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PROUDMAN OCEANOGRAPHIC LABORATORY

CRUISE REPORT No. 34.

Deployment and recovery of offshore moorings for the MAST3
INDIA Project (INlet Dynamics Initiative - Algarve)

1999.

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DOCUMENT DATA SHEET

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ABSTRACT	<p>As part of the fieldwork component of the MAST3 <i>INDIA</i> (INlet Dynamics Initiative: Algarve) project, measurements of tides, tidal currents, waves, suspended sediments and turbulence were required at a number of locations offshore of the primary field site in the Ria Formosa, Algarve, Portugal. The work was undertaken in collaboration with Instituto Hidrografico, Lisbon by the Centre for Coastal and Marine Sciences Proudman Oceanographic Laboratory during the period January to March 1999, and comprised two cruises.</p> <p>Instrument deployment cruise with NRP "AURIGA", 14 - 15 January, 1999. <i>The objectives of the Auriga deployment cruise were: to perform a site survey and find correct locations for depth-sensitive moorings; to deploy four current meter moorings; to deploy two PMP moorings; to deploy the BLISS apparatus; to deploy a Triaxys directional wave-buoy; and to photograph the seabed at the BLISS site.</i></p> <p>Instrument recovery cruise with NRP "ANDROMEDA", 9 - 15 March, 1999. <i>The objective of the Andromeda recovery cruise was to recover all moorings deployed by the Auriga.</i></p> <p>All the objectives of the deployment and recovery cruises were achieved.</p>		
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		PRICE:	

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Introduction

INDIA (INlet Dynamics Initiative – Algarve) is a large, multi-institute, international, interdisciplinary project, funded in part by the European Union under contract number MAS3-CT97-0106. The CCMS Proudman Laboratory activities described in this report were funded by the EU and by the Natural Environment Research Council through the CCMS core strategic research programme FORCE: FORecasting Coastal Evolution.

A major feature of the coast of the Algarve is the Ria Formosa, a system of low sand spits enclosing a large tidal lagoon comprising saltmarsh, tidal mudflats and sinuous drainage channels. Faro airport lies close to the western end of the system, and the feature extends eastwards almost as far as the Spanish border (Figure 1). The lagoon has important commercial, environmental and recreational uses, supporting shell-fisheries, fish-farms, several port facilities, major feeding-grounds for birds and other wildlife, and boating interests based partly on the tourist industry of the Algarve coast.

The series of spits separating the lagoon from the sea are composed of coarse sand and are nourished by sediments from the rapidly eroding cliffs to the West of Faro. This material is transported eastward by strong longshore currents. The whole feature appears to be in dynamic equilibrium, relying on physical processes and a continual supply of sediment for its existence.

The islands in the system are separated by inlets which connect the lagoon to the eastern Atlantic Ocean. Under natural conditions, these inlets form near the western end of the beach, and move steadily eastward over periods of tens or hundreds of years. The Barra Nova inlet, created artificially in 1997 and now naturalised, is the focus of the present investigations by the INDIA Partnership. Work has been undertaken to examine the processes which maintain the beach, and the dynamic relationship between the sediments of the inlet and the local tidal currents and waves.

The CCMS Proudman Oceanographic Laboratory has provided instrumentation to measure, water flows and sediment transport in the inlet in detail from a jack-up barge. In addition, a series of oceanographic instruments was deployed offshore of the inlet to provide boundary condition information for a range of numerical models predicting the hydrodynamic conditions (waves/tides), sediment transport and bathymetric/morphological evolution. To facilitate this, the CCMS Proudman Oceanographic Laboratory and the Instituto Hidrografico of Lisbon collaborated and used inshore survey vessels of the Portuguese Navy to deploy and recover the offshore moorings. A record of these offshore activities is reported below. A record of key personnel involved in this work is given in Appendix 1.

NRP Auriga cruise: objectives and narrative

The cruise was arranged to deploy a number of moorings offshore of the Barra Nova supporting current meters, and seabed frames fitted with sensors to measure sediment transport, current-profiles and water depth. In addition a Triaxys buoy was moored further offshore to measure directional wave spectra. The approximate location of the moorings is shown in Figure 2. However, note that the final positions and mooring-depths were modified as a result of preliminary surveys during the deployment cruise.

Using locations shown on Figure 2 as a guide, preliminary surveys of the mooring areas were performed. Using the echo-sounding and DGPS equipment fitted to the Auriga, lines were

surveyed, running perpendicular to the beach. These surveys quickly showed that water depths shown in the chart in Figure 2 were in error. Since mooring components were designed for specific depths, the mooring location were moved generally further offshore. Deployment dates, times, depths and positions for the offshore moorings are given in Table 1. Diagrams of the moorings are given in Appendix 1.

Figure 2 shows that in the original plan, current meters and PMPs were to be moored to the East and West of the inlet, BLISS was to be placed directly off the ebb plume, and the directional wave buoy was to be moored furthest offshore. Despite the need to relocate some moorings, this general arrangement was maintained.

All mooring-equipment (except the anchor-weights) were transported to Lisbon from POL by a commercial shipping line in a standard container. Components had been assembled and all instruments had been started at a Naval depot at Azinheira, on the banks of the River Tagus opposite Lisbon. Concrete anchors, weighing between 150 and 450 kilos in air, were supplied by Instituto Hidrografico. When complete, all moorings were taken to the Auriga by lorry.

The Auriga sailed for Portimão in the Algarve on Wednesday, 13th January, arriving at about 2000, after being delayed for two days by gales on the West coast. She sailed from Portimão the next morning at 0700, for the experimental site, with Humphery, Banaszek and Ballard on board. The ship arrived off the inlet at approx 1100, and immediately started the pre-deployment surveys over the proposed mooring sites. After finding the correct water depths for the moorings, we deployed the two PMPs and the directional wave buoy. The Auriga then sailed for Faro harbour, where she stayed overnight.

The Auriga sailed again for the mooring-site at 0700 the next morning (Friday, 15th January), with Bloomer and Ganderton (from Plymouth) as well as the POL staff. BLISS was laid first followed by the four current meter moorings. Three seabed sand samples were obtained using a grab, and one UMEL bed-hopping camera film was exposed (25 shots nominal), close to the BLISS site. The positions of the samples and the seabed photographs are shown in Table 2 and Table 3, respectively. The Auriga then returned to Faro harbour, where arrangements were made for the safe-keeping of POL equipment until the recovery cruise in March.

NRP Andromeda cruise: objectives and narrative

The second cruise aboard, NRP Andromeda (Figure 3), was arranged to recover the offshore moorings. It was known in advance that one of the current meter moorings had broken adrift and come ashore shortly after deployment. CMNW, the north-westerly, 15m, current meter mooring had been trawled and the 80cm spherical sub-surface float and a small part of the upper mooring had been found on the beach to the West of Praia de Faro by Mal Heron (an Australian collaborator in the INDIA project) on the morning of Friday, 22nd January. The rest of the mooring, down to the mechanical release mechanism, was found on the same part of the beach by Nick Bloomer and Peter Ganderton (Plymouth) on the morning of Sunday, 7th March. Only small parts of the plastic flotation modules were visible above the sand-surface. The plastic parts of the Pyrolease mechanisms had been torn apart, presumably by fishing activity. The current meters were intact, but one was shown later to contain a small amount of water. The evidence indicated that the whole mooring had been torn from its 450kg concrete anchor; it then drifted onto the beach, where repeated rolling in the surf unscrewed the tie-bar of the upper current meter. The large sub-surface float was seen and recovered easily, but only a chance Sunday

afternoon stroll by experienced observers led to the recovery of the instruments and acoustic release much later.

The NRP Andromeda sailed from Lisbon on Monday, 8th March, arriving at Portimão the same evening. She sailed to the INDIA mooring-site with Humphery, Banaszek, Ballard, Bloomer and Ganderton on board the next morning, Tuesday, 9th. The BLISS apparatus and the two PMP moorings were recovered successfully, although the wind was rising (force 4) and a swell was beginning to form towards the end of the day, making work more difficult and hazardous.

The deterioration in the weather continued, and no work was possible for the next five days. A small but energetic depression moved slowly southward from Cape Finisterre and then eastward through the Straits of Gibraltar, eventually blowing itself out during Sunday, 14th March. All important instruments were sent back to the UK by van, leaving only Humphery and Ballard with the bare minimum of tools, etc, to recover the balance of the moorings.

The Andromeda sailed from Faro harbour to the experimental site on Monday, 15th March. The three remaining current meter moorings and the Triaxys directional wave buoy were recovered in very good conditions. The dates and times of all mooring recoveries are shown in Table 4. Andromeda returned to Faro harbour. Arrangements were made to store all POL and PML equipment at the Azinheira base until arrangements could be made for containerised return to the UK. (This had to be left until later because personnel were required for urgent work off Holland.) Arrangements were also made for the Triaxys buoy to be returned to Canada by the NERC agent in Lisbon, James Rawes and Co.

