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Report on DELP 1986 Cruise in the Northwestern Pacific Part 4: Measurement of Three Components and Total Force of the Geomagnetic Field

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Abstract

During the DELP-1986 cruise, three components of the geomagnetic field and the total force intensity were measured with an STCM (Shipboard Three Component Magnetometer) and a proton precession magnetometer. STCM provides three component geomagnetic field intensities on board a research vessel, of which results can be used to identify the orientation of the magnetic lineament from only one single ship track. Our data give some additional information on the magnetic anomaly lineation patterns of the northwestern Pacific and the direction of lineation of the area surveyed by the present cruise is reexamined by the three component magnetic field data. The direction of geomagnetic anomaly lineation of this area is confirmed to run with a N70°E strike. Two vessels were used for the present study, i.e. WakashioMaru for three component magnetometer run and Daisan KaikoMaru for single proton magnetometer run.

1. Introduction

Studies of the magnetic lineation pattern in the northwestern Pacific region provide us with information on the formation of various geomorphological units in this area. One of the most important problems concerning these studies is to identify ages of the various portion of the Pacific basin and also to clarify the configuration of the ancient plates, Izanagi, Farallon and Pacific (I-F-P). There is also still controversy as to how the Shatsky Rise was formed; it is one of the biggest oceanic rises or plateaus with unresolved seismic structure. The magnetic lineament bight on the southwestern side of the Rise has also drawn marine geoscientists' attention. Systematic studies on the marine magnetic anomaly pattern of the older part of the Pacific are have been conducted by a number of geoscientists such as LARSON and PITMAN (1972), LARSON and HILDE (1975), HILDE *et al.* (1976, 1977), CANDE *et al.* (1978), TAMAKI *et al.* (1987), MAMMERICKX and SHARMAN (1988), SHARMAN and RISCH (1988), and HANDSHUMACHER *et al.* (1988). The general conclusion on the origin of the magnetic bight around the Shatsky Rise as well as the strike of the magnetic lineament in the present survey area (Fig. 1) from these studies is that the bight might have been formed as a result of opening at an R-R-R (ridge-ridge-ridge) type triple junction some time in the Mesozoic and the strike of the lineament of this area consists of two main trends, *i.e.*, N40°E and N65°E. Recently, NAKANISHI *et al.* (1989) showed that the magnetic bight around the Shatsky Rise was formed by a series of hot spot activities among I-F-P plates during 148 and 123 Ma.

The present study was planned to study the lineament of this area by making use of a three component magnetometer on board a research

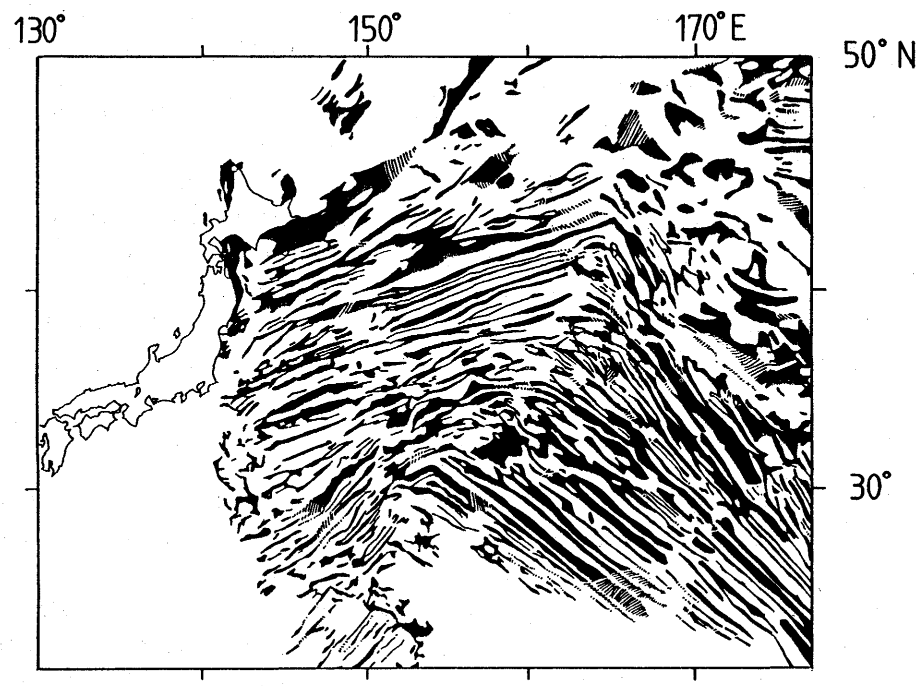

Fig. 1. Total geomagnetic anomaly lineation [ISEZAKI (1987)].

vessel, from which we might expect to acquire some knowledge on the rifting processes of the ancient R–R–R junction.

2. Methods of measurement

The bathymetric features of the present survey area and track lines are shown in Fig. 2. It is noted that there is a topographic channel along 150°E longitude. The topography in the area around the intersection of line NS and line EW is ragged, reflecting the influence of this channel. An asterisk * in Fig. 2 shows the position where the research vessel was circled to figure out the effect of the geomagnetic field on the ship's magnetization. These parameters are used to derive the magnetic moment of the ship; by subtracting the effect of this magnetization from the field data we could eliminate the bias magnetic field to obtain three true geomagnetic components. The data processing system consisted of a micro-computer, a color display, a disk unit, and a printer. The navigation system was a hybrid system of NNSS and Loran-C which was provided

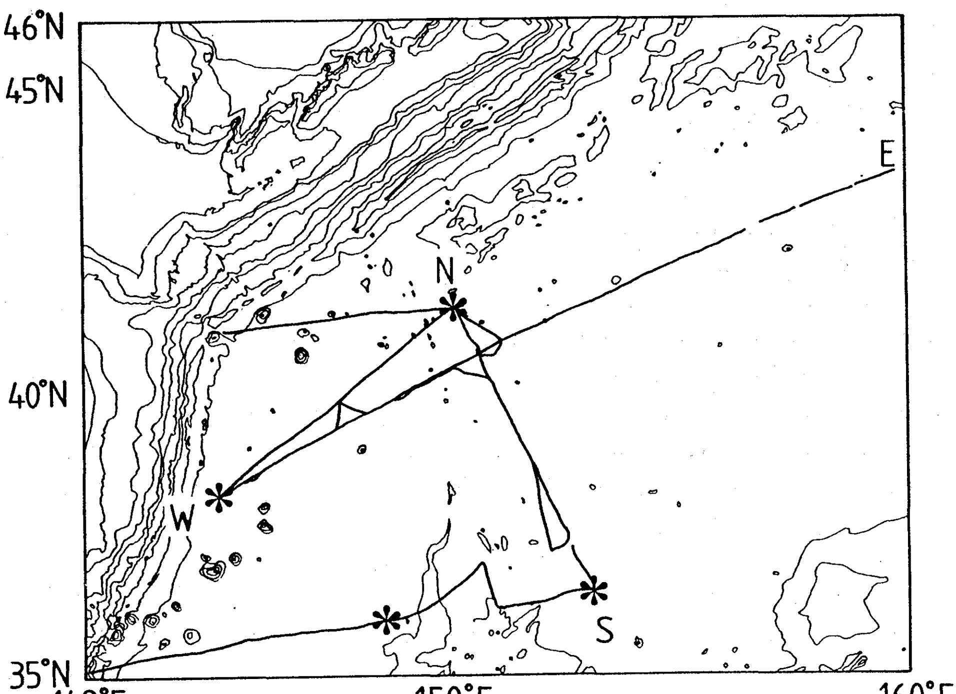

Fig. 2. The bathymetric feature of the Northwestern Pacific and track lines. The asterisk * shows the position where the research vessel was circled to figure out the effect of the geomagnetic field on the ship's magnetization.

in the bridge. More details about the STCM and its data processing are discussed by ISEZAKI (1986). The total magnetic field intensity composed from the STCM data was always checked with the output of a proton precession magnetometer towed in the stern.

The geomagnetic total force inetnsity was also measured by another proton precession magnetometer by a collaborating vessel, Daisan Kaiko Maru, during the entire DELP86 cruise period. Both the precession magnetometer systems consist of an electronic circuit, a sensor with a toroidal coil, and a towing cable with length of about 200 m. The measurement was made in the following way.

The main unit (electronic part) sends excitation signales to the sensor at 30 second intervals. In the main unit of the magnetometer the precession frequency around the geomagnetic field is fed to the microcomputer. All the data are logged on floppy disks and printed out. Geomagnetic anomalies presented in this report are calculated in reference to IGRF 1985 (IAGA DIVISION I, WORKING GROUP 1, 1985).

