INSTITUTE FOR GEOPHYSICS
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February 21, 1985

MEMORANDUM

TO: Dr. Arthur E. Maxwell

FROM: Yosio Nakamura

SUBJECT: Cruise Report - FM-28

The R/V Fred H. Moore cruise FM-28 took place on February 6 through 14, 1985. The primary purpose of the cruise was to collect large-offset seismic data, using ocean bottom seismographs (OBS) and large capacity air guns, from two intersecting lines located in the outer slope area of the western Gulf of Mexico known as Alaminos Canyon. The experiment was a part of our continuing study of the deep crustal structure of the Gulf of Mexico, and was conducted in similar fashion as the preceding experiments during the Fred H. Moore cruises FM-17, 19, 20-02, 22 and 24. The lines for the present experiment generally occupied the area west of line 4 of the two-ship ESP/OBS experiment (FM-20) of late 1983 and nearly connected the eastern end of line 3 and the western end of line 5 of that experiment. In addition to the OBS data, we also acquired simultaneous multichannel reflection data from a 5-channel streamer for the same lines.

The cruise was generally quite successful. However, there were some problems. Of the five OBS's deployed on the second section of line A, one recorded data only on one track of the 4-track tape, one was released prematurely without recording any shots and one was not recovered. A later attempt to reshoot a portion of this line was met with a deteriorating weather condition, which forced us to cancel shooting after two OBS's had already been deployed.

The first sections of both line A and line B, however, were 100% successful, with all OBS's coming back with full data. In all, a total of 19 OBS's were deployed instead of 12 as originally planned. Of these 19, 12 recorded full data from shots as programmed, 3 recorded partial data, 2 functioned as programmed while no shooting took place because of the bad weather, one was released prematurely without data and one was lost. The bad weather added one extra day to the originally planned 7-day cruise, making it an 8-day cruise.

As usual, the ship's crew performed admirably. The ship track was maintained excellently and perfect positioning of the ship made the deployment and recovery of OBS relatively easy. The captain displayed an especially remarkable skill in searching for the three OBS's that surfaced a long time before we reached the recovery area and thus drifted off several miles under strong wind.

The navigation team, headed by Jan Garmany with Jeanne Shaub and Denise Kakas, did an excellent job of maintaining the ship track, positioning the ship for easy deployment of OBS, keeping good records of navigation data and maintaining good communication with the bridge. The addition of the Magnavox satellite navigation data to the data logger since the last OBS cruise clearly has been an added convenience to the OBS navigation data processing. The data logger did not "bomb" during the shooting this time - what a relief!

The new member of the data archive section, who was on board for the first time to help us on navigation, appeared to have difficulty processing some of the navigation data on board, but this did not affect our experiment because we were not dependent on their processing. As far as the OBS experiment is concerned, their processed data is of little use and we have been taking all necessary navigation information directly from the raw data available on data logger tapes and bathymetry read outs.

The OBS deployment/recovery team of Bill O'Brien and Dale Sawyer, helped by students Jürgen Oberst and John Dunbar, worked very hard on the deck, often soaking wet in rough seas. Deployment and recovery of OBS's went very smoothly.

Problems with air guns recurred several times during the cruise with broken o-rings and hoses. We even lost both guns at one time on line B for 38 minutes, giving us a 5½ km gap in the OBS data. I understand that we were using old o-rings for these air guns, which caused these troubles. New sets of o-rings for future OBS experiments are strongly suggested because once OBS's are deployed, we cannot delay the shooting. Recording on OBS's cannot be controlled remotely to accommodate failing air guns. Oscar, George and Stirling worked hard to get these guns working as much as possible.

The OBS instrumentation team of Phil and Paul showed their usual excellence even under the very heavy schedule of this cruise. The no-data problem due to malfunctioning electronics which we experienced often in our earlier experiments, did not occur this time. This is likely due to the software modification Phil had put in and helped by the purging of the sphere with dry nitrogen which we tried this time.

Ken Griffiths developed a real-time navigation plot program on a MacIntosh during the cruise. It certainly is a great help in bringing the ship to an OBS deployment site or to a shooting line. The navigation plot on the Tectronix terminal was also a great help.

The OBS cartridge tape playback system on the Demuxer computer malfunctioned early in the experiment. Though the trouble was temporarily cured by unscrambling bits on data stream, this delayed on-board processing of the acquired OBS data. Joe Ebeniro was very helpful in processing the data.

The success of the experiment is entirely due to all of the people aboard, each of them knew exactly what he/she was doing, took pride of his/her work and worked very hard. As always, I was sick for the first two days of the cruise, but I had no need to worry because I could completely depend on everyone for a smooth operation.

Shipboard equipment worked fairly well this time compared with earlier cruises. Some troubles we experienced were relatively minor and did not cause much difficulty. They were:

(1) One of the magnetic tape drives on the ship board computer was out of order, lacking a piece of spare parts.

(2) The ship was stocked with the wrong kind of paper for the Versatec printer. Fortunately, we discovered this a day before the cruise so we could get the right kind of paper from Austin.

(3) The data logger gave only occasional trouble and fortunately none during the shooting.

(4) The satellite clock was out of order during the first line of shooting.

(5) The shot time counter skipped up-dates several times during the first line of shooting.