Assessment

The NRP Andromeda (Portuguese Navy designation number 5203) and the NRP Auriga (Portuguese Navy designation number 5205) are sister-ships and are virtually identical. They are inshore hydrographic survey vessels providing information and services for the Portuguese Navy. Each is 31.5m long by 7.75m beam, drawing about 2.7m of water; they have a service speed of about 12kt, and are about 15 years old. They are smart, well-run and ably-crewed.

They are primarily intended for hydrographic survey, and the surveys performed before deployment of the instrument-moorings were done quickly and efficiently. However, they are not ideally suited to the task of handling heavy moorings, especially in swell-conditions. They are small and tend to roll. They have no mooring-winch, but each is fitted with two capstans, a hydraulic crane and a small A-frame. All POL mooring-work was done "over the side."

The Andromeda was visited during a planning-trip in October, 1998. An assessment was made of her capabilities, and the mooring designs were drawn-up accordingly. A deployment-philosophy of "pay out and stop-off" was used: a chain stopper with latching-hook was taken to Portugal for the purpose. This method proved very successful, and recoveries were made in a similar way.

Despite the misgivings of Mr Caldas, 12mm long-link chain was used in the mooring-lines because it would be more resistant to fishing-activities than fibre rope (which was his preferred option). To facilitate deployment and recovery, the moorings were fitted with oval-links for stopping off: this worked well. Where longer lengths of fibre rope were used, lines were passed

round one of the capstans and through a large fairlead on the starboard bulwark.

As well as the loss of the CMNW mooring, there was ample evidence of fishing activity in the area when moorings were recovered. Most moorings had pot-lines (fishing for octopus with 30cm earthenware pots) wrapped round them, and the electromagnetic current meters on BLISS were festooned with a dense tangle of monofilament nylon netting. It was a matter of some luck that the release mechanisms were not tangled in lines, which would have prevented the moorings from coming up. We shall never know if the use of chain reduced losses of moorings.

Acknowledgements

This work was undertaken as part of the MAST 3 project 'Inlet Dynamics Initiative: Algarve' (INDIA). It was funded jointly by the UK NERC and by The Commission of the European Communities Directorate General for Science and Education, Research and Development under contract number MAS3-CT97-0106. The authors and other member of the INDIA Partnership wish to thank our colleagues at Instituto Hidrografico, Lisbon, Portugal for their willing and cheerful assistance with the INDIA project. The Azinhera base provided good facilities for mooring-construction. The captains and crews of the Auriga and Andromeda were friendly, and always demonstrated a high degree of professionalism. Mr Caldas was very helpful, and was very skilled at handling heavy moorings. Lt Cdr Ventura Soares acted as a capable interpreter, and as an efficient liaison officer at all times. Finally, we would like to thank Dr Aurora Bizarro, of the Instituto Hidrografico, Lisbon, for her help in setting-up this difficult project.

Tables

Mooring	Deployment Date	Time, GMT	Depth (m)	Position (Referenced to Datum ED-50)
PMP, Southeast	14/01/99	1406	17	36deg 58.0N 07deg 58.3W
DWB	14/01/99	1458	25	36deg 58.0N 08deg 00.1W
PMP, Northwest	14/01/99	1546	17	36deg 59.3N 08deg 00.2W
BLISS	15/01/99	928	15	36deg 59.0N 07deg 59.1W
CM, Southwest	15/01/99	1113	20	36deg 59.0N 08deg 00.4W
CM, Northwest	15/01/99	1148	15	36deg 59.6N 08deg 00.1W
CMSE, Southeast	15/01/99	1326	20	36deg 57.6N 07deg 58.6W
CMNE, Northeast	15/01/99	1347	15	36deg 58.3N 07deg 58.2W

Table 1 Deployment dates, times, depths and positions for the offshore moorings

Sample Number	Position relative to datum ED-50.
1	36deg 59' 1.1"N 07deg 59' 9.4"W
2	36deg 59' 2.7"N 07deg 59' 11.8"W
3	36deg 59' 3.4"N 07deg 59' 12.6"W

Table 2 Positions of seabed grab-samples, 15th January 1999

Exposure Number	Time GMT	Position relative to datum ED-50.
1	14.43.17	36deg 59' 3.0"N 07deg 59' 14.4"W
2	14.44.30	36deg 59' 3.7"N 07deg 59' 15.6"W
3	14.45.40	36deg 59' 4.4"N 07deg 59' 16.4"W
4	14.47.00	36deg 59' 4.9"N 07deg 59' 17.2"W
5	14.48.15	36deg 59' 5.6"N 07deg 59' 17.8"W
6	14.49.35	36deg 59' 6.2"N 07deg 59' 18.5"W
7	14.50.53	36deg 59' 7.2"N 07deg 59' 19.4"W
8	14.52.51	36deg 59' 7.8"N 07deg 59' 20.0"W
9	14.54.10	36deg 59' 8.4"N 07deg 59' 20.7"W
10	14.55.28	36deg 59' 9.2"N 07deg 59' 21.4"W
11	14.56.49	36deg 59' 9.9"N 07deg 59' 22.1"W
12	14.58.15	36deg 59' 10.6"N 07deg 59' 22.7"W
13	14.59.33	36deg 59' 11.1"N 07deg 59' 23.2"W
14	15.00.45	36deg 59' 11.8"N 07deg 59' 23.7"W
15	15.02.00	36deg 59' 12.5"N 07deg 59' 24.2"W
16	15.03.15	36deg 59' 13.1"N 07deg 59' 24.7"W
17	15.04.27	36deg 59' 13.8"N 07deg 59' 25.1"W
18	15.05.38	36deg 59' 14.4"N 07deg 59' 25.6"W
19	15.06.49	36deg 59' 15.1"N 07deg 59' 26.2"W
20	15.08.07	36deg 59' 15.8"N 07deg 59' 26.6"W
21	15.09.18	36deg 59' 16.4"N 07deg 59' 27.2"W
22	15.10.31	36deg 59' 17.1"N 07deg 59' 27.6"W
23	15.11.44	36deg 59' 17.7"N 07deg 59' 28.1"W
24	15.12.55	36deg 59' 18.4"N 07deg 59' 28.7"W
25	15.14.11	36deg 59' 19.0"N 07deg 59' 29.1"W

Table 3 Positions of seabed photographs, 15th January 1999

Instruments Deployed/Recovered INDIA Jan-March99 (RV Auriga+Andromeda)									
STATION Details	Position	Instrument	Sample Rate	1st scan	In Water	Out Water	Last Scan	FILENAME	Comment
1. PMPSE	36 58.0N	UWB W/H 0253	see setup	14:00gmt 6/1/99	14:06gmt 14/1/99	3:50gmt 9/3/99	ff 16:26gmt 9/3/99	indse00.000	4801180Bytes
FMP	07 58.3W	S4-08582006	20min/hr	2:00gmt 12/1/99			Off 07:53gmt 18/3/99	se2006.s4b	3731250Bytes
Acoustics 7A		TRB2-1686(PL10)	1 min	09:40gmt 6/1/99			10:12gmt 17/3/99	trb1686.txt	3428356Bytes
MORS 262		WIPR-03	20min/3hr	14:30gmt 6/1/99			Off 08:48gmt 17/3/99	pwr03.int	222889Bytes
								pwrburst.dat	1357614Bytes
2. PMPNW	36 59.3N	POL W/H 0572		12:00gmt 6/1/99	15:46gmt 14/1/99	3:05gmt 9/3/99	ff 16:32gmt 9/3/99	indnw00.000	4808148Bytes
FMP	08 00.2W	S4-08582005		12:00gmt 12/1/99				nw2005.s4b	3965970Bytes
Acoustics 8A		TRB2-1761(PL10)		10:22gmt 6/1/99				trb1761.txt	3427982Bytes
MORS 260		WIPR-01		13:50gmt 6/1/99	Instrument faulty.				No data
3. BLISS Rig	36 59.0N	X,Y,Z EMCs	13.6min/hr	2:00gmt 15/1/99	09:28gmt 15/1/99	1:24gmt 9/3/99	10:00gmt 16/2/99		41cm above sb
MORS	07 59.1W	OBS+pressure	at 2.5Hz	(1st burst)			(last burst)		OBSs 41+90cm
Release 27		Pitch,roll,compass	C,T						50cm above sb
4. Directional Wave Buoy	36 58.00N 08 00.1W	TRIAXIS			14:58gmt 14/1/99		15/3/99		
5. CM5W	36 59.0N	RCM7-10526(top)	10 min	10:04gmt 15/1/99	11:13gmt 15/1/99	10gmt 15/3/99	F 13:15gmt 15/3/99	10526sw.rcm	241279Bytes
Pop-up CM	08 00.4W	RCM8-9959(bot)	10 min	10:06gmt 15/1/99	11:06gmt 15/1/99		Off 13:48gmt 15/3/99	9959sw.rcm	237595Bytes
Acoustics 5A	depth 20m								
6. CM1W	36 59.6N	RCM7-7570(top)	10 min	10:06gmt 15/1/99	11:48gmt 15/1/99		Stopped	7570mw.rcm	Flooded
Pop-up CM	08 00.1W	RCM8-9680(bot)	10 min	10:04gmt 15/1/99	11:45gmt 15/1/99		Off 11:21gmt 17/3/99	9680mw.rcm	283616Bytes
Acoustics 4A	depth 15m ed and recovered at Prairo Faro beach March99								
7. CM5E	36 57.6N	RCM7-12173(top)	10 min	10:04gmt 15/1/99	13:26gmt 15/1/99	20gmt 15/3/99	F 13:25gmt 15/3/99	12173se.rcm	249817Bytes
Pop-up CM	07 58.6W	RCM8-10529(bot)	10 min	10:04gmt 15/1/99	13:23gmt 15/1/99		Off 13:35gmt 15/3/99	10529se.rcm	256855Bytes
Acoustics 3B									
8. CM1E	36 58.3N	RCM7-9631(top)	10 min	10:05gmt 15/1/99	13:47gmt 15/1/99	45gmt 15/3/99	F 13:10gmt 15/3/99	9631ne.rcm	263061Bytes
Pop-up CM	07 58.2W	RCM8-10528(bot)	10 min	10:05gmt 15/1/99	13:44gmt 15/1/99		Off 13:41gmt 15/3/99	10528ne.rcm	271432Bytes
Acoustics 1B									
SS buoy 9									
POL and UWB 1.2MHz ADCP Workhorse Set-ups									
10 min ensembles, 20 pings/ensemble. 20 bins Bin size 1 metre.									

