A SURVEY OF THE PUBLISHED LITERATURE ON SAMPLING AND IN SITU MEASUREMENTS ON PHYSICAL PROPERTIES IN THE VICINITY OF THE OCEAN'S BOTTOM

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September 1981

Acknowledgements

This survey was aided by the good will of many people at Bedford Institute. The staff of the excellent library at Bedford Institute was forever helpful. George Fowler (Metrology, AOL) and Mike Lewis (Coastal Dynamics, AGC) provided encouragement and supervision. Steve d'Apollonia (GeoResources) provided administrative and logistical support. Pat Ryall (Dalhousie University - BIO Rock Drill Project) provided assistance on the Rock Drill portion, and George Fowler generated the computer search and a reprint collection that served as the starting point of this project. Thanks are also due to the typing services of Bedford Institute and the aid in production and administration so graciously given by Cecilia Middleton (AGC). The working conditions provided by those fine gentlemen in the Electronics lab of the Metrology Division of AOL made this project a pleasure in which to have participated. The responsibility for the contents and oversights are those of the author.

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A. INTRODUCTION

A.1. Purpose and Summary

This survey was prepared for the Atlantic Geosciences Centre of the Bedford Institute of Oceanography to provide an up-to-date bank of information on ocean bottom sampling devices and devices used to measure in-situ physical properties of marine sediments. The task of effectively and efficiently sampling and measuring the characteristics of the ocean bottom, especially in the area of the deep continental shelf and rise will become increasingly important in the Canadian context. A collection of published information will aid the process of design and development of equipment to use in this important ocean environment while not duplicating unnecessarily the mistakes or successes of others.

The presentation of this survey has been modelled after a survey on oceanographic mooring systems prepared for BIO Metrology/Ocean Circulation by B. Brady and G. A. Fowler in 1977. Citations and abstracts of publications which have been collected into a reprint file constitute the bulk of this report.

The citations are organized by type of sampling or testing device and described in a manner similar to that classification used in the excellent review by P. G. Sly in 1979: sample recovery, in-situ tests, and continuous surveys. The references included in this report are primarily concerned with description of equipment or instruments, design criteria, development programmes, and procedures of equipment or instruments. A few representative references are included which are concerned with measurements, observations, and interpretation of results gathered with these devices, but inclusion of such citations is not complete.

A.2. Search Method

The Library of the Bedford Institute of Oceanography was the primary source of information. The limited time of the survey allowed little use of other large and useful libraries in the area (Dalhousie Science Library and Technical Univ. of N.S. Library). The reprint collection can be augmented by use of an effective interlibrary loan system that operates in Halifax/Dartmouth.

The search was completed over February and March of 1981. An extensive Oceanic Abstract on-line computer search was instigated by G. A. Fowler in August of 1980 and this served as the base for the survey. The computer search returned 576 citations (keywords used in search format: (Sea or Marine or Ocean or Underwater or Seabed or Seafloor) and (Core or Cores or Coring or Corer or vibracore or geotechnical or drill) and (piston or gravity or box or push or submersible or bottom or situ or sample or technique).). About 30% of the citations were relevant to the search and a few significant categories were missed. The great variety of devices surveyed requires either a most general format or many specific searches of more restricted format. The search used probably was a satisfactory compromise. The Oceanic Abstracts' computer file provided a broad spectrum of literature and now overlaps most other on-line systems. Engineering Index or NTIS on-line searches would be largely redundant.

After the on-line search, the fundamental method used in compiling this survey was a manual search of the bibliographies of the relevant papers as they were collected. Recent exhaustive review articles by Sly (1979), Chari (1979, 1978), Dayal (1978) and Ryall (1980), all in a Canadian context, made this task rather easy.

The on-line search and the search of bibliographies were supplemented by manual searches of:

1. Indexes and Abstracts--Oceanic Abstracts and Indexes

   Instruments and Methods sections 1967-1980
   Index titles "Soil Conditions"
   "Soil Mechanics"
   "Sampling Instruments"
   "Sampling Systems"

   The Engineering Index

   Index titles "Oceanography: instruments, equipment"
   "Soil Mechanics"
   "Soils: testing measurement"

   Deep Sea Research, Part B - Oceanographic Literature Review
   International Underwater Information Bulletin

   Index title "Instrumentation and Equipment"

   Dissertations Abstracts

2. Proceedings--Offshore Technology Conferences
   IEEE Conferences on Engineering in the Ocean Environment
   Port Ocean Engineering under Arctic Conditions
   Conferences of the Marine Technological Society
   ASCE Conferences on Civil Engineering in the Oceans
   Oceanology International Conferences
   Interocean Conferences

3. Journals-- Marine Geotechnology
   Marine Geology: "letters" section
   Deep-Sea Research: "instruments and methods" section
   Limnology and Oceanography: "notes" section
   IEEE Journal of Ocean Engineering
   Journal of the Marine Technological Society
   Journal of the Society for Underwater Technology
   Meeretech
   IEEE Transactions on Geoscience Electronics
   Exposure
   Applied Ocean Research
   Marine Geophysical Researches

A.3 Classification

The classification which is used to present the citations is an expansion of the categories used by Sly (1979). There is some overlap between categories and these will be noted in the brief introduction provided to each category. Citations are assigned to only one category but enough general categories are included to allow easy classification of virtually all the references found in the search.

Each citation is presented on one full page. The page consists of seven entries, from top to bottom:

1. Classification
2. Year of publication; Author(s)
3. Full title; Source of article
4. Index number for reprint collection; nearest library in which the article is stored
5. Abstract
6. Number of references cited in the publication
7. Address of first author at the time of the activity being reported.

Within each category, citations are ordered chronologically allowing additions to be made at a later date to the end of the section. The index number is a number which appears on the reprint in a collection to accompany this report. This reprint collection and a card index is stored with Metrology Division of AOL (attn. G. A. Fowler). The abstracts are about 300 words in length. If the author of the publication provided an adequate abstract, this has simply been reproduced. Some have been shortened. Many have been lengthened to include specific information about the device being described. New abstracts were provided for about 20% of the citations and they are mainly concerned with the descriptive portion of the reference.

The collections of citations and reprints can be expanded by adding new references as they are obtained to the reprint file by clearly identifying it with the next available reprint number and preparing a citation page to add to the end of the relevant section in this report.

B. CITATIONS

B.1. Review Articles

This project has been aided by the existance of a group of recent comprehensive review articles. P. G. Sly (1979) provides an excellent commentary on equipment being used and equipment under development to provide information on the ocean bottom for surveying offshore construction sites. Special attention is focussed on the techniques used and the problems presented in the deep shelf areas of the Canadian offshore. the French literature is exhaustively summarized by LeTirant (1979). The specific problems of measuring geotechnical properties are addressed by Dayal (1978) and Chari (1978). A large number of reviews were published throughout the 1970's relating the equipment and techniques used in offshore site evaluations as the importance of offshore oil exploration and exploitation increased and the water in which these activities occurred deepened and the latitudes increased. Bascom (1979) provides a brief review of instruments used in monitoring pollution: the problems of obtaining representative bottom samples for meaningful analysis for this purpose are only beginning to be addressed. Design and development continues to be concentrated on developing in situ instrumentation for measuring engineering properties of submarine soils and indexing acoustical surveys to map these properties over the future sites of offshore structures which are being planned for even deeper water and more hostile seas.

Several comprehensive, illustrated reviews of bottom sampling devices were published in 1964. The papers of Hopkins (1964) and Holme (1964) exhaustively summarize geological and biological sampling respectively. This collection contains only a few citations to devices described by Hopkins or Holme and those interested are encouraged to consult these two sources for evaluations of the history of bottom investigations from the time of the Challenger voyages.

B.2.a: Grab Samplers

Little new development has occurred in the nature of grab samplers since the review of Hopkins in 1964 and adequate descriptions and sketches are provided in his paper for most standard grabs in use today. The citations since 1964 do include several useful modifications to standard grab samplers to increase the dependability of their operation. More attention has been spent in the literature in the evaluation of various samplers in taking a predictable sample for the purposes of statistical treatment of the benthic organisms in the sample. This section also contains a short collection of articles on underway samplers that have been used while conducting hydrographic surveys over the continental shelf.

B.2.b.(1): Gravity and Piston Covers

These devices are the fundamental tools for obtaining samples for geological and geotechnical information and the literature about them is vast. Current research is concentrated around the Long Coring Facility programme in the United States to design a piston corer with the capability of taking cores of 50 metres length. The bulk of the citations in this category are concerned with design criteria for the Long Coring Facility and its predecesor, the Giant Piston Corer, or descriptions of modifications to the basic piston corer with tripping device, piston and core catcher described by Hvorslev and Stetson in 1946. The development of the split piston, sphincter core-catcher, PVC liner, and piston stabilizing devices are all included. Also included is the literature on evaluating the quality of cores obtained as they relate to both geological sequence and geotechnical properties. A selection of descriptions of multiple corers for ecological sampling and a selection of papers on corehead cameras can be found as well. Some of the historical literature including descriptions of Piggot's explosive corer are provided as well.

Orienting devices, which were primarily designed for piston and box corers are presented in a separate section as are release mechanisms for free cores though the basic free corer literature is cited here.

B.2.b.(2): Shallow-water Corers

A brief collection of descriptions of shallow-water corers is included in this survey to provide a sampling of the tehcniques used to obtain quantitative samples for the study of benthic organisms. Some of the suction devices may be useful in the design of deeper-water devices and some may be adaptable to use from a deep-water submersible. Those interested in a more thorough treatment of this subject are directed to review articles of benthic samplers.

B.2.b.(3): Rock Drills

Bedford Institute has been in the vanguard in the development of submersible, bottom-mounted rock-drills. P.J.C. Ryall (1980, 1981) gives a thorough review of the subject in terms of BIO developments.

B.2.b.(4): Bottom-Triggered Corers

This category includes box corers and hydrostatic cores triggered mechanically when they hit the ocean bottom. The coring is only begun after the device is on the bottom. This allows slower coring and, hopefully, a better quality of sample. The basic samplers are the Rieneck box (or spade) corer which is bulky and demands much deck space and the Makereth hydrostatic corer which is restricted to shallower depths because of its air hose to the surface. The quality of the samples obtained indicate that developments in this area should continue.

B.2.b.(5): Vibration Corers

The bottom-mounted vibratory corer allows relatively rapid recovery of long cores on sandy bottoms. Though the quality of the core for geotechnical uses is moot, it can usually be estimated by monitoring the corer penetration and treating this record as a penetrometer record. The recent descriptive literature is quite complete primarily because of the competition for making offshore site surveys by companies and institutions that have developed their own corers.

B.2.b.(6): Bottom-mounted, Powered Corers

Tirey (197?) and LeTirant (1979) provide excellent illustrated reviews of this type of corer. All are mechanically complex and some can be diver-operated. Most are designed for shelf depths, are hydraulically powered, and are primarily designed for site evaluations. Several expensive programmes to develop incremental corers with 50 meter capacity for deep water were commissioned by the U.S. government to enable the evaluation of deep-sea muds as on site for nuclear waste disposal. Most of these designs were abandoned in the prototype stage.

B.2.b.(7): Other Corers

Included in this section are descriptions of corers designed for divers and submersibles powered by elastic bands, a rocket corer, and an explosive corer.

B.2.c.: Fluid Samplers

Pore fluids are usually sampled from piston cores on board ship. This poses many sampling problems that in situ sampling can help address, especially where chemical analyses are the object. A sampling of references for sampling bottom water is also provided.

B.2.d.: Miscellaneous Samplers

A variety of samplers are included here and may provide a starting point for expanding this search. Included are: a bottom-mounted sediment monitoring tripod, sediment traps, a bottom-triggered mousetrap sampler for boundary layer benthic organisms, and samplers for microbiological sampling.

B.3.a.: Geotechnical Measurement Systems

This section is comprised of accounts of systems of instruments for making geotechnical measurements. The individual instrument is often described separately elsewhere and will be found under the appropriate classification heading. Most are comprised of penetrometer, vane shear meter, and acoustic probe and are designed as a package for use by a submersible or are mounted on a platform remotely controlled from a surface ship. Also included are a group site-survey systems of in situ probes combined with acoustic profiling to provide maps of geotechnical properties.

B.3.b.: Penetrometers

The penetrometer test is standard engineering practice on land and much effort has gone into applying this test and vane shear tests to marine site surveys in preparation for offshore construction. Chari, et al. (1978) provide an excellent review of penetrometer design criteria and directions of past development. Both static cone penetrometers on submersible platforms for detailed surveys and dynamic cone penetrometers for more remote, reconnaisance surveys are well represented in this section.

B.3.c.: Vane Shear Meters

A variety of bottom-mounted platforms at all scales with vane shear meters are described. Most have interchangeable blades of different sizes for different bottom conditions and can penetrate the bottom incrementally. A sampling of the literature relating vane shear measurements to actual geotechnical properties as well as discussions of the quality of vane shear tests is included.

B.3.d.: Plate-bearing Testers

A representative sample of the literature or plate-bearing devices is included. Remote, electrical-resistivity monitoring of these tests over varying lengths of time, is a recent development.

B.3.e.: Pressure Meters

The use of the pressure meter is described well in most of the review articles on geotechnical equipment and techniques but the descriptive literature is quite sparse. A search of European conference proceedings is necesary to provide an adequate representation in this category.

B.3.f.: In situ Acoustic Probes

Probes to measure the *in situ* acoustical properties of marine sediments in concert with goetechnical measurements are a necessity in indexing acoustical profiles to distinguish the geotechnical character of large areas of the sea bottom rapidly. Corers with acoustic monitoring probes and platforms with more sophisticated capabilities are described.

B.3.g.: In situ Electrical Probes

Several varieties of electrical probes have been developed to provide profiles of electrical properties analogous to the electrical logs taken in a borehole. The quality of these measurements and the possibility of estimating density and porosity with these devices is discussed at length in the literature.

B.3.h.: In situ Radiometric Probes

Both backscatter and transmission radiometric probes (gamma-gamona) have received attention as a means of estimating sediment density, analogous to petroleum industry borehole logging devices. Recently research has also been made into neutron activation analysis on the deep sea floor to analyze manganese nodules *in situ*.

B.3.i.: Piezometers

Submersible piezometers have been developed to monitor the sea floor response to storm waves and earthquakes. The latest Sandia Labs instrument has an impressive data handling and telemetering system.

B.3.j.: Ocean-bottom Siesmometers (OBS)

The OBS was not a primary category in this search and is included because of a recent series of well edited descriptive articles in *Marine Geophysical Researches* and the advanced methods of release applicable to other free vehicle instruments or samplers.

B.3.k.: In situ Thermal Probes

A selected collection of citations on heat flow probes is included as well as a selection of historical literature on heat flow. Recent papers hint at a new leap in heat flow technology allowing more rapid measurement and the ability to make multiple measurements in one lowering (the pogo stick technique).

B.3.l. and B.3.m.

Single citations of an ocean-bottom magnetometer for measuring the long term variation of the magnetic field and an ocean bottom gravimeter are provided as seeds for any further searches on these instruments which have seen only rather restricted use.

B.4.a.: Acoustic/Seismic Reflection Profilers

Citations in this section are concerned with both instrumentation and the use of profiles to interpret geotechnical properties. Work in this area is extensive and on-going and a more thorough search should be made at a later date of this important technique.

B.4.b.: Towed Electrical Arrays

Shallow-water electrical surveys have been developed to prospect for metallic minerals and to map bottom sediment distribution through sediment density estimates.

B.4.c.: Towed Radiometric Probes

Gamma-gamma probes towed along the bottom have been used to map the distribution of bottom sediment in a way similar to towed electrical resistivity arrays. Design-stage reports of a neutron activation sled for assaying deep ocean manganese modules are also included.

B.4.d.: Other Continuous Survey Methods

Single citations are included here to seed further searches for side-scan sonar and continuous photo-survey towed systems.

B.5.a.: Orienting Devices

A large variety of orienting devices for taking oriented samples have been reported in the literature. The complexity and expense varies greatly.

B.5.b.: Release Mechanisms

Instruments and samplers which are deployed without cables to be recovered when they float to the surface after releasing their ballast serve a variety of categories of devices. Release mechanisms can be bottom-triggered, time-triggered, mechanically-triggered when the measurement sequence is completed, or remotely-triggered from the surface. More examples of release mechanisms can be found in every reference describing ocean-bottom seismometers.

B.5.c.: Other Devices

A collection of miscellaneous items are included which fit categories of their own. Everything from a transponding pebble to core barrel lubricant can be found here.

1

Reviews

l.a.l.

1964: Hopkins, T. L.

A survey of marine bottom samplers. <u>Progress in Oceanography</u>, <u>2</u>, 213-256.

228; BIO

This paper brings together the descriptions of a wide variety of bottom samplers which have been designed both for biological and geological work. Many of these devices no longer see service, but their descriptions are included both for historical interest and as a source of ideas for new equipment. The categories chosen for samplers in this paper are arbitrary and a considerable number of the samplers described can readily fit in several categories (e.g., many samplers classed as piston corers are also gravity corers and numerous samplers classified as manual corers are piston corers as well). The discussion of each device contains a brief account of its essential features, often an evaluation of its performance, and in most cases a line drawing.

105 refs.

Allan Hancock Foundation, University of Southern California, Los Angeles, California.

1.a.2.

1964: Holme, N. A.

Methods of sampling the benthos. Advances in Marine Biology, 2, 171-260.

352; BIO

The grab type of sampler has been modified in various ways to improve its efficiency, but remains the basis of the majority of bottom-samplers.

Core-samplers, which have the advantage of sampling a uniform area at all depths in the sediment, are also sometimes employed, but the majority do not cover a sufficiently large area for sampling the macrofauna.

The choice of a sampler for any given purpose must always be a compromise, based on such considerations as:

(1) The size, density, and habits of the animals to be collected.
(2) Whether qualitative or quantitative samples are desired.
(3) The nature of the deposit.
(4) The size of ship and facilities for working heavy gear.
(5) Whether sampling is to be under open sea conditions and, if so, whether extra time is available so that in the event of bad weather sampling can be postponed until conditions improve.
(6) Depth of water.

There is no instrument which takes really satisfactory quantitative samples on sandy grounds under open-sea conditions. The choice of sampler will depend upon local conditions, but among the most widely used are the van Veen and Aberdeen grabs for quantitative sampling; underwater cameras; and the anchor-dredge for semi-quantitative work. Although widely used on muddy grounds, the Petersen grab is not the best choice on a hard sandy bottom. It is difficult to give a fair estimate of the orange-peel grab's abilities on sandy grounds; it appears to be not too satisfactory. I do not know of any tests comparing the Okean grab with others in common use, but it should be at least as efficient as any other grab of comparable size and weight.

186 refs.

1.a.3.

1969: van Haagen, R. H.

Oceanographic Instrumentation. Handbook of Ocean and Underwater Engineering, J. J. Meyers, C. H. Holm, and R. F. McAllister, eds., McGraw-Hill, N.Y.

181; BIO

The purpose of this section is to provide an annotated listing of the principle types of oceanographic instruments currently in use and to indicate the state of technological advancement in the various kinds of equipment. Many of the instruments now in use were invented decades ago. Although they are mostly mechanical devices, often limited in sensitivity and response time, they are frequently clever in conception and execution. Today's instrument designer may well find in them more to learn from and to emulate than to criticize. Further technological advance in oceanographic instrument design may be expected to derive from the aerospace industry's experience in instrumentation techniques. The results of such "technology transfer" can be expected to yield faster collection, processing, analysis, and presentation of data; higher-quality data; and expanded areas of investigation.

38 refs.

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1.a.4.

1969: Kajak, Z.

Benthos of standing water: survey of samplers. A Manual on Methods for the Assessment of Secondary Productivity in Fresh Water, W. T. Edmonson, ed., IBP Handbook No. 17, Blackwell Scientific, Oxford, 25-57.

343; BIO

Many different samplers have been invented to meet the problems of sampling the very different kinds of bottom material in lakes and oceans, all based on relatively few principles. Any given sampler may be unstable on more than one type of substrate, and a given type of substrate may be accessible to more than one type of sampler. The choice will largely depend on the relative effectiveness and the availability to the investigator. Some samplers can be used only from large boats, while others require personal manipulation by the investigator who enters the water with the apparatus. In the following section, many samplers are mentioned, arranged according to structural type, as far as practicable. Some of the more generally useful are described in more detail. This section will show the reader the range of apparatus which is most generally used or which may become used. The next section makes recommendations about how to sample various types of habitat. On the basis of this information, the reader can decide what sampler or samplers he will want to have. Constructional details can be found in the literature cited. Since few of the samplers mentioned are sold commercially, arrangements must be made to have most of them made. However, some of the most useful samplers can be purchased.

1.a.5.

1971: Bailey, R.J.

Geological sampling of the sea floor. Underwater J., 6(6), 110-119.

007; BIO

This article reviews current methods and some future prospects in geological sampling of the sea floor. It examines critically the techniques for the acquisition of mineralogical, chemical, sedimentological, geotechnical and acoustical data on sea-floor materials, since these data are all ultimately related and collectively reflect the geological character of the sea-floor. Wherever possible, it draws on the accumulated experience in the field of marine geological sampling to suggest techniques likely to yield useful data.

48 refs.

Department of Physical Oceanography, University College of North Wales, Marine Science Laboratories, Menai Bridge, Anglesey.

1.a.6.

1971: Martinais, J.

L'instrumentation scientifique au Centre Oceanologique de Bretagne. Colloque Internationale sur l'Exploit. des Oceans, Theme V, Vol. 1, 11 p.

264;

Scientific instrumentation of the Centre Oceanologique de Bretagne is described, including automatic platforms and machines (oceanographic buoys, autonomous elevators, tripods for bottom studies, towed cylinders with remote-controlled immersion, and autonomous torpedoes for great depths), special samplers (geophysical, geologic, physical, chemical, biological, and biochemical), and the acquisition, treatment, and transmission of data. The method of use of these different instruments and type of data obtained are given. These 3 categories are not at the same stage of evolution; only automatic machines are sufficiently developed to be used for reliable research.

no refs.

Centre Oceanologique de Bretagne, Brest, France.

1.a.7.
1972: Tirey, G. B.

Recent trends in underwater soil sampling methods. Underwater Soil Sampling, Testing, and Construction Control, ASTM STP 501, Am. Soc. Testing and Materials, 42-54.

410; BIO

The recent trend in underwater soil sampling has been toward submersible, remote or diver-operated equipment set on the seabed. Rotary and vibratory drills of these types are described.

Submersible rotary drills: Wimpey drill (hydraulic, diver operated), the Institut François du Petrole drill (electric, remote-controlled, flexible drill pipe), Worth drill (hydraulic, remote controlled), and the Koken drill (hydraulic, remote controlled).

Submersible vibratory drills: U.S. Naval Ordinance Laboratory jackhammer drill (pneumatic), Sanders and Imbrie drill (electric), Alpine vibracorer (pneumatic), and the two corers of Ocean Science and Engineering--the M-30,000 hydraulic Vibra-Corer and the Horton sampler. The submersible incremental corer of the U.S. Naval Civil Engineering lab is also described.

9 refs.

Alpine Geophysics Associates, Inc., Norwood, New Jersey.

1.a.8.

1975: Richards, A. F., H. D. Palmer, and M. Perlow, Jr.

Review of continental shelf marine geotechnics: distribution of soils, measurement of properties, and environmental hazards. Mar. Geotech., 1(1), 33-67.

351; BIO

Vibratory coring is the most common method of sampling shelf sands to depths of about 13 m; greater soil depths are sampled by borings often using drilling and wireline sampling tools. Employment of self-contained or wireline static cone penetrometers to obtain in situ measurements of sands has not been as common in the United States as in Europe. Dynamic piston corers are the most common samplers in cohesive soils, but rotary and hydraulically activated incremental corers are becoming available for marine use. Self-contained or wireline vane shear devices and static cone penetrometers are used for the in situ testing of cohesive soils, and the latter device is also used for cohesionless soils. Dynamic cone penetrometers have been developed and have had limited experimental use at sea. In situ electrical resistivity and nuclear-transmission and backscatter probes have been used in cohesive soils to obtain bulk-density and water-content measurements and for stratigraphic correlation. Acoustical properties of cohesive and cohesionless soils have been measured by in situ probes and have been estimated from results from geophysical surveys made on ships that are under way.

A representative sample of the widely scattered engineering and scientific literature of continental shelf marine geotechnics and geotechnically related subjects has been made to aid marine geologists, geotechnologists, and other specialists.

105 refs.

Marine Geotechnical Laboratory, Lehigh University, Bethlehem, Pennsylvania.

1.a.9.

1977: Pelletier, B. R.

Bottom samples as taken by the hydrographer and the geologist. International Hydrog. Rev., 54(2), 103-124.

130; BIO

Over the past two decades, the hydrographer and the geologist have worked closely together on mutual operations on the Polar Continental Shelf Project in the Arctic ocean and adjacent channels to the east; hydrographers have provided bathymetric data, and the geologist the description of the sea bed. At the Bedford Institute of Oceanography in Dartmouth, Nova Scotia, geologists received bottom samples collected by the hydrographer from many marine areas in Canada, and from this sampling, laboratory work was undertaken and geological reports written. Soon hydrographers and geologists worked together on the interpretation of the sea bottom from an examination of the sounding records and a laboratory analysis of the samples. The results are superior charts of the sea bed.

7 refs.

Geological Survey of Canada, Ottawa, Ontario.

1.a.10.

1979: Bascom, W. N.

Instruments for measuring pollution in the sea. Progress in Water Tech., 4, 99-111.

167; BIO

Many kinds of instruments and sampling devices are needed to determine whether areas of the sea are polluted and to quantify the various pollutants. This paper describes 15 kinds of devices that are believed to be the most effective of those available. They make it possible to measure nearly all the characteristics of the water, the bottom, and the sea life. However, one must appreciate that these instruments will only obtain reliable data if they are operated carefully by experienced technicians. Their use should be part of a well thought out plan of investigation and analysis.

The instruments described here often fall into three general classes, as follows: those for making measurements in the water (current meters, bathythermograph, turbidity meter, floatable sampler, sediment collector, multiple measurements, microbe samplers, and mussel buoy); those for sampling or studying sea life (television and 35 mm cameras, trawls, baited cine camera); and those for examining the bottom sediments (grab samplers, interstitial water sampler, corer and box corer).

no refs.

Southern California Coastal Water Research Project, ElSegundo, California.

1.a.11.

1979: Fowler, G. A. and P. F. Kingston

The use of bottom operating sampling equipment for investigation of the continental shelf. Proc. 1st Can. Conf. Mar. Geotech. Engng., 238-244.

226; Metrology

Bottom samples from the Continental Shalf are sought to assist in the definition of local geology, the preparation of surficial and bedrock geology maps, and the emplacement of offshore bottom-mounted structures. Where the bottom is composed of soft sediments which can be penetrated easily, gravity core samples can be recovered for later analysis or strength characteristics can be obtained in situ using recently developed penetrometers. However, where sediments offer high resistance to penetration, such as those with a high sand or gravel content, or where bedrock approaches the sea floor, specialized coring equipment is required.

To sample bedrock an underwater diamond drill has been developed at the Bedford Institute of Oceanography and for sands and gravels a Vibrocorer has been adapted for use on Institute ships. Field operations with the underwater drill have been carried out since 1972 and since 1975 in the case of the Vibracorer. A considerable amount of field experience has been collected on the operation of the equipment in the ocean environment which has resulted in new developments and extension of capabilities over the original designs. Paramount among these has been the improvement of sampling capability due to advances which have been made in site survey techniques.

Work is continuing to improve the depth of operation of both the drill and Vibracorer, presently set up at 600 m, and to increase the diameter of drill cores.

10 refs.

Atlantic Oceanographic Laboratory, Bedford Institute, Dartmouth, Nova Scotia.

1.a.12.
1979: LeTirant, P.

Chapter V: Seabed exploration coring devices and techniques. Seabed Reconnaissance and Offshore Soil Mechanics for the Installation of Petroleum Structures, (trans. from the 1976 French edition by J. Chilton-Ward), Technip, Paris, 133-217.

171; BIO

While not detracting from the many geological advantages of knowledge of the soils, the present chapter dwells more specifically on the geotechnical aspect which governs the type and importance of the structural foundations to be set up on the site.

The various coring units and techniques used on the continental shelf fall into six categories, depending on the method of implementation, operation, maximum penetration reached, etc.:

- drilling and wireline coring from a surface support (ship or possibly drilling platform); the method uses various coring variants: most often by percussion, fairly rarely by rotation and for a short time now by push into certain consolidated soils,

- drilling and wireline coring using submerged sounding units set on the bottom and operated by divers; this method is limited by the depth of water to which divers can economically be used, namely about 40 m,

- vibracoring achieved by means of hydraulic or electrical vibro-drivers; the penetration depth can vary from a few metres to 10-15 m,

- "flexocoring", derived from the "flexodrilling" method implemented either from a frame on the bottom, or a specially equipped vessel,

- coring by means of sounding units laid on the bottom and remote-controlled, the development of these units is still encountering major technological difficulties, and they are still of inadequate reliability and excessive cost,

- surface coring by means of a gravity corer or stationary piston corer (of the Kullenberg type); the penetration reached varies from a few metres to about 10 or more metres in soft sediment.

23 refs.

Marine Geotechnics Department, Institute Français du Pétrole.

1.a.13.
1979: LeTirant, P.

Chapter VI: Seabed exploration by in situ measurements. Seabed Reconnaissance and Offshore Soil Mechanics for the Installation of Petroleum Structures (trans. from the 1976 French edition by J. Chilton-Ward), Technip, Paris, 218-281.

172; BIO

The increasing difficulties in obtaining undisturbed core samples as depths of water increase are resulting more and more in the recourse to in situ measurements for the reconnaissance of soils at sea. However, one should not lose sight of the fact that whilst in situ measurements, even when carried out under optimum conditions, make it possible to obtain representative and comparative figures, the sampling of cores remains indispensable to the geological knowledge and identification of the soils. Cores and in situ measurements are therefore perfectly complementary.

The in situ measurement techniques and devices (penetrometers, pressuremeters, vanes, drilling logs) used for the reconnaissance of soils at sea are directly derived from devices used on land, only differing in their implementation.

It is proposed in the present chapter to examine in turn the principle, operation, implementation at sea and the interpretation of the results:

- of modular penetrometers,
- of static and dynamic cable operated penetrometers,
- of the Menard pressuremeter,
- of the wireline remote vane,
- of log probes (in particular nuclear) used in the borehole.

16 refs.

Marine Geotechnics Department, Institut Français de Pétrole.

1.a.14.

1980: Rossfelder, A. M., D. Daguise, and R. J. Pollock

Drilling and coring systems for shallow water exploration. Proc. Offshore Tech. Conf., 4, 217-221.

131; BIO

For several years, GEOMAREX has conducted waterborne and tideland drilling to limited penetration depths of 100' to 150' in various areas of the United States and the Pacific. Most of the work was performed in distant sites, generally undrilled, unexplored and often uncharted. These difficult logistics and their demanding sampling requirements led to the development of a new, specific suite of equipment. Upon this experience, GEOMAREX has extended these developments to some new components particularly aimed at shallow water mineral exploration, with the accent on electrical rotary, percussive and vibratory drives.

6 refs.

GEOMAREX

1.a.15.
1979: Sly, P. G.

Equipment and techniques for offsore survey and site investigations. Proc. 1st. Can. Conf. Mar. Geotcech. Engng, 211-228.

414; BIO

In this contribution, the author has chosen to maintain emphasis on "sampling techniques," although it is recognized that the value of site investigations is largely dependent upon a successful blend of sampling techniques, measurement and matched data processing, and predictive interpretation.
An extensive review of survey devices is followed by a brief commentary on their usefulness in Canadian offshore enviroments. The devices are discussed under three broad categories: sample recovery, in situ tests, and continuous geophysical surveys.

Sample recovery includes surface grabs, gravity coring, bottom mounted push corers, bottom-mounted vibratory and impact corers, and bottom mounted drills. In situ tests discussed are penetration tests (standard, static cone, and dynamic penetrometers), vane shear tests, pressuremeter tests, electrical tests (resistivity and self-potential), radiometric tests (natural gamma, gamma-gamma and neutron-neutron), and acoustical measurements. Seismic reflection and side scanning sonar surveys are also mentioned.

The applicability of these techniques to the determination of the geotechnical properties of offshore sediments is discussed at the end of each group of descriptions.

96 refs.

Golder Associates, Burlington, Ontario.

l.b.l.

1967: Scott, R. F.

In-place soil mechanics measurements. Marine Gĕotechnique, A. F. Richards, ed., Univ. of Illinois Press, Urbana, 264-273.

032; BIO

The paper reviews various direct and indirect techniques of obtaining information on the physical properties of ocean-floor soils. Among the direct methods discussed are the vane shearing test, both static and dynamic penetration tests, the "Surveyor" spacecraft surface sampler, a subsurface soil vehicle, and the pressure meter. A brief description is given of the results obtained by attaching a new accelerometer to a coring device.

Indirect approaches to the problem which are mentioned in the paper include acoustic, thermal, nuclear, and magnetic exploration techniques.

47 refs.

California Institute of Technology, Pasadena, California.

1.b.2.

1969: Fletcher, G. A.

Marine-site investigation. <u>Handbook of Ocean and Underwater Engineering</u>, J. J. Meyers, C. H. Holm, and R. F. McAllister, eds., McGraw-Hill, N.Y.

182; BIO

Because the majority of marine construction has been and almost certainly will continue to be land connected, an estimated 90 percent of marine-site investigations are located in water 150 ft deep or shallower. The remaining 10 percent relates to water depths from 150 to 250 ft. Except for deep inland lakes, such as Lake Washington in Washington and Lake Champlain in Vermont, these 10 percent are for offshore drilling platforms, as in the Gulf of Mexico. Investigation operations in water depths from 300 to 1,000 ft have proved feasible but have been undertaken largely for petroleum and mineral prospecting. The equipment and technical knowledge for marine-site investigations in deep water are available and ready for the advance of civil engineering construction into deeper and deeper water.

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1.b.3.

1970: Inderbitzen, A. L.

Marine geotechnique what is it? Oceanology International, 5(12), 19-21.

084; BIO

Marine, or seafloor, geotechnique is a discipline concerned with the dynamics of the sea floor. It includes study of--the rheological and mass physical properties of sub-marine sediments --the natural processes affecting the structure and mechanical behavior of these sediments; and the reaction of seafloor sediments to natural and man-made forces. This is a relatively new field in oceanographic research and incorporates certain aspects of physics, chemistry, geology, soil mechanics, geophysics, and hydrodynamics. Future seafloor construction projects include oil production systems, larger semipermanent multiple-level habitats, mining systems, and other complex, imaginative fabrications.
no refs.

Lockheed Ocean Laboratory, San Diego, California.

1.b.4.

1971: Monney, N. T.

Measurements of the engineering properties of marine sediments.
J. Mar. Tech. Soc., 5(2), 21-30.

274;

Instruments currently used to measure engineering properties of marine sediments in situ are evaluated with respect to actual performance and required accuracies. The inherent difficulties of measuring these properties in the laboratory rather than in situ are reviewed, and test results are provided which indicate existing sampling devices and procedures produce questionable results. Measurement of shear strength of sediments is of particular interest to engineers, and development of an in situ direct shear device is recommended, with a description of how such an instrument could function.

40 refs.

Department of Ocean Engineering, U.S. Naval Academy, Annapolis, Maryland.

1.b.5.

1971: True, D. G.

Determination of engineering properties of ocean-bottom soils by in-situ testing, sampling, and laboratory testing: present and projected capabilities. Proc. Int. Symp. Engng. props. Sea-floor Soils Geophys. Ident., 11-25.

276;

Methods for determining the properties of ocean-bottom soils currently include sampling with gravity and fixed-piston type corers and conducting vane shear, triaxial shear, consolidation, grain size, and Atterberg limit tests on recovered samples in the laboratory, and conducting vane shear, penetration, plate bearing, and long-term settlement tests directly on sediments in situ.

11 refs.

U.S. Naval Civil Engineering Laboratory, Port Hueneme, California.

1.b.6.

1972: Ling, S. C.

State-of-the-art of marine soil mechanics and foundation engineering. <u>U.S. Army Eng. Waterways Exp. Sta. Misc. Rep. S-72-11</u>, 182 p.

262; NTIS-AD-747-366.

An extensive literature search was conducted, and the fields of subbottom exploration, laboratory and in situ testing, soil properties and marine foundation engineering were examined to delineate existing capabilities and limitations. The viewpoint taken was that of a soils and foundation engineer attempting to plan, design, and construct an offshore foundation with the available knowledge and experience. The study was limited to water depths of 600 ft or less.

U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

1.b.7.
1972: Noorany, I.

Underwater soil sampling and testing - a state-of-the-art review. Underwater Soil Sampling, Testing, and Construction Control, ASTM STP 501, Am. Soc. Testing and Materials, 3-41.

018; BIO

The paper reviews the state of the art of underwater sampling and in situ testing. Near surface sampling as well as deep penetration sampling are discussed. In situ testing procedures on the sea floor and their limitations are described.

73 refs.

Department of Civil Engineering, San Diego State College, San Diego, California

1.b.8.
1973: Terry, T. A. and A. F. Richards

Mechanical engineering, geotechnology and research submersible operations. Am. Soc. Mech. Engs. Paper 73WA/OCT-10, 8 p.

267;

Mechanical engineers are introduced to marine geotechnical or sea floor engineering operations from research submersibles by summarizing relevant past and present geotechnical research, presenting 2 case studies, reviewing submersible capabilities and limitations, and identifying several problem areas requiring a mechanical solution. The requirements of 2 basic geotechnical probes for the measurement of shear strength and bulk density of ocean bottom sediments are given to indicate design constraints. The design and development of drive systems to operate these probes from submersibles of quite different size and capability are described. The operation of a vane shear strength probe aboard the large submersible Deep Quest led to successful penetrations of 3.2 m into the bottom mud. Several mechanical configurations were used for the operation of a transmission nuclear densitometer aboard both the Deep Quest and the small submersible Alvin; penetrations were made to a depth of 1.5 m from each submersible.

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Marine Geotechnical Laboratory, Lehigh University, Bethlehem, Pennsylvania.

1.b.9.

1974: Bjerrum, L.

Geotechnical problems involved in foundations of structures in the North Sea. Norg. Geotek. Inst. Publ. no. 100, 1-28.

417;

Owing to the development of oil and gas fields in the North Sea, the Norweigian Geotechnical Institute has in recent years become involved in extensive investigations of the sea bed. Work has been carried out to obtain geotechnical information relevant to the design of offshore constructions such as platforms, bridges and pipelines. This paper examines the behavior of the sea bed beneath such structures which are of unprecedented size and which may give rise to problems of a type which has never been tackled before. These problems, which include the stability of structures resting on fine sand where it is necessary to make predictions of the undrained bearing capacity of footings on the sand, and of the effect of repeated wave loads on structures and foundations, are dealt with in this paper.

68 refs.

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1.b.10.
1974: Silva, A. J.

Marine geomechanics: overview and projections. Deep-Sea Sediments., A. L. Inderbitzen, ed., Plenum Press, N.Y., 45-76.

329; BIO

Until recently, most geotechnical studies of deep-sea sediments have been necessarily concerned with the upper few meters, and comprehensive studies aimed at determining basic stress-strain parameters in relation to sediment processes are scarce. There are important differences between some deep-sea sediments and most fine-grained terrestrial soils including compositional differences and differences due to rate of deposition, pressure, and temperature. Some diagenetic processes are reviewed along with a brief discussion of the factors which affect microstructure. Detailed studies of sediment microstructure coupled with geochemical and engineering studies may yield valuable insight into the basic mechanisms involved in sediment diagenesis as well as stress-strain behavior.

Simple strength measurement systems such as vane shear and cone penetrometer can only be viewed as indicators of gross strength properties. The Mohr-Coulomb theory used in conjunction with triaxial methods of testing gives satisfactory results for engineering applicaitons. In order to study basic stress-strain behavior, it is recommended that a more sophisticated yield theory, such as is embodied in the critical state method, and appropriate compatible testing procedures be used to develop predictive mathematical models of sediment behavior.

The author's experiences with a large diameter long piston corer (up to 40 m) indicate that good quality sediment cores can be obtained in deep water (up to 5600 m). The recovered cores (maximum length of 30.5 m) showed considerable vertical variation in sediment properties and anomalous zones of high water content coincident with high shear strength. These anomalous zones are related to micro-structural changes observed with the scanning electron microscope and correlate with acoustical reflectors on the 3.5 kHz record.

46 refs.

Worcester Polytechnic Institute, Worcestor, Massachusetts.

1.b.11.
1975: Richards, A. F.

Research on the mass physical and engineering properties of deep-sea sediments: final report 1969-1973. Office of Naval Res. Contract N00014-67-A-0370-0005, NR 083-248.

075; BIO (NTIS AD A016 657)

The most notable achievements during the period of the contracts are the:

1. Development and use of the first self-contained equipment to measure:

   a. shear strength by an in situ vane at a water depth of 3.6 km
   b. bulk density directly and water content indirectly by an in situ nuclear transmission densitometer at a water depth of 3.6 km
   c. pore-water pressure by an in situ differential piezometer at a water depth of 280 m.

2. Development and use of an in situ cone penetrometer to measure shear strength at a water depth of 3.6 km.
3. Extended development of the laboratory and in situ vane shear test leading to the working hypothesis that differences in laboratory and in place tests may be the result of differences in test method or procedure rather than differences in materials or in the stress environment of the material tested.

4. Discovery that excess pore pressures may occur in normally consolidated seafloor sediments. It is postulated that slope stability analyses ought to be based on effective stress rather than total stress methods of analysis.

5. Discovery that measurement of bulk density and calculation of water content and effective overburden pressure in unopened sediment core barrels and in situ is eminently practical, and provides a superior method of analyzing the consolidation (dewatering) of sediments than by using results of laboratory consolidation tests for the solution of seafloor geological processes.

6. Discovery that the apparent overconsolidation of seafloor sediments may be more a function of test method and depth of sample testing than a condition of sediments.

7. Demonstration that the integration of relevant geophysical, geotechnical, and geochemical methods can lead to a major improvement in the quantitative knowledge of seafloor processes.

8. Discovery, using second-generation equipment based on first-generation ONR design, that sediment core shortening may be the results of densification (dewatering by sampling). Core shortening is non-linear, if it exists at all, in predominently clayey sediments and linear in predominently silty sediments.

1.b.12.

1975: Inderbitzen, A. L.

State-of-the-art summary for session T-11: marine soil mechanics and Foundations II. Proc. Civil Engng. in the Oceans III, Am. Soc. Civil Engineers, 1, 486-489.

322; BIO

There are two areas that still lack proper definition before significant advancements can be made in the field of marine geotechnique. One involves the instrumentation and tools to do the job and the other involves our understanding of the phenomena we study.

To date, we still use extremely crude and club-like tools to obtain samples or make measurements. We expect scientific accuracy from antiquated equipment. The situation is analogous to expecting 200 km/h speeds from a 1903 Ford. Our technological demands have greatly outdistanced our technological accomplishments in instruments. The challenge to engineers today should be to design and produce the sophisticated instrumentation we need for (1) obtaining truly undisturbed samples of sea floor materials and/or (2) being able to make all our measurements in-place directly on and in the sea floor.

We still have not developed proper instrumentation or tools to be able to go deeper than about 2 m into the bottom to make in-place measurements of physical properties or to obtain samples without major disturbance. Systems are in existence which give us a suite of in-place measurements of various physical properties of the surficial sediments on the sea floor, but as we all know, these systems are only prototypes and they are not to the sophisticated level that we need. Nor do they offer the depth of penetration into the sea floor that is needed. I offer a challenge to all present and other engineers, design better equipment so that we can obtain the accurate data we need in order to precisely predict the reactions of the sea floor to induced stresses.

no refs.

College of Marine Studies, University of Delaware, Lewes, Delaware.

1.b.13.

1976: Hitchings, G.A., H. Bradshaw, and T.D. Labiosa

The planning and execution of Offshore site investigations for a North Sea gravity platform. Proc. Offshore Tech. Conf., 1, 61-69.

016; BIO

The planning and execution of offshore investigations to collect bathymetric, topographic and geotechnical information at proposed gravity platform sites in the North Sea is discussed. In particular, platform site selection criteria, required field data, and the rational for the evaluation and selection of surveying equipment are outlined. Procedures used during actual surveys and recommendations for improving future investigation are also included.

no refs.

Conoco North Sea, Inc.

b.14.

1977: Cox, W. R.

Definitive studies on engineering properties of marine sediments: problem description. Atlantic Offshore Users Workshop, Univ. of Delaware College of Mar. Studies Publ. DEL-SG-11-77, 292 p.

086; BIO

There is a need for a basic understanding of those engineering properties of marine sediments that can be studied in isolation. The program should be comprehensive and include theoretical analysis, in situ test procedures and instrumentation, improved core sampling techniques, and laboratory testing. The proposed research and development effort should focus on:

a. Research to improve the understanding of engineering properties of marine sediments such as creep strength, short-term shear strength, liquefaction, damping, change in strength and material properties under dynamic and static loading, and compressibility.

b. Development of comprehensive laboratory and in situ instrumentation and standardized techniques for determining realistic dynamic and static loads.

c. Development of improved core sampling equipment and techniques to provide relatively undisturbed soil samples for laboratory testing.

no refs.

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1.b.15.

1977: deRuiter, J.

Planning an offshore soil investigation. Pet. Eng., 49(5), 112-120.

104;

The drilling of production wells offshore may cause an adverse change in foundation conditions, due in part, to mud losses. Consequently, improved soil survey techniques have been developed, particularly in connection with North Sea installations. This article surveys such techniques and cites aspects needing further study.

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Fugro-Cesco, Leidschendam, The Netherlands.

1.b.16.

1977: Focht, J. A. and M. K. Leland, Jr.

Progress in marine geotechnical engineering. J. Geotech. Engng. Div., (ASCE), 103(GT10), 1097-1118.

107;

This paper highlights the progress during the past 30 yr in several subareas of marine geotechnical engineering, which includes pipelines, small footing structures such as jack-up rigs, gravity structures, piles, object penetration and break-out resistance, seafloor stability, and geotechnical data acquisition. The progress is illustrated using a number of significant events subsequent to World War II, such as hurricanes, planning for projects in new geographic areas, installation of specific structures, and initiation of major research.

53 refs.

McClelland Engineering Inc., Houston, Texas.

1.b.17.
1977: Sangrey, D.A.

Marine geotechnology - state of the art. Mar. Geotech., 2, 54-80.

010: BIO

The state of the art in marine geotechnology can best be defined with reference to what is known about soils on land. Differences between these two states of knowledge are the significant problems for the marine environment. Among the major problems addressed in this paper are (a) Sampling of soils, which involves much more serious disturbance than is considered acceptable on land. Disturbance results from several uniquely marine factors including total stress release and drilling mud overpressure. (b) Underconsolidation, or excess in situ pore pressure, caused by rapid rates of sedimentation, gas, leaks from an artesian pressure source, or cyclic loading. (c) Gas in sediments, which can cause an increase in the in situ pore pressure, hinders subsurface investigation, and is a major cause of sample disturbance. (d) The difficulty and necessity of in situ measurements. (e) The predominance of dynamic loading effects which can cause significant changes in soil behavior. A major difference between geotechnical engineering on land and in marine areas is the use of effective stress methods. Significant improvement in geotechnical engineering offshore can be achieved through the increased use of effective stress methods. Illustrations of these improvements are presented in this paper with particular reference to the problems of submarine slope stability.

55 refs.

School of Civil and Environmental Engineering, Cornell University, Ithaca, New York

1.b.18.

1978: Chari, T. R.

Instrumentation problems related to determining geotechnical properties of ocean sediments. <u>IEEE J. of Ocean Engng.</u>, <u>OE-3(4)</u>, 120-127.

046; BIO

The extraction of most oceanic resources including the methods and economics is influenced by the nature and type of the ocean floor as well as the extent to which the geotechnical properties of the ocean bed can be confidently evaluated. In the near-shore and inner continental shelf zones, methods for such evaluation are mostly extensions and modifications of he conventional procedures used onshore. With the expansion of offshore activities into deeper zones, new techniques are needed for preliminary and detailed evaluation of ocean bed characteristics if operations in these deeper regions are to be viable.

In recent years, there has been a proliferation in the instrumentation for offshore environments. Geotechnical engineers generally have limited exposure to sophisticated instrumentation techniques, nor are the instrumentation engineers fully conversant with details of geotechnical measurements and their application. This paper reviews the methods currently used for evaluating geotechnical properties of the ocean floor including sampling (corers, etc.), in situ testing (shear vanes, penetrometers, etc.), and indirect (seismic, acoustic, etc.) techniques. The type of data that a geotechnical engineer generally wishes to obtain, the problems in obtaining them, and the application of the data in practice are briefly reviewed.

102 refs.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

1.b.19.

1978: Dayal, U.

Recent trends in underwater in situ soil testing. IEEE J. Ocean Engng., OE-3(4), 176-186.

355; BIO

It is recognized that currently available underwater soil sampling techniques provide a disturbed sample for laboratory analysis, especially for shear strength testing which is a useful parameter in designing and assessing the behavior of offshore structures. Test results have indicated that the ratio of in-situ vane to laboratory vane strengths varies from one to more than three. Hence, measurement of the soil strength properties in-situ is suggested as a means of enhancing data quality. Available significant information concerning the recent trends in underwater in-situ soil testing has been summarized.

Each of the direct methods described has or will have its place in meeting needs for deep-penetration in-situ testing below the ocean floor. Each method also has its limitations, either physical capacity, suitability, availablility or economic feasibility. For example, the vane shear test is not applicable to sand and inorganic silt. The pressuremeter is to be used in a cased borehole. The cone penetrometer test does not yield any soil sample for physical identification and other laboratory tests. The penetration capacity of the rig. The selection of any one of these methods should be based on site and project requirements.

50 refs.

D'Appolonia Consulting Engineers, Inc., Pittsburg, Pennsylvania.

1.b.20

1979: Andersen, A., T. Berre, A. Kleven, and T. Lunne

Procedures used to obtain soil parameters for foundation engineering in the North Sea. Mar. Geotech., 3(3), 201-266.
088;

Field equipment, drilling, sampling, and in situ and laboratory soil testing procedures are described. Laboratory testing onboard, run simultaneously with the sampling operation, is stressed. Future trends and desirable developments are outlined. Manned and unmanned submersibles are being used to conduct shallow sampling and in situ testing. Remote controlled drilling rigs and piston samples are being developed for use with seafloor jacking units. The cone penetration test is expected to maintain a dominant role in North Sea site investigations. Calibration efforts are under way to increase the value of cone penetration testing, and the pressuremeter test is being adapted for offshore use. The simple shear has been extensively used for North Sea soil testing. More emphasis will be placed on cyclic soil stress-strain behavior at low strain levels to study the dynamic soil-platform interaction and structure fatigue aspects.

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Norwegian Geotechnical Institute, Oslo.

l.c.l.

1967: Richards, A. F.

Basic literature of marine geotechnique and related fields. Marine Geotechnique, A. F. Richards, ed., Univ. of Illinois Press, Urbana, 319-323.

033; BIO

A short, selected list of sources of published information covering the fields of marine geotechnique, marine geology, ocean engineering, and soil mechanics are given that may be of use to persons considering marine geotechnical investigations.

Persons knowledgeable in both terrestrial soil mechanics and marine geology have become interested in marine geotechnique in recent years. Tremendous opportunity exists for newcomers in this challenging field because the ocean floor constitutes about 71 percent of the earth's surface. This paper was written to help introduce either a marine geologist or a marine soils engineer to the basic literature in each field, as well as to relevant published information on oceanography in partial answer to numerous inquiries. I will be well satisfied if this list dispels some of the initial dismay that often results from the newcomer's finding the basic references so widely scattered in the engineering and scientific literature.

1.c.2.

1971: McIntyre, A. D.

Efficiency of benthos sampling gear. International Biol. Handbook No. 16, N. A. Holme and A. D. McIntyre, eds., Blackwell Scientific, Oxford, 140-146.

349; BIO

Sampling eficiency is a useful concept only when referring to quantitative or semi-quantitative gear. Most dredges, defined as collecting instruments which are towed along the bottom, are at best semi-quantitative.

The concept of efficiency is more meaningful for true grabs, which may be defined as instruments lowered on (ideally) a vertical warp from a stationary ship, to take a deposit sample of a given surface area. In this context the term efficiency tends to be used loosely to cover various purely functional aspects of an instrument's general performance and digging characteristics, as well as its ability to produce an acceptable picture of animal number and distribution. Although all these uses of the term are obviously related, they should not be confused.

From the purely functional aspect, coring devices have a high digging performance and most tend to be relatively reliable in that a particular instrument of a given weight will usually provide consistently similar lengths of core, depending on the type of sediment sampled. The main difficulty may be the loss of the core during ascent, and on sandy grounds a core retainer is usually required.

As a means of providing quantitative data on the fauna, the main criterion of a corer's efficiency must be the accuracy with which the collected core represents the sediment column as it was in situ. A pecularity of gravity open-barrel corers is that the length of the core retrieved may be considerably less than the penetration depth of the tube into the sediment. The shortening ratio (core length: penetration distance) may be 0.5 or less for long cores, and this ratio depends on the weight and dimensions of the corer as well as on the type of sediment.

1.c.3.
1974: Hamilton, E. L.

Prediction of deep-sea sediment properties: state-of-the-art. Deep-Sea Sediments, A. L. Inderbitzen, ed., Plenum Press, N.Y., 1-43.

198; BIO

Prediction of sediment surface properties in deep-sea sediments falls into two categories: (1) a sediment sample is available, or (2) location, only, is provided. Given a sediment surface sample in which water content, grain size, and grain density can be measured, porosity and density can be computed or measured. Given only a dried sample, grain size data provide predictive relations with the other properties. Having derived one or more of these properties, velocity of compressional waves can be predicted within about 1 to 2% because of its relations with grain size and porosity. Given certain restrictive conditions, reflection coefficients and bottom losses at normal incidence can be computed. All of these properties can be corrected to in situ conditions. With less confidence, values of compressional wave attenuation can be approximated because of relations with grain size and porosity, and values of elastic properties (e.g., shear-wave velocity) can be computed. The values of attenuation and the elastic properties require additional confirmation by future in situ measurements. There is apparently no useable relationship between soil mechanics shear strength and velocity, but there may be a relation between dynamic rigidity and attenuation of compressional waves.

This report will present previously unpublished results of measurements of sediment physical properties by the writer (since 1970), and will discuss the present state-of-the-art in predicting some properties. Those properties considered are indicated in table and text headings. They are mostly acoustic and related physical properties. Previous reports by the writer contain numerous references to the pertinent literature, and no attempt is made to compile an exhaustive bibliography.

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U.S. Naval Undersea Center, San Diego, California.

1.c.4.

1977: Collins, V. G.

Methods in sediment microbiology. Advances in Aquatic Microbiology, Vol. 1, M. R. Droop and H. W. Jannasch, eds., Academic Press, N.Y., 219-272.

297; BIO

74 refs.

Freshwater Biological Association, Ambleside, Cumbria, U.K.

2

SAMPLERS

2.a.1.

1958: Birkett, L.

A basis for comparing grabs. J. Cons. Perm. International pour l'Exploration de la Mer., 23, 202-207.

209: BIO

In 1953 I made two comparative tests, using four grabs in all, from the research vessel "Sir Lancelot" on the Dogger Bank. The four grabs were as follows, all sampling $0.2m^2$.

(a) Petersen ---- the grab used by DAVIS (1923, 1925).

(b) van Veen-type grab (THAMDRUP, 1938). This departs from the original design in being operated by chains of fixed length instead of warps.

(c) and (d) van Veen grabs, operated by endless warps running over pulleys. In series (c) the grab had side-plates to prevent loss of material during closing, as suggested by ORTON (1925). No previous tests of this device are recorded. In (d) the side-plates were removed.

At each station the "Sir Lancelot" was anchored, so that substantially the same community was sampled throughout the series of hauls.

9 refs.

Fisheries Laboratory, Lowestoft, U.K.

2.a.2.

