Acoustic Reflection Profiles

VENEZUELA CONTINENTAL BORDERLAND

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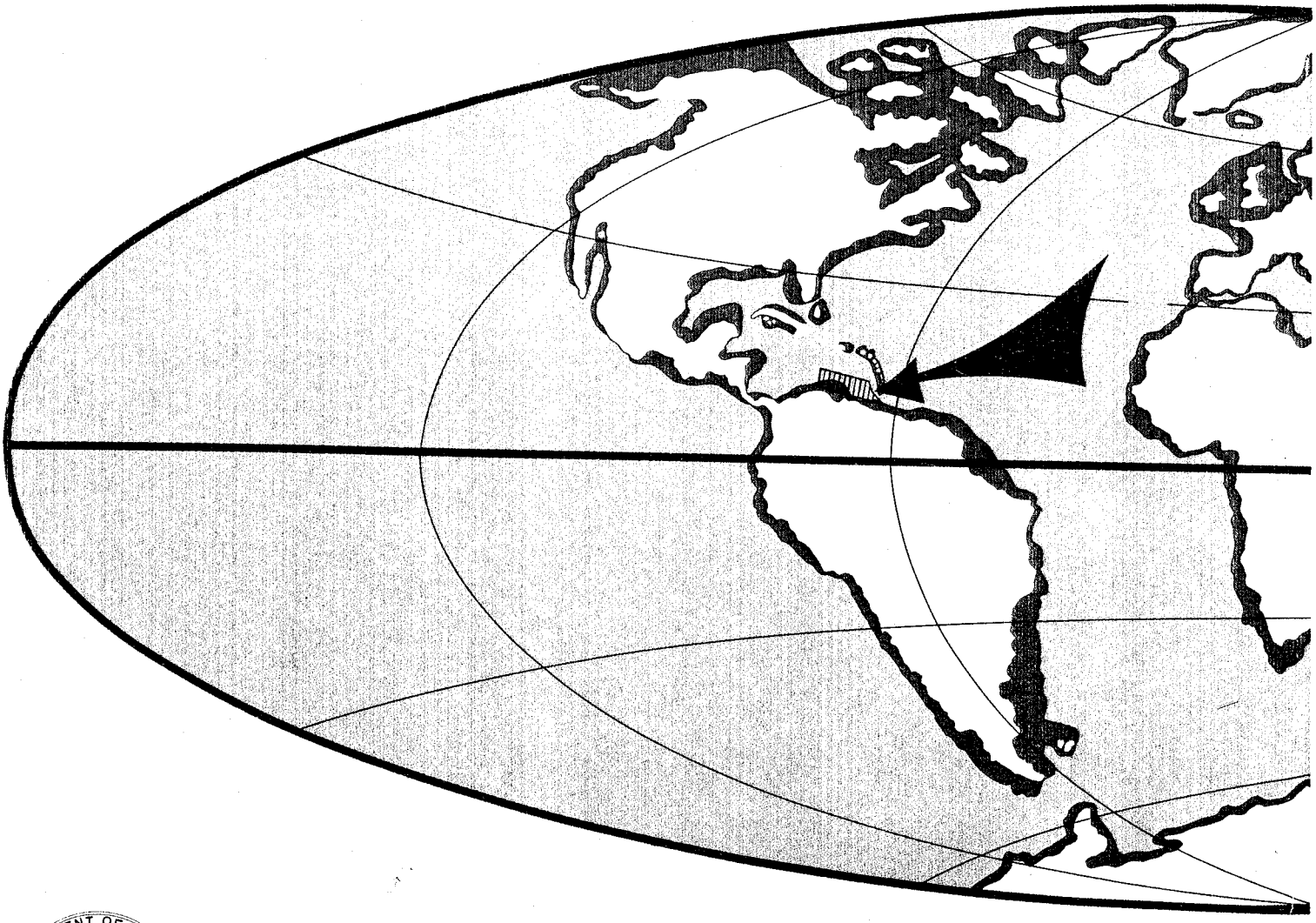

INTERNATIONAL DECADE OF OCEAN EXPLORATION

U. S. GEOLOGICAL SURVEY

USGS - GD - 72 - 005

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INTRODUCTION

As part of a cooperative marine research program designated the International Decade of Ocean Exploration (IDOE), the United States Geological Survey is participating in an investigation of the geologic framework and resource potential of continental margins and small ocean basins in the Gulf of Mexico, Caribbean Sea, and west African continental shelf areas. These studies are funded through the National Science Foundation. Legs 1-3, completed June 22, July 8, and August 4, respectively, were concerned with subbottom features and tectonic history of the Bay of Campeche, the continental margin east of the Yucatan Peninsula, and the Antilles region of the northeastern Caribbean Sea. Leg 4, described in this report, was conducted in the continental borderland area of Venezuela, including the Netherlands Antilles, between August 18 and October 1, 1971. The cruise leg began at San Juan, Puerto Rico, and ended at Port of Spain, Trinidad, after having run a total distance of 8,000 km (fig. 1). Other geophysical records collected during the cruise include magnetometry, gravimetry, and bathymetry.

Visiting scientists from the University of Amsterdam, the University of Utrecht, the Venezuelan Petroleum Corporation, and the Venezuelan Ministry of Mines and Hydrocarbons joined the research vessel UNITEDGEO I during separate phases of the cruise. The cruise offered an excellent opportunity for scientific interchange between investigators from the Netherlands, Venezuela, and the United States and permitted cooperative efforts both aboard the research vessel and during the geologic mapping of the islands of Aruba, Curacao and Bonaire.

SCIENTIFIC PARTY

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SHIP SCHEDULE

A total of 26 days was spent at sea in the central and southern Caribbean Sea during Leg 4. The departure from San Juan was approximately 10 days later than originally scheduled due to delays in filling out ship's crew list. Departure from Curacao was delayed an additional 15 days due to breakdown of various pieces of ship's equipment. Departure from the first port call at La Guaira was delayed another 2 days due in part to a passing hurricane and in part to breakdown of ship's generator. Departure from second La Guaira port call was delayed another one-half day due to breakdown of ship's equipment.

