On the Local and Anomalous Change of Geomagnetic Declination

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Abstract

The instrument used for continuous observation of geomagnetic declination at the deep underground room is described. An account is also given on some local and anomalous changes of declination observed in the epicentral regions of two destructive earthquakes.

1. Introduction

Gravity and magnetism are two outstanding physical properties of the earth, and all things and phenomena on the earth are more or less under their influences. The distribution of gravity value on the earth depends upon the density distribution of the earth's interior and the angular velocity of the earth's rotation. Roughly speaking, the equipotential surface of gravity on the earth is considered to be approximately a spheroidal surface, but the real geoid is far more complex. The difference between the geoid and the niveauspheroid presents the interesting problem of gravity anomaly and plumb line deviation and affords a good way to study the irregularity of the earth's crust and the degree of isostatic compensation. On the other hand, the origin of the magnetism of the earth has been for a long time a subject for discussion, but the recently proposed theory of the inducing motion of the earth's central core seems to be the most favorable to date. The magnetic field measured on the earth is roughly represented by that of a strong dipole magnet placed near the earth's center and in the direction of the magnetic axis. But the small difference between the observed magnetic element and the dipole distribution is also an interesting phenomenon because of the geomagnetic anomaly suggesting the magnetic heterogeneity of the earth's crust such as, for example, the magnetically different properties of the continent from those of the ocean floor, or the more regional and local deformations of the geomagnetic equipotential surface.

On their variation with time, the value of gravity at any place receives only a minute but periodic change of earth-tidal origin, and its secular

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variation has not yet been fully ascertained. But the recent development of the highly sensitive and portable gravitymeter will make it possible in near future to examine the real existence of the secular variation of gravity. In contrast with gravity, the geomagnetic element at any place suffers various changes, such as diurnal variation, magnetic storm, micro-pulsation and a large secular variation. But for secular variation, all changes are considered to be caused by the motion and activity of the sun through the ionosphere. Secular variation is interpreted at present as originating from the regional and turbulent motion of matter in the earth's core. Secular variation never appears as a phenomenon common to all parts of the world, but it often does show a same tendency in regions as wide spread as Europe or North America. The geomagnetic secular variation treated in this article is not the regional secular variation stated above, but a variation having an extremely local character as observed, for example, only in the area of several scores of kilometers in length.

It is important to ascertain whether or not there exists any local change with time of geomagnetic element in the region near the epicenter of a destructive earthquake, or near the crater of the active volcano, or generally in any area greatly disturbed by the movement and deformation of the earth's crust. Concerning the problem of connection of the local magnetic change with the occurrence of destructive earthquakes, Y. Kato published in series some papers on the local change of geomagnetic inclination as measured at the place near the epicenters of destructive earthquakes before and after their occurrence. [1938, 1940, 1949, 1953] It was reported by him that the amount of change of geomagnetic declination considered to be related to an earthquake reaches to more than 10' at the epicentral region. His surveys were made mainly by the dip circle or the earth-inductor at the proper yearly intervals, and continuous observation by self-recording methods near the epicenter are not discussed. For the purpose of studying the local geomagnetic variation, if existent, relative to the occurrence of destructive earthquakes, volcanic eruptions and other local disturbances, continuous recording observations with the geomagnetic variometer have been made since 1933 (the Second International Polar Year) at several places in our country under the supervision of our Geophysical Institute. Standard observations with the geomagnetic variometer of three components, (H, D, Z) which are frequently calibrated by the absolute measurement of three elements (H, D, I,), have been made at the Senrigahama station in Aso during 1932 to 1938 and afterwards at the room in the tunnel on the hill of the Aso Volcanological Laboratory since 1939 to the present time. [Hasegawa, Ōta, and others, 1940] At present, variometers of one component of geomagnetic declination are in operation at ten stations under our management, their observation room being for the most part deeply under the ground surface and are used concurrently with tiltmeters and other instruments. The reason why only the instrument for the measurement of declination is adopted is that it is considered to be the least affected by such instrumental errors as changes in the magnetic moment of the suspended magnet and torsional rigidity of the suspension wire caused by temperature change and secular weakening. But from the experience of many years' observation of declination (D) at various places, it has been deduced that the observation of geomagnetic vertical intensity (Z) made concurrently with the declinometric observation may be preferable by reason that the Z-value is considered to be more sensitive than the D-value, in some cases, to disturbances of a local nature. A variometer of geomagnetic vertical intensity has recently been designed and observations using the Z-variometer in conjunction with the D-variometer has been started at several stations. On the other hand, the results of observation with a magnetic torsion balance of high sensitivity at a place close by the sea was reported by E. Nishimura and K. Wakayama at the Second Annual Meeting of Society of Terrestrial Magnetism and Electricity of Japan in 1947,[1] and the tidal changes of the geomagnetic element effected by the tidal currents of the neighbouring sea were discussed. Recently both a magnetic torsion balance and a gravitational torsional balance have been constructed in a same dimension and structure, and these evacuated torsion balances have been set up at three stations where the D- and Z-variometer are being operated in conjunction. On the instruments (the Z-variometer and the magnetic torsion balance), and their operation and results, some detailed reports will be published in the near future. In the following a physical description of the D-variometer will be given, and next the local and anomalous changes of declination observed before and after the occurrence of two destructiv earthquake at stations near their respective epicenters will be reported and discussed in some detail.