3. Results

3-1 STCM (shipboard three component magnetometer) on board WakashioMaru

North component anomalies: The profiles X in Figs. 3-(1), (2) and Fig. 4 present the north component anomalies on NS and EW lines. The feature of anomalies on the NS line is of a rectangular wave; this pattern seems to be typical of a deskewed anomaly pattern. The anomalies on the EW line have longer wavelengths than those on line NS, which suggests that the direction of the lineation is aligned closer to EW.

East component anomalies: The profiles Y in Figs. 3-(1), (2) and Fig. 5 present the east component anomalies on NS and EW lines. The smaller amplitude of the east component anomalies compared with the other two component anomalies (X and Z) suggests also that the strike of the lineation is aligned nearly EW.

Vertical component anomalies: Profiles Z in Figs. 3-(1), (2) and Fig. 6 present vertical component anomalies on NS and EW lines. Profile Z shows that the vertical component anomalies are more skewed than the north component anomalies. The features of the profile Z are very similar to those of the total intensity anomalies (P and cT) due to the steep geomagnetic inclination in the area.

Total intensity anomalies: The profiles cT in Figs. 3-(1) and (2) are the total intensity anomalies calculated from the three component geomagnetic

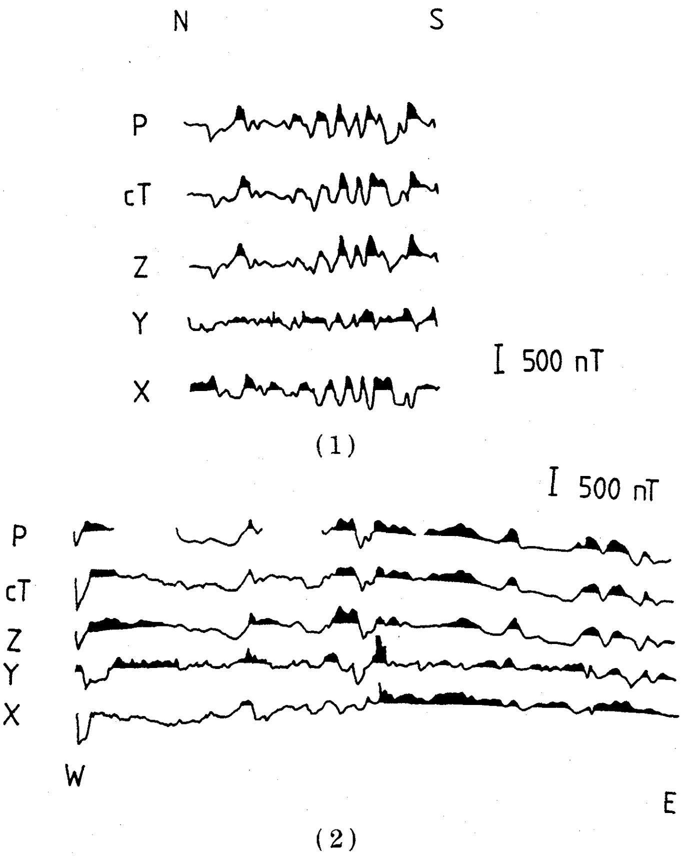

Fig. 3. (1) and (2) The profiles of three component (x, y, and z) anomalies, total intensity anomaly calculated from the three component anomalies (cT) and total intensity anomaly measured by a proton magnetometer (p).

fields as well as from those measured by a proton magnetometer. Good agreement of cT and P suggests that the stability and processing of STCM was performed correctly and produced a valid data set.

The lineation of anomalies is disturbed at many points of track lines probably due to complexities of faults in the magnetic basement (oceanic layer 2 and 3). Especially in the area where two NS and EW track lines run into each other and a deep channel is running almost north to south (Fig. 2), anomalies are highly disturbed.

As a whole, the strike of the magnetic lineament of the survey area could be calculated statistically from three component anomalies of NS and EW track lines to be N70°E.

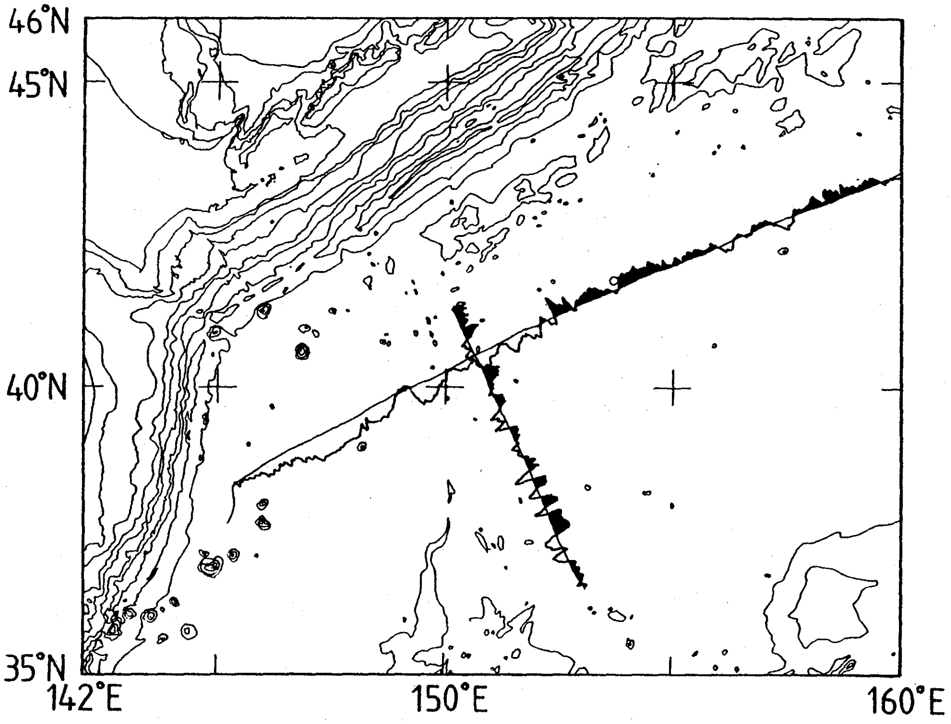

Fig. 4. X component: The profiles of north component along track lines.

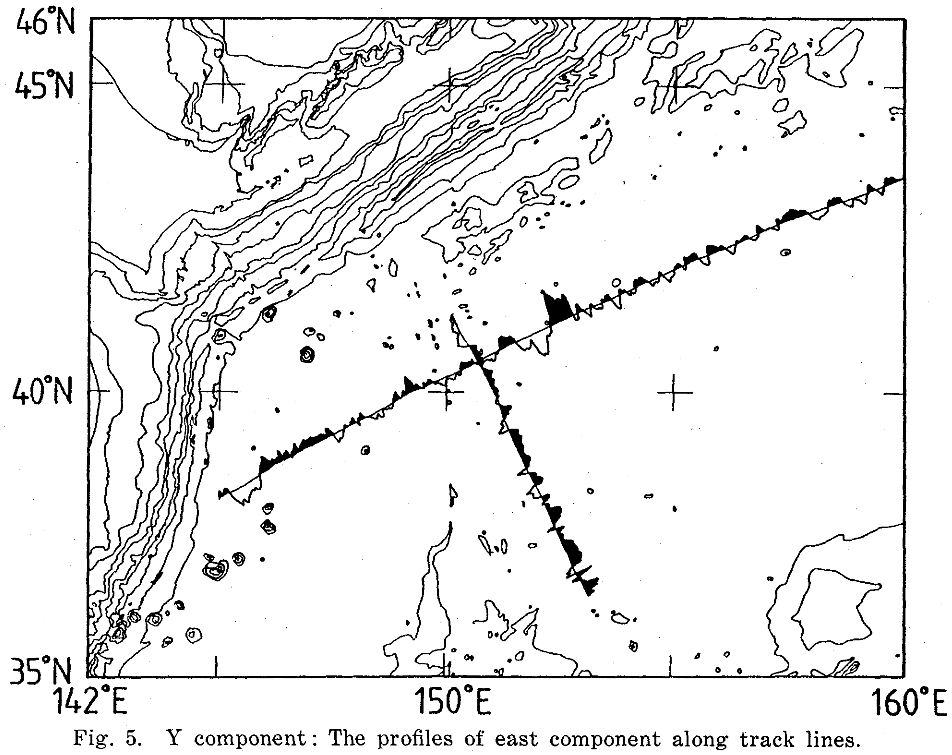

Fig. 5. Y component: The profiles of east component along track lines.

