Report No. 100

# Cruise Report for Project 79/02 and Project 79/16

Edited by

E J Armstrong

INSTITUTE OF GEOLOGICAL SCIENCES
CONTINENTAL SHELF DIVISION
MARINE GEOPHYSICS UNIT

Report No. 100

# Cruise Report for Project 79/02 and Project 79/16

Edited by

E J Armstrong

Murchison House
West Mains Road
Edinburgh EH9 3LA.

August 1979

CONTENTS

## INTRODUCTION

This report covers the mobilisation of the m.v. Sperus for survey work on the UK Continental Shelf in 1979 and work on projects 79/02 and 79/16.

Project 79/02 was designed to provide regional geophysical coverage of the south North Sea in the British sector between 54°N and 52°N on a primarily NS-EW grid of lines at approximately 7.5km by 9km spacing. The information obtained from the shallow seismic profiling equipment, including a deep towed boomer system was to be used as a basis for drilling and sampling by IGS, CSSU later in the year. Gravity and magnetic equipment were also carried to supplement work carried out in 1978.

Project 79/16 was run at the start of leg 3 with the aim of providing shallow seismic control over a number of sites due to be drilled later in 1979.

The m.v. Sperus, as used in 1978, was chartered from Cosag Marine Services Ltd for work in 1979. The ship has a net weight of 921 tons, an overall length of 63m, a beam of 11m and a 4m draught.

The leg by leg cruise reports, summary charts and log sheets covering the periods 26 March-7 May and 8 June-4 July, during which the two projects were run and on which this report is based, are held on open file in the Marine Geophysics Unit, Murchison House, West Mains Road, Edinburgh.

The authors of the reports for each leg are listed below:

| | Mobilisation | Leg 1 | Leg 2 |
|---|---|---|---|
| Senior Scientist | R A Floyd | A Dobinson | R A Floyd |
| Ship performance | - | R A Floyd | - |
| Navigation | - | A S Mould | A S Mould |
| Geophysical | - | - | E J Armstrong |
| Geological | - | - | D Cameron |
| Technical | - | P R Roberts | P R Roberts |

| | Leg 3 | Leg 4 |
|---|---|---|
| Senior Scientist | R A Floyd | R A Floyd |
| Ship performance | - | - |
| Navigation | A S Mould | R A Floyd |
| Geophysical | J Donato | M C Tully |
| Geological | W Martindale | D Cameron |
| Technical | K Robertson | A Cumming & H Miles |

## MOBILISATION

Sunderland: 26 March-18 April

Despite having access to the ship for two weeks prior to the charter period and the commitment of the staff involved, this period was extended beyond original plans due to a number of factors which include:

(a) Extensive modifications to the ship's stern and deck equipment to enable installation and deployment of the Huntec deep tow boomer.

(b) Manufacture and installation of two new laboratories.

(c) Installation of winch and power pack for the boomer and a large amount of work on the generator container.

(d) Atrocious weather coupled with a lack of technical support during the early stages of mobilisation and the unscheduled arrival of equipment.

During mobilisation, a very favourable on-charter survey of the ship was carried out. Overall, the laboratory equipment was installed with no more than the usual amount of difficulty.

LEG 1

Sunderland-Newcastle: 18-23 April

During the five days available for offshore work on this leg the primary objective of calibrating and checking out the equipment was met though no survey lines were run. The work was carried out off north-east England between 54°N and 55°N in waters over 60m in depth. This area was chosen for suitability of satellite navigation (sat/nav) calibration and boomer trials.

All seismic sources were checked out in the prevailing ideal conditions and the deep tow boomer, gravity and magnetic systems performed well. While the deep towed system indicated its ability to provide the much needed information in the shallow seismic section, problems were encountered with the Osel winch which necessitated its removal at the end of the leg.

The ship's performance overall was good and the stern modifications necessary for work with the deep towed system improved the handling and tow configuration of all the gear for added efficiency and safety.

While the sat/nav calibration was essentially complete by the end of the leg a number of problems beset the system. Due to substantial maladjustment the inclinometers were not used, their absence not being thought to be serious in the calm conditions. The upper Pertec tape unit and spare MK1C gyrocompass also gave problems as did signal locking to the 400mHz satellite channel. Calibration lines A-E were aborted due to the wrong switch setting on the gyrocompass.

The gravity meter and magnetometer were not used for recording purposes. A 0.1mGal gravimeter drift was observed between the Sunderland and Newcastle port calls at the start and end of the leg.

LEG 2

Newcastle-Great Yarmouth-Amsterdam: 23 April-7 May

This leg was beset by technical problems and rough weather. Two days were required for setting up the equipment before 2½ days spent in Great Yarmouth during poor weather, when it was necessary to check out the gyrocompass of the

sat/nav system. Overall, just over 800km of data were collected on the nine lines run.

Sat/nav performance was generally below average due to the poor performance of the gyrocompass and shallow water effects. Following work on the gyro-compass in Great Yarmouth the performance improved though doubts about it still remained. Updates of up to 1km were common.

Despite a number of attempts to solve the problem, oscillation was still observed on the gravity meter when switched to the two minute filter. This caused a poor base to be obtained at the start of the leg. The platform was placed on air mounts whilst in Great Yarmouth and subsequently performed well at sea though the weather was too calm for a complete check. The long axis gyro of the platform started to 'sing' during this leg.

A mean crosstie value of 0.9mGal was obtained from 25 crossovers of the reduced Bouguer anomaly data which generally agreed to $\pm$ 2mGal with 1978 data.

The 4kJ and 800J sparkers were run for most of this leg, giving penetration of up to 700m and 150m respectively, with approximately 8m resolution on the 800J records.

The good quality records obtained showed two extensive reflectors, indicating possibly a mid ?Tertiary unconformity and rockhead, with the upper horizontal unit of ?Plio/Pleistocene marine beds overlying the gently dipping upper surface of the lower unit.

A well defined, continuous reflector between 3-20m below the seabed, seen on the pinger records north of 52°40'N, may represent the Pleistocene/Holocene boundary.

## LEG 3

Plymouth-Great Yarmouth-Newcastle: 8-21 June

This leg was designed to continue the survey of the south North Sea on project 79/02 and to run four shallow seismic profiling lines on the Portland sheet to be used as well control for boreholes to be sunk later in the year.

As there were certain discrepancies in the sat/nav system calibration parameters when on computer toquing of the gyrocompass, the compass was run on internal torquing during project 79/16. Variations in the calibration parameters were still encountered and up to 300m updates were obtained.

The gravity meter worked well and though no internal crossovers were obtained in this area good agreement with previous year's data was obtained.

The sparker and deep tow boomer gave good resolution and penetration down to 100msec and 25msec respectively. The sequence observed in this structurally complex area is steeply dipping Permo Trias in fault contact with the Chalk at the end of line 1 passing up elsewhere via a faulted boundary to highly folded lower and middle Jurassic which is unconformably overlain by the Cretaceous. The Lower Cretaceous is folded into broad anticlines and synclines. Surface sediment is thin, mainly sand.

At the end of project 79/16 and whilst on transit to the North Sea survey area the sat/nav gyro was run on computer torquing. After putting in to Great Yarmouth on 18 June due to the failure of the Silent 700 teletype and lack of spares, the rotary generator for the compass failed and was replaced. Further calibration was carried out en route to Newcastle after leaving Great Yarmouth. Variation in the calibration parameters seen earlier may have been due to a gradual deterioration of the compass rotary generator.

During this leg a new program, M2001G-79092 was used without problems and 400mHz noise levels were generally low.

A further 14 lines were run in the southern North Sea survey area during this cruise, a total of 1103km, obtained in fair weather. The gravity meter was operated on all lines, giving a mean mistie of 1.02mGal from the reduced data.

The 1kJ sparker was run as an alternative to the 4kJ and 500J sparker on a number of lines. The sparkers, in addition to the deep tow boomer, transit sonar and pinger provided good quality records giving coverage of the seabed and the upper 700msec.