1963: LeRoy, L. W.

Pressure-disc sediment sampler. J. Sed. Petrology, 33, 944-945.

065; BIO

Many types of "grab bucket" and "clamshell" bottom-samplers have been designed and used for obtaining unconsolidated, subaqueous sediments. They vary widely in mechanical complexity-particularly in the cocking and release principles. To this diversified group the writer adds another variety--one that was used (1935) while establishing a bottom-sediment traverse across Peper Bay on the west coast of Java. Operations were performed from a small boat under sail at 2 knots. One hundred and thirty-two samples (depths 10 to 30 feet) of mud, silt, fine- to coarse-grained sand, and coral debris were collected in as many attempts.

The sampler (20 pounds) is shown in figure 1. Successful operation of this unit depends on (1) the cylinder being at least 0.3 inch iron (preferably chrome steel to minimize rusting), (2) the end of the trigger point so tapered that it is easily released from the perforated overlapping ends of the cocking arms, (3) the pressure disc at least 2.5 inches in diameter, (4) the cable brackets attached on opposite sides of the cylinder to maintain its alignment and balance, and (5) the trigger stem of such length that when the sampler is cocked, the pressure disc does not extend beyond the bottom of the cylinder.

To insure tighter closure of the appartus, weights may be added to the lower part of the cylinder segments.

no refs.

Department of Geological Engineering, Colorado School of Mines, Golden, Colorado.

2.a.3.

1965: Gallardo, V. A.

Observations on the biting profiles of three 0.1 m^2 bottom-samplers. Ophelia, 2(2), 319-322.

140; BIO

Observations were made on the mode of biting of three widely used bottom samplers: the Petersen, van Veen, and Smith & McIntyre grabs. Air-to-ground trials were conducted with the 0.1 m^2 models on hard and soft substrata. Examination of grab bites revealed that the Petersen and van Veen grabs dig deeper along the edges of the bite. The van Veen grab gave the most rectangular cuts in both types of substrata. The performance of the Smith & McIntyre sampler is considerably affected by the consistency of the substratum, with the sampler digging deeper in the middle of the sampling area in soft substratum and cutting less deeply but more rectangularly in firmer sediments. While the bite patterns of the first two grabs are relatively similar in both soft and hard substratum, the Smith & McIntyre bite pattern differs considerably. In the first two, biting profiles seem to be a reflection of their particular closing mechanisms, while the Smith & McIntyre bite pattern is further affected by the substratum consistency.

7 refs.

Department of Zoology, University of Concepcion, Chile.

2.a.4.

1965: Lassig, J.

An improvement to the van Veen bottom grab. J. Cons. Perm. International pour l'Exploration de la Mer., 29, 352-353.

022; BIO

In the wide soft bottom areas of the Baltic the van Veen grab is a good sampler, being easy and quick in operation. However, there is a great disadvantage when operating this sampler in a rough sea, because of the tendency to premature closing.

On board the R.V. "Aranda" I have used the 0.1 m^2 van Veen grab with an improved release mechanism. The first model of this mechanism was made by my friend, the late Nils-Olof LAURELL, Lic. phil. For two summers I have used similar ones made of stronger material and found the construction very convenient. It is simple and may be recommended for use in unsheltered waters. Corresponding constructions for other samplers are reviewed by HOLME (1964).

An arm with a pilot weight hanging on the end of a flexible wire is fitted to the release hook of an ordinary van Veen sampler (Fig. 1). Only when the weight strikes the bottom does the hook release the mechanism by which the grab is held in the open position, and the buckets can be closed when the grab is lifted up. The length of the arm is 35 cm, that of the wire 71 cm, and the pilot weight being about 2 kg. However, the construction has to be balanced for a particular sampler by varying the length of the arm and the wire. The material used for the arm should be light and strong. It is most practical to make the arm longer than necessary, and then gradually cut it down to the correct length. If the locking pin is used the sampler can be set already when the vessel is under way towards a station, so that the grab is ready for lowering when the ship reaches the station. I have not had an opportunity to try the construction under very severe conditions, but at a wind force of 6, with the ship heading to the wind, we have taken good samples without difficulty.

1 ref.

Institute of Marine Research, Helsingfors, Finland

2.a.5.

1965: Lie, U. and M. M. Pamatmat

Digging characteristics and sampling efficieny of the 0.1 m^2 van Veen grab. <u>Limnol. and Oceanog.</u>, <u>10</u>, 379-384.

139; BIO

Replicate samples were collected with a 0.1m^2 van Veen grab during high tide and by hand-digging during low tide on an intertidal sandflat. The volume of sediment in the grab samples was measured; the coefficient of variation from replicate series varied from 7.4 to 20.3%, with a mean for all stations of 13.4%. Digging characteristics of the grab were studied by SCUBA-divers under water, and by an experiment on a sandy beach. It was concluded that the jaws approached each other horizontally when closing rather than digging a semi-circular cut. The shock-wave of the grab appeared to be negligible for the infauna included in this study.

Sample counts for the most abundant species obtained by digging and with the grab were compared. In only 8 out of 37 cases was there a significant difference between the two sets of samples. The vertical distribution of the fauna in the substrate in terms of numbers and biomass was studied.

12 refs.

Department of Oceanography, University of Washington, Seattle, Washington.

2.a.6.

1966: Prokopovich, N. P.

Ecologic sampler for soft sediments. Ecology, 47(5), 856-858.

165; BIO

The sampler consists of an open, rectangular box with a moveable, reinforced plastic bottom. It is lowered and advanced into the sediments in an opened condition by pushing with the supporting rods or by its own weight if lowered on a cable. The plastic bottom with a sharp cutting edge is then released to undercut and hold the uppermost 3 to 6 in. of sediments inside the sampler for retrieval. The device was successfully tested in the fall of 1965 and proved to be efficient and easy to operate.

1 ref.

U.S. Bureau of Reclamation, Sacramento, California.

2.a.7.

1967: Wigley, R.L.

Comparative efficiencies of van Veen and Smith-McIntyre grab samplers as revealed by motion pictures. Ecology, 48, 168-169.

002; BIO

Two commonly used benthos samplers, van Veen and Smith-McIntyre, were tested to detect possible adverse characteristics for sampling epibenthic animals. A strong hydraulic disturbance (shock wave) was formed below the van Veen sampler as it descended through the water toward bottom. In this sampler the shock wave was sufficiently strong to force aside unattached benthic animals as long as 8 cm. The Smith-McIntyre sampler created only a weak, oscillatory shock wave. Available information indicates that, under standard operating procedures, the smaller the screened opening in the top of the sampler's jaws the stronger the shock wave.

8 refs.

Bureau of Commercial Fisheries Biological Laboratory, Woods Hole, Massachusetts.

2.a.9.

1969: Sly, P. G.

Bottom Sediment sampling. Proc. 12th Conf. Great Lakes Res., International Assoc. Great Lakes Res., 883-898.

047; BIO

Tests with sampling equipment during 1967 and 1968 in Lake Ontario showed that some of the bottom samples were badly disturbed. As a result of tese tests, further extensive trials of bottom sampling equipment were conducted in Georgian Bay in 1968. These were designed to test the disturbance of the bottom sediments caused by ship movement and to test the efficiency and suitability of various types of sampling devices. It was found that under typical sampling conditions, bottom disturbance was induced by the ship when the total water depth was less than about 6 m. It was also found that the ship, during typical sampling procedures in deeper water, induced disturbance in the water column, beneath it, to a depth of at least 14 m. Tests were conducted with three types of Gravity corer, two multiple corers, and six Grab samplers. These tests were designed to show their usefullness for both biological and geological samplings. All three gravity corers proved efficient for particular tasks. The most successful bottom grab samplers were found to be the Ponar grab and the Shipek bucket sampler.

6 refs.

Canada Centre for Inland Waters, Burlington, Ontario.

2.a.10.

1970: Flannagan, J. F.

Efficiencies of various grabs and corers in sampling freshwater benthos. J. Fisheries Res. Bd. Can., 27(10), 1691-1700.

193; BIO

None of several samplers compared in limited tests in Lake Ontario gave realistic estimtes of benthos in all substrates encountered. The Ponar and shipek grabs, the only samplers that functioned in gravel, came closest to all-sediment samplers. In sand, however, the Franklin-Anderson grab appeared to be much more efficient than either of these two samplers. In mud the Ekman grabs gave the highest mean numbers of animals per m^2.
In trials in Lake Winnepeg profundal mud, hand-taken diver's core samples being used as a quantitative standard, only the Fisheries Research Board multiple corer and the standard Ekman grab gave quantitative results for total macrobenthos. However, the multiple corer collected significantly few chrionomids, and the standard Ekman grab signicantly fewer oligochaetes, than did the diver's cores. There were indications that the tall Ekman grab was either not tall enough or too heavily weighted for use in soft sediments and that a small improvement in design could make both this and the standard Ekman more efficient. Most of the samplers apparently sampled some groups of organisms much bettern than others. Neither the Ponar grab nor the tall weighted Ekman grab sampled the chironomid or oligochaete populations satisfactorily. However, both grabs indicated densities of sphaeriids not significantly different from the diver's samples.

9 refs.

Fisheries Research Board of Canada, Freshwater Institute, Winnipeg, Manitoba.

2.a.11.

1970: McKinney, T. F. and G. M. Friedman

Continental shelf sediments of Long Island, New York. <u>J. Sed. Petrology</u>, <u>40</u>, 213-248.

282; BIO

The samples represent surficial sediments which have been collected with grab-sample devices; a few samples were from short cores. Most of the samples were collected with the Phipps underway grab sampler (Fig. 2). This device is an open-ended tube with tail fins at the rear so that it will tow horizontally while the ship is underway. When sample is required, the tube is lowered to the bottom. When the front of the tube strikes the bottom, a weak link (a few strands of cotton cord) breaks. A sample enters the front of the tube and is collected by a bag at the opposite end of the tube. After the weak link breaks, the tube becomes inclined to the vertical because of the shifting of the point of attachment from the mid-length balance point to the front of the tube. Some of the samples, most of those taken in 1965, were taken with a simple bucket-type grab sampler which was dragged on the bottom. A few samples were from the upper few centimeters of short cores collected by a vibrating corer which operated on tanks of compressed air.

Hudson Laboratories of Columbia University, Dobbs Ferry, New York.

2.a.12.

1971: Holme, N. A.

Macrofaunal sampling: grab sampling and suction sampling. International Biol. Handbook No. 16, N. A. Holme and A. D. McIntyre, eds., Blackwell Scientific, Oxford.

348; BIO

For sampling the macrofauna, samplers covering a surface area of 0.1 or 0.2 m^2 are commonly used, several samples being taken to aggregate to 0.5 or 1 m^2 per station. Samples of this size are usually considered adequate for quantitative determinations, measurements of biomass etc. (see pp. 8 and 142), but do not adequately sample scarcer species, particularly of the epifauna. Moreover some faster moving species escape the grab altogether. It is therefore advisable to supplement grab estimates of the epifauna by hauls with an Agassiz or small beam trawl fitted with a fine-meshed net, or by underwater photography, television or diving.

In view of the manifest deficiencies, particularly as regards penetration of hard-packed deposits, of so many bottom samplers, it is not possible to recommend any single instrument as suitable for general use. Much will depend on such factors as size of ship and hoisting gear available, the type of sediment to be sampled, depth of water, and whether sampling in sheltered waters or in the open sea. A great variety of instruments have been described, and choice will no doubt depend largely on what is already available or can be obtained without difficulty.

It is proposed to considered briefly a number of samplers which are in general use at marine laboratories, some others used for special purposes or which may be used for calibration, and then to make some recommendations on choice of a sampler.

Sixteen samplers are described and evaluated.

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2.a.13.

1973: Ellis, J. P.

Report on a new underway sediment sampler. Woods Hole Inst. Oceanog. Tech. Rept. 73-35, 26 p.

290; BIO (NTIS-PB-224-499/4GA)

The "Phipps Underway Grab Sampler" is a 72 inch long, open ended pipe, having an internal diameter of 2 inches. Two fins are welded to one end of the sampler allowing it to tow horizontally (Fig. 3). A 5 inch long cloth bag is fastened to the after end of the sampler, behind the stabilizer fins. While the sampler is being lowered, the point of wire tension application is kept at the mid-body point by means of a cotton string "weak link". This configuration forces the sampler to assume a slightly nose down attitude during lowering. When the sampler strikes the bottom, the "weak link" breaks; sediment enters the tube and is collected in the cloth bag, into which a plastic bag has been stapled. After the "weak link" breaks, the sampler attains a vertical posture, the towing point having shifted from the mid-length balance point to the front of the sampler (McKinney and Friedman, 1970).

The basic design of the Phipps sampler was modified to accomplish several objectives: The sampler's length was shortened to 31 inches to facilitate handling. The mouth was widened to increase sediment intake. Three reversed fins were used to improve towing characteristics. The mid-body towing plate was modified to allow the point of attachment for the "weak link" to be shifted slightly to either side of the balance position. Finally, a ring was welded around the fin assembly to keep the nose of the sampler in the sediment (Fig. 4).

10 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.a.14.

1974: Beukema, J. J.

The efficiency of the Van Veen grab compared with the Reineck box sampler. J. Cons. Perm. Internationale pour l'Exploration de la Mer, 35, 319-327.

312; BIO

To test the efficiency of the 0.2 m^2 Van Veen grab, 200 comparative samples at 5 stations off the Netherlands coast were taken with this grab and with the 0.06 m^2 Reineck box sampler.

Numbers and size of the macrofaunal benthos species and at two stations, also biomasses, were compared. Burrowing depth of the various species could be observed from the undisturbed box samples.

Depth penetration in the box sampler was invariably more than 15 cm. This was sufficient to catch all infaunal species completely.

Depth penetration in the grab depended on the type of the sediment. The tests were made in the sediment with the worst penetration, viz. 5-6 cm in relatively fine sand.

Most species were restricted to the top 5 cm of the sediment and were sampled equally well with both instruments.

Individuals of some species were also found at depths between 5 and 10 cm. The numbers of the following species needed a relatively small correction to obtain good estimates of their densities from grab samples: large specimens of both Tellina fabula and Venus gallina, Ensis phaxoides, Pectinaria spp., and Nephtys spp.

The rear ends of the tube building Lancie conchilega were found as deep as 20 cm. A very small proportion of these worms actually present were sampled by the grab.

The epifaunal species may have been underestimated by both instruments. The highly mobile species were sampled in relatively higher numbers by the grab.

14 refs.

Netherlands Institute for Sea Research, Texel, The Netherlands.

2.a.15.

1975: Christie, N. D.

Relationship between sediment texture, species richness, and volume of sediment sampled by a grab. Mar. Biol., 30, 89-96.

402; BIO

This paper discusses the problems involved in obtaining grab samples for direct comparison of the respective benthic fauna, using information from a survey conducted across the South African Continental Shelf below the Benguela Current. Many factors influence the depth of grab penetration into the sediment and, hence, the grab sample volume. One of the most important of these factors is sediment texture. While this fact has been long recognised, most workers have attached little significance to it. It is shown here that an exponential relationship exists between the grab sample volume and sediment texture, until the minimum percentage of silt plus clay that will give a maximum grab sample volume is reached. This relationship only extends to a certain depth, in this case to 280 m. There are more species per unit number of specimens ("species richness") in association with sand or muddy-sand than with mud. A linear relationship is given between the grab sample volume and species richness between the depths of 280 and 440 m, inclusive.

25 refs.

Deparment of Zoology, University of Cape Town, Cape Town, South Africa.

2.a.16.

1976: Hunter, B. and A. E. Simpson

A benthic grab designed for easy operation and durability. J. Mar. Biol. Assoc. U.K., 56(4), 951-957.

245; BIO

Experience leading to the formulation of a design specification for a new benthic grab is briefly described. The engineering design philosophy and essential features of the grab are outlined, and its operation described. Some detail design features are explained and operating experience and comparative trials reported. The relative merits of the new grab are suggested.

1 ref.

The Department of Mechanical Engineering, The University of Leeds, U.K.

2.a.17.

1978: Tyler, P. and S. E. Shakley

Comparative efficiency of the Day and Smith-McIntyre grabs. Estuar. Coastal Mar. Sci., 6, 439-445.

369; BIO

The efficiency of the recently introduced Day grab is compared with that of the Smith-McIntyre grab. The volume of sediment retrieved by the Day grab varies with sediment texture. No significant difference is found between the grabs for the sampling of the shallow burrowing infauna, but deeper-burrowing species are sampled more efficiently by the Day grab. This grab also proves to be more reliable for use in inclement conditions.

16 refs.

Department of Oceanography, University College of Swansea, U.K.

2.a.18

1968: Kutty, M. K. And B. N. Desai

A comparison of the efficiency of the bottom samplers used in benthic studies off Cochin. Mar. Biol., 1, 168-171.

401; BIO

The efficiency of the van Veen and Foerst "Petersen" grabs used in sampling the bottom fauna near the Cochin Harbour area has been compared in two selected stations having different hydrographic and substratic conditions. The results indicate that the heavier grab is generally more efficient that a lighter one, especially when the substratum is sandy. An examination of the quantity of the sediment and the total number of species brought by the two grabs showed that the design of the van Veen is superior to the "Petersen" type grab used in the present study. However, due to the highly patchy distribution of the organisms the superiority of the van Veen was less evident when a comparision was made of the total numberof animals sampled by the two grabs. When the distribution is "bunched" it is suggested that samples are drawn, as far as possible, from the same sampling position. The grabs should also be of the same weight and biting area.
12 refs.

Biological Oceanography Division, National Insitute of Oceanography, Ernakulam, India.

2.b(1).1.

1940: Pettersson, H. and B. Kullenberg

A vacuum core-sampler for deep-sea sediments. Nature, 145(3369), 306.

347; BIO

The first instrument, constructed during last summer in the workshop of this Institute and put to practical tests in the fall of the same year consisted of 2 m. length of steel tubing, 2 in. wide, closed at its upper end and having a water-tight piston at its lower end, released by trigger action as soon as it touched the sediment surface. The air was pumped out of the tube before immersion, so that the piston, followed by a column of sediment, was able to move up to the upper end without compressing any air behind it, which might otherwise expand and push out the core on hauling up the sampler to the surface. The tests made with this first sampler proved the release to function well, and the tube was filled with sediment: but at depths exceeding 150 m. the shock due to the impact from the piston proved too severe for the steel bolts securing the lid to the upper end of the tube. Moreover, the looser kinds of sediments were sucked into the tube, before it had time to descend completely into the sediment.

A modified instrument was accordingly constructed with a cylindrical container of much wider bore attached to the upper end of the tube. The container is evacuated, whereas the tube itself is completely filled with water which, after the release, is free to enter the container through a nozzle of a more or less narrow bore, according to the depth in which the sample is to be taken. Thus the rate at which the tube sinks into the sediment can be made practically equal to the rate at which the sediment core mounts into the tube.

1 ref.

Oceanographic Institute, Göteborg.

2.b(1).2.

1941: Emery, K. O. and R. S. Dietz

Gravity coring instruments and mechanics of sediment coring. Bull. Geol. Soc. Am., 52, 1685-1714.

147; BIO

A gravity-type coring apparatus, which is used on the research vessel E. W. Scripps of the Scripps Institution of Oceanography for taking sediment samples of the ocean floor, is described. With this instrument more than 200 cores have been taken in many types of sediment. The 174 mud cores have an average length of 6 feet, 3 inches and a maximum length of 16 feet, 9 inches.

Data from a number of experiments and from field coring operations were analysed in order to improve the design of the device and to permit proper interpretation of core samples. A detailed study was made to explain the observation that the length of the cores averaged about 50 per cent of the depth of penetration of the core barrel. Laboratory coring experiments using mud of uniform water content show that, as the core barrel penetrates the mud, progressively smaller increments of core are added througout the entire depth of penetration. However, studies of cores taken on a tidal flat and others obtained in field operations show that the size of core increments per unit of penetration remains practically constant with increasing penetration.

10 refs.

Scripps Institution of Oceanography, LaJolla, California.

2.b(1).3.

1941: Piggot, C. S.

Factors involved in submarine core sampling. Bull. Geol. Soc. Am., 52, 1513-1524.

146; BIO

The unconsolidated condition of deep ocean-bottom sediments and their remoteness from the operator place definite limitations upon the design of apparatus and the technique of obtaining core samples of them. The varved clays of glacial lake bottoms, while not identical with deep-ocean sediments, are sufficiently similar to warrant some comparisons and provide a means of estimating the factors affecting the validity of a core taken from the ocean bottom. Tests indicate that cores are not so long as the instrument penetration but that they contain material from depths greater than the core length. Relationships have been established that indicate the corrections that must be applied to an ocean-bottom core and require only the measurement of the core itself.

3 refs.

Geophysical Laboratory, Carnegie Institution of Washington, Washington, D.C.

2.b(1).4.

1946: Hvorslev, M. J. and H. C. Stetson

Free-fall coring tube: a new type of gravity bottom sampler. Bull. Geol. Soc. Am., 57, 935-950.

184; BIO

A new method of operating gravity-coring tubes has been developed and tested. By means of a pilot weight and release mechanism, the coring tube with drive weight and guide vanes is released at a predetermined distance above the sea bottom and allowed to drop freely through the water. It thereby gains considerable velocity and momentum, and the energy available for forcing the tube into the sediments may be increased in this manner. This method of operation has proved to be especially valuable in coring firm sediments, in which hitherto it has been difficult to obtain a satisfactory depth of penetration with a coring tube whose downward velocity is governed by the safe speed at which a cable may be payed out. Two coring tubes of this type have been built for the Woods Hole Oceanographic Institution, and cores of bottom sediments obtained in the North Atlantic Ocean at depths up to 2250 fathoms. The general theory and details of construction and operation and some of the results obtained are described.

11 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).5.

1951: Phleger, F. B.

Ecology of foraminifera, northwest Gulf of Mexico Part I. Foraminifera distribution. Geol. Soc. Am. Memoir 46, 1-88.

327; BIO

A bottom sample was taken at each station with a simple instrument which obtains a short, relatively undisturbed core of sediment in a plastic liner tube. The sampler consists essentially of four parts, a steel or brass tube, a plastic liner, fins, and lead weight. The tube is constructed of steel or brass and has an outer diameter of 1 5/8 in., inner diameter 1 ½ in. Approximately 30 lbs. of molded lead is fastened to the outside of the steel tube to provide weight to force the sampler into the sediment. Four fins are fastened to the steel tube above the lead weight. The lower end of the steel tube is fitted with a brass sleeve containing a threaded connection so that the tube below the weight can be detached and replaced. This is advisable becuase the end of the tube may become damaged if it hits a hard object. There is a hardened steel cutting edge which fits on the lower end of the tube by a bayonet-type lock.

The liner for holding sediment is composed of clear, extruded plastic tubing of cellulose acetate butyrate having an outer diameter of 1½ in. and an inner diameter of 1 3/8 in. A simple "core-catcher" device is constructed of leaf-shaped pieces of thin spring brass which are soldered on a 1/4-inch section of brass tubing having inner and outer diameters equal to the plastic tube. This is placed in the lower end of the plastic tube with the leaves of spring brass inside the tube. The action of this device is to prevent the sediment from sliding out when the sampler is pulled from the bottom material. The plastic liner and core-catcher rest on a flange of the detachable cutting edge; the inside diameter of the cutting edge is the same as the inside diameter of the plastic tube.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).6.

1952: Heezen, B. C.

Methods of exploring the ocean floor: discussion. Oceanog. Instru., J. D. Isaacs and C. O'D. Iselin, eds., Nat. Res. Connc. Publ. 309, 200-205.

342; BIO

In 1948 Professor Maurice Ewing and Mr. Angelo Ludas of Columbia University modified a Hvorslev-Stetson free-fall corer to use tubes of greater diameter (2½" diameter) and to take a piston according to the principle described by Kullenberg (1947). In subsequent years they have further improved and modified the instrument. Figure 1 is a drawing of this apparatus as constructed at present. Figure 2 (modified Hvorslev, 1949) diagrammatically shows its operation. From the experience of using the piston corer to obtain over 600 cores (figure 3) in the North Atlantic it has been modified and improved until now it is an efficient, convenient instrument. One of these improvements is the wire clamp by which the tripping mechanism is attached to the main trawl wire. Before the addition of this clamp a serious problem was encountered in getting the apparatus aboard after it was brought back from the ocean floor since the coring head was hanging about 60 feet below the tripping device on a separate wire. Now all that is necessary is to remove the clamp and winch in the wire.

Telling when instruments are on bottom is extremely difficult and often next to impossible. With the free-fall corer this problem is usually not serious. As long as the core trips properly and the dynamometer is working, even in very deep water an experienced man can have little doubt when contact is made. A careful observer can observe the tripping of a free-fall core if the weight of the core equals or exceeds approximately 10% of the weight of the wire. Figure 4 is a reproduction of a tension vs. wire paid out plot of a type made on each lowering on Lamont Geological Observatory cruises. A great advantage of the free-fall core is the sharpness of the contact signal made by the momentary release of the entire weight of the core from the trawl which sends a jerk up the wire.

no refs.

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

2.b(1).7.

1955: Bader, R. G. and R. G. Paquette

A piston coring device for sediment sampling. University of Washington Department of Oceanog. Tech. Rept. # 41, 18 p.

085; BIO

A new piston corer is described which is a modification of the Kullenberg coring tube, but eliminates some of the disadvantages of the latter. A cable-clamping device termed a piston immobilizer, prevents the upward movement of the piston after penetration into the sediments has ceased. This prevents drawing in large quantities of sediments from a single level. The collapse of the liner tube and leakage at the liner joints are eliminated and disruption of the core sample is kept to a minimum. An improved core-retaining device and a flange connector between weight stand and core barrel are also described.

4 refs.

University of Washington Department of Oceanography, Seattle, Washington.

2.b(1).8.
1960: Hersey, J. B.

Acoustically monitored bottom coring. <u>Deep-Sea Res</u>., <u>6</u>, 170-172.

068; BIO

An adaptation of the sound pinger designed by EDGERTON to position an underwater camera for bottom photography has been used to monitor bottom coring operations with a Stetson corer. It is found that the pinger portrays the whole procedure in considerable detail, including the triggering of the corer for free-fall at the bottom. Cores have been taken successfully in water depths of 1912 and 2635 fathoms in the Ionian Sea.

4 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).9.

1961: Mills, A. A.

An external core-retainer. Deep-Sea Res., 7, 294-295.

227; BIO

This note describes a device which, by replacing the conventional retainer in the above corers, facilitates the collection of undisturbed samples from a variety of sediments. Two models have been developed for use with deposits of varying consistency - one for stiffer sediments, the other for the more fluid silts or sands.

The construction and mode of operation of this apparatus are shown in the illustrations. The corer is lowered in the open position A. Penetration in excess of a pre-determined length (6 in. has been found satisfactory) forces the collar upwards, allowing the supporting arm to spring free of the catch. Upon withdrawal from the sediment the sliding weight drives the retainer down the coring tube, over the bevelled edge of the cutting head, into the closed position B. When hauled inboard the corer is held vertically, the core-retainer carefully displaced, and a tightly-fitting cork disc pushed through the cutting head into the plastic liner. The latter, with the enclosed core, is then easily removed and sealed.

3 refs.

Institute of Oceanography, Dalhousie University, Halifax, Nova Scotia.

2.b(1).10.

1961: Richards, A. F. and G. H. Keller

A plastic-barrel sediment corer. Deep-Sea Res., 8, 306-312.

073; BIO

The design of the apparatus, called the Hydroplastic corer, is more or less conventional. The corer is adaptable for use with or without a piston by respectively removing or installing a check valve screwed to the top of the weight stand. Neoprene gaskets under PVC attachment bolts and a sponge-rubber gasket at the top end of the barrel provide an adequate water seal to enable the valve to be effective. Whether operated with or without a piston, an appropriate release mechanism is recommended for use with the corer to permit free-fall operation.

15 refs.

U.S. Navy Hydrographic Office, Washington, D. C.

2.b(1).11.

1964: Burns, R. E.

A note on some possible misinformation from cores obtained by piston-type coring devices. J. Sed. Petrology, 33, 950-952.

078; BIO

A simple qualitative experiment has been conducted in an attempt to determine possible misinformation on sediment sequence that could result from improperly functioning piston corers. An attempt was made to evaluate some of the possible varieties of core disturbances that can occur, but no determination of the probability of various types of misfunction was attempted. Three different conditions were tested: I--the piston was stopped at the water/sediment interface; II--the piston was not stopped until it was below the water/sediment interface; and III--the piston was stopped before reaching the water/sediment interface. The cases of full and partial penetration of the core barrel were tested for each conditions. In all cases, retrieval of the core was made by pulling upward on the wire fastened to the piston.

In the cases examined, it appears that is major difficulty is with the non-deactivated piston; but it also appears that additional difficulties are introduced by the impossibility of precise adjustment of the position of the piston at the time of impact.

4 refs.

U.S. Coast and Geodetic Survey, Washington, D.C.

2.b(1).12.
1964: Emery, K. O. and J. Hülsemann

Shortening of sediment cores collected in open barrel gravity corers. <u>Sedimentology</u>, <u>3</u>, 144-154.

066; BIO

Significant field data bearing upon the mechanics of sediment coring are provided by photographic studies, mechanical recording, detailed stratigraphy, radiocarbon dating, and temperature measurement of the sediment. These data indicate that cores obtained by open barrel gravity corers are shorter than the depth of penetration and that the final ratio of core length to penetration is characteristic of the entire process of coring. The in situ depth of most clayey sediments is approximately twice the depth within the core.

14 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).13.

1964: Heezen, B. C.

Discussion of "A note on some possible misinformation from cores obtained by piston-coring devices". J. Sed. Petrology, 34, 699-700.

344; BIO

With few exceptions investigators with even modest experience can easily recognize core material which is in improper sequence as a result of the processes described.
The experienced operator plans to core a little water above the sediment and to adjust the apparatus so that the core will be taken under Burns' condition 3. One always avoids getting mud on the piston in the coring apparatus for this is a good indication that penetration of the upper layer may have been blocked by the piston (resulting in Burns' condition 2). For this reason, a small gravity core is usually attached to the trigger weight so that a positive identification of the surface sediments can be made. The piston should always be examined for mud and this information noted in the log. If mud is found on the piston, proper readjustments must be made to prevent this occurrence in subsequent coring.

Considerable effort has been expended by various workers in developing piston arresters designed to immobilize the piston before withdrawal of the core from the sea floor. This prevents additional sediment from flowing into the barrel during withdrawal. It is claimed that use of an arrester will avoid possible confusion in the later interpretation of the sedimentary sequence. However, it does not seem that an immobilizer is necessary, for the sediment which is sucked into the core barrel has an entirely different structure than that which is actually cored. The flowing of the sediment produces an artificial vertical streaking which even in rather homogenous sediment is quite obvious, and if the "flow in" is overlooked in the wet core by an unobservant technician, the vertical grain of the dried sediment is an obvious giveaway.

no refs.

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

2.b(1).14.

1964: Van den Bussche, H. K. J. and J. J. H. C. Houbolt

A corer for sampling shallow-marine sands. Sedimentology, 3, 155-159.

067; BIO

The paper describes a new coring device in which a core barrel attached to a weighted, streamlined "bomb" that by a free fall from a height exceeding 7 m can penetrate up to 1.5 m of shallow marine sands. The corer is automatically inverted on being withdrawn from the sea bed, so that the loose sands are retained in the core barrel as the corer is hoisted aboard ship. The corer can be operated from a small launch or fishing vessel.

no refs.

Koninklijke/Shell Exploratie en Produktie Laboratorium, Rijswijk, The Netherlands.

2.b(1).15.

1965: McManus, D. A.

A large-diameter coring device. Deep-Sea Res., 12, 227-232.

070; BIO

A 15 cm-diameter coring device of polyvinyl chloride has been developed and successfully tested with barrels as much as 6 m in length. No sediment distortion was observed. The large-diameter corer is especially useful for obtaining samples for radiocarbon dating and other analyses requiring large volumes of sediment.

13 refs.

Department of Oceanography, University of Washington, Seattle, Washington.

2.b(1).16.

1966: Burns, R. E.

Free-fall behavior of small, light-weight gravity corers. Mar. Geol., 4, 1-9.

056; BIO

The increasing use of small, light-weight gravity corers equipped with free-fall devices, has raised the question of applicability of the optimum free-fall distance criteria originally established for large, heavy corers. Measurements have been made of the free-fall velocities of several devices representative of the class of small corers. These data indicate an optimum free-fall setting of 2-3 m, with general caution indicated on the minimum setting and specific caution indicated on the maximum for corers not fitted with stabilizing fins.

7 refs.

Coast and Geodetic Survey - University of Washington, Joint Oceanographic Research Group, Seattle, Washington.

2.b(1).17.

1966: Jonasson, A. and E. Olausson

New devices for sediment sampling. <u>mar. Geol</u>., <u>4</u>, 365-372.

249; BIO

A wide variety of marine bottom samplers are designed for both biological and geological research. A guide to the literature can be found in a paper by HOPKINS (1964). Here, below, new kinds of the grab type sampler and the gravity corer are described. They have been devised for our scientific and marine-technological studies of the sediment-water interfaces and the uppermost sediment layers.

Grab type samplers are devices with boxes that are forced shut by weights, lever arms, springs, or cords. Our type uses lever arms.

In order to get the orientation of box samples, a self-locking compass has been deviced (Fig. 2).

In order to obtain thick, undisturbed cores of the uppermost part of the sediment layer a gravity corer with a barrel of polyvinyl chloride (PVC) was designed (Fig. 3, 4). It can also be used as a piston corer.

4 refs.

Institution of Oceanography, University of Gothenburg, Sweden.

2.b(1).18.

1966: Kermabon, A., P. Blavier, V. Cortis, and H. Delauze

The "sphincter" corer: a wide-diameter corer with watertight core-catcher. Mar. Geol., 4, 149-162.

141; BIO

A long, wide-diameter corer with a watertight core-catcher is described.
The main new features of this corer are:

(a) A "Sphincter-type", nylon core-catcher, which seals the cores within a watertight container during retrieval.

(b) A split piston, which prevents suction of the core when the corer is retrieved from the sediments.

This paper also describes an electrical release system which prevents accidental triggering due to sudden shocks, thereby making it safer than other systems when working in heavy seas.

The design of this corer is close to those theoretically ideal proportions generally accepted as providing minimum sample disturbance.

The equipment has worked successfully, and little or no disturbance has been observed in the cores taken with it.

10 refs.

SACLANT Anti-submarine Warfare Centre, LaSpezia, Italy.

2.b(1).19.

1966: Rosfelder, A. M. and N. F. Marshall

Obtaining large, undisturbed, and oriented samples in deep water. Marine Geotechnique, A. F. Richards, ed., Univ. of Illinois Press, Urbana, 343-363.

220; BIO

A multiplicity of causes of sample disturbance during coring, retrieving, and handling hinders obtaining true undisturbed cores in deep water. However, most of these causes can be reduced in such a way that, for specific analytic purposes, a well-preserved sample can be obtained and considered as satisfactorily "undisturbed." Recent trends in sedimentological and geotechnical procedures result in marine corers with larger diameter and with sample orientation. Attempts were made in improving and modifying several devices for taking large, well preserved, and orientated cores in deep water. These developments, trials, and tests at sea led to the design of modified and improved coring assemblies and also to some new conceptual designs which are presented here.
39 refs.

Scripps Institution of Oceanography, LaJolla, California.

2.b(1).20.

1967: Ewing, M., D. E. Hayes, and E. M. Thorndike

Corehead camera for measurement of currents and core orientation. Deep-Sea Res., 14, 253-258.

059; BIO

The corehead camera is an instrument designed for use with the piston coring apparatus. It has been used for determining the direction and strength of the bottom currents and for core orientation. Results from the central North Pacific indicate that bottom current velocities are of the order of 1-2 cm/sec. Manganese nodules were photographed on the bottom and have been disturbed by the coring operation. Other transient bottom effects can be monitored.

9 refs.

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

2.b(1).21.

1967: Ross, D. A. and W. R. Riedel

Comparison of upper parts of some piston cores with simultaneously collected open-barrel cores. Deep-Sea Res., 14, 285-294.

069; BIO

Although some marine geologists have reported that open-barrel gravity cores are shortened relative to the upper sections of simultaneously collected piston cores, the opposite relationship is shown by virtually all correlatable pairs of the two types of cores collected in recent years by the Scripps Institution of Oceanography. This inconsistency is apparently due to slight differences in the coring apparatus or technique used by the various workers. Because of these differences, no simple correction factors can be used to convert measured lengths in recovered cores to in situ distances below the sediment surface. The effects of the coring process on the mass physical properties of the sediments in three simultaneously collected open-barrel gravity and piston core-pairs are evaluated.

19 refs.

Scripps Institution of Oceanography, LaJolla, California.

2.b(1).22.

1967: Richards, A. F. and H. W. Parker

Surface coring for shear strength measurements. Proc. Civil Engng. in the Oceans (ASCE), 445-488.

183; BIO

Gravity and piston coring equipment and methods currently in use for obtaining quality surface samples of fine-grained soils from the ocean floor are evaluated in terms of disturbance affecting the shear strength. The methods are applicable to shallow-water sites, but since conventional drilling and sampling techniques are successful in shallow water, emphasis is placed on the recovery of samples from very deep water. Reasons for sample disturbance are cited to indicate features that should be considered in the design of samplers to minimize disturbance. Accepted standards for the design of samplers are reviewed and summarized. It is concluded that conventional marine piston samplers have undesirable features that disturb cores more than the disturbance encountered in properly designed open-barrel gravity samplers. A table summarized the relationship between the sample quality and the method of sampling.

78 refs.

Deparment of Geology, University of Illinois, Urbana, Illinois.

2.b(1).23.

1967: Woodruff, J. L.

A device for releasing a piston corer and deactivating the piston.
Deep-Sea Res., *14*, 809-810.

071; BIO

A device is described for releasing a piston corer, holding the piston cable during free fall and penetration, and deactivating the piston by dropping the piston cable. Combined in the instrument are a cocking and triggering device, a safety catch, and a closed-system timing cylinder with a needle valve that controls circulation of oil and thereby regulates the time the piston cable is held. The device eliminates the complexity, unreliability and much of the time involved in the use of previous deactivators.

4 refs.

Department of Oceanography, University of Washington, Seattle, Washington.

2.b(1).24.

1968: Bouma, A. H. and J. A. K. Boerma

Vertical disturbances in piston cores. Mar. Geol., 6, 231-241.

058; BIO

Piston cores collected from the Atlantic Ocean and from the shelf off Surinam appeared to have vertical disturbances in their lower part in about 40% of all cases. The phenomenon could be detected in most cases after the core had been split lengthwise and when the sediment was dried out sufficiently so that small textural differences stood out. Fresh cores were examined by means of X-ray radiography.

The change from normal "horizontal" sedimentary structures into vertical line patterns is sudden. It is most likely that these disturbances originate by the upward motion of the piston during the first stage of pulling up of the coring device, which leads to sucking up of sediment. (When dealing with hard sediments, the penetration may be little and the corer may fall over, thus pulling up the piston.)

7 refs.

Department of Oceanography, Texas A. and M. University, College Station, Texas.

2.b(1).25.

1968: Burke, J. C.

A sediment coring device of 21-cm diameter with sphincter core retainer. Limnol. and Oceanog., 13, 714-718.

122; BIO

The coring device consists of four basic sections. A weight stand weighs 85 kg. The core barrels are 21.3 cm in inside diameter. A valve at the top of the core barrel opens during coring. A nose cone with core cutter and a core catcher are at the leading edge of the core barrel.

The corer can be used from small boats and has been used successfully to water depths of 600 m to recover cores of one meter in length.

6 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).26.

1968: Chmelik, F. B., A. H. Bouma, and W. R. Bryant

Influence of sampling on geological interpretation. Trans. Gulf Coast Assoc. Geol. Soc., 18, 256-263.

304; BIO

Examination of samples taken on the northwest slope of the Gulf of Mexico with a newly developed flexible liner coring device indicates a possible source of error in the interpretation of recent basin deposition. Visual and radiographical comparisons of samples from a piston corer and a gravity corer used at some stations confirms the existence of highly incompetent layers previously only suspected. The detection of these layers in a more consolidated sedimentary column as well as undetected shortening of samples obtained by piston and gravity corers is important if the sedimentary history and the engineering properties are to be examined.

The major feature of this corer is the use of a flexible liner to minimize wall friction. This liner completely encases the core as it enters the barrel and prevents any part of it from coming in contact with the inside wall of the barrel. the liner retards fluid loss by its impermeability, keeps the core layers in place by adhesion and cohesion, and makes it possible to treat the core and its liner as a single and separate unit. In theory, the "barrel" could be replaced by a simple structural arrangement of rods whose only requirement would be to push the core head into the sediments.

The corer is generally similar to the Kullenberger and Ewing devices in that it is a gravity, free-fall, piston corer. The primary difference is in the use of the flexible liner. Although the concept of the flexible liner was developed independently by at least three other investigators, this work, originally started at Texas A & M University in the spring of 1965, appears to be the earliest.

6 refs.

Department of Oceanography, Texas A. and M. University, College Station, Texas.

2.b(1).27.

1968: Inderbitzen, A. L.

A study of the effects of various core samples on mass physical properties in marine sediments. J. Sed. Petrology, 38(2), 473-489.

095; BIO

In this study, samples collected by seven different corers at the same location were measured for shear strength, water content, and unit weight. Of the three properties measured, unit weight appears to be least affected by sampling disturbance. In repeatability of measurements none of the corers tested was significantly superior to any of the others. Each corer tested appeared to yield good results for at least one of the measured properties but yielded the poorest results on another property. No definite trend between disturbance across a core section could be established in connection with kind of corer, depth in the core, or variability in shear strength. Apparently the effects of dessication and tensional disturbance to a core do not necessarily radically alter all of the mass physical properties of a core.

In comparing laboratory data measured on samples obtained from one corer with data obtained by another, a variable factor must be introduced. The factor appears to vary with the property being compared and the depth within the core.

17 refs.

Lockheed Ocean Laboratory, San Diego, California.

2.b(1).28.

1968: Isaacs, J. D. and D. M. Brown

"Bootstrap" corer. J. Sed. Petrology, 38(1), 159-162.

125; BIO

The characteristics and construction of a large, light, coring tool capable of penetrating ocean sediments to a depth of at least 5 to 7 meters are described. The new device, termed a "bootstrap" corer, features: (1) light weight (approx. 140 kg. for a tube 7 meters long), (2) simplicity, (3) large internal diameter (approx. 13 cm), (4) powerful "vacuum" operation, (5) deep penetration, (6) a novel piston and pullout relief mechanism that minimizes pullout forces, and (7) a not abnormal degree of distortion of the sediment sample. The device demonstrates principles applicable to a number of feasible devices for penetrating the sediments, such as corers, imbedment anchors, sediment "motors" and the like, and principles suitable for the improvement of other existing corers.

no refs.

Scripps Institution of Oceanography, LaJolla, California.

2.b(1).29.

1968: Onorati, R. P.

The 1/2 mono 1/2 corer: a wide diameter, general purpose, gravity coring tool. M.Sc., U.S. Naval Postgrad. School, Monterey, California, 52 p.

089; (NTIS AD 694 412)

A gravity corer in its simplest form consists of a tube with a check-valve at the upper end which is driven into the sediment by encircling weights in order to obtain a sample. At many oceanographic institutions where a variety of research is undertaken relative to the ocean bottom, an efficient and reliable general purpose coring device is required. Such a device should enable the biologist, geologist, sedimentologist, or engineer to obtain a sample which meets his particular requirements. A simple gravity corer fits many of these needs. The gravity corers in use at the present time have not significantly changed from the earlier corers. Even the most reliable of gravity corers are not without some drawbacks. An attempt is made herein to solve some of these problems and produce and reliable, easy to handle, general purpose, gravity coring tool useful for all phases of oceanographic research.

13 refs.

U.S. Naval Postgraduate School, Monterey, California.

2.b(1).30.

1969: Kermabon, A. and U. Cortis

A new "sphincter" corer with a recoilless piston. Mar. Geol., 7, 147-159.

142; BIO

The "Sphincter" corer developed by KERMABON et al. (1966) was intended as an improvement over most of the existing piston corers. It included the following two original features:

(a) A "Sphincter-type" nylon core catcher, which seals the cores within a watertight container during retrieval.

(b) A split piston, which prevents suction of the core when the corer is retrieved from the sediments.

However, this corer had the defect inherent to all heavy piston corers that after release the piston does not remain stationary.

A simple system for monitoring the piston relatively to a fixed platform lying on the sea floor is described here. The device involves only cables and thin pulleys and can be adapted to any existing "Sphincter" corer.

The equipment has worked successfully and little or no disturbance could be observed in the cores.

3 refs.

SACLANT Anti-submarine Warfare Centre, LaSpezia, Italy.

2.b(1).31.

1969: Patton, K. T. and G. T. Griffin

An analysis of marine corer dynamics. J. Mar. Tech. Soc., 3(6), 27-40.

040; BIO

An analysis of marine corer dynamics was performed by the authors as part of the physical oceanography program at the Navy Underwater Sound Laboratory. The computer program developed from this analysis is being used to predict the performance of new corer designs and to determine distortion of previously obtained core samples. This analytical model is offered to the ocean science community as a first approximation to marine corer dynamics.

7 refs.

U.S. Navy Underwater Sound Laboratory, New London, Connecticut.

2.b(1).32.

1970: Winterhalter, B.

An automatic-release piston for use in piston coring. Mar. Geol., 8, 371-375.

009; BIO

An automatic-release piston has been developed to replace the conventional fixed piston/wire combination used in Kullenberg-type corers.

At the end of penetration of the corer into the sediment this piston breaks into two parts. The acutal piston is jammed in place by spring-actuated barbs that are pressed into the P.V.C. core liner. The released upper portion to which the piston wire is attached, is free to move up against the piston stop at the top of the barrel before the corer is pulled out and brought to the surface. In the case of incomplete penetration, core disturbances due to suction caused by the movement of a conventional piston during pull out are thus eliminated.

5 refs.

Geological Survey of Finland, Otaniemi, Finland

2.b(1).33.

1970: Woodruff, J. L.

A self-deactivating piston for a piston corer. Ocean Engng, 1, 597-599.

072; BIO

Described is a piston containing an internal valve that is closed during penetration and open during extraction of the corer. It requires no cocking or other preparatory steps before use, and prevents liner collapse, core distortion, and consequent erroneous interpretation of the core materials as sometimes occurs when a conventional piston is used (i.e. without a deactivator).

5 refs.

Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii.

2.b(1).34.

1971: Dixon, F. S.

Marine technician's handbook: gravity coring. Scripps Institution of Oceanography Ref. 71-9, 14 p.

092; (NTIS COM 71 01022)

Gravity coring is presented as one of the cheapest and easiest means of obtaining samples of ocean-bottom sediment. The gravity corer consists of a valve, weight stand, barrel, plastic liner, catcher, and cutter.

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Scripps Institution of Oceanography, Institute of Marine Resources, La Jolla, California.

2.b(1).35.

1971: Holme, N.A.

The Butler corer. <u>International Biol. Handbook</u>, N.A. Holme and A.D. McIntyre, eds., Blackwell Scientific, Oxford, U.K. 289-290.

024; BIO

The simple corer, Fig. A.6, has been used by B.I. Butler and Miss S. Tibbits of the Marine Biological Laboratory, Plymouth, for sampling <u>soft</u> <u>estuarine</u> <u>muds</u>. It is made of brass, with a perspex lining tube. Its construction should be within the capabilities of most laboratory workshops.

Overall length, 70 cm;
Internal diameter of brass tube, 3.5 cm;
Internal diameter of perspex lining tube 2.5 cm, length 52.5 cm;
Weight 7 kg, plus 6 kg of lead weights.

no refs.

Marine Biological Association, Plymouth, U.K.

2.b(1).36.

1971: McCoy, F. W. and R. P. Von Herzen

Deep-sea corehead camera photography and piston coring. Deep-Sea Res., 18(3), 361-373.

060; BIO

The operation of a piston corer, and its effectiveness in taking deep-sea samples, has been studied by mounting cameras and other instruments within a corehead. Analysis of data collected during 63 stations would suggest that during descent the only significant motion of the corer was vertical oscillation. Free-fall and penetration was usually completed in less than 5 seconds, accompanied by rotation of 20° to 60° and a change of about 6° in vertical deviation. A large sediment cloud produced during penetration disturbs the surrounding sediments. While in the bottom, the corer generally remained motionless. Considerable rotation occurs with pull-out and during ascent, with frequent discharges of sediment from the nose of the piston corer.

No consistent relationship was found between the length of core recovered and the amount of penetration. The position of the mud-mark appears to be a reliable indicator of the amount of penetration; estimates by extrapolation of the thermal gradient to the sediment surface from heat-flow measurements are less reliable. Where comparisons were possible, the piston cores have been shortened and disturbed relative to the pilot cores, and as much as a meter of the upper portion of the piston core may be lost. Bedding dips in the recovered cores correspond poorly to the vertical deviation of the piston corer in the bottom.

33 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).37.

1972:

Piston coring. _Scripps. Inst. Oceanog. Inst. Mar. Resources Tech. Rept. 38_, 39 p.

302;

Descriptions and istructions for using piston corers to obtain relatively undisturbed ocean floor samples are given. The small-diameter Kullenberg piston corer and the improved large-diameter piston corer are treated separately. Although the 2 operate similarly when in the water, differences exist in assembly and in launching.

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Institute of Marine Resources, Scripps Institution of Oceanography, La Jolla, California.

2.b(1).38.

1972: McCoy, F. W., Jr.

An analysis of piston coring through corehead camera photography. Underwater Soil Sampling, Testing, and Construction Control, Am. Soc. Testing and Materials Spec. Tech. Publ. 501, 90-105.

212; BIO

Cameras were mounted within the corehead of a piston sampler to photograph coring operations at 35 stations in the North Atlantic ocean. Through the analysis of these photographs, the operation of the corer during descent, tripping, impact with the bottom, and ascent has been studied, providing information on its effectiveness in obtaining a representative sample of sub-marine soil and its influence on the surrounding sea floor. Direct determinations of the amount of penetration were possible, allowing comparisons to be made with the indirect methods of determining penetration and with the length of core recovered. These comparisons indicated that the piston cores were shortened and disturbed, often with as much as a meter of surface material missing. No consistent relationship was found between the length of core recovered and the amount of penetration. Dips of layers within the core evidently had been produced by the coring process. Problems in piston immobilization are discussed relative to these results and a number of recommendations made for decreasing core disturbances.

33 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

2.b(1).39.

1973: Hollister, C. D., A. J. Silva, and A. Driscoll

A giant piston-corer. Ocean Engng., 2, 159-168.

111; BIO

A new large piston-coring device utilizing well-casing pipe 14 cm (o.d.), 11 cm (i.d.) has obtained cores over 20 m in length in water depths of 100 to 5000 m. Recovery ratios range from 0.76 to 0.87. Penetration varies between 24 and 29 m with a total core weight of 3200 - 4000 kg and 2 to 3 m of free fall.

10 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).40.

1973: Silva, A. J. and C. D. Hollister

Geotechnical properties of ocean sediments recovered with giant piston corer. 1. Gulf of Maine. J. Geophys. Res., 78(18), 3597-3616.

112; BIO

A large-diameter (14 cm) long piston corer (20-40 meters) has been used successfully to obtain relatively undisturbed sediment samples in water depths from 80 to 5500 meters with recovery ratios ranging between 0.76 and 0.87. The first recovered core (KN-10-1) was taken in the Stellwagen basin, western Gulf of Maine, at 81-meter water depth using a pipe length of 33.5 meters and total core weights of 3500 kg. The 21.74 meters of recovered sediment is black, gray to olive green silty illitic clay. Visual observations and results of consolidation studies indicate that structural disturbance to the sediments was not severe, that it is normally consolidated, and that no postdepositional compaction occurred. Another core (KN-27-1) was taken about 3 km east of the first core location, and 19.5 meters of sediment were recovered. An anomalous zone in core KN-10-1 reveals high water content (96%) and high shear strength (260 g/cm^2). A marked abundance of diatoms may explain the high water content, and the highly flocculated nature of the abundant clay minerals observed with a scanning electron microscope accounts for the high shear strength. A similar anomalous zone in core KN-27-1 occurs where the water content is 53% and shear strength is about 250 g/cm^2. Preliminary correlations with the 3.5 kHz subbottom profiles suggest that changes in both texture and water content may produce reflecting horizons.

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Department of Civil Engineering, Worcester Polytechnic Institute, Worcester, Massachusetts.

2.b(1).41.

1974: Driscoll, A. H. and C. D. Hollister

The W.H.O.I. giant piston core: state of the art. Proc. Mar. Tech. Soc. 10th Conf., 663-676.

170; BIO

In the fall of 1969 the Woods Hole Oceanographic Institution initiated a Giant Coring program aboard the Canadian cable laying ship the JOHN CABOT. Since then the Giant Core has been successfully launched and recovered from the Woods Hole Oceanographic Institution Research vessel KNORR in a variety of water depths and sea surface conditions. The longest continuous core sample recovered has been a 41.58 meter sample, of which 31.28 meters was non flow-in.

The success of the Giant Core operation has been due in part to the excellent facilities available aboard the KNORR and to the specialized handling apparatus mounted along the rails. Using this apparatus and the ship's station keeping ability it has been possible to launch and recover a 34 meter corer in up to sea state five, (3.05 m. wave height).

The large diameter, (11 cm), sample permits the use of standard soil mechanics techniques used for consolidation studies; sufficient material for reliable paleontological age dating, paleomagnetic stratigraphic determination and analysis of trace contents such as organic carbon, radon, plutonium, etc.

The Giant Core has a unique place in the inventory of sediment sampling devices in that it is capable of recovering samples of greater diameter and length than any other existing piston core. Secondly, these samples can be taken from the upper 30 meters of sediment which are usually destroyed by conventional boring or drilling techniques. This capability makes the Giant Core of particular interest where pile supported structures are to be employed and where accurate knowledge of properties of the supporting sediment is required.

Currently the Giant Core is undergoing a re-design and construction phase calculated to improve the penetration capability and maintain a minimal amount of sample disturbance during coring and extrusion.

5 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).42.

1974: Meischner, D. and J. Rumohr

A light-weight, high-momentum gravity corer for subaqueous sediments. Senk. Marit., 6(1), 105-117.

248; BIO

A simple, reliable corer is described. By the kinetic energy of the freely falling instrument an acrylic glass tube is pushed into the bottom sediment like a pipette. The coring tube is then tightly closed by use of the weight of the apparatus itself transferred to the valve by a lever mechanism. Resulting sediment cores show minimal disturbance. They are immediately ready for visual inspection, measurements of physical and physico-chemical data, and quantitative ecological sampling.

18 refs.

Institute of Geology and Paleontology, Universität Göttingen, W. Germany.

2.b(1).43.

1976: Silva, A. J., C. D. Hollister, E. P. Laine, and B. E. Beverly

Geotechnical properties of deep sea sediments: Bermuda Rise. Mar. Geotech., 1(3), 195-232.

185; BIO

The Giant Piston Corer has been used to obtain good quality sediment samples from several sedimentological/acoustic regimes in the northwestern Atlantic. A total of 185 m of sediment were recovered in nine cores with lengths ranging from 6.5 to 30.5 m. Sediment types include calcareous ooze, pelagic brown clay, organic-rich gray-green silty clay, and graded sand. Data are presented from three of these cores, taken from three different acoustic provinces.

38 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(1).44.

1978: Axelsson, V. and L. Hakanson

A gravity corer with a simple valve system. J. Sed. Petrology, 48(2), 630-633.

166; BIO

The general principles in coring with open barrel gravity corers are briefly discussed, and a gravity corer with a new, simple and efficient valve system is described. The coring tubes are rectangular and specially designed for scanning of the cores by x-radiography before extrusion. The closing mechanism of the valve system works in two steps: the valve is held in open position one when the lowering wire is taut, in open position two when the wire slackens and the corer penetrates the sediment, and closes automatically after sediment penetration when the wire tautens at the upheaval.

15 refs.

Department of Physical Geography, University of Uppsala, Uppsala, Sweden.

