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POCKMARK STUDY IN FORTIES AREA

CRUISE REPORT 3-16 JULY 1975

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AIMS

The main object of the cruise was to survey a close grid of N/S lines in an area 12 x 9 miles (see diagram 1). The area is well noted for pockmarks and the detailed survey was to investigate these anomalies and to check the area for any small pockets of gas lying near the surface. It was hoped to survey lines 1000 metres apart with the Bath University Sonar so as to be able to build up a mosaic of the whole of the sea floor. Various shallow seismic tools were to be employed in the area to give information on the sediments below the sea floor. Among these tools were conventional multi-spark seismics, pinger profiling and the Nova Scotia Research Foundation Deep Tow Sparker System.

On board the m.v. Aqua Star there is a 12 channel digital recording seismic system and it was hoped to operate this equipment over a proposed Sealab borehole site and to get one or two profiles over selected areas using all the systems for comparison purposes. If time allowed, a corridor of reconnaissance lines were to be run N and S of the detailed area to assess extension of pockmark occurrence towards the Piper and Forties fields.

PARTY CHIEF'S REPORT

The main setback and disappointment of this cruise was the failure of the Bath University Sonar to tow correctly. At four different times the equipment was launched but despite various alterations to the fairing and position of tow, tow off occurred. At one time some short lines were attempted to assess the data but only one channel was operational and only sweeping half of the normal sweep due to the fish being tilted. Apparently Bath University have had this problem for a few years and they had thought before this cruise to have solved it.

Despite this disappointment the rest of the cruise went well and some excellent seismic results were obtained. At one point, over 80 msec of penetration with excellent resolution was recorded by the Edo Western Pinger. Some of the multi-spark seismics have been as good as IGS have obtained to date. Several lines were surveyed using the 12 channel digital seismic recording equipment belonging to Aquatronics and though the single channel analogue record is good, it is too early to assess these records until processing has been undertaken.

The Nova Scotia Research Foundation Deep Tow Sparker equipment was on board for the cruise and over 278km were surveyed using it. At the same time the Edo Western Pinger was operated so a direct comparison between the equipment for resolution and penetration could be obtained. The method of tow and the handling operation of the Deep Tow system is excellent.

The m.v. Aqua Star is well laid out, is an excellent sea boat and is very quiet seismically. She suffers from being a little too fast as the slowest speed obtained was 5½ knots which did not altogether help in operating the Bath Sonar. The ship lacks sufficient electrical power and a deck generator had to be installed to operate the Satellite Navigation system. One was constantly filling up generators by hand as the sparker generators are also mounted on deck. There are two HIAB cranes situated aft of the boatdeck, one on either side.

These are ideal for towing hydrophones and source arrays near the water thus reducing noise problems.

In all over 1445km were surveyed with excellent results. The weather was very favourable with nothing over force 4 except for one day when force 5-6 conditions were encountered. Forecasts of severe gales forced the abandonment of the survey 12 hours ahead of schedule.

TECHNICIAN'S REPORT

During this survey nearly all the basic geophysical equipment belonged to other organisations and though IGS staff operated some of it, most was under the control of Aquatronics, Nova Scotia Research Foundation and Bath University. Difficulties encountered with these instruments were dealt with separately. The only IGS equipment was multi-spark electrodes which worked well and appeared in this area to give slightly better penetration and as good resolution as those of Aquatronics. The other major IGS equipment was the Satellite Navigation system which is reported on later in this report.

GEOLOGY/GEOPHYSICS REPORT

The major part of the cruise was spent surveying a small study area where pockmarks were known to be common. The main geophysical effort was devoted to resolving the upper layers and good, high resolution data was obtained from closely spaced lines (approximately 1km line spacing) across the area. The primary objective of surveying the surface distribution of pockmarks however was frustrated by the almost total failure of the Bath University Side Scan Sonar system due to towing problems. Despite this difficulty some sonar coverage was obtained and with the other data has provided very valuable additional information on pockmarks and the shallow geology of the area.

Preliminary information suggests that the pockmark distribution is higher than previously thought and in some areas exceeds 100 pockmarks/sq.km. Buried pockmarks are also extremely common and that all seems to be confined to a well layered (probably silty clay) horizon ranging from 9-36m in thickness and immediately underlying the thin North Sea sand layer which covers the region. Below this a sandy sequence which is commonly 6m thick overlies the deeply channelled top of the Glacio-Marine Aberdeen Ground Beds. These are similar to channels seen further south and in this area are up to 190m deep. Four major channels have been mapped, all trending approximately E-W but anastomasing in a complex fashion. The channel fill also varies and in some cases the sediments are well layered.

