Jour. Fac. Sci., Hokkaido Univ., Ser. VII (Geophysics), Vol. 11, No. 5, 811-820, 2001.

Geomagnetic Survey in the Eastern Part of Hokkaido, NE Japan : A Data Report

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(Received December 15, 2000)

Abstract

We made geomagnetic surveys at 199 stations in the eastern part of Hokkaido, NE Japan. The main objective of the present paper is focused on establishment of the geomagnetic field data to lead the following tectono-magnetic study in this area. Positive anomalies are distributed along the coastal region of the Pacific Ocean, suggesting the existence of highly magnetized rocks beneath this region. Dorelite is a candidate for the causal rock of the anomalies.

1. Introduction

The eastern part of Hokkaido, NE Japan, situated in the southwesternmost part of the Kuril Arc, is tectonically important place where a collision of the Okhotsk paleoland with the Eurasia plate occurred in the late Cretaceous or Paleogene (e.g., Niida and Kato, 1986). In addition, subduction of the present Pacific plate has caused big earthquakes in this area (e.g., Morikawa and Sasatani, 2000). To elucidate the detailed mechanism of the above-mentioned phenomena, many geophysical studies, such as seismological (e.g., Motoya and Ichiyanagi, 1996), crustal deformation (e.g., Stephane et al., 2000), gravimetric (e. g., Yamamoto and Moriya, 1989 ; Morijiri et al., 2000) and magnetotelluric (e.g., Satoh et al., submitted) studies, have been made. Three components of the geomagnetic fields were mapped by Geographical Survey Institute (1955) and a supplemental survey of the vertical component was made by Seino (1958) in the eastern part of Hokkaido. However, the observation points in these surveys were insufficient in number to reveal the detailed magnetic structure. Airborne geomagnetic surveys by Geological Survey of Japan (1979) have well mapped the geomagnetic total force intensity in Hokkaido. However, the eastern part of Hokkaido has been a blank region of the airborne geomagnetic data because of the boundary problems between Japan and Rusia (ex-USSR). Then, we

planned to establish geomagnetic mapping on land. The present paper shows a surveyed data to lead the following tectono-magnetic study in this area.

2. Geomagnetic Survey

We measured the magnetic total force intensity at 199 stations in the study area by means of a proton precession magnetometer based on the Overhauser effect (Fig. 1). The surveys were performed for periods from August 30 to September 3 and October 29 to November 1, 2,000. Horizontal geomagnetic field gradient at almost all stations is within 20 nT/meter as shown in Fig. 2.