2.b(1).45.

1979: Driscoll, A. H. and A. J. Silva, editors

Long Core Facility report of first workshop with steering committee. University of Rhode Island, Kingston, R.I., 142 p.

413; Metrology

The progress of the Long Coring Facility (LCF) project to obtain piston cores of 50 meters lengths is reported at the workshop. The LCF is compared to the Giant Piston Core programme which preceded it. LCF engineering design is reported at length. Progress is reported briefly on other sub-projects: coring hardware, ship, winches, cables, instrumentation, and computer modelling. Also included is a report on development and initial field trials of a 200 m capability hydraulic piston corer to be used on the Glomar Challenger in conjunction with the D.S.D.P.

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University of Rhode Island, Kingston, Rhode Island.

2.b(1).46.

1979: Szwilewski, P. T., S. N. Burchett, and C. H. Karnes

Long coring facility engineering systems design. L.C.F. Rept. of 1st. Workshop with Steering Comm., A. H. Driscoll and A. J. Silva, eds., Univ. of Rhode Island, 20-68.

412; Metrology

The computer modelling of piston coring phenomena has progressed to the point where reasonable agreement has been obtained between calculated penetration depths and those measured in some past coring operations. Agreement depends on the availability of a valid wall friction model which relates sediment properties to the surface friction developed.

Preliminary parametric calculations have been performed for a 50 m coring system to determine the effects of inside and outside diameters, corer mass and entry velocity (or freefall height) on the penetration depth and piston motion during penetration. Before the pullout forces can be satisfactorily calculated, the effects of the end suction forces must be separated from the wall friction. These calculations are proceeding, but are incomplete.

An analysis technique to calculate the tendency to buckle during penetration is available and the calculations will be performed shortly. Also, calculations will be initiated to determine the hydrodynamic drag force distribution using nominal dimensions for a 50 m coring system in order to determine the degree of hydrodynamic stability during free fall and early penetration stages.

The penetration of a coring device into the seafloor is a complex dynamic process. Simplifying assumptions have been made to make the calculation of this process possible. The parameters used in the calculation procedure have been varied to match actual coring events (KN31 GPC5 and LL 44 GPC3).

The finalized model was then used to perform a 50 m corer parameter study. The parameters varied were mass of corer, impact velocity, inside and outside diameter of the corer.

no refs.

Civil Nuclear Systems Corporation, Sandia Laboratories,
Albuquerque, New Mexico.

2.b(1).47.

1980: Karnes, C.H., S.N. Burchett, and P.T. Dzwileski

Optimized design and predicted performance of a deep ocean 50 m piston coring system. Conf. Record, Ocean '80 (IEEE), 231-239.

011; BIO

Calculated techniques are described which were developed or adapted for the purpose of analyzing the mechanical response of a proposed piston coring system capable of recovering high quality 50 m long cores. The analysis includes the effects of barrel geometry on the mass required to penetrate 50 m of an assumed sediment, the effects of non-vertical entry and pullout on the stresses within the barrel, and the effects of steel cable or parachute piston restraints on the resulting core sample distortion. The results show that a wall thickness of 50 mm in the upper section is necessary to survive an entry of up to 1.5° from vertical or a recovery angle of up to 5°. They also show that a mass of 15,400 kg and a pullout force of 330 kN are required. It is shown that active piston control is necessary to eliminate piston motion during penetration.

21 refs.

Sandia National Laboratories, Albuquerque, New Mexico

2.b(1).48.

1980: Lee, H. J.

Offshore soil sampling and geotechnical parameter determination.
J. Petroleum Tech., 32(5), 891-898.

308;

During a six-year study conducted by the U.S. Navy's Civil Engineering Laboratory, nine piston and gravity coring devices were tested, compared with in-situ measurements, and ranked according to the degree of sample disturbance they caused. Correction factors were defined for non-plastic soils and soils with a plasticity index greater than 15%. When correction factors were applied to core samples, the in-situ strength of fine-grained sediments could be determined within ± 20%.

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U.S. Geological Survey

2.b(2).1.

1964: Willemoës, M.

A ball-stoppered quantitative sampler for the microbenthos. Ophelia, 1(2), 235-240.

247; BIO

The sampling unit described consists of a plexiglass tube which cuts out an area of 3 cm^2 from the sea-floor. The sample, which may be several cm long, is prevented from dropping out of the tube by a small rubber ball being pulled against the tube end by a perlon fishing line which runs up through the core and the tube.

A special triangular frame which will hold three sampling units is also described.

Although originally designed for sampling benthic diatoms the sampler has also proved to be very suitable for quantitative sampling of other unicellular organisms such as foraminifera as well as for certain groups of the meiobenthos which occur in large numbers, as for example nematodes and harpacticoids.

12 refs.

Danish Institute for Fisheries and Marine Research, Charlottenlund, Denmark.

2.b(2).2.

1965: Craib, J. S.

A sampler for taking short undisturbed marine cores. J. Cons. Perm. International pour l'Exploration dë la Mer, 30(1), 34-39.

199; BIO

The sampler, incorporating a hydraulic damper and ball closing device, weighs 44 kg and can be used from a launch. It takes cores 15 cm long and 5.7 cm in diameter from sediments varying from hard sand to soft mud. The light superficial layer of the sediment is retained undisturbed.

5 refs.

Marine Station, Millport, Isle of Cumbrae, Scotland.

2.b(2).3.

1967: Livingstone, D. A.

The use of filament tape in raising long cores from soft sediment. Limnol. and Oceanog., 12, 346-348.

318; BIO

A length of flexible Mylar tape slightly longer than the sample tube, and of a width equal to the inside circumference of the tube, is wrapped longitudinally around the outside of a piece of thin-walled metal tubing of the sort commonly used by paleo-limnologists. Rubber bands or cellophane tape may be used to hold the tape in place. The extra length of tape, which overlaps the lower end of the tube, is firmly attached to a piston. The piston is then pulled into the tube by the piston cable, so that the tape wraps around the edge of the tube and up the inside.

The sample tube wrapped with tape is lowered into a lake using a Lichtwardt drill rod. When the bottom is reached, the piston cable is clamped, fixing the piston in place, and the sample tube is pushed down around it by the rod. This part of the operation does not differ from ordinary piston sampling (Deevey 1965), but it has a different result: As the tube penetrates the mud, the Mylar tape slides down the outside and up the inside, lining it smoothly. There is no motion between the sample of sediment entering the tube and the Mylar liner, so the frictional force is absent, as in the Swedish foil sampler.

There are, of course, frictional forces in other parts of the system, and these may be great enough to rupture an unsupported tape of Mylar. For that reason, the Mylar is reinforced with Scotch filament tape (No. 890), which is strong and stretches very little. Samples were raised successfully with Mylar carrying only one 3/4-inch (1.9 cm) strip of this filament tape, but more strips may be added for extra strength.

4 refs.

Department of Zoology, Duke University, Durham, North Carolina.

2.b(2).4.

1969: Brinkhurst, R. O., K. E. Chua, and E. Batoosingh

Modifications in sampling procedures as applied to studies on the bacteria and tubificid oligochaetes inhabiting aquatic sediments. J. Fisheries Res. Bd. Canada, 26, 2581-2593.

128; BIO

The KB corer has many advantages over other bottom-sampling devices including some other coring tubes. It may be used to obtain reliable estimates of the standing stock of benthic invertebrates inhabiting soft sediments and of their spatial distribution in lakes and rivers. It may also be used for studies of the vertical distribution of animals and bacteria, and could be used for a wide variety of studies on sediments. Multiple-unit versions have been built and operated, thus overcoming the size limitation imposed by the basic design. This paper communicates some results obtained using this sampler.

10 refs.

Department of Zoology, University of Toronto, Toronto, Ontario.

2.b(2).5.

1969: Barnett, P. R. O.

A stabilizing framework for the Knudsen bottom sampler. Limnol. and Oceanog., 14, 648-649.

325; BIO

Observations by diving at Millport showed that when the Knudsen was used on a variety of sands, a high proportion of empty hauls was attributable to the top-heavy sampler falling on its side before it could penetrate the sediment. To overcome this difficulty, a stabilizing framework has been designed to fit around the Knudsen sampler. It supports the instrument on all sides, yet allows it to capsize freely when it is hauled out of the sediment (Knudsen 1927). The framework also makes the sampler more easily handled aboard ship.

5 refs.

Marine Station, Millport, Scotland.

2.b(2).6.

1969: Makereth, F. J. H.

A short core sampler for subaqueous deposits. Limnol. and Oceanog., 14, 145-151.

354; BIO

The apparatus is best used from an anchored boat so that there is no danger of pulling the instrument sideways as the boat drifts. The air hose is attached to the connection at the top of the outer tube plug, and the nylon handling line to the stainless steel bridle. The apparatus is lowered by hand until the sediment surface is reached. While the instrument is supported in the vertical position, about half a minute should be allowed for the anchor chamber to sink into the sediment. At this stage the ball valves lift and allow water to escape freely from the anchor chamber. When the anchor chamber ceases to sink into the sediment, the ball valves close and prevent the water from reentering. The anchor chamber now provides sufficient grip on the sediment to hold the apparatus in position while the core tube is driven in. The air supply is turned on and a pressure applied via the needle valve of some 6.8 atm above the hydrostatic pressure. The core tube is driven into the sediment while the presence of the stationary inner piston (16) ensures that the sedimentary material must enter the tube since the external pressure forces it to do so. The completion of this part of the operation can usually be deteced if the lowering line is hand held because the impact of the driving piston on the top of the anchor chamber can usually be felt. Two or three minutes are normally enough to be certain that the core tube has been driven fully home.

3 refs.

Freshwater Biological Association, Ambleside, Westmoreland, England.

2.b(2).7.

1971: McIntyre, A.D.

Deficiency of gravity corers for sampling meiobenthos and sediments. Nature, 231, 260.

303; BIO

Gravity corers are widely used for the collection of the smallest marine metazoans (meiofauna) from subtidal grounds, and it has been generally accepted that cores which appear undisturbed give reasonably representative samples. But, after comparing gravity cores with samples collected by SCUBA divers, I suggest that this is not so.

The data, which represent the range of variation found througout the year, show that the diver cores consistently gave substantially higher counts than the gravity samples. This applies to the copepods in particular, and it can be shown by dividing cores into segments 1 cm thick, that these animals are largely restricted to the top 1 cm of mud. These results support the suggestion that the downwash caused by gravity corers in their descent disperses a substantial proportion of the superficial layer of deposit and that such instruments thus fail to collect all the animals associated with this layer. Most previous assessments of meiofauna (and especially copepods) by methods of this type may therefore be substantially underestimated. Furthermore, the deficiency of these instruments (or of any instrument dropped, however gently, onto the sea bed) in collecting intact the superficial layer of sediment should be recognized in selecting sampling techniques to study recently settled organic matter or pollutants which might be concentrated at the mud-water interface.

3 refs.

Marine Laboratory, Aberdeen, Scotland.

2.b(2).8.

1973: Keegan, B. F. and G. Könnecker

In situ quantitative sampling of benthic organisms. Helg. Wiss. Meeresunters., 24(1-4), 256-263.

219; BIO

1. The burrowing range of some infaunal animals and their accessibility to benthic sampling instruments is briefly considered.

2. An excavation depth of greater than 50 cm is deemed necessary for effective sampling of most deposits.

3. A diver-operated suction-sampler is described and evaluated. This "air-lift" was used most successfully over a wide range of substrates.

4. Constructional and operational details are given for a new "minimum-disturbance" core sampler.

Basically, the sampler (Fig. 2) consists of a cylinder which is forced into the sea bottom under hydrostatic pressure (see BARNETT & HARDY 1967). This cylinder concentrically encloses - and rigidly confines - a "core-tube" of smaller dimensions. Limited in use to sand/mud substates, the sampler was designed so as to ensure minimum disturbance of the sediment core. The constructional details may be inferred from Figure 3.

15 refs

Zoology Department, University College, Galway, Ireland.

2.b(2).9.

1973: Kanneworff, E. and W. Nicolaisen

The "haps": a frame-supported bottom corer. Ophelia, 10(2), 119-128.

251; BIO

A new quantitative bottom sampler is described. It is basically a corer with top valve and core catcher, supported by a frame, and can be used for in situ studies of bottom invertebrates. It functions very well in mixed and soft sediments and fairly well in sand; it can be operated from a motor boat provided with a power winch.

The area sampled is about 150 cm^2, the sampling depth about 25 cm in mixed and soft sediment and about 10 cm in hard sand.

2 refs.

Marine Biological Laboratory, Helsingor, Denmark.

2.b(2).10.

1973: Rowe, G. T. and C. H. Clifford

Modifications of the Birge-Ekman box corer for use with SCUBA or deep submergence research vessels. Limnol. and Oceanog., 18(1), 172-175.

253; BIO

The Birge-Ekman box corer has been modified for use by SCUBA divers or deep submergence research vessels, thus allowing control in the precision of sampling. Data suggest that the modified box corer exhibits greater accuracy and precision in estimating the abundance of species and individuals than conventional surface ship samplers or smaller corers used widely for in situ investigations.

7 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(2).11.

1975: Thayer, G. W., R. B. Williams, T. J. Price,and D. R. Colby

A large corer for quantitatively sampling benthos in shallow water. Limnol. and Oceanog., 20, 474-481.

279; BIO

A hydraulically operated device for obtaining cores 30.5 cm in diameter and up to 46 cm long is described. The corer is able to penetrate firm bottoms but is unsuited for water depths greater than 4 m.

Our sampler is modeled after the suction corer of Knudsen (1927) and is composed of two parts: the corer (Fig. 1) and the hydraulic system which facilitates driving freeing, and emptying it (Fig. 2). The corer is made of welded steel and is relatively durable. The coring tube consists of a steel pipe sharpened at the lower end and closed with a steel plate a the upper end. The corer is manipulated from the surface with a removable handle of galvanized pipe which fits into a socket welded to its upper surface. The rods supporting this socket continue down the sides of the corer and are formed into eyes near the cutting edge. A short bridle of steel cable inserted into these eyes supports the sampler (Fig. 3). Around the periphery of the corer are water jets of galvanized pipe connected by short hoses to a manifold clamped to the handle socket. The corer is exhausted through a pipe which penetrates the upper plate, extending about 4 cm into the corer and is welded to the plate. The pipe is screened in the corer (1.0-mm mesh openings) to prevent loss of organisms and to exclude coarse debris from the hydraulic system.

7 refs.

National Marine Fisheries Service, Atlantic Estuarine Fisheries Center, Beaufort, North Carolina.

2.b(2).12.

1979: Barton, C. E. and F. R. Burden

Modifications to the Mackereth corer. Limnol. and Oceanog., 24(5), 977-983.

057; BIO

The 6 m Mackereth corer has proved excellent for many aspects of Quaternary research, particularly in the growing field of paleomagnetic work on lake sediments. A 12 m version of the corer is described together with a magnetic orientation system.

2 refs.

Research School of Earth Sciences, Australian National University, Canberra.

2.b(2).13.

1979: Williams, J. D. H. and A. E. Pashley

Lightweight corer designed for sampling very soft sediments. J. Fisheries Res. Bd. Can., 36(3), 241-246.

099; BIO

An underwater corer has been developed capable of taking 10-cm diam cores up to 1 m long from unconsolidated, fine-grained fluvial and lacustrine sediments including organic-rich (gyttja-like) deposits. The corer is lightweight and compact for transport and hand operation from float planes and small boats. It is of the piston type and has a sphincter valve for core retention. A miniature optical sensor triggers the corer when the sediment-water interface is penetrated. The corer is compatible with a system to subdivide the cores by vertical extrusion.

21 refs.

Department of Fisheries and the Environment, National Water Research Institute, Canada Centre for Inland Waters, Burlington, Ontario.

2.b(3).1.

1914: Joly, J.

On the investigation of the deep-sea deposits. Sci. Proc. Roy. Dublin Soc., 14, 256-267.

432; Dalhousie

In 1897 I communicated to the Royal Dublin Society a suggested method of boring into such rooks as might be exposed on the sea-floor. The boring-machine then described involved a motor to drive the drill and an insulated wire from the surface. This machine I subsequently improved, but the features just referred to still remained as essential.

There are difficulties and much expense involved in transmiting electric power from the surface to the bottom at great depths. To develop power below from storage cells or wound-up springs presents even greater difficulties. These considerations have prevented me from hitherto embarking on the construction of any machine intended for the purpose of submarine exploration.

Recently, however, it occurred to me that the pressure of the water prevailing at great depths might itself be utilized to provide the necessary power in situ. The principle is simple. Suppose an empty vessel, of sufficient strength to resist the pressure, lowered to the bottom. This provides a receptacle into which the working substance--that is the water--may be discharged after it has done work in a hydraulic engine. this engine may be of the ordinary reciprocating type with the usual directions of the pressure reversed and acting from without inwards. Or the motor may be of the Pelton-wheel form; the wheel being protected from the pressure, and water directed from without upon its, the spent water finding its way to the receptacle.

The dynamical principles are easily stated. We may trace back the work to the sinking of the receptacle under the influence of gravity--a general rise in the level of the ocean occurring in consequence. In the operation we do no work. we, in fact, borrow the work at the expense of the conditions of gravitational potential obtaining. If we desire to recover the receptacle, however, we must pay back what we have borrowed.

no refs.

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2.b(3).2.

1968: Anonymous

Alvin extracts hard-rock core at 1,246 foot depth. Ocean Industry, 3(10), 18.

110; BIO

Deep diving submersibles have scored another breakthrough in ocean floor exploration. In this instance, Woods Hole Oceanographic Institution's Alvin extracted a hard-rock core for the first time at a depth of 1,246 feet.

Jack Hathaway, Geological Survey scientist, was the observer aboard Alvin when the new coring procedure was attempted in an undersea canyon some 200 miles south of Cape Cod, Mass. The first try was completely successful, he said, and several samples were taken.

The new drill was designed and built by Clifford Winget, project engineer of the Alvin group for Woods Hole. Capable of obtaining 3/4-in.-diameter core that is 3 in. long, the drill can be used at any depth to 6,000 ft. Power for the drive system is supplied from the submersible's 30-volt DC battery. Core samples are kept in the diamond drill by steady, low-pressure suction provided by a water pump.

Winget said that scientists now can sample any part of an outcrop using this new drill, and they no longer have to rely on finding small rocks or bits and pieces that have been weathered by constant seawater action. As a result, geological formations on the Continental Shelf can be studied more completely than ever before.

no refs.

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2.b(3).3.

1968: Brooke, J. and R. L. G. Gilbert

The development of the Bedford Institute deep-sea drill. Deep-sea Res., 15, 483-490.

208; BIO

A new concept for drilling short cores of rock from the floor of the deep ocean is described. The power for operating the drill is obtained from water which moves from the normal ambient hyrodstatic pressure into a low pressure void. A general description is given of the complete drill assembly and its method of operation. The results of three series of experiments at sea, and of a number of tests on land are given, from which the abilities and limitations of the drill in its present form may be inferred. The plans for future work are described and long-range objectives are outline.

2 refs.

Atlantic Oceanographic Laboratory, Bedford Institute, Dartmouth, Nova Scotia

2.b(3).4.

1968: Brooke, J. and R. L. G. Gilbert

A deep sea rock core drill. Bedford Institute of Oceanog. Rept. BI1968-6, BIO, Dartmouth, Nova Scotia.

431; BIO

This report is an historical review of the work involved in developing an undersea drilling tool. Little, if any, background work was available for reference. Despite the wealth of knowledge gathered and freely given by drilling supplier companies, particularly during the later stages, their experiences lie generally in the realm of man-operated tools. The drilling crew, by experience, can sense when loads, coolant flow and other factors should be changed to prevent blocking and other causes of inferior coring. Our task is to replace "the man" by a tool which has sufficient sensitivity to achieve the same results.

During the past two years, considerable knowledge has been obtained in the development of this drill. While it would have been simpler to present this information in the form of specific results and brief summaries, it was felt that many factors of "why" and "how" would have been lost in such a presentation. The authors, therefore, feel justified in presenting this report in this fashion so that others who may follow will not have to repeat or research along the same avenues.

This project is concerned with scientific, engineering and marine work; therefore, units of measurements are used that are akin to the field of interest being described.

6 refs.

Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

2.b(3).5.

1969: Brooke, J. and C. S. Mason

Some instruments for monitoring the performance of undersea mechanical devices. <u>Proc. Oceanology Internationa Conf.</u>, <u>2</u>, paper #5, 5 p.

168; BIO

The usual methods of observing and recording the performance of a mechanical device are not possible with many instruments designed to operate in the deep ocean. Most of the mechanical components cannot be contained in a protective casing and therefore realistic tests require that the unit operate in salt water, of great hydrostatic pressure and at the correct ambient temperature. Simulation of these conditions is moderately difficult even for relatively small devices and is not economically feasible for a large device such as a rock core drill. The Bedford Institute drill could only be tested at sea and at a distance of more than a quarter mile below the ship. A variety of instruments were required for these tests as it was necessary to clarify some of the more puzzling aspects of the drill's behavior.

1 ref.

Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

2.b(3).6.

1970: Brooke, J.

Sea drilling techniques of the Bedford Institute. Underwater Sci. and Tech. J., 2(3), 165-167.

087; BIO

The paper describes methods used to obtain oriented cores of hard rock material from the ocean floor in depths ranging from tidal flats to 1800 m. Two different drill units have been developed by the Bedford Institute, each covering a specific range of depth and each powered by a different energy source. Both units have been used to obtain cores from areas of the ocean floor, and the deeper range drill units has retrieved cores from areas that have previously not been accessible.

7 refs.

Mechanical Design Group, Atlantic Oceanographic Laboratory, Bedford Institute, Dartmouth, Nova Scotia.

2.b(3).7.

1970: Welling, C. G.

Designing an advanced marine corer. Mech. Engng., 92(10), 28-33.

433;

An intermediate-size submarine corer is described. The device was designed to be operated from the deck of any ship having a l-t crane (a 50 ft boat) and in currents up to 5 knots. The drill is powered by a 3 hp three phase a-c motor and includes a water circulation system employed to lubricate the bit and flush cuttings so as to minimize core disturbance. The core barrel automatically retracts at the end of the penetration stroke and thereby eliminates core barrel binding.

7 refs.

Mechanical Design Group, Atlantic Oceanographic Laboratory, Bedford Institute, Dartmouth, Nova Scotia.

2.b(3).8.

1972: Eden, R. A. and D. A. Ardus

Sampling solid rock outcrops at continental shelf depths: the problems and a discussion of methods. <u>Proc. Oceanology International Conf.</u>, 392-395.

339; BIO

The IGS maxi-drill under construction will combine and extend the capabilities of the 6-metre vibrocorer and 1-metre rock drill. The vibrocorer will be almost identical with the present unit except that the housing will have a 900-metre depth capability. Modified support legs for the frame will fold back during launch and recovery operations, being extended to the operating position only when they are clear of the ship's hull.

The motor is carried in a carriage running on nylon rollers in a tripod frame, with a television camera and light slung beneath the fin fitted to one of the legs. The field of view includes the drill bit at the top of the field during the initial search for a suitable drill site, and the top of the drill hole toward the bottom of the field during drilling.

To change the unit into a 5-metre rock drill the sediment barrel will be removed and the drill motor and water pump unit bolted to the flange at the base of the vibrator housing. A suitable spacer collar in the base plate will locate the diamond drill barrel. The vibrator housing will thus act as the necessary dead weight on the drill string. Two rates of water flow will be provided, one high to jet through overburden to rockhead, the other low for flushing the bit while rock drilling.

Experimental work started in conjunction with Liverpool University, the outcome of which was the Harrison drill (Eden, Flinn and Harrison 1969). This is a small battery operated drill dangled from its mother ship and incorporating television observation.

Swell effects make site location difficult because of the up and down motion transmitted to the drill. Occasional impacts on the bottom during search and lowering phases cause serious inconvenience in all but very calm conditions.

3 refs.

Institute of Geological Sciences, Edinburgh, Scotland

2.b(3).9.

1975: Davis, R. E., D. L. Williams, and R. P. Van Herzen

ARPA rock drill report. Woods Hole Oceanog. Inst. Tech. Rept. 75-28, 29 p.

169; BIO

This report outlines the development and capabilities of the Woods Hole Oceanographic Institution's Rock Core Drill. The Rock Drill is shown to provide a relatively inexpensive means of recovering oriented bottom rock samples from the oceanic crust for magnetic and petro-chemical studies. It is completely self-contained and capable of recovering 1 m long, 3/4-inch diameter, rock cores from depths to 4000 m. Most efficient deployment is from a surface vessel, but with sufficient modification it is capable of being safely transported by a DSRV.

8 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(3).10.

1975: Skidmore, G. and J. Bircham

Development of an unmanned cable controlled submersible vehicle for surveying and sampling exposed subsea rock shelves. Proc. Offshore Tech. Conf., 3, 127-139.

324; BIO

The following paper describes the design, build and testing of an elementary unmanned mobile platform. It can be maneuvered over selected areas of the sea bed at depths down to 600m by means of power and signals passed down a buoyed umbilical cable which connects the vehicle with the mother ship on the surface.

Video and photographic records of the areas studied could be made for detailed analysis at a later date and rock core samples (1 cm diameter by 5 cm long) can be recovered from the sea bed by deploying a small rock drill.

The general requirements of the rock drill called for a unit which could be remotely controlled for both forward and reverse traversing and rotational direction and that would apply a constant drilling force of 130N and a possible pull-out force of 260N if required.

It was decided to give the rock drill maneuverability by mounting it on the same pan and tile head as the television camera and position it in such a manner as the drilling operation could be monitored by the observer in the surface control station.

A small impeller type of water pump was attached to the drive shaft of the drill and during the drilling operation this pumps sufficient water down the hollow drill bit to keep the cutting face clear. When the drill reaches the full extent of its travel the supply of water is shut off and this causes the drill bit to clog up and the core to shear off. The sample is then retained in the drill barrel for recovery when the vehicle reaches the surface.

no refs.

British Aircraft Corporation.

2.b(3).11.

1977: Kinoshita, Y., H. Oshika, and E. Inoue

A new type of submerged rock drill, "MD-300PT". Mar. Geol., 25, 321-331.

133; BIO

A new type of rock drill, which has compact size and a simple mechanism and which can be automatically operated in water, was developed. The drill can obtain 75 cm of rock core from a rocky bottom covered by thin sediments at a maximum depth of 300 m.

The drill was operated under a current of 1.5 knots in Sagami Bay south of Tokyo and obtained a 40-cm core of volcanic conglomerate of Miocene age from the slope of a small bank at a depth of 130 m. During the operation the vessel was not anchored.

3 refs.

Marine Geology Department, Geological Survey of Japan, Kawasaki, Japan.

2.b(3).12.

1980: Ryall, P. J. C.

Drilling rock on the deep-ocean floor. J. Mar. Tech. Soc., 14(5), 23-27.

188; BIO

The promise of a drill and associated acoustic positioning system is the ability to provide accurately located, orientated samples from the sea floor. It is capable of doing this in many geological circumstances such as recovering rock from beneath a few meters of sediment, or sampling massive lava flows where no other equipment can do the job. Some of the capabilities of the drill overlap with those of the drill ship or submersible but the bottom drill has the advantage of being operable from a normal oceanographic research ship. This, then, achieves the aim that geologic samples can be collected as part of an integrated geophysical/geological cruise rather than requiring a special program with very specialized vessels.

15 refs.

Department of Geology, Dalhousie University, Halifax, Nova Scotia.

2.b(3).13.

1981: Ryall, P. J. C., G. A. Fowler, and K. S. Manchester

An electric rock core drill for deep ocean use. Proc. Offshore Tech. Conf.
206; BIO

The recovery of accurately located, oriented rock samples from the sea bed and near subsurface in the deep ocean cannot be readily achieved using existing techniques. For operation on the continental shelf (1000 ft. water depth) an underwater electric drill has been developed at the Bedford Institute of Oceanography. The drill, which is powered and controlled from an unanchored surface vessel, is capable of driving a 20-ft. long diamond drill barrel, using a modified screw feed mechanism, into the bottom to take a 1-inch diameter core.

This paper reviews the design of the original drill and its subsequent development for deep ocean work. From its inception the drill has been powered and handled using a two-cable system which severely limited its depth capability. To alleviate this restriction the two-line system has been replaced by a contrahelically armoured triaxial cable. Power is transmitted at 2300 volts while signals from the drill are multiplexed and superimposed on the power lines. In addition the drill rig itself has been redesigned to allow operation on slopes up to 30' which may easily be encountered on oceanic ridges, the primary area of application.

The earlier version of the drill has been used extensively for geological reconnaissance on the shelf off Canada's East Coast. Cores have been recovered from various rock types while operating in a wide range of weather conditions. The new version has been used successfully on the Mid-Atlantic Ridge in June 1980 with core recovered in 10 to 11 attempts in water depths to 800 m. The use of the system will be extended to operating depth of 3500 m within the year.

In addition to bedrock reconnaissance and other scientific sampling the drill should find application in site surveys for projects such as the laying of deep-water pipelines and cables. Other tools, such as vibrocorer will also be operated on the new power system.

3 refs.

Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Dartmouth, Nova Scotia

2.b(4).1.

1964: Bouma, A. H. and N. F. Marshall

A method for obtaining and analysing undisturbed oceanic sediment samples. Mar. Geol., 2, 81-99.

191; BIO

A German coring device (REINECK, 1958) has been improved to obtain oriented, undisturbed cores at any depth of water. The samples are rectangular in shape, 8 x 12 inches in plan and a maximum of 18 inches high. Good cores have been obtained from clayey material as well as from gravelly sand. No disturbances due to coring were observed on the collected samples.

These large samples make it possible to conduct many varieties of investigations, such as study of living organisms and shear strength measurements, as soon as the sample is on deck of a ship; radiography on slices, peeling and impregnation techniques, granulometry, mineralogy, porosity, fossil content, etc.

Construction and use of the box corer and applications of some of these analytical techniques are described.

12 refs.

Scripps Institution of Oceanography, LaJolla, California.

2.b(4).2.

1964: Bouma, A. H. and F. P. Shepard

Large rectangular cores from submarine canyons and fan valleys. <u>Bull. Am. Assoc. Petroleum Geologists</u>, <u>48</u>, 225-231.

299; BIO

The box corer consists of a central stem with a tripping mechanism on top and a housing for the box on the bottom. Lead weights can be placed on top of the housing around the stem. The box is 8 x 12 inches in ground plan and 19 inches high. It can be mounted in the housing with four pins. The base of the two 8-inch sides of the box is round to enable a closing mechanism to turn underneath the box, thus closing it and preventing loss of sediment. This mechanism pivots around rods welded to the housing. The entire sampling unit hangs in a frame. The top of the frame has a gimballing device through which the central stem can slide. When the frame hits bottom the rest of the sampler continues to fall vertically and pushes the box into the sediment by its own weight. A tripping device enables the closing mechanism to cover the base of the box before the unit is pulled up. A compass with locking mechanism is attached to the sampler for obtaining the orientation of the samples. Vertical slices are taken of the sediment sample to make radiographs and ordinary photographs. The large amount of material which the box can hold make it possible to carry on different types of investigations of the sediment.

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Scripps Institution of Oceanography, La Jolla, California.

2.b(4).3.

1972: Smith, K. L. and J. D. Howard

Comparison of a grab sampler and large volume corer. Limnol. and Oceanog., 17, 142-145.

037; BIO

Sampling efficiencies of the Smith-McIntyre grab and the USNEL spade corer were compared based on macrofaunal abundance, biomass, and size. The spade corer's efficiency was greater than that of the grab sampler; this is attributed to its greater depth penetration.

19 refs.

University of Georgia Marine Institute, Sapelo Island, Georgia.

2.b(4).4.

1973: Roots, W.

A stored energy seabed corer for sediments and bedrock. <u>Underwater J.</u>, <u>5(1)</u>, 6-8.

036; BIO

A seabed corer is described which uses energy, stored in stretched rubber cords, to ram a piston-filled core barrel into the sea bed.

Undisturbed cores of 50 mm diameter and up to 1200 mm length have been taken of mud, sand, gravel and bedrock.

Free fall lowering, intertial triggering and very rapid core barrel penetration results in a vertical core regardless of sea-surface conditions or sea-bed topography.

Penetration pressures as high as 480 kg/cm^2 are available. Development to 7m length is in progress.

Use is foreseen for sampling swamps, streams, jungles, surf zones and rugged terrain from helicopters, as well as more usual uses on the continental shelf.

no refs.

School of Earth Sciences, Macquarie University, North Ryde, New South Wales.

2.b(4).5.

1973: Werner, F.

An improved core catcher for the Kiel box corer ("kastenlot").
Mar. Geol., 15(5), M59-M65.

265; Dalhousie

The optimum efficienty of the Kiel box corer ("Kastenlot") is dependent upon certain mechanical properties of the sediments. To avoid this limitation, a new core catcher was constructed and has been tested for several years in shallow and deepwater sediments. The essential part of this catcher is a reinforced canvas curtain which is pulled slantwise through the core before the corer is pulled out of the sediment.

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Institute of Geology and Paleontology, Christian-Albrechts-Universitaet Kiel, Kiel, F.R.G.

2.b(4).6.

1974: Hagerty, R.

Usefulness of spade cores for geotechnical studies and some results from the northeast Pacific. Deep-Sea Sediments, A. L. Inderbitzen, ed., 169-186.

003; BIO

The next best thing to in situ measurements of sediment engineering properties is probably data collected from cores taken with spade corers. Included in the discussion are the advantages and disadvantages of spade cores compared to conventional small-diameter cores.

The "undisturbed" nature of spade cores is also illustrated. Changes in temperature or storage in water for periods up to 7.5 months do not significantly alter the shear strength of the sediment.

Despite popular beliefs, pelagic sediments are not homogeneous over extended distances. Significant differences in shear strength occur even within the horizontal confines of a single spade core. These differences are ascribed to bioturbation. Drastically different strength characteristics also occur over distances of a mile or less due to different depositional histories. Characteristics of deep-ocean sediments may prove to be as variable as shelf sediments.

6 refs.

Deepsea Ventures, Inc.

2.b(4).7.

1976: Karl, H. A.

Box core liner system developed at the Sedimentary Research Laboratory, University of Southern California. Mar. Geol., 20, M1-M6.

285; BIO

Marine geologists now collect many box cores for detailed analysis at onshore laboratories. Stainless steel boxes are very expensive. Consequently, few research facilities are able to purchase large quantities (25-50) of these sampling boxes. Plastic core liners have been developed and used by the Sedimentology Research Laboratory of the University of Southern California. The fundamental liner system consists of a plastic box core liner and a detachable base plate mounted on the corer spade. These liners are remarkably durable; of 22 liners constructed 2 years ago, 15 are still servicable after heavy use on 9 cruises. One plastic liner-base plate unit costs approximately $15-$20. This low unit cost should make it possible for most research laboratories to construct large quantities of sampling containers when necessary and still stay within working budgets.

1 ref.

Department of Geological Sciences, University of Southern California, Los Angeles, California.

2.b(5).1.

1960: Sanders, J. E.

The Kudinov vibro-piston core sampler: Russian solution to underwater sand-coring problem. International Geol. REv., 2, 174-178.

426; Dalhousie

The Kudinov vibro-piston core sampler has been developed recently by Russian scientists to take undisturbed underwater core samples of sand, 4 to 6 meters long, from the shallow shelf areas of the Black Sea. The device is activated by an elecromagnetic vibrator of the type used to settle concrete and features a one-way permeable piston inside the sampling tube and vibrator plus the up-and-down vibration of the sampling tube cause penetration into the sand. Water from the sediment passes upward through canals in the piston, which itself rises in the sampling tube as the sample enters.

The device differs from the Kullenburg-type of gravity free-fall piston corers in that the piston is not connected to the winch cable, but to a counterweight apparatus inside one of the two vertical supporting tubes. An additional feature is the arrangement which permits the sampling tube to be pivoted to a horizontal position on board ship when the sample is removed.

The maximum water depth in which the Kudinov core sampler operates is 150 meters. An electric cable from the shipboard power supply is required in addition to the winch cable.

4 refs.

Department of Geology, Yale University, New Haven, Connecticut.

2.b(5).2.

1970: anonymous

Taking undisturbed samples of the sea bed. Ocean Industry, 5(4) 118-120.

207: BIO

A NEW SYSTEM for taking undisturbed samples of the sea bed has been developed by Conrad-Stork, Haarlem, Holland, in cooperation with the Dutch Governmental Geological Service.

The apparatus, which is called the Geodoff, has only two connections with the vessel ---- the hoisting wire rope and the multicore electric cable. Thus, the work on bottom is not affected by the ship's response to the waves and the current. The sampling device is placed on the bottom of the sea by means of the wire rope and a deck winch.

Control of the sampling unit and checking of the operations on the sea bottom (such as performance of the core barrel and inclination of the unit on the sea bed) are affected through the flexible electric cable and read back from a control panel on deck. The cable is wound on a separate frame-mounted electrically driven cable drum.

A novelty is that the Geodoff not only drives the core barrel into the sea bottom by means of a vibrator but also withdraws the core barrel by its own power, so the ship does not have to remain strictly over the apparatus.

The frequency of the vibrator is variable during operation. The vibrator is connected to the core barrel by means of a specially developed hydraulically operated clamp, because the core barrel is more than double the length of the stroke of the vibrator. Special provisions have been made for filling the core barrel to the best of the user's ability and for keeping it filled.

The sample unit is designed for penetrating the sea bottom (in alluvial formations) at a maximum water depth of about 60 meters (200 ft). A core barrel with a diameter of 2 3/4 in. takes core samples with a maximum length of about 7 meters (23 ft).

no refs.

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2.b(5).3.

1970: Sly, P. G. and K. Gardener

A vibro-corer and portable tripod--winch assembly for through ice sampling. Proc. 13th Conf. Great Lakes Res., International Assoc. Great Lakes Res., 297-307.

194; BIO

A simple vibro-type corer has been built and successfully tested, for obtaining gravelly sand, sand and silty sand cores, 2 m long and about 5 cm in diameter. The corer uses a standard pavement-breaker (pneumatic impactor), mounted above a plastic lined steel core barrel, which rides down two guide tubes. These also serve as the main supporting components of the structure. The corer can be operated to considerable depth, limited only by the operating pressure of the impactor and by the length of the return air-hose. Most components except the frame, but including the compressor, are generally avilable on a rental basis. Sediment structures and laminations appear to be well preserved, though there is evidence of some re-packing in the cores.

A specially designed portable winch and frame has been built and tested for use in throug ice sampling programs. The complete system is made in modular form, easily handled by two or three people, and is operational even in temperatures as low as - 40°C. It can be transported by ski-plane, or snow/ice vehicle. It can provide line up to a rate of about 40 m/min, a line pull of 590 kg under power, or 2250 kg under manual drive. There is ample lift to provide for the use of a slightly modified vibro corer, operating either through ice or even directly on an exposed or shallow water beach surface. The system has "fumble-free" controls and can be covered with a plastic sheet to provide an operating shelter.

11 refs.

Canada Centre for Inland Waters, Burlington, Ontario.

2.b(5).4.

1971: Harker, R. J. and R. M. Shah

Design and test of a torsional vibratory core sampler for marine sediments. Proc. Int. Symp. Engng. Props. Seafloor Soils Geophys. Ident., 37-48.

277;

The torsional system of vibration offers several specific advantages with respect to penetration of a marine sediment probe: Shear stresses, for inducing thixotropic transformation in the sediment, are obtained without involving the pre-load mass in the vibratory system, by swivel mounting; a sawing action is provided at the leading edge of the probe, and a square tube in torsion generates an envelope by soil compression, both outside and within the tube. The square tube has further advantages in facilitating construction of a core retainer and in allowing transverse sampling for daughter cores through ports in the sidewall.

6 refs.

Department of Mechanical Engineering, University of Wisconsin, Madison, Wisconsin.

2.b(5).5.

1972: anonymous

New coring method supplements geophysical survey in North Sea. Ocean Industry, 7(4), 134-135.

298; BIO

Geodoff I, originally developed as a vibracorer, is growing into a multi-purpose offshore drilling tool. The apparatus has only two connections with the survey vessel (or pontoon): the hoisting electric cable, used for power and emergency hoisting and the wire rope used for placing the unit on the bottom of the sea by means of a deck winch or davits. The cable has a foam-plastic coating and thus can be extended to any length without risk of breaking.

One of its advantages is that the Geodoff not only drives the core barrel into the sea bottom by means of a vibrator, but also withdraws it with its own power. Thus, the ship or pontoon does not have to remain strictly over the apparatus.

The frequency of the vibrator is variable ranging from 0 and 3500 vibrations per minute.

The Geodoff is designed for penetrating the sea bottom (by vibration into alluvial formations) at a maximum water depth of about 150 meters (up to 500 ft). Core barrel samples are 70 mm OD (2 3/4 inch) and a maximum core length of about 7 meters (22 ft).

Disturbed samples with enough information (for instance in tin-ore exploration) can be counterflushed (or air-lifted). A double wall core barrel with water flushing (air) between the walls to the cutting shoe, the mixture flows through the inner pipe and hose to a sample reservoir on deck (See Fig. 2).

Penetration depth of about 10 meters (30 ft) have been achieved during the North Sea activities, even in clay.

For harder formations, such as sandstone, the vibrator is replaced by a power swivel (with or without hydraulic clamp) having a torque of about 50 kgm by 90 rpm. Drilling can be accomplished with a rotary, double or single core barrel by means of a small water pump on board the ship or pontoon.

no refs.

2.b(5).6.

1972: Shah, R. M.

Design, development and testing of vibratory core sampler for marine sediments. Unpubl. PhD., Univ. of Wisc., Madison, 222 p. (Diss. Abs. Int. no. 72-19, 003).

305;

The approach utilized in this investigation was that of gentle penetration of the sediments by a torsionally vibrating, thin-wall square coring barrel and capturing of a continuous sample that rises within the barrel. Vibration induces thixotropic transformation, or the transition of soils from the state of gen to the state of sol. Secondly, due to the angular motion of a square probe geometry, an envelope is developed and maintained which will reduce skin friction and facilitate the rise of sediments within and without, relative to the coring tube, with minimal disturbance in cross-section and sequence. The tip resistance is considerably reduced by using a thin wall.

The core retrieval experience varied considerably with the nature of the bottom, which included relatively hard, dry clay, sand and mud. The maximum core was in clay, with several feet of mud overlay, in which a penetration of 15 feet yielded a core of 11 feet. Several subsurface interfaces were identified.

There being no visual contact in an underwater environment and only limited shipboard time available, it is difficult to analyze the nature of the penetration problems encountered in the myriads of bottom materials. In order to study these problems for improving the design, a small version of the sampler was built and trailer-mounted for land-type testing. The preload on the probe was controlled by a manual winch. Three different exciters were built and tested on this rig to optimize design parameters which include mode of vibration, tip geometry, and preload weight. A. High amplitude, low frequency torsional exciter. B. Low amplitude, low frequency whirl exciter. C. Bottom mounted whirl exciter with blunt penetrator and bucket-type external sampler.

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University of Wisconsin College of Engineering, Madison, Wisconsin.

2.b(5).7.

1973: Kögler, F.-C. and K. H. Veit

Entnahme von Kernan aus Lockersediment on des Schelfgebietes mit em Vibrohammer-kerngerät. (Extraction of cores from loose sediments of the shelf area with the vibration-hammer core-gear.) Meerstech., 4, 91-95.

205; BIO

A core-gear for extracting cores of sand from the water at depths up to 300 m, operating on the principle of vibration-blowing, and its handling are described, and experiences collected with the gear so far are reported. The sampling instrument differs from a vibration core-gear not only by its method of operation, but mainly by the fact that the sediment structure of this core with large surfaces of 15 x 15 cm, is only slightly disturbed, and that the compaction of the core is approx. 2 % of the core length.

10 refs.

Institutes of Geology and Paleontology, Universität Kiel, Kiel, W. Germany.

2.b(5).8.

1973: McMaster, R. L. and C. E. McClennen

A vibratory coring system for continental margin sediments. J. Sed. Petrology, 43(2), 50-552.

041; BIO

A vibratory coring system has been developed specifically to sample sands on continental margins for more detailed data concerning sedimentary processes. It consists of three vibration mechanisms with attached 2 m coring tubes, a battery powered energy source, and a locking compass for orientation. Coring units, 2 m apart, are located at the apices of a triangular platform. Field tests indicate that the system is operational at all depths on the continental shelf.

5 refs.

Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island.

2.b(5).9.

1974: Ardus, D. A.

Institute of Geological Sciences vibrocore developments and operations. Exploitation of Vibration Symposium, Glasgow, Paper 14, 13 p.

411; Metrology

Development has produced a vibratory corer with barrel lengths of 5, 10, and 20 feet, diameters of 4 and 8 inches, capable of working in water depths of up to 3,000 feet. Current developments include a dual purpose vibratory/rotary rock drill with a retraction system and self-deploying legs.

The vibratory corer is mounted on a tripod-style frame with one leg fitted with a canvas fin to prevent the equipment from spinning. Power is provided at 440 volts via a 1,000 foot cable.

no refs.

Scottish Continental Shelf Unit, Institute of Geological Sciences, Edinburgh, Scotland.

2.b(5).10.

1974: Foster, K., T. A. Hollobone, and P. Smith

Vibratory and impact coring in a marine environment. Exploitation of Vibration Symposium, Glasgow, Paper 16, 17 p.

233; Metrology

Vibratory corers, through widely used, have limitations with regard to the materials which can be penetrated. There is a threshold vibratory force below which penetration cannot take place, and variations in the type of material being penetrated lead to the idea that a "tunable" type of device may be of value. Tests have indicated that advantage can also be gained by varying the crown force. This is feasible in the case of land-based drivers, but more difficult in undersea machines. Sealing and corrosion problems exist with any type of advanced machinery. They are more severe when the machinery is subjected to the marine environment, coupled with the fact that the operator cannot physically see or feel what is actually happening. Stresses may easily be built up by the coring operation and lead to severe damage because of the physical remoteness of the operator. These factors call for much higher standards of design and development coupled with extensive field trials. Two new units have been described which attempt to provide a variable behaviour to suit soil or sediment conditions, one being a remote controlled unit, the other being self-adjusting.

1 ref.

Birmingham University, U.K.

2.b(5).11.

1974: Hill, J. C. C.

Vibratory coring of the seabed. Offshore Services, 7(8), 82, 85-86, 7(9), 102, 104-105.

189; BIO

In considering some of the economic and practical aspects of obtaining core samples from the seabed using vibratory techniques I shall regard these both from the point of view of the consultant and contractor undertaking the investigation and the client for whom the work is carried out.

The basic purpose of obtaining seabed samples is to acquire knowledge about the nature of the seabed in the area being investigated in order to improve the performance of the subsequent activity.

The emphasis on the type of information which is possible to gather from cores and samples varies with the type of activity that is to follow.

For example, obvious requirements for the offshore contractor are the reduction of operating costs and commercial risks whereas, in the case of scientific studies, the area of main interest often lies in the finer details of the core structure.

Ideally, a sample from the seabed would consist of a column of material totally undisturbed and exactly as it was in situ from the surface of the seabed to the required depth or to bedrock. This can rarely be achieved for practical and economic reasons. It is therefore necessary to compromise with regard to both technique and expenditure.

no refs.

Alluvial Mining Company, U.K.

2.b(5).12.

1974: Hill, J. C. C.

Economic evaluation of a marine alluvial deposit using vibratory coring. Exploitation of Vibration Symposium, Glasgow, Paper 17, 19 p.

234; Metrology

In this paper, I shall consider some of the economic and practical aspects of obtaining core samples from the sea bed using vibratory techniques. I shall attempt to look at these from the point of view of the consultant and contractor undertaking the investigation and the client for whom the work is carried out.

The basic purpose of obtaining sea bed samples is to acquire knowledge about the nature of the sea bed in the area being investigated in order to improve the performance of the following activity.

The emphasis on the various types of information which it is possible to gather from cores and samples changes with the type of activity that is to follow.

For example, obvious requirements for the offshore contractor are the reduction of operating costs and commercial risks whereas, in the case of scientific studies, the area of main interest often lies in the finer details of the core structure.

Although all such undertakings offshore have a vein of similarity running through them, the detailed requirements of various projects differ widely in the information that is required.

Ideally, a sample from the sea bed would consist of a column of material totally undisturbed and exactly as it was in situ from the surface of the sea bed to the required depth or to bedrock. This can rarely ever by achieved for practical and economic reasons. It is, therefore, necessary to compromise both with regard to technique and expenditure.

no refs.

Alluvial Mining Company, U.K.

2.b(5).13.

1974: Kirby, R.

The recognition of original and induced internal structures in samples taken with vibratory seabed corers. Exploitation of Vibrations Symposium, Glasgow, Paper 15, 16 p.

232; Metrology

Sand and gravel cores taken with the IOS vibrocorer are sectioned longitudinally and impregnated with a lacquer to provide a relief model of any internal structures. Muddy cores are sectioned into 1 cm thick slabs and photographed with an X-ray apparatus to reveal their internal structures.

The usefulness of such cores is limited by difficulties in distinguishing natural sedimentary structures from those induced by the operation of the coring device itself. Study of the lacquer impregnations and X-ray photographs indicate that in general the primary sedimentary and secondary internal fabrics of the samples are preserved with little alteration and thus the samples are generally reliable macroscopically.

To evaluate any disturbance on a microscope scale silt and clay and some fine sand cores have been subjected to magnetic fabric analysis. These investigations show that little or no fabric alterations have been imposed on the silt and clay cores by vibration. The sand cores show a poorer fabric partly because the material was at the limiting size range for discrimination by this technique and partly because the sand samples may be more disturbed.

The disturbance structures recorded fall into two main groups, those produced by the vibration and those resulting from other effects of sampling. Vibration effects result from fluidization of the cores causing complete or partial homogenization of the internal structures. In certain cases this is sufficiently severe to cause upward migration of fine material and the formation of a clay cap. Other effects of sampling include dragging down of bedding planes on the edge of the core, disorientation of marginal gravel grade clasts, core shortening and structures resulting from the formation of cones of compression on barrel retraction.

13 refs.

Institute of Oceanographic Sciences, U.K.

2.b(5).14.

1974: Kögler, F.-C., E. Seibold, and K. H. Veit

Problems and experiences of sand-core sampling by vibration. Exploitation of Vibration Symposium, Glasgow, Paper 19, 6 p.

235; Metrology

Several important problems in connection with the undisturbed sampling of representative cores, taken mainly from sand, are discussed. Functioning of and practical experience with three corers are briefly described which operate on the vibro-hammer principle and allow the sampling of representative cores.

The presently existing vibro-hammer corers, which are electrically operated and have been in use for years, are briefly described below (in sequence of core dimensions):

a) Core 10 x 10 x 100 cm

A light (approximately 120 kg) equipment with rigid frame for operation in extremely shallow waters off a rubber dinghy or helicopter (2), so far about 400 applications in the Baltic and North Sea.

b) Core 10 x 10 x 200 and 300 cm, respectively

A medium-weight (approximately 600 kg) equipment with rigid frame for operation off smaller boats which, if required, can be provided with its own hoisting gear and an automatic measuring and control unit for depth penetraiton and inclination. So far aout 350 applications in the Baltic, North Sea, Atlantic and Indian Ocean.

c) Core 15 x 15 x 600 and 800 cm, respectively

A heavy (2.6 tons) equipment with four hinged basal plates which allow the operation in regions with heavy currents and a bottom sloping up to 20°. The standard system is equipped with its own hoisting gear and an automatic measuring and control unit for depth penetration inclination, automatic stop, and an overload safety device. This equipment is taken off and on board with separate device, which allows operation even under rough water conditions (3). So far about 40 applications in the Baltic, North Sea, Atlantic Ocean.

8 refs.

Kiel University, Kiel, W. Germany.

2.b(5).15.

1975: Fowler, G. A. and P. F. Kingston

An underwater drill for continental shelf exploration. J. Soc. Underwa ır Tech., 1(4), 18-22.

156; BIO

The drill system was designed for use on geological surveys of the Continental Shelf where operations are carried out from an oceanographic research vessel. For this reason, the system requires limited deckspace, can be handled with existing shipboard equipment, including a 5 ton crane and 50 hp winch, and can be easily installed and removed from the ship. The drill is capable of penetrating the ocean bottom to 5.75 m in water depths of up to 360 m.

The drill drive mechanism is mounted on the base of a tetrahedral frame 1.6 m on a side, which is ballasted with lead to gie a total rig weight of 850 kg. A drill barrel 6 m long is housed in a close-fitting aluminum mast equipped with lubricating fittings throughout its length and is guyed at its top end to the three base corners of the frame. The mast serves to eliminate the vibration caused by high speed rotation of the drill barrel.

Sea water flushing at a rate of 16 litres/min is provided by a gear pump, driven off the main input drive shaft. The sea water is pumped down to the diamond bit through the drill barrel and mast assembly. Drill tilt on two axes and flushing pressure are measured continuously using sensors mounted inside a pressure case on the drive mechanism.

6 refs.

Metrology Division, Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

2.b(5).16.

1975: Harker, R. J. and J. H. Ball

Design considerations in vibratory core sampling equipment. Proc. Offshore Tech. Conf., 2, 457-464.

164; BIO

This paper presents laboratory data obtained in a study to simulate vibratory sediment core sampling using torsional action and design equations based upon the data. Variables studied included vibratory amplitude, frequency, torque, and time-phase angle, preload, rate of penetration, tube geometry, and power requirements. Cohesive soils exhibited a reaction to the vibratory probe motion which included spring, mass, and damping effects. Relief clearance at the tip was found to be crucial in clay.

12 refs.

University of Wisconsin, Madison, Wisconsin

2.b(5).17.

1975: Jonasson, K.

Haamer vibrocorer and its affect on the geotechnical properties of cohesive sediments in Gothenburg Harbor, Sweden. Mar. Geotech., 1(3), 233-257.

061; BIO

The Haamer vibrocorer is a cheap and easily handled sampler for containing continuous cohesive or cohesionless sediment cores. This vibrocorer can be handled on board an ordinary trawler or small vessel. The penetration of the sampling barrel is actuated by two synchronized vibrators. Additional penetration force is provided by the buoyancy of a guiding buoy. To extend the maximum sampling length and to decrease the degree of disturbance, the vibrocorer is equipped with a plastic foil, which encases the core as it enters the liner and reduces inside friction. By providing the sampler with jetting water, the necessary penetration force is decreased. Testing a prototype is always difficult, but a working cycle of up to three cores an hour has been reached using a 6 m vibrocorer. A limited investigation has been conducted to determine the quality of the recovered cores; however, because of the poorly defined quality of the reference samples, no definitive answer to the question of sample disturbance can be given.

11 refs.

Department of Geology, Chalmers University of Technology, Gothenburg, Sweden.

2.b(5).18.

1975: Menard, L.

Intéret technique et économique du vibromarteau hydraulique annulaire pour le prélèvement d'échantillons en mer et la réalisation d'essais géotechniques in situ. (Technical and economic advantages of hydraulic annular vibro-hammer for underwater sampling and geotechnical in situ explorations.) Proc. 2nd Colloq. Int. sur l'Exploit. des Oceans., 2, Pap. Bx. 117, 17 p.

105;

The tool is provided with four double action unbalanced weights with an incorporated hammer. Its rotary action extends sampling possibilities in ground ranging from sediments to rocks. It can work in 200 m of water and then recover up to 100 m of samples. It can be utilized from a supply vessel, either "hanging" or on a self-stabilized sub-marine frame. The maximum weight is approximately one ton. Data in graphical form are appended. In French with English abstract.

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Soc. Tech. Louis Menard, Longjumeau, France.

2.b(5).19.

1976: Koutsoftas, D.C., J.A. Fischer, J.T. Dette, and H. Singh

Evaluation of the vibracorer as a tool for underwater geotechnical explorations. Proc. Offshore Tech. Conf., 3, 107-121.

013; BIO

The Vibracorer was used extensively for underwater coring as part of the full range of geotechnical explorations for an offshore floating nuclear power plant, located 2.8 miles off the coast of New Jersey with water depths of 30 to 40 feet. Experiences gained with the Vibracorer are described and evaluated as they relate to stratigraphy. The quality of samples obtained with the Vibracorer is evaluated by comparing the results of a variety of laboratory tests on Vibracore samples of two medium stiff to stiff Holocene clays, to the results of similar tests on "undisturbed" samples obtained in test borings drilled from a jack-up platform.