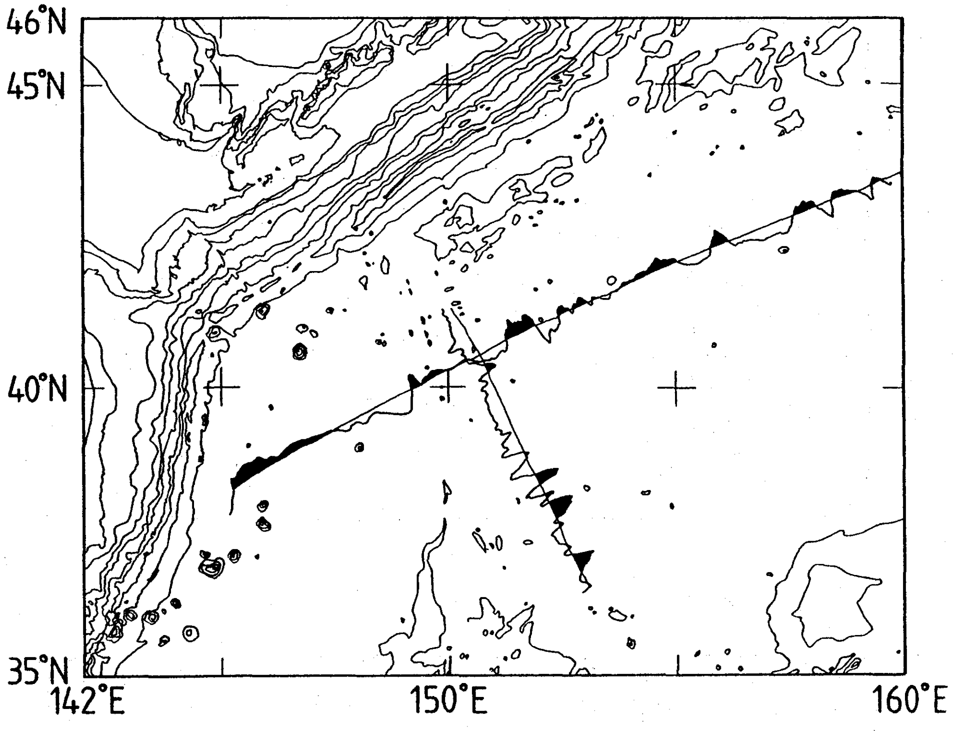

Fig. 6. Z component: The profiles of downward component along track lines.

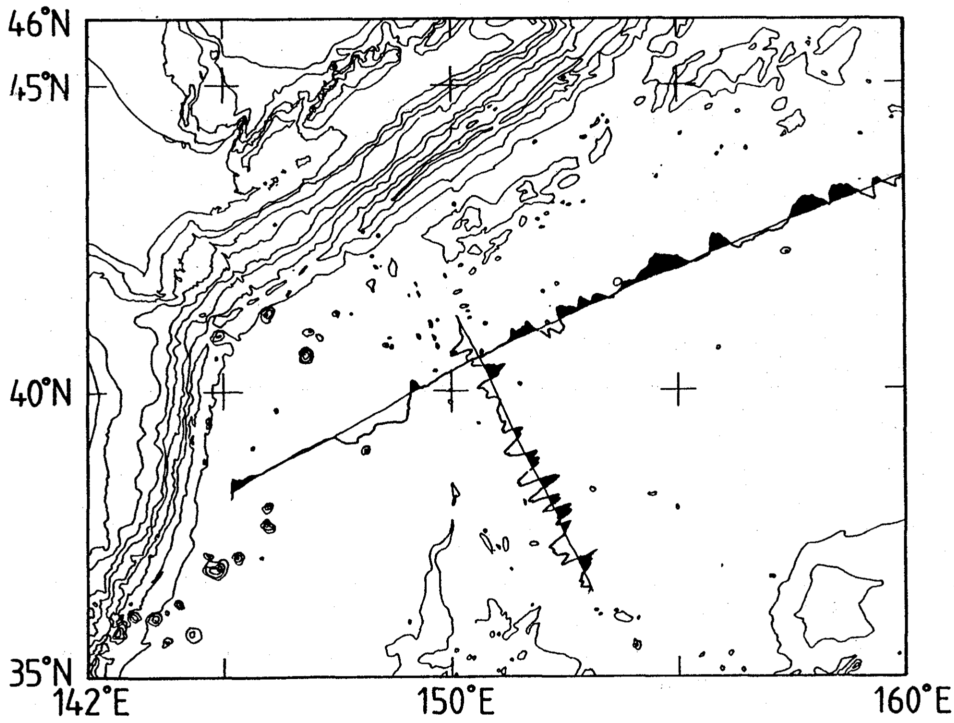

Fig. 7. The profiles of total intensity anomaly along track lines.

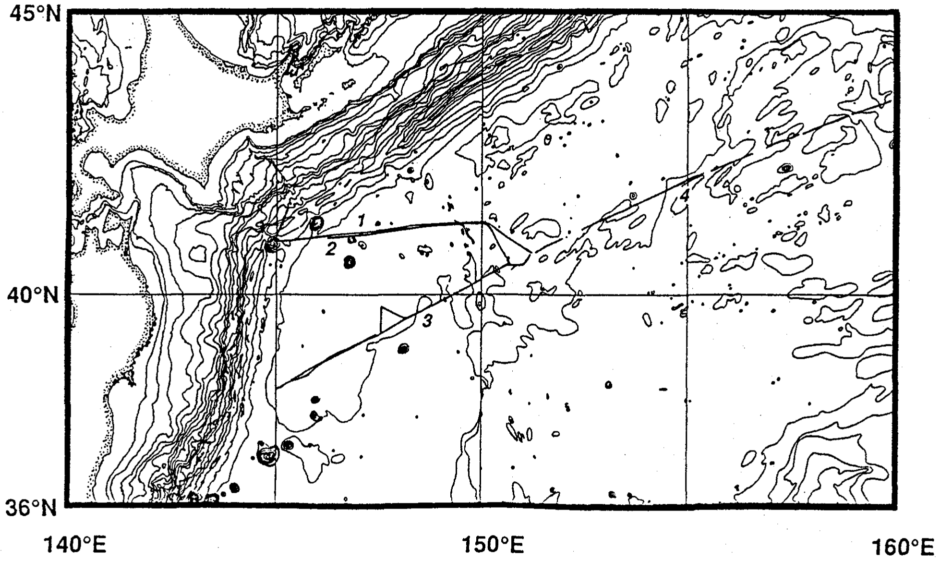

Fig. 8. Tracks of geomagnetic measurements. Numbers of lines are cited in Fig. 9.

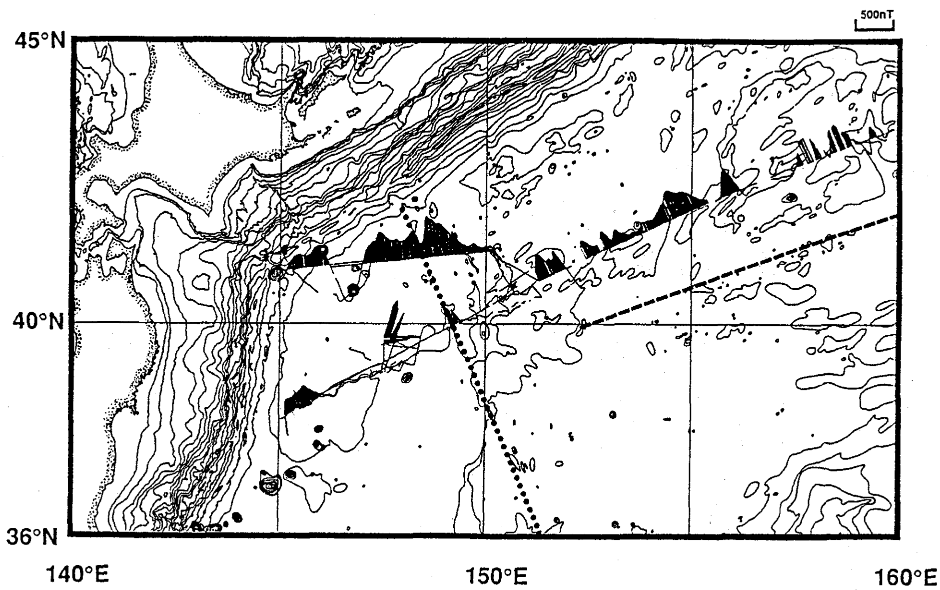

Fig. 9. The geomagnetic anomaly profiles along tracks (reference field IGRF 1985). Dotted line is the trace of the fracture zone (LARSON and CHASE, 1972), Dashed line is the track of the DSDP Leg 55.