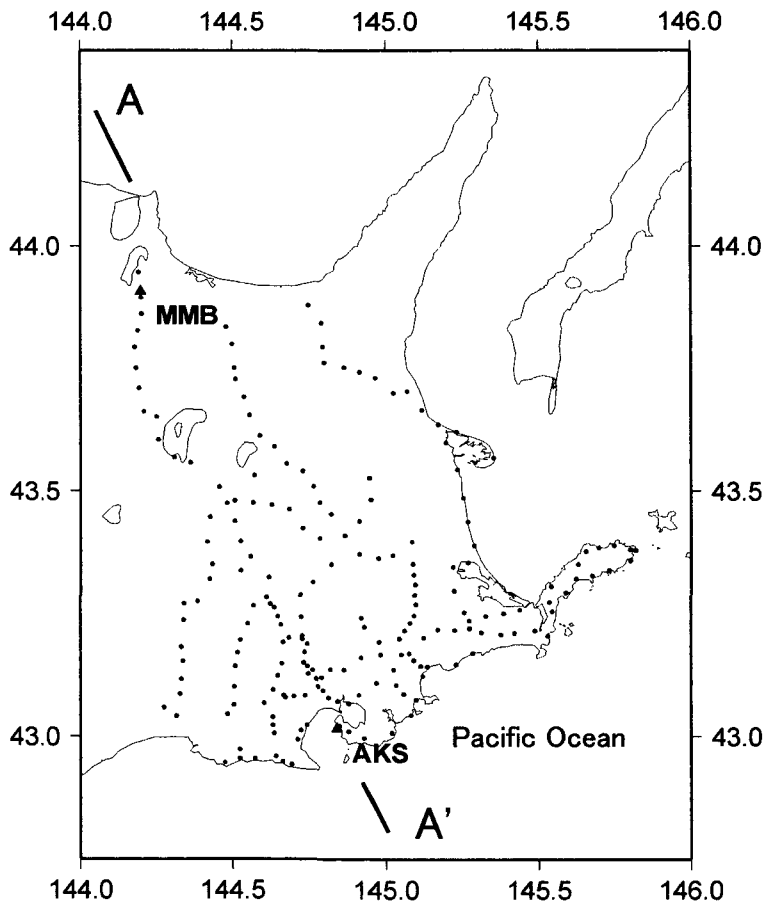

Fig. 1. Geomagnetic stations are shown. Triangles denote the continuous geomagnetic stations. MMB: Memanbetsu; AKS: Akkeshi.

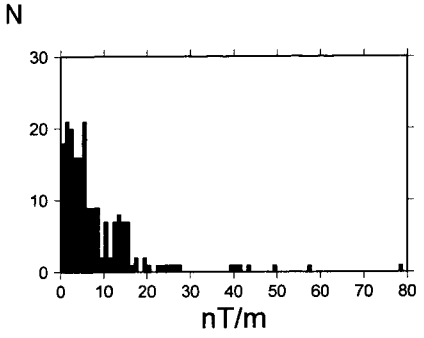

Fig. 2. Histogram of the geomagnetic field gradient.

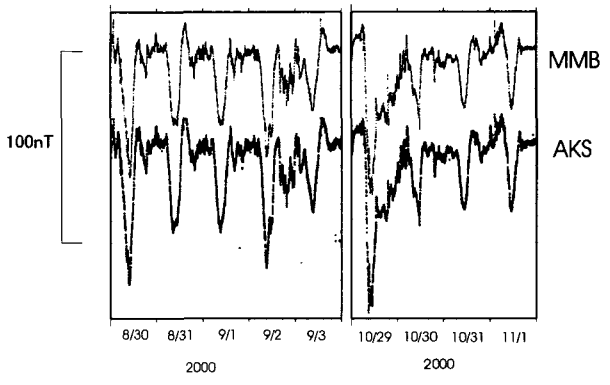

Fig. 3. Continuous records of the geomagnetic total force at MMB and AKS.

Corrections for geomagnetic diurnal variations and other disturbances are made on the basis of continuous magnetic records at Memanbetsu Magnetic Observatory belongs to Japan Meteorological Agency (MMB in Fig. 1). As geomagnetic variations at Akkeshi (AKS) are almost the same as those at MMB in amplitude and phase as shown in Fig. 3, it may be appropreate to use the data at MMB for the correction. Distribution of the geomagnetic anomalies relative to the IGRF2,000 values is shown in Fig. 4 with contour interval of 300 nT. The contours are drawn by using a gridding method with continuous curvature splines in tension developed by Smith and Wessel (1990). Observation time, geographical location, observed value, corrected value, magnetic field gradient and residual anomaly at each station are tabulated in Appendix A.