Days 230 (August 18, 1971)	Depart San Juan. Long profile across Carribbean passing west of Puerto Rico, through DSDP Site 146, and west of Curacao.
Days 233-248 (Aug 21 - Sep 5)	In Curacao repairing equipment and doing geological reconnaissance in Aruba, Curacao and Bonaire.
Days 248-256 (September 5-13)	Geophysical work on Venezuelan borderland between Aruba and Bonaire.
Days 256-259 (September 13-16)	In La Guaira repairing equipment and avoiding storm at sea.
Days 259-267 (September 16-24)	Geophysical work between Bonaire and Los Roques.
Days 267-268 (September 24-25)	In La Guaira
Days 268-274 (Sep 25 - Oct 1)	Geophysical work on Venezuelan borderland.

ys 274-286 (October 1-13) In Port of Spain overhauling main engines and replacing deck generator that had shorted out near end of Leg 4.

OBJECTIVES OF INVESTIGATION

The objectives of the geophysical and geological studies were:) to determine the structure, crustal thickness, and composition the continental margin, (b) to tie this structure to that of the nezuelan mainland, the Leeward Antilles and to the central Caribbean ea, where structural information has been provided by Deep Sea illing, (c) to determine the nature and history of the boundary tween the Caribbean and South American plates, and (d) to outline eas of potential mineral resources on the continental margin.

Geologic Setting

The Venezuelan borderland and adjacent parts of northern South erica make up a broadly arcuate structural zone that lies between e relatively stable Guyana Shield of Venezuela on the south and e Venezuelan Basin to the north (fig. 1). Parts of the structural ne in western Venezuela trend roughly NE-SW, but at the coast the ne turns eastward into the coast range area of Venezuela. The zone en parallels the coast and passes through Caracas, the Araya and ria Peninsulas, and into northern Trinidad.

The structural zone was intensely deformed during Mesozoic and nozoic time. In the coast range area of Venezuela, the metamorphic ade tends to increase northward, although major southward thrusting blueschist facies rocks complicates the pattern. In north central nezuela, the pre-Upper Cretaceous rocks are metamorphosed to high-essure glaucophane - bearing rocks of the greenschist facies hagam, 1960) and to lower-temperature moderate-pressure rocks inkler, 1965) of the lawsonite-pumpellyite facies (Piburn, 1968). e basement rocks of Aruba, Los Rogoes and La Orchila are metamor-osed to greenschist facies assemblages, but the rocks on Curacao d Bonaire are only weakly metamorphosed. The rock sequence on ch island was intruded by dioritic or quartz dioritic masses in te Cretaceous time, and possible ignembrites were erupted on naire at that time also.

Upper Mesozoic intrusive rocks in the Netherlands Antilles form basement complex composed largely of diabase (Schaub, 1948; Beets, 66; Lagaay, 1969). Positive gravity and magnetic anomalies over e islands of Curacao, Bonaire and Aruba (Lagaay, 1969) are presumably sociated with a diabase core or basaltic rocks on these islands. e Deep Sea Drilling Project cored Upper Cretaceous basaltic base-

ment rocks in the Caribbean basin also (Edgar and others, 1971). The basement rocks in the Netherlands Antilles are overlain by strata containing ammonites of Late Cretaceous age (Beets, 1966). Lagoonal limestone terrace deposits of middle to late Cenozoic age cap many of the islands.

Field evidence for middle to late Cenozoic movement on faults suggests a complex interaction of compressional, extensional and lateral movement on the major fault zones. Rod (1956) discussed the transcurrent faults of northern South America and estimated about 33 km of post-Oligocene right-lateral movement on the northeast-trending Bocono fault. The east-trending El Pilar fault has strike slip displacement of 5 to 15 km (Metz, 1964), some of which is Holocene and right-lateral based on first motion studies (Molnar and Sykes, 1969). The east-trending Oca fault also has right-lateral movement and probably has not been active since the early Pleistocene (Vasquez, 1971).

In addition to the right-lateral movement on the Bocono, Oca and other faults in northern South America, large vertical offsets have also been measured. Bell (1971) suggests up to 40 km of N-S shortening in northern Venezuela, and published sections across the Cordillera Oriental suggest Cenozoic horizontal shortening of approximately 10 km (Hedberg, 1950; Campbell and Burgl, 1965; Julivert, 1970).

Preliminary Results

Approximately 8,000 km of survey lines were run during the geophysical cruise, and in addition the United States and Dutch scientists conducted a 10-day geological reconnaissance of the islands of Aruba, Curacao and Bonaire. Observations of pillow basalts were extended from the well-known exposures on Curacao to previously unknown occurrences on Aruba and Bonaire. A rich fossil-bearing chert horizon was discovered on Bonaire. The abundance of pillow basalt, diabase, chert and siliceous sedimentary rocks on the islands and the presence of positive gravity anomalies of as much as 100 mgals indicate that this island area is a raised segment of oceanic rocks.

The Curacao Ridge is a broad submarine upwarp that is highly deformed only on the north side west of Las Aves, but to the east of the island the entire ridge is deformed. The deformation is in sharp contrast to the eastward-thickening ponded turbidites north of the continental slope.

All profiles between Aruba and Las Aves show layer "B", the basaltic or diabasic layer under the sediments of the Venezuelan

Basement. This layer, which was cut by drilling in DSDP site 146 (Edgar and others, 1971), passes smoothly beneath the deformed deposits of the continental slope for several kilometers southward. East of Las Aves islands the sediment thickness beyond the continental slope approaches 4 km, and layer "B" could not be followed under the slope. In profiles from this region, however, and in other profiles to the west, the outermost deformed sediment of the Curacao Ridge is seen to be continuous with the undeformed layered strata to the north in the Venezuela Basin. In this basin, the thickness of the pelagic section is fairly uniform, but the section is reduced in thickness where it underlies horizontally bedded reflectors of possible turbidity-current origin in the trough north of the slope. The great increase in sediment thickness in the Venezuelan Basin north of La Orchila suggests that the pathway of sediment transport was through Los Roques Canyon.