3-2 Proton magnetometer run (Daisan KaikoMaru)

The track lines of the other vessel (Daisan KaikoMaru) are shown in Fig. 7. The geomagnetic anomaly profiles along these tracks are shown in Fig. 8. Fig. 9 shows examples of the magnetic anomaly profiles along various sections of the track lines run in the present work.

3-2-1 Profiles from 1 to 3

The peak to peak amplitudes of these profiles are about 800 nT and their wavelengths are a few hundred kilometers.

3-2-2 Profile 4

The peak-peak amplitude of this profile is about 400 nT and its wavelength is less than one hundred kilometers.

4. Discussion

The geomagnetic anomaly lineations in the northwestern Pacific have been mapped and correlated with M-sequence by several authors (*e.g.*, LARSON and CHASE, 1972; HILDE *et al.*, 1976). They showed that the strike of lineations to the south of the area of this study is about N70°E (which is consistent with the results of the present STCM study) and that their age is confined to between the Early Cretaceous and Late Jurassic.

They have also shown that a fracture zone runs in this area as shown in Fig. 9 by a dotted line. Profile 4 in Fig. 10 is situated at the eastern side of this fracture zone and is parallel to the geomagnetic anomaly lineations. Generally the wavelength of anomalies of the profile parallel

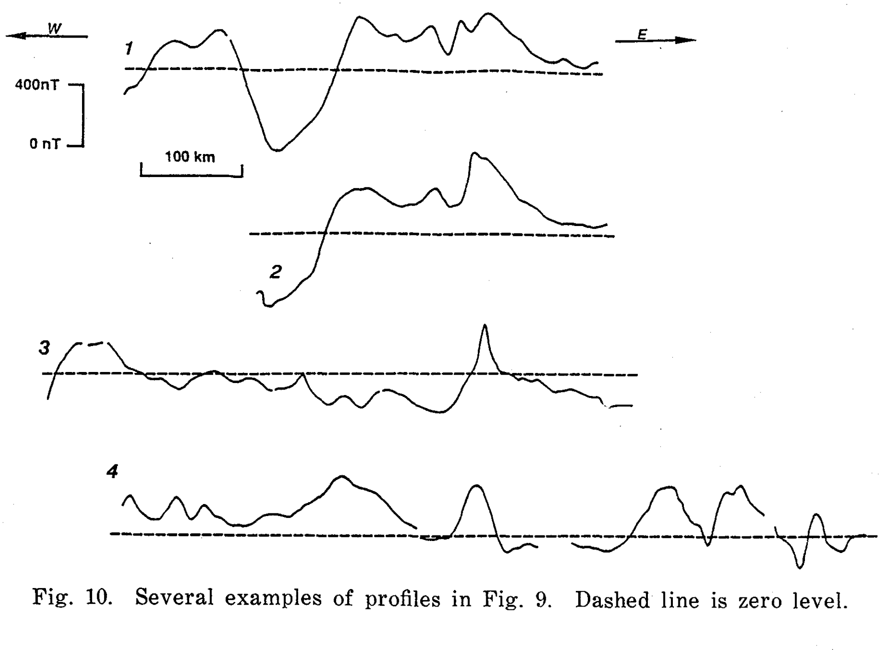

Fig. 10. Several examples of profiles in Fig. 9. Dashed line is zero level.

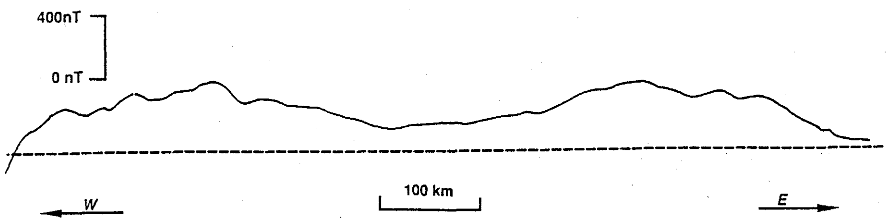

Fig. 11. The geomagnetic anomaly profile of DSDP Leg 55. Dashed line is same as Fig. 10.

to a single geomagnetic lineation is several hundred kilometers. The profile obtained by DSDP underway geophysical survey of Leg 55 along anomaly M5 (HILDE *et al.*, 1976; M5=127.52−127.97 Ma by KENT and GRADSTEIN, 1985), the dashed track line in Fig. 9, has an anomaly with a wavelength as long as 800 km (Fig. 11). But the wavelength of Profile 4 is less than one hundred kilometers. This shows that a big difference in the wavelength of magnetic anomaly field exists between track line 4 (Fig. 9) and the DSDP track line to the south of line 4, both located on the eastern side of the fracture zone. However, it is claimed by HILDE *et al.* (1976) that they could delineate the lineations between M3 and M25 (123.03–125.36 Ma, KENT and GRADSTEIN, 1985) further south in the southern area beyond the DSDP track line of Fig. 9. Therefore, the result of the present cruise suggests that tectonic events that changed the strike of geomagnetic anomaly lineations have occurred between M3 and M1 time if we can assume that the northern part of the present survey area belongs to younger ages.

Acknowledgments

Thanks are due to captains and crews of the chartered research vessels, WakashioMaru (Nippon Salvage Company) and Daisan KaikoMaru (Tokai Salvage Company) for their dedicated performance in the magnetometer experiments on rough seas hit by typhoons. The authors are also grateful to Drs. K. KOBAYASHI and K. TAMAKI, Ocean Institute, University of Tokyo, for their encouragements to the present authors to carry out magnetic measurements during the whole periods of the DELP program. This manuscript was read by several persons and the authors thank them for spending precious time.

Appendix

Geomagnetic data obtained by the present cruise, WAKASHIOMARU, are listed below. Contents of the data columns are explained as follows.

1 Three (north, east and downward) component anomalies and total intensities anomaly in nano-tesla with the sea depth every ten minutes.

2 Data list format

year : year of time measurement (I2)
month : month of time measurement (I3)
day : day of time measurement (I3)
hour : hour of time measurement (I3)
minute : minute of time measurement (I3I)
x : north component anomaly (I7)
y : east component anomaly (I7)
z : downward component anomaly (I7)
p : total intensity anomaly (I7)
lat 1 : degree of latitude (I3)
lat 2 : minute of latitude (F5.2)
lon 1 : degree of longitude (I4)
lon 2 : minute of longitude (F5.2)
depth : sea depth in meters (I6)