Table 4 Mooring details

Figures

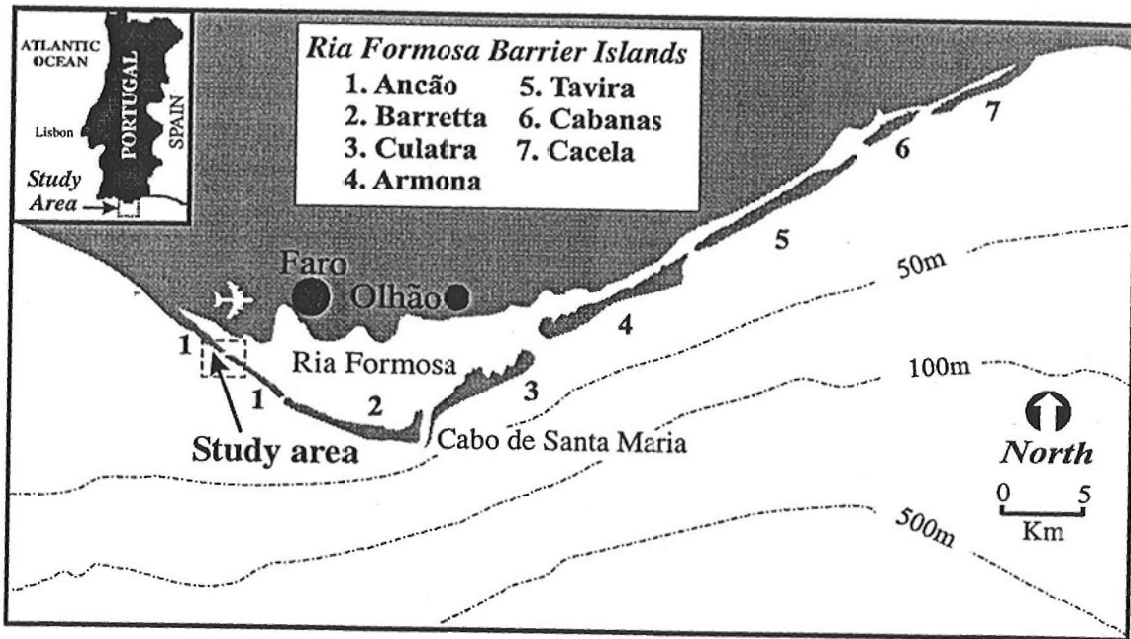


Figure 1 Location of the INDIA field site

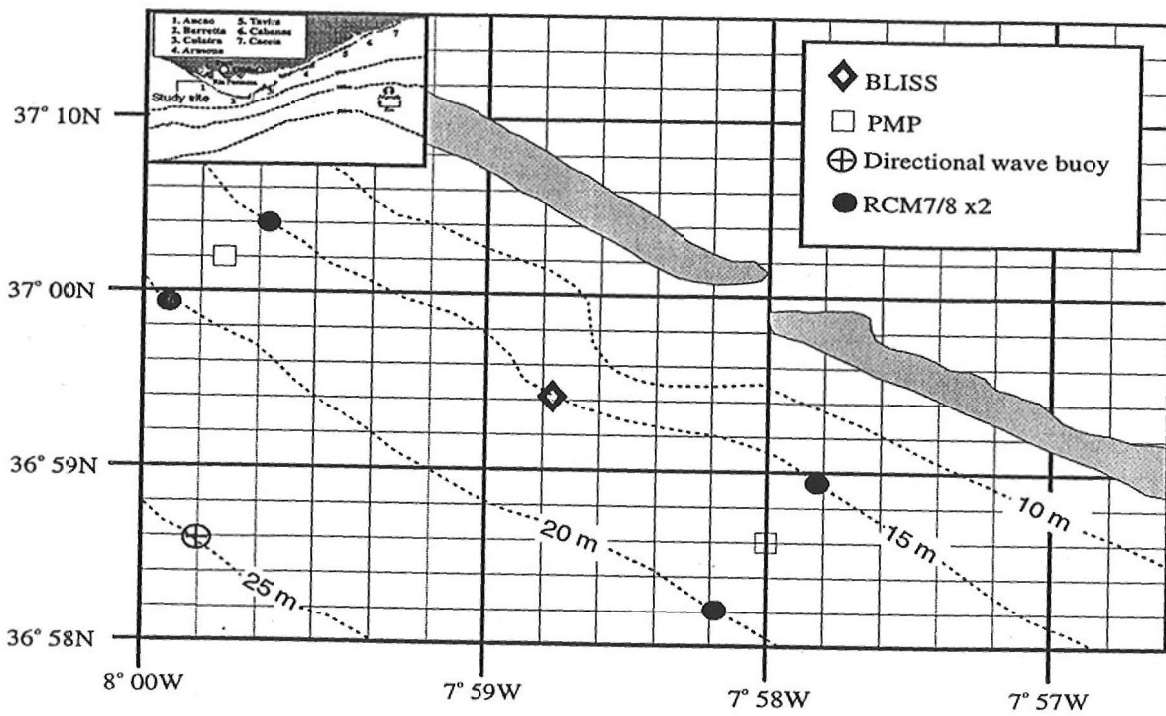
