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Model Reference Adaptive Theory on International Technology Transfer (II)

—— Transfer of Triangulation Technology for a Vast Area of Hokkaido ——

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Abstract

J. R. Wasson started the use of triangulation to survey vast areas for drawing a map of Hokkaido. *Wasson* was commissioned by Hokkaido Colonization Agency in march of 1873. Later on, *M. S. Day* continued to survey work in detail. The *Ikunosuke Arai's* group of engineers adopted the western triangulation technology from *J. R. Wasson* and *M. S. Day* for the first time in Japan.

This paper discusses the effort process and considers the process of model reference adaptation upon the introduction of western triangulation technology for the survey of Hokkaido.

Key words : Model Reference Adaptive Process, Triangulation Technology.

1. Introduction

Tadataka Inoh started to survey from Hakodate, through Muroran, Horoizumi, Ohtsu to Kushiro along the seaside by order of Tokugawa Shogunate from 1800. *Rinzo Mamiya* also learned the measurement technology from *T. Inoh* and started to survey western Hokkaido from 1800. In 1826, *Kageyasu Takahashi* drew Hokkaido seacoast map based on the survey by *T. Inoh* and *R. Mamiya.*

Takesiro Matsuura visited Hokkaido and surveyed the eastern part of Hokkaido in 1845, and also surveyed two islands, Kunashiri and Etorofu in 1849. In 1850, *T. Matsuura* published three books namely First trip of Hokkaido [Syokouezonisshi] Second trip of Hokkaido [Saikouezonisshi] and Third trip of Hokkaido [Sankouezonisshi]. Tokugawa shogunate employed *T. Matsuura* for surveying Hokkaido in 1855. *T. Matsuura* surveyed around Hokkaido and published books of 31 volumes, Diary of trip [Takeshirokaihou Nikki] in 1856. And also, *T. Matsuura* surveyed the interior of Hokkaido and published books of 85 volumes, Report on hills and rivers research as a whole Hokkaido [Touzaiezosansenchirimitorizu] and sketch maps with 28 sheets, Geographical sketches of whole Hokkaido [Touzaiezosansenchirimitorizu].

In 1869, *T. Matsuura* was employed by Hokkaido Colonization Agency of Meiji Government and he chose the names of Hokkaido and its districts. But, the sketch maps drawn according to the survey by *T. Matsuura* were not correct. *J. R. Wasson,* a foreign

engineer of Hokkaido Colonization Agency from America, started a survey by triangulation of the vast area of Hokkaido drawing a correct map of Hokkaido.

2. The Traditional Technology of Measurement

The traditional technology of measurement was usually characterized by astronomical observation and was introduced from China, but there was a lack of data before Tokugawa Shogunate. Nevertheless, this technology has been extended and accumulated for hundreds of years from the middle of 16 century because, the technologies of fortification, navigation, fighting and land surveying were introduced by the traders of China (Ming).

In 1643, some Hollanders drifited ashore to Yamada village in Iwate prefecture. *Gonemon Higuchi*, a police sergeant of Edo period acquired the perspective measurement technology from Hollanders for the first time in Japan. *Teitoku Shimizu* also developed the *Shimizu* method based on the perspective measurement technology. This method was succedded by the transmission and license in secret and was not published in book form.

But, the main part of this technology was published in two books Survey guidance [Riyochisinan] in 1733 and Survey guidance two [Riyochisinankohen] in 1794 by *Akihiro Murai*. In these books, this method was divided into five techniques such as plane table, compasses, magnetic needle, arithmetic and expendiency.

Many books on measurement were published during Kyoho period of Shogunate Yoshimune. In 1720, the books of astronomy from foreign countries were published openly.

In these books, the trigonometrical function table was introduced. But, this table was actualy not used.

The measurement technology of *T. Inoh* was not new and was based on the traverse method using compass and actual survey of length. But, by this method the accumulation error was becoming greater. Then, the accumulation error was corrected by a large quadrant made of subtle parts.

Tokugawa shogunate established Nagasaki Navy Academy in 1855 for the modernization of military. In 1857, excellent engineers and doctors such as *H. V. Kattendijke* and *P. V. Meerdervoort* were dispatched from Holland to this academy. In this academy, *Kaishu Katsu* and *Ikunosuke Arai* studied the technology of measurement and navigation.

3. Introduction of Triangulation Technology to Hokkaido

In 1873, the Ministry of Industry established the agency of measurement and invited several engineers from England who surveyed on a small scale by triangulation in Tokyo. Hokkaido Colonization Agency ordered *J. R. Wasson* to survey on large scale by triangulation in Hokkaido from 1873. *Wasson* invited one engineer and ordered many surveying instruments from America.