2. The Variometer of Geomagnetic Declination

The variometer used for the observan of geomagnetic declination is a simple system comprising a small magnet suspended by a long and thin metal strip as shown in Figure 1. In Figure (M) is a circular cylindrical magnet of K. S. steel, whose sectional diameter, length and magnetic moment are 6 mm, 55 mm and 650 c.g.s. respectively. A reflecting plane mirror (m) of 8×15 mm is attached under the magnet nearly at its center. The system of the magnet and mirror is suspended by a thin No. 48 phosphorbronze strip whose length and torsional rigidity are 6 cm and

1) Nishimura, E. and Wakayama, K., Observation of geomagnetic variation on the sea coast, (unpublished).

this effect is fatal for continuous observation of secular geomagnetic change unless the datum value of the variometer is frequently calibrated by an absolute measurement of geomagnetic elements. Contrary to having these inconveniences. the D- variometer unaffected by the above mentioned disturbances is safely used if properly handled. That is, it is advaisable that, in case of declinometric observation, the magnetic moment of the suspended magnet should be sufficiently large and that the torsional rigidity of the suspension wire should be somewhat small. These conditions of a strong magnet and a fine suspension wire permit the declinometric observation to escape from the undesirable influences of temperature change and secular creep. In the case of the D-variometer the suspension wire is almost in a torsionless state and really, in our case, it has been experimentally proved that a temperature change of several score degrees will also not affect the function of the instrument. Consequently, it may safely be said that the D-variometer discussed is almost entirely free from imstrumental errors.

3. Observed Secular Variation of Geomagnetic Declination

There is a huge amount of data on the secular variation of geomagnetic declination observed with the above described D-variometer at several places in our country, but here the secular variations observed at the four stations of Makimine, Ogoya, Yura and Ikuno are selectively discussed in reference to two destructive earthquakes which occurred near the stations of Ogoya and Yura. The conditions of the observation rooms of these four stations are as follows:

Station	Position	Height (m)	Depth (m)	Ground rock	Commencement of the declinometric observation	Declination for 1950.0
Makimine	131°27′E 32°37′N	130	165	Paleozoic clay slate	May, 1949 (Resetting, March, 1952)	5°19′W
Ogoya	136°33′E 36°17′N	210	300	Tertiary tuff	July, 1948 (Resetting, October 1951)	6°39′W
Yura	135°07′E 33°57′N	10	30	Mesozoic sandstone and shale	November, 1951	5°53′W
Ikuno	134°50′E 35°10′N	440	237	Liparite	March, 1952	6°19′W

Of these four stations the declination values at 0-hour on each day were read from the photographic records and then the mean values of every ten days were calculated. The numerical values obtained at the two stations of Ogoya and Yura are tabulated in Table 1 and 2, and their ten days' mean values are plotted in Figure 2.

