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VI. MICRO-TOPOGRAPHIC FEATURES IN THE OFF TOKAI AREA OBTAINED BY DEEP-TOW-TYPE SIDE-SCAN-SONAR SURVEYING

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Abstract

A deep-tow-type side-scan-sonar surveying system was used at 3 survey lines (during the May 12th, 13th and 17th cruises). Distinct features showing a number of geological phenomena were recognized in several parts of the survey lines.

Equipment

The deep-tow-type side-scan-sonar surveying system is composed of SMS-towfish model 990, SMS digital modem model 996, SMS dry type recorder model 960, SMS digital magnetic tape recorder model 9000 with formatter and 6000 m length of co-axial armored cable. The digital magnetic tape recorder did not work during our cruises, so only analog records on papers were obtained for a 500 m range, 1 km for both sides, by using the maximum range of this system.

Results

The survey area for deep-tow-type side-scan-sonar surveying system is shown in Fig. VI-1 as (a), (b), and (c) together with ship tracks for the GH97 cruise, on a shaded topographic map made from the data obtained in R/V "Hakurei-maru" cruise. Detailed survey lines are shown in Fig. VI-2.

The equipment was usually lowered vertically when the sensor used was only a side-scan-sonar, meaning that the sensor was usually stationary until the record of the bottom appeared. In case of multi-sensor type hydrophone or proton magnetometer the sensor was 20 m in length and was sometimes twisted with wire when vertically lowered. The system was lowered while cruising at 1 or 2 knots. When we towed the system very close to the bottom in an area with a depth of 1500m, the cable length became approximately 2500m at 2 knot. This means that wire was inclined at 45 to 50 degree and the sensor ran approximately 1500m behind the vessel. Taking this effect into consideration the marks in Fig. VI-2 are adjusted to show the true positions of the sensor. Table VI-1 summarizes the basic data such as ship speed, towing direction, cable length, etc. In Fig. VI-4 ((#1) to (#7)) the actual records that bear geological information on the sea floor are shown. Numbers refer to Fig. VI-2.

Explanation of records

Line (a)

#1 in Fig. VI-4 shows a line-like structure, which has a pair of white (weak

keywords: side-scan-sonar, deep-tow, micro-topography, Enshu-nada, Tokai offshore

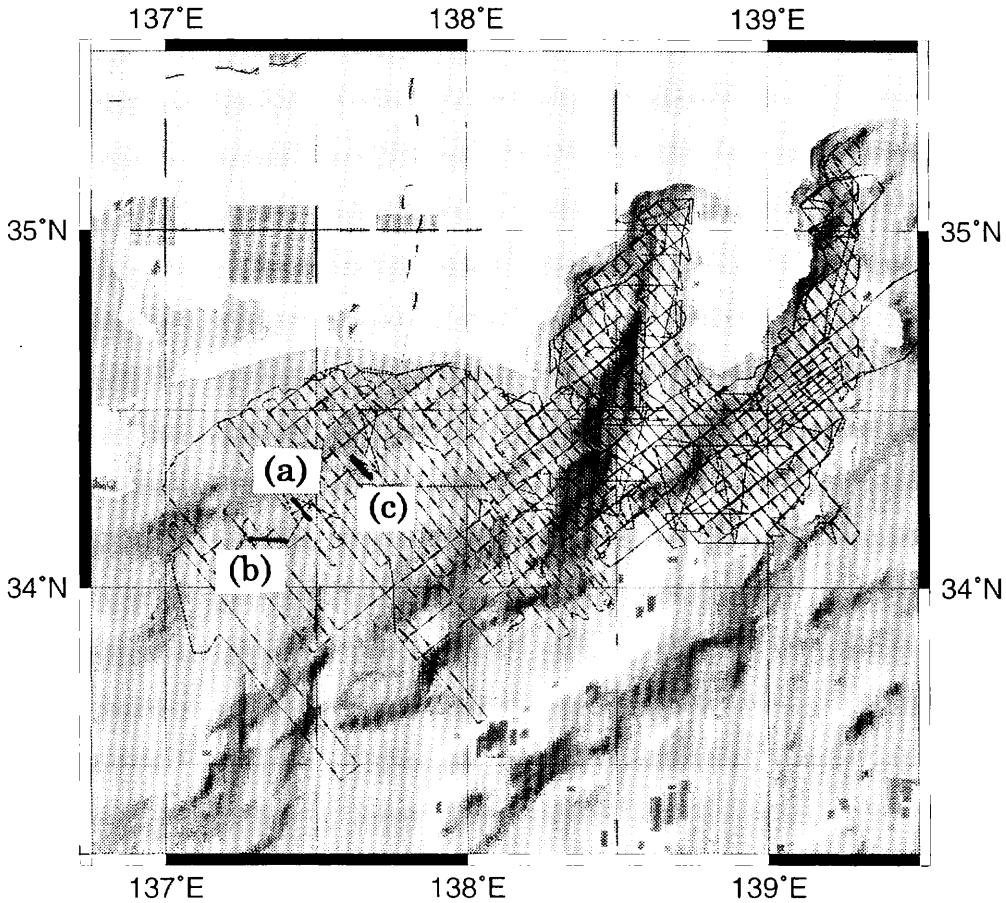

Fig. VI-1 Approximate locations of deep-tow survey areas (a, b, and c) on a shaded topography map with ship tracks for GH97 cruise.

reflection) and dark zones (high reflection) with the center line (sensor position). The structure indicates something like a rather linear groove, 200 to 300m in length and 10 to 20m in width(explanation is shown in Fig. VI-3). Between 12:35 and 12:40, the height correction could not be effectuated, causing difficulties to trace the line.