Acoustic shadowing below the thick surface sand tended to obscure the underlying beds. The Top Cretaceous however was seen on the 4kJ sparker and evidence of soft movement was observed in sub-Cretaceous reflectors in the Indefatigable area. The Dowsing Fault was also delineated with the 4kJ sparker. The boomer records tended to deteriorate in shallower water.

LEG 4

Newcastle-Newcastle: 21 June-4 July

Over 1300km of survey work were completed during this leg. Despite a number of equipment problems the seismic records, obtained in moderate conditions, were of generally good quality.

The 500J sparker gave penetration of up to 100m with improved reflector resolution over previous legs. The 4kJ sparker worked well though mains interference marred some lines.

Pinger and boomer records provided good definition in the top 20m below seabed and enabled the tracing of two major channel systems across the survey area. These were thought to represent part of the ancient courses of the Thames and Rhine during the late Pleistocene.

Recent cover is patchy and usually less than 3m thick, allowing Pleistocene and Tertiary rocks to outcrop locally at seabed. North of $52^{\circ}40'N$ recent sediment cover is commonly greater than 10m thick consisting of fine or silty sand resting on an undulating surface.

Good results were obtained from the gravity meter although the Easterline Angus recorder failed due to some cogs being stripped from one of the drive wheels.

Overall, 175 crossovers were obtained on this project giving a mean mistie value of 0.92mGal.

Using RMSAad $= \pm \sqrt{\frac{\sum_{o}^{n} (\Delta a_o)^2}{2n}}$ where Aad = uncorrected system error
n = number of crossovers
$\Delta a_o$ = mistie value

an RMS value of $\pm$ 0.77mGal for the survey was obtained.

Certain discrepancies in some areas will necessitate slight reviewing of the accumulated data though cross coupling errors on the S75 meter appear to have been eliminated.

## EQUIPMENT PERFORMANCE SUMMARY

### LaCoste and Romberg S75 Gravity Meter

After work on the gravity meter during legs 1 and 2 failed to completely cure the small fluctuations on the gravity and total correction traces when on the two minute filter it was thought that the doppler sonar was the cause. The 9400 logger failed on the second leg due to a short circuit in the read preamplifier and on leg 2 the long axis gyro started to 'sing', an indication of impending failure, though it gave no trouble during these projects.

### Edo Pinger

The performance of this instrument was maintained by regular bleeding of air from the transducer housing.

### Satellite Navigation/Doppler Sonar System

During leg 1 the BOT/EOT sensor on the number 1 Pertec tape deck was replaced and after continued write errors was serviced by a manufacturer's engineer at the end of the leg.

On leg 2 after inconsistent CC errors and checks indicated gyrocompass error it was reported that a major service was required.

Due to an intermittent fault on the doppler sonar during this leg the mains signal cable and computer cable were reterminated as a precaution.

During leg 3 the Silent 700 teletype keyboard locked on to the figure 3 and although the printout via the computer was alright this caused a premature call at Great Yarmouth. A spare teletype and/or spares should be carried. During this port call the rotary generator for the gyrocompass failed and the poor reference C phase caused severe gyro errors.

### Decca Data Logger

Following rewiring of the gravity and depth I/P leads to enable logging of the four least significant digits and the proper recording of depth digits respectively, the system worked well on legs 2 and 3. On the seventh day of leg 4 the system went down due to a low -15v supply until the end of the survey.

Magnetometers

Both sensors were tested out satisfactorily on leg 1. On leg 2 the cable of the bottle in use was contaminated with moisture and had a short circuit on the instrument end of the signal cable. Neither bottle was used on legs 3 and 4.

Airguns

The 10 cu.in. and 40 cu.in. guns operated well from the Hiab crane when tested on leg 1. They were then only used for a short period on leg 2.

Watergun

Generally the gun worked well. It was necessary however, to connect the airgun hose to that of the watergun due to similar terminations on the air control box and the watergun hose. Only one gun connection on the rear panel of the firing circuit worked and the older version of the 24v DC power supply managed to supply only 10v.

Sparkers

On leg 1 the laboratory trigger circuit was modified to ensure trouble-free firing. The two systems in the sparker container were operated from different phases of the generator supply and on leg 2 the sparkers were adapted for alternate operation.

On leg 3 the tow cable pulled out of the electrode frame clamp on the 9 element array. The float was then removed to reduce drag. On leg 4 the power supply to the 4kJ sparker failed due to an open circuit on the interlocks and a broken circuit lead stopped the trigger and recording system for a time.

Sat 7H Compressor

Worked well though the batteries needed to be charged after not having been used for a period of time.

EPC Recorders

The recorders worked well apart from a single sweep problem on the pinger recorder and a faulty tacho generator on RVS 1461 which caused uncontrolled running at high speeds. The tacho was replaced and the accelerate comparator reset. A tachogenerator was also replaced in one machine on leg 4.

Hydrophones

A hydrophone preamp was constructed on leg 1 and worked well. The power supply to the old 30m hydrophone array was doubtful while the 50m and new 30m Geomecanique arrays worked well. The new 50m array needed a tail rope and tended to tow on the surface. All arrays in use operated well on leg 2 but on leg 3 the old 30m array could not be made to work.

Also on leg 3, the 263C array was stripped and reassembled though the sensitivity was poor on about half the crystals. Good results were obtained from the 265 hydrophone borrowed from Gardline Surveys. A varying DC bias obtained from the amplifier summing unit in the laboratory restricted gain adjustment in the IGS seismic electronic system and caused recording problems. The tape/EPC gain adjust mode was changed to AC coupled input to clear the trouble.

On leg 4 the 263C array was lost when caught in the propellor. The 265 gave mediocre results during this leg.

Osel Winch

There were numerous problems with this winch on leg 1 including a line pull not fully up to maximum specification and an inability to retrieve the fish and 150m of cable under tow. There was also no continuously variable line speed and these problems coupled with the poor operation of the cable spooling mechanism and the absence of a blanking/shorting plug for remote/local operation necessitated returning the winch to the manufacturers for repair at the end of the leg.

The winch was back on board on leg 3 when operation was good except for occasional pressure fluctuations from the hydraulic power pack and incorrect operation of the trumeter line counter.

When operated in shallow water on leg 4 the system worked well.

Sonarmarine Towing Block

The fish catching ram was not operable from the Osel winch and was connected to a control point on the gantry hydraulics. The block was damaged beyond

repair on leg 4 when the centre supported pin broke.

Uninterruptable Power Supply

The operating mode was changed from static to invertor on leg 2 in order to adjust the frequency supply to the S75 gravity meter; otherwise there were no problems.

Generators

Water trap filters were fitted to all three generators on leg 2. After starting problems with number one on legs 1 and 3 and with number two on leg 3 it was found that number one would not run for more than five hours on leg 4 without stopping. An engineer was called for the end of survey port call, at which time a replacement 12v alternator was fitted to number three generator.

Huntec Deep Tow Boomer

This system generally worked well throughout the four legs though it was necessary to run it from a separate supply from that used for the sparkers. A number of fuses and SCU components were changed on legs 3 and 4 and after towing block failure on leg 4, over 40 feet of faired cable was damaged. Checks on the fish after this incident indicated that damage to the fish, caused on recovery in adverse conditions, was purely mechanical to the fairings.

Seismic Recording Systems

The new unit was discovered to have been incorrectly wired-up on leg 1, however, both units worked well for the rest of the survey.

Atlas Deso 10

The Atlas Deso 10 was trouble-free in operation.

MS47 Sonar

Worked well, after installation, on legs 3 and 4 until the bottom bracket broke, necessitating recovery of the transceiver.

Hiab Crane

This worked well, though due to the absence of spares, proper servicing could not be carried out on leg 3.

## CONCLUSION

A total of 3263km in all were surveyed in a difficult area during the four legs of project 79/02. This completed coverage of the East Anglia and Flemish Bight sheets with a number of lines on the Indefatigable sheet, leaving the northern areas for later surveys.