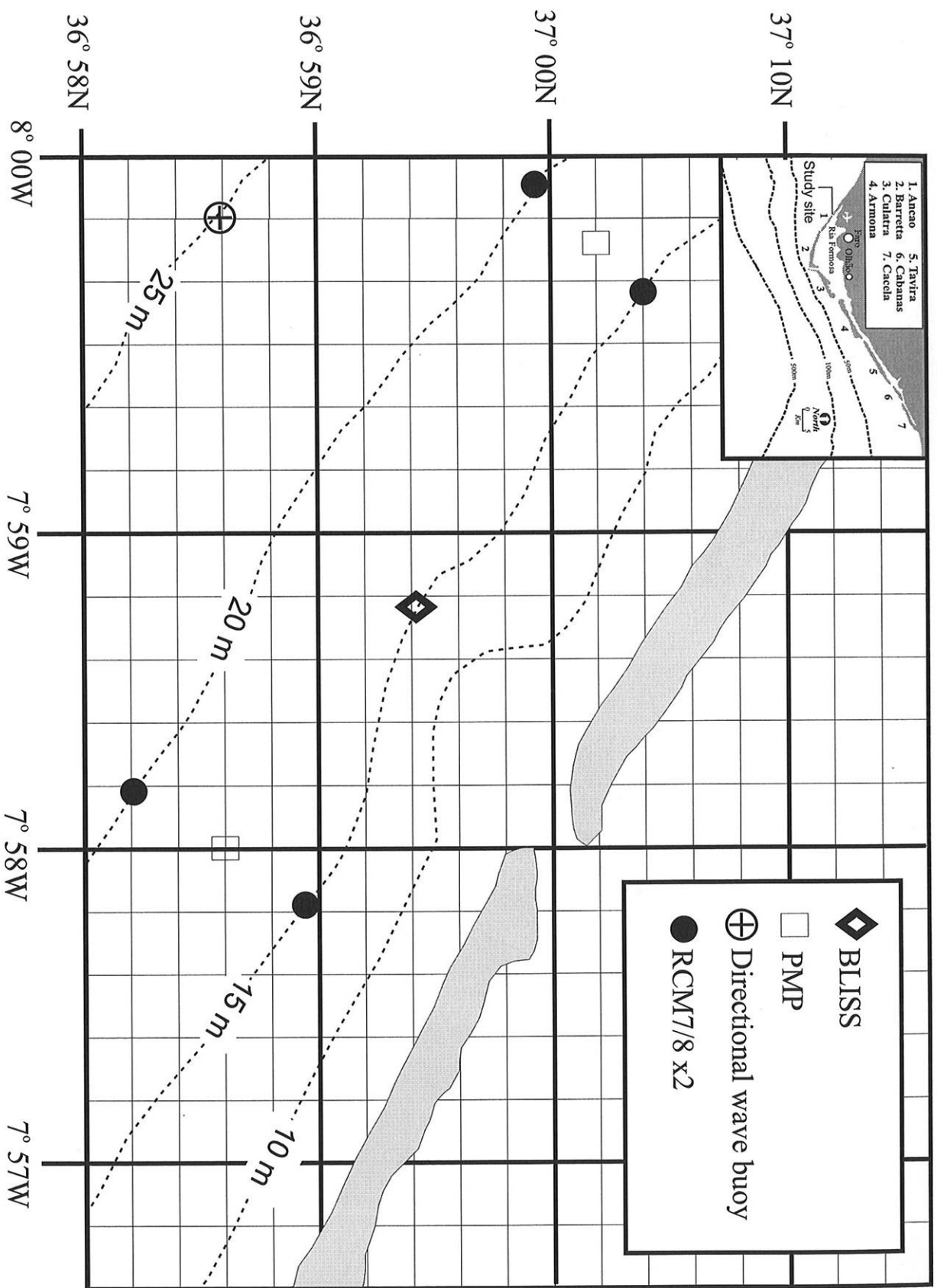
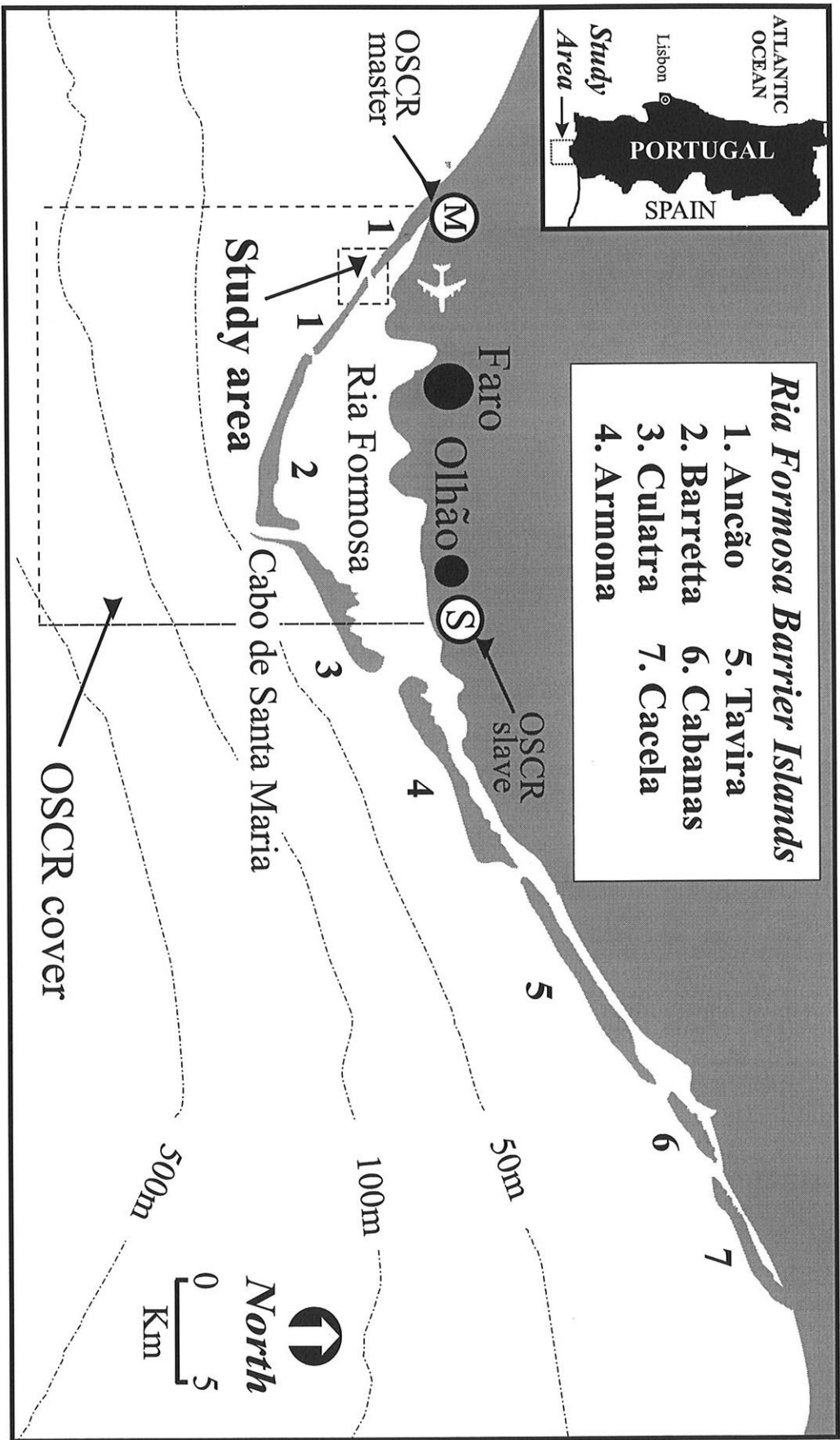


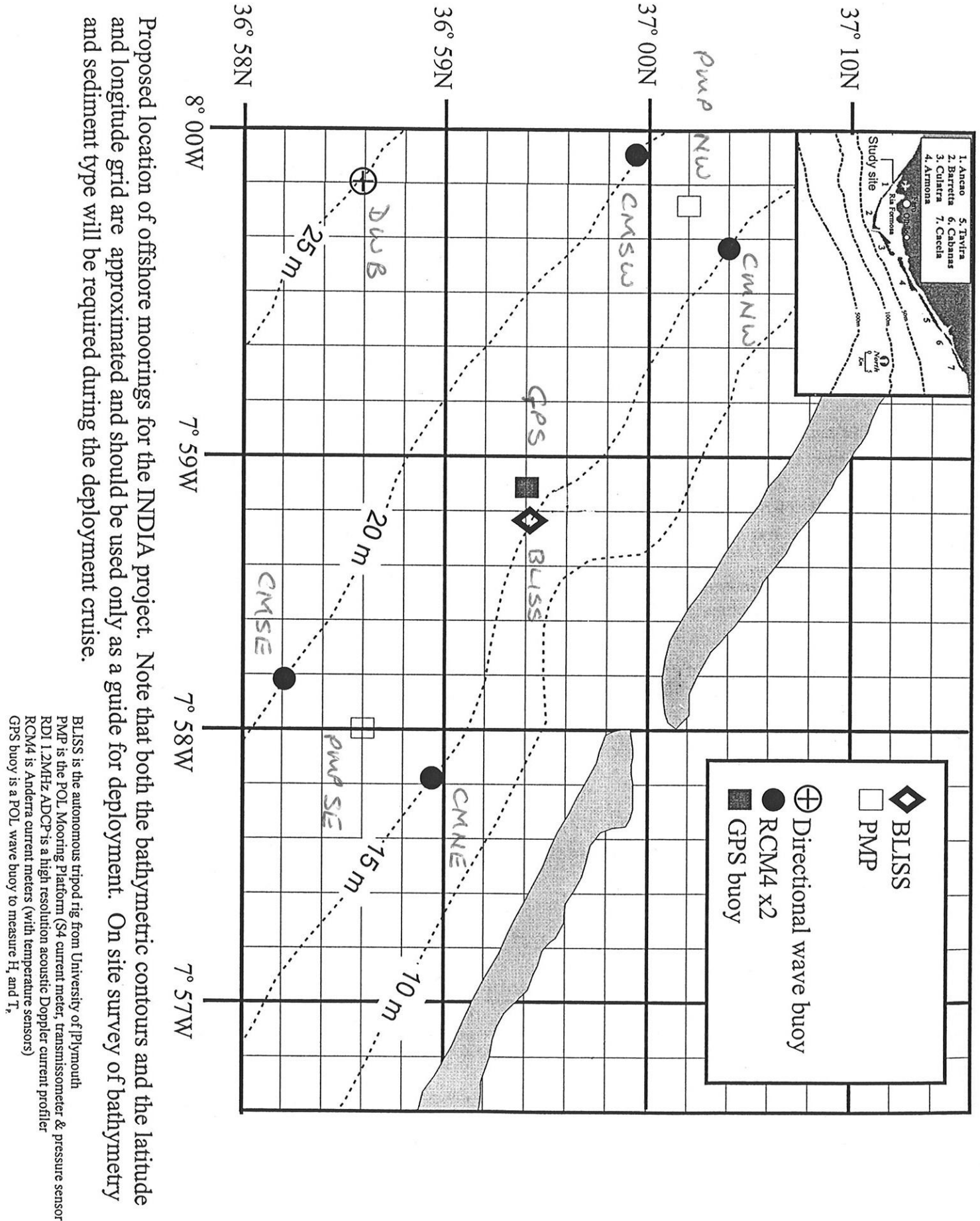
Figure 2 Location of the offshore moorings