The Vibracorer is found to provide useful supplementary stratigraphic information when used in conjunction with other methods of underwater sampling. Vibracore samples, however, are severely disturbed. Undrained strength tests on such samples underestimate in situ shear strengths by as much as a factor of two. Triaxial tests on Vibracore samples of a lean sensitive medium stiff clay (CL) and a stiff plastic clay (CH), which were reconsolidated in the laboratory to stresses greater than the maximum past pressure, were found to give reasonable estimates of effective stress-strength parameters.

9 refs.

Dames and Moore

2.b(5).20.

1977: Cavillin, J. E., C. G. Bemis, and S. C. Haley

The vibratory corer in offshore investigations. Ports '77 Proc. (ASCE), 1, 308-319.

129; BIO

The vibratory corer is a sampler widely used in unconsolidated sediments where the required depth of penetration is not greater than 40 ft. The sampler obtains a complete stratigraphic sequence of materials and penetration data that can be correlated to the engineering properties of sea floor sediments.

Since the late 1960's, Woodward-Clyde Consultants has used the vibratory corer in scores of projects such as harbor dredging studies, and investigations for platforms and pipelines. This paper describes the vibratory corer, its operation and limitations in offshore investigations. The paper also presents examples of its application to common offshore projects.

The vibratory corer is a sediment core sampler which can be set on the sea floor and operated from a surface support vessel. It consists of a pneumatic impacting bin vibrator mounted on top of a core barrel (up to 40 ft in length) made of 4-in. standard pipe which contains a 3-1/2 -in. inside diameter tubular plastic liner to hold the core. A check valve at the top of the core barrel and a spring leaf core retainer at the bottom are used to retain the core sample in the plastic liner during withdrawal of the core barrel and raising of the sampler. The coring equipment is mounted in a mast consisting of an aluminum H-beam supported in a vertical position by a base consisting of four legs braced to the mast which is set on the sea floor (Figs. 1 and 2). The vibrator and core barrel are spring-mounted to a slide attached to the mast, and thus are set free to move vertically, guided by the mast, with the weight of the slide exerting a constant downward pressure on the core barrel.

5 refs.

Woodward-Clyde Consultants, San Diego, California.

2.b(5).21.

1978: LeLann, F. and J. Ulrich

Le Vibrocarottage comme moyen d'Exploration des Plateaux Continentaux: l'experience du B.R.G.M. dans ce domaine. (The vibrocoring tehnique and cotinental shelf survey: The B.R.G.M.'s experience.) GERMINAL Seminar on Offshore Mineral Resources, Proc., DocBRGM7-1979, 217-229.

160; BIO

The Marine Geology department of the French state body B.R.G.M. has developed a very light vibrocorer which can take undisturbed samples for measurement of the physical, mineralogical and mechanical characteristics of the sediments.

Three lengths of the core-barrel are possible (3, 5, 8 meters). Extraction of undisturbed cores is very easy owing to opaque polythene sleeves (dia. 100, 125, 250 mm).

The vibrocoring device of the B.R.G.M. is of great importance for the preparation and realisation of numerous offshore operations:

- survey of submerged pipeline and harbour channel sites;
- establishment of marine construction (piers, basins, break-waters, s.o.);
- preliminary studies for dredging work;
- research for marine aggregates, offshore heavy mineral deposits, s.o.

no refs.

Department of Marine Geology, B.R.G.M.

2.b(5).22.

1979: Barnes, P., E. Reimnitz, L. Toimil, D. Maurer, and D. McDowell

Core descriptions and preliminary observations of vibracores from the Alaskan Beaufort Sea shelf. <u>U.S. Geol. Surv. Open-file Rept. 79-351</u>, 13 pt.

326; BIO

The samples described in this report were obtained using a vibratory corer. Vibrations are generated from the forces created when a pair of electrically driven, counter-rotating, eccentric weights in the core head drives a hammer against an anvil. The hammer impact from the downstroke is repeated 2,840 times per minute transmitting 700 kp of force at each stroke through the driving head to the 2-meter core barrel. The repetitive blows and the weight of the driving head force the barrel into the sediment. The vibrating head and core barrel are guided into the sediment by a bottom-resting quadruped frame with vertical rails. This same frame supports penetration and inclination measuring devices and a winch which withdraws the core barrel from the sea bed after sampling.

Two types of core barrels were used - 10 cm x 10 cm boxes of sheet metal and 10.8 cm round fiberglass tubing. The steel barrels propagated the hammer vibrations to the sediment more efficiently and therefore generally obtained longer cores. Spring type core catchers were necessary in both barrel shapes to retain sand and gravel samples.

The coring procedure at each sample site in both 1976 and 1977 was essentially the same.

After the core frame had settled to the sea floor, the vibrators were operated for 3-minute increments alternating with 20-minute cooling intervals, until either full penetration was indicated or further penetration was unlikely. Vibrating times ranged from less than 3 minutes to a maximum of 10 minutes. In 1976, incremental times and penetration depths were recorded for determining the rate of penetration.

Several sedimentary environments were chosen for the sampling program including bays, lagoons, ice gouge terrain, delta front platforms, shoals, and islands.

11 refs.

U.S. Geological Survey, Menlo Park, California.

2.b(5).23.

1979: Lanesky, D. E, B. W. Logan, R. G. Brown, and A. C. Hine

A new approach to portable vibracoring underwater and on land. J. Sed. Petrology. 49, 654-657.

197; BIO

An effective and inexpensive new method of vibracoring has been developed for acquisition of continuous cores up to 13 m long in unconsolidated sediments. This system can be used on land and in water depths up to 18 m. The principal components, a 7 hp. concrete vibrator, drill pipe and liner or thin-walled aluminum irrigation tubing, are stock items. The entire system weighs 150 kg and costs about $2,000. With this system approximately 200 cores averaging 4-6 m in length have been recovered in sediments ranging from clay to coarse sand. Percentage of recovery is usually 90 to 100 % and distortion of delicate sedimentary structure is generally minor.

11 refs.

University of Miami Rosenstiel School of Marine and Atmospheric Science, Comparative Sedimentology Laboratory, Fisher Island, Miami Beach, Florida.

2.b(6).1.

1958: Mackereth, F. J. H.

A portable core sampler for lake deposits. Limnol. and Oceanog., 3, 181-191.

115; BIO

A pneumatically operated core sampler is described which is easily portable and may be used by two men from a rowing boat. The apparatus takes an undisturbed sediment core 6 m long and is substantially independent of water depth up to a limit of some 250 m. The hydrostatic pressure operating on a cylindrical anchor chamber embedded in the sediment is used to hold the apparatus in contact with the bottom while the coring tube is driven downwards by compressed air. On completion of the coring operation, the anchor chamber is automatically filled with air, the coring tube is extracted from the sediment, and the apparatus brought to the water surface by the buoyancy lift. The use of heavy weights and the associated lifting tackle is therefore avoided.

1 ref.

Freshwater Biological Association, Ambleside, England.

2.b(6).2.

1962: Zumberge, J. H.

A new shipboard coring technique. J. Geophys. Res., 67(6), 2529-2536.

120; BIO

Coring operations in the bottom of Lake Superior were undertaken during the summer of 1961. The motor vessel Submarex, 173-foot converted Navy P.C., was used on contract from the Global Marine Exploration Company of Los Angeles, California. This ship was equipped with an over-the-side rotary drilling rig capable of drilling in a maximum water depth of 1300 feet. A modified piston coring technique was developed whereby continuous soft lacustrine material could be cored. The wire line normally used to suspend a piston coring device was replaced by rigid drill pipe. The technique permitted the taking of a 28-foot core from any part of the upper 50 to 60 feet of soft sediments. Other modifications permitted using the inner core barrel techniques for punch coring in the deeper sediments of compact clay and glacial till. After complete penetration of the uncemented sediments, bedrock was cored by ordinary rotary techniques. All drilling sites were in water 500 feet or deeper. Six locations in the central and western Lake Superior basin were drilled. Two went to bedrock through 116 and 147 feet of lacustrine and glacial deposits, and at one location in 938 feet of water near the Minnesota shore, the bottom was penetrated 686 feet without striking bedrock.

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Glacial Geology and Polar Research Laboratory, University of Michigan, Ann Arbor, Michigan.

2.b(6).3.

1970: anonymous

New development in sea-bottom sampling. Ocean Industry, 5(10), 32.

143; BIO

Conrad-Stork, Haarlem, Holland, and the Dutch Geological Survey Department have developed Geodoff II, the latest of their units designed for remote-control drilling of the upper 50 meters of the sea floor and for recovering undisturbed samples.

The new drilling method is a combination of two different penetration methods; i.e., pressure penetration and ordinary rotary drilling. The new unit has the advantage, over other methods for obtaining undisturbed samples, of being able to penetrate hard formations efficiently.

The main body, its three legs emplaced on the sea bottom, contains the rotary drilling device and a rotating supply disc on which the complete drill string is placed in 12 lengths of about 4 meters each. The electric motor driving the hydraulic pumps, the computer, etc. are housed in the drums on the main body. An umbilical cord from the surface vessel supplies electric power, electric signals and drilling mud. The filled core barrels are stored by mechanical arms after every pipe length of drilling progress. The tubes are placed on the supply disc in special clamps. After the hole has been completed, the drill string linking procedure is reversed and the drill pipes are returned one by one to their original positions on the supply disc.

1 ref.

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2.b(6).4.

1970: Delacour, J. and J. Debyser

French core-drill in 8,000 feet of water. World Oil, 171(1), 99-101.

081;

An unusual flexible drill string has been used to recover core samples in ultra-deep waters of the Mediterranean Sea. The electrically driven downhole motor, instrumentation and support equipment should be adaptable for similar coring work in water depths to 20,000 ft. Specifications of downhole, manipulation equipment and of flexible line are given.

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Institut Francais du Petrole, Paris.

2.b(6).5.

1970: Delacour, J. and J. Debyser

Flexodrilling used for deep-water seabed reconnaissance. Ocean Industry, 5(7), 31-33.

083; BIO

The Institut Francais du Petrole has designed and built equipment for drilling and coring under 8000-ft water depths using the plumb-line method which permits easy tripping and complete remote control of drilling and coring. The surface support is a small-displacement vessel (850 metric tons for the Terebel) equipped with dynamic anchoring for nearly instantaneous positioning at a given spot no matter what the water depth may be. Instruments, motors and downhole tools for drilling and coring are simply hung on the end of a continuous flexible power-conducting line that is wound and unwound quickly and efficiently between surface and bottom and is protected from heat effect by special onboard equipment. The technical characteristics of the equipment are given, and the first operation of the system, in the Mediterranean under nearly 7900 ft of water, is described.

Institut Francais du Petrole, Paris.

2.b(6).6.

1971: Bailey, E.I., G.L. Davis, and H.O. Henderson

Design of an automatic marine corer, <u>Proc. Offshore Tech. Conf.</u>, <u>1</u>, 397-416.

019; BIO

Upon request of several geophysical organizations, a program was initiated at Texas A&M U. under the Sea Grant Program to design a self-contained automatic seafloor setting corer which will (1) extract up to 50 ft of continuous undisturbed core, (2) operate in depths up to 1,000 ft of water, (3) core in hard as well as soft material and (4) be as compact as possible to facilitate shipboard handling. This program was partially funded by Oceanonics, Inc., Houston, Tex. The SEACORE 50 will extract a 3-in. diameter core 49.5 ft long in 11 sections. The unit is octagonal in cross-section measuring 6 ft side to side and is 12 ft in height. When the unit reaches the sea-floor, four legs fold down and level the unit on slopes of up to 15°. The unit weighs 10,000 lb dry, 8,000 lb in water, and is lowered to the seafloor by a single power-tension cable. An automatic control system is contained in the unit with shipside manual control available at any time. A drill pipe fitted with a ring-type core bit is rotated under a considerable thrust load while water is pumped down the center of the drill pipe to wash the cuttings back up the annulus. This water is routed through the double-walled bottom joint around the core barrel so that the sample is not washed. A square rod extending from the top of the coring unit retains the rotation of the core barrel. This square rod also supports a piston in the core barrel, thus affecting "fixed piston" coring. A hydraulic powerhead produces 1,000 ft-lb of torque and 6,000 lb of thrust or pull.

no refs.

Texas A and M University

2.b(6).7.

1971: Hironaka, M.C. and W.C. Green

A remote controlled seafloor incremental corer. Proc. Offshore Tech. Conf., 1, 13-20.

020; BIO

Presently there are no corers capable of taking undisturbed samples to sediment depths of 50 feet in water depths to 6,000 feet. With the objective of developing a corer to sample at these depths with a relatively small vessel, a bottom resting corer has been designed under contract for the Navy. The corer, as designed, has a submerged weight of 15,700 pounds and the following dimensions: width 10 feet, length 13 feet (23 feet x 26 feet respectively with bearing pads extended) and height 16 feet. The corer utilizes the fixed piston and incremental sampling techniques and incorporates other features intended to minimize sample disturbance. It is believed that the corer will be economical to use and that its design will eliminate sampling deficiencies and permit the extraction of relatively undisturbed samples of the seafloor to sediment depths heretofore unobtainable.

2 refs.

U.S. Naval Civil Engineering Laboratory, Port Hueneme, California

2.b(6).8.

1971: O'Brien, R. D. and E. J. Duley

Aids to utilization of a shallow penetration sea floor sitting drill. U.S. Nat. Oc. and Atm. Admin. Mar. Mins. Tech. Center Tech Memo #1, 16 p.

091; (NTIS COM 71 01011)

Suspending a drilling tool over the side of a ship and under water raises problems relating to assuring that the penetration into the marine sediments is perpendicular to the sea floor. A breakaway tripod which provides support for the initial penetration, then collapses to allow further penetration is described.

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National Oceanic and Atmospheric Administration, Marine Minerals Technology Center, Tiburon, California.

2.b(6).9.

1973: anonymous

Maricor: Atlas Copco and Wimpey develop diamond core drill for seabed sampling. Mar. Engineers Rev., 42, Aug. 1973.

268;

Maricor, a multirun diamond core drill, is able to penetrate 60 m of seabed, operating at a maximum water depth of 200 m. The machine operates on the seabed by remote control from a control console on the attendant vessel. Core recovery is achieved by core barrels of wire design. The system, which can operate from a modified vessel, increases operation time and reduces standby time due to adverse weather conditions. Maricor has the capacity for drilling on the continental shelf for several purposes, including site investigation and surveying geotechnical conditions before installation of platforms, geological mapping, exploration of deposits of economic value, and exploration of proposed undersea tunnel routes.

no refs.

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2.b(7).2.
1938: Piggot, C. S.

Core samples of the ocean bottom and their significance. Carnegie Inst. Wash. Supp. Publ. 36, 17 p.

328; BIO (doc. no. 2615)

The apparatus, in its present state of development, consists of five parts: a weight, or gun, a cartridge, a firing mechanism, a water exit port and a bit. The gun is made of ordinary cold rolled steel 10 inches in diameter and 22 inches ong. The cartidges, trigger and housing are of stainless steel. The water port is of welded steel, and the bit of a special alloy steel developed for airplane construction.

The explosive charge which furnishes the energy necessary to do the required work varies with the depth and the character of the bottom. The charge consists of a primer, 1 gram of high-speed black powder, 1 gram of rifle powder and a varying number of pellets of 155-mm howitzer powder.

The firing mechanism consists of only three parts, a trigger, firing-pin and spring. A safety-pin of hardened steel is put in place before the cartridge is attached, and this is withdrawn by means of a lanyard just before the apparatus goes under the water.

The apparatus is assembled in chocks, so arranged that when it is laid in them the center of the bit and cartridge coincides with the center of the bore of the gun. The firing mechanism is cocked and the safety-pin inserted.

When all is ready, the cartridge is fastened in place and the gun "loaded," by sliding the bit toward the gun, and the shear pin is put in place.

Finally, the safety-pin is pulled out and the apparatus is lowered to the bottom. With shallow soundings in the explosion can be heard and felt on the ship, and with the deeper ones it may also be picked up by a microphone or the ship's sonic sounder. Where these fail to give any indication the cable is paid out until more than the anticipated depth is out, and then the apparatus is hauled to the surface again. If it has fired, the gun and bit will be hanging separately at the end of their respective cables, the bit supported in the stirrup.

no refs.

Carnegie Institution of Washington, Washington, D.C.

2.b(7).3.

1961: Moore, D. G.

The Free-corer: sediment sampling without wire and winch. J. Sed. Petrology, 31, 627-630.

179; BIO

The free-corer is a simple, inexpensive bottom sediment coring device intended to eliminate the necessity of wire line lowering of gravity corers. The free-corer consists of two basic assemblies: (1) a recoverable core barrel, check valve, buoyant chamber assembly, and (2) an expendable weight and casing assembly. When these two assemblies are combined, the core barrel fits loosely inside of the casing. Operation of the free-corer is accomplished by dropping the device from the ship and allowing it to fall free through the water column to the sea floor. A simple release-delay timer then releases the core barrel and its buoyant float from the weight-casing assembly; the barrel is then lifted up out of the casing and back to the surface by its attached float while the expendable weight-casing remains embedded in the sediments.

3 refs.

Sea-floor Studies Section, U.S. Navy Electronics Laboratory, San Diego, California.

2.b(6).10.

1976: Hironaka, M. C.

A remotely-controlled seafloor corer. U.S. Naval Civil Engng. Lab. Tech. Rept. NCEL-TN 1462, 27 p.

079; BIO (NTIS AD A035 801/0G1)

A bottom-resting corer has been designed that can be remotely operated from a control console located aboard a support vessel. The corer can obtain relatively undisturbed samples of the complete sediment profile to 50 feet (15 m) in water depths to 6,000 feet (1,830 m). The corer is 10 feet wide by 13 feet long (24 feet wide by 27 feet long with bearing pads extended by 17 feet high and weighs 26,500 pounds when submerged in seawater 30,200 pounds in all). It is operated via a combined load power telemetry electromechanical cable to take core samples from the same hole in the sediment profile in ten measurements, each sample of which is 3 inches in diameter and 5 feet long. The corer is completely self-contained including core barrels and drill pipes necessary for sampling to 50 feet. The corer has not been evaluated at sea. Sufficient land tests have been performed to suggest that the mechanical design is functional. Problems still exist in the system, but most of these appear to be correctable and of a nondevelopmental nature.

5 refs.

U.S. Naval Civil Engineering Laboratory, Port Hueneme, California.

2.b(7).1.

1936: Piggot, C. S.

Apparatus to secure core samples from the ocean bottom. <u>Bull. Geol. Soc. Am., 47</u>: 675-684.

430; Dalhousie

The apparatus here described is the last of several to be built and tested. It has three working parts and operates on one explosion. It consists of five principle parts: a weight (which also may be regarded as a gun), a cartridge, firing mechanism, water-exit port, and a bit. The weight or gun is made of cold rolled steel, 10 inches in diameter and 20 inches long. The cartridges are made of stainless steel, and are exactly two inches in diameter and about 4.75 inches long. The explosive charge furnishes the energy required to do the necessary work. This varies with the depth and the character of the bottom. The charge consists of a primer, one gram of high speed black powder, one gram of rifle powder, and a varying number of pellets of 155 mm howitzer powder. The firing mechanism consists of a trigger which slides in an appropriate key-way and contains a projection which catches the end of the firing-pin when cocked. A slight downward movement of the gun, on reaching the bottom, forces the trigger over and disengages the firing-pin which is pushed forward by a stiff coiled spring. The water exit port allows water to leave the sampler as mud enters and still allows the force of the explosion to be imparted evenly to the bit. The portion of the appartus below the water-exit port has been called the bit. Bits of different lengths may be used as found desirable. It consists of a tube of alloy steel of a composition to give great strength and resiliency. Brass sample tubes line the inside of the bit and allow samples to be stored and transported with ease.

no refs.

Geophysical Laboratory, Carnegie Institution of Washington, Washington, D.C.

2.b(7).4.

1965: Raymond, S. O. and P. L. Sachs

Development of the boomerang sediment corer. Mar. Scis. Instrumentation, 3, 55-69.

176; BIO

An improved corer that is dropped into the ocean from a moving ship, sinks rapidly to the ocean floor, and automatically returns to surface for recovery has been developed, tested and used at sea. Over 70 corers have been launched by marine geologists in deep water with better than 90% recovery. Steel ballast is used to propel the corer downwards; hollow spherical glass floats pull the core sample to the surface; electronic flash inside one of the glass floats is used for recovery. The round trip travel time is less than 15 minutes per 1000 meters of depth.

13 refs.

Benthos Company, North Falmouth, Massachusetts.

2.b(7).5.

1965: Sachs, P. L. and S. O. Raymond

A new unattached sediment sampler. J. Mar. Res., 23(1), 44-53.

174; BIO

An improved sediment sampler that is used without winch or wire has been developed, tested, and used at sea. The device employs an expendable iron-ballast, steel-casing combination and a recoverable glass-float, plastic-liner assembly. Of 50 samplers launched in deep water under a variety of conditions, 46 instruments were recovered. Forty-one of these contained samples. The round-trip travel time is less than 15 minutes per 1000 m of depth. The sampler appears to be effective, reliable, and economical in obtaining short sediment cores, often under circumstances beyond the capabilities of existing equipment.

10 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.b(7).6.

1966: Fowler, G.A. and L.D. Kulm

A multiple corer. Limnol. and Oceanog., 11, 630-633.

023: BIO

The main core body is composed of five disk-shaped lead weights; three of them weigh approximately 110 kg each, and the other two weigh 55 kg each. Each weight was molded with five holes to accommodate the core barrels. The weights are held together with pieces of pipe with couplings screwed to each end. Steel plates are used at the top and bottom of the stack of weights to prevent the couplings from denting the soft lead. A simple mold for the weights was made by placing a sheet metal band around the basal plate and inserting sections of pipe in the holes. The corer is suspended by a chain and bale arrangement attached to the upper plate. Pipe sections are screwed into the lower couplings, and the cutting heads are screwed to the bottom of these pipes. The valves are attached to the upper couplings by means of short pipe nipples. All pipe, couplings, and nipples are of standard $1\frac{1}{2}$-inch (3.8 cm) plumbing type. The valves are standard water well foot valves obtainable from most plumbing shops. All joints are made with $1\frac{1}{2}$-inch (3.8 cm) pipe threads.

Plastic liners of the size used in standard Phleger corers extend the entire length of each multiple corer barrel. They fit into each cutting head and rest against stops in each valve. The difference between the inside diameter of the core barrels and the outside diameter of the liners is large enough to allow the liners to slip out of alignment with the cutting heads. To eliminate this possibility a step was turned on the inside of the cutting heads to hold the liners in position.

5 refs.

Department of Oceanography, Oregon State University, Corvallis, Oregon

2.b(7).7.

1969: Rosfelder, A. M.

Bouyant coring apparatus - Patent No. 3, 434, 551. <u>Off. Gaz. U.S. Pat. Office</u>, <u>860(4)</u>, 1110.

269;

The description discloses a buoyant rig for supporting coring operations of an underwater coring barrel. The buoyant rig includes a float and a bottom weighted stand which are interconnected by at least one guide wire. The core barrel slidably extend through the weighted stand and is positioned parallel to the guide wire and is slidable therealong by a guide means. When the core barrel is powered the barrel will be guided along the guide wire as it penetrates the ocean bottom. A gimbal connection between the core barrel and the stand for uneven ocean bottoms and the guide wire may be separated from the stand after a sample is obtained so that the float will raise the core barrel and the remaining rigging apparatus to the ocean surface.

—

Scripps Institution of Oceanography, La Jolla, California.

2.b(7).8.

1970: Hamilton, A. L., W. Burton, and J. f. Flannagan

A multiple corer for sampling profundal benthos. J. Fisheries Res. Bd. Can., 27, 1867-1869.

196; BIO

A multiple corer for sampling the benthos of profundal sediments is described. This sampler is relatively simple to construct and is light (approximately 17.5 lb (7.9 kg)) and easy to use. Four core samples are taken simultaneously and trials reported elsewhere indicate that in soft sediments the samples taken are generally superior to those collected with most, if not all, of the more conventional samplers tested.

3 refs.

Fisheries Research Board of Canada, Freshwater Institute, Winnipeg, Manitoba.

2.b(7).9 .

1970: Pierce, G. E. and R. J. Smith

The NPS rocket corer: a first generation rocket powered coring tool. U.S. Naval Postgrad. School Tech. Rept. NPS-58SJ70011A, 34 p.

090; (NTIS AD 700 707)

A rocket motor powered corer has been designed and built. Limited tests of the rocket corer, conducted in a sand-silt-clay bottom at a depth of 10 feet off Pitas Point in Ventura County, showed promising results. It has been demonstrated that available rocket motors can be used to drive coring devices in relatively shallow water. Further tests are warranted to determine the maximum depth that rocket-powered instruments may be used. It presently appears possible that rocket motors may be used as a general source of power for varied underwater applications.

4 refs.

Department of the Navy, Washington, D.C.

2.b(7).10.

1971: Greene, M. L.

A line cutter and a coring device powered by elastic bands. J. Mar. Tech. Soc., 5(3), 48-50.

109; BIO

A manned submersible permits the scientist to observe directly the environment and exact location where measurements are made and samples are taken. However, it is difficult to take bottom core samples manually from a neutrally buoyant submersible operating on or near the bottom since the driving force of a manipulator arm of the submersible on a corer tends to lift the vehicle off the bottom rather than drive a corer into the sediment. The coring device illustrated in Figure 1 was conceived to permit coring with a submersible without ballast adjustment. Even though the Navoceano program using chartered submersibles was curtailed before this device was built or tested, a patent on the design is pending. With a few modifications the device might be useful to scuba divers for bottom sampling.

To actuate the corer electrically without the use of explosive elements, a cord-cutter release mechanism was designed, fabricated, and tested to a limited degree. The mechanism is illustrated in Figure 2 and shown in the photograph. Its simplicity makes it attractive as a release mechanism for many marine or atmospheric applications.

The corer consists of four basic parts: a core tube, a case, elastic bands, and a base. The motive force for driving the corer into the sea floor and extracting it is provided by the elastic bands.

no refs.

U.S. Naval Oceanographic Office, Washington, D.C.

2.b(7).11.

1971: Kemp, A. L. W., H. A. Saville, C. B. Gray, and A. Murdrochova

A simple corer and a method for sampling the mud-water interface. Limnol. and Oceanog., 16, 689-694.

123; BIO

A triple corer has been designed, based on a modification of the Benthos corer. Satisfactory cores have been taken in clay muds, silty clay muds, silts, and glacio-lacustrine clays at depths up to 250 m. The sediment is extruded layer by layer on a simple screw thread piston device. Results show that extrusion of each tube separately is reproducible, and that it is possible to subsample the cores at close intervals. Bottom water for analysis is also collected by the corer.

3 refs.

Canada Centre for Inland Waters, Burlington, Ontario.

2.c.1.

1962: Murray, J. W.

A new bottom-water sampler for ecologists. J. Mar. Biol. Assoc. U.K., 42, 499-501.

289; BIO

Basically the sampler consists of a sphere (a Nokalon trawl-net ball, A in Fig. 1) anchored to a sheet of lead, B, to ofset its buoyancy. At the top of the sphere is a safety valve, C (as used in blow-lamps), while from the bottom there issues a rubber tube, D. this tube passes under a metal bar, E, which is attached by two rods to a lead weight, F, hinged from the lead sheet, B.

The hydrostatic pressure of the water is relied upon to fill the sampler. To operate the instrument, the rubber tube, D, is bent so that the end comes under the bar, E, and the instrument is lifted. As the lead weight, F, is hinged along the line, G, as soon as the instrument is raised off the substratum the weight falls and in so doing the bar clamps the tube. Thus the sampler is closed. It is then lowered to the sea floor and gently brought to rest to avoid disturbing the sediment. On landing, the bar is raised automatically thus opening the tube. The air pressure inside the closed sphere is one atmosphere, whereas the pressure of the water is proportional to the depth but always greater than that inside the sphere. Consequently, water enters the sampler and compresses the air but this cannot escape through the safety valve as the pressure within and without are the same. However, on raising the sampler to the surface, the bar again clamps the inlet tube, and the air is able to escape as the outside pressure decreases.

1 ref.

Department of Geology, Imperial College, London, U.K.

2,c,2,

1966: Schink, D. R., K. A. Fanning, and J. Piety

A sea-bottom sampler that collects both water and sediment simultaneously. J. Mar. Res., 24(3), 365-373.

114; BIO

A simple sampler, assembled mainly from commercially available equipment, is described. It simultaneously collects water samples at 1, 2, 3, 4, 5, and 6 m above the sea floor and takes a short core at the same location.

5 refs.

Narragansett Marine Laboratory, Kingston, Rhode Island.

2.b(7).12.
1976: James, P. N.

Cable-free data retrieval from the deep sea. Sea Tech., 17(2), 22-23.

178; BIO

The concept is based on the use of Benthos glass flotation spheres. A deep sea camera system, for example, can be attached to a mounting framework and a buoyancy package consisting of two or more glass spheres added. Then releasable ballast weights are added to carry the camera system and buoyancy package to the bottom.

A bottom contact switch automatically triggers the camera to obtain a number of photographs, and also trips the ballast release so that the buoyancy package can carry the instrumentation back to the surface.

A stroboscopic flash, radiobeacon or pinger placed within one of the glass spheres, or attached to the mounting frame, signals the location of the package as soon as it reaches the surface. After being quickly retrieved, it can be used again as a "boomerang"--surface to bottom and back again. Only the ballast weights are expendable.

The sediment corer recovers 1.2 meter (3.93 feet) long core samples from the sea bottom down to 6,700 meters. The high impact velocity of the free falling corer results in longer cores of sediment than can be obtained with cable lowered corers of the same weight and with less sample disturbance.

The free-falling sediment corer, which reaches a descent velocity of 425 meters (1,394 feet) per minute, nearly four times faster than cable lowered corers, was developed in conjunction with the Woods Hole Oceanographic Institution. The faster descent rate gives greater accuracy because the corer is offset less by underwater current.

A third type of instrument, the Boomerang Grab sampler, is used for manganese nodule and other ocean mining survey operations. This instrument system, originally devised by the Kennecott Co., leader of one of the consortiums developing nodule mining systems, is actuated when it touches bottom by automatically snapping closed the jaws of a heavy duty grab sampler and simultaneously releasing ballast.

no refs.

Benthos, Inc., North Falmouth, Massachusetts.

2.b(7).13.

1979: MacTernan, F. C.

Eleven years of drilling industry innovations. Ocean Industry, 14(9), 201-212.

161; BIO

A hydraulic piston corer was developed and sucessfully operated for the recovery of undisturbed cores. The present hydraulic piston corer is currently capable of recovering undisturbed cores, 4.4 m long and 6.35 cm in diameter. The unit is lowered and retrieved by wireline through the drill string. By repetitive operation in the same hole, high quality undisturbed cores may be taken in 4.4-m increments through the unlithified interval. Recently, the corer recovered a continuous section, totalling 152 m of undisturbed laminated core at Site 480. The maximum shear strength of the recovered material was 1,000 g/cm^2.

The system is designed for a total sub-bottom penetration approaching 200 m. A special 11.5-in. OD bit with a 3.6-in. core throat opening is required. Coring with the system must be discontinued when the sediments become too indurated since it is not designed for drilling and coring in this type of material.

An analysis of the operating time for the coring system compared to a conventional core barrel shows the operational time to be relatively the same. Currently under design is a same. Currently under design is a larger unit which would take undisturbed cores up to 9.15 m long. It is anticipated that this design will be ready for testing in approximately six months.

no refs.

Scripps Institution of Oceanography, University of California at San Diego, LaJolla, California.

2.c.3.

1969: Broenkow, W. W.

An interface sampler using spring-activated syringes. Limnol. and Oceanog., 14, 288-291.

284; BIO

The sampler consists of a 3.5-m-long aluminum frame on which twelve 30-ml glass syringes are attached at 25-cm intervals (Fig. 1). The syringes can be spaced as closely as 10 cm or as far apart as is practical. The syringes are mounted on polyvinyl chloride (PVC) bases that can be quickly attached or removed from the aluminum frame by thumbscrews. The syringe plungers are held snugly closed by brass pivot arms permanently fixed to the syringe bases. The plungers are connected to the rear of the PVC bases with surgical rubber tubing, and when the pivot arms are moved aside tension by the tubing withdraws the plungers to calibrated stops. A setscrew in the calibrated stop allows the sample volume to be adjusted without contamination. The lower end of the pivot arm on each syringe base fits through a slot in the tripping bar that extends the length of the aluminum frame. The syringes open simultaneously when a messenger opens the Nansen bottle release mechanism at the top of the frame.

3 refs.

Department of Oceanography, University of Washington, Seattle, Washington.

2.c.4.

1970: Sholkovitz, E. R.

A free vehicle bottom-water sampler. Limnol. and Oceanog., 15(4), 642-644.

292; BIO

A free vehicle which samples water at 20-cm intervals for the first 2 m above the ocean sediment is described. The free vehicle approach enables closely spaced water sampling just above the ocean sediment interface for studying chemical gradients.

The sampler falls to the bottom where it remains for about 3 hr before sampling and floating back to the surface, to ensure that the bottles will flush out and sample bottom water.

The sampler has 4 parts: 1) the framework; 2) the 10 water-sampling bottles; 3) the time-release triggering mechanism; 4) the flotation and recovery equipment.

2 refs.

Scripps Institution of Oceanography, La Jolla, California.

2.c.5.

1973: Barnes, R. O.

An in situ interstitial water sampler for use in unconsolidated sediments. Deep-Sea Res., 20(12), 1125-1128.

281; BIO

A sampler which filters and encapsulates pore water in situ from unconsolidated sediments has been constructed. The collected sample is sealed against gas loss and atmospheric contamination. The precision of the technique appears to be ± 1% or less for sampled dissolved gases.

The sampler is designed to operate as an outrigger attached to a core barrel or can be mounted on a 2.54-cm diameter probe that is driven into the sediment. The outrigger method would usually be preferred because a core is simultaneously obtained for complementary studies with the filtered fluid. A sampler is also mounted on the core weight assembly to collect a bottom water sample.

The trigger mechanism can be tripped in a variety of ways. I have used a lever that trips upon impact with the sediment (Fig. 2a) or a pin that is pulled as the piston core carrying the samplers is released above the sediment (Fig. 2b). A variable delay time between tripping and initiation of sampling allows the sampler to come to rest in the sediment.

The pore fluid is filtered under in situ hydrostatic pressure through a three-layer stainless mesh filter element (1 micrometre nominal rating) and collected in a previously evacuated stainless steel cylinder through a one-way check valve that seals the evacuated cylinder, keeps the sample under pressure and minimizes contamination and loss.

11 refs.

Scripps Institution of Oceanography, La Jolla, California.

2.c.6.

1973: Joyce, J. R.

An improved bottom-water sampler. J. Mar. Biol. Assoc. U.K., 53(3), 741-744.

256; BIO

A device is described which is capable of retrieving a simultaneous series of water samples at predetermined points above the sediment/water interface. This device has been successfully used in a study of the Tawe estuary, where a bottom layer of high- turbidity, low-salinity water has been discovered.

6 refs.

Department of Geology and Oceanography, University College Swansea, U.K.

2.c.7.

1973: Sayles, F. L., T. R. S. Wilson, D. N. Hume, and P. C. Mangelsdorf, Jr.

In situ sampler for marine sedimentary pore waters: evidence for potassium depletion and calcium enrichment. Science, 181, 154-156.

151; BIO

A device for sampling the interstitial waters of deep-sea sediments in situ has been developed and tested. The sampler collects a series of samples over a depth of 1.5 meters in the sediment and thus makes possible the accurate delineation of chemical gradients existing in the pore waters. Samples collected in the North Atlantic indicate that significant gradients of K^+ and Ca^{2+} exist in the sediments sampled. Interstitial solutions sampled between Ireland and Cape Cod, Massachusetts, are characterized by the depletion of K^+ and the enrichment of Ca^{2+}.

17 refs.

Department of Chemistry, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.c.8.

1973: Wellershaus, S.

A new method for collecting near-bottom water in the deep sea. "Meteor" Frosch., Reihe A: Allg. Phys. Chem. Meeres, No. 13, 50-57.

294;

A bottom water sampler (Suctor) for application in the deep sea, in shallow waters, and in estuaries is described. It is operated by hanging the device on a wire and placing it on the seafloor. After the stirred up sediment has washed away, an electrical pump in the sampler is activated from the ship. The bottom water sampler then samples a volume of 10 l from each of 8 depths simultaneously. The depths range between 0 and 200 cm above the bottom. The samples are sucked into plastic bags through silicon rubber tubes. The sampler was used successfully between Madeira and the Straits of Gibraltar.

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Institut fuer Meeresforschung, Bremerhaven, F.R.G.

2.c.9.

1976: Sayles, F. L., P. C. Mangelsdorf, Jr., T. R. S. Wilson, and D. N. Hume

A sampler for the _in situ_ collection of marine sedimentary pore waters. _Deep-Sea Res._, _23(3)_, 259-264.

031; BIO

An _in situ_ sampler for pore waters of marine sediments is described. Filtered pore water from six depths in the upper 2 m of sediment and bottom water are collected and stored in capillary tubing, thereby preserving sampling sequence. Tests demonstrate the collection of uncontaminated samples.

The instrument consists of two rigidly connected parts, a 2-m length of thick-walled aluminum tubing (5-cm o.d., 2.5-cm i.d.) fitted with a sharp tip, and an open work superstructure that protects parts such as the master cylinder, tubing connections, valve, etc. (Fig. 1). As the sampler is lowered into the bottom (80 to 100 m min^{-1}), the barrel is driven into the sediment until the bottom plate of the superstructure (g, Fig. 1) prevents further penetration. Just below the bottom plate (10 cm) is a tripping ring (h, Fig. 1) that is lifted to the base plate by contact with the sediment. A lift of approximately 6 cm is sufficient to trigger the sampler, commencing sampling through sample ports 45 cm above and 5, 15, 30, 60, 100 and 200 cm below the base plate. After approximately 30 min, the instrument is pulled out. When lifted about 5 cm, sampling is halted by the return of the valve to its original position. On deck the samples are expressed directly into syringes inserted into the sample ports by pressurizing the barrel interior with an hydraulic pump, preventing exchanges with the atmosphere.

15 refs.

Department of Chemistry, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

2.c.10.

1977: Jonasson, A.

New devices for sediment and water sampling. Mar. Geol., 24, M13–M21.

353; BIO

There is a large variety of samplers for water and sediments. In many cases a sampler is designed for a certain project. In the research carried out at the Marine Geological Laboratory, University of Göteborg, and cooperating institutions, there has been need for a sampler which can take large volumes of water, a sampler which can take water from a thin water layer, a bottom-water sampler, and a sediment sampler with easily exchangeable plastic tubes and which can be used in a small boat. In the following the designs of these samplers are presented.

no refs.

Marine Geological Laboratory, University of Göteborg, Göteborg, Sweden.

2.d.l.

1968: Menzies, R. J. and G. T. Rowe

The LUBS, a large undisturbed bottom sampler. Limnol. and Oceanog., 13, 708-714.

121; BIO

This paper describes a new benthic collecting device, the LUBS (large undisturbed benthos sampler), which satisfies many of the criteria for a successful soft-bottom quantitative sampler. the design is simple, inexpensive, and such that samples may be canned on retrieval. Stratified sediments can be collected in large diameters, so the device also should be useful to geologists. The need for such a sampler has long been recognized by biologists.

The LUBS has an exceptionally simple design. It consists of hinged weights attached to a metal frame surrounding a removable can [5 gal (19 liters) mini-LUBS, 25 gal (95 liters) meso-LUBS and 55 gal (208 liters) mega-LUBS]. Attached to the bottom of the can by an adjustable stainless steel strap is a canvas or nylon bag. Wires close the bag after penetration.

12 refs.

Oceanography Department, Florida State University, Tallahassee, Florida.

2.d.2.

1970: Schiemer, E. W. and J. R. Schubel

A near-bottom suspended sediment sampling system for studies of resuspension. Limnol. and Oceanog., 15(4), 644-646.

291; BIO

Studies of the resuspension of bottom sediment require periodic collection of samples at several levels close to the bottom. We have designed a bottom-mounted support rod with intakes for pumping water samples from fixed levels above the bottom. All of the sampling tubes are purged continuously, and samples are selected with a special 6-way valve.

no refs.

Chesapeake Bay Institute, The Johns Hopkins University, Baltimore, Maryland.

2.d.3.

1971: Emrich, W. J.

Performance study of soil sampler for deep-penetration marine borings. Sampling of Soil and Rock, Am. Soc. Testing Materials Spec. Tech. Publ. 493, 30-50.

082;

A relatively economical method for performing foundation investigations in several hundred feet of water to penetrations as much as 300 ft from a floating platform has been devised. The exploration system employs drill pipe and a 2.25-inch outside diameter thin-wall, open-drive sampler operated by a wire line. Comparative land trials show that the shear strength of clay samples obtained by this procedure are consistently lower than that associated with conventional sampling methods. Application of correction factors provides satisfactory soil strength information that can be used in the foundation design of offshore platforms.

16 refs.

McClelland Engineers, Inc., New Orleans, Louisiana.

2.d.4.

1972: Sorokin, Y. I. and H. Jannasch

Sampling techniques. Techniques for the Assessment of Microbial Production and Decomposition in Fresh Waters, Y. I. Sorokin and H. Kodata, eds., Blackwell Scientific Publs., Oxford, U.K., 40-44.

288; BIO

In contrast to ordinary water samplers for chemical studies, microbiological samplers have to be sterilizable. The sampling gear must permit lowering of the collecting vessel to the desired depth, opening, filling and closing it by a triggering mechanism. Different types of microbiological sampling vessels are: (a) evacuated bottles, (b) rubber bulbs, (c) plastic bags, and (d) syringes.

2.d.5.

1975: Davey, E. W. and A. E. Soper

Apparatus for the in situ concentration of trace metals from seawater. Limnol. and Oceanog., 20(6), 1019-1023.

283; BIO

An apparatus designed to reduce trace metal contamination also functions to concentrate in situ particulate and dissolved Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn from seawater over integrated time intervals ranging from 1 day to 1 week.

The acid extracted metals are usually analyzed by conventional flame AAS. However, Cd, Co, Mn, and Zn adsorbed on Chelex-100 can also be analyzed directly by NAA if the resin is rinsed with deionized water to reduce its salt content and dried. The carefully purified ammonium form of Chelex-100 was found to be essentially free from trace metal contamination after analysis by NAA.

The apparatus (Fig. 1) is arranged to sample at 10 cm from the sediment-water interface by attaching the filter and column directly to the anchoring cement block and at 0.5 m below the air-water interface by attaching filter and column directly to a water collection bottle. Intermediate depths could also be sampled by the further addition of filter, column, tubing, and bottle assemblies. The water collection bottles are suspended from the surface float so that they will stay at the same distance below the water surface regardless of tidal cycles. The whole apparatus is kept upright by a rope harness attached to the anchoring cement block. The depth at which the water collection bottles are placed provides the hydrostatic driving force to pass seawater at the prescribed flow rate through the filter and column and to fill the bottles through the connecting polyethylene tubing.

6 refs.

National Marine Water Quality Laboratory, Environment Protection Agency, Narragansett, Rhode Island.

2.d.6.

1975: Mesecar, R.

Benthic sampling system. Exposure, 3(1), 5-7.

364; BIO

The sampling principle is based on exposing a collecting surface for a fixed period of time and rolling it up interleaved with a cover sheet for storage. The outside dimensions of the sampler are 2 by 3.3 m and it has an exposed sampling surface of 4.5 m^2. Flooded aluminum tubing was used for most of the structural components. An integral underframe forms the structural base for the rest of the mechanical appendiments. A single 2 m long roller at one end serves at the supply reel for the sample surface material. At the opposite end of the unit there are two more rollers. Material unreeled from the top roller serves as a cover for the sample surface being rolled up for storage on the lower roller. Both supply reels contain a 2 m wide, 16 m long, and 0.15 mm thick sheet of polyurethane.

Figure 2 is a cross section showing construction details of the sampler. The tubular frame has multiple angular braces for mechanical rigidity to maintain a flat sampling bed and a true mounting frame for the reels. On top of the frame an expanded metal was used as a support surface for the sample collecting material and to create an open structure so that it would not kite upon deployment.

The honeycomb structure above the sample surface is made up from 1.5 mm thick aluminum cylinders, 15 cm in diameter and 12.5 cm long. The cylinders prevent advective currents parallel with the bed of the sampler from disturbing the samples on the collecting surface. Also, aluminum skirting encloses the sides to prevent side wash of the samples. The sampler weighs 300 pounds in air and is designed to operated to a 3000 m depth.

no refs.

Technical Planning and Development Group, School of Oceanography, Oregon State University, Corvallis, Oregon.

2.d.7.

1976: Saur, F.

Un cadre polyvalent pour l'étude de la plate-forme continentale. All. Inst. Oceanogr., Paris, 52(2), 241-246. (A multi-purpose instrument frame for the continental shelf.)

260; BIO

In order to study the kinematics of the continental shelf, we have devised a polyvalent instrument carrying frame named Zebulon which enables to take simultaneously vertical photographs, current-measurements, water and sediments samples. This device is highly versatile; it can be lowered on the sea-bottom, or used during hydrological stations, or dragged by the ship at a fixed distance from the bottom in the same way as a trawl-net.

6 refs.

Geographic Oceanography Laboratory, Institut. de Géographie, Paris.

2.d.8.

1978: Kirsten, O. H. and R. F. Weiss

A hydrostatically actuated piston and hydraulic system for deep-sea free vehicle applications. Conf. Records, Oceans '78 (IEEE), 596-598.

038; BIO

A piston actuated by hydrostatic pressure at ocean depths up to 6 km is used to provide a controlled source of hydraulic fluid at above-ambient pressure. This fluid energy is used to collect box cores of deep-sea sediment and ferromanganese nodules from a free vehicle instrument platform. At the completion of the coring operation, the same hydrostatically actuated piston is used to release ballast and to extract the vehicle and its cores from the sediment.

5 refs.

Scripps Institution of Oceanography, University of California at San Diego, LaJolla, California.

3
In Situ Instruments

2.d.9.

1979: Hargrave, B. T. and N. M. Burns

Assessment of sediment trap collection efficiency. Limnol. and Oceanog., 24(6), 1124-1136.

418; BIO

Theoretical considerations of the effects of turbulence around and within sedimentation traps show that the aspect ratio (height:mouth opening) of the traps is important in determining particle retention. Collection efficiency and comparative measures of deposition per unit area in traps of various design were independent of this ratio in calm water, but an asymptotic relation of increased collection efficiency with higher aspect ratio existed under nonstagnant conditions. Turbulent mixing in a water column could be assessed by comparisons of deposition in collectors exposed simultaneously but having different aspect ratios. The design of several sedimentation traps are discussed.

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Marine Ecology Laboratory, Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

3.a.l.

1969: Lewis, L., V. Nacci, and J. Gallagher

In situ investigations of ocean sediments. Proc. Conf. Civil Engng. in the Oceans, Am. Soc. Civil Engineers, 641-654.

052; BIO

The research reported here discusses a single platform for use in determining properties in situ and obtaining an "undisturbed" sediment sample on which to make correlative laboratory measurements. Major goals are to evaluate the degree of disturbance in sampling and to confirm the validity of careful in situ tests.

A Deep Ocean Sediment Probe (DOSP), figure 1, was designed and built by the University of Rhode Island (URI) for the Navy Underwater Sound Laboratory (NUSL) under Contract Number N00140-69C-0078. Atkins and Merrill Corp., Engineering Model and Mockup Divison, of Sudbury, Mass., assisted in the platform design and performed the construction. The objective in constructing this device was to obtain in-situ values of acoustic, geotechnical, and geochemical properties of marine sediments. Currently, the sensor components consist of a capacative discharge spark acoustic source, hydrophones and thermistors.

23 refs.

Department of Ocean Engineering, University of Rhode Island, Kingston, Rhode Island.

3.a.2.
1970: anonymous

New tool for testing and analyzing ocean bottom. Ocean Industry, 5(5), 39-40.

202; BIO

DOTIPOS is a bottom-sitting, tethered platform developed as a control and monitoring system for use in water depths to 6,000 ft. All command and control is contained in a seagoing van which is carried on board the supportship and which is attached via a single combination load-bearing, instrumentation, and power cable to the submersible DOTIPOS platform. This 17-ft square platform contains closed-circuit television, movie camera, and underwater lights on a pan and tile system for visual observation. Fourteen wide-band telemetry channels and 20 narrow-band feedback channels are available for monitoring various sensors or operations on the seafloor. In addition, 40 control channels and 10 KW of electrical power are available at the platform to operate various pieces of equipment such as the in-situ soil testing devices which are designed as accessories to DOTIPOS.

A second in-situ soil test device has been developed by the NCEL to measure the soil properties influencing directly the short-term behavior of footing type foundations. This device operates independently of DOTIPOS. The triangularly based, 8-ft diameter Plate Bearing Device applies stresses of from 0 to 12 tons per square foot to the surface soils.

The third in-situ soil test device is designed to measure soil properties related to the long-term behavior of footing type foundations. The Long-term Ocean Bottom Settlement Test for Engineering Research (LOBSTER) is basically a model footing, 4 ft in diameter, applying a stress of 100 lbs per square foot to the seafloor. LOBSTER is designed to be deployed on the seafloor in water depths to 6,000 ft for periods of up to 400 days.

no refs.

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3.a.3.

1972: Bouma, A. H., W. E. Sweet, Jr., W. A. Dunlap, and W. R. Bryant

Comparison of geological and engineering parameters of marine sediments. Proc. Offshore Tech. Conf., 1, 21-34.

190; BIO

Three-inch diameter piston cores collected from the Gulf of Mexico undergo a large number of geological and soil engineering tests in order to determine relationships between various physical parameters. Electrical resistivity logs are run to determine zones of interest. Cone penetrometer and vane shear measurements are being made on these zones and samples collected for water content, density, grain size, plasticity and carbonate content analyses. Additional samples are collected for absolute resistivity calibration, pore water properties, consolidation and triaxial (CU) tests. Lithological, structural and textural characteristics are also examined.

The vane shear and cone penetrometer readings are correlated with triaxial tests. Comparison of all above mentioned parameters and other parameters derived from those measured indicates interesting relationships and clearly reveals that many of the fast tests adequately describe the general characeristics of the material, as long as a number of the time-consuming experiments, such as triaxial testing, are conducted for calibration purposes. Horizontal correlation can be done with shallow penetration high resolution subbottom profiling while in situ electrical resistivity logging can replace detailed coring that is normally required for determining sedimentary characteristics.

13 refs.

Texas A. and M. University, College Station, Texas.

3.a.4.

1970: Lewis, L., V. Nacci, and J. Gallagher

In situ investigation of ocean sediments. Proc. Offshore Tech. Conf., 2, 637-644.

215; BIO

The Deep Ocean Sediment Probe (DOSP) is a hydrostatically anchored four probe assembly with a centrally located slow penetrating corer. It is used to measure sediment acoustic and thermal properties during incremental penetrations to 5.0 feet in water depths to 5000 feet. The DOSP can function from submersibles or surface vessels. Preliminary investigations have shown the DOSP cores to be considerably less disturbed than conventionally obtained cores. Present research endeavors concerning the DOSP include a design program in hydrostatic anchoring, construction of a nuclear sediment density probe, development of a hard-wire telemetry link, conversion to a complete d.c. power system and continued work on correlation of parameters determined from DOSP and conventionally taken cores.

10 refs.

University of Rhode Island, Kingston, Rhode Island

3.a.5.

1970: Taylor, R. J. and K. R. Demars

Naval in-place seafloor soil test equipment: a performance evaluation. U.S. Naval Civil Engng. Lab. Tech. Note N-1135, 45 p.

034; Metrology

The Naval Civil Engineering Laboratory (NCEL) has developed a vane shear and cone penetrometer apparatus capable of obtaining the in-place undrained shear strength of sediments to a depth of 10 feet in the seafloor. The device is a subsystem of the Deep Ocean Test In-Place and Observation System (DOTIPOS). Information obtained with this equipment will enhance the Navy's ability to design foundations more economically and reliably for seafloor installations. The results of tests performed at 100- and 600-foot deep sites and the evaluation of DOTIPOS and the vane shear and cone penetrometer apparatus are presented.

The DOTIPOS-mounted vane shear and cone penetrometer apparatus operates satisfactorily to water depths of 600 feet and produces results which appear reasonable when compared to previous theoretical and laboratory experimental results. Laboratory and in-situ results exceed the laboratory results by 10 to 20 percent. A relationship between percent clay content of the sediment and the ratio of cone resistance to vane shear strength appears feasible for seafloor sediments. Verification of this relationship will establish the cone penetrometer as a more useful and economical site survey tool.

13 refs.

Naval Civil Engineering Laboratory, Port Hueneme, California.

3.a.6.

1971: Lewis, L.F.

An investigation of ocean sediments using the deep ocean sediment probe. Unpubl. Ph.D. thesis, University of Rhode Island (Oc.Engng.), 230 pp. (Diss. Abs. Int. No. 72-9795).

The Deep Ocean Sediment Probe (DOSP) was designed, constructed and used to obtain the speed and attenuation of compressional sound waves through ocean sediment. A sample of the sediment was collected at the same site and used to obtain correlative geological and engineering properties in the laboratory. ATmperature, reference water sound speed and mechanical performance data on the DOSP were also obtained *in situ*. Nondestructive tests on the sample included sound speed using a core velocimeter and structural patterns using x-ray radiography.

Sediment sound speed *in situ* was found to be linearly related to laboratory determined sediment shear strength, buoyant density, and water content. A fit to published formulas was found for sound speed and porosity. No relation was determined between sound speed and Atterberg limits, the various grain size indices, or compositional parameters.

Attenuation of sound in sediment was determined to be linearly related to sound frequency for all depths (to 5.0 feet) in the sediments investigated. The magnitude of attenuation is compared to that found in previous work. Rayleigh reflection coefficient (normal incidence) and bottom loss were calculated from *in situ* data and found to be linearly related to porosity and density. Acoustic impedance is also shown to be a strong linear function of porosity.

In situ sound speed and laboratory determined properties were used in a homogeneous elastic model of the sediment to determine average elastic parameters which compare closely to published values.

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Department of Ocean Engineering, University of Rhode Island, Kingston, Rhode Island.

3.a.7.

1971: Smith, D. T.

Acoustic and electric techniques for seafloor sediment identification. Proc. International Symp. Engng. Props. Seafloor Soils Geophys. Ident., Seattle, 235-267.

241;

Acoustic (velocity, attenuation, reflectivity) and electric (resistivity) properties of sea-floor sediments correlate reasonably well with certain mechanical properties (grain size, porosity, wet density, Atterberg Limits, and uni-demensional compresibility). Measurement of the geophysical parameters can be obtained from a ship under way as part of routine sonar profiling as well as by the use of probes. Using a combination of both techniques it is possible to produce an approximate geotechnical map of the sea-floor.

45 refs.

Marine Science Laboratories, University College of North Wales, Menai Bridge, Wales.

3.a.8.

1972: Anderson, V. C., J. R. Clinton, D. K. Gibson, and O. H. Kirsten.

Instrumenting RUM for in situ subsea soil surveys. Underwater Soil Sampling, Testing, and Construction Control. Am. Soc. Testing and Materials Spec. tech. Publ. 501, 216-228.

158; BIO

The RUM (Remote Underwater Manipulator), one of the laboratory research vehicles of the Marine Physical Laboratory, is a tracked vehicle capable of operating on the sea floor to depths of more than 6000 ft. An umbilical coaxial strain cable connects it with a surface support platform ORB (Oceanographic Research Buoy) and provides the power and data transmission required for unmanned remote sea floor operations. A brief description of this sea floor work system is presented, whose main emphasis concerns the instrumentation suit developed for in situ soil trafficability studies with RUM. RUM has been instrumented for remote operation of a 2-ft-long 3-in.-diameter corer, a vane shear meter, a cone penetrometer, an anchor-winch-tensiometer combination for the measurement of drawbar pull, and a short range, high resolution echo-sounding profiler for examination of track depression. All of these instruments are adapted for use by the manipulator arm mounted on RUM, and all telemeter their data back to ORB via the coaxial strain cable. Results of initial measurements with the system are discussed.