Greater coverage was prevented by a longer than usual mobilisation and numerous problems with the weather and equipment. Problems with the sat/nav calibration resulted in a lower than usual accuracy in fix positioning.

The new deep tow boomer was successfully tested and provided good definition in the shallow seismic section. The gravity data acquired was very useful in supplementing the 1978 coverage.

Project 79/16 was completed successfully and good seismic coverage for the proposed borehole sites was obtained along 137km of line.

TABLE 1

Personnel on Project

Leg 1: 18-23 April 1979: Sunderland-Newcastle

| | | |
|---|---|---|
| A Dobinson | Senior Scientist | MGU, IGS |
| J Donato | | |
| R A Floyd | Ship performance | |
| A S Mould | | |
| M Glen | | |
| D Soutter | | |
| H Vance | | |
| D Tappin | | CSSU, IGS |
| K Robertson | | RVS, Barry |
| P Mason | | |
| I Strangward | | |
| R Hutchins | 18-22 April | Huntec Ltd |
| D Tullett | | |
| S Middleton | | Gardline Surveys |

Leg 2: 25 April-7 May: Newcastle-Gt Yarmouth-Amsterdam

| | | |
|---|---|---|
| R A Floyd | Senior Scientist | MGU, IGS |
| A S Mould | | |
| S E Deegan | | |
| E J Armstrong | | |
| J R Walker | | |
| M Davis | | |
| P R Roberts | | |
| D Cameron | | CSSU, IGS |
| P Walters | | RVS, Barry |
| P Mason | | |
| I Strangward | | |
| S Middleton | | Gardline Surveys |
| M Greeney | | |

Leg 3: 8-21 June: Plymouth-Gt Yarmouth-Newcastle

| | | |
|---|---|---|
| R A Floyd | Senior Scientist | MGU, IGS |
| J Donato | | |
| A S Mould | | |
| M Glen | | |
| P Western | | |
| J R Walker | | |
| B Martindale | | CSSU, IGS |

Leg 3 (cont.....)

| | | |
|---|---|---|
| K Robertson | | RVS, Barry |
| R Powell | | |
| D Walker | | Cosag Marine Services Ltd |
| H Miles | | Gardline Surveys |
| B Austin | | |

Leg 4: 21 June-4 July: Newcastle-Newcastle

| | | |
|---|---|---|
| R A Floyd | Senior Scientist | MGU, IGS |
| M C Tully | | |
| D Ham | | |
| E J Armstrong | | |
| H Vance | | |
| D Cameron | | CSSU, IGS |
| A Cummings | | RVS, Barry |
| P Armitage | | |
| H Miles | | Gardline Surveys |
| B Austin | | |
| D Walker | | Cosag Marine Services Ltd |

PROJECT 79/02
LINE SUMMARY

TABLE 2

| LINE No. | LAST FIX | START DAY | START TIME | END DAY | END TIME | LINE LENGTH Km. | MAIN Nav. AID | EQUIPMENT USED: Echo Sounder | Pinger | Sparker | A.G.* / W.G. | Side Scan | D.T. Boomer | Magnetometer | Data Logger | L&R S75 / L&R S40 | 9400 Logger |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 50 | 117 | 0050 | 117 | 0900 | 73 | SATNAV | ATLAS DESO 10 | EDO 248 | 1000J | | | | | IGS | LDR S75 | FROM FIX 39 |
| 2 | 86 | 117 | 2350 | 118 | 1400 | 171 | ✓ POOR ACCURACY | ✓ | ✓ | ✓ | AIRGUN 10 cu.in | | | | ✓ | ✓ | ✓ |
| 3 | 29 | 118 | 1640 | 118 | 2120 | 40.5 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ |
| 4 | 43 | 124 | 1500 | 124 | 2200 | 74 | SATNAV/DOP | ✓ | ✓ | 4KJ + 800J | | | | BARRINGER | ✓ | ✓ | ✓ |
| 5 | 38 | 124 | 2340 | 125 | 0550 | 86 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ |
| 6 | 49 | 125 | 0800 | 125 | 1600 | 91.5 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ |
| 7 | 64 | 125 | 1720 | 126 | 0350 | 123 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ |
| 8 | 34 | 126 | 0530 | 126 | 1100 | 77.5 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ |
| 9 | 37 | 126 | 1250 | 126 | 1850 | 66 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | PART ✓ |
| 10 | 23 | 162 | 2140 | 163 | 0120 | 41 | ✓ | ✓ | ✓ | 1000J | | MS 47 | ✓ | | ✓ | ✓ | ✓ |
| 11 | 19 | 163 | 0210 | 163 | 0510 | 31 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 12 | 41 | 163 | 0620 | 163 | 1300 | 69 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 13 | 38 | 163 | 1500 | 163 | 2110 | 73 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 14 | 36 | 163 | 2330 | 164 | 0520 | 89 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 15 | 13 | 164 | 0600 | 164 | 0800 | 25 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 16 | 40 | 164 | 2010 | 165 | 0240 | 77 | ✓ | ✓ | ✓ | 4KJ + 500J | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 17 | 71 | 165 | 0420 | 165 | 1600 | 144 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 18 | 83 | 165 | 1840 | 166 | 0820 | 145 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 19 | 25 | 166 | 1150 | 166 | 1550 | 48 | ✓ | ✓ | ✓ | 4KJ + 1000J | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 20 | 48 | 167 | 1050 | 167 | 1840 | 95 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 21 | 45 | 167 | 1930 | 168 | 0250 | 94 | ✓ | ✓ | ✓ | 4KJ + 500J | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 22 | 40 | 168 | 0325 | 168 | 0955 | 87 | ✓ | ✓ | ✓ | 1KJ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 23 | 39 | 168 | 1135 | 168 | 1755 | 85 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 24 | 26 | 175 | 1430 | 175 | 1840 | 47 | ✓ | ✓ | ✓ | 4KJ + 500J | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 25 | 24 | 175 | 2040 | 176 | 0030 | 49 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |

*A.G.=Airgun W.G.=Watergun

PROJECT 79/02
LINE SUMMARY
TABLE 2

| LINE No. | LAST FIX | START DAY | START TIME | END DAY | END TIME | LINE LENGTH Km. | MAIN Nav. AID | EQUIPMENT USED: Echo Sounder | Pinger | Sparker | A.G.* / W.G. | Side Scan | D.T. Eoomer | Magnet-ometer | Data Logger | L&R S75 / L&R S40 | 9400 Logger |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | 27 | 176 | 0210 | 176 | 0630 | 45 | SATNAV DOP/SON | ATLAS DESO10 | EDO 248 | 4KJ + 500J | | MS47 | ✓ | | IGS | L&R S75 | ✓ |
| 27 | 22 | 176 | 0730 | 176 | 1100 | 35 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 28 | 16 | 176 | 1235 | 176 | 1505 | 22 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 29 | 41 | 176 | 1640 | 176 | 2320 | 74 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 30 | 48 | 177 | 0100 | 177 | 0850 | 83 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 31 | 46 | 177 | 1000 | 177 | 1730 | 83 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 32 | 17 | 177 | 2240 | 178 | 0120 | 32 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 33 | 30 | 178 | 0320 | 178 | 0810 | 56 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 34 | 33 | 178 | 1030 | 178 | 1550 | 62 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 35 | 29 | 178 | 1820 | 179 | 0040 | 67 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 36 | 32 | 179 | 0150 | 179 | 0700 | 60 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 37 | 15 | 179 | 1640 | 179 | 1900 | 20.5 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 37A | 30 | 179 | 2010 | 180 | 0100 | 48 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ |
| 38 | 26 | 180 | 0220 | 180 | 0630 | 37 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ |
| 39 | 19 | 180 | 0820 | 180 | 1120 | 30 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ |
| 40 | 15 | 180 | 1300 | 180 | 1520 | 29 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ |
| 41 | 55 | 180 | 1820 | 181 | 0320 | 83 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ |
| 42 | 9 | 181 | 0420 | 181 | 0540 | 16 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ |
| 43 | 23 | 181 | 0620 | 181 | 1000 | 46 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ |
| 44 | 18 | 181 | 2020 | 181 | 2310 | 25 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | ✓ | ✓ |
| 45 | 10 | 182 | 1340 | 182 | 1510 | 18 | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ |
| 46 | 22 | 182 | 1600 | 182 | 1930 | 42 | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ |
| 47 | 18 | 182 | 2050 | 182 | 2340 | 33 | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ |
| 48 | 16 | 183 | 0110 | 183 | 0340 | 27 | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ |
| 49 | 22 | 183 | 0530 | 183 | 0900 | 41 | ✓ | ✓ | ✓ | 4KJ + 1KJ | | | | | | ✓ | ✓ |