Line (b)

#2 in Fig. VI-4 shows a distorted ellipsoid-like structure, which appears at the SW side 375 m from the center line from 9:45 to 9:47. It might be artificial considering its peculiar shape. The oblique figure symmetrically on the right side is an artifact due to cross-talk from the left side's sensor.

#3 in Fig. VI-4 at the time of 10:30 indicates oblique figures which line up with an interval of 100 m in a N53° E direction. Each structure has a length of 100 m and a direction is N30° W (same as #4) and might have a relation with #4.

#4 in Fig. VI-4 shows linear features near the end of Line (b), at 10:50 and 11:07, which look like faults. Their direction is N30° W (same as #3), whereas their interval

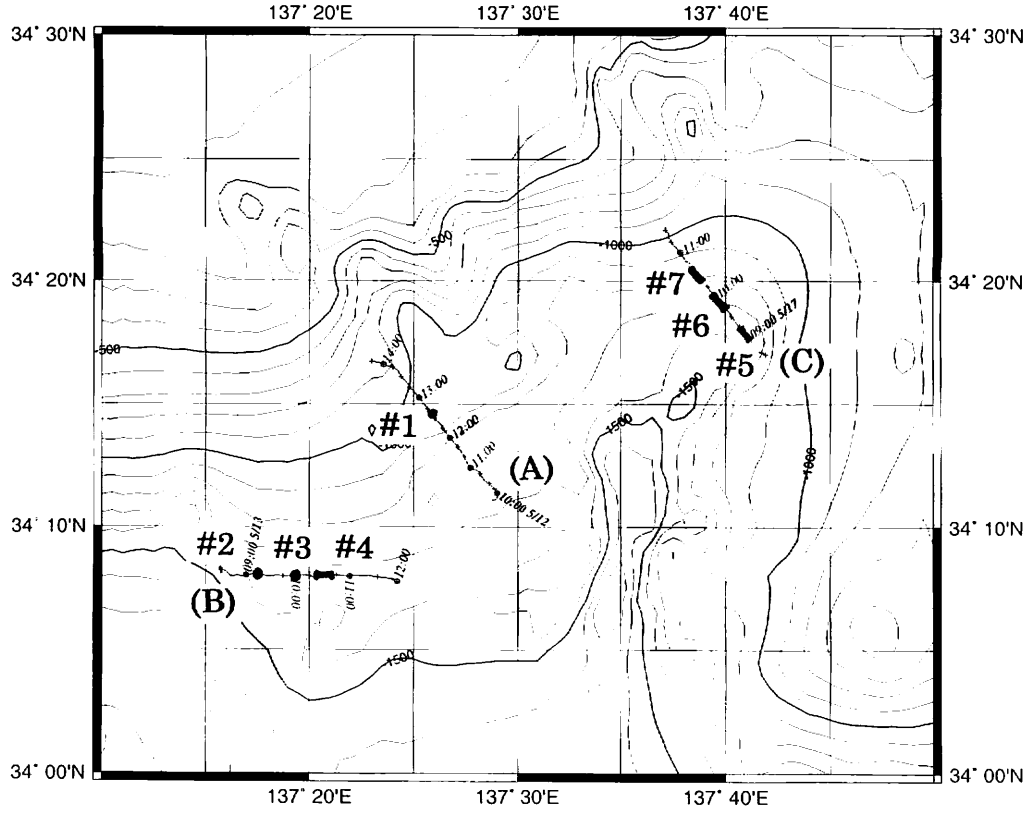

Fig. VI-2 Deep-tow tracks (a, b, and c) in each area. Approximate positions of deep-tow sensor records are also shown.

is 900 m.

Line (c)

which is the NW half of the Tenryu Deep Sea Canyon, the broadest zone in the canyon.

#5 in Fig. VI-4 at the time of 9:25 shows linear structures with a spacing of 125m and a direction of N60° W. It looks like current ripple mark and if so then was caused by the flow from the NNE side.

#6 in Fig. VI-4 shows the changes of the structure in #5. From around 9:50 the direction changes to N37° W, parallel to fish's track, whereas the interval becomes narrower to about 100m. The continuity becomes worse and interval is 30m or 40m from around 10:03. It might be caused by the change of flow due to the shorter distance from the wall of the canyon.

#7 in Fig. VI-4 fully out of the canyon shows a completely different pattern from #5 or #6. It shows a mix of 2 patterns, N87° W lineations in long continuity, on the other hand, short lines of N100° W.

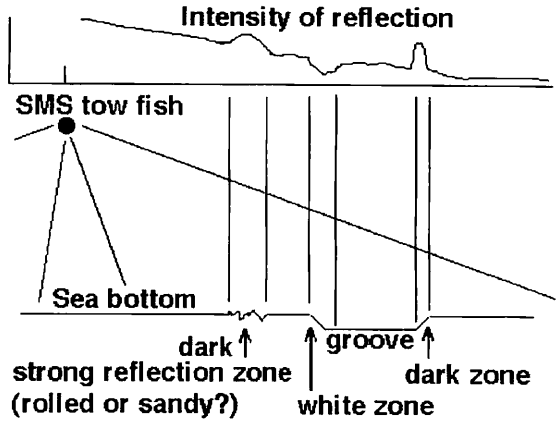

Fig. VI-3 Explanations of the patterns in a side-scan-sonar record. Dark zones indicates rolled topography or facing slope and white zones smooth surfaces or shadow zones.