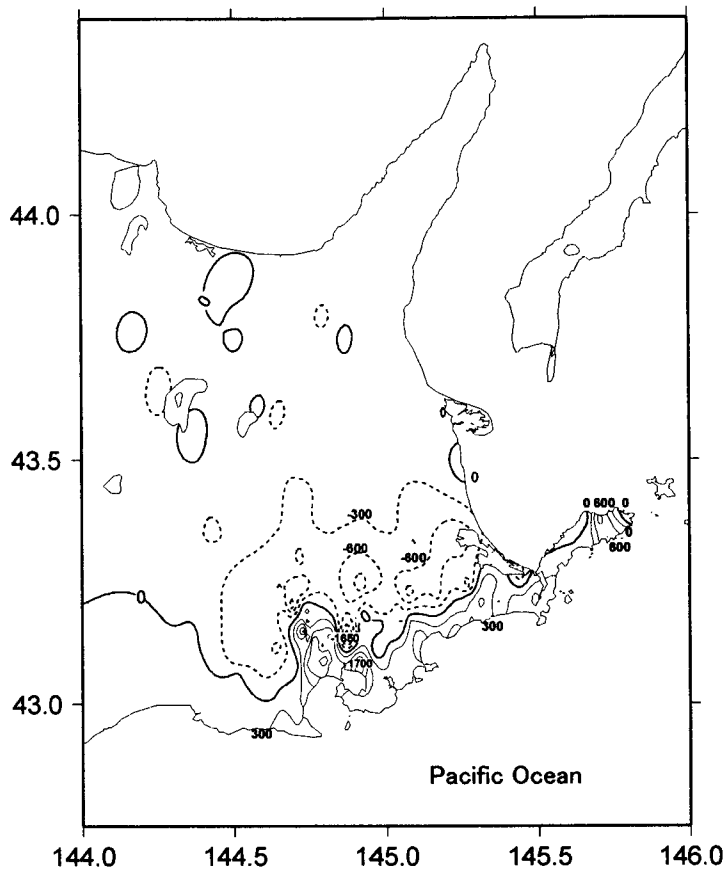

Fig. 4. Distribution of the geomagnetic anomalies relative to the IGRF2,000 values with contour interval of 300 nT. Thin solid contours represent the positive anomalies, while the dashed ones denote the negative anomalies. Thick solid contours show the reference value.

3. Geomagnetic anomalies

Horizontal distribution (Fig. 4) and a cross section along the profile A-A' (Fig. 5) reveal the characteristic features of the geomagnetic anomalies: positive anomalies amounting to about 1,700 nT in maximum are distributed on the coastal region of the Pacific Ocean, contrary to the negative ones (about −1,650 nT in minimum) in the north of the positive anomaly region. These two seem to make pair. Therefore, highly and normally magnetized rocks are probably distributed beneath the coastal region with the ENE-WSW trend. Dolerite

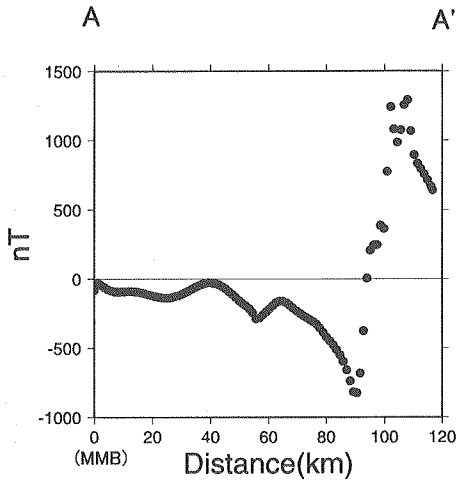

Fig. 5. Solid circles represent the geomagnetic anomalies relative to the IGRF2,000 values along the profile A-A' in Fig. 1.

outcrops in this region (Geological Survey of Japan, 1992) and is a candidate for the causal rocks of the anomalies because rock samples of the dolerite in this region show exceedingly high magnetization, about 10 A/m (Fujiwara and Ohtake, 1975).

4. Conclusion

We established the 199 magnetic stations in the eastern part of Hokkaido, NE Japan. Positive anomalies are distributed along the coastal region of the Pacific Ocean, suggesting the existence of highly magnetized rocks beneath this region. Dorelite is a candidate for the causal rock of the anomalies.