(6) The intercom system to the back deck did not work well, but was repaired during the cruise.

(7) The DFS did not work to indicate the true direction of OBS beacon signals. Many people agree that the problem is the location of the antenna. Can it be moved to elsewhere on the ship for a more effective detection?

It was a great relief that we did not have any trouble at all with other seismic ships shooting in the area this time. I do not know whether this was because Bill Mitchell notified the geophysical coordinating group of our intention to shoot in the area in advance or simply because there weren't many seismic ships in the area at this time.

A copy of the pre-cruise test plan is attached. The section 2 of line B was not shot in favor of reshooting the section 2 of line A. Actual deployment and recovery locations are listed on Table 1. Table 2 lists the recorded shots and distances covered by each OBS. All geographical coordinates have been computed from Loran-C TD's using the satellite navigation as calibration. The additional secondary correction factors (ASF) as determined from satellite navigation for this experimental area during this experiment were: WASF=0.30±0.04 μsec, XASF=0.32±0.36 μsec.

A summary of activities during the cruise follows:

Wednesday, February 6

12:00	Departed from Galveston UTIG pier on schedule, cloudy and cold
13:32	Conducted a fire drill
17:00	First group of OBS's were turned on

Thursday, February 7

Line A, Section 1 Operations

04:03	Deployed OBS No. 1 (see Table 1 for location and depth)
06:19	Deployed OBS No. 2
07:27	Deployed OBS No. 3
09:05	Deployed OBS No. 4
10:38	Deployed OBS No. 5
12:48-13:15	Deployed 5-channel streamer
13:15-14:00	Deployed air guns and tested
14:00:01	Started shooting the section, about 2 miles short of the planned starting point and still turning to get on the line

Friday, February 8

00:00:01	Completed shooting on schedule
00:20-	Retrieved air guns and streamer
01:42	Recovered OBS No. 1; full data on tape
03:21	Recovered OBS No. 2; full data on tape
04:36	Recovered OBS No. 3; full data on tape
06:12	Recovered OBS No. 4; full data on tape
07:36	Recovered OBS No. 5; full data on tape

Line A, Section 2 Operation

08:53	Deployed OBS No. 6
10:05	Deployed OBS No. 7
12:34	Deployed OBS No. 8
14:30	Deployed OBS No. 9
16:31	Deployed OBS No. 10
16:41-	Streamer, twisted earlier at retrieval and damaged, was repaired.

Friday, February 8 (Cont'd)

Line A, Section 2 Operation Cont'd)

?	Deployed streamer
20:20-	Deployed air guns
21:00:01	Started shooting, 0.4 mile passed the planned starting point.

Saturday, February 9

03:20-05:55	Starboard gun lost pressure; off line for repair (shot Nos. 761-1070)
06:55-07:00	Starboard gun indicated low pressure (shot Nos. 1191-1200)
08:09-08:30	Port air gun out of service (shot Nos. 1338-1381)
08:30:01	Completed shooting, 1/3 mile beyond the planned end point
08:30-08:37	Retrieved starboard air gun
08:45-	Retrieved streamer
10:07	Recovered OBS No. 6; data on track 1 only
11:07	Recovered OBS No. 7; full data on tape
13:25-14:15	No sign of OBS No. 8; decided to proceed to OBS 9 site
14:45	Radio signal from OBS No. 9 detected before its expected surfacing at 15:30
15:40-16:20	OBS No. 9 not found near the deployment site though the radio signal remained audible; decided to proceed to OBS 10 site leaving OBS 9 for a later search.
18:02	Recovered OBS No. 10; drifted 1/3 mile WNW from the deployment site in 45 minutes since its surfacing
19:30	Arrived at about 3 miles west of OBS 9 site to start searching for the OBS

Sunday, February 10

00:38	Sighted OBS No. 9
00:55	Recovered OBS No. 9 at about 10 miles WSW of the deployment site. The distance of drift indicates that this unit surfaced shortly after its deployment.

Since this line was only 45% successful, it was decided to reshoot the line with 3 OBS's (Nos. 6, 8 and 9) after the line B section 1 operation, instead of the optional section 2 of line B.

Line B, Section 2 Operation

05:56	Deployed OBS No. 1
07:23	Deployed OBS No. 2

Sunday, February 10 (Cont'd)

Line B, Section 2 Operation (Cont'd)

09:33	Deployed OBS No. 3
10:29	Deployed OBS No. 4
12:45-	Deployed streamer and air guns
14:00:01	Started shooting; 0.4 miles north of the planned starting point
14:50-15:46	Starboard air gun out of service (Shot Nos. 101-212)
17:19-17:25	Port air gun lost pressure (Shot Nos. 399-410)
17:45-18:36	Port air gun out of service again (Shot Nos. 451-552)
18:36-19:14	Starboard air gun lost o-ring; now both air guns were out of service (Shot Nos. 553-629)
19:14-19:49	Port air gun back in service (Shot Nos. 630-698)
19:49	Both air guns back in service

