ERRATA

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No.23

No.24</td><td>5 00 〃┐
│ 5°15′E
5 30 〃┘

6 00 〃</td><td>5 00 〃┐
│
5 30 〃 │ 5°15′E
│
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Secular Variation of the Magnetic Declination in Japan.

By SHUITI IMAMITI

Abstract

Data used for the 17th. and the beginning of the 18th century are mostly observed on boat. Accuracy of compasses in this period is discussed, and the observed values were reduced to that of Kakioka, which is situated in the middle of Japan.

Assuming the rate of changes for secular variation is lineaı with respect to time, period and amplitude of it are estimated and compared them with those of Europian stations.

§ 1. Introduction

The secular variation of the magnetic declination in Japan was studied by Shinozaki* in 1938, using data observed by magnetic compasses in the 17th century. The present author has added more data to those of Shinozaki's, and studied it further.

§ 2. Data

Declinations in the period from the beginning of the 17th to the 18th century were all observed on boat and obtained from "Die Abweichung der Magnetnadel; Beobachtungen, Secular-Variation, Wert-und Isogonensysteme bis zur Mitte des XVIII^{ten} Jahrhunderts." by W. Van Bemmelen except No. 21 in Table 1, and the rest are all observed on land with the exception of M. C. Perry's observation, which is supposed to be carried out on boat. These data were given in Table 1 and the observed positons can be seen in Fig. 1. To deside the observed positions on the sea, we refered the remarks in Table 1 rather than numerical values of latitude and longitude, because some of thc astronomical observations on the sea at that time seem to be inaccurate.

* The Kagaku, Vol. 8. No. 7 P. 258. 1938

Table 1. TOKYO JAPAN

No.	Date.	Latitude Longitude	Remarks	Observer	Observed value	Reduced value	mean.
1	1613 Dec.	23.°30′N 129. 20E	HIRADO	John Saris.	2°50′ E	5°20′ E	
2	1615 Aug. 28	33. 0N 128. 30E	WNW 7M von GOTO	HOSEANDER	2 10 E	4 40 E	
3	1639 Aug. 24	37. 30N 142. 0E	Land W 10M	Mathus Quast	7 20 〃	7 20 〃	7°25′ E
4	1639 Aug. 25	37. 40N 141. 20E	12M östlich vom Japan	〃 〃	7 30 〃	7 30 〃	
5	1643 May 21	34. 50N 139. 40E	Sehen die südöstliche Ecke Japans	Maarten Geritsz	6 50 〃	6 50 〃	
6	〃 〃	35. 30N 139. 50E	SE Ecke Japan's SW 1/2 S 5M	〃 〃	7 0 〃	7 0 〃	
7	〃 May 26	37. 20N 141. 30E	Ein Kap. W 1/2 S. 7. M.	〃 〃	7 0 〃	7 0 〃	
8	〃 May 30	37. 40N 141. 30E	Land 7~8M.	〃 〃	7 0 〃	7 0 〃	
9	〃 June 7	42. 0N 143. 20E	bei der SE Ecke Yesso's	〃 〃	8 0 〃	8 0 〃	
10	1643 June 8	42. 20N 143. 30E	SE Ecke Yesso's SW 1/2 S 5M	Maarten Geritsz	7 50 〃	7 50 〃	
11	〃 June 11	43. 10N 144. 0E	2.1/2M vom Lande	〃 〃	9 10 〃	9 10 〃	
12	〃 〃 12	43. 30N 146. 0E	E Ecke Yesso's	〃 〃	9 50 〃	9 50 〃	
13	〃 Aug 10	43. 40N 147. 0E		〃 〃	10 0 〃	10 0 〃	7°56′ E
14	〃 Sept 4	41. 0N 145. 30E		〃 〃	9 50 〃	9 50 〃	
15	〃 〃 7	39. 50N 145. 0E		〃 〃	10 50 〃	10 50 〃	
16	〃 〃 10	37. 40N 141. 30E	Küste Japans 10M	〃 〃	7 30 〃	7 30 〃	
17	〃 〃 14	37. 20N 144. 0E		〃 〃	7 20 〃	6 50 〃	
18	〃 〃 15	37. 20N 146. 0E		〃 〃	7 40 〃	6 40 〃	
19	〃 Oct. 26	36. 10N 142 0E		〃 〃	7 20 〃	6 50 〃	
20	〃 〃 29	33. 20N 139. 50E	vor Anker bei Tatsidshoshima	〃 〃	6 10 〃	5 40 〃	
21	1694		Kochi	Taizan Tani	5 40 〃	7 10 〃	
22	1709 May 5	29. 30N 144. 0E		Pierre Moirie im Stillen Ocean	6 00 〃	5 00 〃	
23	1709 〃 6	30. 40N 144. 0E		〃	6 30 〃	5 30 〃	5°15′E
24	1712 Aug 3	29. 10N 136. 0E		Duboccage	5 30 〃	6 0 〃	
25	1802		Tokyo	Tadataka Ino	0 19 〃	0 19 〃	