Future study

In our deep-tow side-scan-sonar surveying system the biggest problem is missing of records, just like defects of tooth of comb. We have tried to make improvements to the towing system (Murakami *et al.*, 1993), by adding a thin 15m long cable between the weight and the tow fish. This gave good results to some extent but it is not yet a final solution of this problem (Kuramoto *et al.*, 1994). The results of this year were good due to the shallowness of target area, around 1500 m in depth and the use of an around 2500m long wire. The missing of records of the side-scan-sonar in our system starts as the wire length becomes larger than 3000 or 3500 m. The missing of data happened only in the area, the wall of Tenryu Canyon, where we wound up the wire at full speed to avoid the crushing of the side-scan-sonar sensor, against the wall of the Tenryu Canyon.

We could not get digital data due to the malfunctioning of the digital magnetic tape recorder. The processing of the data helped us to get a better image by adding a filter or by erasing bad records (Joshima *et al.*, 1993). Our side-scan-sonar system becomes very old and if the malfunction of digital magnetic tape recorder was caused by the malfunctioning of the formatter we will not be able to repair it, as the maker is no longer able to supply the device. In this case we must reconstruct the digital recording system by using new equipment.

References

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Table VI-1 Winch log of multi-sensor type deep-tow surveying system (5/12, 5/13, 5/17).

GH97DT01

Date/970512	Event	wire speed	wire length	tension	water depth
		(m/min.)	(m)	(t)	(m)
956	start of deployment				1245
1128	stop winding out		1380		1280
1141	restart winding out	20			1275
1144		30			
1146	start tracking		1500	1	1270
1152		20	1700	1	
1153		10			1260
1155	stop winding out				1250
1157	restart winding out	10			
1204	stop winding out		1816		1205
1206	restart winding out	10		1	1170
1208	stop winding out		1839		1135
1214	start winding up	-10			1055
1215	stop winding out		1827		1045
1225	restart winding up	-10			985
1231		-20			990
1234		-30			1000
1238		-20			1015
1240		-10			1023
1241		-10	1500	0.9	1027
1244	stop winding up		1461	0.8	1035
1251	restart winding out	10			1040
1254		10	1500	0.9	1040
1256	stop winding out		1520	1	1040
1258	restart winding out	10			1038
1302	stop winding out		1568	0.9	1030
1306	restart winding out	10			1025
1309		20			1020
1312		10		0.9	1015
1313	stop winding out		1666	1	1010
1323	start winding up	-10			990
1327	stop winding up		1619	0.9	980
1331	restart winding up	-10			65
1337		-60	1500	1	945
1345			1000	0.9	915
1352			500	0.5	890
1356		-60	300	0.4	880
1412	recovery of SSS				835
1413	recovery of hydrophone				835

Table VI-1 (continued)

GH97DT02

Date/970513	Event	wire speed	wire length	tension	water depth
		(m/min.)	(m)	(t)	(m)
811	start of deployment				1470
830			200	0.3	1460
833	winch control shift	30	300		
835	wire speed up	50			
838			500	0.4	1465
842			800	0.5	1465
846			1000	0.6	1460
849			1200	0.7	1455
852			1400	0.8	1430
854			1500	0.8	1420
902	wire speed down	30	2000	1	1395
907		20			1395
914		10	2340		1380
917	stop winding out		2382	1	1370
921	restart winding out	10			1365
924		30			1360
926		10			
927	stop winding out		2460		1360
933	restart winding out	10			1345
937	stop winding out		2492	1.2	1340
942	start winding up	-10			1330
949	stop winding up		2408	1	1325
957	restart winding out	10			
1004	stop winding out		2471	1.1	1310
1008	restart winding up	-10			1310
1011	stop winding up		2431	1.2	1305
1016	restart winding up	-10			1310
1020	stop winding up		2386	1.2	1300
1030	restart winding out	10			1285
1034	stop winding out		2431	1.1	1300
1036	restart winding up	-10			1320
1053	stop winding up		2396	1	1310
	restart winding up	-10		1.1	
1056	stop winding up		2378	1.2	1325
1102	restart winding up	-10		1.1	1330
1103	stop winding up		2364	1.1	1330
1106	restart winding out	10			1345
1109	stop winding out		2398	1.1	1345
1118	start winding up(end)	-60			
1125			2000		
1132			1500	1.1	1400
1139			1000	0.9	1395
1146			500	0.5	1400
1149		-60	300		
1153			100		
1203	recovery of SSS				
1204	recovery of hydrophone				

Table VI-1 (continued)

GH97DT03

Date/970517	Event	wire speed	wire length	tension	water depth
		(m/min.)	(m)	(t)	(m)
820	start of deployment				1400
824	deployment of fish	30			1400
841	winch control shift		200		1395
845	wire speed up	50			1395
848			500	0.4	1395
857			1000	0.7	1395
905	star of hun shot				
906	wire speed down	30			
908	ship passed SP	20			
909		10			1385
912		20			1380
914		10			
927	stop winding out		1986	1.3	1375
928	restart winding out	10			
930			2000	1.1	1375
934	stop winding out		2052	1.2	1375
1004	start of winding up	-10			865
1007	stop winding up		2014	1	840
1011	restart winding up	-10		1.2	800
1012			2000	1.2	
1014	stop winding up		1985	1	790
1017	restart winding up	-20		1.2	775
1018	speed up winding up	-40		1.4	
1020		-50	1900		
1021	fish height 30m	-60	1800	1.4	770
1025	fish height 110m		1500	1.4	780
1027		-40	1300		755
1028	fish height 140m	-20		0.9	
1029		-10		0.8	
1030	stop winding up		1232	0.8	765
1036	restart winding out	20		0.6	
1038	stop winding out		1270		785
1040	restart winding up	-10			785
1041		-20			
1043	stop winding up		1210	0.8	785
1044	restart winding up	-10		0.9	
1048	stop winding up		1161	0.6	785
1054	restart winding up	-10		0.6	785
1058	stop winding up		1107	0.7	785
1104	ship passed EP				
1107	restart winding up	-10			790
1107		-20		0.6	
1109		-10			
1111	stop winding up		1027		795
1115	restart winding up(end)	-60			
1124	recovery of gun				
1140	end of recovery				