Monday, February 11

00:00:01	Completed shooting on schedule
00:03-01:11	Retrieved air guns and streamer
00:30	Weather forecast predicted strong northerly wind after completion of the experiment, with possible delay on our way home to Galveston.
02:01	Recovered OBS No. 1; full data on tape
03:35	Recovered OBS No. 2; full data on tape
04:00	Wind picking up to 20 mph, gusting to 30 mph
06:07	Recovered OBS No. 3; full data on tape
07:22	Recovered OBS No. 4; full data on tape

Line A, Section 2 Reshoot Operation

09:03	Deployed OBS No. 6R
11:41	Deployed OBS No. 8R
13:30	Wind getting very strong; 40 mph from NW, gusting to 75-80 mph; wave height 10-12 feet; significantly stronger wind than predicted. Cancelled deployment of OBS No. 9R. The captain decided to drift SE with the wind for safety. Planned shooting cancelled. Rescheduled possible reshooting when the wind subsides.
17:00	Requested Austin for permission to extend the cruise one additional day for a possible resumption and completion of the reshoot.

Tuesday, February 12

00:00	Drifted 66 miles SSE from the OBS 8R site; the wind had come down slightly and the captain decided to turn around and try to get back to the OBS 6R and 8R sites for recovery.
~07:00	OBS 6R surfaced 62 miles from the ship
~10:00	OBS 8R surfaced 26 miles from the ship
11:52	Radio beacon signal from OBS 8R heard; estimated distance 12 miles
13:09	OBS 8R in sight
13:16	Recovered OBS 8R; drifted 3.6 miles due south in 3 hours; recorded full data, but no shot fired.
14:40	Radio beacon signal from OBS 6R detected; estimated distance 9 miles
16:09	OBS 6R in sight
16:13	Recovered OBS 6R; drifted 5.8 miles due south in 9 hours; recorded full data, but no shot fired.
19:17	Deployed OBS No. 8T
21:07	Deployed OBS No. 9S
22:00	Noted problems with recording schedule programmed into these two OBS's. Cancelled shooting, which was to start at midnight. Decided to deploy an OBS using the last available frame at site 9 and reschedule the shooting.

Wednesday, February 13

00:01	Deployed OBS No. 9T
00:43-	Deployed air guns (no streamer for this reshoot)
01:13	Problem developed on starboard air gun
01:20:00	Started shooting with port air gun only; 0.8 mile behind the planned starting point
02:11	Starboard air gun back in service (Shot No. 503)
07:00:00	Completed shooting on schedule
09:33	Recovered OBS No. 8T; some shots recorded despite the recording schedule error.
11:29	Recovered OBS No. 9T; full data on tape
11:34	Recovered OBS No. 9S; 90% of the shots recorded despite the recording schedule error.
13:00-13:30	Streamer party to remove bird collars from the streamer
13:30	Heading back to Galveston; nice breeze from the south, fair skies and calm sea

Thursday, February 14

08:00 Returned to Galveston UT-IG pier.

Alaminos Canyon OBS Experiment Plan

Dates: February 6-13, 1985 (Wednesday-Wednesday)

Lines: Line A Section 1: 27°10.0'N, 94°49.6'W to 26°32.2'N, 94°15.2'W
Section 2: 26°45.4'N, 94°27.2'W to 26°01.9'N, 93°48.0'W
Line B Section 1: 26°33.9'N, 95°04.6'W to 26°46.2'N, 94°12.1'W
Section 2: 26°41.3'N, 94°33.1'W to 26°55.7'N, 93°30.0'W (optional)

Each line is 162 km (87.5 nm) long.
The lines intersect at 26°43.2'N, 94°25.2'W.

Signal Source: Two 2000 in^3, 2000 psi air guns

Detectors: (1) OBS's: 4.5 Hz geophones as follows:

Line/Sec.	OBS No.	Component	Location,km	Lat. N	Long W	Depth,m
A1	1	Vertical	3	27°08.71'	94°48.43'	1275
	2	Vertical	25.5	26°59.28'	94°39.82'	1410
	3	Vertical	39	26°53.62'	94°34.66'	1490
	4	Vertical	54.75	26°47.01	94°28.65'	1155
	5	3-Component	70.5	26°40.39'	94°22.65'	1455
A2	6	3-Comp. Test	64.5	26°42.91'	94°24.94'	1140
	7	3-Component	70.5	26°40.39'	94°22.65'	1455
	8	Vertical	104.25	26°26.20'	94°09.85'	1485
	9	Vertical	129	26°15.79'	94°00.49'	1860
	10	Vertical	150	26°06.94'	93°52.57'	3060
B1	1	Vertical	9	26°35.18'	94°59.38'	1785
	2	Vertical	27	26°37.66'	94°48.89'	1600
	3	3-Component	60	26°42.13'	94°29.63'	1395
	4	3-Comp. Test	70.5	26°43.55'	94°23.50'	1155
B2	5	3-Component	60	26°42.13'	94°29.63'	1395
	6	Vertical	90	26°46.17'	94°12.10'	1400
	7	Vertical	126	26°50.97'	93°51.05'	1665
	8	Vertical	154.5	26°54.74'	93°34.36'	1450

(2) Streamer: 600m, 5-channel

Ship Schedule: (R/V *Fred H. Moore*)