*AG.=Airgun W.G.=Watergun

PROJECT 79/02
LINE SUMMARY

TABLE 2

| LINE No. | LAST FIX | START | | END | | LINE LENGTH Km. | MAIN Nav. AID | EQUIPMENT USED | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DAY | TIME | DAY | TIME | | | Echo Sounder | Pinger | Sparker | A.G.* / W.G. | Side Scan | D.T. Boomer | Magnet-ometer | Data Logger | L&R S75 / L&R S40 | 9400 Logger |
| 50 | 32 | 183 | 1030 | 183 | 1540 | 52 | SATNAV DOP/SON | ATLAS DESO 10 | EDO 248 | 4KJ + 1KJ | | | | | | ✓ | ✓ |
| 51 | 28 | 183 | 1710 | 183 | 2140 | 51 | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ |
| 52 | 26 | 183 | 2330 | 184 | 0340 | 44 | ✓ | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

*A.G.=Airgun W.G.=Watergun

PROJECT 79/16

LINE SUMMARY

TABLE 2a

| LINE No. | LAST FIX | START | | END | | LINE LENGTH Km. | MAIN Nav AID | EQUIPMENT USED | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DAY | TIME | DAY | TIME | | | Echo Sounder | Pinger | Sparker | A.G.* / W.G. | Side Scan | D.T. Boomer | Magnet-ometer | Data Logger | L&R S75 / L&R S40 | 9400 Logger |
| 1 | 33 | 160 | 1800 | 160 | 2320 | 58 | SATNAV DOPPLON | ATLAS DESO 10 | EDO 248 FIX 1-9 | 4 KJ | | MS47 | ✓ | | IGS | LAR S75 | ✓ |
| 2 | 23 | 161 | 0130 | 161 | 0510 | 40 | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 3 | 12 | 161 | 0900 | 161 | 1050 | 19 | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 4 | 23 | 161 | 1120 | 161 | 1500 | 20 | ✓ | ✓ | | 1KJ | | ✓ | ✓ | | ✓ | ✓ | ✓ |

*A.G.=Airgun W.G.=Watergun

GRAVITY BASE TIES TABLE 3

| Date | Place and Berth | g at main base | g at berth corrected for tidal effects | Meter reading corrected for tidal effects | Drift |
|---|---|---|---|---|---|
| 14:40 GMT<br>108<br>18-4-79 | SUNDERLAND DOCK | 981506.98 mGal | 981502.0 mGal | 12284.9 | |
| | | | | | +0.1 mGal |
| 07:30 GMT<br>113<br>23-4-79 | NEWCASTLE QUAY<br>NO. 11 WHARF | 981494.89 mGal | 981505.5 mGal | 12288.5 | |
| | | | | | +3.3 mGal |
| 11:45 GMT<br>115<br>25-4-79 | NEWCASTLE QUAY<br>NO. 11 WHARF | 981494.89 mGal | 981505.5 mGal | 12291.8<br>UNSETTLED READING | |
| | | | | | 113 – 120/121<br>+0.4 mGal |
| 120/121<br>30/4 a/s 5/79 | Gt. YARMOUTH<br>TOWN BERTH | 981301.5 ± 0.2 mGal | 981301.5 mGal | 12083.1 | |
| | | | | | +0.4 mGal |
| 12:21 GMT<br>123<br>3-5-79 | Gt. YARMOUTH<br>TOWN BERTH | 981301.5 ± 0.2 mGal | 981301.5 mGal | 12083.5 | |
| | | | | | +0.4 mGal |
| 11:50 GMT<br>128<br>8-5-79 | AMSTERDAM DOCK<br>PASSENGER TERMINAL<br>OOSTELIJKE HANDELSKADE | 981273.44 mGal | 981277.6 mGal | 12059.8 | |
| | | | | | +0.7 mGal |
| 17:10 GMT<br>141<br>21-5-79 | PLYMOUTH<br>WEST WHARF | 981109.6 mGal | 981116.6 mGal | 11898.1 | |
| | | | | | +3.3 mGal |
| 09:30 GMT<br>169<br>18-6-79 | Gt. YARMOUTH<br>OPP. POWERSTN. | 981301.5 ± 0.2 mGal | 981300.9 mGal | 12087.4 | |
| | | | | | +0.2 mGal |
| 08:00 GMT<br>172<br>21-6-79 | NEWCASTLE QUAY<br>NO. 11 WHARF | 981494.89 mGal | 981505.5 mGal | 12294.0 | |
| | | | | | +0.7 mGal |
| 09:58 GMT<br>174<br>23-6-79 | NEWCASTLE QUAY<br>NO. 11 WHARF | 981494.89 mGal | 981505.5 mGal | 12294.7 | |
| | | | | | +0.6 mGal |
| 01:13 GMT<br>185<br>4-7-79 | NEWCASTLE QUAY<br>NO. 11 WHARF | 981494.89 mGal | 981505.5 mGal | 12295.3 | |

TABLE 4

Equipment Carried

1.1 LaCoste and Romberg air-sea gravity meter S75.

1.2 LaCoste and Romberg 9400 data acquisition system.

2. Two Barringer magnetometers.

3. Edo Western 248 pinger with hull mounted transducers.

4. Atlas Deso 10 echo sounder with digital readout unit (EDIG 10).

5. Magnavox satellite navigation system integrated with MX610 doppler sonar.

6. Decca MK21 main chain receiver.

7. Decca data logger.

8. Three Lewis 60KVA, 3 phase generators.

9. Stabilised, no break power supply system (UPS).

10. MS47 side scan sonar.

11. Reavell SAT 7H compressor.

12. EG & G trigger, power and capacitor units.

13. Huntec deep tow boomer and power supply.

14. Sodera 80 cu.in. watergun.

15. Bolt 40 cu.in., 20 cu. in. and 10 cu. in. aurguns.

16. Multi element spark arrays (IGS).

17. EG & G 9 candle and 3 candle spark arrays.

18. Two 30m Geomecanique hydrophones.

19. 50m Geomecanique hydrophone.

20. 263C and 265 hydrophone (265 legs 3 and 4 only).

21. EPC graphic recorders (4100 and 4600).

22. Analogue tape and control system (IGS).

23. Osel cable winch and power unit.

24. Hiab 650 deck crane.

25. 3KVA generator.