A wide basin of deposition, the Bonaire Trough, lies between the island chain and the Venezuelan coast. A zone of deformation is seen on its south flank. A continuous reflector passes beneath the deformed zone in one profile.

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OPERATIONAL DATA

Navigation

A satellite-navigation system, supplemented near the shore by radar, was used for positioning. The satellite system consisted of an ITT 4007 AB satellite-navigation receiver, a DEC PDP-8L computer, and an ITT teletyprewriter. Precision of satellite fixes while underway was estimated at about 180 m (600 ft.). The radar system was a Decca RM 329, with 25 kw of power and a range up to about 65 km (40 mi.). A 9-foot wave-guide antenna giving a beam width of less than 1° at the half-power points provided high azimuth resolution. Accuracy of radar fixes was subject to many variables, but the average positioning error was estimated at about 925 m (3,000 ft.). Plotting was done on bottom contour charts 703, 704, 803, and 804 of the U.S. Navy's Hydrographic Office. The detailed track chart (Plate 1) is at the same scale as the bottom contour charts.

Time for navigation and scientific records is referred to Greenwich Mean Time (Z), and days are numbered consecutively from the first day of the year. Scientific clocks were adjusted according to WWV radio.

Acoustic-reflection System

The acoustic-reflection profiles were obtained using a sparker system consisting of separate, van-mounted, self-contained 160- and 120-kilojoule units triggered from a single source. Maximum total usable power was about 220 kilojoules. The triggered discharge of large capacitors through 6 twin-electrode "ladders" trailed behind the ship created sparks that produced the low-frequency acoustic pulse. These pulses were reflected from the sea bottom and from subbottom surfaces and were received and preamplified by a 100-hydrophone streamer. They were then selectively filtered and recorded graphically on a Raytheon recorder. The sparker ladders were trailed about 70 m behind the navigation antenna; the center of the hydro-streamer was at about 180 m.

Organization of profile records.--The subbottom acoustic profiles in this report are presented in numerical order at approximately 1/5th scale. Many are shown reversed in order to facilitate comparison of structural and sedimentary features from profile to profile. All north-south profiles have been assembled with the north end at the right; thus, the user views such profiles as though looking westward and with land to the left. The start and end of each line are indicated. Day notations are listed consecutively from day one of the year 1971; time marks are every hour. The records in this report were made between days 230 and 274 (August 18 to October 1). Hour marks shown on the profiles are in GMT and correspond with those on the detailed track chart (Plate 1, pocket) and to depth data given in Table 1.

The subbottom profiles were run chiefly at a 4-second firing rate and 4-second sweep, although small parts of lines 2, 5, 6, 10, 12, 13 and 15 were run at 8-second firing rate and 4-second sweep, and brief periods of lines 1 and 10 had a 6-second firing rate and 6-second sweep. The vertical scale shown on the acoustic profiles is two-way travel time in seconds. The sparker energy source was varied according to geologic setting, water depth, and at times equipment malfunction. Maximum power 220 kj was used completely on lines 9 and 10 and on parts of lines 8 and 11, 160 kj was used completely on lines 4-7, 12-13, 23-30 and 33-36 and on parts of lines 8, 11, 14, 30 and 32, and 120 kj was used completely on lines 2-3, 15-22, 31, 37-51 and parts of lines 1, 14, 30 and 32. The filter band pass was 76/20 hz throughout the survey. The average vertical exaggeration of the sea-floor profiles is about 10:1, the

range is between 9:1 and 13:1.

Depth Recorder

A 3.5 khz Edo acoustic-reflection system was used as an echo-sounder and shallow-penetration subbottom profiler. Twelve transducers mounted in a sea chest in the ship's hull emitted a pulse signal programmed by a Gifft graphic recorder that provided uncorrected water depths in seconds (two-way travel time). These water depths were transcribed at quarter-hour intervals and, in conjunction with navigation fixes, were computer-processed using corrections from Matthews' tables. Computer output was printed at one-hour intervals and includes the position of each station, the observed depth in seconds, and the corrected depth in meters (Table 1).

Table 1. Positions and depths expressed in two-way travel time and corrected meters along lines of Leg 4, Venezuela Continental Borderland, 1971

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
1	231	0000	18.5475	66.2468	1.830	1367
1	231	0100	18.5551	66.3984	1.800	1345
1	231	0200	18.5609	66.5596	1.940	1450
1	231	0300	18.5705	66.7268	2.170	1621
1	231	0400	18.5793	66.8935	2.060	1540
1	231	0500	18.5881	67.0603	1.410	1056
1	231	0600	18.5391	67.1910	1.110	834
1	231	0700	18.4488	67.2959	2.450	1830
1	231	0800	18.3512	67.3931	2.040	1525
1	231	0900	18.2240	67.4594	1.400	1048
1	231	1000	18.0943	67.5234	2.080	1555
1	231	1100	17.9633	67.5864	2.790	2086
1	231	1200	17.8340	67.6451	2.910	2176
1	231	1300	17.7085	67.7089	3.680	2754
1	231	1400	17.5864	67.7734	3.500	2617
1	231	1500	17.4696	67.8528	4.220	3163
1	231	1600	17.3528	67.9321	4.870	3658
1	231	1700	17.2399	68.0168	6.550	4953
1	231	1800	17.1299	68.1056	7.150	5452
1	231	1900	17.0079	68.1970	6.750	5104
1	231	2000	16.8805	68.2855	6.500	4915
1	231	2100	16.7549	68.3734	6.230	4705
1	231	2200	16.6295	68.4559	6.030	4549
1	231	2300	16.5042	68.5384	5.810	4382
1	232	0000	16.3802	68.6231	5.550	4182
1	232	0100	16.2545	68.7039	5.500	4144
1	232	0200	16.1289	68.7858	5.520	4159
1	232	0300	16.0048	68.8693	5.410	4074
1	232	0400	15.8806	68.9528	5.360	4035
1	232	0500	15.7565	69.0363	5.300	3989
1	232	0600	15.6319	69.1187	5.130	3858
1	232	0700	15.5024	69.1975	5.080	3819
1	232	0800	15.3720	69.2825	5.170	3889
2	232	0900	15.2373	69.3473	5.200	3912
2	232	1000	15.0899	69.3538	5.230	3935
2	232	1100	14.9426	69.3603	5.350	4028
2	232	1200	14.7929	69.3621	5.630	4244
2	232	1300	14.6407	69.3634	5.780	4360
2	232	1400	14.4836	69.3685	5.990	4518
2	232	1500	14.3266	69.3735	6.210	4689
2	232	1600	14.1696	69.3785	6.280	4743
2	232	1700	14.0125	69.3836	6.440	4868