Wed.	Feb. 6	12:00	Sail from Galveston
Thurs.	Feb. 7	04:30	Start line A, section 1 (129 nm from seabuoy)
		04:30-05:00	Deploy OBS 1
		06:15-06:45	Deploy OBS 2
		07:30-08:00	Deploy OBS 3
		09:00-09:30	Deploy OBS 4
		10:30-11:00	Deploy OBS 5
		14:00-24:00	Shoot section 1

Fri.	Feb. 8	01:30-02:00	Recover OBS 1
		03:15-03:45	Recover OBS 2
		04:30-05:00	Recover OBS 3
		06:00-06:30	Recover OBS 4
		07:30-08:00	Recover OBS 5
		08:00	End line A, section 1
		09:00	Start line A, section 2
		09:00-09:30	Deploy OBS 6
		10:00-10:30	Deploy OBS 7
		12:30-13:00	Deploy OBS 8
		14:30-15:00	Deploy OBS 9
		16:15-16:45	Deploy OBS 10
		21:00-08:30	Shoot section 2
Sat.	Feb. 9	10:00-10:30	Recover OBS 6
		11:00-11:30	Recover OBS 7
		13:30-14:00	Recover OBS 8
		15:30-16:00	Recover OBS 9
		17:15-17:45	Recover OBS 10
		17:45	End line A, section 2
Sun.	Feb. 10	05:30	Start line B section 1 (66 nm from end of line A)
		05:30-06:00	Deploy OBS 1
		07:00-07:30	Deploy OBS 2
		09:30-10:00	Deploy OBS 3
		10:45-11:15	Deploy OBS 4
		14:00-24:00	Shoot section 1
Mon.	Feb. 11	02:00-02:30	Recover OBS 1
		03:30-04:00	Recover OBS 2
		06:00-06:30	Recover OBS 3
		07:15-07:45	Recover OBS 4
		07:45	End line B, section 1
		09:00	Start line B, section 2
		09:00-09:30	Deploy OBS 5
		11:15-11:45	Deploy OBS 6
		13:45-14:15	Deploy OBS 7
		16:00-16:30	Deploy OBS 8
		21:00-09:00	Shoot section 2
Tues.	Feb. 12	10:30-11:00	Recover OBS 5
		12:45-13:15	Recover OBS 6
		15:15-15:45	Recover OBS 7
		17:30-18:00	Recover OBS 8
		18:00	End line B, section 2
Wed.	Feb. 13	12:00	Return to Galveson (155 nm to seabuoy)

Shooting Schedule:

Line/Section	Location	Shot Nos.	Time	Interval
A1	90-0 km	1-1201	07/14:00:01-08/00:00:01	30 sec
A2	162-58.5 km	1-1381	08/21:00:01-09/08:30:01	30 sec
B1	90-0 km	1-1201	10/14:00:01-11/00:00:01	30 sec
B2	162-54 km	1-1441	11/21:00:01-12/09:00:01	30 sec

* Ship speed while shooting: 4.86 knots, Shot spacing: 75 m

Recording Schedule:

Sampling Interval: 10.008 msec

Recording Length: 20.416 sec for single-component OBS
13.611 sec for 3-component OBS

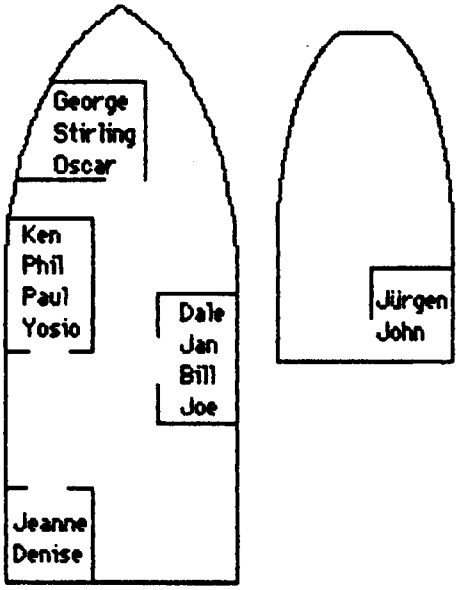
Line	OBS	Shot Nos.	Time	Interval	Blocks
A	1	1-180	01/14:00:15 - 01/15:29:45	30 sec	1
		181-1080	01/15:30:15 - 01/22:59:30	30-1/60	1
		1081-1201	01/23:00:00 - 02/00:00:00	30	1
A	2	1-780	01/14:00:13 - 01/20:29:30	30-1/60	1
		781-900	01/20:30:00 - 01/21:29:30	30	1
		901-1201	01/21:30:00 - 02/00:00:05	30+1/60	1
A	3	1-600	01/14:00:10 - 01/18:59:30	30-1/60	1
		601-720	01/19:00:00 - 01/19:59:30	30	1
		721-1201	01/20:00:00 - 02/00:00:08	30+1/60	1
A	4	1-420	01/14:00:07 - 01/17:29:30	30-1/60	1
		421-540	01/17:30:00 - 01/18:29:30	30	1
		541-1201	01/18:30:00 - 02/00:00:11	30+1/60	1
A	5	221-280	01/15:50:00 - 01/16:19:30	30	2
		281-460	01/16:20:00 - 01/17:49:33	30+1/60	2
		461-580	01/17:50:03 - 01/18:49:37	30+2/60	2
		581-881	01/18:50:07 - 01/21:20:12	30+1/60	2
A	6	741-980	03/03:10:11 - 03/05:09:37	30-1/60	2
		981-1100	03/05:10:07 - 03/06:09:33	30-2/60	2
		1101-1280	03/06:10:03 - 03/07:39:30	30-1/60	2
		1281-1340	03/07:40:00 - 03/08:09:30	30	2
		1341-1381	03/08:10:00 - 03/08:30:01	30+1/60	2
A	7	661-900	03/02:30:11 - 03/04:29:37	30-1/60	2
		901-1020	03/04:30:07 - 03/05:29:33	30-2/60	2
		1021-1200	03/05:30:03 - 03/06:59:30	30-1/60	2
		1201-1260	03/07:00:00 - 03/07:29:30	30	2
		1261-1321	03/07:30:00 - 03/08:00:01	30+1/60	2
A	8	121-720	02/22:00:10 - 03/02:59:30	30-1/60	1
		721-840	03/03:00:00 - 03/03:59:30	30	1
		841-1381	03/04:00:00 - 03/08:30:09	30+1/60	1
A	9	1-360	02/21:00:06 - 02/23:59:30	30-1/60	1
		361-480	03/00:00:00 - 03/00:59:30	30	1
		481-1321	03/01:00:00 - 03/08:00:14	30+1/60	1