No.	Date.	Latitude Longitude	Remarks	Observer	Observed value	Reduced value	mean.
26	1809	35°36′N	Western Japan	Tadataka Ino	0°30′ E	0°30′ E	
27	1854	139 39E	Yokohama	M. C. Perry	2 44 W	2 44 W	
28	1883		Tokyo	Hydrographic Office Japan	4 03 〃	4 03 〃	
29	1886		〃	〃	4 07 〃	4 07 〃	
30	1887		〃	〃	4 21 〃	4 21 〃	
31	1895		〃	〃	4 23 〃	4 29 〃	
32	1897	35 41N 139 46E	〃	Central Meteorological Observatory	4 30 〃	4 36 〃	
33	1900	〃	〃	〃	4 35 〃	4 40 〃	
34	1905	〃	〃	〃	4 46 〃	4 51 〃	
35	1910	〃	〃	〃	4 58 〃	5 04 〃	
36	1915	140 12E 36 14N	Kakioka	〃	5 14 〃	5 14 〃	
37	1920	〃	〃	〃	5 …	…	
38	1925	〃	〃	〃	5 36 〃	5 36 〃	
39	1930	〃	〃	〃	5 42 〃	5 42 〃	
40	1935	〃	〃	〃	5 50 〃	5 50 〃	
41	1940	〃	〃	〃	6 00 〃	6 00 〃	
42	1945	〃	〃	〃	6 08 〃	6 08 〃	
43	1950	〃	〃	〃	6 19 〃	6 19 〃	
44	1953.5	〃	〃	〃	6 22 〃	6 22 〃	

§ 3. Accuracy of the old navigation compass

To what degree the old navigation compasses in 17th and 18th century have the accuracy has been studied. For this purpose "Der Kompass" by A. Schuk is exceedingly instructive, in which compasses of every type being used upto the end of the 19th century and thein constructions are illustrated and described, while he did not discussed on accuracy of them. Nevertheless, we can estimate it by detailed studing the description of magnetic needles, pivots and gimbals in Shuck's work and have come to the conclusion that the errors of compasses on boat in the 17th century would had been ±30′ of angle.

The ships at that time were made of wood, accordingly it might be reasonable to presume that the deviation of the magnetic force by ship itself would had been very slight. Indeed, the compasses in that time seem more accurate than our presumption when we check the observational results given in Table 1. For instance, notwithstanding No. 1 and No. 2 were observed on different ships at the intervals of two years at the