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Appendix A

	Time	Lat(°)	Long(°)	Obs(nT)	Corrected(nT)	Fieldgrad(nT/m)	Res Anomaly(nT)
Aug.30	11:29	43.201	144.687	47945.85	47977.15	2.00	-1111.75
	11:40	43.205	144.729	48625.19	48653.99	0.85	-421.91
	11:50	43.199	144.730	49230.15	49253.06	3.18	176.95
	12:08	43.189	144.745	49502.75	49518.36	2.94	450.15
	12:18	43.172	144.737	48873.50	48885.10	4.54	-171.60
	12:30	43.151	144.733	50459.40	50467.21	7.64	1419.70
	12:40	43.144	144.745	48588.04	48591.94	2.43	-447.26
	12:52	43.135	144.763	50522.70	50527.60	15.07	1494.00
	13:03	43.118	144.775	50023.96	50026.36	5.41	1005.96
	13:15	43.103	144.781	52279.88	52277.08	15.31	3271.18
	13:23	43.094	144.797	50589.33	50584.94	0.52	1584.83
	13:32	43.080	144.815	49759.93	49757.53	1.85	770.13
	14:07	43.022	144.851	49600.93	49595.73	5.39	653.93
	15:28	43.228	144.660	48622.47	48623.28	6.18	-487.93
	15:39	43.244	144.649	48460.99	48464.19	2.86	-655.41
	15:48	43.263	144.638	48623.51	48626.82	1.18	-506.39
	16:05	43.270	144.625	48530.81	48531.72	14.76	-612.39
	16:15	43.284	144.613	48769.40	48770.80	0.88	-382.60
	16:33	43.325	144.620	48852.91	48853.71	2.02	-319.19
	17:06	43.267	144.571	48803.41	48807.51	2.29	-352.19
	17:17	43.230	144.552	48820.07	48824.17	1.43	-318.73
	17:28	43.197	144.528	48620.99	48625.59	4.48	-506.41
	17:40	43.171	144.517	48760.38	48765.69	5.26	-352.02
	17:53	43.144	144.510	48598.09	48604.69	7.60	-499.61
	18:04	43.101	144.507	48457.66	48464.16	1.56	-618.44
	18:14	43.065	144.506	49131.91	49140.51	10.29	78.61
	18:26	43.046	144.485	49130.69	49140.09	4.51	79.09
Aug.31	8:16	43.338	144.528	48897.60	48937.80	10.56	-271.30
	8:38	43.367	144.561	48962.25	49003.35	1.36	-213.95
	9:15	43.398	144.528	49109.10	49149.90	2.96	-91.80
	9:32	43.439	144.509	48966.19	49007.39	6.50	-261.51
	9:54	43.475	144.483	49119.10	49159.61	4.07	-133.50
	10:17	43.509	144.459	49117.08	49159.18	0.82	-160.52
	10:51	43.532	144.574	49088.76	49127.06	8.04	-173.54
	11:07	43.558	144.363	49543.82	49579.93	6.22	204.22
	11:24	43.569	144.310	49319.04	49352.55	2.14	-42.36
	12:16	43.605	144.258	49048.55	49068.55	6.86	-356.05
	12:45	43.652	144.253	48879.94	48886.84	8.18	-560.86
	13:08	43.663	144.210	49241.65	49241.55	8.97	-226.65
	13:27	43.710	144.194	49374.87	49374.47	5.22	-131.83
	13:44	43.751	144.184	49707.73	49704.74	12.93	172.93
	14:05	43.793	144.179	49621.45	49614.56	14.73	60.55
	14:24	43.828	144.190	49435.72	49429.02	3.38	-143.88
	14:49	43.861	144.202	49513.88	49504.09	8.21	-82.02
	15:27	43.895	144.201	49628.28	49622.08	1.51	13.08
	15:50	43.947	144.193	49141.80	49139.10	17.49	-500.80
Sep.1	10:22	43.123	145.120	49689.02	49727.62	10.33	803.92
	10:32	43.144	145.113	49689.22	49726.63	8.17	790.62
	10:39	43.156	145.091	49369.42	49406.02	3.85	453.42
	10:48	43.170	145.076	49237.77	49273.47	1.45	312.07
	10:55	43.168	145.051	48629.93	48665.73	2.11	-304.07
	11:03	43.200	145.044	48752.18	48784.48	3.54	-204.92
	11:11	43.216	145.062	48196.46	48228.96	5.38	-765.94
	11:19	43.232	145.079	47891.31	47923.52	7.82	-1071.49