Line	OBS	Shot Nos.	Time	Interval	Blocks
A	10	1-121	02/21:00:02 - 02/21:59:30	30-1/60	1
		121-240	02/22:00:00 - 02/22:59:30	30	1
		241-1140	02/23:00:00 - 03/06:29:45	30+1/60	1
		1141-1321	03/06:30:15 - 03/08:00:15	30	1
B	1	1-140	01/14:00:15 - 01/15:09:45	30	1
		141-1040	01/15:10:15 - 01/22:39:30	30-1/60	1
		1041-1201	01/22:40:00 - 02/00:00:00	30	1
B	2	1-780	01/14:00:13 - 01/20:29:30	30-1/60	1
		781-900	01/20:30:00 - 01/21:29:30	30	1
		901-1201	01/21:30:00 - 02/00:00:05	30+1/60	1
B	3	361-420	01/17:00:00 - 01/17:29:30	30	2
		421-600	01/17:30:00 - 01/18:59:33	30+1/60	2
		601-720	01/19:00:03 - 01/19:59:37	30+2/60	2
		721-1021	01/20:00:07 - 01/22:30:12	30+1/60	2
B	4	221-280	01/15:50:00 - 01/16:19:30	30	2
		281-460	01/16:20:00 - 01/17:49:33	30+1/60	2
		461-580	01/17:50:03 - 01/18:49:37	30+2/60	2
		581-881	01/18:50:07 - 01/21:20:12	30+1/60	2
B	5	801-1040	03/03:40:11 - 03/05:39:37	30-1/60	2
		1041-1160	03/05:40:07 - 03/06:39:33	30-2/60	2
		1161-1340	03/06:40:03 - 03/08:09:30	30-1/60	2
		1341-1400	03/08:10:00 - 03/08:39:30	30	2
		1401-1441	03/08:40:00 - 03/09:00:01	30+1/60	2
B	6	241-960	02/23:00:12 - 03/04:59:30	30-1/60	1
		961-1020	03/05:00:00 - 03/05:29:30	30	1
		1021-1441	03/05:30:00 - 03/09:00:07	30+1/60	1
B	7	1-420	02/21:00:07 - 03/00:29:30	30-1/60	1
		421-540	03/00:30:00 - 03/01:29:30	30	1
		541-1321	03/01:30:00 - 03/08:00:13	30+1/60	1
B	8	1-60	02/21:00:01 - 02/21:29:30	30-1/60	1
		61-180	02/21:30:00 - 02/22:29:30	30	1
		181-1080	02/22:30:00 - 03/05:59:45	30+1/60	1
		1081-1321	03/06:00:15 - 03/08:00:15	30	1

*For OBS A5-10, B3-5 and B7-8, record shots till tape runs out.