3 Ship positions were fixed by LORAN-C

4 When data are not available the spaces are filled with "9"s.

86	7	14	8	20	17	-36	-108	-104	36	31.90	153	7.00	5669
86	7	14	8	30	54	-197	-8	8	36	33.30	153	6.20	5700
86	7	14	8	40	5	-22	43	1	36	34.60	153	5.40	5749
86	7	14	8	50	-45	178	14	-95	36	36.10	153	4.70	5773
86	7	14	9	0	-102	265	-71	-189	36	37.50	153	4.00	5774
86	7	14	9	10	-25	278	-131	-196	36	38.90	153	3.30	5789
86	7	14	9	20	7	148	-124	-146	36	40.30	153	2.60	5806
86	7	14	9	30	54	120	-127	-105	36	41.70	153	1.80	5749
86	7	14	9	40	22	57	-100	-91	36	43.10	153	1.10	5752
86	7	14	9	50	53	73	-92	-76	36	44.50	153	0.40	5750
86	7	14	10	0	34	32	-79	-45	36	45.90	152	59.60	5761
86	7	14	10	10	25	15	-55	-11	36	47.10	152	59.00	5739
86	7	14	10	20	22	-8	-24	11	36	48.20	152	57.90	5755
86	7	14	10	30	58	-47	-38	20	36	49.60	152	57.40	5754
86	7	14	10	40	103	-45	-40	42	36	50.80	152	56.50	5747
86	7	14	10	50	33	-32	12	70	36	51.80	152	55.70	5592
86	7	14	11	0	17	-44	-27	103	36	52.50	152	54.60	5714
86	7	14	11	10	-39	-142	69	140	36	53.20	152	53.40	5641
86	7	14	12	0	117	-1	77	219	36	55.60	152	52.10	5986
86	7	14	12	10	30	-240	134	263	36	56.70	152	51.30	5791
86	7	14	12	20	67	-158	125	297	36	57.90	152	50.60	5799
86	7	14	12	30	17	-91	229	324	36	58.90	152	49.80	5781
86	7	14	12	40	70	53	280	358	37	0.00	152	49.00	5805
86	7	14	12	50	34	12	412	383	37	1.10	152	48.40	5778
86	7	14	13	0	-31	34	423	372	37	2.10	152	47.60	5771
86	7	14	13	10	-145	39	435	306	37	3.00	152	46.80	5769
86	7	14	13	20	-239	149	417	180	37	4.10	152	46.20	5715
86	7	14	13	30	-397	222	315	17	37	5.20	152	45.70	5719
86	7	14	13	40	-498	197	161	-147	37	6.30	152	45.10	5738
86	7	14	13	50	-437	291	32	-272	37	7.30	152	44.50	5784
86	7	14	14	0	-409	212	-98	-330	37	8.50	152	44.10	5790
86	7	14	14	10	-265	221	-147	-318	37	9.60	152	43.40	5761
86	7	14	14	20	-140	246	-138	-229	37	10.70	152	42.80	5793
86	7	14	14	30	-91	161	-73	-106	37	11.90	152	42.20	5761
86	7	14	14	40	-71	181	11	-43	37	13.10	152	41.50	5745
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86	7	14	15	0	-157	191	-44	-138	37	15.30	152	40.20	5818
86	7	14	17	0	-383	191	-77	-418	37	24.70	152	35.00	5894
86	7	14	17	10	-409	-30	-194	-496	37	25.70	152	34.30	5935
86	7	14	17	20	-325	-21	-307	-548	37	26.80	152	33.70	5785
86	7	14	17	30	-200	44	-395	-544	37	27.70	152	33.10	5814
86	7	14	17	40	-74	87	-415	-466	37	28.80	152	32.40	5787
86	7	14	17	50	95	137	-379	-336	37	29.90	152	31.70	5719
86	7	14	18	0	177	35	-308	-205	37	31.10	152	31.00	5773
86	7	14	18	10	221	42	-205	-107	37	32.10	152	30.40	5822
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86	7	14	21	50	-354	244	348	74	37	53.50	152	16.90	5869
86	7	14	22	0	-456	272	226	-89	37	54.50	152	16.10	5932
86	7	14	22	10	-503	288	89	-243	37	55.60	152	15.30	5803
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86	7	14	22	40	-290	185	-278	-403	37	58.80	152	13.30	5876
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86	7	15	1	20	-363	125	-107	-281	38	11.50	152	6.60	5884
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86	7	15	5	10	43	5	-447	-391	38	38.00	151	50.10	5700
86	7	15	5	20	0	-276	-454	42313	38	39.00	151	49.90	5690
86	7	15	5	50	-7	103	-493	-256	38	39.00	151	49.80	5688
86	7	15	6	0	87	-149	-354	-92	38	40.00	151	48.90	5709
86	7	15	6	10	139	-187	-262	31	38	41.10	151	48.10	5710
86	7	15	6	20	143	-118	-161	100	38	42.30	151	47.40	5699
86	7	15	6	30	126	8	-94	127	38	43.50	151	46.50	5626
86	7	15	6	40	63	-20	-73	127	38	44.60	151	45.70	5672
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86	7	15	7	0	77	84	-13	166	38	47.00	151	44.10	5674
86	7	15	7	10	43	45	50	201	38	48.20	151	43.40	5699
86	7	15	7	20	-23	84	116	195	38	49.40	151	42.60	5725
86	7	15	7	30	-158	39	105	118	38	50.70	151	41.90	5719
86	7	15	7	40	-293	10	59	3	38	52.00	151	41.20	5687
86	7	15	7	50	-343	41	-16	-107	38	53.20	151	40.50	5738
86	7	15	8	0	-412	87	-99	-204	38	54.40	151	39.80	5753
86	7	15	8	10	-425	132	-202	-290	38	55.70	151	39.10	5740

86	7	15	8	20	-416	139	-306	-378	38	57.00	151	38.50	5789
86	7	15	8	30	-327	77	-438	-430	38	58.40	151	37.80	5895
86	7	15	8	40	-188	64	-492	-373	38	59.70	151	37.00	5888
86	7	15	8	50	-3	-1	-428	-213	39	1.10	151	36.30	5859
86	7	15	9	0	44	70	-301	-83	39	2.40	151	35.60	5683
86	7	15	9	10	-33	9	-249	-75	39	3.70	151	34.80	5724
86	7	15	9	20	-89	57	-277	-145	39	5.10	151	33.90	5747
86	7	15	9	30	-15	107	-357	-174	39	6.40	151	33.20	5824
86	7	15	9	40	42	52	-350	-115	39	7.70	151	32.20	5531
86	7	15	9	50	91	69	-298	-25	39	9.00	151	31.40	5526
86	7	15	10	0	100	-21	-207	36	39	10.40	151	30.60	5508
86	7	15	10	40	90	178	-176	55	39	12.50	151	29.30	5451
86	7	15	10	50	111	-64	-169	59	39	13.90	151	28.50	5444
86	7	15	11	0	131	-183	-132	82	39	15.30	151	27.60	5372
86	7	15	11	10	95	-102	-99	114	39	16.70	151	26.70	5542
86	7	15	11	20	27	44	-53	118	39	18.00	151	25.70	5529
86	7	15	11	30	-34	165	-75	59	39	19.30	151	24.80	5533
86	7	15	11	40	-141	126	-116	-57	39	20.60	151	23.70	5514
86	7	15	11	50	-220	-72	-233	-168	39	21.90	151	22.80	5488
86	7	15	12	0	-187	-98	-313	-215	39	23.10	151	21.80	5382
86	7	15	12	10	-118	-154	-310	-186	39	24.50	151	20.90	5443
86	7	15	12	20	-76	-172	-247	-113	39	25.80	151	20.10	5436
86	7	15	12	30	-40	-137	-169	-37	39	27.00	151	19.10	5445
86	7	15	12	40	-97	-65	-105	-23	39	28.40	151	18.20	5513
86	7	15	12	50	-132	-108	-151	-68	39	29.80	151	17.50	5505
86	7	15	13	0	-102	-54	-167	-98	39	31.20	151	16.70	5350
86	7	15	13	10	-136	-60	-191	-108	39	32.50	151	15.70	5337
86	7	15	13	20	-171	-63	-208	-121	39	33.90	151	14.90	5229
86	7	15	13	30	-111	-50	-228	-136	39	35.20	151	13.90	5252
86	7	15	13	40	-36	67	-239	-145	39	36.60	151	13.20	5286
86	7	15	13	50	-4	134	-248	-149	39	38.00	151	12.50	5313
86	7	15	14	0	20	163	-257	-138	39	39.30	151	11.70	5343
86	7	15	14	10	31	97	-252	-118	39	40.70	151	10.80	5364
86	7	15	14	20	20	79	-238	-110	39	42.10	151	10.00	5383
86	7	15	14	30	36	45	-240	-119	39	43.50	151	9.40	5394
86	7	15	15	10	134	256	-296	-101	39	44.50	151	9.40	5354
86	7	15	15	20	141	42	-300	-90	39	45.70	151	8.50	5222
86	7	15	15	30	128	-130	-271	-54	39	47.20	151	7.40	5382
86	7	15	15	40	146	-87	-242	-7	39	48.50	151	6.40	5440
86	7	15	15	50	128	90	-191	6	39	49.90	151	5.50	5425
86	7	15	16	0	124	134	-187	9	39	51.10	151	4.50	5405
86	7	15	16	10	99	77	-141	26	39	52.50	151	3.30	5422
86	7	15	16	20	-24	71	-140	-15	39	53.90	151	2.40	5333
86	7	15	16	30	-106	51	-227	-128	39	55.30	151	1.60	5311
86	7	25	15	0	82	-56	-205	-1	41	19.50	150	6.80	5384
86	7	25	15	10	139	237	-199	-13	41	18.50	150	7.70	5583
86	7	25	15	20	141	127	-228	-35	41	17.60	150	8.60	5526
86	7	25	15	30	158	19	-234	-48	41	16.30	150	9.20	5934
86	7	25	15	40	152	-109	-232	-53	41	15.20	150	9.90	5421
86	7	25	15	50	163	-109	-238	-63	41	14.00	150	10.70	5929
86	7	25	16	0	154	-134	-217	-73	41	12.90	150	11.50	5907
86	7	25	16	10	124	-134	-248	-73	41	11.70	150	12.30	5936
86	7	25	16	20	115	-143	-227	-62	41	10.50	150	12.90	6644
86	7	25	16	30	132	-100	-236	-47	41	9.40	150	13.70	6815
86	7	25	16	40	142	-123	-243	-48	41	8.30	150	14.60	5730
86	7	25	16	50	138	-146	-234	-59	41	7.10	150	15.30	6118
86	7	25	17	0	167	-82	-243	-69	41	6.00	150	16.00	6420
86	7	25	17	10	199	24	-258	-67	41	4.90	150	16.80	5859
86	7	25	17	20	175	40	-275	-69	41	3.80	150	17.70	5900
86	7	25	17	30	115	-96	-252	-83	41	2.70	150	18.60	6516