D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
2	232	1800	13.8555	69.3866	6.470	4891
2	232	1900	13.6978	69.3952	6.530	4938
2	232	2000	13.5428	69.4073	5.990	4518
2	232	2100	13.3891	69.4216	4.640	3483
2	232	2200	13.2354	69.4360	3.570	2671
2	232	2300	13.0879	69.4548	3.440	2573
2	233	0000	12.9405	69.4739	1.800	1345
2	233	0100	12.7953	69.5011	2.420	1807
2	233	0200	12.6560	69.5303	2.190	1636
2	233	0300	12.5141	69.5589	1.850	1382
2	233	0400	12.3784	69.5699	1.210	908
2	233	0500	12.2298	69.5672	0.790	595
2	233	0600	12.0836	69.5663	0.550	416
2	233	0700	11.9408	69.5435	0.430	326
2	233	0800	11.7913	69.5076	0.290	220
3	233	0900	11.7469	69.4350	0.280	213
3	233	1000	11.8338	69.3339	0.920	692
3	233	1100	11.9207	69.2327	1.500	1121
3	233	1200	12.0146	69.1388	1.690	1262
3	233	1300	12.1030	69.0501	1.270	953
4	248	2000	12.0710	69.0440	1.450	1085
4	248	2100	12.0406	69.1585	1.640	1225
4	248	2200	12.0122	69.2754	1.360	1019
4	248	2300	11.9868	69.3965	0.950	715
4	249	0000	11.9540	69.5131	0.500	379
4	249	0100	11.9167	69.6250	0.250	190
5	249	0200	11.9038	69.7141	0.090	68
5	249	0300	12.0189	69.7174	0.300	228
5	249	0400	12.1341	69.7207	0.350	266
5	249	0500	12.2465	69.7244	0.410	311
5	249	0600	12.3566	69.7338	0.770	580
5	249	0700	12.4643	69.7432	1.000	752
5	249	0800	12.5760	69.7487	1.480	1107
5	249	0900	12.6878	69.7542	1.700	1270
5	249	1000	12.7997	69.7656	1.700	1270
5	249	1100	12.9117	69.7797	2.010	1503
5	249	1200	13.0240	69.7971	2.000	1495
5	249	1300	13.1393	69.8121	2.800	2094
5	249	1400	13.2560	69.8275	3.900	2920
5	249	1500	13.3723	69.8447	4.300	3224
5	249	1600	13.4889	69.8617	4.920	3696

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
5	249	1700	13.6098	69.8772	6.100	4603
5	249	1800	13.7316	69.8923	6.500	4915
5	249	1900	13.8553	69.9118	6.120	4619
5	249	2000	13.9787	69.9353	5.900	4450
6	249	2100	13.9562	70.0150	5.760	4345
6	249	2200	13.8392	70.0505	6.230	4705
6	249	2300	13.7190	70.0863	6.440	4868
6	250	0000	13.5965	70.1208	6.100	4603
6	250	0100	13.4718	70.1607	4.300	3224
6	250	0200	13.3448	70.1970	3.900	2920
6	250	0300	13.2171	70.2321	3.200	2393
6	250	0400	13.0877	70.2696	2.600	1943
6	250	0500	12.9552	70.3120	1.140	856
6	250	0600	12.8227	70.3268	0.670	506
6	250	0700	12.6884	70.3251	0.450	341
6	250	0800	12.5537	70.3223	0.120	91
6	250	0900	12.4270	70.3244	0.100	76
6	250	1000	12.3029	70.3265	0.090	68
6	250	1100	12.1702	70.3106	0.080	61
7	250	1200	12.1945	70.2535	0.063	48
7	250	1300	12.3063	70.1924	0.050	38
7	250	1400	12.3651	70.1001	0.060	45
7	250	1500	12.3709	69.9768	0.170	129
7	250	1600	12.3750	69.8566	0.420	318
7	250	1700	12.3751	69.7445	0.700	528
7	250	1800	12.3729	69.6252	1.050	789
7	250	1900	12.3669	69.4931	1.420	1063
8	250	2000	12.3302	69.3871	1.550	1159
8	250	2100	12.1942	69.3831	1.350	1011
8	250	2200	12.0582	69.3792	1.060	797
8	250	2300	11.9225	69.3762	0.990	745
8	251	0000	11.7867	69.3732	0.480	364
8	251	0100	11.6675	69.4149	0.150	114
9	251	0200	11.6361	69.3215	0.150	114
9	251	0300	11.6194	69.2074	0.260	198
10	251	0400	11.7211	69.1841	0.620	468
10	251	0500	11.8417	69.1845	1.500	1121
10	251	0600	11.9549	69.1889	1.610	1203
10	251	0700	12.0678	69.1902	1.600	1196