Table 1. Daily Value at 0-hour of geomagnetic declination, unit (minute in angle), sign (+westward, −eastward)

Ogoya

	1951			1952												1953				
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1			0.69	0.83		0.65		3.58	2.62	3.26	5.23	5.86	6.24	6.17	5.93	5.93	4.47	6.37	5.42	4.47
2		1.09	0.88	0.76		1.10		3.58	2.94	3.26	5.04	5.86	5.29	6.50	5.93	6.25	6.10	6.25	4.78	4.65
3		1.20	0.56	0.57		1.23	1.67	3.90	2.94	3.26	4.91	7.45	4.97	5.99	6.25	6.44		6.05	5.10	4.65
4		0.94	0.82	0.57			1.67	3.90	3.24	3.26	5.08	6.17	6.24	6.50	6.56	6.56		5.73	6.69	4.65
5		1.04	0.95			1.23	1.99	3.26	3.26	4.22	4.97	5.55	5.93	6.17	7.39	5.93		5.73	6.69	4.58
6		1.51		0.56		1.23	1.99	3.26	2.64	3.58	4.47	5.55	5.61	5.42	6.44	8.15		5.73	5.73	4.78
7		1.07	0.51	0.06			1.99	3.58	3.26		4.72	5.55	5.61	5.86	6.12	6.25	5.10	5.73		5.42
8	0.13		0.82	0.89			1.67	3.26	2.94	3.90	5.23		5.61	5.86	6.25	5.93	5.42	6.05	5.55	4.78
9	0.13	0.88	0.95	1.53				3.58	2.94	3.58	4.40	5.73		6.17	5.61	6.12	5.42	5.73	5.55	4.47
10	0.13	0.71	0.95	1.21			2.62	3.26	2.62	3.53	4.92	5.73	6.88	6.37	6.25	5.93	5.42	6.05	4.58	
11	0.13	1.07	0.95	1.08		1.23	2.62	2.94	2.94	3.90	4.22	6.05	6.56	5.93	5.61	5.93	5.10	6.05	5.55	
12		0.69	1.68			1.03	2.62	3.26	2.94	4.22	5.16	5.73	6.56	5.86	6.25	5.93	5.73	5.73	4.58	4.47
13		0.91	0.76	1.08	0.97	1.86	2.94	3.26	3.26	3.90	4.08	4.78	6.24	5.86	6.05	6.25	5.42	6.05	5.55	4.78
14	0.45	0.88	0.64	1.08	1.10	1.22	2.94	3.26	2.94	3.90	4.08	5.42	6.56	5.86	6.37	6.12	5.42	5.42	5.10	4.78
15	0.64	1.09	0.25	1.08	1.54	1.22	2.94	2.62	2.94		4.08	5.42	6.69	5.86	5.93	5.61	5.73	5.42	5.86	4.47
16	1.08	1.51	0.64	1.08	1.10		2.62	2.62	3.26		4.08	4.78	6.24	6.82	6.37	5.48	5.93	5.42	5.23	4.14
17	0.83	1.01	0.76	1.08	1.10	1.35	2.30	3.26	3.58	3.77	3.90	4.57	6.05	5.86	6.75	5.61	5.42	6.05	4.58	3.51
18	0.45	1.51	0.76	1.08	0.78	2.31		2.94	3.58	3.58	4.53	5.11	6.56	6.50	6.69	5.61	5.73	5.73	5.73	4.14
19	0.76	1.01	0.76		0.65	1.42	3.58	2.94	3.58	4.08	4.72		5.93		6.18	5.61		5.73	5.42	
20	1.84	0.82			0.78	1.67	1.67	2.94	3.58	3.14	4.08	3.39	6.24	6.50	6.12	5.61		6.05	5.23	
21	1.52	1.01	0.76		0.14	1.42	2.94	3.58	3.26	3.77	3.76	4.66	5.61	6.17	5.80	6.25			4.40	
22	1.24		0.89		0.78		2.94	2.94	3.58			5.11	4.43	7.13	5.29	6.25			5.55	
23	0.45		0.89		0.78	1.22	3.90	2.31	3.26		3.96	5.29	6.24	7.26		4.97				
24	0.72	1.01	0.95		0.59	1.80	3.58	2.62	2.62		3.76	5.11	5.61	6.82	5.48	5.42			5.23	
25		1.76	0.76		0.91	1.42	3.26	2.31	1.99		3.64	5.11	6.24	6.63	5.61	5.73	6.05		5.23	
26	0.70	1.01	0.76			1.35	2.30	2.62	2.94		3.96	4.34	5.93	6.18	5.93	5.73	6.05		5.23	
27	0.51	0.82	0.76		0.46	2.31	2.30	2.62	3.26		3.96	4.34	6.24	6.37	5.80	5.73	5.61		4.91	
28	0.83	1.01	0.76		0.46	1.42	2.62	2.62	3.58		4.58	5.29	6.88	6.18	5.73	5.61	6.05		4.91	
29	0.83	1.01	0.76		0.78	1.86	3.58	2.62	3.58	4.08	4.27	5.93	6.24	6.18		5.61		6.69	4.91	
30	0.88					1.54	4.22	2.62	2.94	4.08		5.61	6.56	6.12	5.93	5.42		6.55	4.78	
31	0.83		0.83			1.67		2.62		4.53	4.92		5.93		5.93	4.97		4.78		