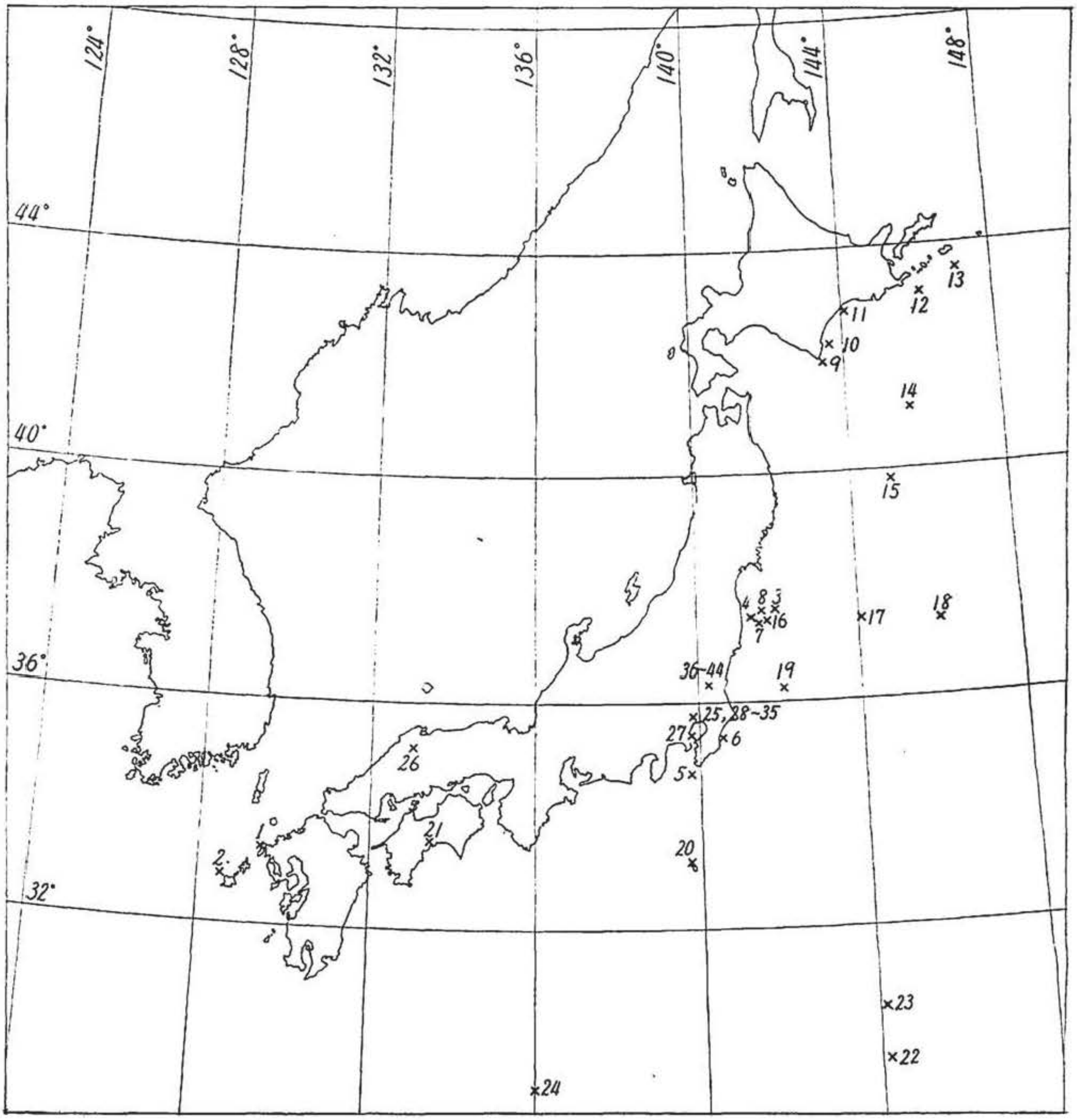

Fig. 1

places not being distant each other, the difference of these two observed values is 40′. The same will be seen between No. 4 and No. 8, the latter observation was carried out about four years after the former at almost the same place on the sea.

From these facts too, the accuracy of compasses in 17 th century will be sufficient to estimate the real value in the limit of ±30′.

§ 4. Treatment of the data

To find out the secular variation in Japan with these data, it is reasonable to reduce all observed values to the one which would be obtained if the observing points for these values were shifted to a certain place in Japan, because we have to have the values at one point which is properly chosen as a standard point for getting the secular variation in Japan. It is true that we can estimate it roughly by means of interpolation with directly using the magnetic charts at each period, but it is not accurate enough to investigate the details both of time and space variations for our purpose. Thus, each observed values at different points around Japan at certain period are reduced to the values at Kakioka, by means of interpolation considering the space gradient of isogonic chart of that very period, and these values are used for obtaining the secular variation in Japan. Actually we make use of the following isogonic charts,

1600 by Chr. Hansteen
1700 by Edmund Halley
1800 by Chr. Hansteen
1858 by British Admiralty
1885 by G. Neumayer
1922 by Greenwich Astronomical Observatory

Isomagnetic charts of 1600 and 1700 show east-ward declination all over Japan, isogonic lines are almost north-southward in directions, and the magnitude of declination increases from west to east. On the other hand, isogonic lines are almost parallel to the chain of Japan islands in 1800 and there after, which lead us to give no correction to the observed values for reduction from 1800 onward till the observed values became more accurate when continuous magnetic observation began in Japan. No · 26 and No. 27 were observed by Tadataka Ino, a famous pioneer of land survey in Japan, who would be fortunate by the fact that isogonic lines run parallel to Japan islands in his time. The reduced values of 1643 show among themselves comparative wide range of difference; this is considered to be as caused by lower accuracy of isogonic charts in 1600 and 1700 and not by that of observed values.

In 1897, absolute observation as well as recording of variation of the magnetic field was begun at the Central Meteorological Observatory, Tokyo, which was succeeded at Kakioka after 1913 in order to avoid artificial disturbances on the magnetic variation by electric tramway.

In this note, the data of Tokyo observatory were reduced to Kakioka by making the correction determined by comparative observation at each observatory. The correction applied to Tokyo data is +5, 5′. From 1898 onward, mean value of every five years is refered to that of the corresponding middle year of that period.