86	7	25	17	40	98	-106	-265	-94	41	1.70	150	19.50	6925
86	7	25	17	50	100	-116	-259	-93	41	0.60	150	20.40	7235
86	7	25	18	0	112	-129	-252	-83	40	59.50	150	21.10	7532
86	7	25	18	10	164	-74	-278	-78	40	58.40	150	21.90	7899
86	7	25	18	20	102	-176	-257	-75	40	57.40	150	22.90	619
86	7	25	18	30	220	-148	-264	-71	40	56.40	150	23.80	5657
86	7	25	18	40	223	-108	-276	-71	40	55.20	150	24.50	6107
86	7	25	18	50	275	-134	-347	-89	40	54.10	150	25.40	5550
86	7	25	19	0	294	-160	-415	-158	40	53.10	150	26.30	5496
86	7	25	19	10	214	-123	-504	-283	40	52.00	150	27.30	5958
86	7	25	19	20	146	-106	-585	-413	40	50.90	150	28.20	6141
86	7	25	19	30	-19	-26	-572	-488	40	49.70	150	29.00	6595
86	7	25	19	40	-148	16	-457	-475	40	48.60	150	29.90	6762
86	7	25	19	50	-170	-36	-396	-413	40	47.50	150	30.90	5619
86	7	25	20	0	-169	-8	-335	-363	40	46.40	150	32.00	5915
86	7	25	20	10	-147	31	-294	-318	40	45.20	150	32.80	6300
86	7	25	20	20	-106	49	-274	-274	40	44.00	150	33.70	5248
86	7	25	20	30	-68	-11	-262	-240	40	42.80	150	34.50	5909
86	7	25	20	40	-66	-32	-250	-224	40	41.80	150	35.60	6267
86	7	25	20	50	-63	-24	-238	-192	40	40.40	150	36.00	6620
86	7	25	21	0	-7	-23	-256	-171	40	39.30	150	36.80	7052
86	7	25	21	10	-54	-1	-255	-197	40	38.10	150	37.70	5598
86	7	25	21	20	-85	-82	-317	-237	40	36.90	150	38.20	5743
86	7	25	21	30	-124	-5	-326	-275	40	35.80	150	39.10	5870
86	7	25	21	40	-153	33	-288	-287	40	34.50	150	39.60	5973
86	7	25	21	50	-156	52	-273	-269	40	33.30	150	40.40	6505
86	7	25	22	0	-163	58	-236	-244	40	32.20	150	41.10	6804
86	7	25	22	10	-201	55	-181	-222	40	31.00	150	41.90	5402
86	7	25	22	20	-243	-3	-153	-203	40	29.70	150	42.60	5520
86	7	25	22	30	-217	51	-152	-188	40	28.50	150	43.60	5849
86	7	25	22	40	-165	74	-110	-158	40	27.20	150	44.60	6101
86	7	25	22	50	-240	66	-50	-118	40	26.00	150	45.30	6735
86	7	25	23	0	-197	117	-1	-69	40	24.80	150	46.30	7256
86	7	25	23	10	-202	117	79	12	40	23.60	150	47.00	7686
86	7	25	23	20	-148	58	166	108	40	22.60	150	47.80	5493
86	7	25	23	30	-35	60	193	210	40	21.60	150	48.50	5485
86	7	25	23	40	66	13	213	279	40	20.60	150	49.20	5707
86	7	25	23	50	179	1	133	297	40	19.60	150	49.70	6239
86	7	26	0	0	272	52	69	329	40	18.70	150	50.60	6776
86	7	26	0	10	277	160	21	239	40	17.60	150	50.90	7139
86	7	26	0	20	241	72	-9	202	40	16.80	150	51.30	5335
86	7	26	0	30	234	47	-67	175	40	16.10	150	51.70	5410
86	7	26	0	40	256	32	-81	160	40	15.40	150	52.00	5897
86	7	26	0	50	257	47	-86	146	40	14.50	150	51.90	5435
86	7	26	1	0	250	126	-91	141	40	14.00	150	52.40	5473
86	7	26	1	10	258	-39	-88	130	40	13.50	150	52.80	5460
86	7	26	1	20	254	-44	-166	68	40	12.10	150	53.30	5577
86	7	26	1	30	227	-8	-246	-23	40	10.70	150	54.10	5815
86	7	26	1	40	210	37	-331	-135	40	9.50	150	54.80	5398
86	7	26	1	50	47	62	-349	-244	40	8.20	150	55.50	5907
86	7	26	2	0	-44	75	-288	-265	40	6.90	150	56.30	6190
86	7	26	2	10	-109	101	-161	-177	40	5.60	150	57.20	6561
86	7	26	2	20	-30	61	-106	-67	40	4.20	150	58.00	6974
86	7	26	2	30	49	-13	-136	-29	40	3.00	150	58.90	5296
86	7	26	2	40	83	-122	-202	-78	40	1.70	150	59.60	5613
86	7	26	2	50	53	-31	-267	-174	40	0.20	151	0.20	5924
86	7	26	3	0	-44	23	-264	-237	39	59.00	151	1.30	5335
86	7	26	3	10	-119	75	-214	-243	39	57.90	151	1.90	5689
86	7	26	3	20	-175	107	-120	-189	39	56.70	151	3.00	5381
86	7	26	3	30	-109	35	-134	-108	39	55.70	151	4.00	5982

86	7	26	3	40	-38	-25	-82	-34	39	54.10	151	3.40	5675
86	7	26	3	50	69	-2	-108	10	39	52.90	151	3.00	6232
86	7	26	4	0	-69	84	8	29	39	52.10	151	2.30	5373
86	7	21	18	50	136	335	104	999999	41	11.80	152	25.30	5338
86	7	21	19	0	93	255	101	999999	41	11.60	152	25.00	5304
86	7	21	19	10	172	233	66	999999	41	11.30	152	24.60	5295
86	7	21	19	20	-17	20	-8	999999	41	11.10	152	24.10	5264
86	7	21	19	30	-56	27	-85	999999	41	10.80	152	23.00	5225
86	7	21	19	40	-52	86	-102	999999	41	10.70	152	22.10	5180
86	7	21	19	50	-24	243	-145	999999	41	10.20	152	20.60	5157
86	7	21	20	0	-11	135	-158	999999	41	9.80	152	19.50	5279
86	7	21	20	10	-63	133	-178	-191	41	9.40	152	18.40	5311
86	7	21	20	20	-68	78	-192	-207	41	9.10	152	17.40	5309
86	7	21	20	30	-59	76	-213	-214	41	8.60	152	16.10	5290
86	7	21	20	40	-25	13	-231	-220	41	8.10	152	14.90	5296
86	7	21	20	50	-25	-64	-265	-222	41	7.70	152	13.90	5262
86	7	21	21	0	14	-120	-228	-199	41	7.30	152	12.80	5087
86	7	21	21	10	96	-115	-186	-146	41	6.70	152	11.50	5015
86	7	21	21	20	88	-148	-165	-96	41	6.30	152	10.40	5007
86	7	21	21	30	101	-114	-170	-65	41	5.70	152	9.10	5022
86	7	21	21	40	105	-140	-228	-84	41	5.40	152	8.20	5428
86	7	21	21	50	61	-127	-279	-153	41	4.90	152	7.10	5434
86	7	21	22	0	4	-109	-360	-246	41	4.50	152	5.80	5422
86	7	21	22	10	-84	-156	-378	-328	41	4.00	152	4.70	5410
86	7	21	22	20	-113	-287	-367	-359	41	3.50	152	3.20	5387
86	7	21	22	30	-186	-360	-286	-328	41	3.20	152	2.10	5365
86	7	21	22	40	-194	-423	-189	-260	41	2.80	152	0.90	5346
86	7	21	22	50	-208	-442	-121	-179	41	2.30	151	59.40	5308
86	7	21	23	0	-228	-457	-53	-115	41	2.00	151	58.40	5307
86	7	21	23	10	-237	-495	27	-61	41	1.70	151	57.20	5303
86	7	21	23	20	-177	-485	90	8	41	1.30	151	55.90	5309
86	7	21	23	30	-206	-454	166	81	41	0.80	151	54.30	5286
86	7	21	23	40	-195	-342	242	148	41	0.40	151	53.10	5403
86	7	21	23	50	-183	-328	296	203	40	59.80	151	51.40	5402
86	7	22	0	0	-176	-213	323	282	40	59.50	151	50.30	5385
86	7	22	0	10	-140	-146	301	228	40	58.90	151	48.80	5404
86	7	22	0	20	-91	-40	284	197	40	58.50	151	47.50	5424
86	7	22	0	30	-66	-45	199	159	40	58.00	151	46.20	5443
86	7	22	0	40	-82	-84	162	140	40	57.80	151	45.50	5437
86	7	22	0	50	-103	-174	173	144	40	57.20	151	43.80	5435
86	7	22	1	0	-68	-202	196	159	40	56.80	151	42.60	5443
86	7	22	1	10	-59	-214	217	175	40	56.30	151	41.20	5427
86	7	22	1	20	-95	-234	195	175	40	55.80	151	39.70	5439
86	7	22	1	30	-143	-227	207	164	40	55.50	151	38.70	5422
86	7	22	1	40	-102	-204	207	161	40	54.80	151	37.00	5442
86	7	22	1	50	-92	-227	204	166	40	54.50	151	35.90	5411
86	7	22	2	0	-168	-231	245	185	40	54.00	151	34.40	5406
86	7	22	2	10	-154	-209	299	211	40	53.60	151	33.20	5399
86	7	22	2	20	-164	-173	327	242	40	53.10	151	31.80	5396
86	7	22	2	30	-235	-107	349	245	40	52.70	151	30.50	5398
86	7	22	2	40	-245	-58	339	235	40	52.30	151	29.20	5409
86	7	22	2	50	-249	-38	320	206	40	51.90	151	27.90	5404
86	7	22	3	0	-254	-19	315	165	40	51.50	151	26.60	5415
86	7	22	3	10	-275	103	261	126	40	51.00	151	25.30	5415
86	7	22	3	20	-299	133	206	94	40	50.70	151	24.10	5440
86	7	22	3	30	-246	158	171	63	40	50.20	151	22.70	5519
86	7	22	3	40	-227	146	134	34	40	49.70	151	21.50	5473
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86	7	22	4	0	-83	192	102	41	40	48.70	151	18.80	5442
86	7	22	4	10	-90	143	80	38	40	48.20	151	17.50	5472