	11:26	43.246	145.093	48239.48	48270.88	15.92	−732.82
	11:37	43.269	145.098	48281.74	48311.35	2.88	−700.16
	11:47	43.289	145.094	48537.85	48565.25	1.67	−460.25
	11:56	43.310	145.095	48706.83	48729.13	1.73	−307.37
	12:08	43.330	145.090	48409.85	48428.75	5.16	−619.05
	12:23	43.352	145.088	48522.80	48542.20	1.25	−516.40
	13:05	43.397	145.085	48575.89	48584.10	5.71	−505.21
	13:19	43.370	145.023	48867.85	48873.85	1.34	−215.25
	13:33	43.364	144.975	48828.54	48833.05	3.47	−264.36
	13:43	43.372	144.916	48774.35	48778.56	1.36	−338.25
	13:54	43.410	144.869	49019.18	49023.78	1.93	−128.12
	14:09	43.454	144.824	48971.55	48968.95	0.63	−218.45
	14:23	43.478	144.786	48998.40	48997.60	4.42	−214.50
	14:36	43.510	144.766	49096.82	49097.33	3.45	−136.38
	14:47	43.541	144.731	49205.91	49210.91	5.02	−49.09
	14:59	43.557	144.679	49212.36	49220.16	5.13	−64.44
	15:09	43.591	144.639	48816.24	48825.54	5.90	−482.96
	15:20	43.613	144.591	49481.47	49489.77	6.38	157.77
	15:33	43.655	144.558	49192.61	49199.71	14.25	−163.59
	15:45	43.692	144.540	49286.18	49295.28	7.19	−103.72
	15:59	43.728	144.511	46162.94	46174.75	7.06	−3253.16
	16:11	43.751	144.508	49494.16	49507.66	5.25	68.76
	16:24	43.800	144.499	49352.00	49365.50	3.45	−104.20
	16:35	43.835	144.480	49696.90	49711.61	0.61	219.40
Sep.2	10:38	43.879	144.750	49403.68	49442.98	15.91	−1.82
	10:50	43.843	144.793	49136.30	49179.90	10.84	−230.20
	11:05	43.795	144.798	48921.36	48966.27	3.41	−410.44
	11:17	43.763	144.802	49061.74	49106.04	12.30	−248.86
	11:29	43.752	144.867	49461.63	49503.13	0.67	167.13
	11:39	43.744	144.918	49091.72	49133.33	2.25	−184.48
	11:49	43.731	144.967	49098.90	49140.00	0.99	−159.70
	11:58	43.701	145.026	49167.80	49207.90	0.50	−60.10
	12:08	43.704	145.070	49034.28	49068.59	3.21	−189.42
	12:21	43.665	145.118	49028.41	49055.71	0.62	−166.69
	13:16	43.636	145.171	49070.20	49078.81	14.73	−118.50
	13:27	43.621	145.230	49068.16	49077.06	13.70	−93.14
	13:43	43.568	145.351	48963.56	48970.57	4.26	−199.54
	14:09	43.599	145.195	49195.03	49197.63	1.57	27.73
	14:25	43.544	145.233	49088.35	49090.45	3.74	−35.15
	14:38	43.487	145.253	49319.70	49320.50	4.68	227.80
	14:51	43.438	145.267	48998.84	48998.44	11.52	−61.06
	15:05	43.390	145.287	48734.49	48732.20	8.17	−294.01
	15:18	43.354	145.267	48287.71	48286.71	8.80	−722.79
	15:27	43.345	145.218	48149.34	48148.55	13.12	−868.96
	15:41	43.297	145.221	48420.13	48420.43	2.26	−574.27
	15:55	43.253	145.255	48371.43	48378.24	0.27	−580.97
	16:08	43.220	145.273	49101.53	49115.93	5.94	179.33
	16:20	43.170	145.283	49137.50	49157.61	2.99	251.40
	16:40	43.147	145.229	49716.02	49727.72		818.52
	16:59	43.143	145.135	49456.61	49469.51	26.14	538.81
	17:16	43.043	145.081	49152.60	49162.20	6.43	272.90
	17:29	43.008	145.020	49190.53	49202.74	2.14	313.83
	17:42	42.997	144.932	49387.76	49402.27	2.24	494.76
	17:51	43.011	144.880	49320.75	49338.85	13.69	411.25