In the study area acoustic blanking suggests that small amounts of shallow gas are present but these seem to be local and are entirely associated with the uppermost silty clay horizon. Just to the south of this a large area of acoustic blanking suggests a much larger patch of this very shallow gas and further south still there seems to be gas pockets associated with some of the deep sand filled channels.

A number of lines were also run to the north and south of the study area to link with the Piper and Forties field data. The assessment of this data is incomplete but a "first look" suggests that it agrees well with the established regional geology.

NOVA SCOTIA RESEARCH FOUNDATION BOTTOM PROFILING SYSTEM

A total of 16 lines were profiled on four separate days comprising some 33 hours. The shortest line was 0.75 hours long, the longest

8.70 hours. Ship's track speed varied between 5 and 8.5 knots. Water depths were in the range 90-160 metres. Sea conditions were generally calm to moderate wave and swell.

Equipment Operation

Deck handling equipment operated satisfactorily. The oblique mounting of the A-frame reduced the effective clearance between the legs and required one or two additional hands to stabilise the V-Fin in all but the calmest sea conditions. The ship proved unable to maintain constant speed when towing with engine timing at less than 120RPM, so that the majority of the profiling was carried out with engine speeds of 130 or 140RPM giving track speeds of 7-8.5 knots. These relatively high tow speeds required the use of long cable tow and also resulted in higher tow noise. The lack of direct control of engine speed at the bridge or conning position, plus the absence during the early part of the cruise of telephone communication with the engine room, required all tow height adjustments to be made by winching.

H.V. supplies, electronic and recording equipment performed satisfactorily. Primary data display on an EPC Model 4600 graphic recorder used 500 msec sweep with 100 msec timing lines. Back-up magnetic tape records of streamer, hydrophone, fixmarks with voice identification, and synchronising pulses from EPC recorder allowed data to be replayed with alternate band pass filter characteristics and different gain settings. The regenerated data was generally equal or superior in quality to the original record.

Apart from routine servicing of sparker and H.V. source electrodes, the only special servicing was the retermination of the main tow cable at the underwater H.V. and signal connectors when resistance and voltage measurements indicated saltwater leakage.

System Compatibility

Simultaneous operation with Atlas Deso Echo Sounder and Edo Western Pinger was carried out with minimal interference. No interference was reported with Hi-fix, Sat Nav or other navigation systems.

Performance

Penetration varied from 20 to 80 msec depending on bottom conditions and tow speed. Resolution was about 1 msec and was almost independent of sea conditions. Ability to resolve events from weak reflectors at depth was limited by the relatively high tow noise levels due to the high ship speed.

Compared with the Edo Western Pinger, the Deep Tow Sparker displayed a superior resolution of sub-bottom details which was unaffected by ship motion. The contrast was particularly marked in rougher conditions when vertical motion and quenching of the Edo hull mounted transducer resulted in almost complete loss of bottom record at a time when the Deep Tow Sparker was giving satisfactory records.

Comments

Where possible the ship should have adequate engine power characteristics to permit tow operation in the speed range 4-7 knots; this is particularly important if operations are to be carried out in water depths in excess of 200 metres. Direct control of ship's engines from bridge or conning position is a major asset. A clear stern area allowing proper placement of A-frame square to ship's longitudinal axis.

BATH UNIVERSITY SIDE SCAN SONAR SYSTEM

It was intended to operate the side scan sonar in a water depth of about 150 metres and to sweep successive lanes 1100 metres wide, ie 550 metres to port and starboard. In the event the intended result was not achieved, which was due to the behaviour of the fairing on the sonar fish towing cable. It exhibited a tow-off to starboard ie towards the ship, so that there was a risk of damage due to chafing. Moreover, tow-off has the effect of lifting the sonar fish so that it does not achieve the required depth of operation. Five towing attempts were made some involving more than one launching operation and several modifications were made to the fairing or to its disposition on the cable. Starboard tow-off occurred every time though not consistently, and on one occasion about 60 metres of cable had been paid out, at a ship's speed of some 5 knots, before tow-off caused the fish to run under the ship. There was also evidence to suggest that a tilt was induced into the sonar fish but this appeared to be inconsistent.