Yura

	1951		1952												1953				
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1		0.00	0.22		-1.34	-2.23	-3.57	-4.68	-5.12	-5.57	-6.92	-9.15	-9.81		-6.92	-5.79	-5.13	-5.79	-4.59
2		-0.22	0.22		-1.56	-2.68	-3.57	-5.12	-5.35	-6.25	-6.70	-9.15	-9.60		-7.14	-6.02	-5.13	-5.79	-4.38
3		-0.22	0.00	-1.12	-1.12	-2.23	-3.80		-5.80	-6.25	-6.02	-9.81	-9.37		-6.25	-6.02	-5.97	-5.57	-4.59
4		-0.45	-0.22	-1.12	-1.12			-5.12	-5.80	-5.57	-7.13	-10.00	-8.92		-5.58	-6.02	-5.13	-6.02	-4.82
5		0.00	-0.45		-1.56	-2.45	-3.12	-5.12	-5.80	-6.02	-7.58	-10.30	-9.15		-6.02		-5.35	-6.24	-5.03
6					-0.45		-2.90	-5.33			-6.92	-8.92	-9.60		-4.24	-6.24	-5.57	-5.79	-4.46
7		0.22	-0.67		-1.78	-2.23		-5.57	-5.35			-9.60	-9.15		-6.02	-5.79	-5.57	-6.02	-4.15
8			-0.67		-1.34	-2.68			-5.57	-5.80	-7.36	-9.60	-9.15	-6.92	-6.47			-6.02	-3.92
9		0.67	-0.67						-5.80	-6.02	-6.92	-10.30	-8.48	-7.18	-6.47		-6.02	-6.47	-5.13
10		0.45	-1.12		-1.34		-3.57		-6.25	-6.02	-6.92	-9.60		-7.13	-6.25		-5.79	-6.02	
11		1.12	-1.12		-1.78		-4.25	-6.02	-6.25	-6.92	-6.70	-10.00	-8.48	-7.36	-6.25		-5.79	-5.79	-4.95
12		1.34	-0.45				-4.91	-6.02	-5.80	-6.25	-7.13	-9.81	-8.48	-6.70	-6.47	-4.90	-6.02	-5.57	-4.77
13		1.12	-0.45				-3.80	-5.57	-5.80	-6.70	-7.81	-10.00	-8.26	-8.26	-6.25	-5.13	-6.24	-5.79	-4.77
14		0.89	-0.89		-2.00	-2.68	-4.25	-6.02	-6.25			-10.00	-8.48	-6.92	-6.02	-5.57	-5.79	-5.79	-5.00
15		0.67	-0.45		-2.68	-2.45	-4.25	-5.80	-6.02	-6.25	-7.81	-9.60	-8.26	-6.92	-6.25			-5.57	-5.45
16			-1.12		-1.78	-3.35	-4.02	-5.80	-5.80	-6.47	-7.58	-10.00	-7.82	-7.59	-6.68	-5.57	-5.57	-6.02	