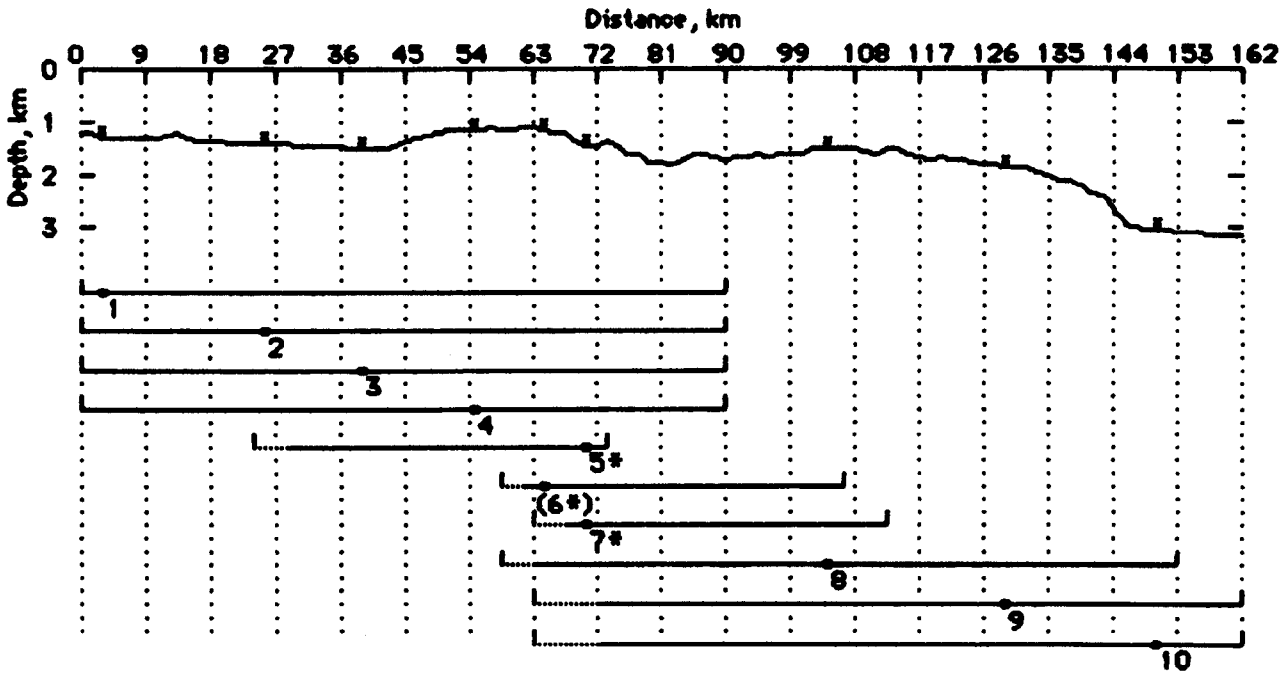
Scientific Party:

Chief Scientist:	Yosio Nakamura	
OBS Instrumentation:	Phil Roper	
	Paul McPherson	
OBS Deployment/Recovery:	Bill O'Brien	
	Dale Sawyer	
Navigation:	Jan Germany	8-12
	Jeanne Shaub	0-4
	Denise Kakes	4-8
Multichannel/Electronics:	Ken Griffiths	
	Stirling Gilfillan	
Air Gun:	Oscar Febres-Cordero	
	George Pearcy	
Students:	Joe Ebeniro	0-4
	Jürgen Oberst	4-8
	John Dunbar	8-12

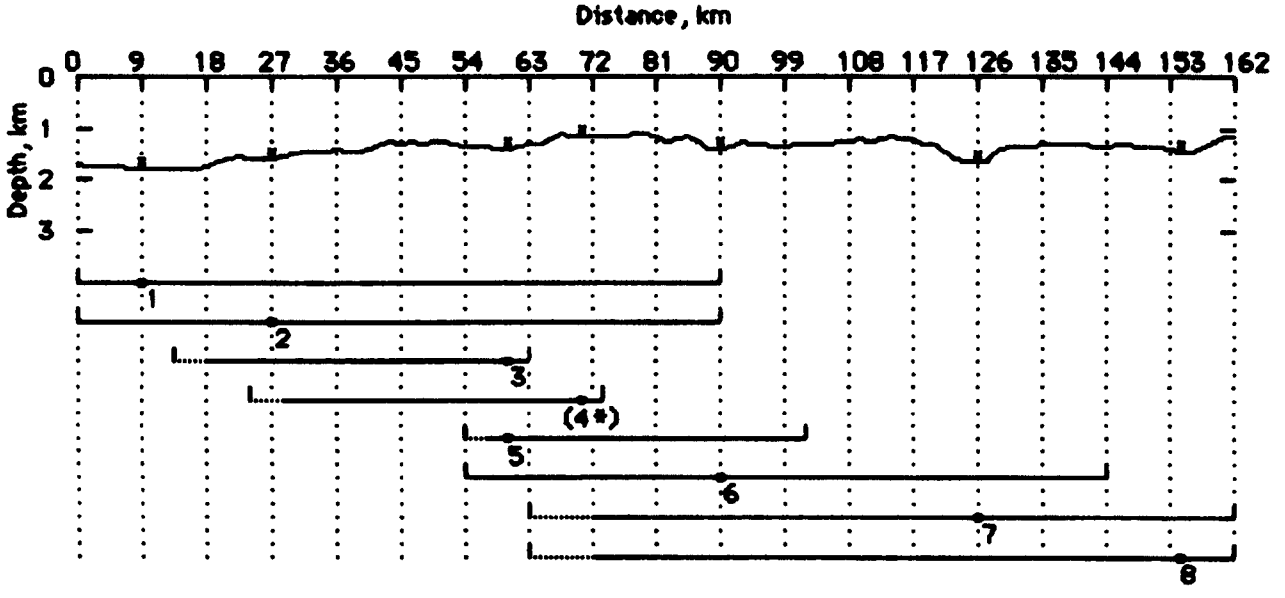


Recording Coverage

Line A



Line B



* 3-component OBS
(n) test OBS
l..... tape runs out sometime within this time interval