CHIEF SURVEYOR'S REPORT

Two position-fixing systems were employed - Decca Hi-fix Cromarty chain and the IGS integrated Sat/Nav/Main Chain system. All daylight position-fixing was carried out with Hi-fix. At night Hi-fix was used where lane lock was held; otherwise positions were fixed by Sat/Nav. Lines 13 and 62 were abandoned owing to poor Sat/Nav dead-reckoning. There are no plotted tracks for these two lines.

1. <u>Hi-fix</u>

   The majority of lines were fixed with this system. Two receivers, a remote indicator, track plotter and Decca Printlog were used.

All hardware functioned well. The extensive use of the track plotter facilitated close adherence to the pre-planned lines in the detailed survey area.

A lane count was carried from buoys "FA South" (1443.1, 730.8) and "FA North" (1423.53, 742.37) close to the Forties field platforms to the detailed survey area and four temporary reference buoys dropped. Of these only one was eventually recovered, and this SE Buoy was generally used for referencing. This buoy was later re-checked against the Forties buoys and the lane count confirmed. A temporary buoy was also dropped and subsequently lost in the extreme south of the survey area to hold the lane count overnight.

During normal Decca daylight, signals were stable except on two occasions when lock was lost. On the first occasion the receiver was reset on a reference buoy; on the second the lane count was held through a thundery squall using the track plotter but subsequently was lost and the line continued using Sat/Nav.

Cromarty Chain was used throughout, even in the extreme south of the project area where lane cuts were poor and ranges from the transmitters high.

Position fixes derived from Hi-fix are probably accurate to better than ± 35 metres during Decca daylight and of an accuracy order of ± 100 metres at night. No pattern corrections were applied.

Owing to the absence of a Hi-Fix lattice for sheet 56°30'N/00, Hi-fix readings were converted by desk calculator to geographicals and plotted as such onto a base map.

2. Sat/Nav

This leg was used to check out and render operational the IGS Integrated Sat.Nav/Decca main chain system for the 1975 field projects. Details of hardware and software trials are dealt with separately.

This system was used for position fixing on a number of lines, mostly run at night. Results were variable, depending on main chain noise levels amongst other more imponderable factors. Experiments were conducted with various filter settings to determine the best operational balance between response time (ie filter setting) and noise levels. Problems were encountered with satellite pass solutions, probably due to dead-reckoning velocity anomalies.

The system of "sail lines" proved very useful in steering precise lines without the aid of a track plotter. Throughout the project the "shot auto" facility was used regularly to trigger Satellite Navigation and Print Log printouts and a contact closure for recorder fiducial marking simultaneously.

Update values used on line meaned out at approximately 200 metres. Owing to the problems with satellite pass solutions, periods of several hours were sometimes run without updates. On these occasions, little serious degradation of dead-reckoning was apparent. Differences between satellite fixes and Hi-fix averaged approximately 200 metres during Decca daylight. On the basis of the above, it would seem reasonable to assign a positional accuracy of ± 200 metres to night-time on-line Satellite Navigation.

3. Sounding

Soundings were taken using an Atlas Deso 10 survey echo sounder with a hull mounted transducer.

A velocity dip to 80 metres depth was carried out at the start of the survey. Results indicated a negligible velocity gradient below 40 metres and an average velocity of 1485 metres/sec. This value was set into the sounder. A Crouzet velocimeter suspended from a graduated line was used.

All plotted soundings are in metres with transducer depth allowed for. Soundings were not reduced to tidal datum.

4. Track Charts

Six fair-drawn track charts were produced. The detailed survey area was plotted on a special 1:20 000 scale sheet, two fair plots being produced because of extensive coincidence of line coverage. These two charts were designated sheets 1 and 2. The southern and northern reconnaissance areas were plotted on IGS standard 1:100 000 series sheets. These sheets were 56°30'N/00, 57°N/00, 57°30'N/00 and 58°N/00, designated respectively sheets 3, 4, 5 and 6.

INTEGRATED SATELLITE NAVIGATION/DECCA MAIN CHAIN SYSTEM

Equipment

The system was as used in 1974 except that doppler sonar was replaced by Decca main chain as a dead-reckoning source. The Arma Brown Mk 1 Mod 5 gyro compass has been removed from the gravitymeter stabilised platform system and with its own power supplies now forms an integral part of the Satellite Navigation system.