6 refs.

Marine Physical Laboratory, Scripps Institution of Oceanography, University of California at San Diego, La Jolla, California.

3.a.9.

1972: Clinton, J. R.

Soil mechanics with the ORB-RUM sea floor work system. Scripps Inst. Oceanog. Ref. Ser. 72-63, 16 p.

263;

Soil mechanics instrumentation used by the remote underwater manipulator in studies of the trafficability of the sea floor are described. In situ test equipment consists of a vane shear meter a cone penetrometer, a track depression profiler, and an anchor winch system. Sample collection, measurement methods, and laboratory analyses are discussed.

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Marine Physical Laboratory, Scripps Institution of Oceanography, La Jolla, California.

3.a.10.

1972: Hirst, T. J., J. L. Kelleman, Jr., and T. A. Terry

Submersible-mounted geotechnical probes. Preprints 8th Conf. Mar. Tech. Soc., 601-614.

048; BIO

A detailed investigation of the vertical and areal variability of the geo-technical properties of seafloor soils in a portion of the San Diego Trough has required the development of two submersible-mounted geotechnical probes for the in-place measurement of shear strength and bulk density. These consist of a four-bladed vane shear probe for direct but discontinuous measurement of sediment shear strength, and a combination cone penetrometer and transmission gamma ray densitometer for indirect but continuous measurement of shear strength and direct and continuous measurement of bulk density, respectively. The two probes, each having a separate support and drive frame and a common 30 Vdc submersible-independent power supply, utilize an 8-channel telemetry system for equipment control and data acquisition functions. Both control and data acquisition are conducted in real time from inside the manned pressure hull. The vane and penetrometer-densitometer probes, which are of modular construction to facilitate extension of their probes, which are of modular construction to facilitate extension of their maximum depth capability, have been successfully and routinely operated from the Lockheed submersible Deep Quest in 1230 meters of water in the San Diego Trough. Sediment penetrations of 3.2 meters for the vane shear probe and 1.2 meters for the penetrometer-densitometer probe have been achieved.

8 refs.

Marine Geotechnical Laboratory, Lehigh University, Bethlehem, Pennsylvania.

1972:

Engineering properties of sea floor sediments from LaJolla Canyon. Proc. 13th. Coastal Engng. Conf. (ASCE), 1559-1570.

238; BIO

Near surface sea floor sediments were obtained by the tracked underwater vehicle RUM from four locations on the floor of the La Jolla Canyon. The sediments were clayey silts of high plasticity. The engineering properties of the sediment, including grain size, index properties, strength and compressibility, were determined.

This paper covers the engineering properties of sediment samples from four locations on the floor of the La Jolla Canyon, north of San Diego on the Pacific coast, at waters ranging in depth from 1256 feet to 1334 feet. the samples were taken by a 2.875 in. in diameter, 22 in. long sampler attached to the RUM (Remote Underwater Manipulator), a research vehicle of the marine Physical Laboratory of the Scripps Institution of Oceanography, University of California.

The RUM, (Fig. 1) is an unmanned tracked vehicle designed for sea floor explorations in water depths of more than 6000 feet (1, 2, 3). An umbilical cable connects RUM with a surface support platform. RUM has been equipped with a remotely controlled sediment corer, vane shear device, (Fig. 2), and cone penetrometer (Fig. 3).

5 refs.

Department of Civil Engineering, California State University, San Diego, California.

3.a.12.

1972: Perlow, M. and A.F. Richards

In-place geotechnical measurements from submersible ALVIN in Gulf of Maine soils. Reprints Offshore Tech. Conf., 1, 333-340.

001; BIO

Direct measurements of bulk density and penetration resistance, and indirect measurements of shear strength and water content in the Wilkinson and Murray Basins were made using the small submersible *Alvin* in July 1971. A probe consisting of a nuclear transmission densitometer and a static cone penetrometer was adapted for use of the submersible. A rack and pinion drive mechanism powered by the manipulator arm of the *Alvin* pushed the probe into ocean soil to a maximum depth of 1.52 m. The drive mechanism was mounted forward of the *Alvin* using a box frame configuration. A total of 10 test penetrations in 240-247 m water depths were made during three dives.

The *Alvin* investigations showed that a small submersible is capable of developing the reaction force needed to penetrate a relatively large probe greater than 1 m in soft clay. Greater vertical and areal variability of measured geotechnical properties was detected in the investigations than had previously been determined from inplace devices and coring machines operated from surface ships. The dives marked the first successful in-place measurement of bulk density from a submersible using a gamma ray transmission probe.

12 refs.

Lehigh University, Bethlehem, Pennsylvania.

3.a.13.

1973: Huebner, G. L., Jr., A. H. Bouma, and F. B. Chmelik

Sediment survey by Hi-Resolve system. Proc. Offshore Tech. Conf., 2, 235-244.

187; BIO

A number of techniques have been combined in a "high-resolve" system to obtain detailed information on the properties, structures, texture, and distribution of unconsolidated sediments in the upper meters of coastal areas and the ocean floor.

High resolution, shallow penetration, sub-bottom profiling is combined with a towed array for measuring resistivity and spontaneous potential. Box corers and flexible-liner corers provide disturbance free samples. In order to obtain a more detailed correlation of sedimentary units without proportionally increasing coring time, an *in situ* logging probe is used.

An electrical resistivity and spontaneous potential core scanner indicates subtle property differences that might be overlooked. These measurements indicate zones for detailed engineering, structural, and textural observations. An electro-osmotic knife allows distortionless cutting of cores and samples while core photography and X-ray radiography give non-destructive sediment structures.

Each component is described and correlations between measured properties are discussed with examples from estuarine, shelf, and deep ocean environment.

16 refs.

Texas A. and M. University, College Station, Texas.

3.a.14.

1974: Gibson, D. K. and V. C. Anderson

Sea-floor soil mechanics and trafficability measurements with the tracked vehicle "RUM". Deep-Sea Sediments, A. L. Inderbitzen, Ed., Plenum Press, N.Y., 347-366.

409; BIO

A brief description of the ORB-RUM Sea Floor Work System, program history, philosophy and direction is given. An instrumentation suite developed for the use of RUM in soil mechanics and trafficability study program is also described. Highlights of over 400 operating hours on the sea floor at depths ranging from 40 to 1880 meters illustrates the problems encountered and the experience that has been obtained in this program.

The vane shear meter has a four-bladed vane, which has a height to diameter ratio of 2.5 to 1 and can be slowly driven into the sediment to any depth up to 60 cm. Measurements are usually made at four depths, 15, 30, 46 and 61 cm. Four vane sizes are available for shifting operating range of the instrument. The manipulator is used to set the vane shear meter onto the sea floor away from any disturbance which might be caused by the vehicle. Depth of the vane, torque and angular position are telemetered to the surface and displayed on a multi-channel graphic recorder.

The cone penetrometer is driven into the sediment at a constant velocity of about 20 cm/sec. As in the use of the vane shear meter, the manipulator is used to set the instrument away from RUM. Depth of cone and force on the cone are telemetered to ORB where they are displayed on a multi-channel graphic recorder.

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Marine Physical Laboratory, Scripps Institution of Oceanography, La Jolla, California.

3.a.15.

1974: Sherif, M. A., R. C. Bostrom, R. H. Stockman, and C. M. Burrous

An assessment of existing submarine soil strength testing techniques. Proc. Int. Symp. Engng. Props. Seafloor Soils Geophys. Ident., 49-74.

278;

The propsed visco-elastic model of submarine soil strength response and the special triaxial cell testing system are not intended to replace the simpler, more convenient rotation vane and cone penetration testing devices. Rather, the rheological testing program is proposed to be used with existing and improved versions of laboratory and in situ strength testing systems to assess long term behavior and to attempt to unify the empirical data within the theoretical framework of the conceptual rheological model. The goal of practical and efficient engineering operations in and on the ocean floor can only be achieved through a combined program of in situ and laboratory investigation of submarine soil that is unified by a body of theoretical understanding.

35 refs.

University of Washington, Seattle, Washington.

3.a.16.

1976: Lee, H. J.

DOSIST II - an investigation of the in-place strength behavior of marine sediments. U.S. Naval Civil Engng Lab. Tech. Rept. NCEL-TR-N-1438, 20 p.

077; BIO (NTIS AD A026 189/1G1)

DOSIST II (Deep Ocean Sampling and In-Situ Testing) was a cruise in the Western North Atlantic Ocean conducted to evaluate the in-place engineering behavior of several typical deep ocean sediments. In-place vane shear tests were performed and sediment cores (gravity, piston and box) were taken. Laboratory tests were conducted on the cored samples to classify the sediments and to determine which testing procedure best reproduces the measured in place strength. This was found to be consolidated-undrained triaxial testing. The sediments tested in place were a foraminifera-dominated calcareous ooze and a proximal turbidite. Both of these sediments are nearly cohesionless and retain little of their in-place strength when sampled. A deep sea pelagic clay was cored and subjected to laboratory testing, but was not tested in-place. Estimated in-place strength profiles were derived for each of these sediments to sub-bottom depths in excess of 50 feet (15 m).

8 refs.

U.S. Naval Civil Engineering Laboratory, Port Hueneme, California.

3.a.17.

1977: Niper, E. and G. Williams

Project SEASWAB: real-time acquisition/reduction of submarine sediment data. Proc. Offshore Tech. Conf., 2, 475-480.

035; BIO

Project SEASWAB is a multi-disciplinary research effort considering primarily the stability of underconsolidated sediments in the Gulf of Mexico. A significant part of this study is the real-time acquisition, transmission and subsequent reduction of the offshore time-dependent data gathered during the project. The SEASWAB field instrumentation includes submarine accelerometers, piezometers, pressure sensors and a waverider buoy. Twelve time histories selected from these sensors are analog recorded in the field on a slow speed recorder. All data channels are also sampled and transmitted via an "S" band RF link to an onshore receiving station, which then buffers this signal into a voice grade line for transmission to Texas A & M University. At this point the data is reconstructed, displayed and optionally analog recorded. Subsequent reduction of both the field and remote station-recorded data includes the analog-to-digital conversion and calibration, spectral computations and graphic output generation. SEASWAB was initiated in October 1976, with initial data recording/transmission beginning in early December 1976. Scheduled for operation through the 1977-1978 winter, the data gathered and analyzed will be a valuable tool in assessing the causes of submarine sediment instability.

no refs.

Sandia Laboratories, Albuquerque, New Mexico.

3.a.18.

1978: Reece, E.W. and D.E. Ryerson

Development of an experimental marine sediment instrumentation system. Proc. Offshore Tech. Conf., 1, 657-662.

004; BIO

An experimental marine sediment instrumentation system incorporating a high data rate acoustic telemetry link has been designed, fabricated, and successfully field tested. Data has been transmitted acoustically at data rates up to 2,400 bits per second through up to 600 ft of sea water with fewer than 1 error per 1,000 bits transmitted. A limited number of sensors have been tested, and the capability to detect, measure, process, store, and transmit seismically induced acceleration data has been demonstrated. The high data rate acoustic telemetry link provides a means of retrieving large quantities of data from sea-floor instrmentation systems in a relatively short period of time. In addition, the acoustic system provides a heretofore unavailable capability to check periodically the status of ocean-bottom systems and retrieve data as often as desired during the lifetime of the system.

The experimental system consists of three principal subsystems: a data gathering subsystem, which is on the sea floor, a command and recording subsystem, which is carried onboard a ship, and an optional buoy relay subsystem, which is moored over the data gathering subsystem. All subsystems are controlled by similar microcomputers consisting of a microprocessor, programmable read-only memory, read/write random access memory, clock, universal asynchronous receiver/transmitter, and additional input/output devices as required by each subsystem.

This paper describes the design features of the experimental system, presents and discusses field test results, and outlines future work and potential applications of the technology developed.

4 refs.

Sandia Laboratories, Albuquerque, New Mexico

3.a.19.

1979: Barneich, J. A.

Discussion of "The development of in situ marine seismic and geotechnical instrumentation systems" by E. W. Reece, et al., Proc. Port. Ocean Engng. Arctic Conditions '79, 3, 366-368.

380; BIO

The authors are to be commended for the innovative and much needed development of SEMS and GISP sea floor probes to be used for monitoring of earthquake ground motions and in situ pore water pressures, respectively. The sections that follow briefly discuss each probe and are followed by a general summary of this review.

This probe has many unique features that allow for the remote acquisition and retrieval of earthquake ground motion data in sea floor sediments in water depths of up to 230 meters. This capability could help revolutionize seismic event monitoring considering the fact that many large earthquakes occur offshore.

The sophisticated techniques described for the recording and storage of data are impressive and allow for the maintaining of the largest and therefore most important events in storage for eventual retrieval. It is felt, however, that the 1.7-second pre-event buffer is marginally short and that consideration should be given to extending it to about 5 seconds so as not to loose important information such as the compression-wave arrival.

As in the case of the SEMS, the GISP has many unique features that allow for the in situ acquisition and retrieval of pore water pressure data in sea floor sediments in considerable water depths. The data acquisition and storage system allows for 52 records consisting of about 24 measurements each over a 45-day period including closely spaced measurements (100 milli-seconds apart) during insertion and extraction of the probe.

If possible and if the GISP is deployed near the SEMS, it would be useful to be able to tie the pore pressure measurements to seismic activity at least during strong ground shaking (amplitude of motion greater than 50 to 100 gals).

no refs.

Woodward-Clyde Consultants, U.S.A.

3.a.20.

1979: Chari, T. R., A. D. Dunsiger, G. B. Fader, G. R. Peters, P. G. Simpkin, and A. Zielinski

Ocean sediments--a study relating geophysical, geotechnical and acoustical properties. Proc. 1st Can. Conf. Mar. Geotech. Engng., 151-162.

231; Metrology

During the second half of May, 1978, the Ocean Engineering Group in cooperation with personel from the Bedford Institute of Oceanography (BIO), HUNTEC ('70) Ltd. and the Geological Survey of Canada undertook a multi-device high density seafloor survey in the outer Placentia Bay area on the Newfoundland Grand Banks (Figure 1), using the BIO ship C.S.S. HUDSON (Cruise 78-012). About 1000 line km of data were obtained simultaneously using the HUNTEC broadband high resolution Deep Tow Seismic (DTS) system, the BIO side scan sonar system, a 40 cubic inch Bolt air gun and a Kelvin Hughes 26B echo sounder. Based on the information gathered during a large scale quick look survey (see track chart, Figure 1) a preliminary map of the surficial geology was produced by one of the authors (G. B. Fader). On the basis of the acoustic information, six areas overlain with 5 different sediment types were selected for intensive examination. The intensive study included an acoustic survey using the DTS system, the side scan sonar, the echo sounder and ground truth stations using a Benthos piston corer, Van Veen bottom grab sampling equipment and remote bottom photography. An impact penetrometer was used at 20 stations. Thirty-three piston core samples were recovered to a maximum of 10 m in length. A transverse sound velocity profile of each core, in its lining, was obtained immediately after removal from the core barrel.

11 refs.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

3.a.21.

1979: Dunlap, W., W. R. Bryant, G. N. Williams, and J. N. Suhayda

Storm wave effects on deltaic sediments--results of SEASWAB I and II. Proc. Port Ocean Engng. Arctic Conditions '79, 2, 899-920.

375; BIO

11 refs.

Project SEASWAB (Shallow Experiment to Assess Storm Waves Affecting Bottom) was part of a larger study of the Mississippi Delta being conducted by the U.S. Geological Survey. SEASWAB I, conducted in 1975, and SEASWAB II in 1976, were designed to measure submarine sediment pore pressures, hydrostatic pressure, bottom accelerations and wave characteristics at two locations in the East Bay area of the Mississippi Delta.
Piezometers were implanted at depths below the mudline ranging from 10 to 50 ft. The piezometers were placed within a known deformational feature and in a nearby stable area. Significant ambient excess pore pressures were measured both within the deformational feature and the stable area. Pore pressures approached and even exceeded the overburden pressure.

The measured effects of winter storm waves and waves generated by three hurricanes - "Eloise" in 1975, "Anita" and "Babe" in 1977 - showed that significant bottom pressures, sediment accelerations and pore pressure fluctuations occured during storm conditions. Wave-induced orbital bottom sediment displacements wer ein the order of 10 inches from the vertical.

Sinking of up to 14 feet was noted during the pullout of the accelerometers and up to 6 feet for the piezometers. These large displacements are believed to be caused by a phenomenon similar to liquefaction of sands. In the clayey deltaic sediments this resulted in a total loss of support and the subsequent sinking of the instruments.

In addition to wave-induced pore water pressures the generation of biogenic methane serves to continually contribute to the high excess pore water pressures and prevents the sediment from achieving a stable configuration.

11 refs.

Texas A. and M. University, College Station, Texas.

3.a.22.

1979: Reece, E. W., D. E. Ryerson, J. D. Kestly, and R. L. McNeill

The development of in situ marine seismic and geotechnical instrumentation systems. Proc. Port Ocean Engng. Arctic Conditions, 1, 331-344.

381; BIO

A unique pair of in-situ marine geotechnical instrumentation systems, capable of operating unattended for extended periods of time in remote locations, have been designed, fabricated, and are currently undergoing testing. The Seafloor Earthquake Measurement system (SEMS) measures the response of marine sediments to strong and moderate seismic activity. The Geotechnically Instrumented Seafloor Probe (GISP) measures the in-situ pore pressure in soft marine clays. The two systems have many common characteristics. soth systems consist of two principal subsystems: a seafloor data-gathering package and a shipboard command and recording package. The seafloor packages are totally self-contained and incorporate microprocessor-based electronics which control data collection, processing, and storage. Data collected and stored by the seafloor packages are transmitted on command to the command recording package via a high-data-rate acoustic telemetry system.

This paper describes the design, development and testing of the Seafloor Earthquake Measurement System and the Geotechnically Instrumented Seafloor Probe. Data are presented and discussed. Advanced concepts for future marine geotechnical instruments are discussed.

12 refs.

Sandia Laboratories, Albuquerque, New Mexico.

3.a.23.

1980: Coleman, J. M., J. N. Suhayda, and T. H. Dawson

Determination of elastic shear modulus of marine sediments from wave theory and field measurements. Proc. Offshore Tech. Conf., 3, 171-177.

132; BIO

A method is described for determining the elastic shear modulus of marine sediments from field measurements of wave-induced bottom acceleration and water pressure. The procedure relies on results form a wave theory that assumes a linearly elastic sea floor response. The method is thus limited to wave-induced pressures which are sufficiently small to allow this simple idealization. Specific application is made to field data taken in the Mississippi Delta region during winter storm conditions where wave heights ranging up to about 6 ft. were observed, corresponding to wave induced bottom pressures ranging up to about 40 lb/ft^2. Results show that the assumption of a linear elastic sea floor response is reasonable for these pressure levels and that the elastic shear modulus is approximately 50 $kips/ft^2$.

8 refs.

Louisiana State University

3.a.24.

1980: Stockdale, W. K.

Development of the Auguste Piccard manipulator corer. Conf. Record) Oceans '80 (IEEE), 281-285.

\- 323; BIO

The August Piccard submarine is a deep submergence vehicle operating as a survey vessel and geophysical exploration tool at ABS certified depth of 2200 feet. She is owned and operated by Horton Maritime Explorations Ltd. of North Vancouver, B.C.

The purpose of the August Piccard's Manipulator is to provide a geotechnical support system capable of being developed to carry out direct in-situ marine geotechnical measurements such as Dutch Cone Penetrometer, shear vane tests and other related soils measurements and obtaining 5 ft. long x 4 ½ undisturbed core samples of unconsolidated soils or of rock. Additionally the system will function as a conventional manipulator.

The prototype corer consisted of a cylindrical buoy shaped body 48" dia. x 48" high with a central tube arranged to contain a hydraulic cylinder to which was attached a 4½" dia. x 36" long coring tube. The cylinder was positioned such that the coring tube was fully retractable inside the buoy.

A number of pockets were located peripherally around the buoy, the purpose of which was to add or subtract lead blocks thus providing a variable mass to the system. 60 ft. hydraulic hoses were attached between the cylinder and a portable hydraulic power pack and air lines electrical cable and valving were attached to the buoy from a 71.2 cu. ft. 3000 P.S.I. diving tank with a 1st stage 130 P.S.I. pressure reduction from a standard scuba breathing regulator.

no refs.

Horton Maritime Explorations Ltd., North Vancouver, B.C.

3.b.1.

1967: Scott, R. F.

In-place measurement of the strength of ocean-floor soils by accelerometer. Proc. Civil Engng. in the Oceans I, Am. Soc. Civil Engineers, 419-444.

321; BIO

The use of a single-axis self-contained recording accelerometer in conjunction with ocean-floor coring devices results in a considerable increase in the amount of information obtained in the sampling process. It enables the functioning of tripping devices to be checked, permits the hydrodynamic behavior of the corer in free fall to be calculated, and allows of the calculation of the soil resistance as a function of depth of penetration. With some assumptions the shearing resistance of the soil can be calculated. Since the soil in which penetration occurs is actually (in general) retained by the core-barrel, a comparison can be made between the in-place behavior of the soil and its shearing strength as subsequently measured in the laboratory on the returned sample. Changes in the material resistance can be correlated with the subsequent core analysis. Normally, a core of the full length of soil penetrated is not obtained; the use of an accelerometer enables an estimate of the recovery ratio to be made. The accelerometer may also be employed with non-sampling penetration devices such as solid rods and cone penetrometers. An acceleration record obtained during the lowering process gives some information on the vibrations in the lowering cable and the oscillations of the corer. Usually accelerations are recorded during the corer extraction process also.

To the present (Nov. 1967) about 20 accelerometer records have been obtained in water up to 6000 ft. deep.

9 refs.

Division of Engineering and Applied Science, California Institute of Technology, Pasadena, California.

3.b.2.

1969: Stoll, R. D.

A dynamic penetrometer for investigating sediment properties.
Proc. Civil Engng. in the Oceans., Am. Soc. Civil Engineers,
209-220.

320; BIO

A cone mounted on the end of a thin rod is positioned in such a way as to penetrate into undisturbed sediment just ahead and outboard of the cutting shoe of the coring apparatus. A cone-type penetrometer was chosen in lieu of a probe of constant section so that the main part of the resistance would occur at the tip in order to be able to sense sudden changes in structure or thin layering in the sediment. Furthermore it was felt that the use of a thin rod would tend to minimize the effects of flow in the sediment behind the cone resulting from displacement by the cutting shoe.

A number of variations in the shape of cone, type of force transducer and method of recording data have been investigated. The ideal place to sense the penetration resistance is obviously at the cone itself where the effects of friction on the rod and the flow of sediment around the cutting shoe of the corer are a minimum. On the other hand this requires extreme miniaturization of the force transducer and puts it in the position most vulnerable to damage if the cone strikes rock or other hard objects. The second alternative that has been investigated in some detail is to position the force transducer in a rigid, protective housing behind the cutting head as shown in Fig. 1. Two prototypes of this configuration have been built using quite different methods of recording the data. In one case the transducer is designed to convert the force to an electrical signal that is transmitted to a recorder at a remote location (i.e. a pressure-tight recorder housing in the tail of the coring rig) while in the second case the force is converted directly into the motion of a stylus that is an integral part of the recorder.

1 ref.

Lamont-Doherty Geological Observatory of Columbia University,
Palisades, New York.

3.b.3.

1970: Preslan, W. L.

Accelerometer-monitored coring. Proc. Civil Engng. in the Oceans (ASCE), 655-677.

236; BIO

A corer-mounted accelerometer appeared to be a potentially valuable instrument for an analysis of corer behavior because of the wealth of information contained in the continuous record of acceleration versus time. The accelerations applied to the corer and recorded by the accelerometer can be converted directly into forces by multiplying by the appropriate mass for the corer in water. Integration of the acceleration versus time record yields the velocity of the corer, and a second integration yields the displacement of the corer. The relative times at which events occur as shown by the accelerometer record also are useful. The instrument is passive and does not interact with the environment, so that when properly mounted, its presence has no effect on the coring process. Moreover, because of the expense of the ship time required to lower and raise equipment at oceanic depths, it is extremely worthwhile to incorporate any instrument in a corer which will give more information about the material sampled.

The evaluation of the soil forces from a corer-mounted accelerometer record must be done indirectly. Since the accelerometer measures the summation of all the forces acting along the corer axis, analysis for the soil forces alone requires knowledge of the non-soil forces.

This research has been devoted to the development of qualitative and quantitative methods of separating soil and non-soil forces and to the measurement of several aspects of corer behavior which influence sample quality. The information gained may make it possible to improve the efficiency of routine coring operations and will lay the groundwork for more detailed interpretations of the information on soil properties contained in the accelerometer records. It also has been possible to evaluate the potential worth of an accelerometer as a tool for routine use on deep-sea sediment corers.

22 refs.

Scripps Institution of Oceanography, LaJolla, California.

3.b.4.

1970: Thompson, L. J. and J. L. Colp

Application of earth penetration technology to ocean bottom penetration. Proc. Offshore Tech. Conf., 1, 571-576.

340; BIO

It is the intent of this paper to provide a broad overview of the application of the available technology of earth penetrators to the many problems of ocean bottom exploration. Enough discussion of the background and current research on earth penetrator has been included to indicate that a very real and valuable technology with much of the required hardware is already developed and in use.

Although the system might have several different configurations depending upon its purpose, in every case, it should have the following features:

a. Reasonable initial cost.
b. necoverable for reuse.
c. Self-contained so that it is deployable from a moving ship or aircraft.

The sequence of operation of the system would be as follows:

At water impact the container would open. The surface buoy would inflate, and the penetrator would start its free fall toward the bottom. The connecting cable to the surface buoy would be paid-out automatically from the bobbin on the penetrator.

On the rocket-boosted systems, the rocket motor would ignite when the penetrator reached the desired stand-off distance from the bottom. The penetrator would penetrate the bottom materials to the desired depth and send the data from the on-board transducers up the connecting cable to the buoy-mounted transceiver for transmission to and recording by the base station.

At the conclusion of the penetration trajectory, the electro-osmotic release system would be actuated to drive the penetrator back up through the bottom materials it had penetrated. When clear of the bottom materials, the gas generator would inflate the balloon to float the system back to the surface for later pick-up by a surface ship.

11 refs.

Texas A. and M. University, College Station, Texas

3.b.5.

1971: de Ruiter, J.

Electric penetrometer for site investigations. J. Soil Mechs. Found. Div., Proc. Am. Soc. Civil Eng., 97(SM2), 457-472.

341; Metrology

Since its introduction in the 1930's the penetrometer test has been used extensively, and in many cases exclusively, for field investigations in Holland and Belgium. It is also often referred to as the static penetration test, the Dutch cone test, or the Dutch deepsounding. In recent years the method has met with increasing interest in many other parts of the world as it provides an efficient and reliable system for establishing the soil profile at a site. This is, in particular, the case because the separate measurement of the cone resistance and the side friction immediately above the point permits the engineer to draw conclusions about the type of soil penetrated.

The penetrometer sounding is mostly used as a model test for foundation piles and empirical methods are available for computing the bearing capacity of a pile from a penetrometer graph. Important advances have been made, however, to correlate the penetrometer readings with the main soil parameters. Further research is being carried out at various institutes which is aimed at defining the necessary correlations and at making the test more generally useful for foundation design.

The electric measurement and recording of the cone resistance and local side friction has made it possible to semi-automate the sounding operation and to design a machine for underwater use. A first model for underwater penedepths up to nearly 50 m (see Fig. 12). It has, as yet, only a limited range of penetration with a maximum of about 13 m. It is placed on the seabed by a small crane from the deck of a ship and is connected by means of an electric cable with a control cabin aboard. Adequate penetration tests will facilitate the solution of many problems concerning offshore structures for the oil industry and developments are in progress to enlarge the working range of the underwater equipment.

6 refs.

Fugro Ltd., Leidschendam, The Netherlands

3.b.6.

1971: Migliore, H. J. and H. J. Lee

Seafloor penetration tests: presentation and analysis of results. U.S. Naval Civil Engng. Lab. Tech. Note 1178, 63 p.

275; NTIS-AD-732-367

A series of eleven in situ penetration tests was conducted by the Naval Civil Engineering Laboratory (NCEL) at two seafloor sites. The objectives of these tests were to illustrate the capabilities of existing penetration evaluation equipment and to acquire data for use in evaluating a series of proposed penetration prediction techniques. The tests consisted of allowing two types of objects to free-fall into the seafloor with the accelerations experienced by the objects during penetration being recorded mechanically. The resulting data were subjected to a regression analysis which yielded information about the penetration mechanism but no practical results. This was followed by a physical analysis based on static soil mechanics relations. The latter analysis was shown to yield predictions of penetration depth which were within 50 percent of the measured values. A suggested prediction technique based on this analysis is presented.

11 refs.

U.S. Naval Civil Engineering Laboratory, Port Hueneme, California.

3.b.7.

1972: Babcock, F. M. and H. J. Miller

Correlation of standard penetration test results with vibracore sampler penetration rates. Underwater Soil Sampling, Testing, and Construction Control, Am. Soc. Testing and Materials Spec. Tech. Publ. 501, 81-89.

211;BIO

A correlation between the penetration rates of a vibratory underwater sampling device and blow counts from the conventional standard penetration test and the continuous-drive cone penetration test is described. Although limited test data are available, the correlation shows promise for low blow count underwater soil deposits. A practical example of the correlation is given for a recent construction project on one of the Great Lakes. The need for more data and future research to obtain a more universal correlation are discussed.

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Woodward-McMaster and Associates, Kansas City, Missouri

3.b.8.

1972: Hirst, T. J., A. F. Richards, and A. L. Inderbitzen

A static cone penetrometer for ocean sediments. Underwater Soil Sampling Testing, and Construction Control, Am Soc. Testing and Materials Spec. Tech. Publ., 501, 69-80.

152; BIO

A static cone penetrometer for deep ocean exploration has been developed and successfully tested in soft sea floor sediments at an ocean depth in excess of 1200 m. The penetration resistance of a standard 60-deg cone is detected by appropriately insulated strain gages whose output may be monitored remotely from the sensing unit. Initial deployment of the device was aboard the submersible Deep Quest in the San Diego Trough off the coast of southern California. Resistances as low as 7 N (1.6 lb) were measured near the surface of the sediment, generally increasing with depth. At the maximum depth of penetration of 1.1 m (restricted by the limited negative buoyancy of the submersible), tip resistance reached 80 N (18 lb). By means of a conventional bearing capacity analysis, the cone resistance was converted to in situ strength and compared to vane shear measurements taken in the immediate vicinity of the penetration tests. Reasonable agreement between vane shear and penetration strengths were obtained for an assumed bearing capacity factor N_o=9.

6 refs.

Marine Geotechnical Laboratory, Lehigh University, Bethlehem, Pennsylvania.

3.b.9.

1973: Dayal, U. and J. H. Allen

Instrumented impact cone penetrometer. Can. Geotech. J., 10, 397-409.

148; BIO

The present paper describes the development of an instrumented impact cone penetrometer for a direct measurement of in situ strength properties of a soil target. The developed penetrometer, in addition to providing acceleration signatures (as obtained by previous investigators), is capable of recording cone thrust and local side friction simultaneously and continuously. The procedures have been outlined for estimating in situ strength properties and soil type of the target materials throughout the penetrated depth from the output records of these sensors. Typical test results generated from an on-going experimental program aimed at providing the data for (1) understanding the penetration mechanism. (2) development of penetration theory, and (3) designing the penetrometer for field tests, i.e. in situ testing of ocean floor soils, are also presented.

31 refs.

Ocean Engineering Group, Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

3.B.10.

1974: Dayal, U.

Instrumented impact cone penetrometer. Unpubl. Ph.D., Mem. Univ. Nfld., St. John's, Nfld., 222 p.

307;

This thesis deals with the formulation of an analytical model applicable to low velocity impact penetration problems of soil media and the development of an instrumented impact cone penetrometer for measuring in situ strength properties of soil targets.

A penetration theory based on momentum considerations is developed for a cone-tipped right circular cylinder impacting on a C - phi soil target. A relationship is established between the instantaneous velocity, various 'static' and 'dynamic' soil properties, penetrometer characteristics and the instantaneous depth of penetration. It is assumed that impact causes shear failure and the resistance to the motion of penetrometer is provided by the inertial resistance of the accelerated soil mass plus the 'dynamic' soil resistive force distributed over the base and shaft of the penetrometer. The soil resistive force is calculated on the basis of plastic theory modified for 'dynamic' conditions and extending the previous analysis for the 'static' condition. The relationship obtained, in addition to providing the velocity profile and the maximum depth of penetration, can also be used for estimating the 'static' soil strength properties although only under idealized conditions.

The penetrometer utilised, in addition to providing acceleration signatures (as obtained by previous investigators), is capable of recording cone thrust and local side friction simultaneously and continuously. The available test results indicate that with this system the 'dynamic' strength profile, the soil type, location, and depth of different layers can be directly evaluated up to the penetrated depth. The procedure is outlined for estimating the 'static' in situ strength profile from the 'dynamic' strength profile. The experimental results obtained in the laboratory under fully controlled conditions are in good agreement with proposed theoretical model.

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Memorial University of Newfoundland, St. John's, Newfoundland.

3.b.11.

1974: True, D. G.

Rapid penetration into seafloor soils. <u>Proc. Offshore Tech. Conf.</u>, <u>2</u>, 612-616.

080; BIO

A method is developed to predict the depth of penetration of objects into seafloor sediments. An existing equation is modified to account for variations in penetration resistance with velocity and length-to-breadth ratio, and recommendations are presented for the evaluation of soil properties and penetration parameters. A calculation procedure is presented for solving the penetrator equation of motion by hand or with the aid of a small computer. An example problem is solved by hand to illustrate the use of the proposed relationships together with the calculation procedure. Recommendations are made for use in preliminary and detailed engineering work.

7 refs.

U.S. Naval Engineering Laboratory, Port Hueneme, California.

3.b.12.

1975: Allen, J. H., U. Dayal, and J. M. Jones

Development of marine sediment impact penetrometer. Proc. Oceanology International 75 Conf., 244-248

217; BIO

Operating capabilities:

1. Obtain data from sediments ranging in strength from 0.5 psi to around 15 psi down to appropriate depths of penetration varying from 50 ft. in soft sediments to 2-3 ft. in stiff boulder clay.

2. Be capable of withstanding a substantial impact loading yet sensitive to variation of in-situ soil properties with depth.

3. Provide rapid print out and evaluation of results in the field.

4. Ease of handling in adverse weather conditions from ships not equipped with elaborate lifting and winch facilities.

Dimensions:

The basic dimensions of the cone and friction sleeve of the penetrometer were selected for the static cone penetration test so that the available knowledge on static penetration test could be utilized in analysing the test results. The impact penetrometer is a cone-tipped right circular cylinder having the following nominal dimensions and characteristics.

Diameter (Outer) = 1.405 in. (35.6 mm)

Shaft length (below the weight carriage) = 10 ft.

Overall height = 14 ft.

Cone angle = 60°

Weight of penetrometer = variable weight adjustment system providing 150 lb. to 300 lb. range

Area of cone base = 1.55 sq. in. (10 sq. cm)

Area of friction sleeve = 23.25 sq. in. (150 sq. cm)

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Ocean Engineering Group, Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

3.b.13.

1975: Colp, J. L., W. N. Caudle, and C. L. Schuster

Penetrometer system for measuring in situ properties of marine sed-
iment. Conf. Record Ocean '75 (IEEE), 405-411.

134; BIO

Increased knowledge about ocean bottom sediments is being sought for many purposes. A free-fall terrestrial penetrometer developed by Sandia Laboratories over the past 14 years is being adapted as a low-cost system to gather much in situ information as sediment shear strength, pore water pressures, densities, heat flow, soil types, penetrability, acoustic properties, etc. Either a hard wire or an acoustic data transmission link connects the instrumentation in the buried penetrometer to a surface recording/telemetry unit. Earlier versions of this system have successfully penetrated to depths up to 16.4 ft (5 m) in Gulf of Mexico sediments.

9 refs.

Sandia Laboratories, Albuquerque, New Mexico.

3.b.14.

1975: Dayal, U., J. H. Allen, and J.M. Jones

Use of an impact penetrometer for the evaluation of the in-situ strength of marine sediments. Mar. Geotech., 1(2), 73-89.

201; BIO

A description is given of the method used in evaluating the in-situ strength properties of soil from the results of impact penetrometer tests. The test results presented include both laboratory tests, conducted under controlled conditions, and field tests, obtained with a Marine Impact Penetrometer developed for shallow sub-bottom depth exploration. The test results indicate that with this system the dynamic strength profile and the soil type, thickness and depth of different layers can be directly evaluated up to the final depth of penetration. The depth of penetration obtained is a function of mass and geomtery of the penetrometer and the sub-bottom soil conditions but a 1000 lb (453 kg) penetrometer should be capable of 50 ft (15 m) penetration in soft sediment. If a soil viscosity coefficient is correctly estimated, the static strength profile can be obtained from the dynamic strength profile by applying a correction for penetration rate effects.

30 refs.

Teshmont Consultants Ltd., St. John's, Newfoundland.

3.b.15.

1975: de Ruiter, J.

Use of in-situ testing for North Sea soil studies. Proc. Offshore Europe 75 Conf., Aberdeen, 219.1-219.10.

345;

Soil investigations in the North Sea have consisted primarily of sampled bore holes. Due to various circumstances the quality of the samples is poor and improvements in the sampling techniques are difficult to achieve. In-situ testing is a necessity therefore to obtain accurate information about the soil characteristics. In the past few years some in-situ testing techniques have been adapted for offshore surveys, of which the cone penetrometer test is the most widely used at present in the North Sea. This paper presents a review of in-situ techniques already in use and being developed, with particular emphasis on the penetrometer test. Information is provided, also on the interpretation and the accuracy of penetrometer tests.

17 refs.

Fugro-Cesco BV, The Netherlands.

3.b.16.

1975: Kolbe, E. R.

The design and development of an ocean sediment probe. unpubl. Ph.D., Univ. of New Hampshire, Durham, 206 p. (Diss. Abs. Int. no. 75-23, 392)

306;

This dissertation describes an engineering design project which includes the following: 1. The development of a prototype device (penetrometer) capable of measuring in-place values of the friction angle of cohesionless soils. 2. A state-of-the-art survey relative to soil penetration techniques and data analysis. Included is a discussion of further research needed to better understand and develop soil penetrometers. 3. The research and development experience focuses thinking on the process of engineering design and on those issues which influence the design process in an academic environment.

Part I of this dissertation deals with the process of engineering design. Within certain organizations such as a university, the orderly steps of the design process are frequently interrupted or retarded. This section describes this phenomenon, suggets reasons for its occurence, and proposes some remedies within the context of the Engineering Systems Design Ph.D. Activity.

Part II describes the design and development of a blunt nose probe capable of measuring normal and radial strains induced on its surface as it penetrates the soil. These strains are then reduced to provide the respective stresses. A static analysis making use of a slipline theory, combined with experiences reported in the literature, indicated that the ratio of normal and radial stresses vary with the friction angle of the soil. Static tests of the prototype probe in dry sand show this to be correct. This study also defines future testing needed to develop the probe as a tool for ocean sediment use.

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University of New Hampshire, Durham, New Hampshire.

3.b.17.

1975: True, D. G.

Penetration of projectiles into seafloor soils. U.S. Naval Civil Engng. Lab. Tech. Rept. R-822,

108; BIO

This report presents Laboratory model tests and field tests of a study conducted on projectile penetration into seafloor soils. Existing relationships for predicting penetration behavior are considered and new relationships are developed to account for observed test results. The derived relationships incorporate conventional soil engineering properties with special modifications to account for the effects of velocity, penetrator shape, and penetration depth on penetration resistance. These relationships are shown to compare favorably with previously available methods for predicting penetration depths where soil properties are known. Recommendations are presented for the evaluation of constants in the relationships. A calculation procedure is presented for solving the penetration equations of motion by hand or with the aid of a small computer. An example problem is solved by hand to illustrate the use of the proposed relationships in the calculation procedure. Recommendations are made for use of results in preliminary and detailed engineering work.

U.S. Naval Civil Engineering Laboratory, Port Hueneme, California.

3.b.18.

1975: Zuidberg, H.M.

Seacalf: A submersible cone-penetrometer rig. Mar. Geotech., 1(1), 15-32.

008; BIO

In the years 1972-1973, an underwater rig was developed in Holland to perform quasi-static cone-penetrometer tests from seabed level. The main features are: (1) The depth of penetration is not limited by the length of the testrods, but by the 20-ton thrust capacity; and (2) with suitable vessels, the rig can be operated in waves of swell of 2 to 4 m. As of mid-1974, about 500 cone-penetrometer tests were performed in the northern North Sea. Three selected tests illustrate results in a soft clay; in a confused layer of clay, gravel, and sand overlying a homogeneous hard clay; and in a layer of sand overlying hard clay.

4 refs.

Fugro-Cesco B.V., Leidschendam, The Netherlands

3.b.19.

1976: Bhushan, K., A. Mahmood, and R.L. Allen

Resistance of ocean sediments to sampler penetration. <u>Proc. Offshore Tech. Conf.</u>, <u>3</u>, 55-64.

014; BIO

The penetration resistance of ocean sediments to a soil sampler represents a measure of in situ soil strength. This resistance can be correlated with soil parameters for use in static and seismic foundation design.
Field records of sampler penetration resistance using the Standard Penetration Test (SPT), wire-line, and vibratory sampling techniques are presented for a site offshore Southern California. It is shown that working correlations between downhole hammer blow counts and SPT N-Values could be determined for this offshore site. Limitations of these correlations are discussed. Use of downhole hammer blow count data to obtain significant soil parameters, such as relative density, is presented.

11 refs.

Woodward-Clyde Consultants

3.b.20.

1977: anonymous

Bullet system profiles sediments. Offshore, 37(13), 154-156.

319; BIO

One of the most promising developments for interpreting the constituents and structure of the seabed is a system for firing bullets into the seabed from a submarine launching vehicle. The system was developed by an ocean engineering research group at the University of Newcastle upon Tyne under the leadership of Bruce Denness, professor of Ocean Engineering.

An instrumented projectile is fired into the seabed and its penetration rate and depth give a profile of the sediments at a rapid pace. Other equipment is being developed to acquire and relate information relating to the strength, compressibility and constitution of seabed sediments and soft rocks. The equipment includes modified geophysical apparatus and other forms of penetrometer, all intended to extract data from in situ testing at comparatively low cost.

The system would use a towed vehicle on which are mounted a firing tub, a gas reservoir and a magazine for projectiles. The vehicle would be towed on or just above the seabed, and the towing cable also would carry gas lines and the instrumentation cabling. The projectile, when fired from the vehicle, would transmit telemetrically accelerometer outputs to a receiver mounted on the vehicle. The projectile itself is designed to weigh in the region of 22 pounds and have an impact velocity of not more than 225 miles per hour. The impact velocities and projectile dimensions and weights have been calculated to allow penetration to at least 32 ft in soft marine silts, clays and sands, which is comparable to the core recovery from gravity coring or vibracoring techniques.

no refs.

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3.b.21.
1977: Beard, R. M.

Expendable Doppler penetrometer: a performance evaluation. U.S. Naval Civil Engng. Lab. Tech. Rept. TR-855.

074; BIO (NTIS AD A043 912/5G1)

An expendable penetrometer using the Doppler principle has been developed to expediently test seafloor soil to a depth of 9 m (30 ft) at water depth to 6,000 m (20,000 ft). The velocity of the penetrometer is measured as it penetrates seafloor soils. From the velocity record, soil penetrability and an estimate of the undrained shear strength profile can be calculated. The penetrometer has a mass of 173 kg (12 slugs) is 2.9 m (9.5 ft) long, is 90 mm (3.5 in.) in diameter, and is easily deployed from a ship. This report presents data from 11 tests at four locations off the southern California coast. Undrained shear strength profiles determined from penetrometer data are compared to other types of in-situ data and core data. It is concluded that the expendable Doppler penetrometer is reliable and simple to use and that reasonable estimates (± 30% of actual values) of undrained shear strength profiles can be obtained even though the analyzed phenomenon is complex. This tool will be of particular value in surveying potential sediment anchor or foundation locations and can, for some cases, provide information sufficient for design purposes.

9 refs.

U.S. Naval Civil Engineering Laboratory, Port Hueneme, California.

3.b.22.

1977: Ferguson, G. H., B. McClelland, and W. D. Bell

Seafloor cone penetrometer for deep penetration measurements of ocean sediment strength. Proc. Offshore Tech. Conf., 1, 471-478.

136; BIO

Foundation design and construction planning for offshore structures are rapidly becoming more complex, involving a wide variety of foundation types, foundation elements, installation procedures and subsurface conditions. Maximum water depths and foundation loads are increasing, and severe environmental conditions producing multiple-hazards are more common. Sophisticated analyses developed for these conditions require accurate and thorough soil property evaluation. In situ testing of soil properties, such as Remote Vane and cone penetrometer tests, enhance the information obtained from laboratory tests on soil samples.

A remotely-controlled hydraulically-operated, seafloor-based system called Stingray has been developed by McClelland Engineers which operates in conjunction with offshore drilling equipment to provide continuous cone penetrometer information, high-quality soil samples and other in situ measurements to any drillable penetration from a floating base. This powerful capability of testing below formations which normally cause cone penetrometer refusal assures information for deep as well as shallow foundation designs.

Results are presented from the onshore development and testing of the Stingray system, and from the offshore use of the cone penetrometer, mechanical and readout subsystems.

10 refs.

McClelland Engineers, Inc.

3.b.23.

1978: Chari, T. R., W. G. Smith, and A. Zielinski

Use of free fall penetrometer in sea floor engineering. Conf. Record Oceans '78 (IEEE), 686-691.

365; BIO

In-situ evaluation of shear strength is an important aspect of geotechnical testing of the ocean floor. The free fall penetrometer is one such test device, capable of quickly examining the top few meters of the surficial sediments. A description of the penetrometer and preliminary results from its sea trials south of Newfoundland during May 1978 are presented in this paper.

16 refs.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

3.b.24.

1979: Chari, T. R., K. Muthukrishnaiah, and A. Zielinski

Performance evaluation of a free fall penetrometer. Proc. 1st Can. Conf. Mar. Geotech. Engng., 203-210.

230; Metrology

Among the in-situ methods, the penetrometer is now finding greater application in both terrestrial and underwater investigations. A free fall penetrometer for marine soil investigation has been under development at Memorial University during the past few years. This instrument underwent sea trials during a cruise on C.S.S. Hudson in May, 1978. Core samples were also collected in conjunction with the penetrometer drops. A description of the penetrometer, and an evaluation of its performance during the sea trial are given in this paper. The analysis of the penetrometer signals and the results of tests on core samples are also reported.

16 refs.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

3.b.25.

1979: Chari, T. R., S. M. Abdel-Gawad, and S. N. Chaudhuri

Geotechnical survey of the seafloor with a free fall penetrometer. Proc. Port Ocean Engng. Arctic Conditions '79, 2 833-842.

378; BIO

An important and critical activity in any offshore operation is the geotechnical evaluation of the seafloor. Detailed and site-specific studies, although expensive, are necessary in the siting of a coastal or offshore structure. However, the availability of preliminary geotechnical data is always an asset in choosing the most appropriate location or locations for further detailed investigation. The free fall penetrometer is an instrument that can be efficiently and economically used to colelct such preliminary information of the surficial ocean soils in the top 10 meter depth range. This instrument is also an extremely useful tool in surveying large tracts for pipeline routing. The viability of the proposed concept was successfully demonstrated during sea trials of the instrument in May 1978. Laboratory research is in progress, using the penetrometer in the free fall and quasi-static modes. This paper describes the correlation of these tests with the results from conventional triaxial and direct shear tests. Details of this penetrometer are described. Its potential use, particularly in the cold ocean environment where operational and economical constraints are severe, is highlighted.

15 refs.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

3.b.26.

1979: de Ruiter, J.

Discussion of "Geotechnical survey of the seafloor with a free fall penetrometer" by T. R. Chari, et al. Proc. Port Ocean Engng. Arctic Conditions, 3, 423-425.

379; BIO

The Memorial University of Newfoundland should be complimented on their efforts to develop and calibrate the free fall penetrometer. The limitations in obtaining reliable quantitative data on soil properties from seabed samples are widely recognized, and the cone penetrometer test has found general acceptance in deep investigations for offshore foundations. For that purpose they are commonly carried out to depths of 100 to 150 m below mudline, requiring heavy equipment and specially equipped drilling vessels. The same need for in-situ tests exists, however, for shallow exploration such as necessary for pipeline surveys and preliminary reconnaissance purposes.

The free fall penetrometer can be a useful tool for those applications as it can be used from a relatively small survey vessel and can thus be part of a geophysical survey. The depth limitation can be somewhat overcome by performing the test in a selective manner, in particular in areas where the geophysical profiles show that deeper layers outcrop at the seabed. After further calibration the FCPT should have the same interpretation possibilities as the QCPT and is then a definite improvement over the Scott accelerometer which has found little application.

In general it is to be expected that correlations can be established between the FCPT with a 45 cm^2 cone and the QCPT with a 10 cm^2 cone. It is recommended that any calibration based on test tank data should be confirmed by an adequate amount of field data in a variety of soils.

no refs.

Fugro B.V., the Netherlands.

3.b.27.

1979: McNeill, R. L.

Enhancement of geophysical soil profiles using instrumented marine sediment penetrators. Proc. Offshore Tech. Conf., 3, 1469-1480.

135; BIO

Static and dynamic penetrators measure strengths and layer thicknesses in soils of all strengths, to great depths in soft to medium soils. Thus, penetrators furnish information, quickly and cheaply, to allow geophysical travel-time profiles to include strengths and layer thicknesses. Case histories indicate that penetrators sense a soil strength between the maximum and the remolded; with about the same scatter as a conventional boring/sampling/testing program. Penetrator data are, however, obtained more quickly and probably more cheaply. For gas-charged soils, penetrator strength data may be the more reliable. Penetrators can also measure in-situ pore pressures and shaft friction.

The implantation and data-analysis techniques, along with the instrument systems, are well developed. What needs to be done now is for the practicing professionals, geophysical and geotechnical, to evaluate penetrators for commercial use.

15 refs.

Sandia Laboratores, Albuquerque, New Mexico.

3.b.28.

1979: Zielinski, A. and T.R. Chari

The Doppler telemetry system for free fall penetrometer. <u>Conf. Record, Oceans'79 (IEEE)</u>, 603-606.

026; BIO

The application of Doppler telemetry for velocity measurements of a free fall penetrometer is demonstrated and presented in this paper. The system design considerations and parameters are outlined together with the description of a prototype. Results from sea trials of the prototype are presented and its performance is evaluated. Possible modifications for the system are suggested.

8 refs.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland

3.b.29.

1980: Dayal, U.

Free fall penetrometer: a performance evaluation. Applied Ocean Res., 2 (1), 39-43.

309; BIO

In-situ strength profiles, soil type, and depth and location of stratigraphic layers can be obtaned with the free fall penetrometer which is simple and fast in operation (about 20 min total is required for deployment, testing and retrieval). Penetrations to 4 m are presently possible with estimations runing to 15 m with some design modifications. The instrument may prove especially useful in the reconnaissance of vast areas.

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Department of Civil Engineering, Indian Institute of Technology, Kanput, India (U.P.).

3.c.l.

1965: Dill, R. F. and D. G. Moore

A diver-held vane-shear apparatus. Mar. Geol., 3, 323-327.

153; BIO

An inexpensive instrument, consisting of a small vane attached to the shaft of a calibrated torque screwdriver, has been developed for measuring the shear strength of sea-floor sediments. It can be used either in situ or on sediment samples removed to the ship or laboratory.

7 refs.

U.S. Navy Electronics Laboratory, San Diego, California.

3.c.2.

1970: McNary, J. F. and H. Frohlich

An in situ vane shear testing device. Mar. Geol., 8(5), 367-370.

317; BIO

A compact self-contained motor driven in situ sediment vane shear tester has been developed. This device can be used to measure the shear strength of sea-floor sediments either by diver or from a manned submersible.

The in situ sediment vane shear tester determines sediment shear strength from the angular deflection of a calibrated torsion spring (Fig. 1). The shear vane, which is connected to the lower end of this spring, is rotated in the sediment by torque applied form a small d.c. motor through a reduction gear at the upper end of the spring. The drive speed is 30°/min. Vane size is 2.54 cm diameter by 5.08 cm long giving the length to diameter ratio of 2.0 recommended by OSTERBERG (1957). The maximum "twist" of the spring during rotation of the vane establishes the resisting torque or shear strength of the sediment (OSTERBERG 1957).

The deflection of the spring is determined directly from the relative motion between an indicator connected to the lower end of the spring and the indicator dial attached to the upper end of the spring. The indicator, as it rotates relative to the indicator dial, pushes a "maximum pointer" (Fig. 2). The final position of the "maximum pointer" then indicates the maximum deflection of the spring during the shearing process. The indicator dial is calibrated to read shear strength directly (in lbs./sq. inch) with an accuracy of ± 1% of full scale. The unit can read a maximum shear strength of 0.28 kg/cm^2. The vane size and the spring constant of the torsion spring can both be varied for other shear strength ranges.

2 refs.

Institute of Marine Sciences, University of Miami, Miami, Florida.

3.c.3.

1971: Doyle, E. H., B. McClelland, and G. H. Ferguson

Wire-line vane probe for deep penetration measurements of ocean sediment strength. Proc. Offshore Tech. Conf., 1, 21-32.

027; BIO

A remotely controlled vane probe has been developed and tested for measuring in-situ shear strengths of sub-bottom clays in marine environments. This device, an adaptation of the long used vane shear test, is employed in conjunction with wire-line soil samplings operations from either a fixed or a floating base.

The development included extensive on-shore testing at Venice, Louisiana, accompanied by conventional onshore and offshore sampling and testing methods. Results indicate that shear strengths measured by the Remote Vane are comparable to those obtained with laboratory tests on high quality samples and with conventional field vane tests. Subsequent to its onshore trials, the device has been operated successfully from a floating base at several offshore locations.

The primary function of this new marine geotechnical procedure is to permit more accurate determination of the in-situ soil strength profile for use in designing pile foundations and bottom support systems and in investigations of marine slope stability. Remote Vane test results obtained at the Venice site are compared with a load test on a 12-inch diameter open-end pipe pile, driven to 147-foot penetration. In addition, Remote Vane results obtained from a floating vessel at an undisclosed offshore location are presented and discussed.

18 refs.

Shell Development Company

3.c.4.

1971: Inderbitzen, A. L., F. Simpson, and G. Goss

A comparison of in-situ and laboratory vane shear measurements. J. Mar. Tech. Soc., 5(4), 24-34.

218; BIO

In situ vane shear measurements and penetration tests were made to a depth of 133 cm into the sea floor sediment by use of a vane shear device attached to Lockheed Aircraft Corporation's submersible Deep Quest. These tests were made in the San Diego Trough off San Diego, California, at a water depth of 1,240 meters. The bottom consisted of silty clay material which was uniform througout the test area. Sediment cores were obtained 60 to 90 cm from five of the six in situ test sites. Vane shear measurements were made in the laboratory on the core samples at the same depths as the in situ tests and results compared. Results of the study indicate that the vane shear strengths determined by in situ tests are consistently higher than the laboratory test values. The laboratory determined vane shear strength values were 2 to 36 percent lower than the respective in situ value for that depth and site. The closest agreement between in situ and laboratory vane shear strength values occurred in the middle section of the cores. All the in situ test profiles exhibited an increase in shear strength with depth, but the profiles based upon laboratory vane shear strength measurements were erratic. Two in situ measurements yielded sensitivity values of 2.6 and 3.0 for the sediment. Within the small area investigated, shear strength values at a given depth did not change significantly with increasing lateral distance. Values were measured over lateral distances of 6.7, 13.4 and 20.1 meters. Greatest vertical variation in shear strength values occurred in the top 30 cm of sediment depth. Within this zone, shear strength differences representing as much as 29 percent of the average in situ shear strength were observed. Below 100 cm sediment depth the variation become less than 8 percent.