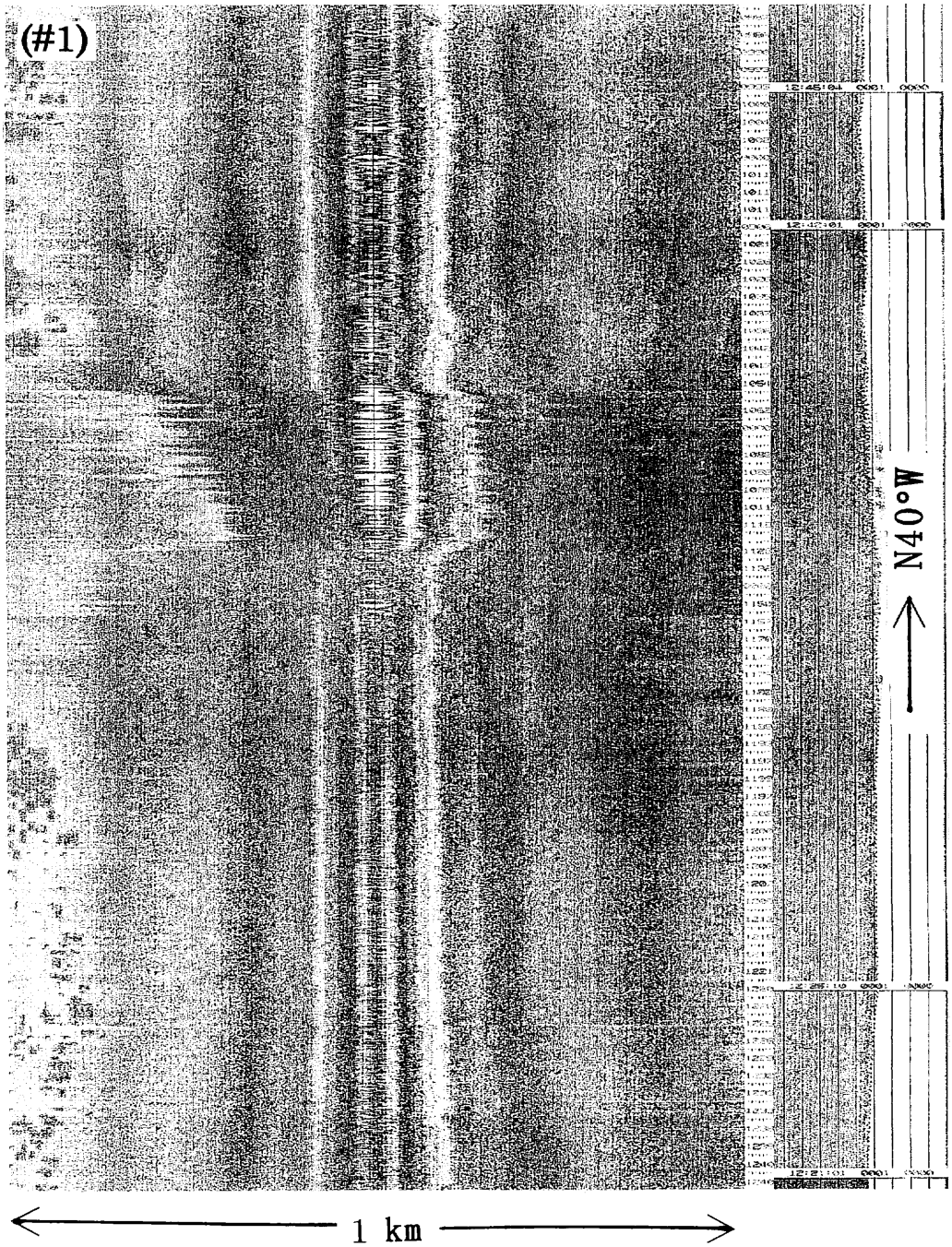
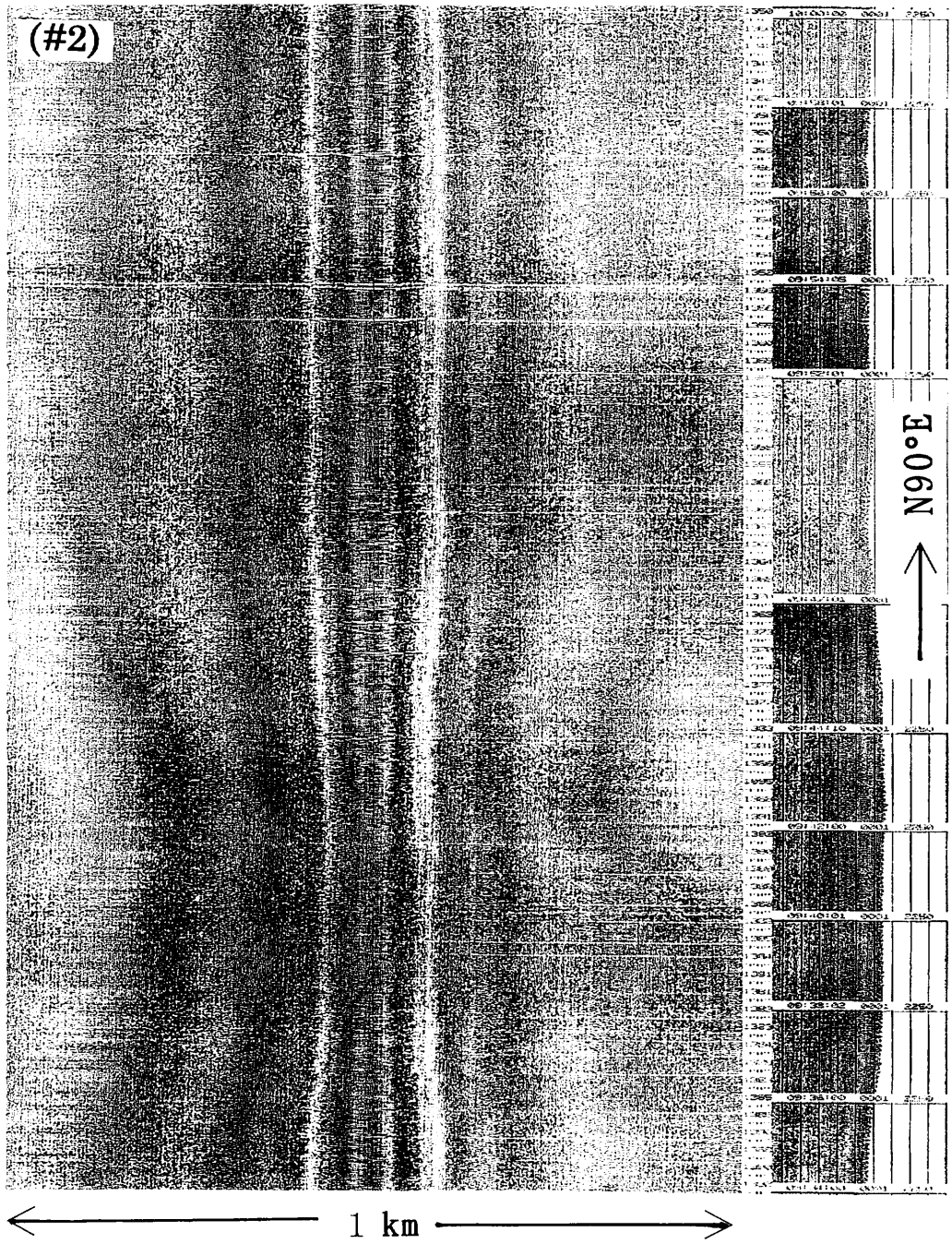