Installation

The Satellite Navigation aerial was mounted five feet above the bridge deckhead, shielded slightly by the ship's funnel at four metres distance but otherwise unobstructed. The Decca main chain receiver was attached to the ship's existing whip antenna via the aerial filter box.

Power supply was from a deck-mounted diesel generator rated at 6KVA. Power consumption was measured as 3 kilowatts.

No hardware difficulties were encountered on installation or during the cruise. Some problems were encountered in loading programs from paper tape but these did not persist.

In the absence of an existing hard-wired gyro-torque cable, installation was made using incomplete telexed instructions from Magnavox. Consequently, although the operation of gyrotorquing appears correct, this must be checked by the Magnavox engineer who is due to check out the doppler sonar next month.

Program

The program used was M200IG 75155, which integrates hyperbolic Decca main chain as a source of dead-reckoning information. This program also includes the facility to produce time-ordered alerts. It should be noted that the alert program is time-consuming, a fortnight's alerts requiring 6 hours of computer time. This ought to be done in port.

Because the Decca information is filtered over a considerable time, it was found that the dead-reckoning system could not closely follow manoeuvres involving rapid changes in speed or direction. However, on long straight lines, the system performed well. It is necessary to allow at least 10 minutes after a sharp turn before utilising dead-reckoning information. The system performs best if initialised to a realistic position fix at the outset. It should be noted that Decca propagation anomalies (skywave), although reduced by filtering, do affect dead-reckoning in the short term (ie over periods of 5 or 10 minutes).

Although many satellite pass solutions appeared to fulfill the normal accuracy criteria, automatic updates were rarely achieved. It is inferred that the dead-reckoning model used by the program is too stringent for the quality of the input dead-reckoning data. It was noticed that the variation in frequency offset values was much greater than usual and that a significant variation from the norm (171 $\pm$ 2) correlated with a poor satellite pass solution. A comparison of auto-updated and other apparently valid satellite passes suggest no apparent difference in accuracy. On this basis a large proportion of valid satellite passes were updated manually with no apparent degradation in position accuracy. Suggested minimum criteria for manual update are:-

S-LA $<$ 0.04

S-LO $<$ 0.08

FREQ = 170 $\rightarrow$ 173

Occasionally auto-updates were made to satellite passes with frequency offsets outside the normal range. These invariably led to poor fix solutions and it is recommended that the update cancellation command (NOUP) is used.

One new program facility which has proved very useful is DLAT and DLON which allow corrections to be made to the current latitude and longitude. This was particularly useful where positions from Hi-fix which could only be retrospectively determined in terms of geographicals were used to reset erroneous dead-reckoning.

APPENDIX 1

Ship Specification

Name:	M.V. Aqua Star
Gross Tonnage:	750 tons
Length O.A.:	167ft
Breadth:	33ft
Draft:	12ft 6ins
Engines:	British Polar: 1025 HP single screw
Speed:	13 knots maximum. 12 knots cruising
Owner:	Aquatronics Ltd

Personnel

M C Tully - Senior Scientist A Dobinson S E Deegan A Mould - Chief Surveyor J Chalmers	Marine Geophysics Unit
N Fannin R Holmes	Continental Shelf Unit II
D Bidgood D Rankin	Nova Scotia Research Foundation
M Heaton B Gay	Bath University