GEOLOGICAL SURVEY AND MUSEUM: [MGU HARBOUR GRAVITY BASE STATION] NO.:

STATION NAME: SOUTH SHIELDS DOCK FIGURE 3a

1 METRE GRID REF.: _____

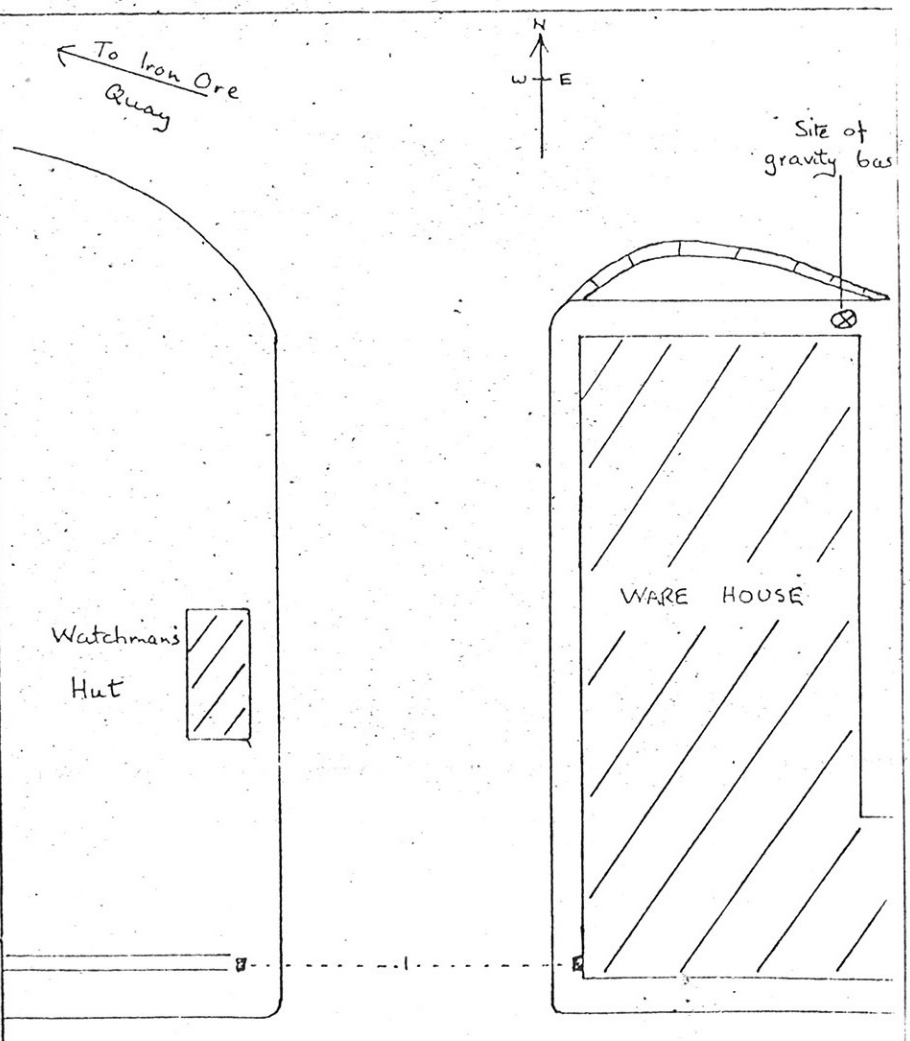
1" O.S. MAP: _____ COUNTY: _____

1" GEOL. MAP: _____ 6" O.S. MAP: _____

SITE DESCRIPTION:

Gravity base on pavement 0.5 m from ware house wall just west of ~~eastern to~~ line of eastern wall of warehouse

| | |
|---|---|
| STATION REFERENCE NO. | |
| LATITUDE | |
| LONGITUDE | |
| HEIGHT | |
| ~~Obs. - Sp.H.~~ NGRN 73 | 981,506.98 |
| GEOLOGY | |
| BOUGUER ANOMALY ρ = gms./c.c. | |
| BOUGUER ANOMALY ρ = 2.67 gms./c.c. | |
| FREE AIR ANOMALY | |
| TERRAIN CORRECTION | |
| METER NO. | World wide |
| OBSERVER | R. McQuillin |
| DATE | 30/10/76. |
| FIELD SHEET NO. | Project 76/4 |
| | Base connections |




DS 67305/1/76 2m 2/81 DL

← Gateshead

Round about

South Shields →

MGU HARBOUR

GEOLOGICAL SURVEY AND MUSEUM: GRAVITY BASE STATION NO.:

STATION NAME: Newcastle Armstrong Building Entrance

FIGURE 3b

1 METRE GRID REF.: _____

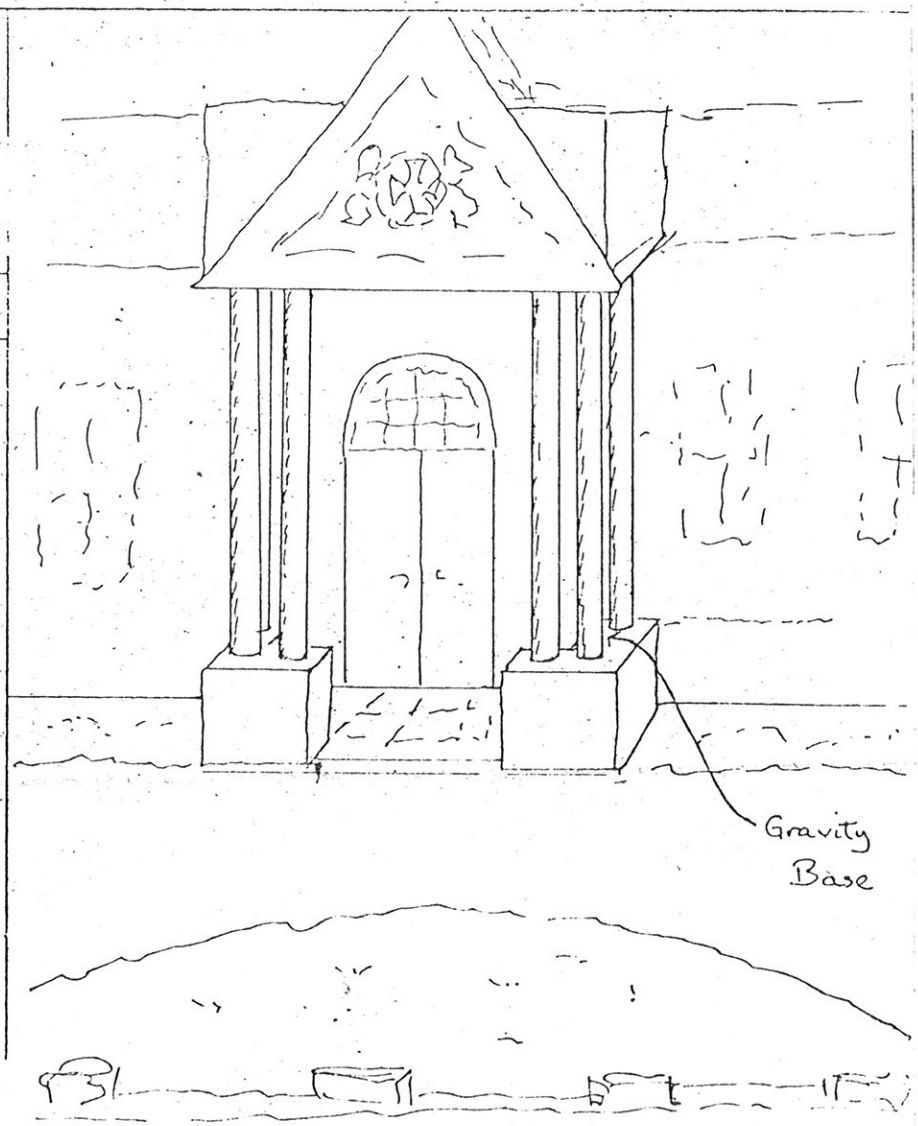
1" O.S. MAP: _____ COUNTY: _____

1" GEOL. MAP: _____ 6" O.S. MAP: _____

SITE DESCRIPTION:

Gravity base on top of stone wall supporting pillars in main entrance to the ARMSTRONG BUILDING — University of Newcastle. Base is sited 0.5m from inside face of wall midway between the side pillars to the RHS of the doorway (looking in).