86	7	22	4	20	-21	146	13	4	40	47.70	151	16.20	5562
86	7	22	4	30	-25	107	-48	-38	40	47.20	151	15.00	5556
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86	7	22	4	50	19	115	-122	-104	40	46.00	151	12.40	5508
86	7	22	5	0	4	-25	-100	-113	40	45.50	151	11.10	5490
86	7	22	5	30	36	143	-37	-74	40	43.80	151	7.30	5222
86	7	22	5	40	2	71	-61	-101	40	43.10	151	5.90	5288
86	7	22	5	50	18	62	-117	999999	40	42.70	151	5.00	5308
86	7	22	6	0	-21	-57	-163	999999	40	42.20	151	4.00	5321
86	7	22	6	10	-31	-89	-165	999999	40	41.70	151	3.10	5339
86	7	22	6	20	-121	-12	-218	999999	40	41.10	151	1.70	5339
86	7	22	6	30	-158	-43	-187	999999	40	40.50	151	0.50	5339
86	7	22	6	40	-132	-88	-170	999999	40	40.00	150	59.40	5387
86	7	22	6	50	-142	-131	-195	999999	40	39.50	150	58.10	5393
86	7	22	7	0	-120	-117	-209	999999	40	38.90	150	56.90	5395
86	7	22	7	10	-207	-133	-192	999999	40	38.30	150	55.50	5402
86	7	22	7	20	-162	-101	-172	999999	40	37.90	150	54.40	5448
86	7	22	7	30	-182	-62	-181	999999	40	37.30	150	53.00	5421
86	7	22	7	40	-275	-118	-184	999999	40	37.00	150	52.00	5356
86	7	22	7	50	-218	-95	-180	999999	40	36.40	150	50.50	5291
86	7	22	8	0	-256	-79	-183	999999	40	36.00	150	49.50	5277
86	7	22	8	10	-250	-52	-196	999999	40	35.40	150	48.10	5280
86	7	22	8	20	-252	-74	-177	999999	40	35.00	150	46.80	5267
86	7	22	8	30	-253	-100	-173	999999	40	34.40	150	45.20	5254
86	7	22	8	40	-240	-86	-195	999999	40	34.00	150	44.10	5285
86	7	22	8	50	-286	5	-205	999999	40	33.60	150	42.80	5366
86	7	22	9	0	-192	62	-208	999999	40	33.10	150	41.30	5489
86	7	22	9	10	-197	77	-199	999999	40	32.60	150	39.90	5331
86	7	22	9	20	-185	29	-192	999999	40	32.20	150	38.60	5300
86	7	22	9	30	-37	-25	-104	999999	40	31.70	150	37.30	5446
86	7	22	9	40	15	-16	-90	999999	40	31.20	150	36.00	5445
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86	7	22	10	0	-37	69	-80	999999	40	30.20	150	33.30	5638
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86	7	22	10	40	-74	1	-25	999999	40	28.20	150	27.90	5208
86	7	22	10	50	-140	-29	-11	999999	40	27.70	150	26.60	5429
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86	7	22	11	30	-150	-2	6	999999	40	25.80	150	21.50	4892
86	7	22	11	40	-190	42	-16	999999	40	25.20	150	20.00	4909
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86	7	22	22	50	-80	40	-384	-371	39	51.40	148	50.00	5486
86	7	22	23	0	-124	-34	-356	-376	39	50.60	148	48.20	5478
86	7	22	23	10	-174	-8	-358	-375	39	49.80	148	46.40	5501
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86	7	23	4	30	-351	-66	-121	-308	39	22.20	147	42.70	5375
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86	7	23	23	20	-156	-373	-21	193	38	17.90	145	18.40	5320
86	7	23	23	30	-321	-361	-7	179	38	17.30	145	17.20	5337
86	7	23	23	40	-457	-296	-16	143	38	17.00	145	15.90	5301
86	7	23	23	50	-362	-167	-55	96	38	16.70	145	14.80	5317
86	7	24	0	0	-478	-27	-134	91	38	16.40	145	13.50	5362
86	7	24	0	10	-514	21	-90	-15	38	16.10	145	12.40	5280
86	7	24	0	20	-506	113	-162	-70	38	15.80	145	11.20	5307
86	7	24	0	30	-512	74	-178	-124	38	15.50	145	10.10	5315
86	7	24	0	40	-525	40	-201	-177	38	15.20	145	9.00	5270
86	7	24	0	50	-578	44	-233	-224	38	14.80	145	7.80	5294
86	7	24	1	0	-566	92	-340	-270	38	14.40	145	6.70	5330
86	7	24	1	10	-629	125	-392	-308	38	14.00	145	5.60	5295
86	7	24	1	20	-719	116	-445	-340	38	13.50	145	4.50	5417
86	7	24	1	30	-617	83	-403	-369	38	13.00	145	3.20	5306
86	7	16	10	30	391	509	-82	130	41	12.00	152	24.10	5262
86	7	16	10	40	447	511	36	192	41	12.60	152	25.70	5319
86	7	16	10	50	154	482	29	224	41	13.10	152	27.10	5343
86	7	16	11	0	180	269	31	234	41	13.70	152	28.70	5129
86	7	16	11	10	303	393	84	233	41	14.30	152	30.20	4872
86	7	16	11	20	167	418	33	219	41	14.70	152	31.60	5646
86	7	16	11	30	150	426	147	201	41	15.20	152	33.00	5712
86	7	16	11	40	189	283	72	182	41	15.70	152	34.80	5623
86	7	16	11	50	149	134	63	160	41	16.20	152	36.30	5684
86	7	16	12	0	110	369	13	143	41	16.50	152	37.50	6492
86	7	16	12	10	16	341	73	125	41	17.10	152	39.20	6377
86	7	16	12	20	84	179	-23	112	41	17.40	152	40.60	6279
86	7	16	12	30	234	354	-14	109	41	17.90	152	42.30	6006
86	7	16	12	50	228	15	-43	108	41	18.60	152	44.80	5629
86	7	16	13	0	68	-9	-48	113	41	19.00	152	46.30	5613
86	7	16	13	40	95	-87	66	52	41	19.70	152	47.80	5996
86	7	16	13	50	25	-55	59	66	41	20.30	152	49.30	5910
86	7	16	14	0	-12	3	95	92	41	21.20	152	51.50	5894
86	7	16	14	10	77	152	104	132	41	21.90	152	53.70	5902
86	7	16	14	20	89	85	149	181	41	22.80	152	56.20	4866
86	7	16	14	30	122	-4	141	200	41	23.40	152	58.30	5339
86	7	16	14	40	110	-83	97	162	41	24.40	153	1.00	5327
86	7	16	14	50	143	-78	34	102	41	25.10	153	3.10	5274
86	7	16	15	0	165	-111	-20	55	41	25.80	153	5.40	5326
86	7	16	15	10	184	13	-41	52	41	26.60	153	7.70	5618
86	7	16	15	20	156	62	-2	88	41	27.30	153	10.10	5419
86	7	16	15	30	160	-47	51	133	41	28.10	153	12.40	5394
86	7	16	15	40	229	-61	36	152	41	28.90	153	14.70	5412
86	7	16	15	50	190	-72	29	135	41	29.60	153	16.90	5416
86	7	16	16	0	229	-83	13	94	41	30.40	153	19.30	5408
86	7	16	16	10	186	37	-40	70	41	31.20	153	21.90	5372
86	7	16	16	20	108	30	-43	50	41	31.80	153	23.90	5606
86	7	16	16	30	82	3	-55	14	41	32.60	153	26.30	5623
86	7	16	16	40	-44	95	-61	-16	41	33.40	153	28.80	5589

