

METHODS IN MOORING DEEP SEA SEDIMENT TRAPS

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ABSTRACT

The experience gained during the process of deployment and retrieval of nearly 39 sets of deep sea sediment trap moorings on various ships like FS Sonne, ORV Sagarkanya and DSV Nand Rachit are outlined. The various problems encountered and the remedies to tackle them are described. Based on the past experience, a methodology is proposed to conduct successful and efficient deep sea mooring operations.

INTRODUCTION

Sediment trap is primarily used for the collection of downward settling particulate flux in the ocean (Fuhs, 1973). Variations of the deep sea moorings are also utilised in the emerging fields such as acoustic tomography. A simple sediment trap along with accessories was designed and moored at 90 metres depth in the Arabian Sea in 1985 (Janakiraman et al 1986). Subsequently under the Indo-German collaboration, deep sea sediment trap moorings were deployed and retrieved successfully in the Central, Eastern and Western Arabian Sea. About 39 moorings were deployed and retrieved in various locations in the Arabian Sea and the Bay of Bengal. Each mooring was more than 3 km in length. During the execution of the above moorings three ships were used at different times of the year. Each ship had a unique layout and different types of deck machinery to handle the mooring systems. This paper briefly describes the methodology of the mooring operations, various problems encountered and the remedies arrived at, for successful completion.

APPLICATION OF KNOWLEDGE

The German research vessel FS Sonne having experienced officers and crew deployed the first 3 moorings in May 1986. On the other hand, ORV Sagarkanya was new to such work with inexperienced crew. At the outset, the ships crew were familiarized. The friction winch was converted to mooring winch and new pulleys were fixed for routing the mooring line (Anon, 1988). Due to the similarity of ORV Sagarkanya and FS Sonne regarding deck arrangements, a working platform was soon established from where the authors perfected the technique of the operation of deep sea moorings. In May 1990 a diving support vessel DSV Nand Rachit was used. This vessel had only one trawl winch and a 14 ton rotary central crane for mooring work, as compared to the multiple drums, hydraulic cranes and jib boom available on FS Sonne and ORV Sagarkanya. Based on the experiences gathered, the various tasks in deploying and retrieving the deep sea mooring on DSV Nand Rachit were accomplished (Anon, 1990).

Deck Machinerles

FS Sonne	ORV Sagarkanya	DSV Nand Rachit
Trawl winch 2 Nos.	Mooring winch (with interchangeable drum)	Trawl winch
Articulated crane	Articulated crane	Rotary central crane
Telescopic crane	Telescopic crane	—
Jib boom	Jib boom	Small tugger winch fitted to the crane.

MOORING CONFIGURATION

General mooring configuration is shown in Fig.1. The top radio float houses the Xenon flasher and radio transmitter, used to locate the mooring system upon surfacing. The mooring array is kept taut to position the sediment traps vertical by placing three arrays of glass floats consisting of 16, 10 and 4 numbers respectively.

Two time series sediment traps "Parflux" Mark VI are positioned approximately 1000m and 2000m from the sea surface at a water depth of around 4000m. For additional information, current meters are attached to the mooring below the sediment traps. The vertical spacing between the sediment traps is achieved by the interconnecting wire ropes and Kevlar ropes of required length. PVC jacketed wire rope is incorporated within the fish bite zone and the rest of the line comprises of Kevlar rope to reduce the load on the mooring (Fowler, 1978). Benthos acoustic transponder provided above the anchor weight serves for position fixing and releasing the mooring from anchor. The plaited nylon rope has been incorporated to dampen the added tension before bottoming (Berteaux, 1976). For a total buoyancy of 830 kg in the mooring configuration, an anchor weight of 1200 kg is used.

METHODOLOGY

The mooring configuration is divided into segments of Glass floats, Sediment traps, Kevlar ropes, PVC jacketed ropes, Acoustic release etc. (Fig. alongside). The deck machinery on

board were rigged to handle the different segments of the mooring while holding the already deployed segments. The various accessories like line stopping cleats and interchangeable drums with mooring shots are prepared before deployment. Anchor last method was followed in all the mooring deployments. The deployments are done with help of winch and quick release.

Deployment

The deployment can be done through aft of the vessel or from the sides, but best done from aft. The quick release is armed at point "A" in the middle of the floats. Using the winch line or crane, the floats are lifted, lowered and released after securing the free end with a stopper line to the cleats. The entire mooring assembly is lowered following the same procedure by alternatively hooking the pear rings at points A, B, C, D, E, F and G through the quick release and taking the traps, floats assembly loads on the winch and releasing in water using quick release. The intermediate mooring shots are lowered from the preloaded interchangeable drums through the mooring winch. Anchor is released last by lifting with a nylon rope attached to the crane, lowered in water and cut by a sharp knife. This prevents accidental release on deck and ensures safety. The descent of the mooring is monitored through the deck unit of the acoustic transponder. The exact position of the mooring is obtained through triangulation.