C.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
10	251	0800	12.1851	69.1923	1.600	1196
10	251	0900	12.3028	69.1945	1.450	1085
10	251	1000	12.4192	69.1983	1.400	1048
10	251	1100	12.5263	69.2046	2.200	1643
10	251	1200	12.6312	69.2131	2.900	2169
10	251	1300	12.7377	69.2209	3.020	2258
10	251	1400	12.8456	69.2282	2.910	2176
10	251	1500	12.9535	69.2355	2.620	1958
10	251	1600	13.0621	69.2434	2.950	2206
10	251	1700	13.1744	69.2538	3.800	2845
10	251	1800	13.2802	69.2617	4.000	2995
10	251	1900	13.3787	69.2664	4.570	3430
10	251	2000	13.4847	69.2641	5.280	3974
10	251	2100	13.5941	69.2597	6.600	4990
10	251	2200	13.7022	69.2562	6.510	4922
10	251	2300	13.8082	69.2485	6.460	4884
11	252	0000	13.8446	69.1866	6.430	4860
11	252	0100	13.8496	69.1075	6.250	4720
11	252	0200	13.8545	69.0283	6.190	4673
12	252	0300	13.8023	68.9904	6.150	4642
12	252	0400	13.6895	68.9990	6.320	4775
12	252	0500	13.5789	69.0082	6.650	5028
12	252	0600	13.4716	69.0180	5.870	4428
12	252	0700	13.3670	69.0272	4.450	3339
12	252	0800	13.2647	69.0209	4.300	3224
12	252	0900	13.1635	69.0085	4.740	3558
12	252	1000	13.0624	68.9956	3.110	2326
12	252	1100	12.9585	68.9814	2.640	1973
12	252	1200	12.8509	68.9713	2.950	2206
12	252	1300	12.7429	68.9618	3.270	2445
12	252	1400	12.6325	68.9611	3.230	2415
12	252	1500	12.5208	68.9651	3.190	2386
12	252	1600	12.4007	68.9798	1.200	901
12	252	1700	12.2927	68.9889	1.250	938
13	252	1800	12.2663	68.9334	1.500	1121
13	252	1900	12.2980	68.8341	2.180	1629
13	252	2000	12.3271	68.7350	2.430	1815
13	252	2100	12.3577	68.6388	3.100	2318
13	252	2200	12.3886	68.5444	3.300	2468
13	252	2300	12.4190	68.4319	3.100	2318
13	253	0000	12.4590	68.2841	3.800	2845

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
14	253	0500	12.5337	68.2029	4.900	3681
14	253	0600	12.4536	68.3159	4.200	3148
14	253	0900	12.2867	68.5653	2.210	1651
14	253	1000	12.2021	68.6701	2.030	1518
14	253	1100	12.1177	68.7750	0.575	435
15	253	1200	12.2338	68.7869	1.630	1218
15	253	1300	12.3601	68.7935	2.720	2034
15	253	1400	12.4864	68.8004	3.190	2386
15	253	1500	12.6127	68.8073	3.450	2580
15	253	1600	12.7390	68.8142	3.450	2580
15	253	1700	12.8588	68.8157	2.880	2154
15	253	1800	12.9924	68.8248	2.500	1867
15	253	1900	13.1363	68.8083	4.720	3543
15	253	2000	13.2631	68.7755	5.130	3858
15	253	2100	13.3964	68.7873	5.430	4089
15	253	2200	13.5297	68.7991	6.690	5059
15	253	2300	13.6569	68.7973	6.640	5021
15	254	0000	13.7885	68.7829	6.470	4891
16	254	0100	13.8631	68.7233	6.430	4860
16	254	0200	13.8647	68.6071	6.650	5028
17	254	0300	13.8366	68.5159	6.670	5043
17	254	0400	13.7064	68.5111	6.640	5021
17	254	0500	13.5757	68.5075	6.620	5006
17	254	0600	13.4446	68.5081	6.680	5051
17	254	0700	13.3174	68.5123	4.800	3604
17	254	0800	13.1930	68.5187	4.900	3681
17	254	0900	13.0695	68.5264	3.910	2928
17	254	1000	12.9478	68.5353	3.120	2333
17	254	1100	12.8282	68.5274	3.300	2468
17	254	1200	12.7060	68.5121	4.080	3056
17	254	1300	12.5832	68.4954	4.260	3194
17	254	1400	12.4654	68.4878	3.140	2348
17	254	1500	12.3415	68.4835	2.500	1867
17	254	1600	12.2116	68.4804	2.200	1643
17	254	1700	12.0821	68.4789	1.920	1435
17	254	1800	11.9536	68.4821	2.030	1518
17	254	1900	11.8242	68.4816	2.330	1740
17	254	2000	11.6935	68.4561	2.080	1555
17	254	2100	11.5632	68.4303	1.220	916
17	254	2200	11.4331	68.4089	0.640	483

I.O.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
18	255	0000	11.2452	68.3848	0.060	45
18	255	0100	11.3041	68.3731	0.240	183
18	255	0400	11.4898	68.3305	1.200	901
18	255	0500	11.6163	68.3066	2.380	1778
18	255	0600	11.7416	68.2844	2.400	1792
18	255	0700	11.8639	68.2663	1.280	960
18	255	0800	11.9709	68.2440	0.660	498
19	255	0900	11.8924	68.2159	1.030	774
19	255	1000	11.7548	68.1958	2.280	1703
19	255	1100	11.6254	68.1706	2.470	1845
19	255	1200	11.4974	68.1399	1.880	1405
19	255	1300	11.3716	68.1139	1.330	997
19	255	1400	11.2465	68.0890	0.910	685
20	255	1500	11.2010	68.0489	0.870	655
20	255	1600	11.3202	67.9846	1.500	1121
20	255	1700	11.4395	67.9202	2.250	1680
20	255	1800	11.5593	67.8586	2.500	1867
20	255	1900	11.6801	67.7975	2.200	1643
20	255	2000	11.8035	67.7450	1.950	1458
20	255	2100	11.9272	67.6898	1.140	856
21	255	2200	11.9147	67.5742	1.350	1011
21	255	2300	11.8726	67.4478	0.900	677
21	256	0000	11.8313	67.3219	1.190	893
21	256	0100	11.7976	67.2004	1.740	1299
21	256	0200	11.7639	67.0790	1.440	1078
21	256	0300	11.7302	66.9575	1.130	849
22	256	0400	11.6706	66.8721	1.370	1026
22	256	0500	11.5376	66.8826	2.000	1495
22	256	0600	11.4083	66.8825	2.315	1729
22	256	0700	11.2795	66.8855	2.000	1495
22	256	0800	11.1505	66.8914	1.200	901
22	256	0900	11.0214	66.8973	0.650	491
22	256	1000	10.8916	66.9032	0.295	224
22	256	1100	10.7510	66.9086	0.340	258
23	260	0500	10.6400	67.0971	0.310	236
23	260	0600	10.6376	67.2178	0.850	640
23	260	0700	10.6275	67.3360	1.090	819
23	260	0800	10.6205	67.4535	1.020	767

