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I.O.S.

R. R. S. DISCOVERY CRUISE 83

26th May - 9th June 1977

GLORIA II Proving Trials

CRUISE REPORT No. 61

1977

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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Institute of Oceanographic Sciences,
Brook Road,
Wormley, Godalming,
Surrey, GU8 5UB, England.

CONTENTS

ITINERARY

Leave South Shields	26th May 1977
Call at Lowestoft	28th May 1977
Arrive Barry	9th June 1977

SCIENTIFIC PERSONNEL

W. E. Elford	Principal Scientist	I. O. S. Wormley
M. L. Somers	GLORIA II Project	"
J. A. Revie	"	"
B. J. Barrow	"	"
S. V. Bicknell	"	"
R. H. Edge	"	"
A. G. Andrews	"	"
A. W. Gray	"	"
R. D Peters	"	"
N. H. Kenyon	Side-scan Project	"
A. R. Stubbs	"	"
J. Legg	"	"
E. P. Collins	"	"
I. G. Chivers	Data Processing	I. O. S. Barry
P. Hartland	"	"
M. D. Conquer	Photographer	I. O. S. Wormley
D. Bradley)	(left ship at Lowestoft)	Schatt Davits Ltd.
W. Monkhouse)		MATSU Project Officer

SHIP'S OFFICERS

M. A. Harding	Master
S. D. Mayl	Chief Officer
J. S. Jones	2nd Officer
J. Evans	3rd Officer
J. A. Lennox	Chief Engineer
P. J. Byrne	2nd Engineer
R. Periam	3rd Engineer
B. Entwistle	4th Engineer
J. Landry	5th Engineer
R. G. Whitton	5th Engineer
R. C. Parker	Electrical Officer
R. Cornford	Purser/Catering Officer

MAIN OBJECTIVES OF CRUISE

The primary object was to carry out trials and to commission the new GLORIA II vehicle, its launch and recovery gantry and associated electrical/electronic power and signal processing equipment for use on Cruise 84.

Secondary objectives were

(a) to carry out further tests on the shipborne side-scan sonar Mk III, to assess modifications made during the refit and the fitting of fins to the pod.

(b) to check the two drum hydraulic capstan for hydrophone/air gun deployment, recently converted for two drum operation.

NARRATIVE

The ship sailed from South Shields after refit at 1130 on 26th May, (after a short delay due to non-receipt of stores), and proceeded north to the measured mile off Blyth.

Opportunity was taken whilst the ship was being sailed over the measured mile to calibrate the E. M. logs. These runs terminated about 1930 and the ship sailed SE in preparation for GLORIA II launching trials on 27th. During the evening, the ship was slowed to deploy the side-scan sonar pod and trials were carried out at 2, 4, 6, and 8 knots to check the effect of the fins recently added to the pod.

On 27th, GLORIA II was launched at 0830 for the first time. Malfunction of the internal electronics, eventually traced to cross-wiring in the winch junction box, put the recording equipment temporarily out of action. It was decided to carry on with launch and recovery trials and repair the electronic fault later. The vehicle was recovered at 1405, and, since it had adopted a nose down attitude during recovery, it was deemed necessary to apply an extra 80 lbs weight in the tail cone, and to fit a 100 ft long braidline drogue rope to the tail.

The vehicle was launched again at 1600 and again recovered at 1700. During this recovery the vehicle surged into the lower end of the launch gantry and damaged the cable at the nose inlet. The cable also got caught between the outboard end rollers on the gantry. Since some modification had to be made to the gantry to prevent this damage occurring again, the ship sailed south during the night for the rendezvous at Great Yarmouth with M. A. F. F. representatives on 28th.

Modifications to the launcher were carried out during this period and a drogue made which could be slipped down the towing cable during recovery to hold the vehicle off the stern of the ship whilst lifting it on to the gantry. The visitors from M. A. F. F. came aboard at 0900 and left at 1430, together with Mr. W. Monkhouse (Project Officer) and Mr. D. Bradley of Schatt Davits Ltd.