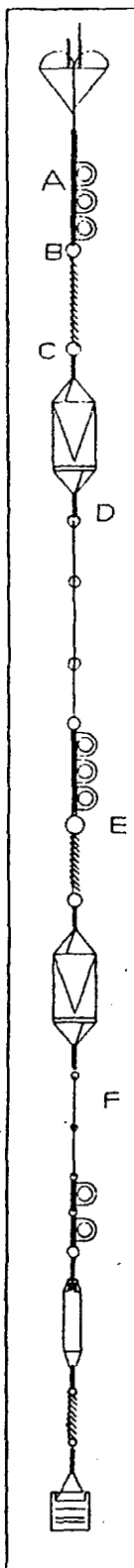
Retrieval

The mooring system is located by interrogating the acoustic transponder. The release command is activated when the horizontal range is within 1500 metres. The mooring floats pop up as shown in Fig.2. After the radio signal is picked up and the mooring is sighted, the ship is maneuvered close to the radio floats and the assembly is hooked with grapnels. The grapnel line is led to the mooring winch through the pulleys. A converse procedure of deployment is followed to retrieve the mooring. The sediment traps and the float assemblies are lifted vertically by the crane. Once the total mooring assembly is retrieved, all the components of the moorings are inspected so as to make them ready for the next deployment.

PROBLEMS ENCOUNTERED AND REMEDIES ARRIVED AT

Ship Maneuvering

During the first sediment trap moorings in May 1987 on board ORV Sagarkanya, in anchor last method towards the end of the operation, the top radio float drifted towards the ship forming a loop and entangled with the third array of floats.



The operation was then stopped and the life boat was lowered to reach the site of entanglement. With great difficulty the entanglement was removed and the entire system was recovered and re-deployed. The bridge personnel then maneuvered the ship such that the floats drift away to prevent entanglement.

In November 1987, from ORV Sagarkanya, anchor last method of deployment was carried out using the stern A-frame and mooring winch. This method considerably eliminated the entanglement problem described above and also reduced the deployment time by nearly two hours as against four and a half hours in the earlier operations.

Kevlar Ropes

The entanglement in the May 1987 cruise resulted in kinked Kevlar rope. The extent of damage was not visible to the naked eyes. During re-deployment, after the launching of anchor weights, the initial tension snapped off the kinked Kevlar sector just below the second array of 10 floats and surfaced up. This broken line was hauled up along with the sediment traps. The rest of the mooring line consisting of 4 floats and transponder anchored at the bottom was released from the anchor weight. Considerable ship time and an anchor weight was lost during this operation.

As the Kevlar rope is susceptible to loose strength due to abrasion, (Bourgault, 1978) preventive measures were taken by covering the sharp edges of the ship's sides temporarily by rubber sheets. At a later stage, two inch diameter G.I. pipe was welded where the Kevlar rope was observed to pass through.

In almost 90 percent of moorings where Kevlar rope was used, the system was recovered with the Kevlar rope entangled with other mooring components. In one of the retrievals the rope was observed to be badly damaged near the termination as a result of entanglement. The damages to the midsections of the Kevlar ropes were replaced with new lengths. The damaged end termination was chopped off and a new splice made on board. Since the exact epoxy resin was not available on board, a general purpose rubber solution was substituted. The splice was allowed to set for 24 hours and then tested on board by hanging one ton load for about 5 minutes. Later this rope was used and found to be satisfactory.

Kevlar ropes were observed to host considerable technical problems in the field leading to undue wastage of ship time. On the other hand, replacement of Kevlar ropes in the mooring line also proved to be an expensive process. Gradually over the years the use of Kevlar ropes in the moorings were discontinued and substituted with PVC jacketed wire

ropes. The recent moorings in May 1990 deployed in the Arabian Sea and the Bay of Bengal consisted no Kevlar rope in the configuration.

Anchor Weights

During the deployment of the second mooring in May 1987, scrap railway wheels were assembled on to a specially fabricated anchor stand. While launching, the assembly swung and hit the ship side breaking the anchor stand. This ultimately resulted in the loss of the railway wheels. In subsequent moorings, two 4m long 3/8 inch galvanized steel chains were used to hold the wheels together. This method of assembly has been found to be more reliable and economical.