2 Hydrographic surveyors - Wimpey Laboratories

2 Engineers - Aquatronics

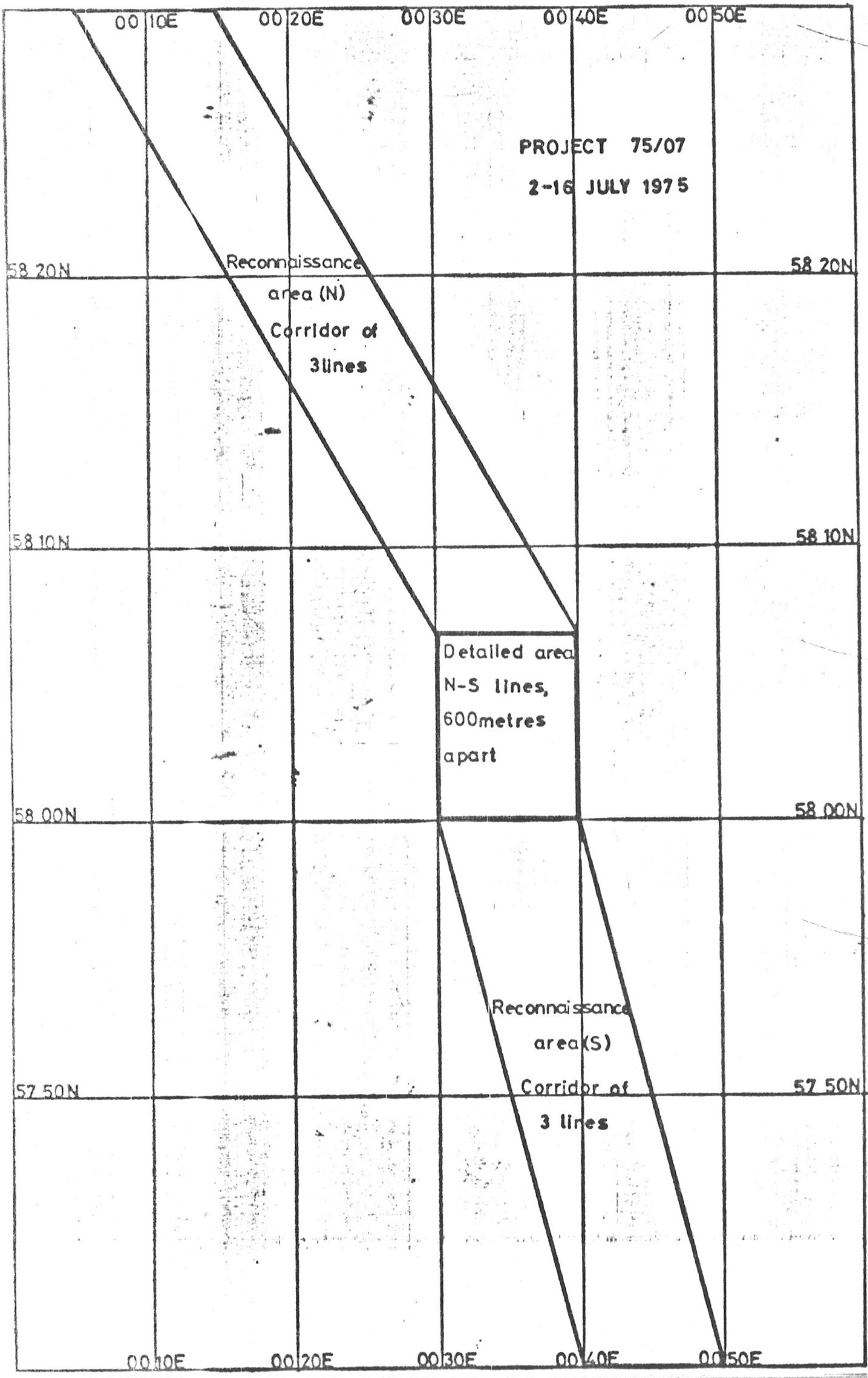
APPENDIX 2

TABLE OF INSTRUMENTS USED

LINE NO	DATE	HI-FIX	SAT.NAV M/C	ECHO SOUNDER	BATH SONAR	KLEIN SONAR	SEISMIC PROFILING SYSTEMS				FIX NO.	KM	COMMENTS
							EDO PINGER	N/S DEEP TOW	MULTI SPARK	12 CHANNEL DIGITAL			
1	6.7.75		✓	✓			✓		✓		20	22.2	
2	6.7.75		✓	✓			✓		✓		25	22.2	
3	7.7.75		✓	✓			✓		✓		22	22.2	
4	7.7.75	✓		✓			✓			✓	29	12.0	
5	7.7.75	✓		✓			✓			✓	35	12.0	
6	7.7.75	✓		✓			✓			✓	7	3.7	Line abandoned - electrical fault
7	7.7.75	✓		✓			✓			✓		12.0	
8	7.7.75	✓		✓			✓			✓	32	12.0	
9	7.7.75	✓		✓			✓			✓	31	12.0	
10	7.7.75	✓		✓			✓			✓	30	12.0	
11	7.7.75		✓	✓			✓		✓		25	22.2	
12	8.7.75		✓	✓			✓		✓		20	22.2	
13	8.7.75		✓	✓			✓		✓		16	11.1	Not plotted - navigation off.
14	8.7.75		✓	✓			✓		✓		6	5.6	Line abandoned - Sat.Nav. off.
15	8.7.75	✓		✓			✓	✓			19	15.8	
16	8.7.75	✓		✓			✓	✓			27	23.1	
17	8.7.75	✓		✓			✓	✓			28	23.1	
18	18.7.75		✓	✓			✓		✓		25	22.2	
19	9.7.75		✓	✓			✓		✓		19	22.2	
20	9.7.75		✓	✓			✓		✓		22	22.2	
21	9.7.75	✓		✓			✓			✓	55	23.1	
22	9.7.75	✓		✓			✓			✓	47	23.1	
23	9.7.75	✓		✓			✓			✓	58	22.2	
24	9.7.75	✓		✓			✓			✓	63	22.2	
25	9.7.75	✓		✓			✓			✓	50	22.2	