Approximate location of offshore moorings - modification may be necessary due to dispute over chart datums and movement of the inlet

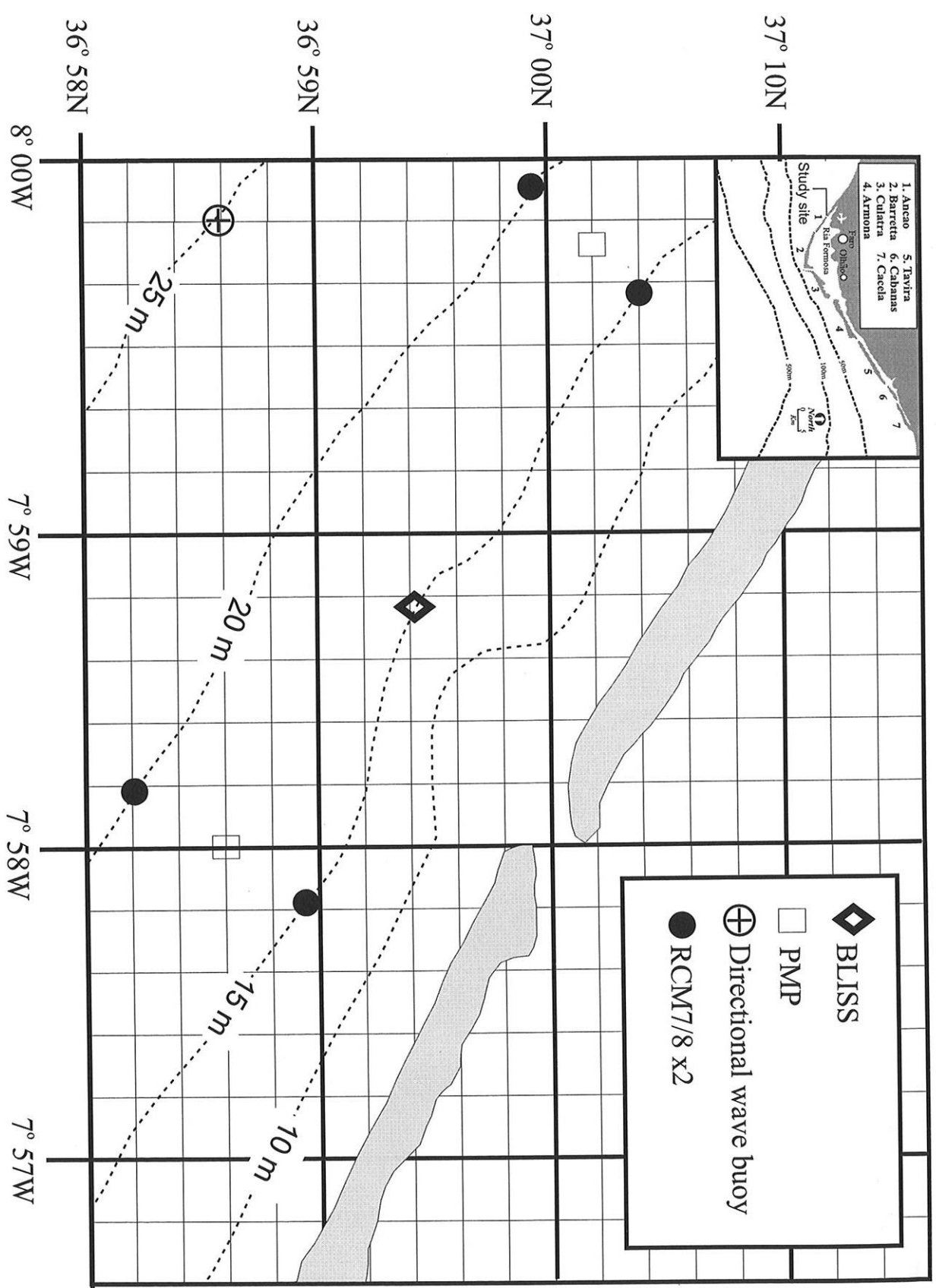


Location of the field site



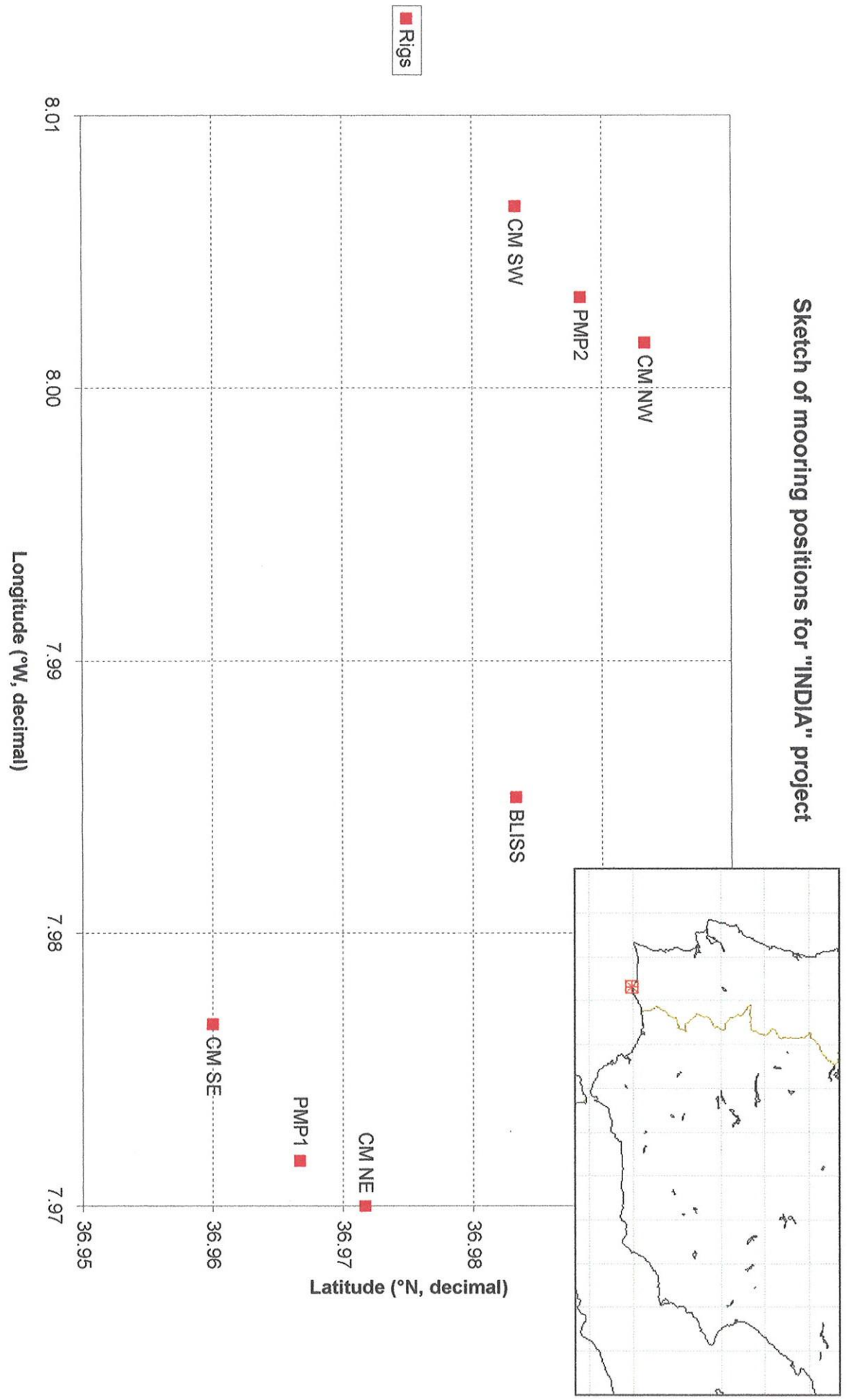
Proposed location of offshore moorings for the INDDIA project. Note that both the bathymetric contours and the latitude and longitude grid are approximated and should be used only as a guide for deployment. On site survey of bathymetry and sediment type will be required during the deployment cruise.