The ship then sailed down channel to Mounts Bay, the side-scan Mk III being used throughout the trip. On the 30th, GLORIA was launched in Mounts Bay at 0900 and recovered again at 1030. The new technique of slipping a drogue down the cable was successful. Two further launches and recoveries were made during the morning in order to ascertain the best ship's forward speed for the operations. At 1500, work was started on removing the damaged cable, replacing it with the spare, and repairing the internal electronics. During this period, arrangements were made by I. O. S. to collect the damaged cable from Falmouth in order that it should be re-terminated in time for Cruise 84.

The cable was landed at Falmouth on 31st at 1600 and passage made to the operational area 48°N 9°w.

On arrival on 1st June, the sea state of 6-7 and wind of 25 knots was considered too rough for GLORIA launch and risk of cable damage. From weather forecasts it appeared that the weather could be better further north, so passage was made in that direction.

On the morning of 2nd June, the sea state and wind had moderated and GLORIA was launched at 0800 hours, and trials on towing characteristics commenced.

During the next few days, GLORIA transmission and signal processing equipment were gradually brought up to full operation and various comparative survey tracks were run. The weather, however, gradually deteriorated to sea state 7 with wind at 30 knots, and on

7th June it was decided to go north to a lee off Ireland to recover GLORIA and to proceed to Barry.

The Mk III side-scan was used extensively throughout the period at sea and right up the channel to Barry, where the ship docked at 1030 on 9th June.

A track chart showing the working areas is shown in Fig. 1.

W. E. E.

PROJECT REPORTS

(1) Launching Gantry

The launch/recover gantry for the GLORIA II vehicle was operated for initial launching trials on the morning of 27th May. With a forward ship's speed of 3 knots, the launch went very smoothly and satisfactorily. The recovery of the vehicle a little later was rather more difficult, and the vehicle surged into the lower end of the launcher ramp due to ship's heave motion, consequently damaging the towing cable. It was also found very difficult to align the vehicle to the ramp.

It was realised that additional drag would have to be applied to the vehicle to hold it aft of the ramp until its nose was lifted clear of the surface. To this end a 3ft dia. canvas drogue was made and attached to a 100ft rope, with a "noose" at the inboard end which could be slipped over the towing cable whilst the vehicle was still about 60ft aft of the ship. The drogue was then launched and allowed to trail until the noose was captured onto the cable termination on the nose of the vehicle. At 4 knots, the drogue applied about 300lbs drag, which was found sufficient to enable the vehicle to be recovered reasonably well. This technique was adopted for all subsequent recoveries.

Various small modifications to the gantry, such as providing cable guards and the replacement of some rollers by wooden blocks, were made during the next few days, eventually leading to a safe and satisfactory recovery technique .

Some difficulty was experienced with the hydraulic brake on the winch, which allowed the vehicle to "run back" about 4ft when the winch was shut off. Modification to the hydraulic system was necessary but could not be carried out on board during this cruise.

(2) Acoustics and Signal Processing

The GLORIA II sonar trials worked systematically through all aspects of operation, starting with array admittance measurements and ending with a full two-sided sonar test over a track previously run by GLORIA I in 1975.

Admittance diagrams were obtained for all six sections of each array, both with and without the power factor correction chokes. These measurements confirmed that the 'nylatron' transducer housings were a satisfactory array mounting from the acoustic point of view, with no detectable coupling between arrays and no loss of efficiency. Array noise measurements in the quiescent condition confirmed that the ship was the major source of noise with the expected free field pressures.

The transmission performance was then built up section by section for each array using a constant frequency dummy pulse. When at least four sections of each array could be used simultaneously, the real sonar pulse was introduced. Due to the drop in amplitude towards the end of this pulse the amplifier protective circuits came into operation. This problem was overcome by truncating the pulse by 10% or so.

After confirmation that the receiving system was working, sidescan runs were made over suitable terrain to compare the port and starboard array performances. The system was also run with two, four or all six amplifiers running on each array, to determine effects of partial excitation of the transmitting arrays.

The various beam steering arrangements were also tested with the exception of the "steer on transmit" option. This test was reserved for a future occasion, because the partial excitation tests had given very good results and time was pressing.

