniques played a big part in this great achievement, but it would never have been possible without the dedication and creativity of Tadataka and the cooperation of the people.

*Ken: Unit of measurement equal to about 1.8 meters

8 - Map of Japan

TECHNOLOGY IN THE EDO PERIOD



Scene of the Inoh Team during a survey (Partial of Urashima Sokuryo no Zu)

This depicts the manpower required by Tadataka's team to carry out a survey. A man standing on the left holds a rod on which several reed-shaped papers are attached. The rod, a *bonten*, served as the landmark of the survey spot. (Masahiro Miyao collection: Custody of Irifuneyama Memorial Museum, Kure-shi)

Survey instruments used in mapping Japan

To lessen the margin of error, survey instruments were improved a number of times both in terms of material and usability. All were indispensable items for map making.

I. Measuring distance

The most basic work in map making is measuring distance. A rod called a *bonten* was set up on survey spots to measure the distance between them.



Tessa (Iron chain)

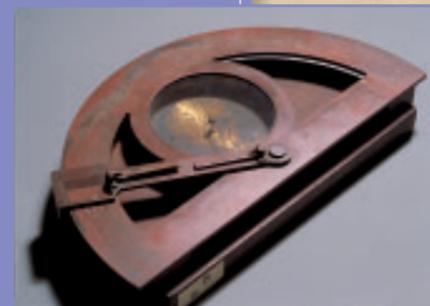
Measuring device made of iron to prevent errors caused by elasticity. Each link of the chain was 30 cm long and 60 links were connected to make this tessa. If any of the links were bent or distorted, the survey result would not be correct. Therefore, to make the survey as accurate as possible, each link was measured before every survey.

II. Measuring the azimuth orientation

After measuring the distance, the azimuth orientation was determined and fixed the survey spot. Other survey methods were also applied to confirm the spot.

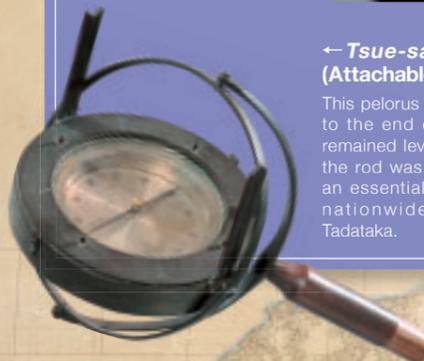
Han-en hoiban (Semi-circular pelorus)→

A pelorus in the Edo Period usually had 120 degrees or 240 degrees but Tadataka applied trigonometric functions in his survey and had a pelorus with 360 degrees. It was made for him in a semi-circular shape for easier handling and was often used when surveying the azimuth orientation of islands or mountain peaks.



← Tsue-saki hoiban (Attachable pelorus)

This pelorus was attached to the end of a rod and remained level even when the rod was tilted. It was an essential item for the nationwide survey by Tadataka.



III. Measuring the sky

No matter how meticulously the azimuth orientation was measured and surveyed spots confirmed, errors were inevitable. To improve survey accuracy, the spots were confirmed through astronomical observations.

Telescope

A telescope used for stellar observation. In the old days, observation was carried out by looking up at the sky and confirming a spot. Today, observation and confirmation are possible by looking down from satellites or aircrafts. This shows a glimpse of how technology has developed from the past to the present.

Shogengi (Quadrant)

An instrument for measuring the altitude of stars or the angle of slopes. Scale marks for measuring angles are inscribed along the circular arc and an attached rotating telescope moves along the scale marks. It was used to calculate the latitude of the survey spots.



The Inoh Map

The Inoh Map positioned Japan in the world but it was also esteemed as being highly artistic. Of the Asian countries, only Japan was capable of making a map of the country with their own techniques and methods. The *Nihon Enkai Yochizu* consists of Hokkaido, Eastern Japan and Western Japan. (*Nihon Enkai Yochizu* (Small version) by Inoh Tadataka, Tokyo National Museum collection; Image: TNM Image Archives)