BLISS is the autonomous tripod rig from University of Plymouth
 PMP is the POL Mooring Platform (S4 current meter, transmissometer & pressure sensor
 RDI 1.2MHz ADCP is a high resolution acoustic Doppler current profiler
 RCM4 is Anderra current meters (with temperature sensors)
 GPS buoy is a POL wave buoy to measure H_s and T_p



Approximate location of offshore moorings - modification may be necessary due to dispute over chart datums and movement of the inlet

Sketch of mooring positions for "INDIA" project





**Southampton
Oceanography
Centre**

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Gwyn Griffiths
Head of Division

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Telephone +44 (0)1703 59
Fax +44 (0)1703 596149

ATTEN: JOHN HUMPERY

John I think the chemist has been at the bottle too early, he says he cannot confirm until next week !

However we have gathered all the raw components together & compared their weight to the finished item. Resulting with a figure of ~~20grams~~.

(much more realistic)

16grams
for Nobel
via Keith Tipping
14-12-98.

Best Regards, Happy Christmas,,,,,

Keith Tipping
11/12/98

Professor John Shepherd
Director, SOC





Figure 3 NRP Andromeda used to recover moorings

Appendices

- a) Instituto Hidrografico, Lisbon, Portugal:
Lt Cdr C Ventura Soares (Scientific liaison)
M Caldas (Scientific deck operations)
- b) CCMS Proudman Oceanographic Laboratory, UK:
J D Humphery
A D Banaszek
G Ballard
- c) CCMS Plymouth Marine Laboratory, UK:
N Bloomer
- d) University of Plymouth, UK:
P Ganderton
- e) Portuguese Navy:
The Captains, Officers and Crews of the survey vessels NRP Auriga and NRP Andromeda.

Appendix 1 List of personnel

Appendix 2 Mooring diagrams

INDIA

BLISS MOORING

STATION: BLISS

JAN - MARCH 1999

NOM DEPTH 15m

NAVAL VESSEL

'ANDROMEDA'

? LAY BLISS ON SLIP-ROPE OR

BOSS RELEASE-HOOK

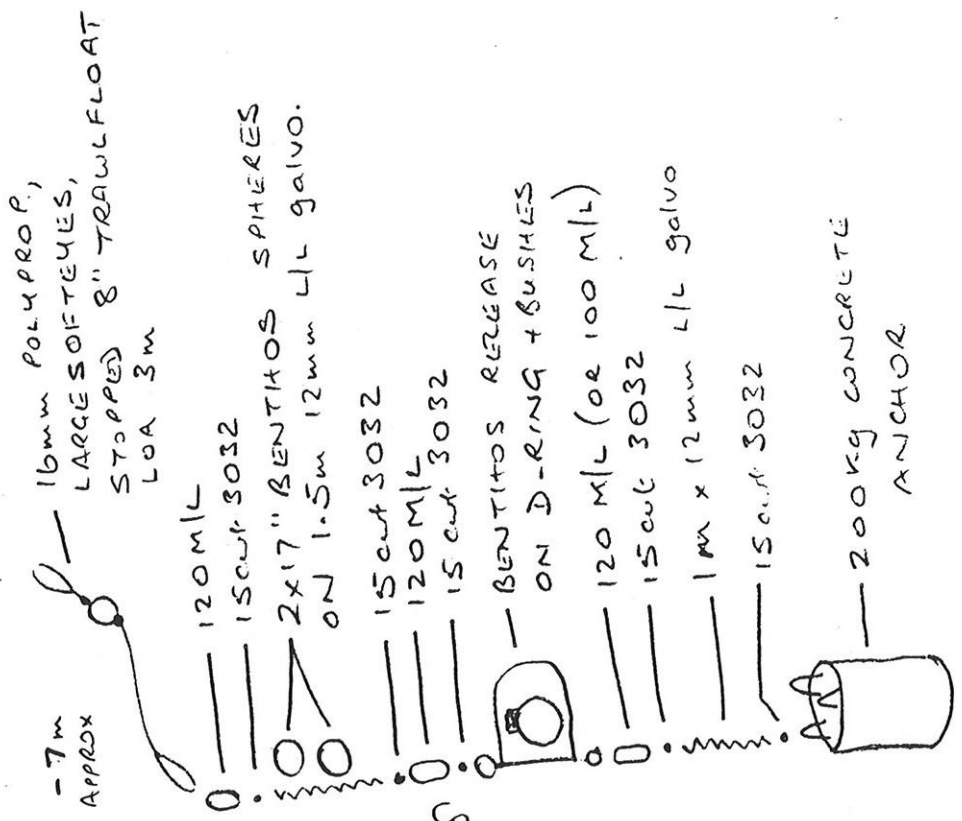
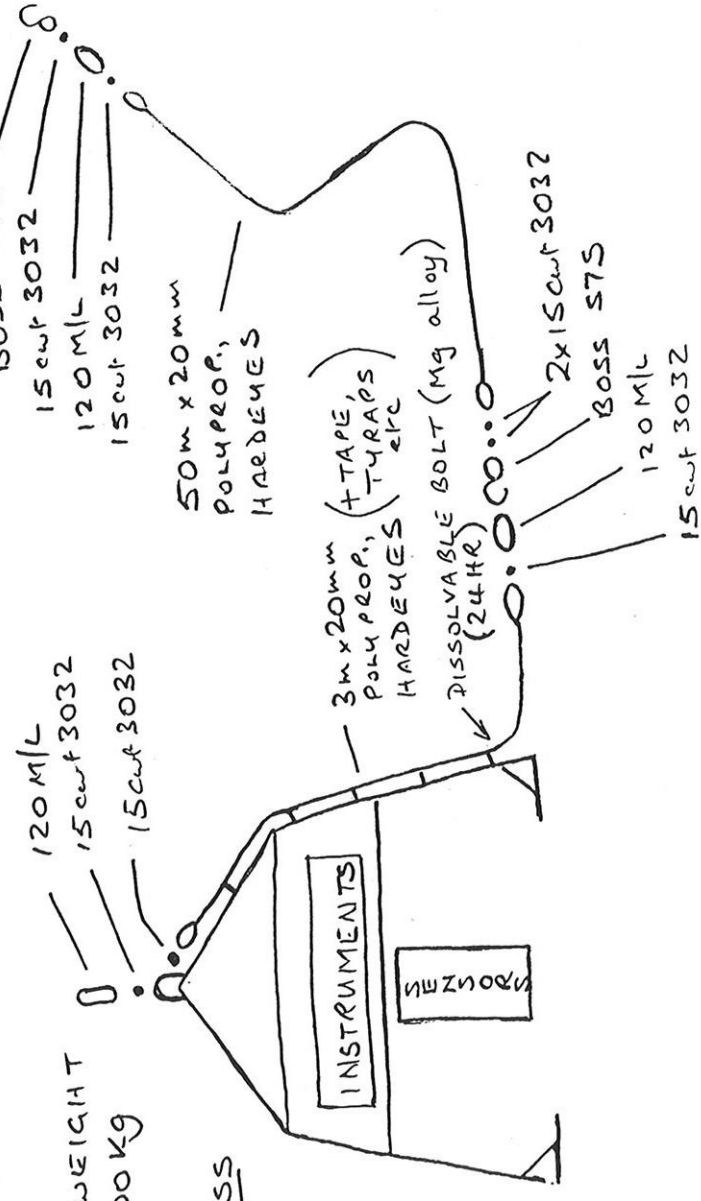
(? USING CRANE?)

NO SPOOLER!

EST. WEIGHT

200 KG

BLISS



J. HUMPHREY
19/10/98

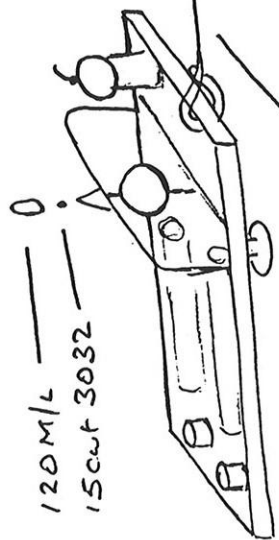
INDIA

PMP MOORINGS (x2)
 STATIONS
 PMPNW, PMPSE.
 JAN - MARCH 1999.
 NOM. DEPTH 18M.
 NAVAL VESSEL
 'ANDROMEDA'.