Fig. VI-4 Examples of side-scan-sonar records (#1, #2, #3, #4, #5, #6, #7).
The written direction and arrow right side in each figure indicates the orientation of the record. The profile right side indicates the sensor's height from the sea bottom. The central line of the figure indicates the passing line of the sensor. The along and cross ratio of the figure is 1 and the figure shows real shape because the figure was corrected in height and speed. The stripe patterns near the central line were caused artificially and the distances from the central line vary with sensor's height.



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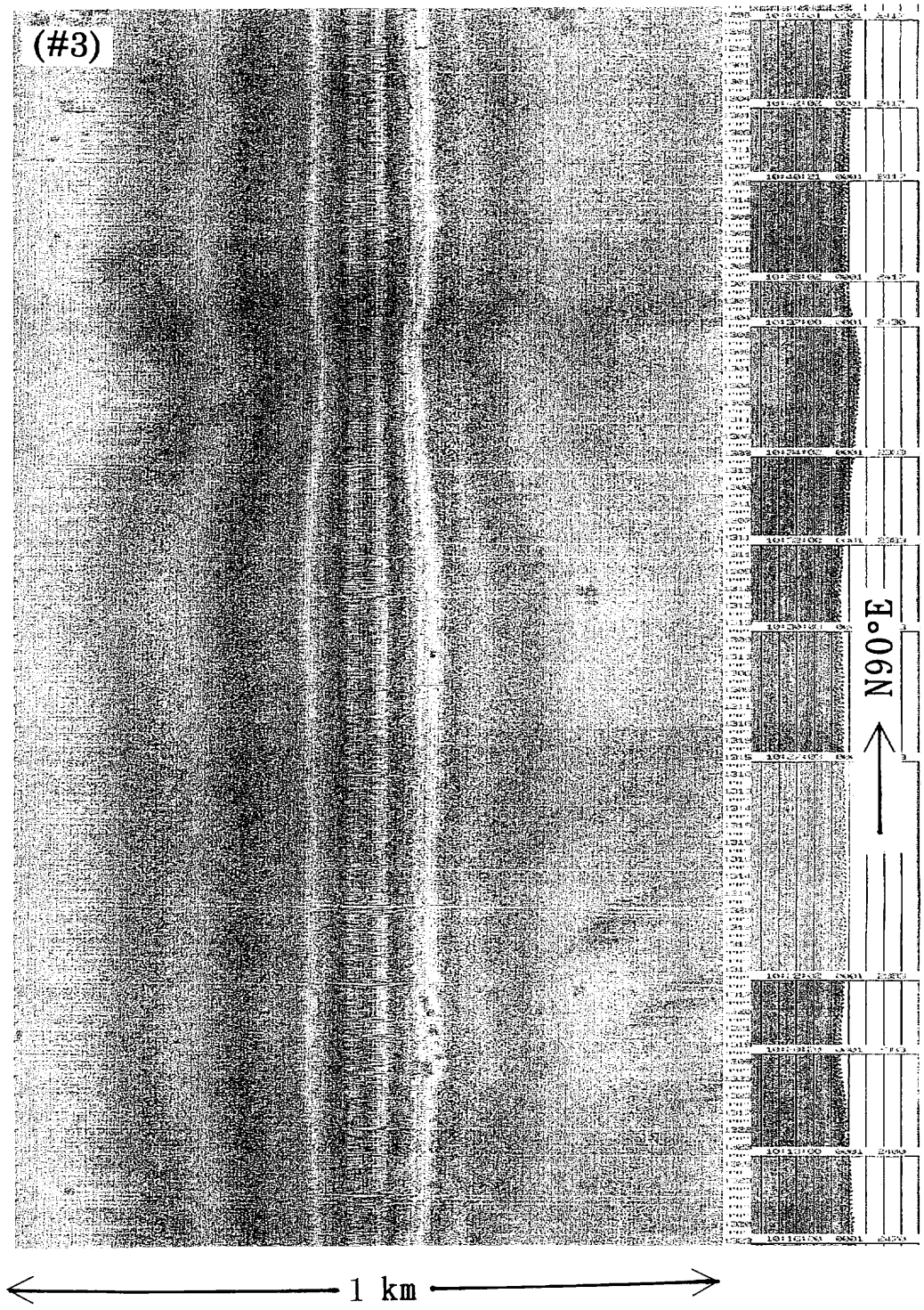