17		0.67	-0.67		-1.56	-2.45	-3.80	-5.57	-5.80	-6.47	-7.81	-9.81	-7.82	-7.36	-6.92	-5.79	-5.75	-5.57	
18		0.45	-0.45	-1.56	-2.00	-3.12	-3.80	-5.80	-6.02			-9.60	-8.03	-7.59	-6.68	-5.57	-5.57	-5.57	
19	0.00	0.22	-0.89	-1.12	-1.78	-3.80	-3.80	-5.12			-9.15	-9.81	-7.59			-5.57	-5.57		
20	-0.22				-1.78	-3.80	-3.57	-5.57	-6.25			-9.37	-7.59	-7.59		-5.57		-5.35	
21	0.00	0.67	-0.89	-0.89	-1.78	-3.35	-3.80		-6.25	-6.92		-9.81	-7.82	-7.59	-6.47	-6.02		-5.92	
22	0.00	0.22	-1.12	-1.12	-2.23	-3.80	-3.80	-5.57	-6.70	-7.13	-8.70	-10.30	-6.92	-7.59	-6.25			-5.00	
23	0.00		-1.56	-1.34	-1.78	-3.35	-3.35	-6.25	-6.25	-7.13	-9.15	-9.37	-7.13	-7.59	-6.47	-6.02	-6.47	-5.35	
24	-0.45	0.22	-0.89		-1.78	-3.80	-3.80	-5.57	-6.25	-6.92	-9.15	-9.81	-7.36	-7.59	-6.25	-5.79	-6.02	-4.59	
25	0.00	0.22	-1.12	-0.45	-2.23	-3.35	-5.57	-6.25		-7.13		-10.40		-6.92	-6.02	-5.35	-6.24	-4.92	
26	-0.22		-1.34	-0.67	-2.00		-5.12	-5.80	-5.80	-6.92	-9.15	-10.00		-7.37	-6.25	-5.35	-6.92		
27	0.00	0.00	-1.56	-1.34	-2.23	-4.02	-5.12		-6.02	-7.13	-9.37	-9.81		-7.14	-6.25	-5.57	-6.02	-5.48	
28	-0.22	0.00	-0.89	-1.34	-2.68	-4.02	-4.68		-5.80		-9.60	-9.15		-7.14	-5.79	-5.35		-4.28	
29	0.00	0.00	-1.12	-1.34	-2.23	-4.24	-4.90		-6.25	-7.57	-9.60	-9.37		-7.37	-6.02		-6.02	-4.28	
30	-0.22	0.22	-1.34			-3.57	-5.12	-6.25	-5.80	-7.58	-8.92	-9.81		-7.14	-6.02		-5.57	-5.35	
31		0.22			-2.45		-4.68		-5.57			-9.81		-7.37	-6.02		-6.02		

Table 2. Ten days' mean value of geomagnetic declination, unit (minute in angle) sign (+westward, −eastward)