LINE NO	DATE	HI-FIX	SAT.NAV M/C	ECHO SOUNDER	BATH SONAR	KLEIN SONAR	SEISMIC PROFILING SYSTEMS EDO PINGER	N/S DEEP TOW	MULTI SPARK	12 CHANNEL DIGITAL	FIX NO.	KM	COMMENTS
26	9.7.75	✓		✓			✓			✓	61	22.2	
27	10.7.75	✓		✓			✓	✓			11	11.1	
28	10.7.75	✓		✓			✓	✓				11.1	
29	10.7.75	✓		✓			✓	✓				11.1	
30	10.7.75	✓		✓				✓			12	11.1	
31	10.7.75	✓		✓				✓			13	11.1	
32	10.7.75	✓		✓				✓			12	11.1	
33	10.7.75	✓		✓				✓			26	22.2	
34	10.7.75	✓		✓			✓	✓			23	22.2	
35	10.7.75	✓		✓			✓	✓			23	22.2	
36	10.7.75		✓	✓			✓		✓		21	22.2	
37	11.7.75		✓	✓			✓		✓		12	13.0	
38	11.7.75		✓	✓			✓		✓		13	13.0	
39	11.7.75		✓	✓			✓		✓		12	13.0	
40	11.7.75		✓	✓			✓		✓		12	13.0	
41	11.7.75	✓		✓	✓		✓				8	2.3	
42	11.7.75	✓		✓	✓		✓				9	2.3	
43	11.7.75	✓		✓	✓		✓				9	2.3	
44	11.7.75	✓		✓	✓		✓				9	2.3	
45	11.7.75	✓		✓	✓		✓				9	2.3	
46	11.7.75	✓		✓	✓		✓				9	2.3	
47	11.7.75	✓		✓	✓		✓				9	2.3	
48	11.7.75	✓		✓	✓		✓				9	2.3	
49	11.7.75	✓		✓	✓		✓				9	2.3	
50	11.7.75	✓		✓	✓		✓				9	2.3	
51	11.7.75	✓		✓	✓		✓				9	2.3	
52	11.7.75	✓		✓			✓		✓	✓	19	22.2	
53	11.7.75	✓	✓	✓			✓		✓	✓	21	22.2	
54	12.7.75		✓	✓			✓		✓	✓	12	16.7	
55	12.7.75		✓	✓			✓		✓	✓	7	9.3	