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
23	260	0900	10.6256	67.5714	0.790	595
23	260	1000	10.6310	67.6903	0.600	453
23	260	1200	10.6389	67.8953	0.160	122
24	260	1400	10.7270	68.0217	0.100	76
24	260	1500	10.8337	68.0243	0.130	99
24	260	1600	10.9407	68.0274	0.330	251
24	260	1700	11.0478	68.0305	0.580	438
24	260	1800	11.1571	68.0255	0.800	603
24	260	1900	11.2653	68.0150	1.390	1041
24	260	2000	11.3698	68.0053	1.500	1121
24	260	2100	11.4742	67.9958	2.090	1562
24	260	2200	11.5767	67.9904	2.485	1856
24	260	2300	11.6767	67.9905	2.260	1688
24	261	0000	11.7778	67.9942	1.775	1326
24	261	0100	11.8794	67.9996	1.630	1218
24	261	0200	11.9810	68.0051	2.120	1584
24	261	0300	12.0824	68.0119	2.490	1860
24	261	0400	12.1836	68.0198	2.500	1867
24	261	0500	12.2868	68.0287	1.890	1412
24	261	0600	12.3915	68.0383	3.330	2490
24	261	0700	12.4931	68.0572	4.500	3378
24	261	0800	12.5938	68.0785	5.890	4443
24	261	0900	12.6923	68.0943	5.180	3896
24	261	1000	12.7877	68.1106	3.800	2845
24	261	1100	12.8847	68.1287	2.980	2228
24	261	1200	12.9822	68.1396	3.305	2472
24	261	1300	13.0790	68.1506	4.660	3498
24	261	1400	13.1746	68.1615	4.960	3727
24	261	1500	13.2703	68.1725	5.120	3850
24	261	1600	13.3659	68.1835	5.680	4283
24	261	1700	13.4738	68.1961	6.690	5059
24	261	1800	13.6054	68.2023	6.650	5028
24	261	1900	13.7385	68.2117	6.640	5021
24	261	2000	13.8715	68.2211	6.650	5028
24	261	2100	14.0114	68.2320	6.680	5051
25	261	2200	14.0653	68.1614	6.685	5055
25	261	2300	14.0481	68.0341	6.685	5055
25	262	0000	14.0301	67.9091	6.685	5055
25	262	0100	14.0121	67.7842	6.690	5059
26	262	0200	13.9028	67.7464	6.680	5051
26	262	0300	13.7544	67.7403	6.680	5051

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
26	262	0400	13.6060	67.7343	6.650	5028
26	262	0500	13.4576	67.7282	6.670	5043
26	262	0600	13.3114	67.7257	6.100	4603
26	262	0700	13.1654	67.7235	5.070	3812
26	262	0800	13.0191	67.7224	4.790	3596
26	262	0900	12.8724	67.7226	3.990	2988
26	262	1000	12.7268	67.7198	5.825	4394
26	262	1100	12.5816	67.7159	6.130	4627
26	262	1200	12.4364	67.7121	5.185	3900
26	262	1300	12.2912	67.7082	2.040	1525
26	262	1400	12.1545	67.7031	0.770	580
26	262	1500	12.0177	67.7424	0.790	595
26	262	1600	11.8844	67.7500	1.580	1181
26	262	1700	11.7514	67.7550	2.050	1532
26	262	1800	11.6193	67.7546	2.300	1718
26	262	1900	11.4875	67.7535	2.590	1935
26	262	2000	11.3515	67.7483	2.530	1890
26	262	2100	11.2142	67.7421	2.200	1643
26	262	2200	11.0828	67.7335	1.805	1348
26	262	2300	10.9564	67.7256	1.285	964
26	263	0000	10.8247	67.7196	1.225	919
26	263	0100	10.6888	67.7222	0.895	674
26	263	0200	10.5530	67.7248	0.360	273
27	263	0300	10.5512	67.6703	0.420	318
27	263	0400	10.6032	67.5481	0.660	498
28	263	0500	10.7427	67.5556	1.440	1078
28	263	0600	10.8843	67.5569	1.550	1159
28	263	0700	11.0265	67.5566	1.950	1458
28	263	0800	11.1690	67.5555	2.300	1718
28	263	0900	11.3067	67.5552	2.430	1815
28	263	1000	11.4413	67.5653	2.565	1916
28	263	1100	11.5765	67.5791	2.420	1807
28	263	1200	11.7125	67.5768	1.900	1420
28	263	1300	11.8493	67.5725	1.690	1262
28	263	1400	11.9874	67.5649	1.150	864
28	263	1500	12.1254	67.5573	0.470	356
28	263	1600	12.2644	67.5504	1.110	834
28	263	1700	12.4043	67.5459	3.750	2808
28	263	1800	12.5411	67.5393	6.200	4681
28	263	1900	12.6768	67.5387	5.920	4465
28	263	2000	12.8126	67.5381	4.830	3627
28	263	2100	12.9489	67.5264	4.900	3681