86	7	16	16	50	71	39	-87	-19	41	34.10	153	31.20	5585
86	7	16	17	0	75	97	-55	-7	41	35.10	153	33.40	5690
86	7	16	17	10	87	-86	-18	9	41	35.90	153	35.30	5549
86	7	17	3	10	95	-27	-167	-63	42	14.50	155	32.80	5593
86	7	17	3	20	45	-62	-154	-48	42	15.50	155	35.10	5562
86	7	17	3	30	28	-165	-143	-55	42	16.40	155	37.60	5481
86	7	17	3	40	-41	-129	-147	-65	42	17.30	155	40.30	5485
86	7	17	3	50	27	-15	-103	-44	42	17.90	155	42.40	5488
86	7	17	4	0	1	134	-82	0	42	18.70	155	44.90	5506
86	7	17	4	10	-5	152	-20	60	42	19.20	155	46.90	5502
86	7	17	4	20	30	171	28	126	42	20.00	155	49.50	5485
86	7	17	4	30	87	145	101	192	42	20.60	155	51.70	5516
86	7	17	4	40	67	92	163	249	42	21.20	155	54.10	5508
86	7	17	4	50	18	48	212	282	42	22.10	155	56.60	5504
86	7	17	5	0	27	58	210	278	42	22.40	155	58.50	5465
86	7	17	5	10	-22	18	235	245	42	23.20	156	1.00	5480
86	7	17	5	20	-50	4	186	187	42	24.00	156	3.30	5478
86	7	17	5	30	-105	-29	132	114	42	24.80	156	5.90	5458
86	7	17	5	40	-120	-100	61	31	42	25.60	156	8.10	5512
86	7	17	5	50	-131	-102	-22	-50	42	26.20	156	10.30	5579
86	7	17	6	0	-150	-63	-97	-108	42	27.00	156	12.80	5676
86	7	17	6	10	-152	-53	-140	-138	42	27.80	156	15.20	5788
86	7	17	6	20	-44	-11	-138	-140	42	28.40	156	17.50	5726
86	7	17	6	30	-9	-2	-149	-130	42	29.00	156	19.60	5778
86	7	17	6	40	-4	-5	-145	-127	42	29.70	156	21.90	5843
86	7	17	6	50	48	7	-109	-118	42	30.40	156	24.20	5440
86	7	17	7	0	49	64	-125	-101	42	31.30	156	26.70	5346
86	7	17	7	10	64	29	-105	-95	42	32.10	156	29.20	5381
86	7	17	7	20	56	62	-110	-103	42	32.60	156	31.20	5419
86	7	17	7	30	28	20	-149	-116	42	33.30	156	33.50	5408
86	7	17	7	40	99	37	-139	-117	42	34.30	156	36.60	5379
86	7	17	7	50	-14	-29	-152	999999	42	34.90	156	38.70	5450
86	7	17	8	30	22	-60	-185	-97	42	36.40	156	41.80	5433
86	7	17	8	40	59	-47	-221	-106	42	37.20	156	44.20	5395
86	7	17	8	50	48	-14	-208	-113	42	38.20	156	47.10	5398
86	7	17	9	0	108	67	-245	-111	42	38.70	156	48.90	5379
86	7	17	9	10	25	4	-209	-101	42	39.60	156	51.60	5394
86	7	17	9	20	76	-57	-226	-95	42	40.10	156	53.50	5423
86	7	17	9	30	65	7	-242	-98	42	41.00	156	56.10	5456
86	7	17	9	40	62	46	-246	-106	42	41.50	156	57.90	5418
86	7	17	9	50	46	40	-255	-115	42	42.40	157	0.80	5428
86	7	17	10	0	82	27	-268	-131	42	43.10	157	3.00	5445
86	7	17	10	10	80	22	-248	-133	42	43.70	157	5.00	5445
86	7	17	10	20	101	-46	-255	-133	42	44.60	157	7.50	5454
86	7	17	10	30	51	-49	-248	-134	42	45.20	157	9.80	5449
86	7	17	10	40	32	-18	-236	-138	42	46.10	157	12.40	5454
86	7	17	10	50	9	97	-272	-139	42	46.30	157	13.70	5458
86	7	17	11	0	-60	90	-314	-144	42	47.40	157	16.60	5505
86	7	17	11	10	-41	123	-319	-147	42	48.20	157	19.00	5510
86	7	17	11	20	-122	30	-298	-145	42	48.70	157	21.10	5524
86	7	17	11	30	-136	82	-282	-127	42	49.60	157	24.00	5513
86	7	17	11	40	-182	140	-281	-110	42	49.90	157	26.20	5487
86	7	17	11	50	-148	191	-251	-93	42	50.50	157	28.60	5424
86	7	17	12	0	-160	164	-191	-62	42	50.90	157	30.80	5543
86	7	17	12	10	-147	141	-126	-20	42	51.50	157	33.40	5516
86	7	17	12	20	-130	48	-90	24	42	52.00	157	35.70	5549
86	7	17	12	30	-47	118	-44	79	42	52.60	157	38.10	5602
86	7	17	12	40	21	235	5	121	42	53.40	157	40.50	5617
86	7	17	12	50	37	78	47	157	42	54.10	157	42.60	5584
86	7	17	13	0	65	-81	67	999999	42	54.80	157	44.40	5577

86	7	17	13	20	-31	-63	134	999999	42	55.70	157	47.00	5558
86	7	17	13	30	-112	-58	132	999999	42	55.80	157	47.40	5565
86	7	17	13	40	46	233	137	196	42	56.00	157	47.90	5561
86	7	17	13	50	49	151	134	214	42	56.70	157	50.20	5530
86	7	17	14	0	39	103	141	225	42	57.90	157	53.20	5580
86	7	17	14	10	84	46	154	231	42	58.60	157	55.40	5564
86	7	17	14	20	54	-6	155	239	42	59.40	157	57.80	5476
86	7	17	14	30	137	-62	133	228	42	60.20	158	0.40	5336
86	7	17	14	40	87	-139	68	188	43	0.80	158	2.80	5363
86	7	17	14	50	111	-152	2	136	43	1.30	158	5.20	5422
86	7	17	15	0	159	-160	-87	78	43	1.90	158	7.50	5473
86	7	17	15	10	176	-119	-147	53	43	2.70	158	10.30	5689

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Part 4　地磁気三成分及び全磁力異常分布調査

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1986年度夏期に実施されたDELP並びに地震予知共同観測で得られた，地磁気三成分（水平二成分，鉛直一成分）及び全磁力の異常分布について報告する．三成分の測定は船舶用フラックスゲート磁力計により，全磁力は，プロトン型磁力計により行われ，両者間では補正を行なうことが可能である．また三成分磁力計はジャイロによる方位の測定と船体磁気の補正により，地理方位三成分の値として得られる．三成分の利点は，航跡が単数であっても，海底下に分布する地磁気異常源の走向を推定できることにある．今日までに得られている，標題海域の地磁気異常分布について今回の様な測定により，新たな吟味を加える事が可能である．この海域に於ける地磁気異常の走向はN70°Eであることが確認された．