11 refs.

Lockheed Missiles and Space Company, San Diego, California.

3.c.5.

1972: Inderbitzen, A. L. and F. Simpson

A study of the strength characteristics of marine sediments utilizing a submersible. Underwater Soil Sampling, Testing, and Construction Control, Am. Soc. Testing Materials Spec. Tech. Publ. 501, 204-215.

210; BIO

One of the tasks of the Lockheed Missiles and Space Company's submersible Deep Quest has been to obtain detailed information on the strength characteristics of the sea floor. Continuing projects, carried out with a corer and a vane shear machine mounted on the submersible, are a comparison of in-place and laboratory vane shear strength values and an investigation of the lateral and vertical variability of in-place shear strength. The area being investigated for these projects is approximately 13 nautical miles southwest of San Diego, Calif., on the floor of the San Diego Trough at a depth of 4050 ft.

Because the projects are still incomplete, no definitive conclusions can be made. However, initial results indicate inconsistencies in the difference between in-place and laboratory vane shear strength values. Lateral variability between in-place vane shear strength measurements does not appear to be related to distance between test locations. Vertical variability in in-place vane shear strength values appears to decrease with depth into the sediment.

12 refs.

Lockheed Ocean Laboratory, Lockheed Missiles and Space Company, San Diego, California

3.c.b.6

1972: McDonald, V. J., R. E. Olson, A. F. Richards, and G. H. Keller

Measurement and control system for deep sea vane-shear device.
Conf. Rec. Ocean '72 (IEEE), 474-479.

154; BIO

A vane shear device was developed for in-place measurement of the undrained strength of clays in the marine environment. This device required a measurement of torque applied to a vane as the soil in which the vane was embedded failed in shear and was remolded. The system was designed to operate at depths of 4.5 km and to conduct measurements at depths up to nearly 3 m below the mudline. Control signals to and data from the apparatus were telemetered over a single wire with ground return and the tower was self-powered. Torque measurements required successful use of electrical strain gages and leads exposed to high hydrostatic pressures. The apparatus has been successfully operated at several sites in the Atlantic Ocean and in the Gulf of Mexico at depths of 3635 m.

4 refs.

University of Illinois at Urbana-Champaign, Urbana, Illinois.

3.c.7.

1972: Richards, A. F, V. J. McDonald, R. E. Olson, and G. H. Keller

In-place measurement of deep sea soil shear strength. Underwater Soil Sampling, Testing, and Construction Control, Am. Soc. Testing and Materials Spec. Tech. Publ., 501, 55-68.

155; BIO

A vane shear device was developed for in-place measurement of the undrained strength of clays in the marine environment. It was designed to operate at a water depth of 4.6 km (15,000 ft) and to penetrate nearly 3 m (10 ft) below the udline in steps of about 0.3 m (1 ft). The device contained its own power supply. Data were wire telemetered to the ship for recording and analysis. Experiments in several locations in the Atlantic Ocean and the Gulf of Mexico demonstrated the capability of the apparatus. The shear strength measured in place generally exceeded the strengths measured on soil samples collected frm shallow water, where the sedimentation rate was relatively rapid. There was little difference between shear strength measured in place and on core from the Gulf of Mexico abyssl plain site, where the sedimentation rate was slow.

8 refs.

Marine Geotechnical Laboratory, Lehigh University, Bethlehem, Pennsylvania.

3.c.8.

1974: Monney, N.T.

An analysis of the vane shear test at varying rates of shear. <u>Deep-Sea Sediments</u>, A. L. Inderbitzen, Ed., Plenum Press, N.Y., 151-167.

045; BIO

Vane shear tests were performed at varying rates of shear on three types of cohesive sediment: a clayey silt, a calcareous ooze, and a red clay. The shear strength was found to vary significantly for the range of shear rates typically used by researchers and practicing engineers. A standard rate of 0.0262 rad/s (90 deg/min) is recommended.

4 refs.

U.S. Naval Academy.

3.c.9.

1975: Perlow, M., Jr.

Influence of sample disturbance and test method on key engineering properties of marine soils. M.Sc., Lehigh University (Department of Civil Engineering), Bethlehem, Pennsylvania, 56 p.

076; BIO (NTIS AD A018 817/7G1)

Detailed measurements of bulk density and vane shear strength were made in situ and on gravity cores in the San Diego Trough, Wilkinson Basin, and Abyssal Plain and Mississippi Delta areas of the Gulf of Mexico. Comparison of in situ and laboratory measurements were made to evaluate the influence of sample disturbance and test method on bulk density and vane shear strength. Location differences between in situ and gravity core locations and the associated areal variation of bulk density and vane shear strength were described in detail for all comparisions.

The influence of sample disturbance on vane strength was difficult to evaluate because of differences in vane rotation rate and vane size between in situ and laboratory vane measurements. Large strength differences resulted from the great differences in angular shear velocity at the vane blade edges between in situ and laboratory vane measurements. A direct linear relationship between vane strength and angular shear velocity was found to exist in the Wilkinson Basin and San Diego Trough Test Areas. Comparison of in situ and laboratory vane strengths at a standard shear velocity, rather than a standard rotation rate, is proposed to eliminate uncertainties associated with rotation rate and vane size differences. A vane test procedure for both in situ and laboratory vane tests based on angular shear velocity is outlined.

46 refs.

Marine Geotechnical Laboratory, Lehigh University, Bethlehem, Pennsylvania.

3.c.10.

1976: Kraft, L.M., N. Ahmad, and J.A. Fucht

Application of remote vane results to offshore geotechnical problems. Proc. Offshore Tech. Conf., 3, 75-96.

012; BIO

A remotely controlled vane probe for in situ measurement of undrained strength of clay was first used offshore in 1970. Since that time the McClelland Engineers' Remote Vane, which is in its fourth generation of development, has been used at many Gulf of Mexico sites to penetrations below the seafloor in excess of 400 ft and in water depths of more than 1000 ft. To identify and quantify soil disturbance effects on strengths measured on samples recovered with a 2 1/8-in. diameter wire-line sampler and to consider the relationship of these effects on foundation design, the Remote Vane data accumulated from these Gulf of Mexico sites were reviewed, synthesized, and compared with the laboratory measured strengths of recovered samples. Factors included in this evaluation were: water depth, penetration, vane size, vane rotation rate, degree of soil saturation, measured methane content, soil plasticity and liquidity index, relative soil strength, and geologic history.

Analysis of data demonstrates that Remote Vane measured strength is not a constant multiple of the strength measured from laboratory tests. The ratio of Remote Vane strength to miniature vane strength, which is useful parameter in assessing the in situ strength profile, ranges from one to more than three. Nevertheless, the results of the analyses demonstrate that when Remote Vane data are used with strength data from laboratory tests, the geologic history of the deposit is more readily and consistently identified and a more accurate assessment of the in situ soil strength profile can be determined.

53 refs.

McClelland Engineers, Inc.

3.d.l.

1965: Robertson, R. M.

Expendable instrumentation. Mar. Sci. Instrumentation, 3, 99-121.

237; BIO

The paper discusses expendable instrumentation which can be used from a fast-moving vessel: 1) a bathythermometer which measures the temperature profile of the ocean, and 2) a Soil-Bearing Meter which gives a reading of the load-bearing capacity of the ocean floor. Their general construction and operation is explained. Different forms of data collection and processing are discussed. Test results are included.

4 refs.

GM Defence Research Laboratories, Santa Barbara, California.

3.d.2.

1969: Kretschmer, T. R. and H. J. Lee

In-situ determination of seafloor bearing capacity. Proc. Civil Engng. in the Oceans, Am. Soc. Civil Engineers, 679-702.

050; BIO

The Naval Civil Engineering Laboratory (NCEL) has developed a device for performing in-situ plate bearing tests on seafloor sediments. The equipment, tethered to a surface vessel by a nylon line, displaces a small spread footing into the seafloor at a controlled rate and measures the resulting load on the footing as a function of displacement. These measurements are transmitted acoustically to the surface vessel where they are monitored and recorded. Tests have been conducted with this device at four offshore sites in water depths ranging from 100 to 6,000 feet. The test results were found to be amenable to analysis by modified elastic and bearing capacity theory. The application of elastic theory involved the derivation of empirical elastic parameters from laboratory vane shear tests on sediment core samples. The results of the plate bearing tests served as a basis for this derivation. The modified elastic theory solution was found to be adequate for predicting all of the in-situ bearing pressure-settlement data. The bearing capacity solution was adequate for predicting settlements at higher bearing pressures only.

13 refs.

Construction Systems Division, U.S. Naval Civil Engineering Laboratory, Port Hueneme, California.

3.d.3.

1976: Wang, M.C., V.A. Nacci, and C.D. Market

Electrical resistivity method for marine sediment consolidation study. Proc. Offshore Tech. Conf., 3, 45-54.

017; BIO

Because of the highly compressible nature of submarine sediments and difficulty in obtaining undisturbed samples, there is a need for conducting in-situ consolidation tests for predicting settlement of a proposed submarine foundation. Unfortunately, direct measurement of settlement on the ocean floor is very difficult. Primary objective of this study was to investigate the feasibility of using the electrical conductivity method to determine compressibility behavior and to monitor settlement for in-situ consolidation tests.

Field consolidation tests were conducted at the bottom of a marina in Rhode Island using a two-foot cubic concrete block. Attached to the bottom of the loading block was a conductivity sensor for monitoring electrical conductivity change of the underlying soil. From the conductivity readings, the settlement of the loading block was determined and was compared with the actual settlement obtained using a galvanized steel cable attached to the test block. Test results encouraged the use of the conductivity method for settlement prediction.

Results of this investigation demonstrate that the use of the electrical conductivity method to determine consolidation behavior of the ocean sediment is feasible and perhaps is the most economical method for in-situ study to date.

8 refs.

Pennsylvania State University

3.e.1.

1975: Menard, L.

Interpretation of pressuremeter test results. Sols Soils, 7(26), 7-43.

106;

A review of the technical rules adopted by specialist engineers employing pressuremeter methods is presented. The paper describes the practical procedures that must be respected by the geotechnicians and drilling personnel in carrying out the borings and the pressuremeter tests. The drilling equipment and test method used will vary in function of the nature of the soil encountered and the type of study undertaken. Rules for the interpretation of the results, based on the pressuremeter theory as well as the experience gained from a large number of full-scale tests are given.

Soc Tech Louis Menard, Longjumeau, France.

3.f.1.

1961: Shumway, G. and W. B. Huckaby

Equipment for in situ measurements of sound velocity and adsorption in sea floor sediments. J. Ac. Soc. Am., 33(6), 841, (abstract).

222; BIO

With the intent of making in situ measurements of sound velocity and absorption in deep sea sediments from the bathyscaph Trieste, equipment for this purpose, useful also in shallow water, has been developed and field tested. Three probes, each containing two transducer 0.5 m apart, are fastened to a rigid beam for simultaneous insertion into the sediment. The receiving probes lie 1 and 2 m distant from the source probe. Pulse-actuated magnetostrictive transducers are used as sound sources, and barium titanate cylinders as receivers. Measurements at two depths in the sediment are possible by using upper or lower transducers. The travel time interval between reception of the transmitted pulse at the near and far receivers is measured on a decade scaler counting a precision oscillator. Oscilloscope presentation of the signals arriving at the two receivers along with the time of gating assures the operator of satisfactory operations and aids in setting certain controls. A frequency range between 7 kc/sec and 30 kc/sec is used, with filtering provided in the receiving circuit to allow measurements in a number of frequency bands. Adsorption measurements are made by matching superimposed oscilloscope traces of the signals from the near and far receivers by means of precision bridge T attenuators in two matched amplifier channels.

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U.S. Navy Electronics Laboratory, San Diego, California.

3.f.2.

1963: Hamilton, E. L.

Sediment sound velocity measurements made in situ from bathyscaph Trieste. J. Geophys. Res., 68(21), 5991-5998.

216; BIO

The first deep-water, in situ measurements of sound velocity in sea-floor sediments (other than seismic) have been made from the bathyscaph Trieste. These measurements were made at three stations off San Diego during August-October 1962 at depths of 338 to 1235 meters. Specially designed probes measured sound travel time over a 1-m path, 46 cm below the water-sediment interface at frequencies of 25 kc/s; probe accuracy was about ±0.5 m/sec. Laboratory measurements of sound speed in sediment can be corrected to in situ conditions in the sea floor by applying full corrections for temperature and pressure, using tables for sound speed in sea water. A significant portion of the vertical sound velocity gradient within the sea floor must be due to thermal gradients. At the Mohole (Guadalupe) site, for example, the thermal gradient (plus a small increment due to pressure) accounts for an increase in sound velocity of 53 m/sec in the upper 100 meters of the sediment. In situ sound speeds of less than 1 per cent error can be predicted for fine-grained, high-porosity sediments off San Diego by means of present sound-speed versus porosity curves; these curves need revision for sands.

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U.S. Navy Electronics Laboratory, San Diego, California.

3.f.3.

1967: Bennin, R. S. and C. S. Clay

Development of an in-situ sediment velocimeter. <u>Hudson Labs of Columbia Univ. Tech. Rept. 131</u>, 24 p.

270; NTIS-AD-649-696.

The Hudson Laboratories in conjunction with the Benthos Company have developed an in-situ sediment velocimeter. The basic unit is a free-fall device instrumented with transducers and core samplers. The unit is released at the surface and free falls through the water column and implants three probes in the sediment to a depth of 48 cm. Since the unit is activated before release into the water, a recording of compressional wave velocity is made during free fall through the water column and subsequent penetration into the bottom. A sequential timer electrically separates the buoyant section from the free fall vehicle and withdraws the transducers and the core sample from the bottom and returns the recording system to the surface.

40 refs.

Hudson Laboratories of Columbia University, Dobbs Ferry, New York.

3.f.4.

1970: Hamilton, E. L., H. P. Bucker, D. L. Keir, and J. A. Whitney

Velocities of compressional and shear waves in marine sediments determined in situ from a research submersible. J. Geophys. Res., 75(20), 4039-4049.

175; BIO

In situ measurements of the velocity and attenuation of compressional waves, and velocities of Stoneley waves from which shear-wave velocities were computed, were made at three stations in the sea floor off San Diego, California, from a research submersible; a fourth station was occupied by divers. Sediment types and water depths ranged from medium sand at 20 meters to clayey silt at 986 meters. Sediment densities, porosities, and grain sizes were measured in sediment samples taken at each station. These unique data allowed tenative evaluations of models and equations, and computations of constants, for elastic and visco-elastic saturated porous media.

33 refs.

U.S. Naval Undersea Research and Development Center, San Diego, California.

3.f.5.

1971: Nacci, V., L. Lewis, J. Gallagher, and M. Huston

Correlation of geotechnical and acoustical properties of ocean sediments. Proc. International Symp. Engng. Props. Seafloor Soils Geophys. Ident., Seattle, 268-278.

242;

The Deep Ocean Sediment Probe (DOSP) was used to obtain compressional wave sound speed and attenuation in situ in shallow water sediments off Ponce, Puerto Rico, in April, 1970. Core samples collected simultaneously were analysed in the laboratory and correlations were drawn between acoustic and soil mechanics properties.

20 refs.

Department of Ocean Engineering, University of Rhode Island, Kingston, Rhode Island.

3.f.6.

1972: Shirley, D.J. and L.D. Hampton

Acoustic velocity profilemeter for sediment cores. Oceans '72, Proc. IEEE International Conf. on Engng. in the Ocean Environment, 550-553.

005; BIO

A system has been developed for attachment to sediment corers to obtain an in situ acoustic velocity profile during a coring operation. The system uses two electroacoustic transducers mounted in the cutting head of the corer and associated electronics circuitry to measure the travel time of an acoustic pulse traversing the diameter of the sediment core. Laboratory and field tests have been conducted and the results show that the system provides useful information. Acoustic velocity profiles were obtained in the Gulf of Mexico using a piston corer and in shallow coastal waters using a hand corer.

3 refs.

Applied Research Laboratories, The University of Texas at Austin, Austin, Texas

3.f.7.

1973: Shirley, D. J., A. L. Anderson, and L. D. Hampton

Measurement of in situ sound speed during sediment coring. <u>Conf. Record Oceans '73 (IEEE),</u> 345-348.

116; BIO

The profilometer developed for attachment to sediment corers to obtain an in situ sound speed profile during coring operations, which was described at Ocean 72, has been refined and used to collect additional data. The refinements, including an automatic gain control, are discussed. Sound speed data and core analyses demonstrating the measurement capabilities and usefulness of the profilometer are presented.

3 refs.

Applied Research Laboratories, The University of Texas at Austin, Austin, Texas.

3.f.8.

1973: Shirley, D. J., A. L. Anderson, and L. D. Hampton

In situ measurements of sediment sound speed during coring. The <u>University of Texas Applied Res. Labs. Tech. Rept. 73-1,</u> 86 p.

261; NTIS-AD-758-659.

A system was developed for attachment to sediment corers to obtain an in situ sound speed profile during a coring operation. The system uses 2 electroacoustic transducers mounted in the cutting head of the corer and associated electronic circuitry to measure the travel time of an acoustic pulse traversing the diameter of the sediment core. Laboratory and field tests which demonstrate the capabilities of the measurement technique are reported. Sound speed profiles were obtained in the Gulf of Mexico with a piston corer and in coastal waters with a special shallow water coring rig. The feasibility of measuring acoustic attenuation and volume scattering is examined.

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Applied Research Laboratories, The University of Texas, Austin, Texas.

3.f.9.

1974: Anderson, A.L. and L.D. Hampton

A method for measuring in situ acoustic properties during sediment coring. Physics of Sound in Marine Sediments, L. Hampton, ed., Plenum Press, N.Y., 357-371.

006; BIO

A system developed for attachment to sediment corers in order to obtain an in situ sound speed profile during a coring operation is described. The system uses two electroacoustic transducers mounted in the cutting head of the corer and associated electronic circuitry to measure the travel time of an acoustic pulse traversing the diameter of the sediment core. Results of laboratory and field tests are presented. There is an ongoing study of the feasibility of expanding the sound speed measurement system capabilities to include a measure of sediment acoustic attenuation and internal volume scattering.

6 refs.

Applied Research Laboratories, The University of Texas at Austin, Austin, Texas

3.f.10.

1974: Anderson, A. L., and L. D. Hampton

In situ measurement of sediment acoustic properties during coring. Deep Sea Sediments, A. L. Inderbitzen, ed., Plenum Press, N.Y., 327-345.

149; BIO

The acoustical properties of liquid-saturated and gas-bearing sediments are discussed and related to other sediment properties. A system is described which has been developed for attachment to sediment corers in order to obtain an in situ sound-speed profile during a coring operation. The system uses two electroacoustic transducers mounted in the cutting head of the corer and associated electronic circuitry to measure the travel time of an acoustic pulse traversing the diameter of the sediment core. Results of laboratory and field tests are presented. There is an ongoing study of the feasibility of expanding the sound speed measurement system capabilities to include a measure of sediment acoustic attenuation and internal volume scattering. Each of these measured acoustical parameters is useful for sediment description and gas assessment.

38 refs.

The Univesrity of Texas at Austin, Austin, Texas.

3.f.11.

1974: Akal, T.

Acoustical characteristics of the sea floor: experimental techniques and some examples from the Mediterranean Sea. Phys. of Sound in Mar. Seds., L. Hampton, ed., Plenum Press, N. Y., 447-480.

338; BIO

The acoustical properties of the sea floor are primarily determined by the physical properties of the sediments, layering in the sediments, and the roughness of the bottom and sub-bottom. Over the last decade many core and bottom photographs have been taken and acoustical measurements made to improve our understanding of the mechanism governing the physics of sound in marine sediments. The results of such studies made by NATO SACLANT ASW Research Centre in different regions of the Mediterranean Sea are presented. Methods of observation and data analysis are briefly discussed. The relationships among those properties of the sediments that affect the acoustical characteristics of the bottom are given and results are compared with the acoustical measurements.

22 refs.

NATO SACLANT ASW Research Centre, LaSpezia, Italy

3.f.12.

1974: Shirley, D. J.

Interim technical description of the ARL compressional wave in situ sediment core profilometer. Univ. of Tex. Applied Res. Labs. Tech. Memo. 74-9.

296; BIO (NTIS-AD-778-689)

The profilometer which was developed at ARL with ONR sponsorship has been shown to provide accurate in situ measurement of sediment characteristic compressional wave speed and attenuation. From the outset, the goal of the work was a measurement instrument which could provide in situ measurements of these parameters in deep ocean sediments and would require a limited modification of existing coring tools. It was accepted early in the program that cabling between transducers on the corer and electronics on the surface was an acceptable compromise for a prototype system to establish the usefulness and accuracy of the technique. Successful results of measurements made with the instrument in this configuration have been reported by Shirley et al. (1972, 1973a,b).

Recent work to eliminate the cable to the surface has involved reducing the volume occupied by the electronics and configuring the circuitry for mounting in a waterproof container capable of withstanding ambient hydrostatic pressures at the water depths encountered in coring (up to 5 km). To implement this configuration for the profilometer, it was also necessary to provide a regulated battery power supply and a means for recording the data inside the waterproof container.

This report describes the new profilometer configuration. The complete assembly with transducers attached is shown in Fig. 18 as it is attached to the corer. The pressure case containing the electronics is attached to the top of the corer, the transducer holders are attached by machine screws to the core cutter, with the transducers projecting through holes drilled in the cutter side wall and contacting the sediment inside the corer. The transducer cables run up the outside of the core barrel and are clamped.

3 refs.

Applied Research Laboratories, the University of Texas, Austin, Texas.

3.f.13.

1975: Shirley, D. J. and A. L. Anderson

In situ measurement of marine sediment acoustical properties during coring in deep water. IEEE Trans. Geosci. Electr., GE-13(4), 163-169.

150; BIO

In order to obtain in situ measurements, to several meters depth in a marine sediment, of compressional wave speed and attenuation, a device has been built for attachment to ocean bottom sediment corers. This profilometer consists of transducers on the lower end of the coring tool which are connected by armored cables to an electronics package on the upper end of the tool, thus allowing acquisition of acoustical data with a minimum of modification to a standard corer. Early measurements with a prototype profilometer, which required electrical cables to the surface, established the accuracy and usefulness of the technique. The new deep water version of the profilometer is self contained including provisions for recording the data in the electronics packages on the corer. Design operating water depth for the new system is 5 km.

Test results for the new profilometer are presented including several high resolution in situ sound speed profiles to 12 m depth in deep water (4.5 km) sediments. Detailed layering is described including a high strength, high water content layer, several thin high speed sand layers, and several low speed layers. The data indicate that the near surface low speed zone in these sediments is composed of several thin low speed layers imbedded in a higher speed matrix.

6 refs.

Applied Research Laboratories, The University of Texas at Austin, Austin, Texas.

3.f.14.

1976: Dow, W.

Development of an acoustic probe for detailed ocean bottom and sub-bottom surveys. Woods Hole Oceanog. Inst. Tech. Rept. 76-35, 13 p.

162; BIO (PB-258-459)

This report outlines the development of an Acoustic Probe designed to resolve fine details of bottom and sub-bottom sediment layering particularly in deep water where ship sounders are usually inadequate. Penetration depths range from 12 to 72 meters and resolution approaches 15 cms.

The new instrument consists of a small but high powered short-pulse echo sounder operating at 12 kHz and designed to be lowered on 1/4 inch diameter single conductor logging cable to a maximum water depth of 6200 meters. This unit is self-contained and battery operated.

Excellent correlation has been observed between depth of sub-bottom layering as recorded by the Probe and as determined from sediment cores taken in the same location. Generally, the acoustic stratigraphy thus obtained in localized survey areas has proven sufficiently detailed to pre-determine acoustically whether an area warrants further investigation via coring or other means.

3 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

3.f.15.

1978: Longuemard, M. J. P.

Mesure _in situ_ des modalités de propagation des ondes longitudinales ultra-sonores dans les sédiments marins: application a la détermination des paramètres méchaniques et physiques de ces sédiments. _Annales Hydrographiques_, _5ème Séries_, _6(2)_, 1-17.

407; BO

Geotechnical properties of marine sediments can be estimated from acoustical data. A small platform for use in measuring the acoustical properties of marine sediments with excellent accuracy is described. Four acoustical probes are attached to the legs of the platform and penetrate the sediment when the platform is lowered to the bottom. Two of the probes are ultrasonic acoustic transmitters (frequency lower than 100 kHz) and two are receivers allowing differential acoustic velocity and attenuation to be measured. The platform is also equipped with a push-corer driven by compressed air. Air and power are supplied from the surface.
The author presents a theoretical analysis comparing acoustical properties with geotechnical properties such as shear strength and sediment density.

16 refs.

Centre for Marine Sedimentary Research, Centre Universitaire de Perpignan.

3.g.1.

1969: Kermabon, A., C. Gehin, and P. Blavier

A deep-sea electrical resistivity probe for measuring porosity and density of unconsolidated sediments. Geophysics, 34(4), 554-571.

042; BIO

A study has been made of the mass physical properties and electric resistivity of marine sediments. The well-known linear correlation of density with porosity was confirmed. A third-degree polynomial curve was found to be the best fit for our data relating porosity and the formation factor, which is the ratio of the bulk resistivity of marine sediments, to the resistivity of interstitial water.

An electrical resistivity probe has been devised to obtain "in-situ" profiles of resistivity versus depth. The instrument is 13 m long and weighs 700 kg in water. About thirty rapid measurements on the sea floor can be made in one lowering. Good correlation was obtained between electrical probe measurements and direct porosity measurements made on cores taken nearby.

9 refs.

North Atlantic Treaty Organization, SACLANT ASW Research Centre, New York.

3.g.2.

1970: Ball, J. R.

Determination of oceanic sediment porosity by electrical conductivity. Preprints 6th Mar. Tech. Conf. and Exposition, Mar. Tech. Soc., 2, 1475-1483.

240;

A Deep Ocean Sediment Probe has been built by the Navy Underwater Sound Laboratory in conjunction with the University of Rhode Island. The purpose of this probe is to gather in situ data about parameters of the oceanic sediment. One of the parameters of interest is sediment porosity. Since electrical conductivity is a volume effect, it should be possible to determine porosity from measurement of the sediment conductivity. Results of a study of the literature indicate that the relationship between conductivity and porosity for sediments is uncertain. Other problems of this technique include chemical effects and the actual volume of sediment measured.

11 refs.

U.S. Navy Underwater Sound Laboratory, New London, Connecticut.

3.g.3.

1970: Chmelik, F. B. and A. H. Bouma

Electrical logging in Recent sediments. Proc. Offshore Tech. Conf., 1, 49-56.

173; BIO

Electrical logging technology offers solutions to many problems involving recent sedimentary deposits. One of the more important of these concerns the time delay between the collection of a sample and the reduction and analysis to useable data. Electrical logs produce results on a real-time bsis thus allowing the operator to take quick action. Further, the availability of real-time data facilitates time-rate-of-change studies of sedimentary environments.

Subtle property differences between layers as thin as 0.5 cm can be easily resolved on both core and in situ logs. The ability to recognize these differences affords the operator a basis for choosing test and sample locations along cores. Comparisons of electrical logs and several physical property tests indicate that: 1) quantitative relationships exist between electrical and other properties of sediments, 2) logs can be used for determining the "weight" to be given to sample points, 3) logs can be used as a positive quality control on cores by identifying "missing" sections, and 4) logs can be used for the correlation of layers between core stations.

Electrical logging technology in sediment investigations find immediate application in several fields including: 1) pollution evaluation and control, 2) foundation evaluation for drilling platforms, pipelines, and other sea-floor construction work, and 3) evaluation of mining prospects. The problems of resolution, both in terms of layer thickness and layer properties, are being investigated. In situ probes operated in the vertical and horizontal modes are suggested as a means of reducing the time-on-location for any one job. Economically, the application of electrical logging technology, as an adjunct to present techniques in the investigation of sedimentary deposits, promises to significantly improve the cost effectiveness of such operations.

11 refs.

Texas A. and M. University, College Station, Texas.

3.g.4.

1970: Chmelik, F. B. and A. H. Bouma

New logging technique will speed ocean bottom surveys. Ocean Industry, 5(5), 56-59.

300; BIO

A test of an experimental 25-ft long electrical probe in the 9,000-ft-deep water of the Tyrrherian abyssal plain showed that in about 90 minutes of recording on the sea floor, 30 electrical profiles could be obtained. Comparison with cores taken at the ends of a traverse established the necessary factors for calculating values of porosity and density from the logs. The recovery of 30 cores from these stations would have taken about two weeks. Analysis for porosity and density would have required months. The test also demonstrated the value of the probe as a means of correlating horizons between stations.

Fig. 1 shows five resistivity logs taken 100 meters apart. The "formation factor" referred to on the illustration is the ratio of the resistivity of the saturated sediments to the resistivity of the saturating water. The correlation between the profiles is readily apparent. Maximum resolution for this probe was 5 cm as determined by its electrode spacing.

Indications have been found that the electrical properties of sediments may be related to other physical and engineering properties.

11 refs.

Texas A. and M. University, College Station, Texas.

3.g.5.

1971: Bouma, A. H., W. E. Sweet, Jr., F. B. Chmelik, and G. L. Huebner

Shipboard and in-situ electrical resistivity logging of unconsolidated marine sediments. Proc. Offshore Tech. Conf., 1, 253-268.,

030; BIO

The electrical logging project is designed to (a) develop quantitative *in-situ* and laboratory electrical logging hardware and techniques for measurements in unconsolidated sediments, (b) define the relationship between the electrical properties and the chemical, physical and engineering characteristics of sediments, and (c) develop computer models for reducing the electrical measurements to a variety of desired parameters. These techniques provide a rapid, accurate and inexpensive means of making sediment distribution and sediment property maps useful in research, pollution control work, offshore foundation work, and offshore mining. The costly and time-consuming coring programs now used for such work can be vastly augmented and, in many cases, replaced by electrical logging as long as a number of cores are collected for calibration purposes. Hardware and techniques are discussed and results obtained from an area in the Gulf of Mexico are presented.

13 refs.

Texas A. and M. University, Department of Oceanography, College Station, Texas.

3.g.6.

1971: Erchul, R. A. and V. A. Nacci

The use of electrical resistivity measurements to predict porosity of marine sediments. Proc. Int. Symp. Engng. Props. Seafloor Soils Geophys. Ident., 296-308.

272;

Investigations were made to determine if porosity of marine sediments could be accurately predicted from electrical resistivity measurements. Tests were conducted in the laboratory comparing electrical resistivity measurements of known sediments (sands, silts and clays) varying in porosity (35 to 90 parts per thousand). In all cases the electrical resistivity data had sufficient order to mathematically predict porosity to within ± 2 per cent. In addition, a proposed electrical resistivity measuring system for the DOSP, which would allow in-situ resistivity readings of marine sediments, is discussed.

14 refs.

Department of Ocean Engineering, University of Rhode Island, Kingston, Rhode Island.

3.g.7.

1972: Erchul, R. A. and V. A. Nacci

Electrical resistivity measuring system for porosity determination of marine sediments. J. Mar. Tech. Soc., 6(4), 47-53.

192; BIO

An electrical resistivity measuring system has been designed for measuring the in situ porosity of marine sediments, and this will be added to the Deep Ocean Sediment Probe. The electrode arrays measure small volumes of sediment both inside and outside the corer barrel. The electronic measuring system permits continuous conductivity readings through the water/sediment column. The FM multiplex telemetry system allows the conductivity (resistivity) data to be transmitted from ocean depths of 5000 feet. Laboratory tests of the system indicate that porosity can be predicted with ± 2 percent and that resistivity measurements can detect sample disturbance.

12 refs.

Department of Ocean Engineering, University of Rhode Island, Kingston, Rhode Island.

3.g.8.

1972: Kermabon, A. J.

Recent developments in deep sea electrical resistivity probings - its application to the sedimentary study of the Red Sea hot brines. Proc. Oceanology International Conf., 385-391.

330; BIO

The electrical resistivity probe has proved to be a useful tool to rapidly extrpolate results from cores; several cores are indispensable for geological studies, grain size analysis and calculation of the regression formulae essential for interpretation of the electrical logs.

The new guard electrode resistivity device is an improvement on the original equipment tested in the Tyrrhenian Sea. The resisitivity measurements are not affected by any bore hole effects, due to the method of probe penetration of the sea floor. Furthermore, the "distance to bottom" measuring device eliminates the bulky base plate used on the first instrument.

The probe is composed of an electronic container located in a frame terminated on its lower part by the probe extender and the electrode holder. The probe extender is composed of two steel tubes (drill collar type) completely electrically insulated inside and out by a special coating of fiberglass and epoxy resin. The electrode holder is composed of three insulated measuring electrodes located on the steel tube acting as a guard electrode.

The effect of using three electrodes instead of one presents the advantage of permitting a choice of measuring electrodes along the guard electrode. The distant reference electrode is located below the electronic container. The general dimensions of the probe are marked on the drawing.

The electronic container is able to swing freely round within its frame, allowing easy access to the inside circuitry without the necessity of employing heavy cranes or lifting systems.

7 refs.

COMEX Equipment, Marseille, France

3.g.9.

1974: Erchul, R. A.

Ocean Engineering applications for electrical resistivity techniques. Proc. Offshore Tech. Conf., 1, 733-739.

054; BIO

An electrical resistivity measuring system (ERMS) has been designed and built for the in-situ determination of marine sediment properties and engineering characteristics. The development of the ERMS resulted from extensive laboratory tests on the electrical properties of a wide variety of sediments (sands, silts, and clays) having porosity values from 26 to 93 percent. The laboratory data indicated that porosity predictions to within ± 2 percent were attainable by electrical resistivity techniques. In addition, the sediment particle size, distribution, and structure influenced the electrical resistivity measurement independent of porosity, while particle shape did not. To date, the ERMS has been used in the marine environment to predict and measure sediment type, porosity, water content, consolidation coefficients, and changes resulting from oil/gas and other pollutants. The system also had detected sediment core losses, bottom touchdown, and sample disturbance. In addition, the relatively inexpensive system could easily be adapted to temporal ocean-engineering applications such as monitoring scouring action and measuring erosion or deposition phenomena.

10 refs.

U.S. Navy

3.g.10.

1975: Jackson, P. D.

A new electrical method for evaluating the in-situ strength of marine sands? International Elect. Rad. Engs. Conf. Proc. no. 32, 301-310.

137; BIO

A technique is discussed where the in-situ electrical resistivity (measured in terms of apparent formation factor) is related to porosity using laboratory measurements, a sample from the sea-floor being re-constituted in the laboratory until it exhibits the same resistivity as it did in-situ. It is shown that in this condition the sample is expected to exhibit the same values of selected strength parameters as it did in-situ.

24 refs.

Marine Science Laboratories, Menai Bridge, Anglesey, U.K.

3.g.11.

1975: Jackson, P. D.

An electrical resistivity method for evaluating the in-situ porosity of clean marine sands. Mar. Geotech., 1(2), 91-115.

180; BIO

A well-known parameter in electrical bore-hole logging is the formation factor (formation resistivity/pore-water resistivity) and its relationship to formation porosity (or void ratio). This in turn can be used to give an assessment of the foundation characteristics of a saturated sand. To use this relationship in marine sediment investigations, a device has been constructed which measures the resistivity of a seafloor sand by passing a focused current into the sediment from a superior position, rather than by physically penetrating the sediment with an electrode array which would inevitably produce a mechanical disturbance. At present, the investigated depth (which is a function of the size of the electrode array) relates to a zone within 0.5 m of the water-sediment interface. Knowing the sediment resistivity, the formation factor can be determined from a separate assessment of the pore-water resistivity. The formation factor is empirically related to the porosity of the sand by means of a graph prepared from measurements made in a formtion factor-porosity cell, which allows both parameters to be determined simultaneously throughout a range of packing conditions. From the determination of in-situ porosity the relative density of the sand can be subsequently calculated.

24 refs.

Department of Physical Oceanography, Marine Science Laboratories, University College of North Wales, Menai Bridge, Gwynedd, U.K.

3.h.l.

1965: Jennings, D., N. Cutshall, and C. Osterberg

Radioactivity: detection of gamma-ray emission in sediments in situ. Science, 148, 948-950.

259; BIO

A probe for measuring emission of gamma-rays in sediments in situ in water depths to about 35 meters was used to measure radioactivity in the Columbia River estuary and Oregon coastal areas. This technique offers some advantage over methods in which sediment samples are collected at sea and returned to the laboratory for radioanalysis.

9 refs.

Department of Oceanography, Oregon State University, Corvallis, Oregon.

3.h.2.

1965: Keller, G. H.

Deep-sea nuclear sediment density probe. Deep-Sea Res., 12, 373-376.

039; BIO

Considerable effort has been devoted to investigating the mass physical properties of submarine sediments in connection with sedimentation problems and the geological history of ocean basins. The increasing need for placing instrumentation on the sea floor has required knowledge of such properties as sediment shear strength, water content, and bulk density. Due to the numerous problems involved in conducting such investigations in the deep sea, it is highly desireable to obtain in situ measurements rather than crudely extracting sediment samples from their environment and subsequently making measurements in the laboratory at some later time.

In 1962 a request to the U.S. Atomic Energy Commission was made by the U.S. Naval Oceanographic Office to develop a nuclear probe capable of measuring sediment bulk density in the sea floor. The instrument, which uses scattered gamma rays to measure in situ sediment density profiles in water depth down to about 6-9 km, was later designed and built by the Lane-Wells Company under contract with the U.S. Atomic Energy Commission. Field tests were conducted by the writer and other personnel of the U.S. Naval Oceanographic Office with support from the Lane-Wells Company in June 1964. Bulk sediment densities from 1.0 to 2.0 g/cm^2 can be accurately measured to ± 1 per cent with this device.

14 refs.

U.S. Naval Oceanographic Office, Washington, D.C.

3.h.3

1965: Keller, G. H.

Nuclear density probe for in place measurement in deep-sea sediments. Trans Jt. Conf. Mar. Tech. Soc. and Am. Soc. Limnol. and Oceanog., I, 363-372.

200; BIO

A nuclear sediment density probe has been developed for in situ measurement of bulk sediment density in the deep-sea floor. Measurement is based on the scattering of gamma rays from a radioactive source contained in the probe. The intensity of the backscatter is detected by a Geiger counter assembly and recorded photographically by a camera in the instrument. Sediment density is directly correlated with the amount of backscatter. After the probe has penetrated the sea floor the source and detector automatically move vertically within the lower barrel of the probe thus obtaining a density profile. Approximately 60 stations can be occupied during a single lowering of the device. The self-contained probe is about 26 feet long and weighs approximately 700 pounds in air.

17 refs.

U.S. Naval Oceanographic Office, Washington, D.C.

3.h.4.

1967: Preiss, K.

Nondestructive measurement of the water content and bulk density of sediment using radioisotopes. Marine Geotechnique, A. F. Richards, ed., Univ. of Illinois Press, Urbana, 307-318.

044; BIO

The paper reviews non-destructive methods of measuring bulk density and water content using radioisotopes.

Information is presented about sources and detectors of radiation, about health hazards, and about the interactions of gamma rays and neutrons with the atoms of sediment. The methods of bulk density measurement by gamma ray transmission and scattering, and water content measurement by neutron scattering, are described.

Consideration is given to errors in a reading due to inaccurate calibration, to the chemical composition of the sediment, to electronic instability and to the statistics of nuclear delay.

12 refs.

University of Illinois, Urbana, Illinois.

3.h.5.
1968: Preiss, K.

In situ measurements of marine sediment density by gamma radiation. _Deep-sea Res._, _15_, 637-641.

213; BIO

The apparatus consisted of a two-legged probe, one leg of which contained a gamma-ray source and the other a scintillation detector, attached to a 4-meter high tower. The tower was lowered from the ship at the end of a six-conductor armored cable until it stood on the sea floor; the probe was then pushed into the sediment by an electric motor and drive system. The apparatus was controlled from the ship. The detected count rate, which was a measure of density, was observed on the ship, and a profile of the density obtained as the probe was pushed into the sediment.

The probe is attached below the tower (Fig. 1). It consisted of two aluminum legs 51 mm (2 in.) o.d. and 44 mm (1.75 in.) i.d., held 267 mm (10.5 in.) apart by a stainless steel bridge piece.

One leg contained a tungsten alloy shield, within which was a source of 50 mc cesium-137. The cesium source was sealed in a stainless steel welded capsule, which had been pressure tested up to 70 kg/cm^2. A hole in one side of the shield permitted the radiation to penetrate through the sediment to the detector, while being shielded in other directions.

The second leg contained a scintillation detector, within a stainless steel pressure-resisting container. The detector included a sodium iodide crystal, 25 mm (1 in.) thick by 19 mm (0.75 in.) diameter, and a photomultiplier tube. The detector was connected by a single underwater coaxial cable to an electronic package, which was in a pressure-resisting aluminum container on the tower. The source and detector were arranged so that the center of the crystal was opposite the hole in the tungsten shield.

5 refs.

University of Illinois, Urbana, Illinois

3.h.6.

1969: Senftle, F. E., D. Duffey, and P. F. Wiggins

Mineral exploration of the ocean floor by _in situ_ neutron absorption using a Californium-252 (^{252}Cf) source. _J. Mar. Tech. Soc._, _3(5)_, 9-16.

287; BIO

A technique to show the feasibility of using in situ neutron irradiation followed by detection of neutron capture gamma radiation for marine mineral exploration is described. Californium-252 is the source of neutrons, and a germanium lithium drifted crystal is the gamma ray detector. The technique was used to obtain spectra of marine manganese nodules and gold ore (0.3 oz/ton) in a simulated marine environment. A device for such marine exploration is proposed based on the results of the experiments.

13 refs.

U.S. Geological Survey, Washington, D.C.

3.h.7.

1970: Wiggins, P. F., F. E. Senftle, and D. Duffey

Geochemical mapping of the ocean floor using neutron capture gamma rays. Preprints 6th Conf. Mar. Tech. Soc., 2, 1165-1177.

293;

In the near future, man will look to the ocean floor for the treasure of minerals which at present remain hidden. The use of neutron capture gamma rays for identifying the elements present on the ocean floor is being investigated. With californium-232 neutron source and a lithium drifted germanium detector, Ge(Li), initial studies were conducted on pure elements to obtain the capture gamma spectral signature for several elements. The energy lines were used for elemental identification of marine samples. Experiments using an ocean bottom sample from a marine core and manganese nodules indicate that, with refinement, the neutron capture gamma ray method is feasible for marine geochemical mapping or mineral exploration. A small submersible can be used to implement the method.

9 refs.

U.S. Naval Academy, Annapolis, Maryland.

3.h.8.

1971: Rose, V. C. and J. R. Ronsy

A nuclear gage for in-place measurement of sediment density. Proc. Offshore Tech. Conf., 1, 43-52.

029; BIO

A nuclear gauge for measuring sediment density in place is being developed under an Atomic Energy Commission contract. This gauge will be added to the Deep Ocean Sediment Probe (DOSP), a multi-sensor system. The gauge uses a gamma radiation isotope source in a concurrent transmission and backscatter arrangement. Direct correlation with undisturbed cores and acoustic data from the DOSP is possible. An electrical resistivity sensor is being added and will provide additional in place data for correlation. Results of testing both laboratory and prototype design configuration are presented.

Transmission gages are usually superior to backscatter gauges but require a two probe fork arrangement which is more difficult to force into sediments than a single probe backscatter type arrangement. In the design presented, the backscatter gauge arrangement has been optimized to approach transmission results by special design of radiation shields around the isotope source and radiation detector and by the design of energy level discriminating circuits in the instrumentation. This design limits the zone of material sensed to a well defined volume and avoids variations in readings resulting from changes in chemical composition of the sediment.

11 refs.

University of Rhode Island, Kingston, Rhode Island

3.h.9.

1972: Maus, L. D. and V. C. Rose

Gamma-ray backscattering for sea floor prospecting. Preprints 8th Conf. Mar. Tech. Soc., 403-414.

049; BIO

The theory of operation is discussed for a gage capable of real-time, *in-situ* measurement of the chemical composition of ocean sediments. This type of gage employs a radioisotope source of gamma rays and detects those gamma photons scattered by the sediment. By relatively simple processing of the output of a gamma-ray detector in the gage, both the density and the equivalent atomic number (Z_{eq}) of the sediment can be measured. It is shown that many economically important minerals are found in deposits which would be detectable as areas having high Z_{eq} values.

16 refs.

Ocean Engineering Department, University of Rhode Island, Kingston, Rhode Island.

3.h.10.

1974: Richards, A. F., T. J. Hirst, and J. M. Parks.

Bulk Density-water content relationship in marine silts and clays. J. Sed. Petrology, 44, 1004-1009.

117; BIO

Bulk density and water content are defined and then related to one another and to void ratio by 7 polynomial regression equations based on 1680 measured bulk density and water content values of water-saturated sediments from the Atlantic and Pacific Oceans and other areas. Theoretical relationships between bulk density, water content, and void ratio for specific gravities between 2.30 and 2.85 are demonstrated. The average specific gravity of 2.72 found for the data presented compares favorably to similar values reported in the literature.

Use can be made of the regression equations to compute e log p sedimentation-compression curves entirely determined from the bulk density of water-saturated sediment measured nondestructively by laboratory or in situ nuclear transmission densitometers. In an example showing the consolidation of a fine-grained calcareous sediment from the Exuma Sound, Bahamas, the all-nuclear laboratory method compares favorably with the conventional, non-nuclear method of constructing e log p curves. The combination of suitable regression equations and the all-nuclear method is equally applicable to other fine-grained water-saturated sediments.

33 refs.

Lehigh University, Bethlehem, Pennsylvania.

3.h.11.

1975: Hirst, T. J., M. Perlow, Jr., A. F. Richards, B. S. Burton, and W. J. vanSciver

Improved <u>in situ</u> gamma-ray transmission densitometer for marine sediments. <u>Ocean Engng.</u>, <u>3</u>, 17-27.

119; BIO

The first-generation University of Illinois gamma-ray transmission densitometer, designed for the in situ measurement of sediment bulk density, was modified by incorporating in the detector probe (1) an Americium-241 alpha particle pulser and an anti-walk gain stabilization control to maintain better temperature stability and (2) a small power supply and an IC external signal conditioning electronics package. This second-generation Lehigh University system has been successfully deployed since 1971 in routine use from ships and submersibles in the Atlantic and Pacific Oceans and the Gulf of Mexico. Results are presented of system operations to (1) measure bulk density over the range of 1.2-1.8 Mg/m^3 in the Hudson Canyon, (2) penetrate 1.9 m into the seafloor in the San Diego trough and, (3) be lowered to a water depth of 3.6 km in the Gulf of Mexico.

33 refs.

Marine Geotechnical Laboratory, Lehigh University, Bethlehem, Pennsylvania.

3.i.1.

1968: Lai, J. Y., A. F. Richards, and G. H. Keller

In place measurement of excess pore pressure in Gulf of Maine clays. Am. Geophys. Union Trans., 49, 221, (abstract).

221; BIO

A differential piezometer probe was built at the Norweigian Geotechnical Institute in 1966 to investigate whether pore-water pressures greater or lesser than hydrostatic actually exist in Recent marine sediments. The pressure of pore water, admitted through a porous stone located at the tip of the probe, is measured by a bourdon tube. An adjacent bourdon tube measures hydrostatic water pressure. Each tube is spanned by a vibrating wire. The two tubes are connected together in such a manner that when a difference of fluid pressure exists between the tubes the chord length of the wire changes, causing a change in the vibration frequency. The amplified signal is telemetered over an electrical cable to the ship, where it is read out on an electronic counter. This probe is designed to operate in water depth to 500 meters (total fluid pressures of 50 kg/cm^2) and to penetrate a maximum of 20 meters into bottom sediments. Results from the 1967 tests in the Wilkinson Basin, Gulf of Maine were that: (1) the ship could be positioned without anchoring about 250 meters above the probe for extended periods of time without much difficulty; (2) about 12 hours were required for the dissipation of excess pore pressure caused by driving the probe about 4 meters below the bottom; and (3) a small amount, about 0.1 kg/cm^2, of excess pore pressure was measured, although it is uncertain whether this measurement is valid.

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University of Illinois, Urbana, Illinois.

3.i.2.

1975: Richards, A. F., K. Oien, G. H. Keller, and J. Lai

Differential peizometer probe for an in situ measurement of seafloor pore-pressure. Geotechnique, 25, 229-238.

356;

One successful in situ test in the Wilkinson Basin, in a water depth of 274 m, yielded a maximum excess pore-pressure of 59 kPa after the probe was driven about 3.2 m into the silty-clay bottom. An excess pore-pressure of 9.8 kPa was measured 5-10 h after emplacement of the probe. Implications of excess pore-pressures cyclically generated by storm and internal wave loading of seafloor soils is discussed. It is concluded that a better understanding of submarine slope stability through the use of the effective stress principle should now be possible by measuring pore-pressure in situ.

18 refs.

Lehigh University, Bethlehem, Pennsylvania.

3.i.3.

1977: Bennett, R. H.

Pore-water pressure measurements: Mississippi delta submarine sediments. Mar. Geotech., 2, 177-189.

204; BIO

A pore-water pressure probe (piezometer) was implanted in Mississippi delta sediments at preselected site (Block 28, South Pass area, 20°00'N, 89°15'W) 145 m from an offshore production platform (water depth approx. 19 m) in September 1975. Total pore-water pressures (u_w) were monitored for extended periods of time at depths of approximately 15 and 8 m below the mudline concurrently with hydrostatic pressures (u_8) measured at depths of 15 m and approximately 1 m below the mudline. Relatively high excess pore-water pressures, $u_e = (u_w - u_8)$ were recorded at the time of probe insertion measuring 99 kPa (14.4 psi) at 15 m and 50 kPa (7.3 psi) at 8 m. Six hours after the probe was implanted, excess pore pressures were still high t 81 kPa (11.8 psi, 15 m) and 37 kPa (10.4 psi, 15 m) and 32 kPa (4.6 psi, 8 m) prior to the initial effects of Hurricane Eloise, which passed in close proximity to the probe site. Significant variations in pressures were recorded during storm activity. As the effects of the storm subsided, excess pore-water pressures began to decline slightly at the 15-m depth; however concurrently at the 8-m depth, pore pressures began to increase gradually. During the period of 21-25 days after the probe was implanted, excess pore pressures appeared to become more constant, averaging 24 kPa (3.5 psi) at 15 m and 43 kPa (6.2 psi) at the 8 m depth. The presence of methane, a common occurrence in these delta muds, may have influenced, or contributed to the total pore-water pressures measured during this experiment.

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National Oceanographic and Atmospheric Administration--Atlantic Oceanographic and Meterological Laboratories, Miami, Florida.

3.i.4.

1977: Hirst, T. J. and A. F. Richards

In situ pore-pressure measurement in Mississippi delta front sediments. Mar. Geotech., 2, 191-204.

316; BIO

A differential piezometer was used to monitor excess pore pressure in the soft clayey seafloor sediments of Block 28, South Pass, Mississippi delta, from September 1975 to March 1976. An ambient excess pore pressure of about 32 kPa was measured at a depth of 6.4 m below the mudline in a water depth of 19 m. Storm-wave-generated cyclic fluctuations of ± 4 kPa about the ambient were measured during Hurricane Eloise. Irregular, long-period, small-amplitude fluctuations in excess pore pressures persisted for 4 days following the storm. An effective stress analysis was made by using excess pore pressures; in situ field vane-shear strength T_{FV}, measurements; and laboratory wet unit weights measured by Lehigh and NOAA.

The differential piezometer (Richards et al., 1975), which consists of two interconnected fluid-filled bourdon tubes connected to two vibrating-wire strain gauges, was hard-wired to a two-channel strip-chart recorder. Circuitry was arranged such that independent duplicate readings of excess pore pressure were monitored on each channel. Whereas the malfunction of any one circuit did not result in loss of data, only excess pore pressure was recorded and no measure of ambient pore pressure was possible. A companion paper by Bennett (1977) describes a concurrent investigation at the same site in which ambient pore pressure was measured.

The entire system was laboratory-calibrated over the anticipated pressure and temperature range prior to installation in the delta and after recovery from the delta. For both calibrations, the system exhibited very stable response characteristics. No significant differences between the "before" and "after" calibrations were observed, even though these calibrations were separated by 6 months of in situ operation.

7 refs.

Marine Geotechnical Laboratory, Lehigh University, Bethlehem, Pennsylvania.

3.i.5.

1978: Dunlap, W. A., W. R. Bryant, R. Bennett, and A. F. Richards

Pore pressure measurements in underconsolidated sediments. Proc. Offshore Tech. Conf., 2, 1049-1058.

028; BIO

Pore pressures in the sediment were measured at two locations in the East Bay area of the Mississippi delta. These measurements showed the sediment to be highly under-consolidated with the effective stress approaching zero even a significant depths below the mudline. During storms the pore pressures exhibited cyclic response to the wave-induced bottom pressures. In at least two instances the pore pressures increased significantly during storms, which is probably indicative of major sub-bottom movements.

Several different piezometers systems were utilized to make the pore pressure measurements. Each system is described in detail and the advantages and shortcomings of the systems with respect to measurements of pore pressures in the marine environment are presented.

Analysis of the data leads to the conclusion that pore gas, rather than pore water, pressure was measured in most instances even though in one set of experiments high air entry stones were utilized to exclude gas from the measuring system.

14 refs.

Texas A. and M. University, College Station, Texas

3.i.6.

1979: Bennett, R. H. and J. T. Burns

Discussion of "The development of in situ marine seismic and geotechnical instrumentaion systems." by E. W. Reece, et al., Proc. Port Ocean Engng. Arctic Conditions '79, 3, 362-365.

408; BIO

The following list briefly outlines expected advantages and potential problems of the Sandia Labs Geotechnically Instrumented Seafloor Probe (GISP) system. The instrument is self-contained and can thus be deployed in remote areas. State-of-the-art electronics allow miniaturization and flexible programming. The telemetry technique eliminates hard-wiring to ship or shore at continental shelf water depths. The pore pressure module can be replaced in the field prior to deployment. High data-rate capability allow measurement of dynamic pore pressures. The programmable power consumption allows the prediction of the life span of the sea floor data bank. Diver assistance is not required in deployment or actuation of the piezometer probe. Tilt meters determine the vertical orientation of the probe. The probe is limited to continental shelf depths. the large seafloor instrumentation package and five foot diameter "impermeable" plate may result in unpredictable effects on dynamic pore pressures due to surface wave activity. It would be useful to incorporate a triggering mechanism for monitoring pore pressures at rapid data rates during storms. Development of less expensive systems would be more attractive to research-oriented institutions. The Delrin pore pressure module may be subject to biodegradation due to borers and chemical "aging" in sea water.

6 refs.

Atlantic Oceanographic and Meterological Laboratories, National Oceanic and Atmospheric Administration, U.S.A.

3.i.7.

1980: Fredericks, R. G. and J. T. Wells

High-precision instrumentation system for sea-bed pressure measurements in muddy sediments. Conf. Record Oceans '80 (IEEE), 226-230.

043; BIO

A high-precision system for measuring pressure variations in fine-grained sediments has been developed using quartz- oscillating pressure transducers and digital data-handling techniques. This instrument has the important feature of being capable of monitoring remotely both mean and fluctuating components of near-bottom or subbottom sediment density variations and at the same time obtaining a time history of surface water waves and tidal elevation changes. Utilizing this system, we expect to be able to resolve density variations of 0.001 g/cm^3 and, with the addition of a porous ceramic stone, to detect pore-water pressure variations of 100 $dynes/cm^2$.

3 refs.

Coastal Studies Institute, Louisiana State University, Baton Rouge, Louisiana.

3.j.1.

1961: Ewing, J. and M. Ewing

A telemetering ocean-bottom seismograph. <u>J. Geophys. Res.</u>, <u>66(11)</u>, 3863-3878.