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
28	263	2200	13.0854	67.5125	5.250	3950
28	263	2300	13.2215	67.5009	5.900	4450
28	264	0000	13.3566	67.4965	6.680	5051
28	264	0200	13.6277	67.4904	6.670	5043
28	264	0300	13.7635	67.4878	6.680	5051
29	264	0400	13.8894	67.4847	6.690	5059
29	264	0500	13.8990	67.3760	6.690	5059
29	264	0600	13.9022	67.2604	6.690	5059
30	264	0700	13.7877	67.2544	6.690	5059
30	264	0800	13.6625	67.2565	6.680	5051
30	264	0900	13.5382	67.2522	6.670	5043
30	264	1000	13.4133	67.2469	6.670	5043
30	264	1100	13.2875	67.2414	6.700	5066
30	264	1200	13.1615	67.2357	6.390	4829
30	264	1300	13.0320	67.2297	5.490	4136
30	264	1400	12.9025	67.2237	5.110	3842
30	264	1500	12.7731	67.2176	5.000	3758
30	264	1600	12.6447	67.2234	5.500	4144
30	264	1700	12.5144	67.2363	6.300	4759
30	264	1800	12.3881	67.2415	6.300	4759
30	264	1900	12.2551	67.2469	5.190	3904
30	264	2000	12.1187	67.2505	3.300	2468
30	264	2100	11.9911	67.2524	1.030	774
30	264	2200	11.8638	67.2546	1.205	905
30	264	2300	11.7360	67.2570	1.850	1382
30	265	0000	11.6087	67.2603	2.230	1666
30	265	0100	11.4818	67.2642	2.540	1897
30	265	0200	11.3549	67.2681	2.570	1920
30	265	0300	11.2280	67.2666	2.480	1852
30	265	0400	11.1012	67.2624	2.020	1510
30	265	0500	10.9775	67.2614	1.190	893
30	265	0600	10.8517	67.2636	0.820	618
30	265	0700	10.7231	67.2654	1.000	752
30	265	0800	10.5930	67.2643	0.810	610
31	265	0900	10.6210	67.1539	0.440	334
31	265	1000	10.6720	67.0396	0.310	236
32	265	1100	10.7681	66.9999	0.170	129
32	265	1200	10.9019	67.0086	0.340	258
32	265	1300	11.0373	67.0174	0.900	677
32	265	1400	11.1728	67.0262	1.400	1048

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
32	265	1500	11.3083	67.0350	2.390	1785
32	265	1600	11.4485	67.0459	2.520	1882
32	265	1700	11.5899	67.0626	2.080	1555
32	265	1800	11.7304	67.0799	1.540	1151
32	265	1900	11.8769	67.0822	1.500	1121
32	265	2000	12.0186	67.0768	2.450	1830
32	265	2100	12.1598	67.0817	1.880	1405
32	265	2200	12.2945	67.0785	2.800	2094
32	265	2300	12.4322	67.0775	6.180	4666
32	266	0000	12.5746	67.0796	5.600	4221
32	266	0100	12.7149	67.0812	5.175	3893
32	266	0200	12.8495	67.0814	5.280	3974
32	266	0300	12.9842	67.0816	5.650	4260
32	266	0400	13.1203	67.0760	6.450	4876
32	266	0500	13.2535	67.0770	6.670	5043
32	266	0600	13.3988	67.0771	6.650	5028
32	266	0700	13.5420	67.0819	6.650	5028
32	266	0800	13.6853	67.0867	6.650	5028
33	266	0900	13.7216	67.0008	6.670	5043
33	266	1000	13.7297	66.8962	6.675	5047
33	266	1100	13.7395	66.7909	6.670	5043
33	266	1300	13.7608	66.5769	6.670	5043
33	266	1400	13.7717	66.4683	6.650	5028
34	266	1500	13.6482	66.4693	6.650	5028
34	266	1600	13.5217	66.4737	6.660	5036
34	266	1700	13.3945	66.4750	6.660	5036
34	266	1800	13.2634	66.4735	6.650	5028
34	266	1900	13.1320	66.4720	6.630	5013
34	266	2000	12.9989	66.4681	6.650	5028
34	266	2100	12.8637	66.4610	6.600	4990
34	266	2200	12.7337	66.4556	6.650	5028
34	266	2300	12.6022	66.4476	5.980	4511
34	267	0000	12.4703	66.4396	6.415	4849
34	267	0100	12.3381	66.4355	6.420	4852
34	267	0200	12.2085	66.4328	6.425	4856
34	267	0300	12.0809	66.4314	1.940	1450
34	267	0400	11.9533	66.4300	1.450	1085
34	267	0500	11.8270	66.4319	1.190	893
34	267	0600	11.7007	66.4340	1.520	1136
34	267	0700	11.5744	66.4360	1.560	1166
34	267	0800	11.4440	66.4404	1.650	1233
34	267	0900	11.3123	66.4436	1.495	1118

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
34	267	1000	11.1785	66.4435	0.830	625
34	267	1100	11.0465	66.4454	0.530	401
34	267	1200	10.9153	66.4437	0.270	205
34	267	1300	10.7843	66.4410	0.280	213
34	267	1400	10.6533	66.4383	0.140	106
34	267	1500	10.6524	66.5798	0.100	76
34	267	1600	10.6514	66.7212	0.080	61
34	267	1700	10.6505	66.8626	0.120	91
37	269	1000	10.7097	65.9491	0.400	303
37	269	1100	10.5780	65.9540	0.100	76
37	269	1200	10.4670	65.9269	0.090	68
37	269	1300	10.4689	65.7883	0.130	99
37	269	1400	10.5971	65.7824	0.900	677
37	269	1500	10.7504	65.8033	0.910	685
37	269	1600	10.9021	65.8128	0.230	175
37	269	1700	11.0224	65.8470	0.100	76
37	269	1800	11.0261	66.0062	0.350	266
37	269	1900	11.0304	66.1614	0.430	326
41	269	2000	11.1156	66.2303	0.580	438
41	269	2100	11.2597	66.2371	0.940	707
41	269	2200	11.4060	66.2427	1.480	1107
41	269	2300	11.5559	66.2452	1.150	864
41	270	0000	11.7146	66.2528	1.120	841
41	270	0100	11.8691	66.2632	1.653	1235
41	270	0200	12.0151	66.2750	2.870	2146
41	270	0300	12.1611	66.2867	5.600	4221
41	270	0400	12.3038	66.2995	6.390	4829
41	270	0500	12.4378	66.3141	6.100	4603
41	270	0600	12.5772	66.3206	6.410	4845
41	270	0700	12.7185	66.3190	6.650	5028
41	270	0900	13.0016	66.3179	6.600	4990
41	270	1000	13.0548	66.4393	6.620	5006
41	270	1100	13.0962	66.5710	6.640	5021
41	270	1200	13.1351	66.7007	6.650	5028
41	270	1300	13.0858	66.7634	6.670	5043
41	270	1400	12.9712	66.7747	6.650	5028
41	270	1500	12.8566	66.7860	5.750	4337
41	270	1600	12.7433	66.7944	5.850	4413
41	270	1700	12.6315	66.7983	5.300	3989
41	270	1800	12.5176	66.8054	6.030	4549
41	270	1900	12.4022	66.8150	6.410	4845
41	270	2000	12.2867	66.8245	4.800	3604