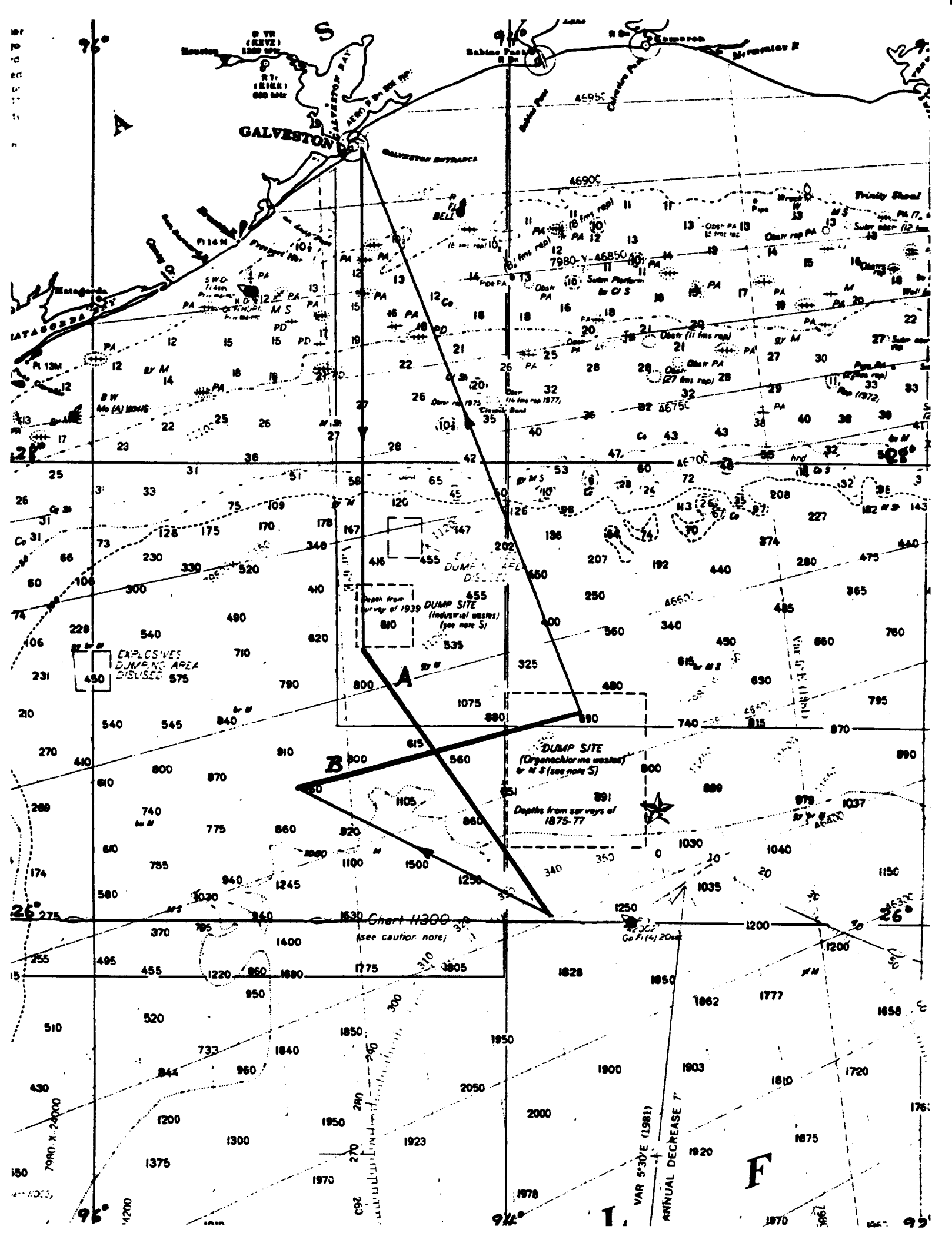

GALVESTON
GALVESTON ENTRANCE
Trinity Shoal
EXPLOSIVES DUMPING AREA DISUSED
DUMP SITE (Industrial wastes) (see note S)
DUMP SITE (Organochlorine wastes) (see note S)
Depths from surveys of 1875-77
Depth from survey of 1939
Chart 11300
(see caution note)
VAR 5°30'E (1981)
ANNUAL DECREASE 7'
A
B
F
1.