398; BIO

Successful tests of a telemetering ocean-bottom seismograh have been made on three occasions. In all cases, the seismograph was resting on the ocean bottom or planted in the sediments, sending its information to the surface by frequency modulation of a supersonic beam. The use of cables connecting the instrument on the bottom to the recording ship was avoided so that the level of background noise would not be influenced by shaking the instrument by a long cable. These first tests were designed to help determine what frequencies should be recorded, at what levels, and what method is best for transmitting to the recording instrument at the surface the earth's vibration in these frequencies. Neither the instrument used nor the method was the optimum for obtaining all of the seismological data from the ocean bottom, but they have demonstrated the feasibility of ocean-bottom seismographs and have helped to determine the criteria for the more complicated instruments and methods of transmittal which will ultimately make up a world-wide system. Data from such a system are expected to settle the question of the origin and propagation of microseisms, provide detailed information about the sedimentary layer and about the earth's crust and upper mantle, and, most important of all, may greatly increase the radius over which a single station can monitor small earthquakes or explosions. This will materially increase our ability to investigate the seismicity of the entire earth and also to monitor nuclear explosions.

In the preliminary tests body waves from one earthquake and several seismic refraction profiles were recorded. The earthquake record indicates reasonably good signal-to-noise ratio in the short-period range. The refraction profiles give indications from P and S waves of important regional and local variations in the character of the crust-mantle interface.

9 refs.

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

3.j.2.
1964: Bradner, H.

Seismic measurements on the ocean bottom. Science, 146, 208-216.

416; BIO

The concern with bomb test detection led, in 1960, to additionl government support of related programs at Columbia and by groups at the University of California's Institute of Geophysics and Planetary Physics and at the Texas Instrument Company, Dallas, Texas. In 1961, the data on ocean-bottom seismic background was meager, and information on signal-to-noise ratios was essentially nonexistent. The prevailing view was that the ocean basins might provide a very quiet environment for monitoring explosion signals. An opposing view was that the ocean basins might be more noisy than land if the microseism background is generated at sea, far from shore. The source and propagation of microseisms have been investigated for half a century, but are still being actively debated. The group at the Institute of Geophysics and Planetary Physics undertook a study of microseism; the Texas Instruments Company group gave special attention to signals from earthquakes and explosions.,

With apparatus developed for ocean-bottom seismic recording, earthquakes have been observed, propagation velocities have been measured, microseism noise has bee studied, and it has been determined that signal-to-noise ratios may allow the monitoring of bomb tests.

17 refs.

University of California, Institute of Geophysics and Planetary Physics, La Jolla, California.

3.j.3.

1965: Nagumo, S., H. Kobayashi, and S. Koresawa

Construction of ocean bottom seismograph. Bull. Earthquake Res. Inst. Tokyo Univ, 43, 671-683.

427; Dalhousie

The camera is the heart of this kind of recording instrument. This is of 4 channels with optical 16 mm film recorder, of which techniques have been developed by Professor Kishinouye. The output of the amplifier is led to the galvonometer and is recorded in the 16 mm film. One month recording of seismic signals of three components requires a film 1200 ft long, even though the speed is limited to 7.5 mm/min. In order to put such long film into the pressure vessel, we divided it into two, namely, we used a double-spool system, each one being 600 feet long. The conventional alignment of galvanometer and film spool is folded back into one to allow it to be put into the cylinder of the pressure vessel. In order to increase the stability of the galvo image on the 16 mm film, the optical path length is shortened, and low sensitivity of galvanometer is adopted. The lamp of light source is specially made with a very narrow filament and very low power consumption. The width of filament winding is 0.075 mm, and the power required for recording is as low as 6 mA. The two lamps with common mirror system are used instead of a single lamp with double mirror system.

The slow driving of the film is performed by a sprocket which is connected to the governor controlled micromotor through gears. The four speeds are available by changing the connecting gear. The maximum speed is 1 mm/sec and it runs for four days. then we have speeds of 1/2, 1/4 and 1/8 of the maximum one. the slowest speed gives us one month recording. The four-speed system is favorable for independent use of this camera as a long recorder for other seismic observations.

6 refs.

Earthquake Research Institute, Tokyo University, Tokyo, Japan.

3.j.4.

1965: Sutton, G. H., W. G. McDonald, D. D. prentiss, and S. N. Thanos

Ocean-bottom Seismic Observatories. Proc. IEEE, 53, 1909-1921.

428; Dalhousie

Observations of seismic motion and other geophysical parameters on the ocean bottom over extended periods of time and over a wide range of frequencies (periods) provide information on the suitability of the ocean bottom as a site for the detection of seismic events. Instrument systems consisting of long- and short-period seismographs, long- and short-period pressure sensors, a temperature sensor, and a water-current sensor were operated on the ocean bottom. Experience and calculation indicate that these systems can be well coupled to the sediment surface, mechanically stable, and relatively insensitive to water currents. Local and distant earthquakes, tides, microseisms (3-8 seconds period), long-period (2-6 minutes period) pressure disturbances, and temperature fluctuations have been well recorded from the ocean bottom at depths greater than 2000 fm. Instrument systems were implanted at two locations: south of Bermuda (2400 fm depth, seismic measurements only) and west of San Francisco (2200 fm depth). Data were telemetered acoustically to a ship (Bermuda) and via deep-sea cable to a shore station (California). Results to date indicate that the ocean bottom can be a favorable location for the detection of seismic events.

12 refs.

Lamont-Doherty Geological Observatory, Palisades, New York.

3.j.5.

1966: Latham, G. V. and G. H. Sutton

Seismic measurements on the ocean floor. J. Geophys. Res., 71(10), 2545–2573.

397; BIO

A seismograph system was placed on the ocean floor of 65 km south of Bermuda in May 1964, at a depth of 4.3 km. Instrumentation consisted of three long-period seismometers (natural period = 15 sec) and one short-period vertical-component seismometer (natural period = 1 sec). Data were telemetered acoustically to a shipborne receiver for 8½ days. This experiment represents the first successful attempt to operate long-period seismographs on the ocean floor.

On the basis of the model used to represent the structure at the ocean-bottom site, for a given energy flux, removal of the unconsolidated sediment layer reduces the theoretical partical-motion amplitude of the water-solid interface by factors of 8 and 94 for the vertical and horizontal components, respectively. Such reduction in background level would make the ocean-bottom site an order of magnitude quieter than the station on Bermuda. This result indicates the possible advantages of locating instruments at sediment-free sites on the ocean bottom.

54 refs.

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

3.j.6.

1967: Rykunov, L. N. and V. V. Sedov

An ocean-bottom seismograph. Isv. Phys. Solid Earth, 8, 537-541. (trans. from Izv., Earth Phys., #8, 83-87, 1967).

421; BIO

In 1962, the development and application of ocean-bottom seismometer equipment were begun in the Faculty of Physics of the University of Moscow. Trials in the ocean and the use of this equipment in certain applications (study of bottom noise, deep seismic sounding, and the recording of weak earthquakes) lead to an improvement of the original design and of the operation. Now a modified version of the ocean-bottom seismograph has been built. This model can be used for a large number of marine seismic studies. This article gives a description of the equipment (DS-1-F) and treats some problems related to its application.

11 refs.

Faculty of Physics, Moscow State University, Moscow, U.S.S.R.

3.j.7.

1970: Whitmars, R. B.

An ocean bottom pop-up seismic recorder. Mar. Geophys. Res., 1, 91-98.

386; BIO

Until fairly recently however suitable buoyant instrument housing to hold the seismic recorder, which could withstand the hydrostatic pressures encountered at oceanic depths, were not available. A previous attempt to make use of such an equipment had to be confined to using it only on the continental shelf (Whitmarsh, 1967, 1968). This paper describes a pop-up bottom seismic recorder (P.U.B.S.) which has been built at the National Institute of Oceanography and successfully used on two cruises.

The instrument housing consists of two 28 inch external diameter hemispheres of forged aluminum alloy (Hiduminuim RR77) (Figure 1). The hemispheres are separated by an equatorial ring of the same material to which the hemispheres are bolted by means of flanges around their circumference. Two 'O' rings held in grooves on either side of the equatorial ring provide the water excluding seal. The wall thickness of the hemispheres is 1.25 inches and they are designed to withstand the hydrostatic pressure at a depth of 6100 m (9000 p.s.i.) with a safety factor of 1.25.

A strong framework of free flooding aluminum (HE 30) tubes encloses the sphere and is bolted onto the equatorial ring. This framework serves to provide lifting points and a base on which various transducers can be mounted. It also protects the sphere from damage especially while the sphere is being launched and recovered at sea.

The buoyancy of the empty sphere in sea water is 109 pounds. The total weight of the equipment when prepared for an experiment is about 550 pounds in air and it has a net buoyancy of about 37 pounds in the sea. A 100 pound cast iron ballast weight is used to sink the sphere. The free fall and ascent velocities in the sea lie between 0.8 and 0.9 m/sec.

17 refs.

National Institute of Oceanography, Wormely, Surrey, England.

3.j.8.

1973: Carmichael, D., G. Carpenter, A. Hubbard, K. McCamy, and W. McDonald

A recording ocean bottom seismograph. J. Geophys. Res., 78, 8748-8750.

396; BIO

The package free-falls with 36 kg of negative buoyancy (drop velocity of 1.7 m/sec), ensuring good coupling with the sea floor. No damage to system components was observed at this impact velocity. At the end of the recording period a timed release mechanism jettisons the footpads and 50-kg lead ballast, allowing the instrument to rise to the surface with about 9 kg of positive buoyancy (rise velocity of 0.55 m/sec). Recovery is aided by the usual combination of flags, radio beacons, flashers, and day-glo paint. The package is light enough (200 kg) to be handled with the ship's hydrographic winch.

The system electronics are housed in a 0.6-meter-diameter aluminum sphere with electrical feed-throughs for external sensors. A crystal-controlled time code generater (TCG) produces a 2-pulse/sec Irig-C format time code, identifying each minute with day, hour, and minute codes. The TCG also supplies a 640-Hz carrier for tape speed compensation. The three data channels (hydrophone and vertical and horizontal seismometers) are preamplified, compressed, frequency-modulated, and recorded on a modified four-channel entertainment-type tape recorder.

Power is furnished by rechargeable lead-acid cells. Tape reel capacity and limited battery output restricted the operating life of the instrument to just over 12 hours. It is expected that subsequent system improvements will extend this life to about 10 days.

The seismometers are housed within the sphere and are 2-Hz Sprengnether geophones. The system also uses an external hydrophone that is a standard low-frequency pressure-compensated piezoceramic unit. Total system passband is 2-120 Hz.

4 refs.

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

3.j.9.

1974: Prothero, W. A., Jr.

An ocean-bottom seismometer capsule. Bull. Seism. Soc. Am., 65(4), 1251-1262.

399; BIO

An ocean-bottom seismometer capsule containing a 1-Hz vertical seismometer and triggered digital recording system has been developed and tested off the coast of San Diego. The output of the seismometer is continuously digitized at 64, 128, or 256 samples per second. The digital data is mixed with a time code and passed through a 256 sample shift register which acts as a delay line. It is then mixed with synchronization characters, serialized, encoded, and recorded on a SONY TC800B tape recorder which is turned on when a seismic event occurs. The event trigger occurs when the seismic signal jumps to at least twice the time-averaged input signal. Data are recovered using the same recorder for playback and a decoder which provides an analog output for field data interpretation or a digital output for computer analysis. The capsule itself falls freely to the ocean bottom. After a predetermined time it is released from a 150-lb. steel tripod and floats to the surface. A dual timer and explosive bolt system provides a high recovery reliability. A number of seismic events have been measured in field tests and the system has proven to be extremely simple to check out, diagnose, and deploy.

8 refs.

Institute of Geophysics and Planetary Physics, University of California at San Diego, La Jolla, California.

3.j.10.

1975: Francis, T. J. G., I. T. Porter, R. D. Lane, P. J. Osborne, J. E. Pooley, and P. K. Tompkins

Ocean bottom seismograph. <u>Mar. Geophys. Res.</u>, <u>2</u>, 195-213.

384; BIO

The ocean bottom seismograph described in this paper has been developed primarily for recording earthquakes on the mid-oceanic ridges. The instrument is suitable for dropping onto the most rugged areas of the ocean floor. Acoustic tracking with the ship's precision echo sounder enables it to be located there relative to both the topography of the sea bed and the ship. The outputs of a 3-component seismometer and a hydrophone are recorded in FM form on a low-power magnetic tape recorder designed specifically for the instrument.

16 refs.

Institute of Geological Sciences, Brimpton, Reading, England.

3.j.11.

1976: Cranford, M. D., S. H. Johnson, J. E. Bowers, R. A. McAlister, and B. T. Brown.

A direct-recording ocean-bottom seismograph. Bull. Seism. Soc. Am., 66(2), 607-615.

400; BIO

A direct-recording ocean-bottom seismograph featuring small size and low cost has been constructed and operated in the deep ocean. The design consists of a cylindrical instrument package 15 cm in diameter and 53 cm long. Signals from a gimbal-mounted 2-Hz vertical geophone and a hydrophone are amplified and direct-recorded at different gain levels on three channels of 6.4-mm wide magnetic tape. BCD-coded time pulses, generated from a crystal oscillator signal, are recorded on the fourth channel. The instrument has its maximum displacement response at 17 Hz. Tape consumption is 22 m/day (0.01 ips) from 12.7-cm reels permitting continuous recording for up to 12.5 days. CMOS electronics are used throughout and, together with a low-power tape drive motor, the unit requires less than 100mW of power. This permits long recording times from 9 D-cell alkaline batteries. Syntactic foam flotation, good to 6400 m, permits a low-profile design 1.0 m long and 0.7 m high. It weighs 114 kg in air and descent and rise rates are 0.64m/sec. For retrieval, an expendable base plate is released by a cable cutter on command from a clock comparator circuit. Data playback is at 10 to 100 times recorded speed.

9 refs.

School of Oceanography, Oregon State University, Corvallis, Oregon.

3.j.12.

1976: Lister, C. R. B., and B. T. R. Lewis

An ocean-bottom seismometer suitable for arrays. Deep-Sea Res., 23, 113-124.

385; BIO

We have developed a cheap and simple three-component ocean-bottom seismometer. One vertical and two horizontal seismometers are levelled in a boat floating on thick silicone oil in the lower half of a buoyant spherical pressure case. Signals are compressed by recording the bipolar square root directly on magnetic tape moving at 1 mm s^{-1}. The nominal bandwidth is 2 to 100 Hz, and a special 24-cm reel of tape will run for 500 h. Fast emplacement is obtained by lodging the buoyant spheres in heavy flower-pot shaped concrete anchors that have stable descent characteristics. Five successful drops have been made with two prototypes in epoxy resin spheres, and clear arrivals from shots and earthquakes have been received.

9 refs.

Department of Oceanography and Geophysics, University of Washington, Seattle, Washington.

3.j.13.

1977: Blackinton, J. G. and M. E. Odegard

An ocean bottom seismograph using digital telemetry and floating-point conversion. IEEE Trans. Geosci. Electronics, GE-15(2), 74-82.

357; BIO

An ocean bottom seismograph (OBS) using digital telemetry to convey eight channels of information to a shore station through 10 km of single-conductor armored cable was installed July 27, 1976 at a depth of 600 m off the northeastern coast of Oahu, Hawaii. Power for the OBS is supplied by the shore station through the same cable. A floating-point scheme requires only 12 bits for the digitization of each channel within a 108-dB dynamic range. The eight channels are each sampled at 70/g rate and include: 1) the outputs from three orthogonal 1-Hz geophones; 2) a crystal hydrophone output; 3) a rectified output from the same hydrophone in the 500-1500-Hz band; 4) a temperature and water current sensing thermistor; and 5) two system test channels. The geophones are mounted in self-leveling gimbals with brakes which are released three times each day. A calibration signal is also applied to each geophone calibration coil three times a day. The OBS has recorded on the average two events a day, 70 percent of which are of apparent local origin, and 20 percent of which are apparently earthquakes originating near the island of Hawaii. The digital telemetry scheme enables direct computer connection and digital recording. Using these digital records, ocean noise spectra have been computed and correlated with temperature and current records.

6 refs.

Hawaii Institute of Geophysics, University of Hawaii at Manoa, Honolulu, Hawaii.

3.j.14.

1977: Byrne, D. and W. Ichinose

Ocean bottom seismometer gimbal systems. Exposure, 5(5), 1-7.

358; BIO

The Hawaii Institute of Geophysics (HIG) has developed two major exploration ocean bottom seismoter (OBS) systems. One operates as a free vertical pop-up ocean bottom seismometer (POBS) and the other is a larger, tethered, ocean bottom seismometer (TOBS). In both instruments it is necessary to maintain proper orientation of the geophones while the instrument is maintained by gimballing the geophones.

5 refs.

Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii.

3.j.15.

1977: Francis, T. J. G. and I. T. Porter

Experience gained with the Blacknest ocean bottom seismograph. Mar. Geophys. Res., 3, 143-150.

392; BIO

A paper describing the design, construction and operation of the Blacknest ocean bottom seismograph (OBS) has recently been published (Francis, et al., 1975). The purpse of this paper, written approxiately two years later, is to bring the reader up to date with the experience we have gained in operating this type of instrument. In addition a number of other items are included which may be helpful to people about to embark on the design and construction of their own instrument.

8 refs.

Institute of Oceanographic Sciences, Blacknest, Reading, England.

3.j.16.

1977: Langford, J. J. and R. B. Whitmarsh

Pop-up bottom seismic recorder (PUBS) of the Institute of Oceanographic Sciences, U.K. Mar. Geophys. Res., 3, 43-63.

387; BIO

A pop-up bottom seismic recorder designed for seismic refraction experiments was built by the Institute of Oceanographic Sciences in 1968. The device is housed within a 71 cm diameter sphere weighing 270 kg when launched. Signals picked up by a hydrophone are recorded in analogue form on magnetic tape in the band 2-100 Hz. The total continuous recording period is 12 hr but the lifetime of the system can be effectively extended by cycling the tape-recorders to allow shooting to go on for up to 3 days. Ballast release is by acoustic command or by pre-set clock. The instruments have been used in water depths from 150 to 4820 m making a total of 63 deployments with a 95% recovery rate. A new version with three-component geophones is being built.

15 refs.

National Institute of Oceanography, Wormley, Surrey, England.

3.j.17.

1977: Johnson, R. V., C. R. B. Lister and B. T. R. Lewis

A direct recording ocean bottom seismometer. Mar. Geophys. Res., 3, 65-85.

388; BIO

We have designed a simple, cheap and reliable ocean-bottom seismometer. Signals from three-component geophones are recorded directly on magnetic tape running continuously at a speed of 1 mm s^{-1}. Time reference is derived from a temperature-compensated quartz crystal oscillator and encoded on a fourth channel as an amplitude modulation of 20 Hz carrier. A bipolar square-root signal-compression scheme doubles the tape dynamic range to 80 db, and the available bandwidth is 2 to 100 Hz. Tape and batteries are capable of 500-hr operation, and the unique magnetic release comes close to being a fail-safe system. A heavy, high-drag concrete anchor shaped like a flower-pot provides easy launching, fast stable descent and good coupling to the ocean floor. We have had numerous successful field emplacements which have yielded good earthquake and shot-refraction data.

4 refs.

Department of Oceanography, University of Washington, Seattle, Washington.

3.j.18.

1977: Johnson, S. H., M. D. Cranford, B. T. Brown, J. E. Bowers, and R. E. McAllister.

A free-fall direct-recording ocean bottom seismograph. Mar. Geophys. Res., 3, 103-117.

390; BIO

A compact and relatively low-cost ocean bottom seismograph has been constructed for use in marine seismic research. The instrument is deployed as a free-fall package and can record for 12.5 days. Signals from a vertical geophone, a hydrophone, and a clock are direct recorded on four channels of 635×10^{-3}m magnetic tape. A time-release system returns the instrument to the surface.

10 refs.

School of Oceanography, Oregon State University, Corvallis, Oregon.

3.j.19.

1977: Mattaboni, P. J. and S. C. Solomon

MITOBS: a seismometer system for ocean-bottom earthquake studies. <u>Mar. Geophys. Res.</u>, <u>3</u>, 87-102.

389; BIO

The MIT ocean-bottom seismometer is a free-fall, pop-up instrument capable of recording three components of seismic data on the sea floor for periods of at least one month. Data are recorded in digital format on a specially designed magnetic tape recorder. An event recording scheme and semiconductor memories assure both efficient data storage and preservation of first motion information. Sensors and recording electronics are housed in a cylindrical pressure vessel, which sits vertically atop an expendable base plate on the ocean bottom. Attached to the pressure case are three glass spheres for buoyancy. After a pre-set time interval, a motor-driven mechanical latch release frees the instrument to float to the ocean surface for recovery.

1 ref.

Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts.

3.j.20.

1977: McDonald, W. G., A. C. Hubbard, R. G. Bookbinder and K. McCamy

Design and shipboard operation of a multipurpose ocean bottom seismograph. Mar. Geophys. Res., 3, 179-196.

394; BIO

Ocean bottom seismographs designed to meet the requirements of both seismicity and refraction experiments have been operated extensively on twelve cruises (72 deployments). Signals from a hydrophone, and two geophones (horizontal and vertical) are direct recorded on a modified commercial tape recorder providing 10 day continuous recording at 1/40 ips and a 2-80 Hz band width. The free-fall deployment technique with timed ballast release has yielded a 93% recovery rate (96% over the most recent 24 deployments) despite frequently difficult weather and sea conditions. Emphasis on reliability and operational simplicity has produced an instrument that can be operated in arrays by a single shipboard technician.

5 refs.

Lamont-Doherty Geological Observatory of Columbia University,
Palisades, New York.

3.j.21.

1977: Prothero, W. A., Jr.

A digital event-recording ocean bottom seismometer system. Mar. Geophys. Res., 3, 119-141.

391; BIO

The ocean bottom seismometer capsule contains a 1 Hz. vertical seismometer and triggerable or programmable digital recording system. The output of the seismometer is continuously digitized at a preselected rate of 64, 128, or 256 samples/sec. The digital data words are mixed with a time code and synchronization characters, serialized and passed through a 1536 sample shift register which acts as a delay line. The serial output bits are then encoded and recorded on a SONY TC800B tape recorder which is turned on when a seismic event occurs. The event trigger occurs when the seismic signal jumps to 8 times the time averaged input signal. A memory may be programmed to run the recorder on a schedule so that small amplitude signals from refraction shots are sure to be recorded. Data are recovered using the same recorder for playback and a decoder which provides and analog output for field data interpretations or a digital output for computer analysis. An acoustic transponder allows precise ranges between the capsule may be given from the surface ship. The capsule falls freely to the ocean bottom. After a predetermined time or when a release command is received, it is released from a 68 kg steel tripod and floats to the surface. A dual time and explosive bolt system is used to increase recovery reliability.

The first capsules were designed and constructed between October 1972 and October 1973. Good results were obtained from 38 out of 43 launchings made on six expeditions in 1974, 1975 and 1976. Four capsules have been lost.
8 refs.

Scripps Institution of Oceanography, La Jolla, California.

3.j.22.

1977: Sutton, G. H., J. Kasahara, W. N. Ichinose, and D. A. Byrne

Ocean bottom seismograph development at Hawaii Institute of Geophysics. Mar. Geophys. Res., 3, 153-177.

393; BIO

Three distinct ocean bottom seismograph (OBS) systems have been developed at the Hawaii Institute of Geophysics to satisfy the different requirements for short-range refraction and anistropy experiments, long-range refraction experiments, and short-term and semipermanent monitoring for earthquakes. One system, originally designed for semi-permanent use in conjunction with a monster buoy of the IDOE North Pacific Experiment has been modified for emplacement off Oahu. It contains 3-component 1 Hz seismometers and a hydrophone and obtains power and transmits data via two conductor cable. Two additional systems were designed for short-term use: a 2 Hz telemetering system (TOBS); and 4.5 Hz free-fall pop-up system (POBS). The TOBS contains 3-component seismometers and a hydrophone and transmits data to the ship via light-weight single-conductor electromechanical cable and an HF-VHF radio link from a surface buoy. The bottom package also includes a backup tape recorder. This system exhibits the advantages of real-time data acquisition (e.g. precise timing, rapid appraisal of data quality, optimum use of explosives, and common recording with other data) and the complexities and difficulties associated with a deep-sea mooring. However, use of cable with near neutral buoyancy permits the design of a deep-water system with low weights and stress levels. The POBS is a self-contained package containing a vertical and single horizontal seismometer, hydrophone, cassette tape recorder, and pre-set timed release. This system is relatively simple and inexpensive. Total weight of 150 kg in air (before launch) permits emplacement and retrieval from a ship with no special equipment by two (strong) persons. Experience to date suggests that the optimum deployment scheme for many studies is a combination of TOBS's and POBS's.

19 refs.

Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii.

3.j.23.

1978: Avedik, F., V. Renard, D. Buisine, and J.-Y. Cornic

Ocean bottom refraction seismograph (OBRS). Mar. Geophys. Res., 3, 357-379.

395; BIO

This paper describes a pop-up ocean bottom seismograph designed primarily for refraction surveys both on the continental shelf and in deep sea. Its development is the extension of our system based on seismic detectors located on the sea floor with radio transmission of seismic signals and used for seismic refraction studies on the continental shelf. The seismic detectors (vertical geophone or hydrophone and two orthogonally mounted horizontal geophones) are located outside of the pressure vessel on the main frame. Optionally, the seismic sensors may be decoupled from the main frame assembly. This decoupling is performed by a mobile arm positioning the separate three component sensor package on the sea floor.

13 refs.

Centre Océanologique de Bretagne, Brest.

3.j.24.

1978: Ryerson, D. E. and E. W. Reece

The development of a seafloor earthquake measurement system. Conf. Record Oceans '78 (IEEE), 692-695.

366; BIO

A Seafloor Earthquake Measurement System is being developed at Sandia to measure marine sediment response to seismic activity. The system will use an acoustic telemetry system to transmit commands to and collect data from the seafloor package. The seafloor package contains a microprocessor which controls the data collection, data processing, and acoustic telemetry. A one million bit magnetic bubble memory is used for storage of seismic data obtained from a three-axis accelerometer package. The microprocessor continuously compares the incoming data in mass memory and saves the "best" data for later readout by the acoustic telemetry system. The seafloor package consists of a ballast emplaced pressure vessel and probe containing the accelerometer. After the probe is inserted into the sediment, the ballast weight is removed and a section of the probe is retracted to mechanically isolate the accelerometers.

4 refs.

Instrumentation Systems Division, Sandia Laboratories, Albuquerque, New Mexico.

3.j..25.
1979: Herber, R.

Ocean-bottom-seismograph of the Institut für Geophysik, Hamburg. Mar. Geophys. Res., 4, 247-253.

423; BIO

The ocean bottom seismograph (OBS) of the Institut für Geophysik, Hamburg (IFG) is designed for refraction seismic experiments and for recording microseismic noise. Hydrophone signals are recorded directly on a cassette tape recorder with a band width of 3-60 Hz. Signals from three component 1 Hz seismometers are recorded on a 2nd cassette tape recorder in FM for a frequency range of 0.1-1 Hz. A telemetering buoy at the surface is connected with the OBS by a polypropylene rope.

4 refs.

Institute für Geophysik, Universität Hamburg, Hamburg, F.R.G.

3.j.26.

1979: Heffler, D. E. and D. L. Barrett

OBS development at Bedford Institute of Oceanography. Mar. Geophys. Res., 4, 227-245.

424; BIO

The Ocean Bottom Seismometer (BOBS) designed and built at BIO is described. The instrument is small, easy to handle and has performed reliably. Signals from two geophones and one hydrophone are recorded continuously for up to 10 days. A microcomputer is used as the clock and control.

An account of past use, and future plans is given.

8 refs.

Atlantic Geoscience Centre, Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

3.j.27.
1979: Koelsch, D. E. and G. M. Purdy

An ocean bottom hydrophone instrument for seismic refraction experiments in the deep ocean. Mar. Geophys. Res., 4, 115-125.

422; BIO

Tests of a new Ocean Bottom Hydrophone (OBH) instrument have recently been completed at Woods Hole Oceanographic Institution. This instrument is designed to float about 3 m above the seafloor at depths of up to 6100 m for periods of up to 10 days and continuously records the output of a single hydrophone on a four-channel 0.064 cm/s (1/40 in./s) analog magnetic tape recorder. This instrument has an acoustic transponder and release system and is designed primarily for multiple deployments as a fixed ocean bottom receiver for seismic refraction work.

4 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

3.k.l.

1954: Bullard, E. C.

The flow of heat through the floor of the Atlantic Ocean. <u>Proc. Roy. Soc. London</u>, <u>A222</u>, 408-429.

415; BIO

The measurement of the temperature gradient and thermal conductivity in the sediments beneath the floor of the North Atlantic Ocean is described. measurements were made at five stations. The high heat flow that was measured is an unexpected result, and it is difficult to find a source for so much heat.

The temperature gradient may be measured by driving a tube containing thermometers into the bottom of the ocean. Since considerable heat is generated by driving in the tube it is necessary to allow time for this to be dissipated by conduction, and desirable to record the temperature as a function of time. The probe used in 1952 is a steel tube 15.5 feet long and 2.70 cm in external diameter; its internal diameter is 1.12 cm. The temperature difference between a point near its bottom and one 458 cm higher up was measured by means of three pairs of copper constantan thermojunctions connected in series. The bottom of the tube was closed by a conical nose-piece. This had a diameter 5 mm larger than that of the tube, as it was hoped that this would reduce the friction while the tube was entering the bottom. The top end of the tube was screwed into a substantial bronze casting in such a way that the top junction was 5 cm below the casting. The thermojunciton leads passed through an axial hole in this to insulated terminals set in an alloy steel plate 1.25 inches thick which forms the base of a pressure-tight container for the recorder. The container consists of an alloy-steel tube of 7.5 inch external and 6 inch internal diameter and 2 feet long.

12 refs.

National Physical Laboratory, U.K.

3.k.2.

1959: von Herzen, R. P. and A. E. Maxwell

The measurement of thermal conductivity of deep-sea sediment by a needle-probe method. J. Geophys Res., 64(10), 1557-1563.

403; BIO

The transient heating of a needle probe is used to measure the thermal conductivity of deep-sea sediments in 10 minutes or less. an accuracy of 3 to 4 per cent compares favorably with steady-state methods, and measurements by both methods on the same sediments show good agreement. Thermal diffusivity of deep-sea sediments is shown to be proportional to thermal conductivity, in agreement with theoretical expectations.

13 refs.

Scripps Institution of Oceanography, La Jolla, California.

3.k.3.

1961: Uyeda, S. Y. Tomoda, K. Horai, H. Kanamori, and H. Futi

Studies of the thermal state of the earth. 7: a sea bottom thermogradmeter. Bull. Earthquake Res. Inst. Tokyo Univ., 39, 115-131.

429; Dalhousie

An apparatus for measuring the geothermal gradient in the sea bottom, or a sea bottom thermogradmeter, has been constructed. The apparatus consists of a probe containing two pairs of thermistors and a recorder set in a pressure tight and water proof steel container. Each of the pairs of the thermisters forms the two arms of an A.C. bridge. The other two arms of the bridge comprise a continuous potentiometer. Signals from the two A.C. bridges consisting of two pairs of thermistors and two potentiometers are separately amplified through amplifiers X and Y.

As the potentiometers rotate coaxially at the same speed as the recording drum, the phase angle of the output signal of the amplifier changes 180° when the potentiometer passes its balancing position. Therefore, as far as the phase angle is concerned, the output signal can be represented logically. It is the same for the output signal of the other amplifier. The output signals of the amplifiers X and Y are fed to an "and" gate circuit. The output signals of the gate circuit trigger the relay, and the contact of the relay makes or breaks when the potentiometers pass through their balancing positions, which give marks on the facsimile paper on the drum. Two pairs of thermistors give the temperature differences between the bottom and the top, and between the bottom and the middle point of the probe. The temperature differences ranging from 0° - 2°C can be recorded on the paper with an accuracy of 0.001°C for about 2.5 hours.

16 refs.

Earthquake Research Institute, Tokyo University, Tokyo, Japan

3.k.4.

1962: Gerard, R., M. G. Langseth, Jr., and M. Ewing

Thermal gradient measurements in the water and bottom sediment of the western Atlantic. J. Geophys. Res., 67(2), 785-803.

145; BIO

A new instrument for obtaining thermal gradient measurements in ocean bottom sediments, called a thermograd, is described. The thermograd is attached to a piston coring device, and it measures temperatures simultaneously at three or more depths in the sediment while obtaining a core for later thermal conductivity measurement. Thermistor needle probes are used to achieve thermal equilibrium with the sediment in about 1 minute after penetration. In situ calibration of the sensors is achieved at each station by recording temperature in the deep ocean waters. Fourteen thermal gradient measurements were obtained in the sediments of the western Atlantic Ocean with an average probe penetration of 10 meters. The average computed heat flow for 11 basin measurements is 1.42 microcal/cm^2sec. A measurement in the mid-Atlantic ridge indicates heat flow of 3.37 microcal/cm^2sec, and one in the Puerto Rico trench is 1.17 microcal/cm^2sec. Nearly continuous water temperature measurements are shown for 15 stations extending from about 2000 meters deep to the ocean bottom.

20 refs.

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

3.k.5.

1963: Lister, C. R. B.

Geothermal gradient measurement using a deep sea corer. Geophys. J., 7, 571-583.

144; BIO

An apparatus to measure heat flow through the ocean floor in conjunction with standard coring techniques has been independently developed at Cambridge. Experimental and theoretical work have shown that the probe configuration used is free from systematic error in the temperature measurement due to heat generated by friction when the device enters the sediment. A number of successful heat flow measurements and temperature/depth profiles in the sea have been obtained; summarized data on these is presented.

7 refs.

Department of Geodesy and Geophysics, Cambridge, U.K.

3.k.6.

1968: Corry, C., C. Dubois, and V. Vacquier

Instrument for measuring terrestrial heat flow through the ocean floor. J. Mar. Res., 26, 165-177.

419; BIO

Terrestrial heat flow through the ocean floor is determined by measuring the temperature gradient and thermal conductivity in the upper few meters of sediment with an instrument lowered on hydrographic wire. The chief novel feature of the device is that the thermal conductivity is measured in situ simultaneously with the temperature gradient instead of in a cored specimen of sediment in the laboratory. The instrument is similar to the one developed by Von Herzen and consists of a heavy case containing the recorder, to the lower end of which is fastened a hollow steel probe carrying three thermistors placed one meter apart. Two independent values of the temperature gradients are thus obtained. Thermal conductivity is measured by the Von Herzen-Maxwell needle-probe method, using a needle 23 cm long, mounted on a body that slides upward on the probe during penetration. The needle is electrically connected to the recorder with an extendable telephone-type cord. Water temperature versus depth can be investigated near the bottom by raising the instrument in small steps following the heat-flow measurement.

11 refs.

Marine Physical Laboratory, Scripps Institution of Oceanography, La Jolla, California.

3.k.7.

1969: Sclater, J. G., C. E. Corry, and V. Vacquier

In situ measurement of the thermal conductivity of ocean-floor sediments. J. Geophys. Res., 74(4), 1070-1081.

406; BIO

Twenty-eight in situ measurements of the thermal conductivity of ocean-floor sediment have been made by the transient heating of a small probe attached to a slider on the Scripps Institution of Oceanography temperature gradient probe. For twelve different locations the mean of the difference between the in situ value and the conductivity determination at the same depth on a gravity core was 0.02×10^{-3} cal/cm sec °C. This indicates that the in situ value is equivalent to a single measurement made at the same depth on a gravity core. A detailed statistical analysis of sixty-six gravity cores gives a 95% confidence limit of 9% for a single conductivity measurement, and hence for a single in situ determination. A detailed investigation of changes of gradient down the temperature gradient probe suggest a possible existance of 4% increase of conductivity in the second meter. The small value of this increase and the 9% error at the 95% confidence limit gives a combined error associated with the in situ measurement that is smaller by a factor of 2 to 3 than other environmental errors affecting the heat flow measurement. These results suggest that, when the Bullard type probe is used, no core need be taken, thus saving about 30% of ship time. The in situ probe has the additional advantage that it will often return a measurement when the sediment is impenetrable by a piston or gravity core.

24 refs.

Marine Physical Laboratory, Scripps Institution of Oceanography, La Jolla, California.

3.k.8.

1970: Lister, C. R. B.

Measurement of <u>in situ</u> sediment conductivity by means of a Bullard-Type probe. Geophys. J. Roy. Astr. Soc., 19, 521-532.

405; BIO

The heated-probe method of measuring sediment conductivity has been successfully adapted to making a multipoint determination in situ over the full gradient interval of heat-flow measurement. A probe 2.3 m long and 1 cm in diameter can complete both the gradient and conductivity measurements in 30 min on the ocean floor. The first two stations show that agreement between the theory of the method and the experimental data is good, and that in situ sediment conductivity at 2.1 x 10^{-3} cal °C cm^{-1} s^{-1} is consistent with representative values obtained by steady state laboratory methods.

10 refs.

—

3.k.9.

1971: Korgen, B. J.

Extending the versatility of the Bullard heat probe. Mar. Geophys. Res., 1, 354-357.

332; BIO

A versatile probe for simultaneous studies of heat flow and near-bottom water parameters has evoled through modifications of the Bullard heat probe frame. Suitable sensor arrays have been used with this instrument to study (1) heat flow through the ocean floor, (2) water column temperature structure, (3) near-bottom current speeds, and (4) the differential cooling of water-column temperature sensors placed in a current speed gradient.

Some of the advantages of such a modified Bullard probe: (1) several parameters, including heat flow, can be measured across the sediment-water interface simultaneously, (2) the instrument frame is rigidly pinned to the ocean floor during measurement, permitting true Eulerian measurement in the water column with no effects of ship movement, swaying moorings or cable oscillation, and (3) the device is inexpensive and simple.

The Bullard heat probe frame (Bullard, 1954) is well-known and can be fabricated from ½ in. (1.27 cm) diameter steel rod with associated fittings. Construction details for one form of the Bullard frame are given by Mesecar (1968). A long, plugged hollow shaft and a shorter coring tube are usually mounted on the probe frame baseplate. The hollow shaft contains transducers, typically thermistors, which are connected to an instrument case mounted in a frame on top of the probe shaft. The instrument case has a self-contained power supply and recording device. During a typical heat flow measurement at sea, the instrument is lowered from a ship and the probe shaft is planted into ocean floor sediments like an oversized dart. After a time interval which permits equilibration of the shaft transducers to the ambient sediment temperatures, the instrument is retrieved.

7 refs.

Department of Geology, University of North Carolina, Chapel Hill, North Carolina

3.k.10.

1972: Clark, T. F., F. J. Malcolm, and B. J. Korgen

An improved Ewing heat probe frame. Mar. Geophys. Res., 1, 451-455.

331; BIO

The standard Ewing heat probe frame has been improved through the design of a new take-down model whose parts are held together by lynch pins. When a 600 lb (272 kg) unit of this type is taken apart, the heaviest single piece of the dismantled unit weighs only 75 lb (34 kg).

This makes it feasible for one person to handle, transport, and assemble the new unit. A central, main support member of a heat probe using this frame can be suspended over the side of a research vessel while the heavier temperature recorder and ballast weights are attached by means of the quick-action lynch pins. This makes it possible to use this device on relatively small vessels which are not designed for coring work, having a minimum of free space and without launching platforms or hydraulic A-frame booms.

Two basic instruments have been widely used for measuring the terrestrial heat flow passing upward through the deep ocean floors. These are the Bullard type heat probe (Bullard, 1954), and the Ewing type heat probe (Langseth, 1965). Both of these devices feature a temperature recorder housed within a pressure case that is attached to the top of a long geothermal gradient probe.

This configuration is analogous in shape to a giant hypodermic needle. Temperature sensors, usually thermistors, are mounted along the geothermal gradient probe. During a measurement at sea, a heat probe is lowered from a surface ship until it is planted, dart-like, into the ocean floor sediments.

A sediment sample is normally taken at each heat flow station, and sediment thermal conductivity is determined later in the laboratory from each sample. The vertical temperature gradient in the ocean floor sediments is sensed by two or more thermistors placed along the geothermal gradient probe which is planted in the sediments in an approximately vertical position.

6 refs.

Marine Sciences Program, University of North Carolina, Chapel Hill, North Carolina

3.k.11.

1979: Finckh, P., G. Streckeisen, and E. Wielandt

A digitally recording probe for heat-flow measurements in lakes and oceans. Mar. Geophys. Res., 4, 207-212.

315; BIO

Some technical problems commonly encountered in marine heat-flow measurements have been overcome with a digitally recording seabottom probe containing in its pressure case no moving parts except a stepper relay. The probe stores digitally at regular time intervals the resistances of 11 thermistors in a 240-word CMOS memory. After return to the surface, it is connected to a digital printer to read out the measured data. The probe can be reused immediately since it need not be opened or recharged.

7 refs.

Institute of Geology, Swiss Federal Institute of Technology, Zürich.

3.k.12.

1979: Hyndman, R. D., E. E. Davis, and J. A. Wright

The measurement of marine geothermal heat flow by a multipenetration probe with digital acoustic telemetry and in situ thermal conductivity. Mar. Geophys. Res., 4, 181-205.

373; BIO

The design and use of a marine heat probe with capability for measuring thermal conductivity in situ with high accuracy, and providing digital acoustic transmission of data to the ship, is described. The instrument employs the 'violin bow' strength member and parallel sensor string configuration suggested by C. R. B. Lister. Several hundred measurements have been made in the deep ocean on multipenetration or 'pogostick' profiles using a 3 m probe and in deep inlets of western Canada using a 7 m probe. The in situ thermal conductivity technique using a calibrated heat pulse has been studied in detail through laboratory calibration of the probe in materials of known conductivity, through numerical models, and through comparison of insitu measurements with needle probe measurements on sediment cores taken from the same sites. The in situ technique permits a conductivity accuracy of better than ± 5% with a recording time of 7 minutes following 7 minutes in the bottom to establish the geothermal gradient. The pulse heating is also more energy efficient than the conventional continuous heating technique.

28 refs.

Pacific Geoscience Centre, Sidney, British Columbia.

3.k.13.

1979: Haenel, R.

A critical review of heat flow measurements in sea and lake bottom sediments. Terrestrial Heat Flow in Europe, V. Cermak and L. Ryback, eds., Springer-Verlag, Berlin, 49-73.

425; BIO

A critical review shows that the equipment used for heat flow measurements gives instrumental errors of 10% - 20%. Further, the measured heat flow is influenced by such local conditions as topography, sedimentation rate, irregularities in sediment cover, uplift, denudation, and water movements, which can give an additional error of 50% - 100% or even more.

The procedure for measuring heat flow is nearly the same for all measurements in seas and lakes.

As the operation starts, the probe is lowered to the sea or lake bottom from a stationary ship. A few meters above the bottom the probe is triggered by a trigger weight and then the probe penetrates the sediment by its own weight. The temperature difference (temperature gradient) between thermal elements is recorded in the pressure vessel at the top of the heat flow probe. In some cases the thermal conductivity of the sediment is also recorded in situ. In order to prevent the ship from pulling the probe out, the measurements must be carried out within 10 to 40 min and the wire must be let out slowly and continuously. To detect a possible inclination of the probe, most of them are equipped with an inclinometer. The navigational accuracy of ship position varied between ±0.5 and ±0.6 km, depending on the type of control (e.g., satellite, omega, loran, celestial).

80 refs.

Niedersachsisches Landesamt für Boderforschung, Hanover-Bucholz, F.R.G.

3.k.14.

1979: Lister, C. R. B.

The pulse-probe method of conductivity measurement. Geophys. J. Roy. Astr. Soc., 57, 451-461.

404; BIO

An alternative to the steady heating of a cylindrical probe, in the 'needle-probe' method of conductivity measurement, is the observation of the thermal decay from a short, calibrated, heat pulse. The theoretical solution is the time-differential of that for the former method, and requires only the measurement of point temperatures rather than the determination of a gradient. A careful analysis of the theoretical decay functon shows that it should be possible to make accurate conductivity measurements in as little as three probe 'time constants' if external information is available on the heat capacity of the medium. A self-contained method, using two temperature determinations from a record about six time-constant long, can be used where such information is not available. The theory was tested by measurements on the ocean-floor and the data correspond to the theory when a correction was applied for some internal probe conduction problems.

12 refs.

Department of Oceanography, University of Washington, Seattle, Washington.

3.k.15.

1979: Olson, L.O. and J.G. Harrison

Sea floor system for an in situ heat transfer experiment. Conf. Record, Oceans '79 (IEEE), 421-423.

025; BIO

A seafloor platform is being developed to measure the In Situ thermal conductivity of deep ocean clays. The system will implant a 400 watt isotope heat source into the red clay sediments of the deep ocean. Thermal sensors will be implanted around the heat source to radial distances of two meters. These sensors will record the temperature build up in the sediments over a one year period. The data will be recorded and stored on the structure for retrieval via an acoustic telemetry link to a surface ship at three month intervals. An important part of the system will be to accurately core samples of the heat affected sediment for laboratory chemical and geotechnical analysis. The structure and all sediment samples will be recovered on a synthetic line at the end of the experiment.

3 refs.

Applied Physics Laboratory, University of Washington, Seattle, Washington

3.1.1.

1972: Owen, T. R. E. and J. M. Sik

A three component fluxgate magnetometer for sea-bottom use. Proc. Oceanology International 72 Conf., 37-40.

301; BIO

The magnetometer described was developed to extend studies of the temporal geomagnetic variations already carried out on land in the British Isles into the surrounding shallow seas. The magnetometer records variations in three field components with periods between 2 minutes and 4 hours with an accuracy of one nT. The instrument is self setting, has a recording life of one month and is housed in pressure containers suitable for use at a maximum depth of 400 m.

9 refs.

Department of Geophysics, Cambridge University, U.K.

3.1.2.

1979: White, A.

A sea floor magnetometer for the continental shelf. Mar. Geophys. Res., 4(1), 105-114.

102; BIO

Measurement of temporal magnetic variations on the sea floor is desirable in order to extend the technique of geomagnetic depth sounding into the oceans. This paper describes a recording three-component sea floor magnetometer and its use in continental shelf depths. The orientation and tilt of the instrument on the sea floor are recorded using gelatine solutions to 'freeze' a compass card and a ball-bearing, respectively. A backing-off procedure initially nulls the magnectic field components along each of the three mutually orthogonal fluxgate sensors. Magnetic variations along each sensor axis are then recorded within a range of ± 300 nT of these nulled positions. The resolution is ± 1 nT, and with a power drain of 800 mW the magnetometer can record continuously for 30 days. The instrument capsule is moored to surface buoys for recovery in continental shelf applications. The buoys may have marker flags, radar reflectors or radio beacons attached to them to aid in relocation.

9 refs.

School of Earth Sciences, The Flinders University of South Australia, Bedford Park, South Australia.

3.m.1.

1966: Beyer, L. A., R. E. van Huene, T. H. McColloh, and J. R. Lovett

Measuring gravity on the sea floor in deep water. J. Geophys. Res., 71(8), 2091-2100.

258; BIO

The feasibility of accurately measuring gravity on the sea floor in deep water was demonstrated on the continental borderland off southern California. A slightly modified LaCoste-Romberg underwater gravimeter was successfully operated at ten stations to depths of 904.2 ± 4.6 meters. During the investigation the reading precision of the gravimenter ranged from ± 0.10 to ± 1.16 mgal because of difficulties in the modified remote-control system. The overall precision of the gravity measurements includes gravimeter reading precision and the uncertainties connected with the determination of gravimeter depth and latitude which range from ± 0.18 to ± 1.03 mgal and from ± 0.07 to ± 0.21 mgal, respectively. Gravity on the deep sea floor probably can be measured with a precision of ± 0.05 mgal at any water depth with feasible refinements of the LaCoste-Romberg underwater gravimeter. Over-all precisions better than ± 0.05 mgal are unlikely in deep water with existing instruments and techniques.

32 refs.

Department of Geology, University of California, Riverside, California.

4.a.1.

1959: Beckmann, W. C., A. C. Roberts, and B. Luskin

Sub-bottom depth recorder. Geophysics, 24(4), 749-760.

223; BIO

The Sub-bottom Depth Recorder (SDR) has been developed to study the underlying geologic structure of water covered areas. The SDR is essentially a broad-band, high-powered echo sounder which utilizes one of two sound sources.

The first, an electrical spark discharge (Sparker), has produced penetrations in excess of 600 ft in 50 ft of water. The second, a combustion chamber using a mixture of propane and oxygen (RASS), has produced penetrations in excess of 1,400 ft in 80 ft of water.

Results obtained from the SDR have been found to be in excellent agreement with test boring and seismic refraction data.

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Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

4

Continuous Surveys.

4.a.2.

1965: Breslau, L. R.

Classification of sea-floor sediments with a shipbourne acoustical system. La Petrole et la Mer No. 132, 9 p. (Woods Hole Oceanographic Institution Contribution No. 1678.)

371; BIO

A practical technique has been devised for routine surveying of sea-floor sediments from a vessel underway. This technique is based upon the fact that the strength of an acoustical echo received from the sea-floor is influenced by the nature of the surficial sediment at the sea-floor.

A relationship is developed between normally-incident acoustic reflectivity and the porosity of natural marine sediment. The well-known empirical relationships between sediment porosity and both grain size and silt plus clay content are discussed and it is shown that acoustic reflectivity can be used as a measure of the sedimentalogical as well as the physical character of the sea-floor.

A semi-automatic instrumentation system was designed and constructed to perform the acoustic measurement. Acoustic measurements were taken at sea in conjunction with a schedule of sediment dredging. Acoustic reflectivity was found to correlate significantly with sediment porosity, median grain size, and silt plus clay content and to be indicative of sediment class name.

33 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

4.a.3.

1971: Feldhausen, P. H. and M. L. Silver

Seismic techniques for dynamic testing and engineering studies of sediments. Underwater J., 3 (6), 263-279.

158; BIO

Seismic soil testing, carried out in both the laboratory and the field, now provide the underwater specialist with a means for determining the engineering properties of soils subjected to dynamic loads from winds, waves, machinery and earthquakes. These seismic techniques provide more information than the familiar seismic reflection profiling because they directly measure wave speeds in marine sediments which are related to engineering properties, such as stress-strain behavior and energy attenuation in a vibrating soil-structure system. Laboratory methods discussed include pulse methods and resonant frequency testing. New and proposed in situ marine testing methods including borehold shooting and surface wave tests are described. A review of case histories describing dynamic testing programmes showed that many research techniques may soon be used in a routine manner in marine site investigations.

6 refs.

Marine Physical Laboratory, Scripps Institution of Oceanography, University of California at San Diego, La Jolla, California.

4.a.4.

1971: Mizikos, J.-P.

Practical applicaions of relations between mechanical and acoustical properties of marine sediments. _Proc. Int. Symp. Engng. Props. Seafloor Soils Geophys. Ident._, 279-287.

271;

A comprehensive theoretical study of the acoustical properties of unconsolidated marine sediments has been undertaken for the purpose of establishing relationships between acoustical parameters (velocity, attenuation, reflection coefficient) and physical properties of these sediments. The results suggest new analytic tools in ocean floor engineering, dealing with: the acoustical determination of in-situ mechanical parameters; and influence of attenuation in signal processing mechanical for reflectivity or refraction-seismic study of superficial subbottom layers.

12 refs.

Laboratory of Sedimentology, Universite de Nice, Nice, France.

4.a.5.

1971: Shavor, R. N., C. S. Anderson, Jr., and R. F. Sweetland

Correlation of geophysical and coring investigations of estuarine sediments for dredging and utilization. Proc. International Symp. Engng. Props. Seafloor Soils Geophys. Ident., Seattle, 268-278.

243;

Estuarine sediment variations indicated by acoustic profiling have been correlated with core data in connection with a multi-channel dredging study. The study area is located in Hampton Roads, the lower Chesapeake Bay, and offshore of Virginia Beach. Parallel correlations of acoustic and core data from other estuarine areas are also presented.

12 refs.

Ocean Science and Engineering, Inc., Washington, D.C.

4.a.6.

1973: Ewing, M., R. W. Embley, and T. H. Shipley

Observations of shallow layering utilizing the £pnger probe echo-sounding system. Mar. Geol., 14, M55-M63.

157; BIO

A "Pingerprobe" is a system of echo sounding in which the sound source is placed near bottom to improve resolution by restricting the area investigated. It is demonstrated that a commercially available 12-kHz "pinger" with a synchronized shipboard receiver is useful not only in the monitoring of the positioning of a bottom or near-bottom instrument package (such as a corer) but also in making observations on the acoustic nature of the sea floor. In rough terrain the Pingerprobe has measured stratified sediments in some places where the PDR (Precision Depth recorder) cannot. Observations on proximal abyssal plains indicate that the prolonged echo character common to these areas may result from small-scale roughness or inhomogeneity. When a suspended instrument is sent to the bottom in rough terrain, or in areas of intermittent subbottom reflections, use of a Pingerprobe improves information about the conditions at the point of contact and permits selection of the desired topographic setting.

13 refs.

Earth and Planetary Sciences Division, University of Texas, Galveston, Texas.

4.a.7.

1974: Bell, D. L. and W. J. Porter

Remote sediment classification of reflected acoustic signals. Phys. of Sound in Mar. Seds., L. Hampton, ed., Plenum Press, N.Y., 319-335.

335; BIO

It is generally accepted that acoustic echoes received from marine sediments are relatable to a number of sediment geotechnical descriptions. To investigate these relationships, mathematical modelling, preliminary system design concepts, specific instrumentation, and a computer aided analytical approach have been developed. Techniques have been implemented and applied to at-sea data acquisition, employing a towed array, which allow simultaneous remote estimates of compressional wave velocity, attenuation rates, and the reflection coefficient as a function of incident angle. Initial correlations between measured acoustic indices and sediment physical parameters are presented and the potential for remote classification discussed.

27 refs.

Submarine Signal Division, Raytheon Company, Portsmouth, Rhode Island

4.a.8.

1974: Kirby, R. and W. R. Parker

Seabed density measurements related to echo sounder records. Dock. Hbr. Auth., 54(641), 423-424.

360; BIO

Figure 1 shows a record obtained with a 30kHz commercial echo sounder. The record shows that various broad categories of sediment can be recognized by acoustic techniques alone. The first echo is the surface of a fluid mud pool. The underlying layered material producing a longer dark signal is 'settled mud' which would be considered as the seabed. Rockhead can be recognizsed as well as surficial areas with good reflecting characteristics consistent with sand or gravel.

Measurements of the in situ density of these muddy sediments have been made using a radioactive transmission gauge with a source/detector separation of 15 cm., a spatial resolution of 1 cm., and an accuracy of ± 2½ per cent. Measurements conducted on a regional basis in the Severn Estuary and Bristol Channel have shown that the density of the surface of the fluid mud is predominantly between 1.15 and 1.17gm/cc., whilst the density of the top of the settled mud is approximately 1.35gm/cc. Since the fluid muds in the Severn are ephemeral deposits the surface of the 1.35gm/cc. layer is regarded as being the seabed in this area.

Figure 2 shows a density profile and its correlation with fluid mud layers recorded simultaneously on an echo sounder. The technique employed for sampling and measuring density profiles, shown in Figure 3, demonstrates how the various interfaces on the echo sounder record can be correlated with samples and densimeter records. The apparatus is lowered in the main lobe of the echo sounder beam so that its altitute and relationship to the various layers can be established.

5 refs.

Institute of Oceanographic Sciences, Taunton, U.K.

4.a.9.

1977: MacIsaac, R. R. and A. D. Dunsinger

Ocean sediment properties using acoustic sensing. Proc. 4th. International Conf. Port and Ocean Engng. under Arctic Conditions, 1074-1080.

350; BIO

Acoustic sources provide a rapid, non-intrusive method of remotely sensing the ocean floor. The use of a high resolution system permits the examination of small areas of the sea floor at frequent spatial intervals. Generally the echo returns require ground truthing by conventional methods such as core and grab samples, but with proper interpretation acoustic techniques can supply averaged information over large bottom swaths.