Glass Spheres

Two 17 inch glass spheres were recovered broken at some stations. Since the glass spheres are rated for 6000m water depth, failure due to hydrostatic pressure was ruled out. This breakage was assumed to occur due to the premature triggering of the quick release while deploying the array of glass floats. In the subsequent operations, the breaking of glass spheres were avoided, by triggering the quick release only after all the glass floats were in water.

OBSERVATIONS

Based on the extensive field expertise gained on handling deep sea sediment trap moorings the following observations are made:

1. The success of the deep sea mooring depends on the vessel used and adapting the vessel for mooring operation. The layout of the ship in terms of free deck space and deck machinery available, are to be studied alongwith mooring configuration, before undertaking the mooring work.
2. Day light and fair weather conditions are preferred to carry out the mooring operations.
3. Prior to the commencement of the mooring operation, it is important to brief the ship personnel about the techniques of deployment and retrieval, and each person on the deck be assigned a specific task to avoid confusion. It is wiser to spend a little more time and inspect all the components prior to deployment.

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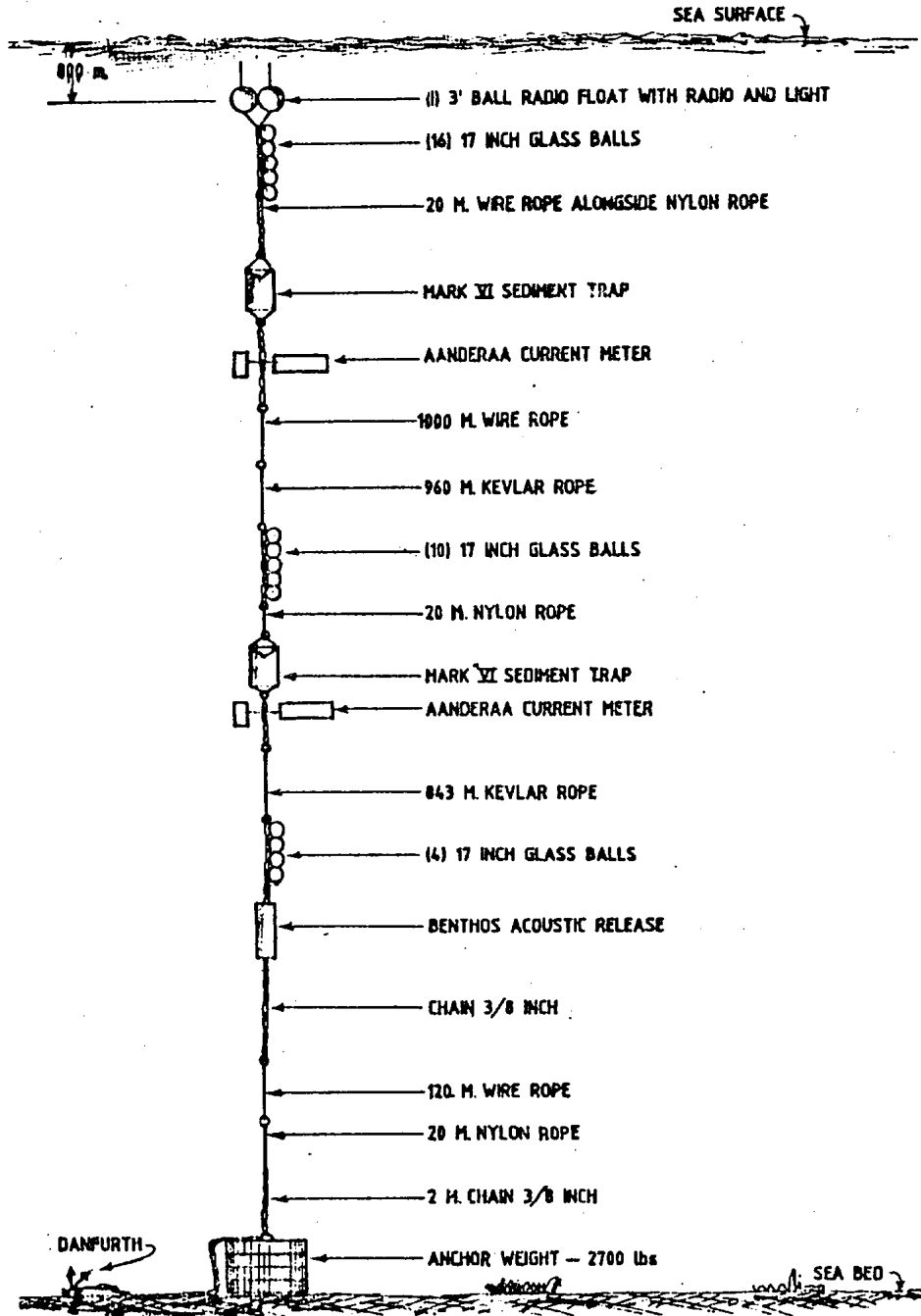