§ 5. Secular variation

The reduced values obtained by treating as mentioned above are plotted, and the smoothed curve is drawn as shown in Fig. 2a.

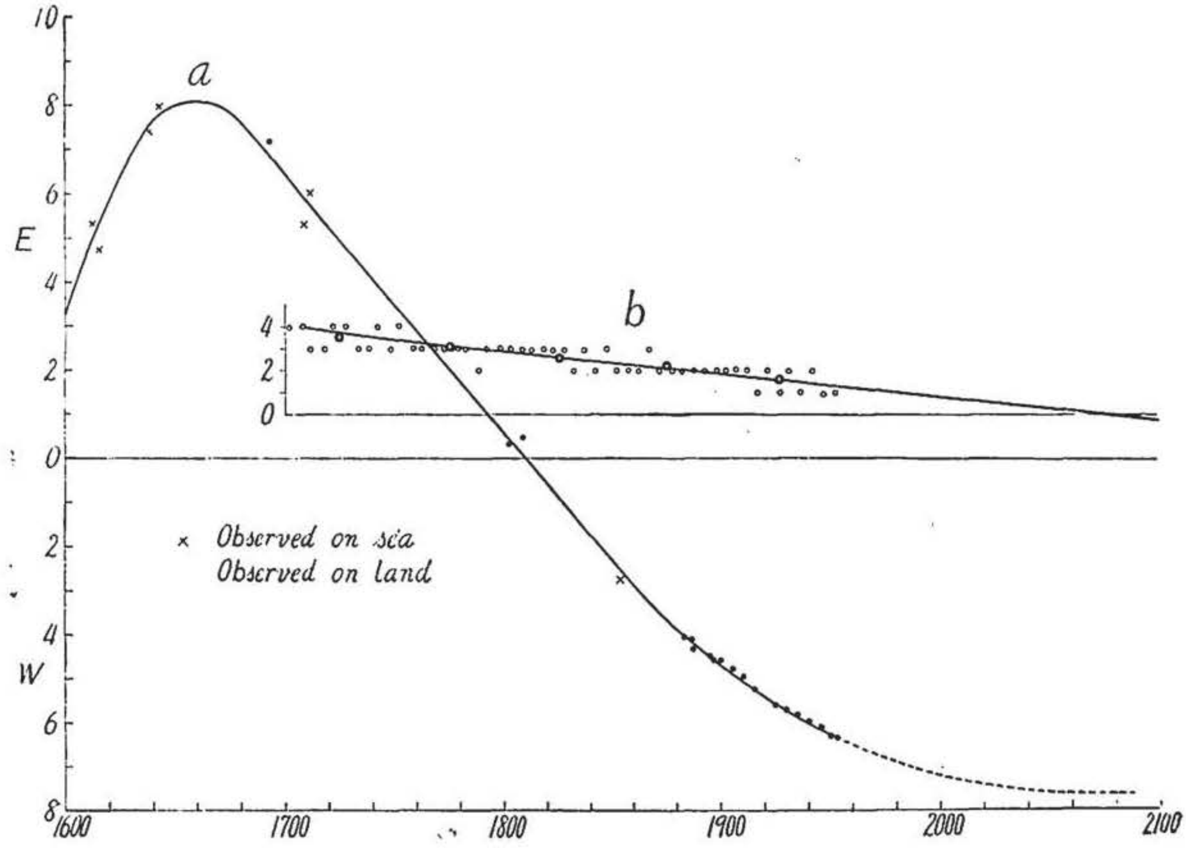

Fig. 2.

It will be seen that extreme value of east declination would occured at a litte after the middle of the 17th century.

Yearly rate of the secular variation are grouped in every five years and their mean values are shown Fig. 2b. It decreases almost linearly with respect to time, therefore if this decreasing continues similarly to the future, the secular variation will come to its extreme value at west declination of about 7° or 8° in 2060 or 2070.

If this secular variation is cyclic, its period and amplitude will be about 800 years and 15 degrees of angle respectively. This period is relatively longer than those of London, Paris and Roma, which would be almost the same values of 450 years, though they are not completed at present. The amplitude in the present case would be also only one half of those of Europian stations. This seems to be a characteristics of secular variation of declination in middle and lower latitude of eastern Asia, especially in the region of southern frontier of China, where the amplitude is only ±2. 5 degree about true north.

Acknowledgment

The author would like to thank Mr. H. Hatano, Tokyokeiki Seizosho, who gave us valuable discussions on old magnetic compasses.