During the trials the system fully lived up to its design specification, and no evidence could be found of interference between the port and starboard sonographs.

M. L. S.

(3) GLORIA towing towing trials

The vehicle was instrumented to measure pitch, yaw, roll and depth. These variables, together with ship's heading and poop heave acceleration, were recorded as analogue signals on an 8 channel recorder.

A series of runs were undertaken in which the primary variables were ship's speed and cable scope; and during the early part of the trials the ship's course was also varied to alter the ship motion input to the system. Each run lasted about 15 mins., and peak values occurring in these periods have been extracted from the analogue records. Sea state gradually improved as the trials progressed.

Some conclusions which may be drawn from the trials are as follows:

(a) Vehicle depthkeeping

The depths achieved by the vehicle are plotted in Fig. 2, as a fraction of cable scope and speed. (The cable scope reference is the cable length in the water). These curves, viewed the other way up, demonstrate the cable catenary shape; it is apparent that the greater part of the cable is straight, and that the vehicle drag only curves the lowest part of the cable - this is in accordance with theory.

The actual depths reached by the vehicle are not as great as had been predicted. The best agreement is at 8 knots, when with 240m scope the depth was 34m, which is 94% of the calculated depth of 38m. The discrepancies are worse at lower speeds, e.g. at 6 knots with 240m scope the depth was 40m which is 74% of the predicted depth of 54m. The table in Fig. 2 shows the calculated and measured values of $\emptyset_c$, the cable critical angle. No single variation of the system parameters, e.g. drag coefficient, will enable theory and experimental values to be reconciled, and the conclusion must be reached that the theory used, (Pode, 1951), is breaking down in some way.

The depth curves in Fig. 1 have been extrapolated beyond the experimental points to predict the vehicle depth which could be achieved with longer cable scopes.

(b) Vehicle Yaw

The analogue records of yaw of the vehicle showed two distinct periodicities. The first of these corresponds to the wave encounter period, the amplitude being generally about 1° peak to peak, occasionally $1\frac{1}{2}$°. Longer period excursions are produced by ship heading which is itself a complex function of the sea-state and the ship's autopilot performance. During the trials some trouble had been experienced with the autopilot, and the ship's heading was varying at times by as much as 12 or 13° peak to peak. The yaw response of the vehicle is shown as a function of ship's speed and cable scope in Fig. 3.

There is a general improvement in performance with increasing cable scope, which was expected. The performance also improves with speed. The results at 8 knots are comparable with the earlier 4/5 scale model trials, shown as bar lines in Fig. 3 , (see Discovery Cruise Report No. 11, 1974), but the lower speed results are worse. This is possibly due to interaction between vehicle pitching and yaw which occurred on this cruise. On the model trial it was not observed because of the very smooth conditions which prevailed during the trials.

(c) Vehicle Roll

The vehicle roll is plotted as a function of depth in Fig. 4. The very obvious correlation suggests that roll is mainly caused by the direct action of wave particle velocity on the body. When the vehicle is below 25 m, roll does not exceed $\frac{1}{2}$° peak to peak. The predominant roll period corresponds to the vehicle natural period of 1. 8 seconds as measured during a pre-cruise test at Southampton.

(d) Vehicle Pitch

The vehicle pitch angle generally did not exceed 4° peak to peak, although one particular example of synchronised ship motion gave 6° peak to peak, the ship's poop motion being an estimated 2. 5m peak to peak with 6 second period. The vehicle pitch motion is worst with short cable scopes and appears to be unaffected by ship's speed. In general, the vehicle motion is very satisfactory, and both yaw attenuation and the depth obtained can be expected to improve when longer towing cables are available.

R. M. C.

(4) Side-scan Sonar and Telesounder

The double-sided side-scan systems were tested at all ranges from 200m to 2500m (in water depths of around 2000m on the latter). Distortion of the beam due to pod refraction was troublesome on the starboard side.

New electronics for the Telesounder system were tested and double-sided working used for the first time. Ranges in excess of 300m were obtained.