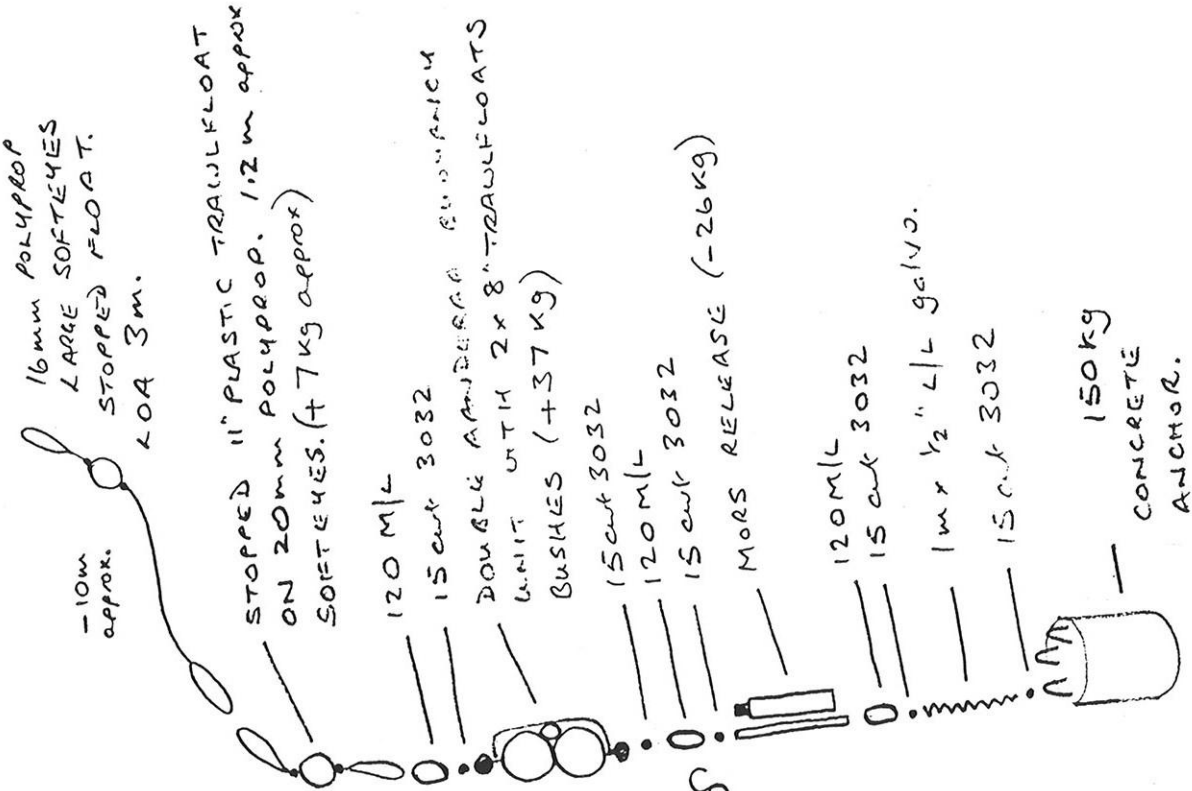
? LAY PMP ON SLIP-ROPE OR
 BOSS RELEASE-HOOK (? USING CRANE?)

PMP FRAME

2m x 1.5m approx
 WEIGHT = 250kg approx
 SPOOLER + FLOAT ON RELEASE
 R21 10.2MHZ ADCP (WORKHORSE)
 TIDES, TRANSMISSOMETER, ETC.

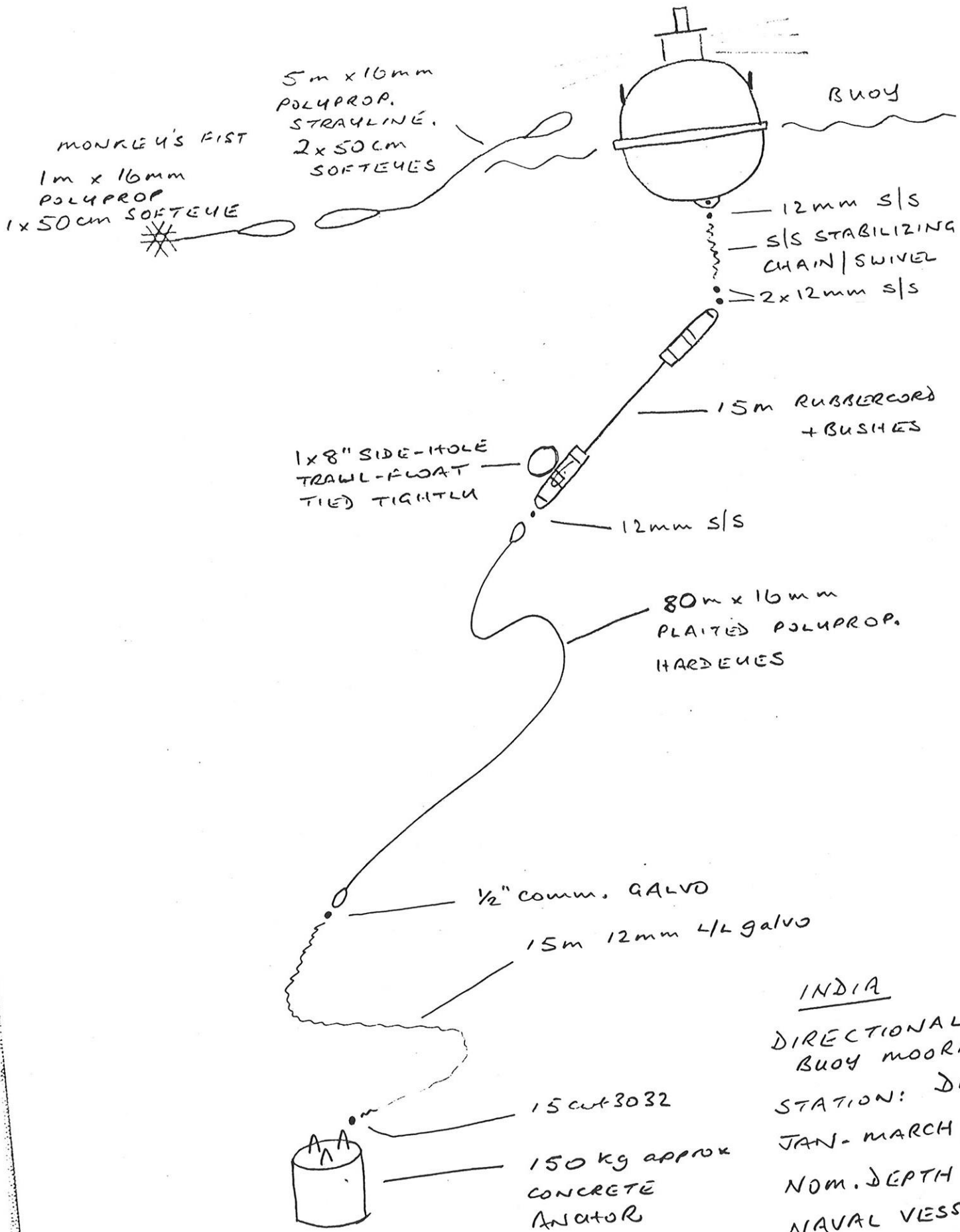


2m x 24mm
 POLYPROP.
 1 x HARDEYE



150kg
 CONCRETE
 ANCHOR.