| | |
|---|---|
| STATION REFERENCE NO. | |
| LATITUDE | |
| LONGITUDE | |
| HEIGHT | |
| ~~Cons. — P.H.~~ NGRN 73 | 981,494.89 |
| GEOLOGY | |
| BOUGUER ANOMALY $\rho$ = gms./c.c. | |
| BOUGUER ANOMALY $\rho$ = 2.67 gms./c.c. | |
| FREE AIR ANOMALY | |
| TERRAIN CORRECTION | |
| METER NO. | World Wide |
| OBSERVER | R. M'Quillin |
| DATE | 30/10/76 |
| FIELD SHEET NO. | Project 76/4 Base connections |

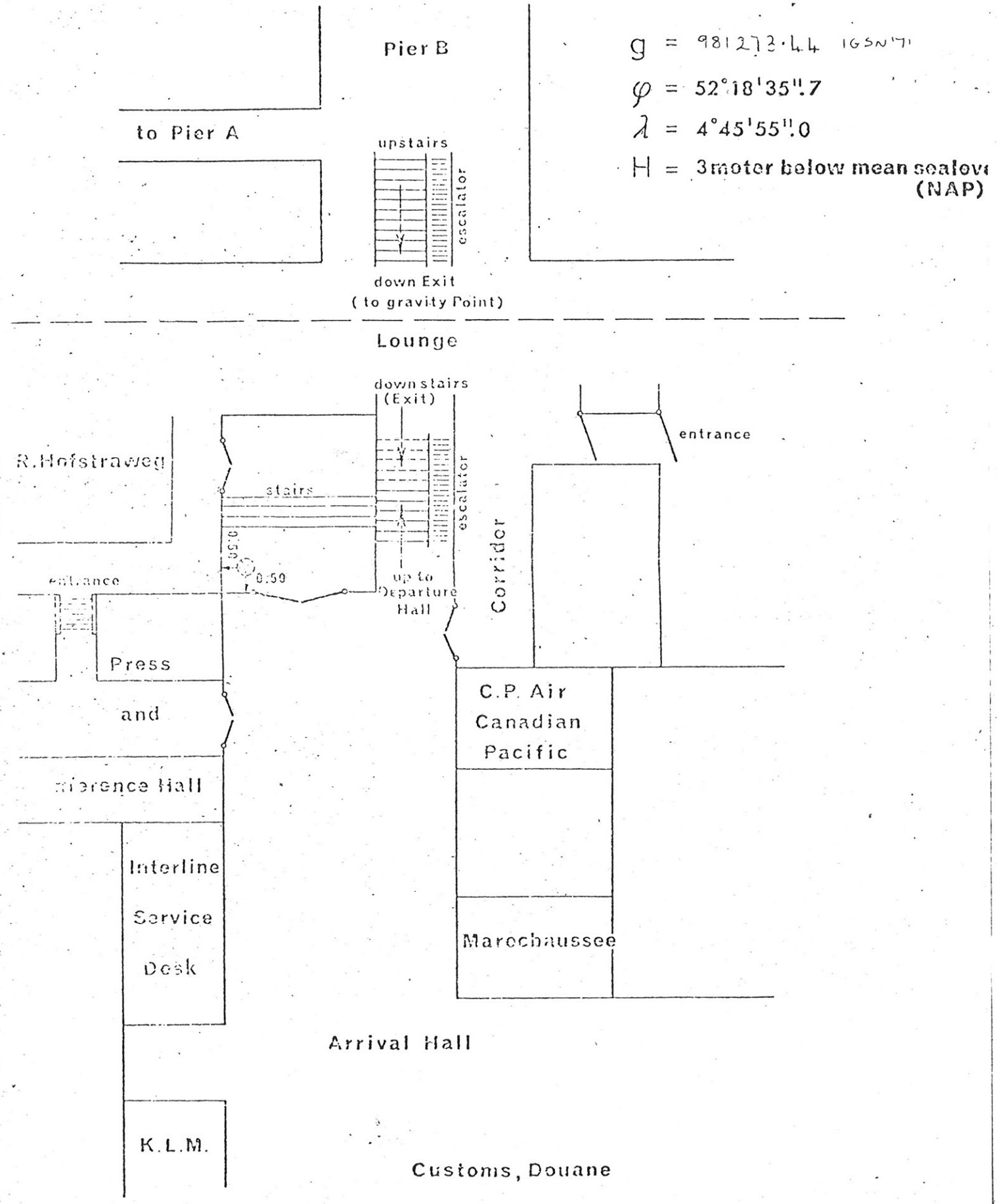



DS 87209/1/76 27.2/91 DL

# GRAVITY STATION

## Amsterdam-Airport-Schiphol

FIGURE 3c




Reference: G.L Strang van Hees. Technological University Geodetic Institute Kanaalweg 4, Delft. Netherlands

# INSTITUTE OF GEOLOGICAL SCIENCES

## MARINE GEOPHYSICS UNIT

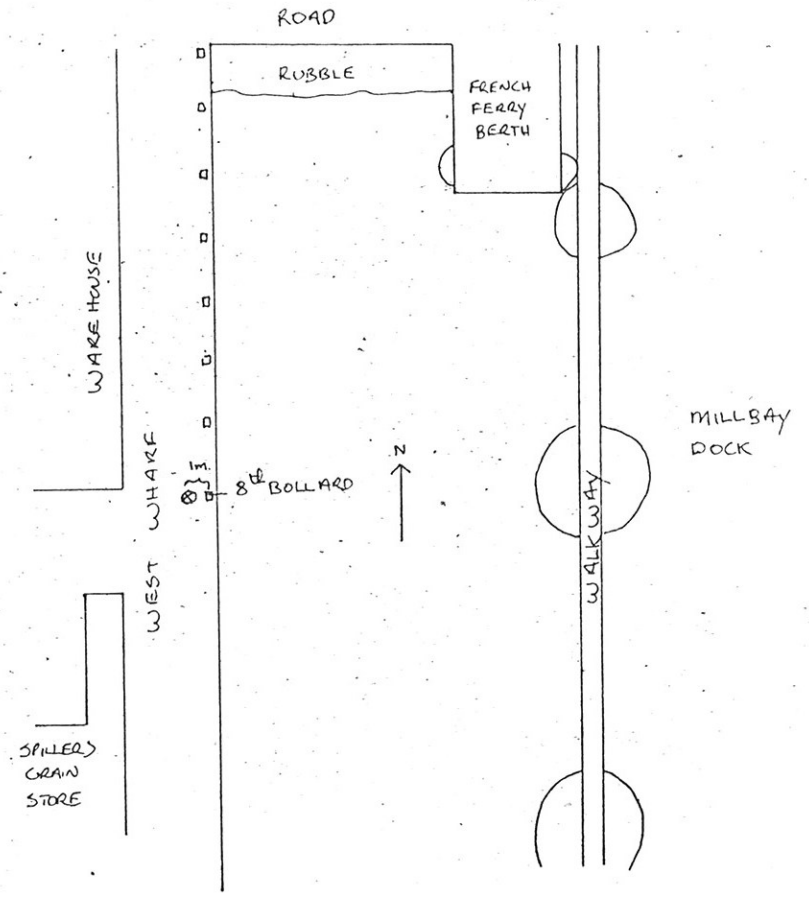
## GRAVITY BASE STATION

STATION NAME: WEST WHARF MILLBAY DOCKS, DEVONPORT NO.(if any): FIGURE 3d

SITE DESCRIPTION:

GRAVITY BASE 1 METRE INLAND FROM 8th BOLLARD ALONG FROM NORTHERN END OF WEST WHARF - MILLBAY DOCKS, PLYMOUTH

| | |
|---|---|
| STATION REFERENCE NO. | |
| LATITUDE | |
| LONGITUDE | |
| HEIGHT | |
| $g_{OBS} - g_{P.H}$ | LINK TO DRAKES STATUE |
| GEOLOGY | |
| BOUGUER ANOMALY $\rho =$ | |
| BOUGUER ANOMALY $\rho =$ | |
| FREE AIR ANOMALY | |
| TERRAIN CORRECTION | |
| METER NO. | WORLD WIDE |
| OBSERVER | E.J ARMSTRONG |
| DATE | 21-MAY 1979 |
| FIELD SHEET NO. | |
| g(IGSN'71/ IGRN'73) | 9811153 |
| | |