Sep.3	10:11	43.192	144.667	48854.71	48881.41	4.93	−205.89
	10:27	43.149	144.662	48806.75	48831.96	1.23	−234.75
	10:35	43.124	144.649	48353.06	48376.96	0.83	−675.74
	10:43	43.095	144.634	48427.49	48449.49	14.16	−592.31
	10:51	43.069	144.605	48618.08	48640.28	2.29	−398.72
	11:04	43.041	144.633	48863.37	48883.57	4.01	−130.43
	11:12	43.024	144.633	48774.93	48794.14	2.54	−208.87
	11:20	43.007	144.637	49234.14	49253.74	3.20	257.64
	11:38	42.956	144.525	49174.91	49191.02	3.69	189.81
	11:45	42.974	144.525	49207.87	49222.98	6.59	217.47
Oct.29	14:21	42.947	144.476	49174.66	49202.36	4.14	196.46
	14:45	42.956	144.575	49190.03	49218.04	4.05	232.03
	15:05	42.961	144.643	49297.84	49326.84	5.87	361.64
	15:14	42.949	144.665	49351.55	49378.95	14.43	423.65
	15:26	42.944	144.695	49218.41	49244.31	0.86	302.91
	16:00	42.994	144.715	49175.51	49197.81	1.01	233.11
	16:16	43.014	144.725	49310.24	49333.54	0.92	360.54
	16:35	43.024	144.744	49305.54	49327.24	1.59	353.84
	16:50	43.068	144.880	49742.68	49764.79	23.80	802.18
Oct.30	9:20	43.212	145.311	49608.82	49618.13	13.89	698.62
	9:35	43.208	145.375	48827.08	48835.99	15.81	−66.82
	9:47	43.211	145.421	49355.44	49364.94	0.49	475.74
	9:55	43.216	145.489	49603.93	49615.44	20.95	739.33
	10:13	43.205	145.530	49153.07	49164.97	3.33	310.97
	10:29	43.255	145.545	49224.59	49238.50	40.64	359.39
	10:40	43.293	145.588	49000.59	49013.50	6.24	126.49
	11:03	43.322	145.622	48912.57	48929.48	5.87	33.27
	11:14	43.328	145.677	49089.25	49108.95	12.37	224.15
	11:30	43.339	145.733	49771.66	49793.46	7.56	916.66
	11:48	43.353	145.802	49364.60	49381.81	13.25	518.70
	11:55	43.380	145.824	48487.45	48497.75	19.12	−376.55
	12:43	43.381	145.802	48519.07	48513.57	13.22	−366.03
	12:50	43.390	145.749	49148.33	49141.84	78.65	242.83
	13:02	43.385	145.699	49951.89	49942.19	16.79	1034.99
	13:12	43.378	145.657	48737.58	48728.79	57.97	−189.52
	13:25	43.351	145.630	49263.62	49254.42	43.70	344.52
	13:46	43.306	145.542	48937.31	48925.41	4.85	12.91
	13:56	43.274	145.604	49263.59	49251.19	17.27	377.09
	14:09	43.258	145.440	48496.49	48482.90	3.20	−429.81
	14:17	43.251	145.385	49168.49	49154.99	0.80	231.69
	14:26	43.246	145.326	49534.00	49520.70	15.36	583.70
	14:40	43.237	145.271	48329.80	48318.00	13.31	−630.30
	14:52	43.217	145.224	48924.74	48914.24	41.49	−36.16
	15:02	43.218	145.169	48308.36	48297.86	11.78	−667.04
	15:13	43.202	145.123	48661.75	48650.85	2.20	−316.25
	15:29	43.136	145.026	48827.57	48818.68	5.23	−140.23
	15:41	43.110	144.970	48688.41	48680.21	27.71	−279.59
	15:51	43.085	144.915	50639.82	50631.33	13.55	1671.52
	16:05	43.072	144.845	49851.37	49840.37	3.77	866.47
Oct.31	9:16	43.075	145.098	49385.80	49403.60	12.42	502.00
	9:23	43.087	145.059	49359.36	49378.27	39.61	455.86
	9:31	43.105	145.035	49476.30	49495.20	1.86	558.40
	10:00	43.167	144.982	49084.16	49104.67	0.98	115.66
	10:13	43.193	144.978	48447.74	48469.44	5.00	−530.66