Table 1. OBS Deployment(D) and Recovery(R) Locations

Line -Sect.	OBS	Depl. Recv.	Date mo/dy	Time hr:mn	Latitude North	Longitude West	Loran-C TDW	Loran-C TDX	Water Depth m
A-1	1	D	2/7	04:03	27°07.94'	94°47.94'	11223.5	25034.5	1311
		R	2/8	01:42	27°07.83'	94°48.02'	11223.6	25033.2	1326
	2	D	2/7	06:19	26°58.46'	94°39.46'	11250.1	25085.2	1406
		R	2/8	03:21	26°58.43'	94°39.27'	11250.4	25087.1	1404
	3	D	2/7	07:27	26°52.84'	94°34.21'	11266.8	25118.8	1486
		R	2/8	04:36	26°52.83'	94°34.31'	11266.7	25117.8	1521
	4	D	2/7	09:05	26°46.28'	94°28.32'	11286.6	25156.7	1158
		R	2/8	06:12	26°46.19'	94°28.44'	11286.6	25155.1	1164
	5	D	2/7	10:38	26°39.60'	94°22.30'	11307.4	25196.4	1428
		R	2/8	07:36	26°39.57'	94°22.47'	11307.2	25194.5	1419
A-2	6	D	2/8	08:53	26°42.18'	94°24.54'	11299.4	25181.8	1193
		R	2/9	10:07	26°42.14'	94°24.73'	11299.2	25179.7	1227
	7	D	2/8	10:05	26°39.58'	94°22.25'	11307.5	25196.8	1430
		R	2/9	11:07	26°39.59	94°22.44'	11307.2	25194.9	1420
	8	D	2/8	12:34	26°25.51'	94°09.46'	11353.4	25284.4	1473
		R	not recovered						
	9	D	2/8	14:30	26°15.10'	94°00.11'	11388.7	25349.8	1847
		R	2/10	00:55	26°13.05'	94°11.14'	11373.7	25231.8	2972
	10	D	2/8	16:31	26°06.27'	93°52.20'	11419.5	25405.8	3065
		R	2/9	18:02	26°06.39'	93°52.56'	11418.6	25402.5	
B-1	1	D	2/10	05:56	26°34.37'	94°58.96'	11267.1	24800.5	1771
		R	2/11	02:01	26°34.28'	94°58.92'	11267.3	24800.6	1773
	2	D	2/10	07:23	26°36.83'	94°48.46'	11276.2	24916.9	1575
		R	2/11	03:35	26°36.82'	94°48.56'	11276.1	24915.9	1571
	3	D	2/10	09:33	26°41.42'	94°29.22'	11294.1	25130.9	1379
		R	2/11	06:07	26°41.23'	94°29.33'	11294.3	25129.2	1372
	4	D	2/10	10:29	26°42.84'	94°23.10'	11300.3	25198.9	1164
		R	2/11	07:22	26°42.64'	94°23.13'	11300.6	25197.9	1125
A-R	6R	D	2/11	09:03	26°43.46'	94°25.08'	11296.3	25180.5	1121
		R	2/12	16:13	26°37.67'	94°25.04'	11306.9	25161.8	1391
	8R	D	2/11	11:41	26°26.27'	94°09.94'	11351.2	25281.7	1480
		R	2/12	13:16	26°22.67'	94°09.45'	11358.7	25276.1	1670
A-R	8T	D	2/12	19:17	26°25.50'	94°09.48'	11353.4	25284.2	1467
		R	2/13	09:33	26°25.43'	94°09.55'	11353.4	25283.2	1465
	9S	D	2/12	21:07	26°15.13'	94°00.14'	11388.6	25349.6	1846
		R	2/13	11:34	26°15.08'	94°00.14'	11388.7	25349.4	1847
	9T	D	2/13	00:01	26°15.14'	94°00.13'	11388.6	25349.7	1847
		R	2/13	11:29	26°15.10'	94°00.17'	11388.6	25349.2	1846

Table 2. End Points of Shooting Lines

Line -Sect.	Shot No.	Latitude North	Longitude West	Loran-C TDW	Loran-C TDX	Water Depth m
A-1	1	26°29.38'	94°14.41'	11338.23	25245.21	1756
	1201	27°09.05'	94°48.99'	11220.40	25028.09	1261
A-2	1	26°01.46'	93°48.02'	11436.33	25435.35	3156
	1381	26°44.97'	94°27.01'	11290.79	25165.61	1175
B-1	1	26°45.93'	94°11.79'	11311.38	25326.01	1312
	1201	26°33.12'	95°04.14'	11262.84	24742.82	1696
A-R	401	26°13.58'	93°58.75'	11393.92	25359.32	1954
	1081	26°35.16'	94°18.20'	11321.68	25224.27	1791

Table 3. OBS Units and Recorded Data

Line -Sect.	OBS	Unit	Geophone*	Shots Recorded	Distance Range km		Remarks
A-1	1	81-1	V	1-1201	-90.7 —	2.7	
	2	81-4	V	1-1201	-68.3 —	25.1	
	3	81-3	V	1-1201	-54.8 —	38.6	
	4	83-4	V	3-1201	-39.2 —	54.2	
	5	81-2	L3	241-875	-1.5 —	46.2	
A-2	6	83-3	U3	747-898	-41.6 —	-30.3	one track only
	7	83-2	L3	664-1321	-41.7 —	8.1	
	8	81-5	V				not recovered
	9	81-6	V				no data recorded
	10	83-1	V	3-1240	-11.1 —	81.2	
B-1	1	81-4	V	1-1201	-81.1 —	8.9	
	2	81-3	V	1-1201	-63.1 —	26.9	
	3	81-2	L3	361-933	-3.3 —	39.2	
	4	83-2	L3	221-881	03.0 —	45.7	
A-R	6R	84-1	U3				no shot fired
	8R	83-1	V				no shot fired
A-R	8T	83-2	L3	401-480	-28.3 —	-22.4	**
	9S	81-4	V	541-1061	6.7 —	46.2	**
	9T	84-1	L3	401-1068	-3.7 —	46.7	

*V: Geosource 4.5 Hz Vertical
L3: Litton 4.5 Hz 3-component
U3: UT-IG 4.5 Hz 3-component
**Other shots were recorded only partially because of shot time table error.