# GRAVITY BASE STATION NO. 619

TOWN: YARMOUTH

COUNTY: NORFOLK

1" MAP:

6" MAP: 66SE FIGURE 3e

DESCRIPTION

Meter in line with S wall of No 186 on East side of Polgrave Road. Vehicle facing South hard against Kerb

NGRN73 Jobs : 981301.5 mgl ± 0.2 mGl

Nat. Grid 652 23083

GRAVITY

ELEVATION

LATITUDE 52°36'51.4"N
LONGITUDE 1°43'40.4"E

DATE 6 Jly 57

OBSERVER DR W BULLERWELL

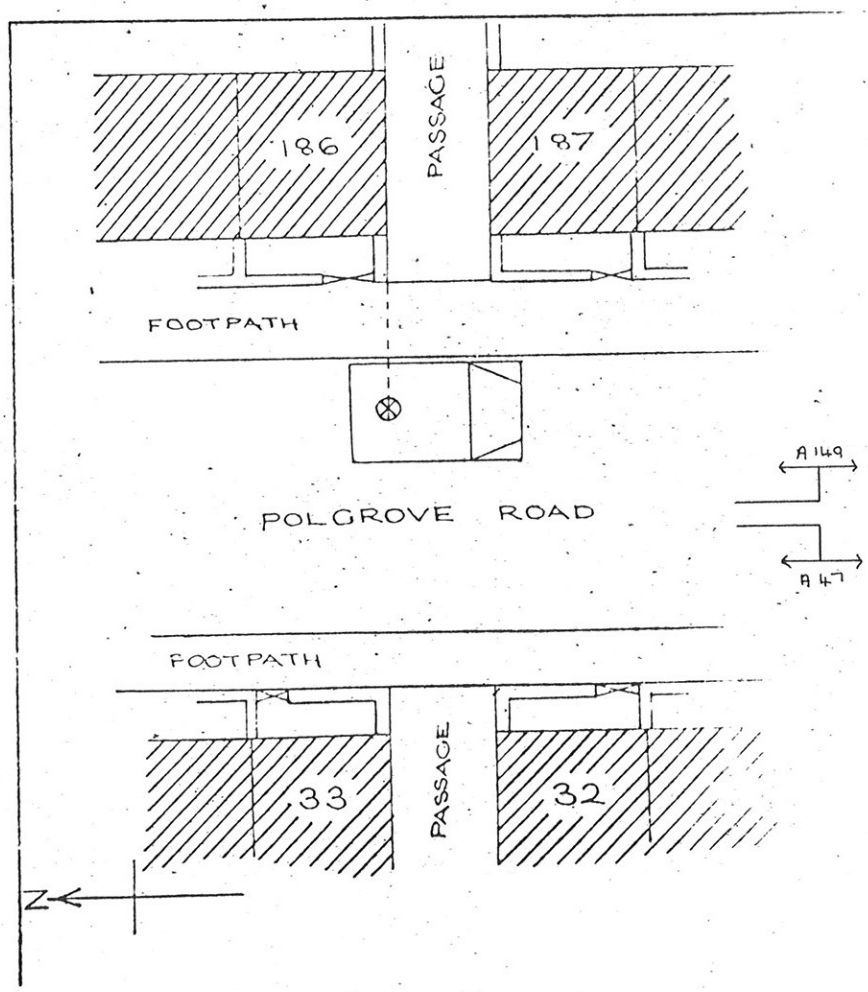


FIGURE 2

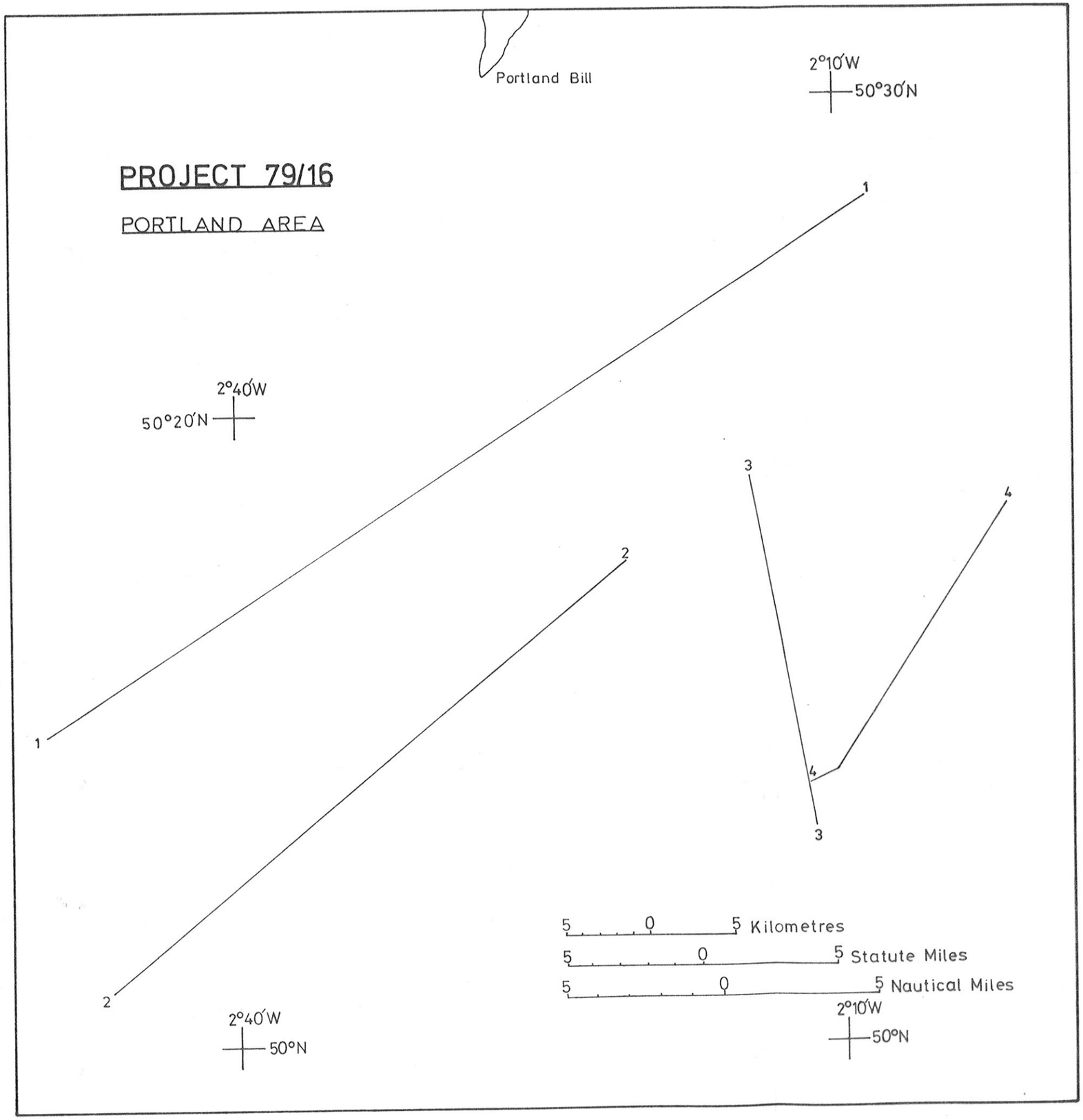
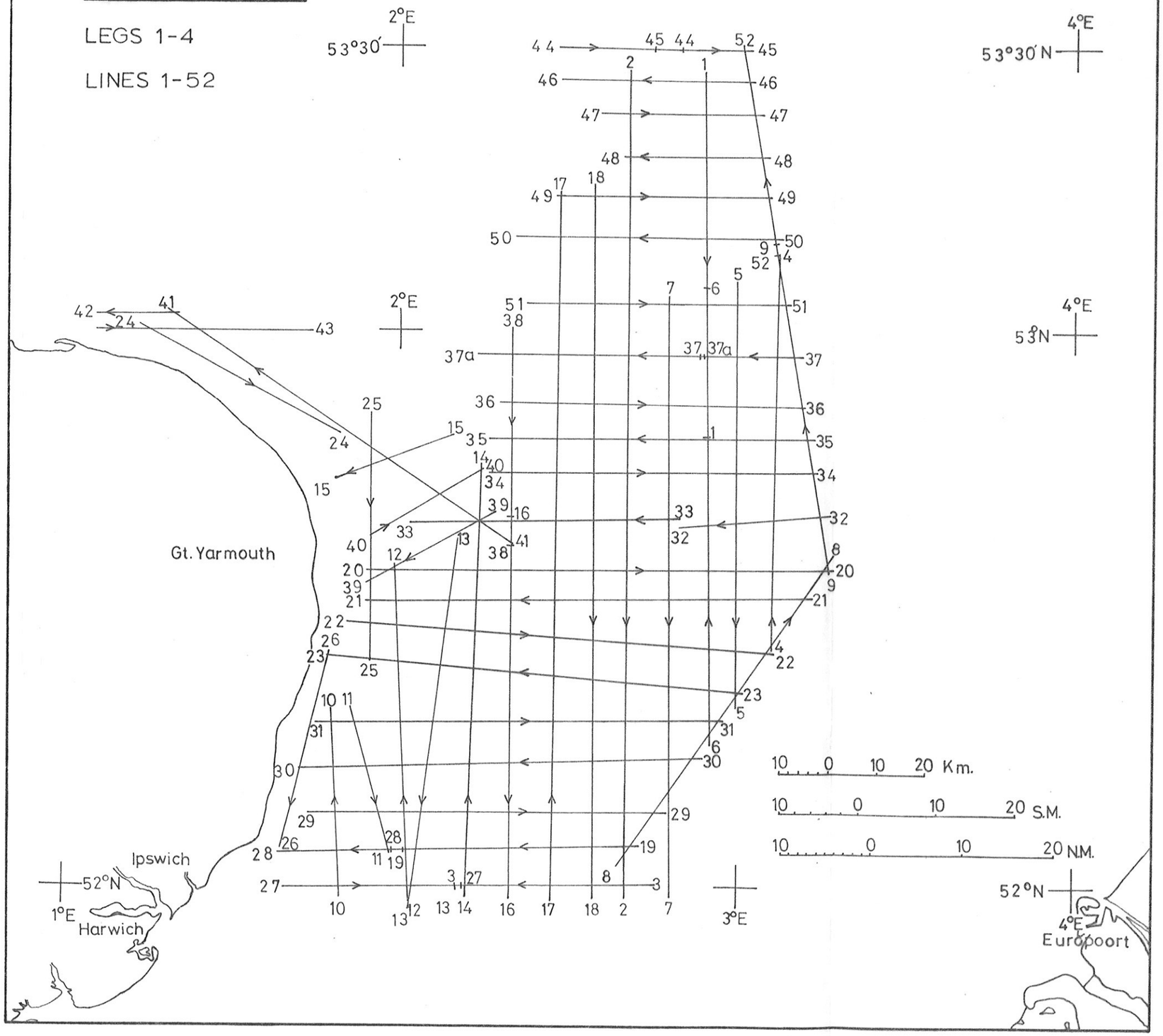