LINE NO	DATE	HI-FIX	SAT.NAV M/C	ECHO SOUNDER	BATH SONAR	KLEIN SONAR	SEISMIC PROFILING SYSTEMS				FIX NO.	KM	COMMENTS
							EDO PINGER	N/S DEEP TOW	MULTI SPARK	12 CHANNEL DIGITAL			
56	12.7.75		✓	✓			✓		✓		12	16.7	
57	12.7.75	✓		✓			✓			✓	70	25.9	
58	12.7.75	✓		✓			✓		✓		37	89.0	
59	12.7.75	✓		✓			✓		✓		14	33.4	
60	12.7.75	✓		✓			✓		✓		14	33.4	
61	12.7.75		✓	✓			✓		✓		24	60.8	
62	13.7.75		✓	✓			✓		✓		4	3.7	
63	13.7.75		✓	✓			✓		✓		21	27.8	
64	13.7.75	✓		✓			✓	✓			17	25.9	
65	13.7.75	✓		✓			✓	✓			16	25.9	
66	13.7.75	✓		✓			✓	✓			53	111.2	
67	14.7.75		✓	✓			✓		✓		20	29.7	
68	14.7.75		✓	✓			✓		✓		20	29.7	
69	14.7.75	✓		✓			✓			✓	70	22.2	
70	14.7.75	✓	✓	✓			✓	✓			14	29.7	
71	14.7.75		✓	✓			✓		✓		51	111.2	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00 30E
00 40E
00 50E
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2-16 JULY 1975
58 20N
58 20N
Reconnaissance
area (N)
Corridor of
3lines
58 10N
58 10N
Detailed area
N-S lines,
600metres
apart
58 00N
58 00N
Reconnaissance
area(S)
Corridor of
3 lines
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57 50N
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00 40E
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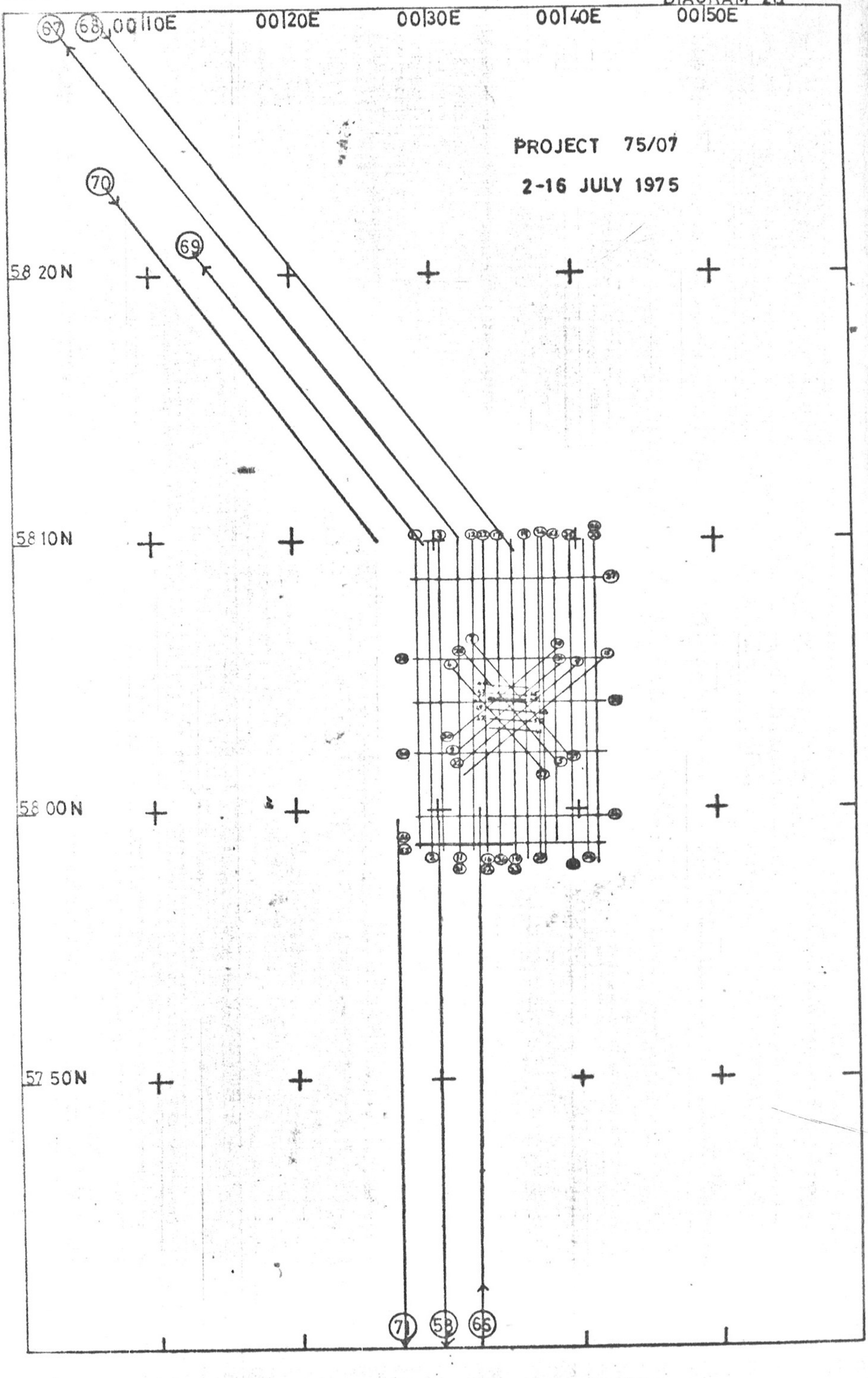