The opportunity was taken to produce unified screening and earthing systems on both equipments in an attempt to ease interference elimination.

The modifications carried out on the pod assembly and trunk have reduced the effect of cavitation. No controlled speed test was carried out but onset of cavitation appears to be about 9 or 10 knots.

Surveying was carried out at every opportunity as allowed by the GLORIA programme.

A. R. S.

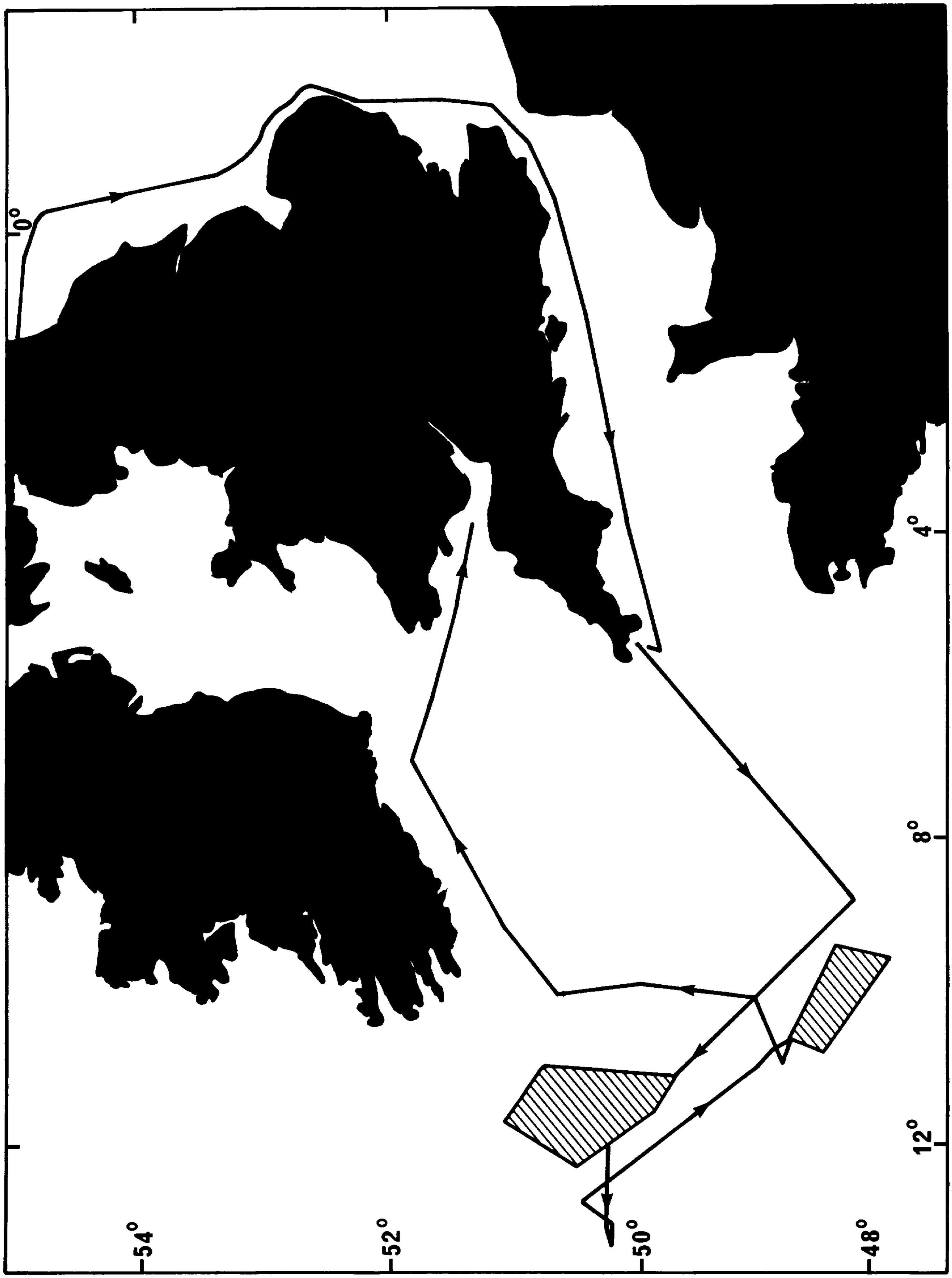

fig.1

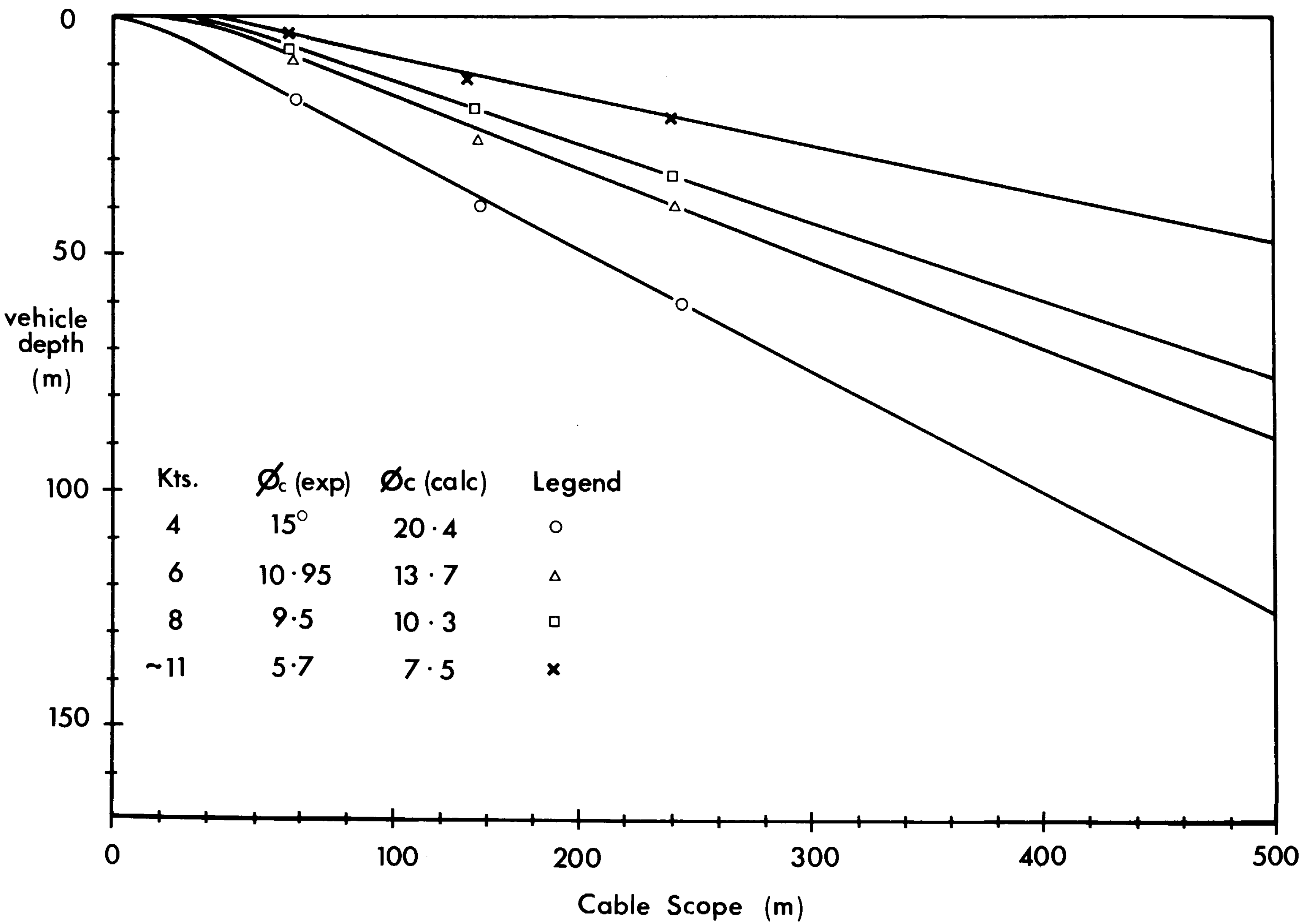
0
50
vehicle depth (m)
100
150
0
100
200
300
400
500
Cable Scope (m)
Kts.
4
6
8
~11
Øc (exp)
15°
10·95
9·5
5·7
Øc (calc)
20·4
13·7
10·3
7·5
Legend