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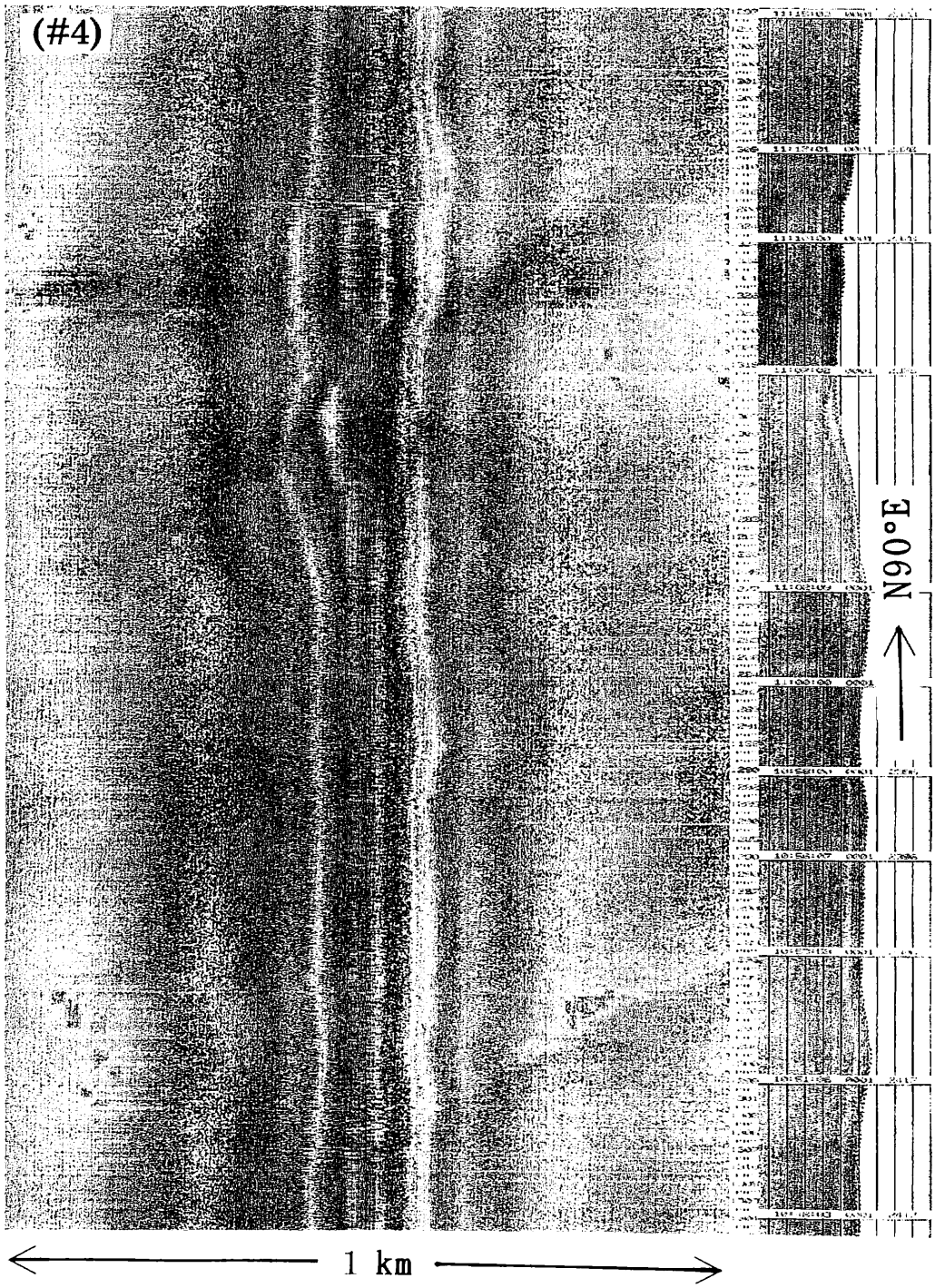