		1~10	11~20	21~30 (31)
1951	Oct.	0.13	0.77	0.85
	Nov.	0.94	1.02	1.09
	Dec.	0.79	0.80	0.81
1952	Jan.	0.78	1.08	
	Feb.		1.00	0.61
	Mar.	1.09	1.48	1.60
	Apr.	1.80	2.69	3.16
	May	3.52	3.00	2.68
	June	2.94	3.26	3.10
	July	3.54	3.81	4.12
	Aug.	4.90	4.29	4.09
	Setp.	5.94	5.03	5.08
	Oct.	5.82	6.36	6.00
	Nov.	6.10	6.12	6.50
	Dec.	6.27	6.23	5.72
1953	Jan.	6.35	5.78	5.69
	Feb.	5.16	5.56	5.94
	Mar.	5.94	5.81	6.06
	Apr.	5.57	5.28	5.02
	May	4.72	4.33	

		1~10	11~20	21~30 (31)
1951	Nov.		0.00	−0.11
	Dec.	0.05	0.80	0.19
1952	Jan.	−0.45	−0.72	−1.16
	Feb.	−1.21	−1.34	−1.06
	Mar.	−1.39	−1.92	−2.06
	Apr.	−2.42	−3.09	−3.72
	May	−3.42	−4.05	−4.54
	June	−6.01	−5.76	−5.95
	July	−5.65	−6.00	−6.07
	Aug.	−5.94	−6.51	−7.16
	Sept.	−6.94	−7.71	−9.20
	Oct.	−9.64	−9.80	−9.78
	Nov.	−9.25	−8.08	−7.31
	Dec.	−7.06	−7.37	−7.35
1953	Jan.	−6.14	−6.44	−6.18
	Feb.	−5.98	−5.46	−5.64
	Mar.	−5.50	−5.79	−6.16
	Apr.	−5.97	−5.67	−5.03
	May	−4.58	−4.99	

As seen in Figure 2, the secular variations of the declination observed at Makimine and Ikuno are moderately small and their general tendencies are a monotonous increasing towards the W-direction, their amounts per year being within 3′, while their absolute values are nearly 5°19′W and 6°19′W for 1950.0 respectively. Actually the secular variations at these two stations are considered to be normal in our neighbouring regions, as discussed by E. H. Vestine [1948] and I. Tsubokawa [1952]. Contrary to these normal stations, the secular variations observed at Ogoya and Yura are, as shown in Figure 2, remarkably abnormal and have local characte-ristics. Concerning the variation at Ogoya (D=6°39′W for 1950.0) the variation during the period of October, 1951 to January, 1952 was very small, and then from the beginning of February on, the westerly change suddenly became conspicuous and its anomalously large variation continued to the middle of October, 1952, the total variation amounting to nearly 6′ during 8.5-months. The variation in the succeeding period of October, 1952 to the present time of June. 1953 has been very calm, the total amount being less than 1′ during 8-months. During the middle 8.5-months of riot, a destructive earthquake has occurred on March 7, 1952, its