fig. 2

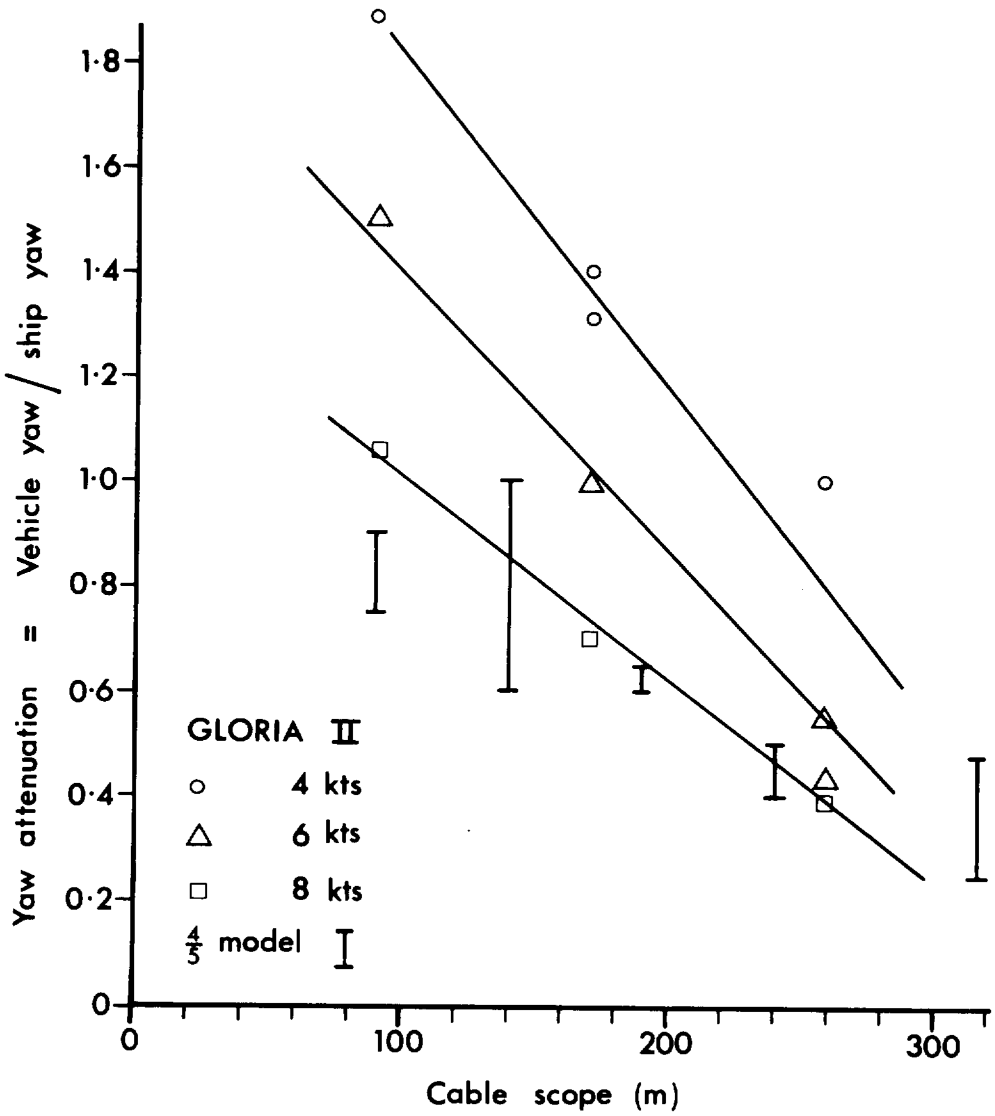
Yaw attenuation = Vehicle yaw / ship yaw
1·8
1·6
1·4
1·2
1·0
0·8
0·6
0·4
0·2
0
100
200
300
Cable scope (m)
GLORIA II
4 kts
6 kts
8 kts
4/5 model