Fig. 1. DEEP SEA MOORING DETAILS

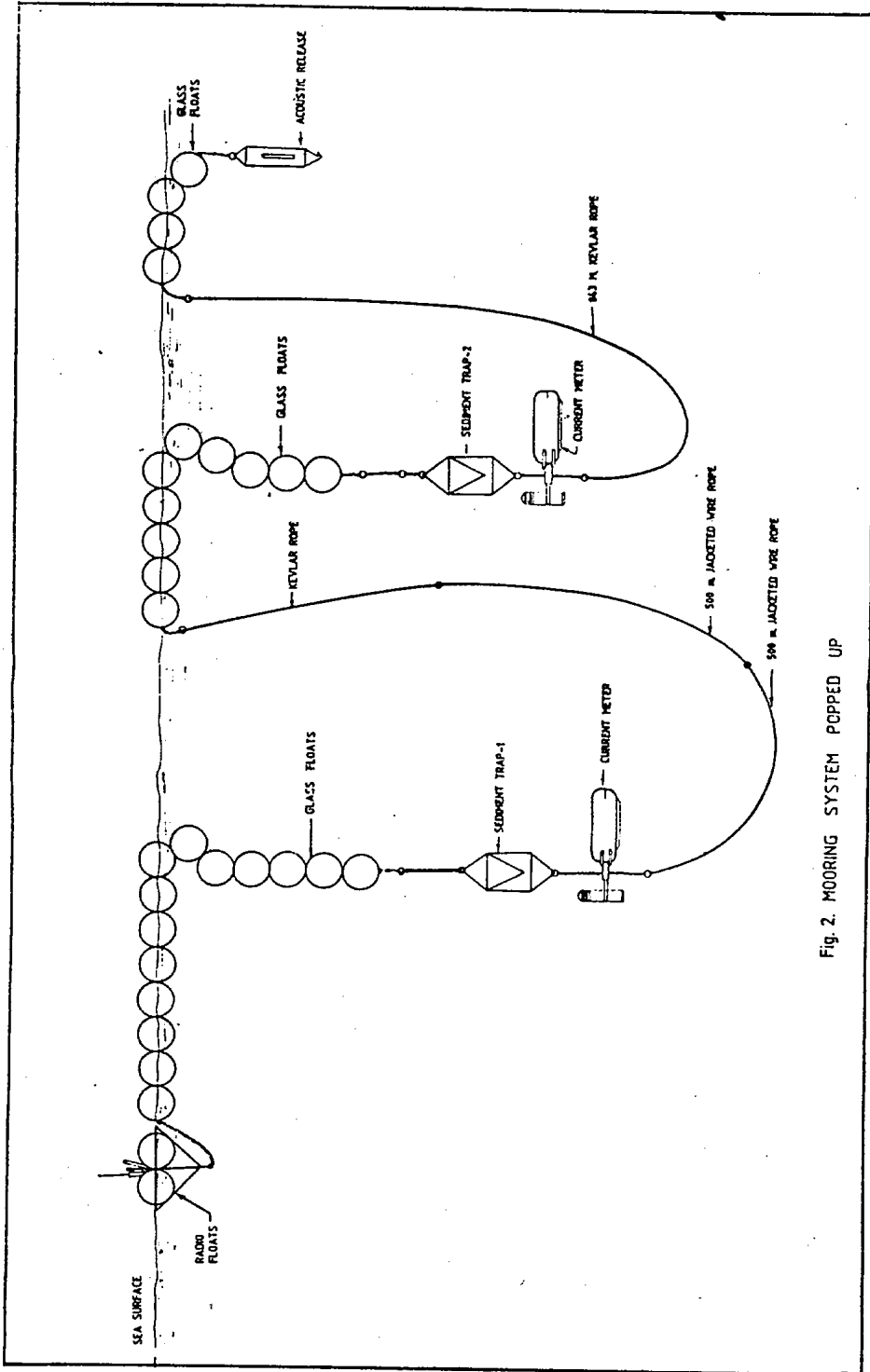


Fig. 2. MOORING SYSTEM POPPED UP