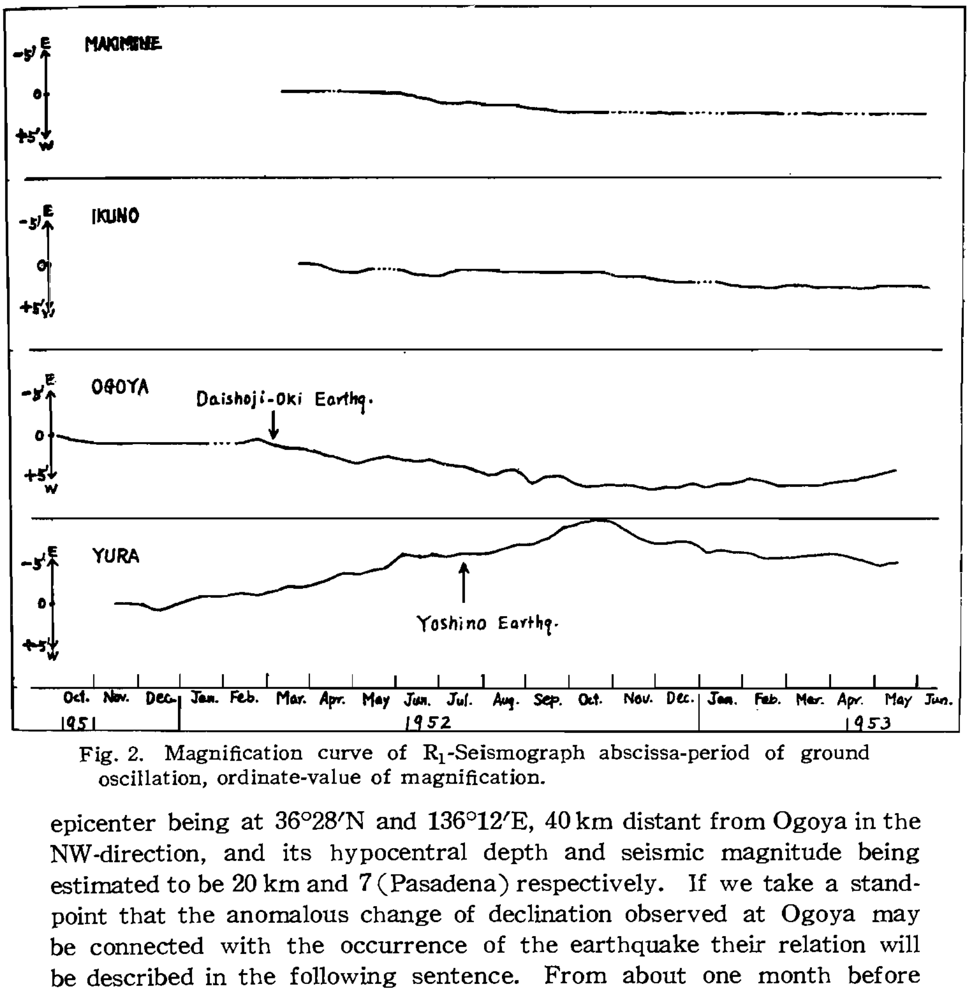

Fig. 2. Magnification curve of R_1-Seismograph abscissa-period of ground oscillation, ordinate-value of magnification.

epicenter being at 36°28′N and 136°12′E, 40 km distant from Ogoya in the NW-direction, and its hypocentral depth and seismic magnitude being estimated to be 20 km and 7 (Pasadena) respectively. If we take a standpoint that the anomalous change of declination observed at Ogoya may be connected with the occurrence of the earthquake their relation will be described in the following sentence. From about one month before the occurrence of the destructive earthquake the magnetic needle horizontally placed at Ogoya had been markedly deflected to the direction of the epicenter, and its motion continued untill about 7-months after the earthquake occurrence.

A similarly anomolous and local change of declination was also observed at Yura (D=5°53′W for 1950.0). For the first one month after the commencement of observation in November, 1951 the variation was very small, but from the middle of December, 1951 the secular variation became conspicuous, as seen in Figure 2, and moreover it pointed to the E-direction contrary to the general tendency of the westward variation observed in our country. This eastward variation continued to the middle of June, 1953, and then after a short cessation of one and a half months it again resumed its speed and reached its peak on the middle of October, 1953. The total amount of the eastward deflection observed during the 10-months between December, 1951 and October, 1952 reached the astonishingly large value of 10′. Since the day of extreme deflection the declination had been recovering from its abnormal eastward deflection and its westward motion during the recent 8-months has amounted to 5′, one half of the amount of abnormal eastward change. During the period of the short cessation of from the middle of June to the end of July, 1952, there occurred a destructive earthquake named Yoshino on July 18 in the region near Yura. The position of the epicenter, the depth of the hypocenter and the seismic magnitude of the Yoshino Earthquake are the point of 34°10′N and 135°40′E, 70 km and 7 (Pasadena) respectively. Its epicenter is 60 km distant from Yura in the ENE-direction. If we assume the connection between the abnormal change of declination observed at Yura and the occurrence of the Yoshino Earthquake, as in case of Ogoya, the following description may be permissible: Beginning on that day, 7-months before the occurrence of the Yoshino Earthquake the magnetic needle horizontally placed at Yura had been deflected more and more in the direction of the epicenter (the E-direction) and there happened a short cessation of change a month and a half before the earthquake-occurrence. The eastward deflection of the magnetic needle, which reached to the maximum point on 3-months after the earthquake-occurrence, turned its direction to W and is gradually recovering from the previous abnormal change.