fig. 3

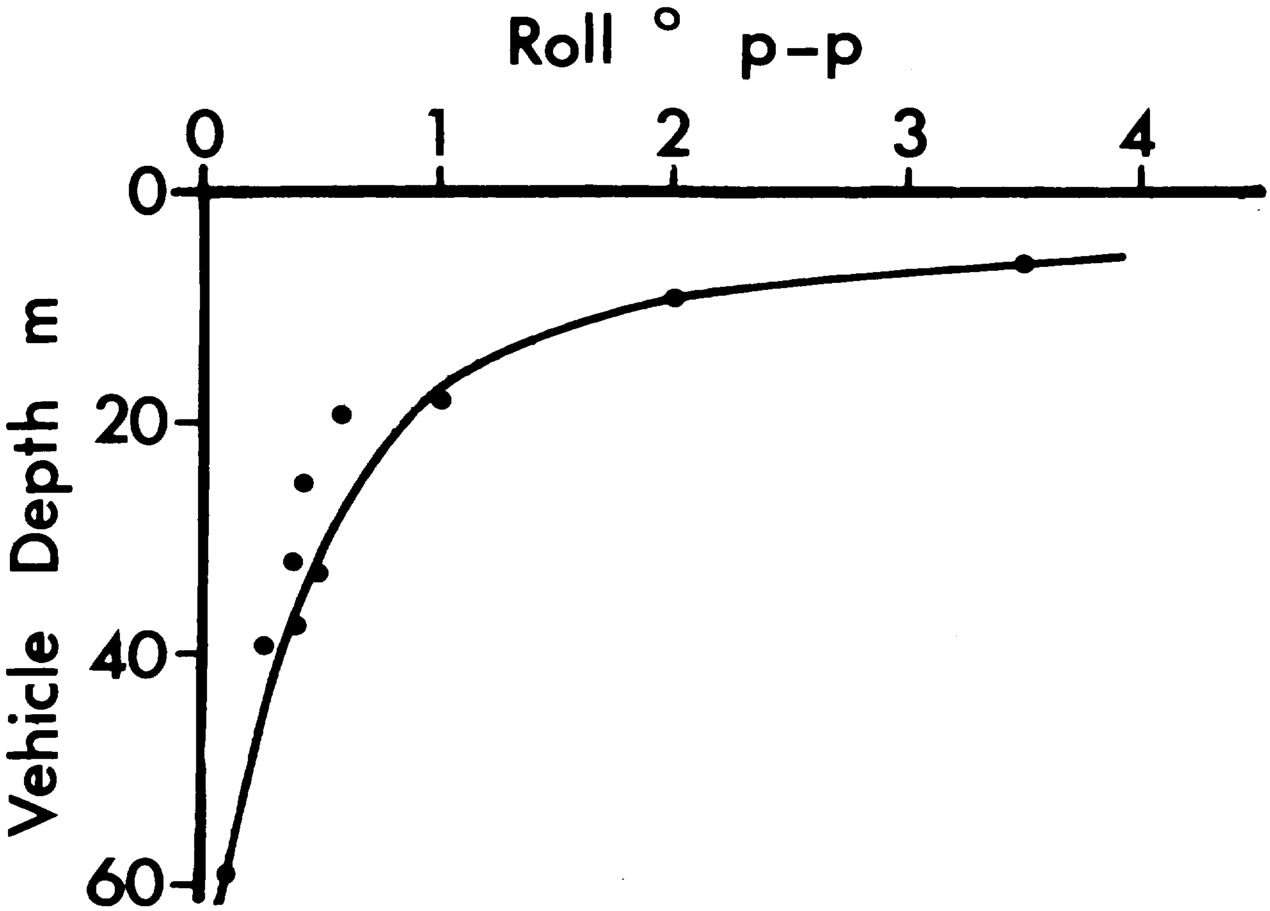

fig. 4