Hokkaido Colonization Agency employed *I. Arai* a past shogunate retainer who finally fought against the Meiji Government in Hakodate war. *Wasson* began to survey with *Arai* and students of Sapporo agricultural school, and chose the base points and base line in Yufutsu field.

M. S. Day arrived in Sapporo from America with part of the surveying instruments. But, it was difficult to survey by triangulation with only part of the surveying instruments. Hokkaido Colonization Agency ordered *Day* to survey Ishikari river side. In 1874, *Wasson* returned to Ministry of Military, and *Day* surveyed by triangulation as a leader.

In 1875, the surveying instruments such as theodolite, astronomy, base, and quadrant arrived from America. Hokkaido Colonization Agency established the survey office and started six survey groups such as astronomy, triangulation, survey point setting, base survey and seacoast survey.

As for astronomy survey, *Day* and *Arai* used the theodolite and surveyed the difference of longitude between Sapporo and Hakodate by using telegraph.

As for triangulation survey, *Naritoyo Fukushi* surveyed the south-west part and cross cut Hokkaido.

As for survey point setting, 23 points were set in the southern part of Hokkaido and were connected between Yufutsu base and Hakodate base.

As for base survey, Yufutsu base (Figure 1) was surveyed in detail and Hakodate base (Figure 2) was set.

As for seacoast survey, the surveys from Horoizumi to Nemuro, from Otaru to So-ya and from So-ya to Nemuro were completed.

In 1876, *Day* returned to America and *Arai* returned to the Geography Agency of Ministry of Internal Affairs and established astronomical observatory.

Hokkaido colonization agency ordered *Fukushi* as a leader who studied many technologies such as ship building, and survey from *T. W. Blakiston*.

Fukushi started to survey the longitude between Tokyo and Aomori and connected the national survey and Hokkaido survey. But, it was becoming difficult to survey due to many small scale land use because many settlers migrated from other regions of Japan to Hokkaido. The triangulation survey was consequently stopped. The survey report by *Day* was published as [Report of the Trigonometrical Survey of the Island of Hokkaido, Japan] in 1876. In this report, the survey method was on the same level as the present day method by using trigonometrical function table and least square method. In the introduction of this report, *Day* praised the survey technology of *Arai* and *Fukushi* as being excellent and expected to complete this survey work.

In 1878, the triangulation survey at the national level was started by director of Measurement Agency, *Arai*.

4. Conclusion

In conclusion, it can be said that the triangulation technology was introduced from foreign countries to Japan.

In Edo period, European technology was introduced from China and Holland, and the accumulation of traditional survey technology also existed. Accumulation of technology also continued under Meiji government. Meiji government employed *Arai*, a past shogunate retainer who finally fought against the Meiji government in Hakodate war. And also Meiji government employed the foreign experts such as *Wasson* and *Day*. Japanese experts were