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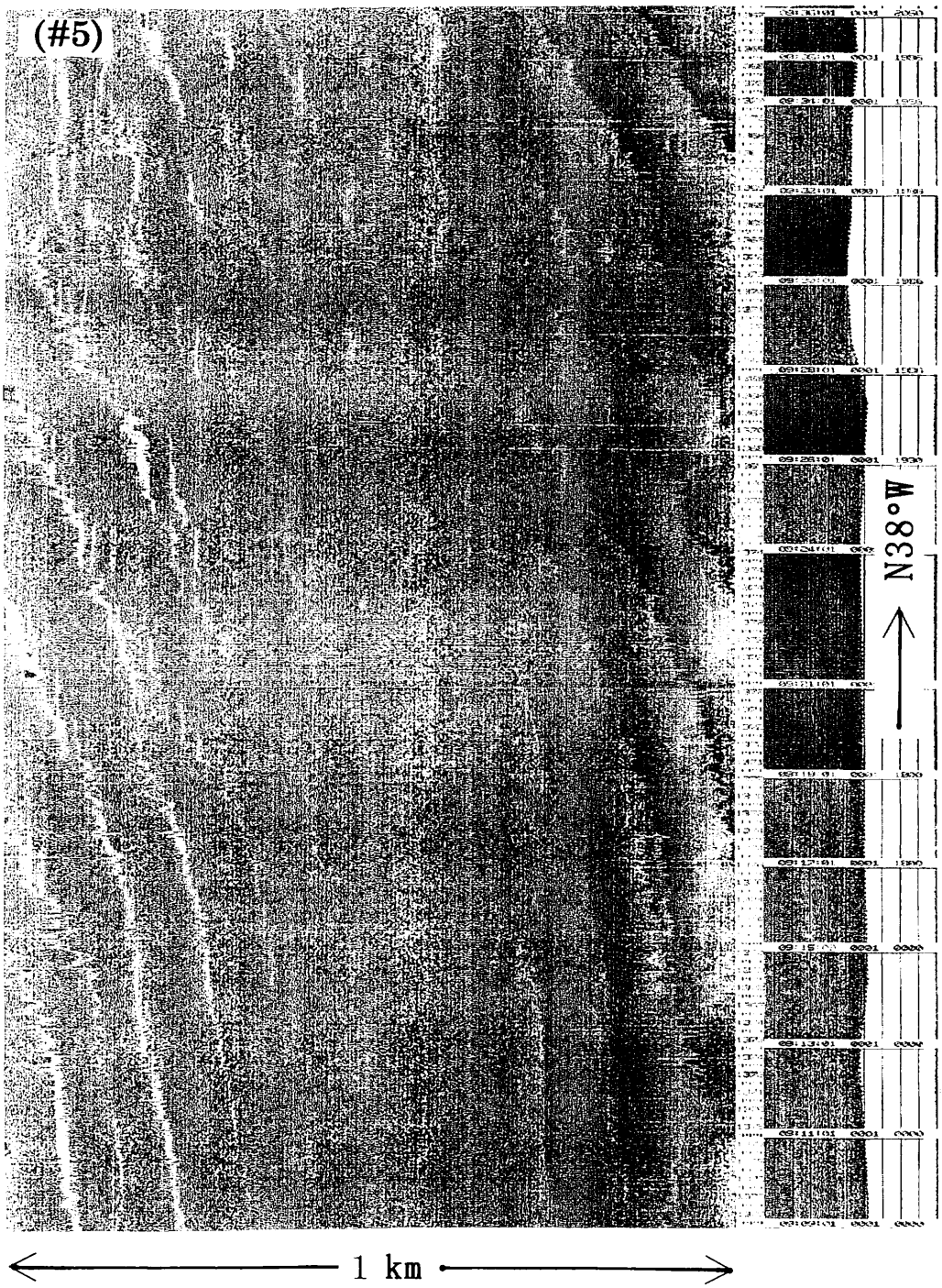

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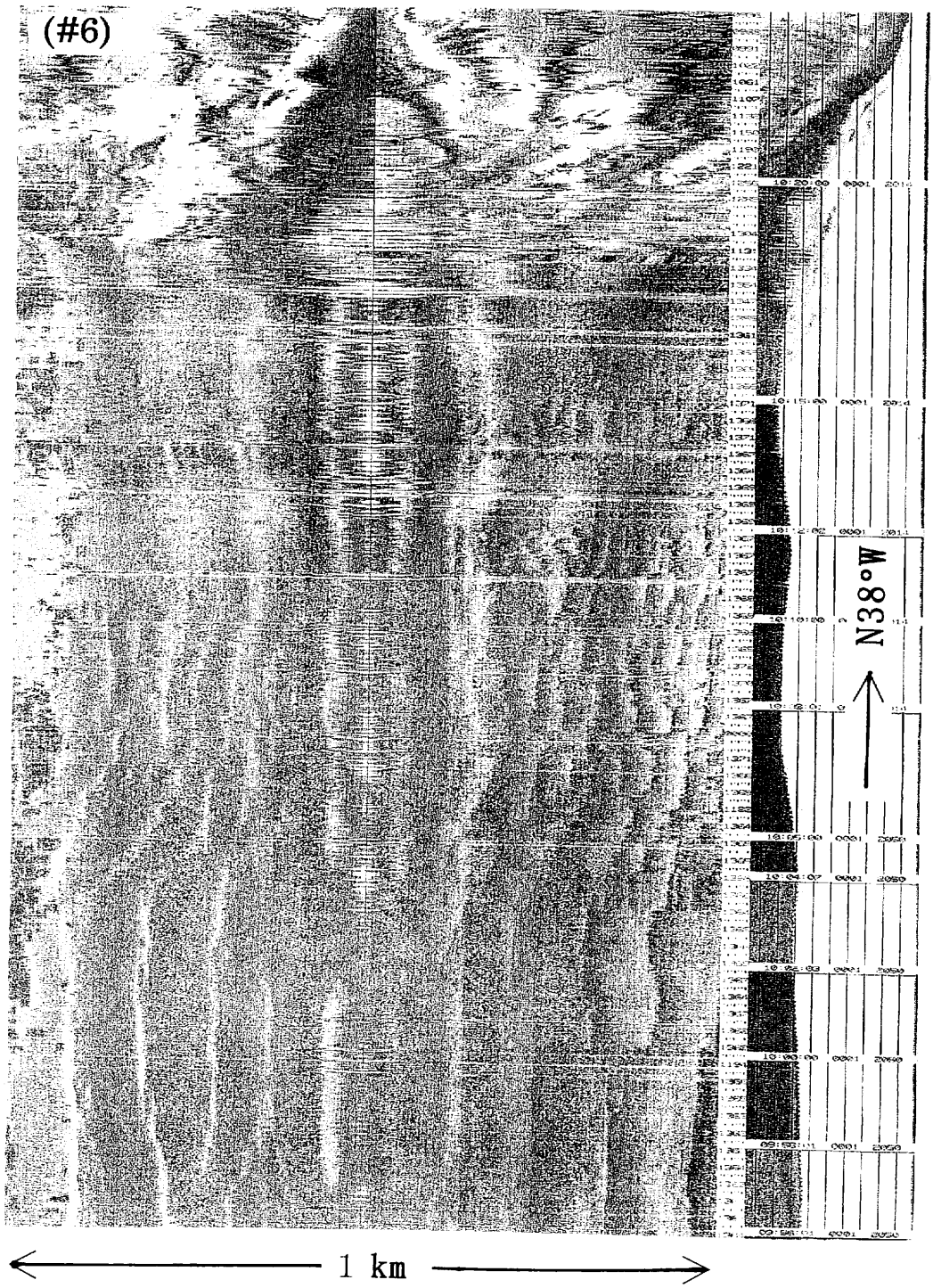