J. HUMPHREY
 18/10/98.



MONKEY'S FIST
 1m x 16mm
 POLYPROP
 1x 50cm SOFTENES

5m x 16mm
 POLYPROP.
 STRAYLINE,
 2x 50cm
 SOFTENES

BUOY

12mm S/S
 S/S STABILIZING
 CHAIN/SWIVEL
 2x 12mm S/S

15m RUBBERCORD
 + BUSHES

1x 8" SIDE-HOLE
 TRAWL-FLOAT
 TIED TIGHTLY

12mm S/S

80m x 16mm
 PLAIED POLYPROP.
 HARDENES

1/2" COMM. GALV

15m 12mm 4/4 GALV

15cut 3032

150 kg approx
 CONCRETE
 ANCHOR

INDIA

DIRECTIONAL
 BUOY MOORING

STATION: DW

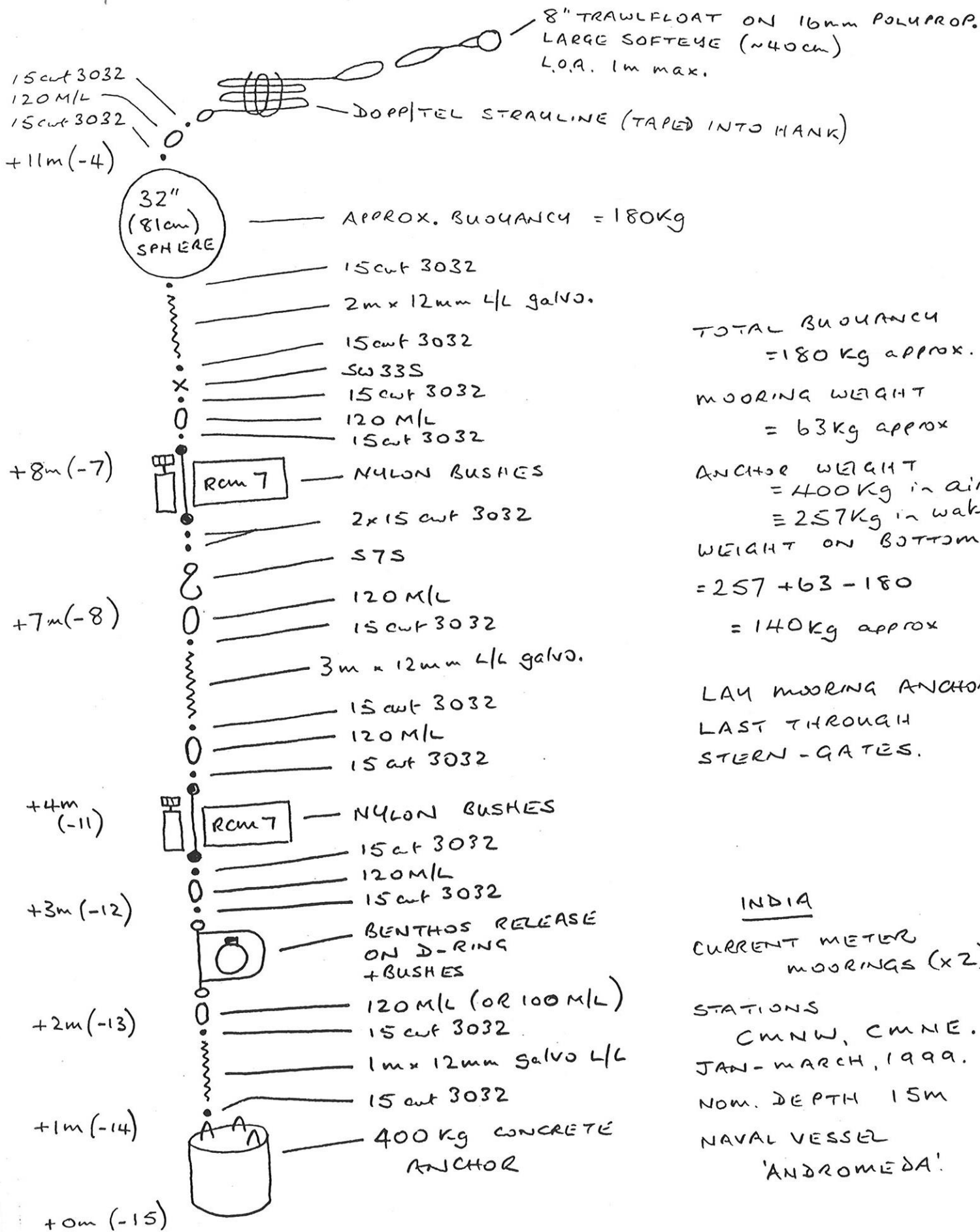
JAN-MARCH,

NOM. DEPTH

NAVAL VESSEL

'ANDROMED

J. HUMPHREY
 10 11-6



TOTAL BUOYANCY
= 180 kg approx.

MOORING WEIGHT
= 63 kg approx

ANCHOR WEIGHT
= 400 kg in air
= 257 kg in water

WEIGHT ON BOTTOM
= 257 + 63 - 180
= 140 kg approx

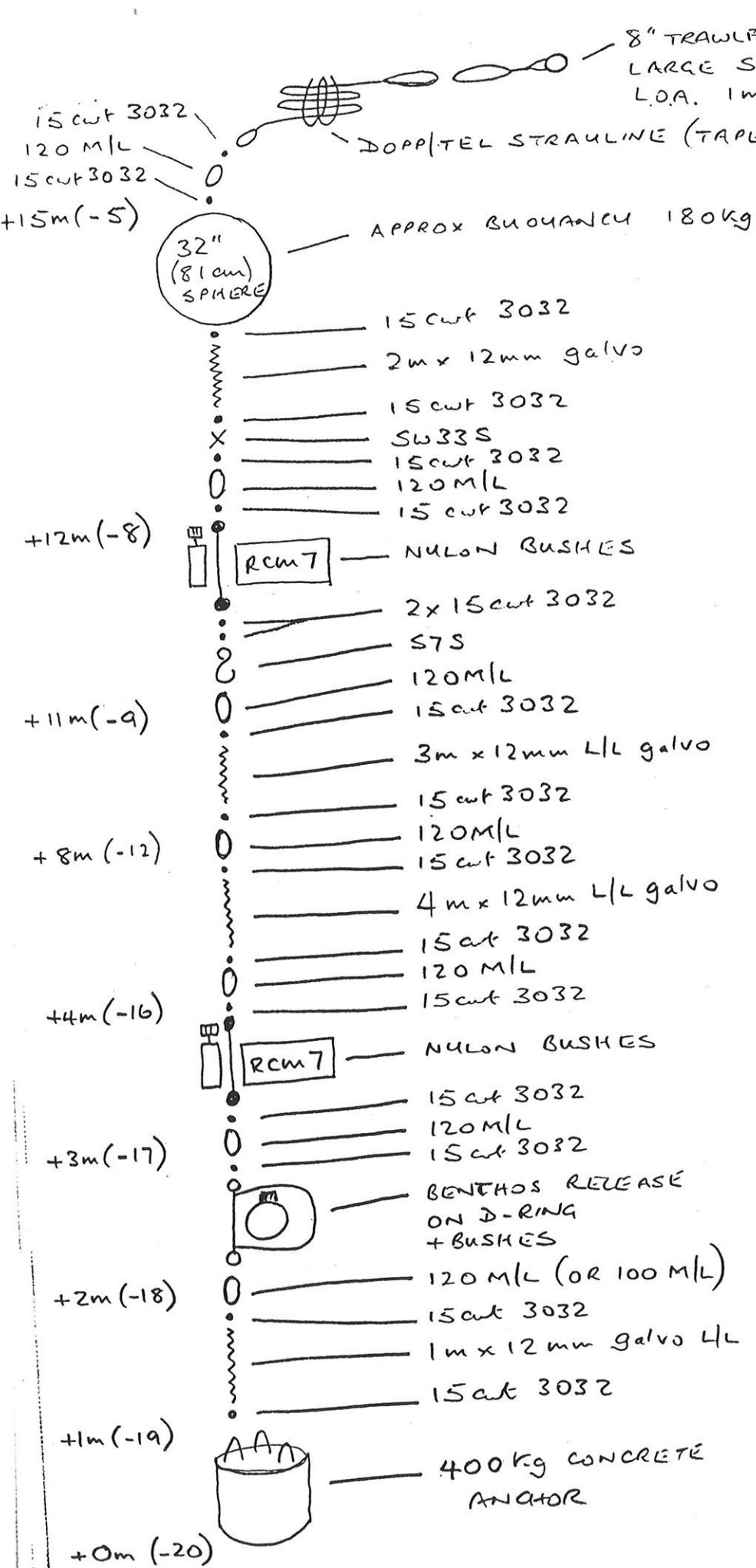
LAY MOORING ANCHOR-
LAST THROUGH
STERN-GATES.

INDIA

CURRENT METER
MOORINGS (x2)

STATIONS
CMNW, CMNE.
JAN-MARCH, 1999.
NOM. DEPTH 15M
NAVAL VESSEL
'ANDROMEDA'

J. HUMPHREY
18/10/98.



TOTAL BUOYANCY
= 180 kg approx

MOORING WEIGHT
= 76 kg approx

ANCHOR WEIGHT
= 400 kg in air
= 257 kg in water

WEIGHT ON BOTTOM
= 257 + 76 - 180
= 153 kg approx

LAY MOORING ANCHOR -
LAST THROUGH STERN-
GATES.

INDIA

CURRENT METER
MOORINGS (x)

STATIONS
CMSW, CMSE.

JAN-MARCH, 1999.

NOM. DEPTH 20m

NAVAL VESSEL
'ANDROMEDA'.

J. HUMPHREY
10/1/98