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
41	270	2100	12.1713	66.8341	1.930	1443
41	270	2200	12.0558	66.8437	0.300	228
41	270	2300	11.9833	66.9183	0.350	266
41	271	0000	12.0134	67.0514	1.330	997
41	271	0100	12.0402	67.1807	1.920	1435
41	271	0200	12.0671	67.3101	1.440	1078
41	271	0300	12.0939	67.4395	0.410	311
41	271	0400	12.1169	67.5656	0.470	356
41	271	0500	12.1358	67.6908	0.370	281
41	271	0600	12.1535	67.8151	1.800	1345
41	271	0700	12.1712	67.9394	2.880	2154
44	271	0800	12.1869	68.0584	2.700	2019
44	271	0900	12.2032	68.1723	0.650	491
45	271	1000	12.3319	68.1436	1.820	1360
45	271	1100	12.4832	68.1152	3.810	2853
45	271	1200	12.6345	68.0860	5.820	4390
46	271	1300	12.6952	68.0093	5.980	4511
46	271	1400	12.6815	67.8954	6.050	4565
46	271	1500	12.6679	67.7815	6.095	4600
46	271	1600	12.6542	67.6676	6.160	4650
46	271	1700	12.6405	67.5537	6.190	4673
46	271	1800	12.6268	67.4398	5.900	4450
46	271	1900	12.6132	67.3259	5.890	4443
46	271	2000	12.6121	67.2073	5.860	4420
46	271	2100	12.6119	67.0875	5.460	4113
46	271	2200	12.6032	66.9646	5.110	3842
46	271	2300	12.5847	66.8464	5.550	4182
46	272	0000	12.5583	66.7296	5.940	4481
46	272	0100	12.5303	66.6131	6.270	4736
46	272	0200	12.5023	66.4966	6.330	4782
46	272	0300	12.4743	66.3801	6.300	4759
46	272	0400	12.4496	66.2706	6.040	4557
46	272	0500	12.4224	66.1603	5.970	4503
46	272	0600	12.3939	66.0491	5.760	4345
46	272	0700	12.3638	65.9364	5.930	4473
46	272	0800	12.3315	65.8214	5.300	3989
46	272	0900	12.3018	65.7104	5.210	3920
46	272	1000	12.2718	65.5979	5.250	3950
46	272	1100	12.2421	65.4858	5.170	3889
46	272	1200	12.2129	65.3698	4.444	3335
46	272	1300	12.1837	65.2538	3.756	2812

I.D.O.E. '71 LEG 4 - VENEZUELAN MARGIN BATHYMETRY (HOURLY)

LINE	DAY	TIME (Z)	LATITUDE (NORTH)	LONGITUDE (WEST)	DEPTH (SEC)	DEPTH (M)
46	272	1400	12.1545	65.1378	3.530	2640
46	272	1500	12.1247	65.0201	3.450	2580
46	272	1600	12.0949	64.9001	4.560	3423
46	272	1700	12.0686	64.7773	3.900	2920
46	272	1800	12.0468	64.6600	2.590	1935
46	272	1900	12.0338	64.5382	1.720	1285
46	272	2000	12.0220	64.4119	1.390	1041
46	272	2100	12.0128	64.3126	1.400	1048
46	272	2200	12.0035	64.2127	0.620	468
46	272	2300	11.9898	64.0919	0.340	258
46	273	0000	11.9987	63.9897	0.500	379
46	273	0100	12.1686	64.0367	3.700	2770
46	273	0200	12.3386	64.0838	4.540	3408
46	273	0300	12.5086	64.1308	4.560	3423
46	273	0400	12.6785	64.1779	4.040	3026
47	273	0500	12.8296	64.1342	4.050	3033
47	273	0600	12.9778	64.0765	3.980	2980
48	273	0700	13.0173	63.9438	3.700	2770
48	273	0800	13.0315	63.7888	3.090	2311
48	273	0900	13.0358	63.6321	1.500	1121
49	273	1000	13.0297	63.4836	1.420	1063
49	273	1100	12.8901	63.4374	1.500	1121
49	273	1200	12.7456	63.4463	1.390	1041
49	273	1300	12.6069	63.4560	1.400	1048
49	273	1400	12.4683	63.4656	1.830	1367
49	273	1500	12.3296	63.4753	2.600	1943
49	273	1600	12.1945	63.5000	2.910	2176
49	273	1700	12.0611	63.5267	2.710	2026
49	273	1800	11.9344	63.5618	2.210	1651
49	273	1900	11.8078	63.5968	1.580	1181
49	273	2000	11.6754	63.6264	0.830	625
49	273	2100	11.5414	63.6542	0.090	68
49	273	2200	11.4108	63.6532	0.700	528
49	273	2300	11.2873	63.5878	0.040	30
49	274	0000	11.1698	63.5291	0.050	38
49	274	0100	11.0578	63.4765	0.060	45
49	274	0200	10.9384	63.4133	0.070	53
50	274	0300	10.8270	63.3436	0.050	38
50	274	0400	10.8299	63.2161	0.050	38
51	274	1500	10.7291	61.7959	0.280	213
51	274	1600	10.6358	61.7595	0.130	99