10:22	43.223	144.933	48585.78	48608.68	10.95	−421.22
10:31	43.242	144.923	47890.56	47913.16	5.08	−1131.04
10:49	43.161	144.922	49280.29	49302.59	5.55	302.49
11:00	43.136	144.866	47323.66	47345.67	2.24	−1658.74
11:08	43.137	144.821	50092.96	50113.27	6.36	1094.96
11:18	43.120	144.793	49501.32	49520.72	1.71	505.82
11:30	43.128	144.748	49429.27	49447.67	5.52	416.47
11:49	43.084	144.738	49912.46	49928.16	4.63	922.46
12:00	43.082	144.703	48749.67	48761.78	12.05	−254.93
12:09	43.080	144.675	48832.85	48843.96	4.13	−181.25
12:18	43.084	144.668	48651.47	48659.67	10.24	−365.83
13:32	43.244	144.726	48170.97	48164.08	10.53	−933.73
13:41	43.289	144.724	48874.43	48866.93	22.77	−260.37
13:53	43.314	144.763	48691.54	48682.25	7.74	−444.46
14:10	43.351	144.824	48850.15	48839.05	9.19	−293.35
14:32	43.439	144.916	49041.58	49029.19	5.42	−125.62
14:47	43.483	144.952	49133.84	49121.94	2.29	−46.96
15:01	43.527	144.948	49010.42	48999.02	3.01	−197.48
15:34	43.404	144.786	49009.83	48998.63	9.55	−169.47
15:45	43.425	144.730	48769.36	48757.47	5.74	−437.94
16:00	43.463	144.688	48931.46	48922.76	0.96	−305.14
16:08	43.472	144.630	49038.42	49031.13	8.88	−219.98
16:18	43.476	144.569	49185.79	49176.69	24.80	−94.41
16:29	43.481	144.509	49002.10	48992.31	7.08	−296.00
Nov.1 9:07	43.447	144.428	49271.18	49285.98	2.51	−9.52
9:23	43.397	144.419	48967.07	48988.08	19.23	−282.63
9:30	43.351	144.435	48841.43	48860.43	12.98	−380.87
9:45	43.321	144.426	48964.81	48983.82	4.59	−240.49
9:59	43.276	144.388	48901.47	48931.07	49.99	−282.23
10:13	43.271	144.343	48925.10	48955.80	8.58	−266.50
10:24	43.238	144.341	49038.48	49071.89	7.69	−132.12
10:47	43.182	144.334	48977.60	49013.90	5.88	−162.20
10:57	43.154	144.338	49339.06	49375.56	25.54	218.36
11:17	43.117	144.334	49094.91	49131.31	15.75	−11.59
11:35	43.087	144.329	49314.25	49348.96	14.10	223.35
11:47	43.059	144.276	49203.60	49237.80	1.78	113.10
11:54	43.042	144.318	49319.83	49352.43	12.18	249.93