In the above paragraph are mentioned two examples of an anomalous and local change of the geomagnetic declination observed at the observation station near the epicenter of a destructive earthquake. It is dangerous to impetuously conclude from only two cases that there is always an intimate connection between the occurrence of the destructive earthquake and the abnormal and local change of geomagnetism observable near the epicenter. But the above described abnormal and local changes of declination are worth noticing, and their nature and relation to the earthquake may become a fruitful subject of research in the coming year. It is convenient to note here a brief discussion on the observation of the secular variation of the geomagnetic element. In our case, the sensitivity of the declinometer is about 0'.4 per 1 mm on the magnetogram, therefore reading errors from the magnetogram calculated and reached a maximum of several millimeters distortion in the worst cases may appear as a secular variation amounting to several minutes in angle. But it is only in the worst cases, and usually their effects became negligible by their mutual cancellation. Next, it may be questioned as to whether it is appropriate or not that we take, as the day's representative value, the value given at 0-hour on each day. It is especially very difficult to determine the right value at 0-hour when a severe magneetic storm disturbs the magnetogram. But this sort of difficulty exists in every case when we determine the representative value of the day from the magnetogram, and its effect may be minimized to a certain degree by taking the overlapping mean value of several days. The curve of this several days' mean value is smoothed by reducing the short period's fluctuation and this smoothed curve is beneficially utilized to show the general tendency of secular variation.

On the instrumental errors of the declinometer, a detailed discussion was given in the previous paragraph, and, in our case, there are no doubts as to its efficiency. Next, the effect of displacement of the observation room itself must be taken into consideration. The observation room itself may suffer displacement and deformation to a certain extent by various causes such as rainfall, sunshine and others (in case of a shallowly seated room), and by earth pressure, crustal deformation and others (in case of a deeply seated room). But the effects of these phenomena on the findings are considered to be negligibly small compared with the large amount of secular variation of declination observed except where observations are undertaken under especially unfavourable conditions.

After a consideration of the various disturbances which may affect the self-recording observation of geomagnetic variation, it may safely be said that the above described secular variation of declination of a local and abnormal character can not be regarded as some illusional result caused by almost any perturbance, but is well founded. However, the most important method of discrimination is lacking in our case; at present, this type of self-recording observation requires a frequent repetition of calibrating measurement with the absolute geomagnetic equipments. And moreover it is necessary that this sort of observation is made by the concurrent setting of three instruments for declination, horizontal intensity and vertical intensity of geomagnetism. For future observation it is planned that frequent calibration by absolute measurement, and concurrent observation with three sorts of magnetometer may be put into practise. From these complete observations we hope to deduce a clear answer as to the nature of this sort of anomalous and local geomagnetic change.

In conclusion, two observed cases of the anomalous and local secular variations of geomagnetic declination are reported, in this article, with reference to the occurrence of the destructive earthquake near the observatory. Though there remain many problems to be discussed, these sorts of phenomena are considered to be very important for the future development of research concerning the connection, if existent, between the geomagnetism and the earthqake.

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