Portland Bill
2°10'W
50°30'N
PROJECT 79/16
PORTLAND AREA
2°40'W
50°20'N
1
2
3
4
5 0 5 Kilometres
5 0 5 Statute Miles
5 0 5 Nautical Miles
2°40'W
50°N
2°10'W
50°N

FIGURE 1

# PROJECT 79/02

LEGS 1-4

LINES 1-52



# INSTITUTE OF GEOLOGICAL SCIENCES

## MARINE GEOPHYSICS UNIT

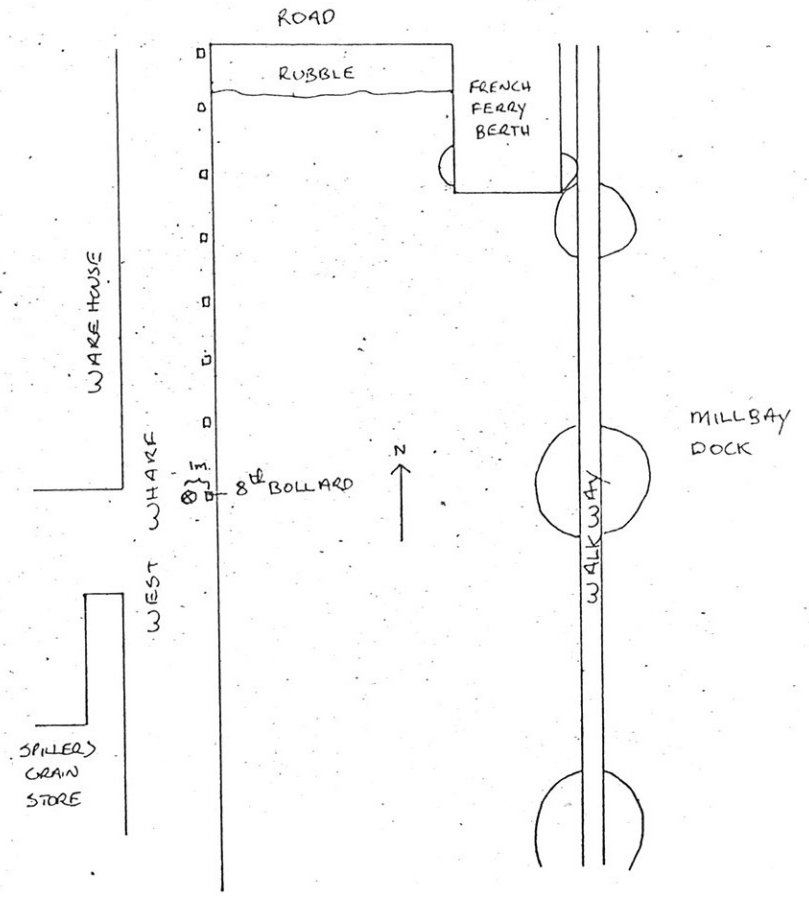
## GRAVITY BASE STATION

STATION NAME: WEST WHARF MILLBAY DOCKS, DEVONPORT NO.(if any): FIGURE 3d

SITE DESCRIPTION:

GRAVITY BASE 1 METRE INLAND FROM 8th BOLLARD ALONG FROM NORTHERN END OF WEST WHARF - MILLBAY DOCKS, PLYMOUTH

| | |
|---|---|
| STATION REFERENCE NO. | |
| LATITUDE | |
| LONGITUDE | |
| HEIGHT | |
| $g_{OBS} - g_{P.H}$ | LINK TO DRAKES STATUE |
| GEOLOGY | |
| BOUGUER ANOMALY $\rho =$ | |
| BOUGUER ANOMALY $\rho =$ | |
| FREE AIR ANOMALY | |
| TERRAIN CORRECTION | |
| METER NO. | WORLD WIDE |
| OBSERVER | E.J ARMSTRONG |
| DATE | 21-MAY 1979 |
| FIELD SHEET NO. | |
| g(IGSN'71/ IGRN'73) | 9811153 |
| | |



# GRAVITY BASE STATION NO. 619

TOWN: YARMOUTH

COUNTY: NORFOLK

1" MAP:

6" MAP: 66SE FIGURE 3e

DESCRIPTION

Meter in line with S wall of No 186 on East side of Polgrave Road. Vehicle facing South hard against Kerb

NGRN73 Jobs : 981301.5 mgl ± 0.2 mGl

Nat. Grid 652 23083

GRAVITY

ELEVATION

LATITUDE 52°36'51.4"N
LONGITUDE 1°43'40.4"E

DATE 6 Jly 57

OBSERVER DR W BULLERWELL