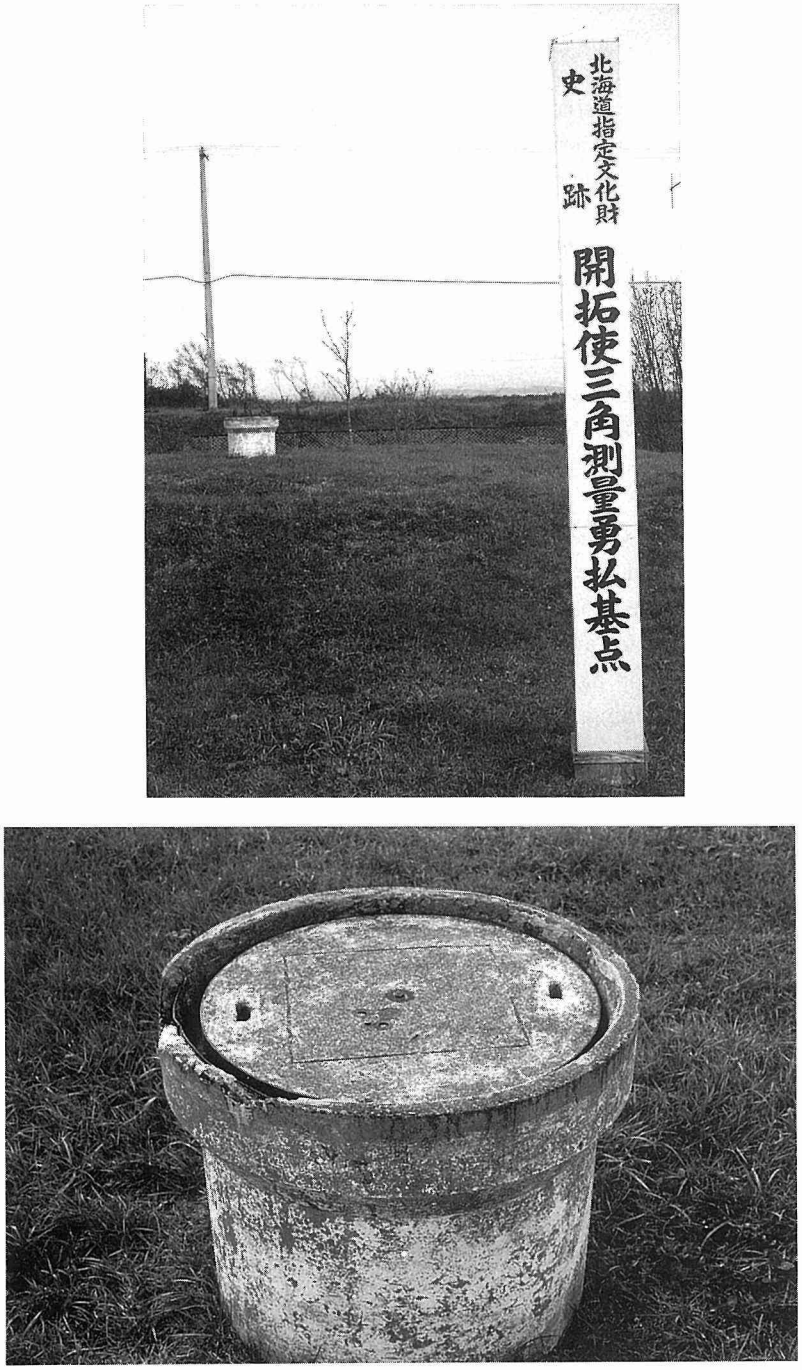

Figure. 1 Plan of Monument of Yufutsu base

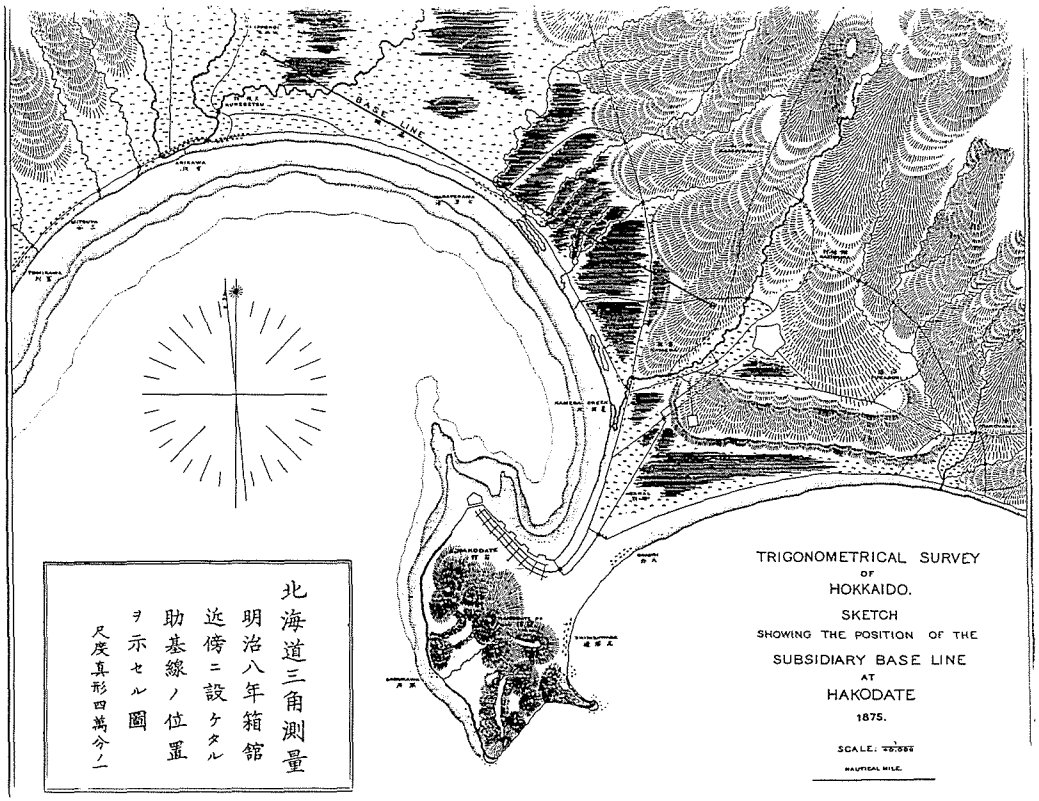

Figure. 2 Subsidiary base line at Hakodate (from Hokkaido Sokuryou Hobun)

successful in connecting European technology with traditional technology.

The technology of *Inoh* was not new, but *Inoh* has completed the correct map of Hokkaido seacoast by the traverse method using compass and a large quadrant made of subtle parts. Production of every kind of instruments for survey in Japan has improved over the years, and the adaptation process has been successfully done by Japanese.

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