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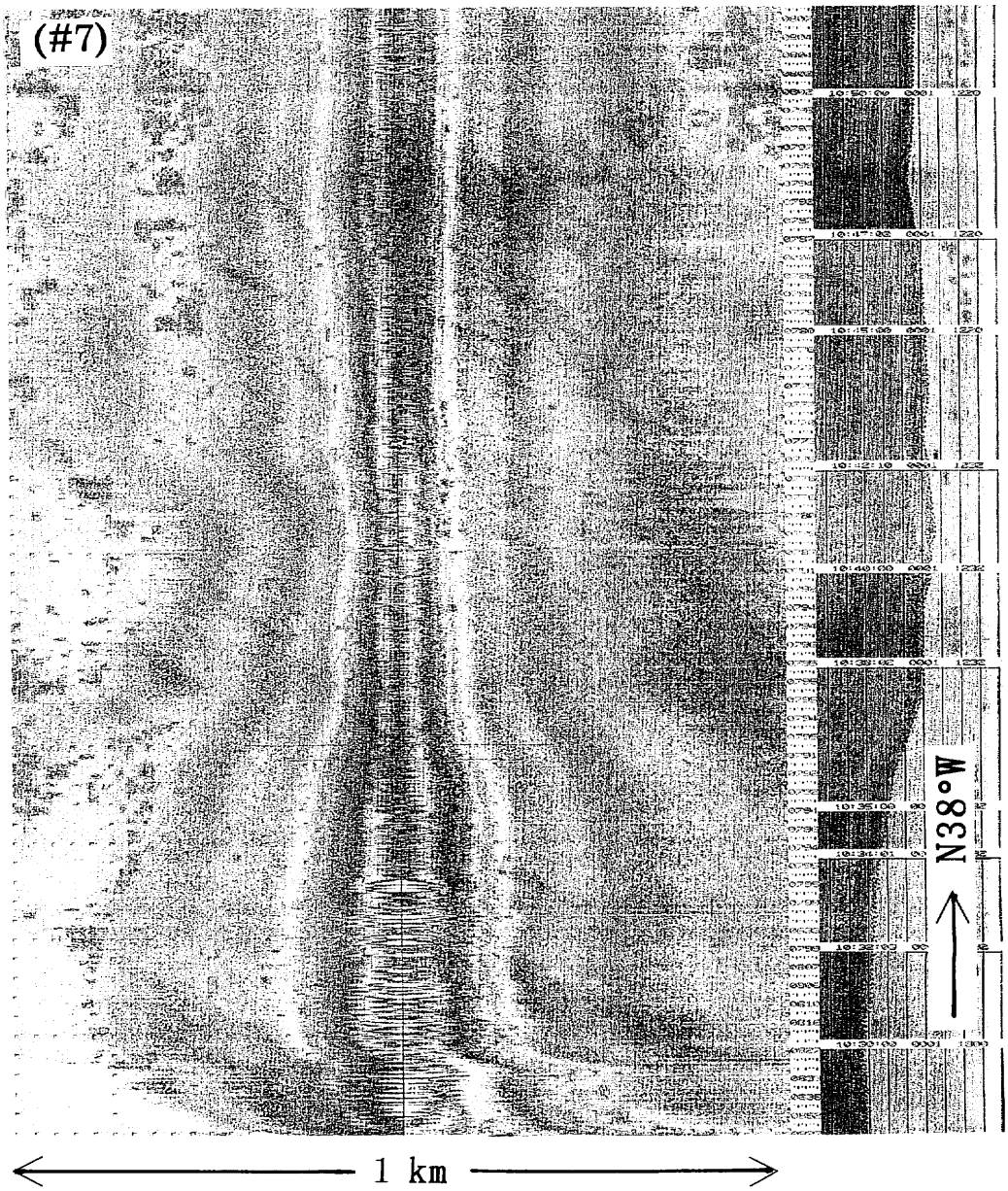

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