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00 30E
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58 10N
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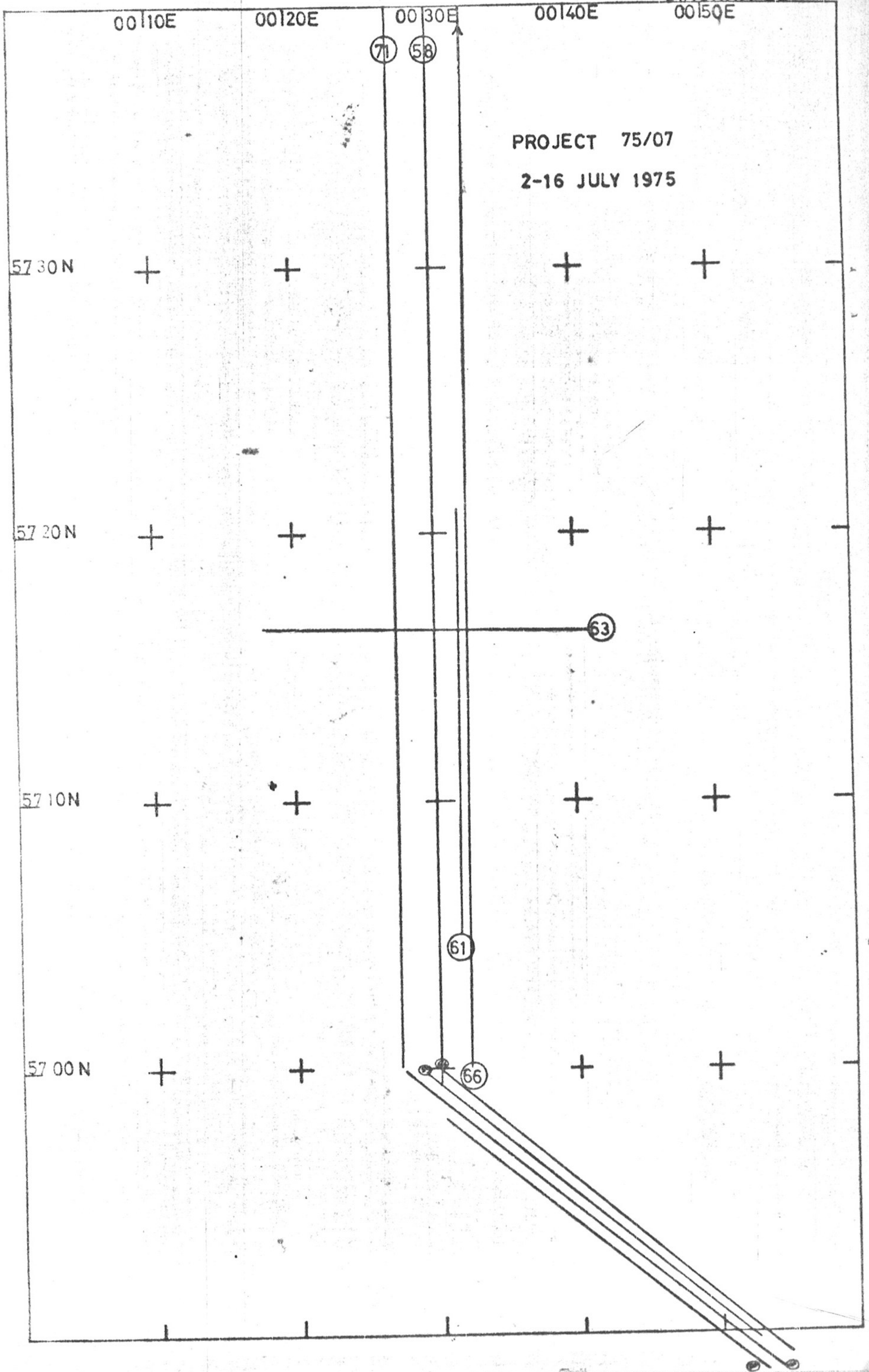
71
58
66

DIAGRAM 2b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71
58
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57 30 N
57 20 N
63
57 10 N
61
57 00 N
66