Using a boomer-type broadband sound source at normal incidence the characteristics of a fixed aperture, the methods of filtering, and the establishment of coherence measurements on a ping to ping basis over various sediment types are presented. Further averaging of the maximum value of the time coherence function yields values which may be separated for four different sediments. The differentiation between smooth finely layered media and smooth homogeneous media is examined by means of the ratio of coherent reflected energy at the water sediment interface to the total returned energy.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

4.a.10.

1977: Tyce, R. C.

Quantitative acoustics near the sea floor. Conf. Record Oceans '77 (IEEE), 10A1-6.

374; BIO

For more than a decade the Deep-Tow group of the Marine Physical Laboratory has been developing acoustic systems for near-bottom geophysical studies of the deep sea floor. A major aim of this work has been the detailed measurement of those properties of the sea floor which affect acoustic propagation. Such properties include the slope of the bottom, the acoustic reflectivity of the sea floor and of buried interfaces, and the attenuation of sound in marine sediments. The extreme lateral variability of such properties in the deep ocean makes near-bottom measurements important. This need has resulted in the development of narrow beam altimeters for accurate depth and slope determination, a computerized seismic profiling system for measurement of sea floor reflectivity and attenuation at 4 kHz, and computerized side-scan sonar systems for acoustic backscatter and bottom slope determinations. These systems were designed to provide real-time processing and displays of acquired data. This paper discusses the development and application of these systems, as well as some of the results which illustrate the extreme variability of sea floor acoustic properties which have been observed by these systems.

15 refs.

Scripps Institution of Oceanography, La Jolla, California.

4.a.11.

1978: des Vallieres, T., H. Kuhn, and R. LeMoal

Test of various high resolution seismic devices in hard bottom areas. Proc. Offshore Tech. Conf., 4, 1455-1459.

186; BIO

Research of operational high resolution geophysical methods for offshore soils and sub-bottom survey in a "seismically hard environment" led to a comparison study of a wide variety of shallow seismic instruments available on the market in the summer 1976.

Different seismic sources (pingers, air-gun, mimiflexichoc, surface or deep towed boomers and sparkers), streamers (mono and multi-trace) and recorders (analog and mono or multichannel digital) were tested in glacial deposits off the East Coast of Canada. The combination of the selected devices (source, receiver and recorder), led to thirty different data acquisition possibilities.

The on site performances and capabilities of each tool and the subsequent data processing possibilities led to an objective assessment of the different pieces of equipment to be used according to the type of soil encountered and the depth of investigation desired. When necessary, improvements were recommended.

4 refs.

Institut Français de Pétrole

4.a.12.

1978: Dunsinger, A. D. and R. R. MacIsaac

Broadband seismic data used for seafloor sediment classification. Conf. Record Oceans '78 (IEEE), 521-526.

367; BIO

The echo returns feom a broadband deep towed seismic system are examined. It is shown to be possible to separate four different sediment types based on two metrics. These are i) the maximum value of the normalized cross-correlation function and ii) the normalized water-sediment interface energy. For the small data base used these two metrics give complete separtion of the four sediment types.

6 refs.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

4.a.13.

1978: Simpkin, P. G.

Evaluation of broadband high resolution seismic data for sea floor sediment classification. Proc. Oceanology International '78, Tech. Session J., 25-30.

295; BIO

The Huntec Deep Tow Seismic (DTS) system is designed to be towed up to 300 metres deep. The heart of the system is an impulsively driven, plane piston transducer (boomer) producing a high intensity, broad band acoustic pulse with exceptional repeatability and long term stability. The system (fig. 1) employs a hydrodynamically efficient towed body (fish) containing the boomer, capacitor discharge system, hydrophones for the acoustic returns and an attitude sensor package. The boomer is pressure compensated so that the acoustic returns and an attitude sensor package. The boomer is pressure compensated so that the acoustic pressure pulse (fig. 2) remains constant with depths to 300 metres. Depending on the particular situation, firing rates can be as high as eight times per second. Although some reduction in energy output level is necessary at high firing rates, pulse shape (and therefore spectral content) of the boomer remains unchanged. Fish roll, pitch, vertical acceleration and depth, along with two channels of seismic information are transmitted via the double armoured, faired tow cable to the surface while the fish high and low voltage power supplies, and trigger signal are sent down the cable from the surface. The shipborne equipment consists of a high voltage power control unit to charge the storage capacitor to a maximum of 540 Joules, a signal processing unit and filter for the graphic recorder, a tape interface and calibration unit to allow direct analogue tape recording of the seismic information and an attitude display unit to monitor the towing characteristics of the fish.

17 refs.

Huntec (70) Ltd., Toronto, Ontario.

4.a.14.

1979: Cochrane, N. A. and A. D. Dunsinger

Seabed roughness characterization by broadband acoustic echosounding. Proc. Port Ocean Engng. Arctic Conditions '79, 2, 877-898.

377; BIO

Rapid systematic remote sensing of seafloor roughness can be achieved by observation of sediment acoustic scattering properties. Roughness estimates, indicative of bottom type, yield a non-intrusive method of sediment classification.

Broadband shallow seismic data were collected in the outer Placentia Bay area on the Newfoundland Grand Banks. The data are analyzed to provide metrics of acoustic scattering correlating with sediment type. The metrics are inverted to obtain absolute measures of bottom roughness under certain restrictive assumptions. Ground truth is obtained from core and grab samples, bottom photographs, and interpretation of standard echograms. It is the purpose of this paper to set forth the achievements as well as the current uncertainties in this approach to remote classification.

9 refs.

Memorial University of Newfoundland, St. John's, Newfoundland.

4.b.l.

1968: Bannister, P. R.

Determination of the electrical conductivity of the sea bed in shallow waters. <u>Geophysics</u>, <u>33(6)</u>, 995-1003.

224; BIO

The electric and magnetic field components produced by horizontal dipole antennas (both electric and magnetic) located within the upper layer of a two-layer conducting earth are derived for the quasi-near range. This range is defined as that in which the measurement distance is much greater than an earth skin depth but much less than a free-space wavelength. Ionospheric effects are neglected. It is assumed that the transmitting and receiving antenna depths are much less than their horizontal separation, and that the fields in the horizontal direction vary only slightly in a distance of one skin depth. It is well known that if the conductivity and thickness of the first layer (sea water) are known, the conductivity of the bottom layer (the sea bed) may be determined form magnetic field measurements alone. However, when extremely low-frequency magnetic field measurements are performed at sea, the movement of the magnetic field sensors in the static magnetic field of the earth (which is many times stronger than the field to be measured) introduces a very strong noise component. It is argued that electric field measurements are preferable because the induced noise component is smaller. It is shown that the sea bed conductivity may be determined by measuring only the horizontal electric field components produced by a subsurface horizontal magnetic dipole antenna.

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U.S. Navy Underwater Sound Laboratory, Fort Trumbull, New London, Connecticut.

4.b.2.

1973: Beckmann, H.

"In-situ" Bistimmung von Formationswiderstandsfaktoren mit Bodenschlepsonden. Erdoel, Erdgas, 89(10), 379-386.

266;

Several new bottom train probes are described which enable logging the formation factor directly or computing it automatically from the resistivities of bottom water and sediment. The original probe of Williams, which contains 2 pairs of circular electrodes, was improved by the addition of a pair of measuring electrodes. The bridge current between the measuring electrodes is equivalent to the formation factor. A more complicated probe with 2 pairs of current electrodes and 2 pairs of measuring electrodes gives the possibility of logging water resistivity, sediment resistivity, and formation factor at the same time. Field tests in a bay of northwest Spain showed that the differences between bottom water resistivity of pore space water are negligible in marine near-bottom sands. These new probes may be run in combination with other electrical, acoustical, or nucleonic devices.

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Institute of Geology, Technische Universitaet Clausthal, Clausthal--Zellerfeld, F. R. G.

4.b.3.

1975: Bouma, A. H., T. W. Ferebee, Jr., F. B. Chmelik, and G. H. Huebner, Jr.

Electrical logging systems and results of unconsolidated marine sediments. Proc. Offshore Tech. Conf., 1, 753-759.

055; BIO

The application of electrical logging technology to the study of unconsolidated marine sediments is still in its early stages. Progress in instrumentation development and the results from sea trials indicate the potential for marine logging techniques. Existing electrical logging analytical techniques cannot be extrapolated readily to produce reliable parametric values in unconsolidated marine sediments.

Horizontal correlation of sediment strata over long distances can be conducted rapidly with an *in situ* electrical logging probe. For calibration purposes, measurements should be done on cores via the core scanner. Although a certain comparison with the high resolution seismic profiles exists, the base for the logging parameters differs and is more refined than the acoustical impedance characteristics.

The towed array records parametric variations often mastered in complimentary high resolution acoustical sub-bottom profiling. The measurements are independent of vertical density changes. Additionally, the towed array can be used in water normally too shallow for other techniques. The ability of the towed array to "see" the bottom of oyster reefs makes it possible to estimate the volume of such reefs. Soft, gas-containing, shallow water muds off the Mississippi Delta reveal variations undetectable by seismic means. A survey of Heald Bank showed both major and minor variations in lithology that were in direct agreement with extensive core analyses previously done from that area.

11 refs.

Texas A. and M. University, Department of Oceanography, College Station, Texas.

4.b.4.

1976: Beckmann, H. and G. Demiray

The nanolog, a new way to log the resistivity of the sea floor. Geophys. Prospecting, 24(2), 309-316.

100; BIO

A new device for resistivity logging has been developed with a doubly focussed system. It resembles a simplified double set of microlaterologs. The diagram of the log shows the formation resistivity factor of the sediments on the sea floor. The probe is trailed after the logging boat on a cable with at least two or four cores. The penetration of this log is better than 10 cm. The log is used for resistivity mapping, and it could be used for the exploration of heavy minerals and manganese nodules.

8 refs.

Techischen Universitàt Clausthal, Clausthal-Zellerfeld, F.R.G.

4.b.5.

1976: Bischoff, J. and J. Sebulke

Geoelektrische Widerstand verfahren zur Prospektion immarinen Bereich. Interocean 1976 Conf. Record, 2, 1081-1090. (Geo-electrical resistivity methods for use in marine prospecting.)

333; BIO

The possibilities to work with geoelectrical resistivity methods in the marine area have been examined by model-calculations. A simplified model of the ground is assumed (three layers which are homogeneous and isotropic relative to their resistivity and which have parallel boundaries).

The apparent resistivity as a function of the distance r has been calculated for different electrode configurations and presented graphically. It was examined if the curves obtained by these calculations let expect results which render possible statements about the structure and thickness of marine sediments. Model graphs will be presented which show that two of the examined configurations are suitable for marine geophysical prospecting.

A digital measuring system for geoelectrical resistivity soundings in marine areas is described. The current electrodes and the electrodes for the determination of the potential differences are connected at a towed multiple conductor cable, which is layed out on the seafloor. The potential electrodes are scanned by an automatic scanner and the data are recorded computer compatible on a digital cassette recorder. The interpretation of the recorded data is carried out by means of a graphical computer system. Results of resistivity measurements obtained by the system are presented.

Institut Für Angewandte Geophysik, Petrologie, und Lager stättenfurschung, Techische Universität Berlin

4.b.6.

1976: Beckmann, H.

Logging the sea floor with geoelectric systems. Interocean 1976 Conf. Record, 1069-1080.

334; BIO

Geoelectrical systems offer a wide variety of technical possiblities for mapping sediments on the sea floor and for exploring marine ore deposits. Logging methods with induced potentials have been developed using the principles of WENNER, SCHLUMBERGER, WILLIAMS. Other systems use focussed arrays similar to the microlaterolog. They enable the resistivity of the sea floor and bottom water to be logged for calculation of the ohmic formation factor. Some of these systems enable direct measuring of the formation factor. From the ohmic formation factor the type of sediment, its porosity and its solidity can be derived. High frequency logs with inductive or capacitive coupling are still undergoing laboratory tests. Other logs have been developed to log spontaneous potentials on the sea floor. On principle they contain two sets of bimetallic electrodes: one scrapping over the sediments and the other contacting the bottom water. More than a dozen of different combinations have been tried, using combinations of different metals as well as different circuits. The resulting diagrams contain different potentials from the different sources, such as scrapping potentials, galvanic potentials, pH, Eh, and some others. Several potentials could be isolated and measured separately in a laboratory simulator for estimating their influence on the diagram.

18 refs.

Department of Geology, Technische Universität Clausthal, Clausthal-Zellerfeld, F.R.G.

4.b.7.

1976: Nebrija, E.L., C.T. Young, R.P. Meyer, and J.R. Moore

Electrical prospecting for copper veins in shallow water. Proc. Offshore Tech. Conf., 1, 319-339.

015; BIO

Electrical measurements using separately a surface-towed Schlumberger resistivity array and a surface-towed, controlled-source audiomagnetotelluric (AMT) system were made in Lake Superior along the north shore of Keweenaw Peninsula. The areas studied were Copper Harbor, where there are known underwater copper veins, and Great Sand Bay, where offshore extensions of onshore copper-bearing fissures may exist.

The Schlumberger array had a 455-foot current electrode separation, sufficient to measure the resistivity of the lake floor in shallow water. The AMT tests were conducted using a circular loop of wire 150-m in diameter laid on the lake bottom and excited by a 400-Hz AC generator as source. With the ship's position regulated by electronic navigation, concentric arcs were traversed about the loop to measure the radial magnetic field, H_r, and the tangential electric field, E_t.

The AMT method yielded distinct and reproducible anomalies in E/H ratios over known copper veins in Copper Harbor and both methods showed correlatable anomalies over expected lithologic contacts in both areas. A previously discovered zone of heavy-mineral concentration inside Great Sand Bay was verified with both methods. A probable underwater vein was also discovered in this area with the surface-towed resistivity array. Other onshore fissures apparently do not extend offshore.

Both methods are strongly affected by bottom topography. For resistivity profiling, a first-order correction for topography has been developed and applied.

18 refs.

University of Wisconsin, Madison, Wisconsin

4.b.8.
1978: Sebulke, J.

The theoretical investigation of resistivity methods from geoelectrical prospecting in marine areas. J. Geophys., 44, 245-255.
337; BIO

The applicability of the geoelectrical resistivity method in marine areas is studied by model calculations. For a simplified three-layer-model assuming homogeneous and isotropic conditions together with parallel boundaries the apparent resistivity is calculated for three different electrode configurations. it is concluded that for two of the configurations the thickness of layer 2 (sediments) can be determined with a sufficient accuracy.

8 refs.

Institut Für Angewandt Geophysik, Petrologie, und Lagerstättenfurschung, Technische Universität Berlin, Berlin, F.R.G.

4.b.9.

1979: Sebulke, J. and W. Hildebrandt

A theoretical investigation of the dipole- and unipole-resistivity methods for geoelectrical prospecting in marine areas. J. Geophys., 45, 409-416.

311; BIO

The apparent resistivity of a dipole-dipole and a unipole-configuration has been calculated based on the potential of a buried electrode. The model calculations indicate that the thickness of seafloor sediments can be determined with good accuracy; however, the results cannot be expected better than by application of the two-electrode configurations, which were described in previous papers (Sebulke, 1973; 1978).

10 refs.

Institute for Applied Geophysics, Petrology, Economic and Mining Geology, Technischen Universität Berlin, Berlin, F.R.G.

4.c.l.

1973: Abdullah, H.

Bodenschleppsonde zur Messung der Gamma-Dichte von Meeresböden. Meerestech, 4(3), 87-89. (Ground trail probe for the measurement of gamma-density on ocean beds.)

370; BIO

In the past few years, a series of ground trail probes for the determination of physical rock parameters of the ocean beds have been developed at the Oil Geology Department of the Technical University Clausthal, including some for the measuring of the grinding noise (microphone probe), the resistance, the angle of inclination and the sound adsorption. For the density determination in the upper centimeters of the ocean beds a ground trail probe was designed incorporating a measuring system according to the principle of the gamma-gamma-density measurement which was tested in shallow waters in the summer 1972. The principle of operation, the probe and the results of measuring are described below.

10 refs.

Oil Geology Department, Technical University of Clausthal, Clausthal-Zellerfeld, F.R.G.

4.c.2.

1973: Beckmann, H. and H. Abdullah

Erforschung des meeresbödens mit Radioaktiven Messmethoden. Inter-ocean '73 Conf. Record, 2, 31-345. (Surveying the seafloor by nuclear logging.)

372; BIO

Nuclear logging methods have proved to be very useful for logging sands with interesting contents of heavy minerals, and for purposes of technical engineering onshore and offshore. During several years a number of different probes with nuclear logging systems have been developed, tested and used, which are trailed after the logging boat, sliding over the surface of the sediments.

The logging boat is a small barge made from reinforced plastic material and has been fitted out with special equipment for registration, orientation, echo sounding and radio transmission. The boat is driven by an outboard motor of 9 1/2 H.P.; the logging speed averages 5 km/h. Usually two operators are sufficient as crew, with at least a third operator to control direction and distance from a mobile radio station on-shore. The logging cable has to withstand severe strain whenever a probe gets entangled with obstacles on the ground. It contains a stainless steel rope with a shear strength of 800 kp. The probes are made from plastic material and metal. Their optimal form has been tested in laboratory and field work. They are weighted with lead, and steering fins keep them in contact with the sediment during logging opearations. Up to now more than an thousand kilometers have been logged, using probes with different logging systems and employing different electrical, acoustic, nuclear and purely technical principles.

Nuclear logging methods have the great advantage of being independent of water salinity, temperature and similar factors affecting other logs.

Most probes contain a combination of nuclear methods with acoustic or electrical system. The most useful nuclear logging systems have proved to be gamma/gamma-neutron/neutron- and natural gamma logging.

31 refs.

Department of Petroleum Geology, Technical University of Clausthal, Clausthal-Zellerfeld, F.R.G.

4.c.3.

1975: Lange, J. P. and W. G. Biemann

Development of components for an in-situ analysis system for the exploration of manganese nodules. Proc. Offshore Tech. Conf., 2, 585-592.

280; BIO

Gesellschaft für Kernforschung mbH develops the comprehensive manganese nodule exploration system MANKA II. The system includes an in-situ analysis by prompt (n, gamma) spectroscopy with ^{252}Cf source, a hydraulic sampling system, Helium Cyrostat, and data transmission by coaxial cable. The system is designed for 6,500 m maximum water depth. Components of the intermediate deep sea sled MANKA I are presented, together with the concept of the in-situ analysis and results of component tests.

A specially designed suction nozzle picks up the manganese nodules which are then transported through a flexible pipe into the separator. Flexibility of the pipe is necessary to compensate the relative movement of inner and outer frame. In the separator the deep sea clay is washed off the nodules and carried away with the exhaust water, while the nodules fall into the analysis chamber.

6 refs.

Gesellschaft für Kernforschung mbH.

4.c.4.

1978: Sobolev, V. M., V. V. Kostoglodov, N. N. Dunaev, and V. P. Vasiliev

Continuous underwater gamma-survey in the Baltic Sea. _Oceanology_, _18(1)_, 54-57.

103; BIO

Based on the findings of field operations at sea during 1976, the possible application of an underwater gamma-survey for detailed mapping of bottom sediments and for detecting tectonic disturbances on the sea floor is considered.
5 refs.

Institute of Oceanology, USSR Academy of Sciences

4.d.l.

1974: Bogoslovsky, V. A. and A. A. Ogilvy

Detailed electrometric and thermometric observations in offshore areas. Geophys. Prospecting, 22, 381-392.

225; BIO

The paper deals with the prerequisites of application, specific pecularities and methods of electrometric and thermometric investigations aimed at the solution of certain engineering- geological problems in offshore areas. Practical examples are supplied.

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Department of Geology, Moscow State University, Moscow, U.S.S.R.

4.d.2.

1979: Phillips, J. D., A. H. Driscoll, K. R. Peal, W. M. Marquet, and D. M. Owen.

A new undersea geological survey tool: ANGUS. Deep-Sea Res., 26A, 211-225.

163; BIO

A towed, near-bottom survey system termed ANGUS (Acoustically-Navigated Geological Undersea Surveyor) has been developed for geological and geophysical studies in the median rift valley of the Mid-Atlantic Ridge. System communication is solely acoustic and incorporates a relay transponder attached to either a camera fish, rock dredge, corer, or heat probe device with a shipboard transducer and a seafloor transponder array. The devices can be located with a precision of 5 to 10 m along a simultaneously collected high-resolution bathymetric profile. Automatic digital computer processing of the acoustic navigational information permits real-time monitoring of the path of the device on shipboard graphic display units. Approximately 60,000 high-quality photographs, 70 rock dredges, and 100 heat-flow observations have been collected and related to seafloor features with relief as small as 20 to 30 m. The basic camera fish allows for the addition of other geophysical instruments. Also, expendable sonobuoys have been positioned precisely to locate microearthquakes.

19 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

4.d.3.

1979: Pace, N. G. And C. M. Dyer

Machine classification of sedimentary sea bottoms. IEEE Trans. Geosci. Elecronics, GE-17(3), 52-56.

382; BIO

The side-scan sonar method for study of the sea bottom enjoys widespread use at the present time. The interpretation of the records is restricted to those observers having some experience, and is offered in terms of geological and man-made features, bottom topography, and sediment types. The most subjective opinions are perhaps found in the latter category, and it is here that the attention of this paper is focused.

By drawing on ideas of texture quantification, this paper explores the potential of using a number of textural features to characterize small areas of side-scan sonar record with the view of producing, via a pattern-recognition procedure, classification decisions in the context of sedimentary sea-bottom identification.

In this initial investigation, high levels of correct classification probabilities were achieved using small numbers of textural features derived from relative signal level variations rather than absolute ones, together with an uncomplicated decision rule.

16 refs.

School of Physics, University of Bath, Bath, Avon, England.

5.a.1.

1964: Bouma, A. H.

Self-locking compass. Mar. Geol., 1, 181-186.

203; BIO

To obtain more information on submarine cores a compass has been designed. This compass can be mounted on any type of coring device where one single orientation is desired. The accuracy is within 5°. The obtained orientation will be locked by means of a tripping part.

4 refs.

Scripps Institution of Oceanography, LaJolla, California.

5

Miscellaneous.

5.a.2.

1964: Felsher, M.

A core aligner designed to recover oriented Recent marine cores. Limnol. and Oceanog., 9(4), 603-605.

346; BIO

The core aligner is attached to the stem of the box corer by three brass bolts. The hasp, holding the trigger wire and weight, is slipped onto the brass eye and the weight is dropped to the water. The thumb screw is then turned, releasing the pressure on the piston. The piston, however, remains retracted owing to the weight hanging from the brass eye

The corer and attached core aligner are now lowered to the sea floor. The length of trigger wire plus the length of the weight is just shorter than the length of the box corer. Therefore, the trigger weight will touch bottom an instant after initial core penetration. Now, with the trigger weight resting on the sea bottom, there is no weight holding the piston retracted. The heavy spring moves the piston forward, carrying the compass assembly with it. The sharp metal point on the compass needle punches through the acetate film, making a permanent record of magnetic north at the time of core penetration.

As the core is lifted, the trigger weight again retracts the piston. When the box corer and core aligner reach the surface, the thumb screw is immediately tightened, preventing further action by the piston during shipboard recovery. The hasp is then removed and the trigger wire and weight are brought on board. The core aligner is then separated from the box corer, brought on board, and the angle between the reference line on the Lucite disc and the punched hole in the acetate indicating magnetic north is read and recorded.

2 refs.

Allan Hancock Foundation, University of Southern California, Los Angeles, California.

5.a.3.

1967: Harrison, C. G. A, J. C. Belshe, A. S. Dunlap, J. D. Mudie, and A. I. Rees

A photographic compass inclinometer for the orientation of deep sea sediment samples. J. Ocean Tech., 1(2), 37-39.

062; BIO

An inexpensive instrument is briefly described which has been designed to provide a method of recording the orientation of deep-sea sampling devices. A compass and bull's-eye spirit level are photographed by a single shot camera shortly after the sampling device hits the bottom. The azimuth of a line on the device may be measured to within 2 degrees, and the inclination of the device to within 1/2 degree.

The instrument consists of a small compass and bull's-eye spirit level which are photographed simulatneously by a single shot camera. The aperture of the camera is permanently open, and light is supplied by a flashbulb which is fired approximately 20 seconds after the device hits the bottom. The camera and triggering circuit are contained inside a pressure case which is fastened in a known orientation to the sampling device. Triggering is achieved by means of a small tripping weight or lever which controls an external switch.

3 refs.

Scripps Institution of Oceanography, LaJolla, California.

5.a.4.

1967: Rosfelder, A. M. and N. F. Marshall

Oriented marine cores: a description of new locking compasses and triggering mechanisms. J. Mar. Res., 24(3), 353-364.

113; BIO

While core-orientation data are becoming more and more necessary for marine sedimentological studies, there are no rugged, inexpensive, or convenient compasses that are insensitive to the ambient pressure, the inclination of the corer, and the bottom impact. This paper describes some instruments designed in an attempt to overcome these problems. A hemispherical compass, a free-floating spherical compass, an inexpensive "compass smasher", and some proposed simplified models of these are described. The triggering mechanisms consist basically of a stretched wire fastened to a yielding point on the corer, this point being (i) a glass shear pin snapped off by the sediment, (ii) a tiny nose lever turned up in the same way, or (iii) a releasing lock positioned on a mobile part of the corer.

14 refs.

Scripps Institution of Oceanography, University of California at San Diego, LaJolla, California.

5.a.5.

1971: Morrison, D.R. and B. Carson

A gyrocompass for measurement of core orientation and core behavior. Deep-Sea Res., 18, 935-939.

021; BIO

An instrument package has been designed to monitor continuously, the horizontal orientation and inclination of a standard piston corer. A gyrocompass is used as an azimuthal reference while two pendulum potentiometers sense deviations from the vertical. Azimuthal orientations obtained with this unit are thought to be accurate to within 5°. Preliminary results on 12 cores taken with this instrument indicate that a piston corer fluctuates less than 4° from the vertical throughout most of the coring operation. Rotational behavior, however, is significantly different during ascent and descent, and varies with water depth. Short period rotations are typical of the ascent, while longer periods (2-5 min) are characteristic during corer descent. The magnitude of rotation increases significantly in the upper 150 m of the water column, in response to wave action and ship motion. In the near-bottom phase of a coring operation, the corer undergoes rapid rotation (30°/10 s) during free-fall and, possibly, bottom penetration.

12 refs.

Department of Oceanography, University of Washington, Seattle, Washington

5.a.6.

1973: Thorpe, S. A., E. P. Collins, and D. I. Gaunt

An electromagnetic current meter to measure turbulent fluctuation near the ocean floor. Deep-Sea Res., 20, 933-948.

314; BIO

The sensing head is 2.1 m above the bottom of the base plate and will be at this height above the sea floor if no sinkage occurs. The orientation of the head and the tilt of the instrument on the sea floor has been measured by a simple but effective device shown in Fig. 5 and Fig. 3(G). The solid polythene cylinder has a hemispherical upper face marked with 5° rings and radial lines which have a known orientation relative to the electrodes on the sensing head. Above it hangs a compass on a torsionless thread passing through a hollow brass pendulum rod. The solid cylinder can slide within the hollow cylinder which is shown cut-away in Fig. 5, and is held away from the pendulum against the force of the spring by the magnesium nickel alloy rod. When the device is in the sea, the magnesium nickel alloy rod corrodes and breaks in about two to three hours (some time after the instrument has settled on the sea floor) so allowing the spring to force the solid cylinder upwards to trap the compass and pendulum and thus providing a record of the tilt and orientation for examination when the instrument is recovered.

4 refs.

Institute of Oceanographic Sciences, Wormley, Godalming, Surrey, England.

5.a.7.

1974: Mallik, T. K.

An underwater compass for collecting oriented ocean-bottom samples. Mar. Geol., 16(5), M85-M89.

286; BIO

An underwater compass to collect oriented ocean-bottom samples was designed and tried in shallow depths of up to 112 m. The present design is very simple as compared to other types and can be fabricated at a very low cost.

6 refs.

Offshore Mineral Exploration and Geology Unit, Geological Survey of India, Calcutta.

5.a.8.

1977: Seyb, S. M., S. R. Hammond, and T. Gillard.

A new device for recording the behavior of a piston corer. Deep-Sea Res., 24(10), 943-950.

118; BIO

The behavior of piston corers during free-fall and penetration of the sea floor is accurately recorded using a relatively simple and inexpensive piston-core orienting device (PCOD). The instrument package, which is deployed in a non-magnetic weight-stand, contains an oil-damped compass, two bubble levels, a watch, and a vertical accelerometer. These instruments are photographed by a super-8 movie camera that is switched on when the corer is triggered. Analysis of the film record reveals both vertical and azimuthal orientation of the corer as it penetrates the sediment. Study of a number of PCOD records has shown that while the piston corer penetrates at an angle which normally varies less than 4° from vertical, it frequently undergoes more than 180° of rotation during penetration.

9 refs.

Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii.

5.a.9.

1979: Chari, T. R., K. Muthukrishnaiah, and S. N. Guha

Breakout resistance of underconsolidated sediments. Proc. 1st Can. Conf. Mar. Geotech. Engng., 270-281.

229; Metrology

Objects embedded in ocean soils,either partially or fully, require forces greater than their own buoyant weight to dislodge them. The additional force required is termed the breakout resistance. The problem of breakout is extensive and has a number of variables such as the effect of soil type, object embedment, depth, nature of object surface and shape, and the type of breakout operation - immediate or added.

Adhesion on the sides, suction at the base, and the weight and shearing resistance of the soil above the object contribute to the breakout resistance of objects sunk in cohesive ocean sediments. Adhesion studies also have an important application to the cold oceans in the studies of ice-soil interaction.

Results of pull out tests on plates and prismatic objects embedded in artificially sedimented silty clay, having strengths comparable to the ocean sediments, are reported in this paper. Cold room tests on adhesive resistance of ice sheets are also described.

21 refs.

Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland.

5.b.1.

1968: Raymond, S. O.

Glass floats and boomerangs. Mar. Sci. Instrumentation, 4, 231-240.

177; BIO

Boomerangs*, devices that sink down in the ocean, release ballast and return to the surface for recovery, must contain a unique floatation material if they are to be used at great ocean depths. Hollow glass spheres composed of two seperable hemispheres have been found to work well for this purpose. Because the floats can be opened, instruments to control ballast release and to emit signals for recovery can be mounted inside them. Electrical and mechanical ballast releases and various recovery aids are described.

* The word "Boomerang" as applied to devices that descend and rise in the ocean is a trademark of Benthos, Inc.

9 refs.

Benthos, Inc., North Falmouth, Massachusetts.

5.b.2.

1971: Sessions, M. H. and P. M. Marshall

A precision deep-sea time release. Scripps Inst. Oceanog. Ref. Ser. 71-5, 24 p.

239;

A family of oceanographic systems that descene freely to the ocean floor later to return to the surface are now in use. Vital to the free vehicle instrument system is a reliable and accurate programmable anchor release device. A release device capable of being easily programmed in one hour increments to a total of 1000 hours is described including results of test and field evaluation.

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Scripps Institution of Oceanography, La Jolla, California.

5.b.3.
1973: Olson, L. O.

Multiple trigger ballast release. Exposure, 1(1), 4-5.

362; BIO

The illustration shows a small ballast release which can be triggered by three different modes to drop a common weight.

This unit employs an electrically actuated explosive guillotine for a commanded drop, a corroding magnesium link for a timed drop and a shear pin pressure actuator for a maximum depth drop. The ballast weight is suspended from the release by a small cable with a ball swagged on the end.

The swagged ball rests on top of three actuation balls with the cable passing between the balls to the weight. Radial displacement of any one or more of the three actuation balls will allow the swagged ball to drop out of the release with the ballast.

Each actuation ball is radially restratined by one of the three trigger mechanisms. Two of the trigger systems use spring loaded cams to restrain the actuation balls. This keeps the force required on the triggering mode constant for different ballast weights.

The third system using the pressure shear pin mode has an actuation force dependent upon the ballast weight but reduced by the mechanical advantage of multiple support and friction as a function of contact angle between the swagged ball and the actuation ball. Since this resultant force is small compared to the shearing force on the pin it can be neglected.

This device has proved to be a compact, dependable and failsafe ballast release for small oceanographic packages used as submerged buoyant drifting-devices in the ocean for short time periods. These time periods are limited by corrosion rate in the actuators and marine fouling.

no refs.

Applied Physics Laboratory, University of Washington, Seattle, Washington.

5.b.4.

1973: Sessions, M. H.

Time release mechanism. Exposure, 1(1), 2-3.

361; BIO

A time release mechanism for deep sea free vehicle applications has been in use at Scripps Institution of Oceanography for about three years.

This device will operate to 10,000 psi for times up to 2000 hours and will operate at loads up to 500 pounds. Time is selected by thumbwheel switches in one hour increments.

Usually two releases are operated in parallel for redundancy with a chain linkage between the two release hooks.

The releases cost about $1000 to build, in addition to some check-out and test time. Used on several hundred missions, no instruments have been lost due to release failure.

Recently we added an external explosive bolt and linkage assembly for loads up to 5000 pounds (shown). This unit has worked well, but we are nervous about the padded electrical connections to the bolts.

Work on a standard deep sea bolts assembly has been carried on by another group at SIO and this assembly will be used in future applications.

no refs.

Scripps Institution of Oceanography, LaJolla, California.

5.b.5.

1975: Brackett, R. L.

Coupling device to increase the reliability and load handling capacity of remote release equipment. Exposure, 3(1), 1-4.

363; BIO

The mechanism is assembled by attaching the remotely actuated release devices to the load transmitting member with band clamps. Two rotating arms are then locked into position in the remotely actuated release mechanism, which holds a pin in place between the arms and the retainer blocks. The instrument package and buoy are attached to the top of the load transmitting member while the dead-weight anchor is attached to the pin. The spacers were included to keep the arms in their proper position. When either of the remotely actuated release devices is triggered, the associated arm is allowed to rotate, allowing the release pin to drop, thus releasing the dead-weight anchor.

All components of this mechanism were fabricated from mild steel, with the exception of the pin for which high carbon allow steel was utilized to increase its load carrying capability.

The configuration shown was designed for two identical 1000 pound capacity acoustic release devices. Static tests have been conducted to verify that this arrangement can safely handle a working load of 4000 pounds. Subsequently two more coupling devices were fabricated to couple nonidentical acoustic releases in a single package.

no refs.

Civil Engineering Laboratory, Naval Construction Battalion Center, Port Hueneme, California.

5.b.6.

1977: Byrne, D. A. and R. Mitiguy

Explosive bolts as separation devices for pop-up instruments. Exposure, 4(6), 5-10.

359; BIO

The seismic group at the Hawaii Institute of Geophysics (HIG), University of Hawaii, started development of a pop-up ocean bottom seismometer (POBS) during the spring of 1975 (Kasahara and Harvey, 1976). Explosive bolts were chosen for the ballast separation devise because of their dependability, strength and low cost. The Holex #2504-13 explosive bolt (1/4-28 x 1.4") originally designed for aerospace applications was selected.

2 refs.

Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii.

5.b.7.

1977: Hefler, D. and D. Locke

A deep ocean release mechanism. Mar. Geophys. Res., 3, 229-232.

383; BIO

This note describes a simple and (we hope) reliable mechanism for releasing an instrument from a deep ocean anchor, so the OBS's could be used in a pop-up mode.

The design was based on the following considerations:

1. The instrument package is a 7 in. (17.8 cm) cylinder 26 in. (91 cm) long weighing 110 lbs (490 N) in air and 20 lbs (89 N) in water. A glass sphere provides 52 lbs (450 N) buoyancy and the anchor weighs 130 lb (585 N) in water. As the anchor is made of concrete, it weighs 215 (970 N) in air.

2. The OBS is designed to withstand up to 10,000 psi (70 MPa) so the release system must operate in depths of 3000 fms (5500 m). The maximum submersion time is 10 days.

3. As the OBS contains geophones, it is essential that the instrument rest firmly on the bottom so seismic waves, particularly shear waves, can be sensed. This requirement eliminates the use of most standard release systems as the instrument package they release must float a meter or more above the ocean floor. The anchor must give a firm plant in soft sediments as well as the rough, hard bottom typical near an ocean ridge.

4. Of course, reliability is always of prime importance in these systems. In addition to redundancy, this was sought by minimizing pressure seals. The release used should not catch, even if the entire package lands on its side.

The AGC release uses an evacuated chamber to hold the OBS to a smooth plate set in a concrete anchor. A similar technique has been used by the Woods Hole Oceanographic Institution (Davis, unpublished). At the release time, as determined by an electronic timer, an explosive device ruptures a tube exposed to ambient pressure, flooding the chamber and allowing all but the anchor to rise to the surface.

2 refs.

Atlantic Geoscience Centre, Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

5.c.l.

1952: Isaacs, J. D. and A. E. Maxwell

The ball-breaker, a deep water bottom signalling device. J. Mar. Res., 11(1), 63-68.
214; BIO

A simple device for signalling the arrival of a deep cast on bottom has been developed and is now in routine use. The device is used either in line with corers or is suspended below as a pilot. When contact of either the ball-breaker or other apparatus is made with the bottom, a small glass sphere in the former is imploded and the resultant signal at the surface is amplified and reproduced over a loud speaker system. The device has been used successfully at depths to 2,700 fathoms.

no refs.

Scripps Institution of Oceanography, La Jolla, California

5.c.2.

1960: Isaacs, J. D. and G. B. Schick

Deep-sea free instrument vehicle. Deep-Sea Res., 7, 61-67.

255; BIO

A number of free instrument vehicles have been designed and tested. These are simple, reliable, inexpensive devices that transport recording instruments or sampling equipment to the deep-sea bottom, or to intermediate depth, and return them to the surface. Vehicles are provided with radar reflectors and other location devices. In the first tests the vehicles bore fish traps and were successfully operated to 2,000 fathoms. Other instruments designed to make use of the free vehicle's unique capabilities are under development.

6 refs.

Scripps Institution of Oceanography, La Jolla, California.

5.c.3.

1964: Muus, B. J.

A new quantitative sampler for the meiobenthos. Ophelia, 1(2), 209-216.

246; BIO

The meiobenthos, which comprises animals with a body length of approximately 0.2 - 2.0 mm, can be sampled quantitatively by means of a new untraditional grab which is described and figured. It cuts out a square of 150 cm^2 of the upper 2-3 cm of the substratum and keeps the sample in a bag of nylon gauze. The instrument has worked successfully in continuous sampling in the Oresund throught 1½ years.

9 refs.

Danish Institute for Fisheries and Marine Research, Charlottenlund, Denmark.

5.c.4.

1965: Sternberg, R. W. and J. S. Creager

An instrument system to measure boundary-layer conditions at the sea floor. Mar. Geol., 3(6), 475-482.

254; BIO

An instrument system (data-collecting devices mounted on a tripod platform) has been built for measuring currents and sediment motion within 2 m of the sea floor. The platform is an aluminum tripod capable of sinking to depths of 200 and returning to the surface. This platform contains its own lighting system and electrical power. Twelve shipboard controlled electrical outputs provide power for the sensing elements.

The system is capable of: (1) providing continuous observation of the sea floor by means of underwater television; (2) continuously measuring the velocity profile (6 current meters and 1 direction vane) within 2 m of the bottom; (3) taking, on command, stereophotographs of the bottom for determination of bed configuration; (4) sampling the suspended sediment within 2 m of the bottom, and (5) measuring water depth. All data are transmitted continuously to shipboard and recorded on paper tape. This system has been used on several occasions in inshore waters for continuous periods up to 32 h.

2 refs.

Department of Oceanography, University of Washington, Seattle, Washington.

5.c.5.

1968: Burke, J. C.

Davit for hanging piston corers. J. Mar. Res., 26, 178-181.

420; BIO

The coring davit, as shown in Fig. 1, is mounted on deck just forward and outboard of the aft limb of the A-frame. The corer weight-stand, when not in use, is fast to the davit cradle and is swung inboard so that the A-frame is free for dredging or trawling. To assemble the piston corer, the weight-stand on the davit is swung outboard, pointing forward in such a position that barrels can be attached along a line between the forward limb of the A-frame and the rail, inboard. In this position the swivel point of the davit cradle is directly beneath the sheave of the A-frame. Forward of the A-frame, ATLANTIS II has 70 feet (21 m) of open rail; along this, barrel racks are placed at 10-foot (3-m) intervals at the height of the rail. To ease assembly of the corer, the height of the davit was determined by the height of these barrel racks; the coupling on the weight-stand, when horizontal in the cradle, matches the height of the barrels on the racks. Thus the piston corer is easily assembled, in the shelter of the rail, while the vessel is underway. When the vessel is hove-to in position to core, 2 inch x 4 inch x 8 feet (5 cm x 10 cm x 244 cm) levers are used to move the barrels outboard; a rope sling with a few turns around a bollard is then slacked off to lower the barrels to the position shown in Fig. 1. The pilot weight or pilot corer is now attached. Not until everything is rigged and the corer weight has been transferred to the trawl wire is the weight-stand released from its firm attachment to the davit cradle and the rig lowered away.

no refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

5.c.6.

1968: Schick, G. B., J. D. Isaacs, and M. H. Sessions

Autonomous instruments in oceanographic research. <u>Mar. Sci. Instrumentation</u>, <u>4</u>, 203-230.

250; BIO

Autonomous instruments that descend freely into the ocean and return to the surface, are obtaining data, performing functions, and providing potentials that are unavailable by other methods. The Free Vehicle Program at Scripps Institution of Oceanography now includes a family of instruments that is yielding new insight into the conditions and processes on the deep-ocean floor. Several of these instrument systems are described including:

(1) A bottom trap that has shown new ranges of marine creatures.

(2) A sediment trap that may provide a new entree into near-surface productivity.

(3) A current recorder that has the potential of revealing the circulation of the deep-ocean basins.

(4) A deep-sea camera system that is photographing surprisingly high organic activity at great depths.

The basic requirements for autonomous instruments systems are delineated, and several possible new developments are discussed.

14 refs.

Scripps Institution of Oceanography, La Jolla, California.

5.c.7.

1968: Snodgrass, F. E.

Deep sea instrument capsule. Science, 162, 78-87.

257; BIO

The capsule is adaptable to a variety of experiments. At present, deep sea tides are being measured by recording the fluctuating pressure on the deep sea floor to an accuracy of a millimeter. Temperature changes, measured to a few millionths of a degree, and water currents in the range of 0.1 to 10 centimeters per second are also recorded. Several dozen drops to depths of 4 kilometers have been made, which yield 1-month records of pressure, temperature, and current speed and direction taken at intervals of 2 minutes.

The deep sea instrument capsule (Fig. 1) is assembled in two parts: (i) the buoyant aluminum spheres (Fig. 2) which house the digital data recorders, the electronics for the acoustical system, the radio beacons, and the flashing lights, and (ii) the instrument frame (Fig. 3) that supports the transducers, the release mechanism, tilt and direction meter, and a battery for the radio beacon. The spheres and instrument frame are connected by a 15-meter cable. A ballast of automobile batteries holds the equipment firmly on the bottom while supplying power to the system. The spheres, because of their buoyancy, are tethered upward at the end of the electrical cable where they cause no interference with measurements made near the bottom. When the release device is activated, the connection to the battery ballast is broken, which allows the spheres and the instrument frame to rise to the surface while the batteries remain on the bottom. The capsule ascends at a speed of about 1 meter per second. All components are designed for safe operation at depths up to 5.3 kilometers.

3 refs.

Institute of Geophysics and Planetary Physics, University of California, San Diego, California.

5.c.8.

1969: Brooke, J. and R. L. G. Gilbert

A hydrostatic power system. Proc. Oceanology International Conf., 4, 17 p.

195; BIO

A system has been developed to obtain power in the sea using fluid moving from the ambient hydrostatic pressure into a low pressure reservoir. The paper describes the methods used to control the energy for practical purposes.

A working system and the problems associated with using the sea water directly in a fluid power system are outlined. Tests, both in the laboratory and at sea, indicate the power available from such a system. Pressure effects on various components, such as flexible piping connections and valves, are dicussed together with control of the initial starting cycle.

A method of servo control from the main power unit, to maximize the useful power output from the system, is described.

Experimental results show that the performance of the system is as predicted by theory, and a successful power source has been built to provide 3 H.P. for 10 minutes at 1400 metres; it is equally evident from this equipment that linear movements can also be provided within the above power limits.

4 refs.

Atlantic Oceanographic Laboratories, Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

5.c.9.

1969: Erchul, R. A. and R. J. Smith

Lubricant and polymer reduction of sediment adhesion. Proc. Civil Engng. in the Oceans, Am. Soc. Civil Engineers, 621-640.

051; BIO

Some types of ocean engineering projects underway require the penetration of components as deep as possible into the sediments of the sea floor. Additionally, sediment cores taken for determination of physical properties for foundation engineering purposes require as long a sample as available with minimal disturbance. Investigations were made to determine if such penetrations could be appreciably increased by applying lubricants and polymer coatings to surfaces exposed to the mud. Tests were conducted in the laboratory using steel plates dropped into sediment containers, and at sea with gravity corers. The closely controlled laboratory tests showed lubricants to increase penetrations up to 46 percent and to appreciably modify the character of the penetration event. Tests at sea indicated corer penetrations increased by 35 percent. Greater penetration increases appear to result from longer time intervals than those applied in this test program. The potential uses of such lubricants and coatings for near-shore and land applications are numerous in addition to those for the deep sea.

16 refs.

Department of Ocean Engineering, University of Rhode Island, Kingston, Rhode Island.

5.c.10.

1969: Rosfelder, A. M.

Hydrostatic energy accumulator--Patent No. 3, 436, 914. Off. Gaz. U.S. Pat. Office, 861(2), 406.

273;

The invention is several different embodiments of hydrostatic energy accumulators to be used in undersea environments. All the embodiments have in combination a valve means and a constriction means for improving operating characteristics; also in combination may be accumulator systems that are compressible providing a system whose pressure is substantially equal to the surrounding sea pressure. My invention also includes in several of the embodiments an amplification of pressure using dual pistons and a sealing arrangement about a piston using a variable diameter piston head.

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Scripps Institution of Oceanography, La Jolla, California.

5.c.11.

1971: Phleger, C. F. and A. Soutar

Free vehicles and deep-sea biology. Am. Zoologist, 11, 409-418.

244; BIO

A free vehicle is a timed and weighted device released from a ship in a free fall to the ocean bottom. Instruments carried on the free vehicle have been built to take biological samples, sediment samples, water samples, and photographs, and to measure currents, tides, and temperature. The instrument then returns to the surface where it is recovered by the ship. A free vehicle system for biological sampling in the deep sea is described in detail. It consists of a mast assembly, flotation, hookline and traps, and a magnesium release attached to weights. Different types of magnesium links used include a rod, a wire on pliers, and a series of diamond-shaped beads that drop through a hole after dissolving. A deck plan for launching the free vehicle and its retrieval at sea are described.

22 refs.

Scripps Institution of Oceanography, La Jolla, California.

5.c.12.

1972: Schubel, J. R. and E. W. Schiemer

A device for collecting in-situ samples of suspended sediment for microscopic analysis. J. Mar. Res., 30(2), 269-273.

252; BIO

An in-situ sampler for collecting small samples of suspended sediment for microscopic analysis has been built and tested. The device rapidly freezes a thin layer of water entraping all of the suspended particles in it; when the sampler is recovered, the disc of ice is placed on a suitable substrate and freeze-dried. The particles can then be examined in an undisturbed state with a light microscope or with an electron microscope.

no refs.

Chesapeake Bay Institute, The John Hopkins University, Baltimore, Maryland.

5.c.13.

1973: Harker, R. J. and R. M. Shah

Analysis of soil penetration by a whirl-excited probe. Am. Soc. Mech. Engs. paper 73-DET-126, 18 p.

376;

One approach to this problem is to achieve orbital motion of a probe in a horizontal plane, thereby displacing the soil radially, with excitation produced by a rotating unbalance. The analysis indicates that such a system is bistable, with radial probe amplitudes dependent upon whirl frequency, soil friction, soil compressive resistance, probe mass, and exciter unbalance. Such a device exhibits several desirable operational characteristics, tending to enlarge the hole at increased radial resistance, and to decrease amplitude at reduced resistance, thus being somewhat self-regulating. A prototype has been built in and tested experimentally; however, this paper is primarily a study of steady-state vibratory behavior of a whirl-excited probe, with basic design equations presented.

9 refs.

University of Wisconsin, Madison, Wisconsin.

5.c.14.

1973: Sternberg, R. W., D. R. Morrison, and J. A. Trimble

An instrumentation system to measure near-bottom conditions on the continental shelf. Mar. Geol., 15, 181-189.

126; BIO

In recent years significant interest has emerged regarding bottom currents and sediment dispersal over continental shelves and shallow marine waters. Although many papers have been written on sediment dispersal mechanisms, they include relatively few long-term observations of bottom currents and/or sediment transport. Lack of observational data is related to the hostile nature of the environment, and the difficulty associated with placing and retrieving instruments on the floor of the continental shelf during some seasons and environmental conditions.

This paper describes an instrumentation system designed for use on the floor of the continental shelf. It can remain submerged for periods of one month continuously recording water speed and direction 1 m from the sea bed, differential pressure, and bed nature by means of half-hourly photographs. Four of these systems are presently in use in arrays across the continental shelf of Washington.

1 ref.

Department of Oceanography, University of Washington, Seattle, Washington.

5.c.15.

1973: Thorpe, S. A, E. P. Collins, and D. I. Gaunt

An electro magnetic current meter to measure turbulent fluctuations near the ocean floor. Deep-Sea Res., 20, 933-938.

313; BIO

A self-contained two-component electromagnetic current meter has been constructed to measure rapid fluctuations in currents at 2.1 m above the ocean floor at depths approaching 3000 m. It has been used at depths between 900 and 1600 m in the Gulf of Cadiz.

The current meter uses the principle of electromagnetic induction. An energizing coil with a vertical axis (Fig. 1) is encapsulated in an ellipsoidal 'head', and the electrical current passing through the field produces a potential voltage gradient at right angles to both field and the direction of flow, and this is sensed by two pairs of electrodes mounted on the face of the head. The voltage ratios bear a direct relationship to the horizontal direction of the flow past the head. Electrochemical effects associated with d.c. and direct electromagnetic and capacitive coupling induced by a.c. are avoided by driving the coil by a switched d.c. A steady current is passed through the coil and, after a fixed interval of time to cover the decay of transients, current is then reversed and the process repeated using second capacitors. The potential difference between the two pairs of stored voltage levels is then a direct measure of water speeds normal to the two pairs of electrodes.

4 refs.

Institute of Oceanographic Sciences, Wormley, Godalming, Surrey, U.K.

5.c.16.

1974: Andrews, R. S. and O. B. Wilson, Jr.

Measurement of viscoelastic properties of sediments using a torsionally vibrating probe. Phys. of Sound in Mar. Seds., L. Hampton, ed., Plenum Press, N. Y., 337-355.

336; BIO

The torsional vibrations of a cylindrical probe immersed in a soft sediment generate shear waves which react upon the probe. Measurements of the radiation impedance due to this reaction provide a method for estimating the dynamic rigidity of the sediment. An experimental model of such an instrument, which is operable at frequencies in the range from 900 to 3300 Hz, is described.

The results of some preliminary measurements in soft, saturated sediments, both in situ and in the laboratory, are presented. These results are used to estimate a shear wave speed which is compared with measurements of the speed of surface waves of the Stoneley type. Agreements are better than an order of magnitude. This points out a need for improvements in the precision of the method.

The torsionally oscillating probe method used for measuring the dynamic shear properties of soft sediments reported here has been developed from methods described by Mason (1947) and McSkimin (1952) for the study of viscoelastic polymer solutions. The essential features of the apparatus are: (1) a cylindrical surface which is made to oscillate in torsion with simple harmonic motion; (2) the walls of this cylinder, when placed in contact with the medium being studied, will generate shear waves which propagate into the medium; (3) the mechanical oscillator containing sensors which permit the determination of the reaction to the radiation of these shear waves, the radiation impedance, which may be used in the calculation of the complex shear modulus of the medium.

14 refs.

Department of Oceanography, Naval Postgraduate School, Monterey, California

5.c.17.

1975: Dorey, A. P., A. R. Finch, and K. R. Dyer

A miniature transponding pebble for studying gravel movement. _International Electr. Rad. Engs. Conf. Proc. no. 32_, 327-332.

138; BIO

The bulk movement of gravel sedimentary deposits may be measured using sonar mapping techniques. Individual pebbles can be tracked by marking them using a transponder of size, shape and density similar to the natural grains.

A miniature transponding pebble is being developed that may be used in conjunction with a Kelvin Hughes MS47 transit sonar. The transponder causes a characteristic mark to be made on the sonar plot and its movement can thereby be plotted and taken as characteristic of gravel particle movement.

2 refs.

Department of Oceanographic Sciences, Taunton.

5.c.18.

1976: Smith, K. L., Jr., C. H. Clifford, A. H. Eliason, B. Walden, G. T. Rowe, and J. M. Teal

A free vehicle for measuring benthic community metabolism. Limnol. and Oceanog., 21, 164-170.

124; BIO

A free vehicle respirometer (FVR) which measures the oxygen consumption of benthic communities in situ to abyssal depths consists of a structural aluminum tripod supporting a two-command acoustic release-transponder, an oxygen monitoring unit, a glass sphere flotation array, and a time lapse camera system. An acoustic signal actuates the first command mode. This releases the oxygen monitoring unit. Settlement is monitored by the camera system. After measurements lasting 1 to 5 days, the second acoustic command releases the descent weights, and the free vehicle is brought to the surface by the flotation array and recovered.

Preliminary results obtained with the FVR at 5,200 m in the northwest Atlantic suggest that benthic community respiration decreases three orders of magnitude from values measured at shallow shelf depths.

13 refs.

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

5.c.19.

1976: Mortensen, A. C. and R. E. Lange

Design considerations of wing stabilized free-fall vehicles. Deep-Sea Res., 23(12), 1231-1240.

096; BIO

Analytical design considerations and the measured behavior of a freely-falling, self-rotating oceanographic instrument using hydrodynamic airfoil wings to control vertical fall rate and enhance stability are presented.

Oceanic measurements of a vehicle of payload 30 kg. wing length 2 m, wing chord 0.16 m, and overmass of 5 kg (in seawater) show tilts from the vertical of order 2×10^{-3} radians and a fall velocity of $0.114 \text{ m s}^{-1} \pm 0.5\%$. The rotation rate is 21.8 s and perceptibly constant. Vertical velocity gradients measured on one drop are compared with vertical and horizontal accelerometer records, documenting the tilt and fall rate constancy. The fall rate and rotation rate compare well with the analytically derived formula.

3 refs.

EG and G Environmental Consultants, Waltham, Massachusetts.

5.c.20.

1976: Renard, V.

In-water path of free-fall packages in oceanography. Meerstech, 7(6), 201-204.

093; BIO

Deep water sampling or measurement of physical parameters is normally accomplished by instruments suspended by wire from a support ship, or by free-fall instruments. The use of free-fall instrument packages represents a useful alternative to, or permits some types of operations that are not possible with the use of the more traditional wire-suspended devices.

2 refs.

Centre Océanologique de Bretagne, Brest.

5.c.21.

1977: Sternberg, R. W., C. A. Nittrouer, and L. H. Larsen

An integrated approach to the study of marine sedimentological processes: new instruments and methods. <u>Trans. Am. Geophys. Union</u>, <u>58(6)</u>, 408.

127; BIO

Recent technological advances can be used to increase our knowledge of sediment motion and accumulation in the shallow marine environment. The use of microprocessor electronics enhances our ability to make time-series field measurements of sediment motion near the seabed, by allowing us to employ multi-instrument combinations in programmable sampling sequences. An instrument system has been developed which rests on the seafloor (up to 200 m depth) for a two-month period and can measure: mean current velocity (1 m off the bed), mean bottom pressure and pressure variance, and light attenuation; and can obtain bottom photographs and samples of suspended sediment. A microprocessor monitors all sensors and adjusts data collection in accordance with wave conditions (e.g. collect suspended sediment samples depending on light attenuation).

Certain short-lived (half-life less than 25 yrs) natural radioisotopes have recently proven to be excellent means for investigating sediment accumulation. Pb-210 studies, in particular, can be used to establish modern (last 100 yrs) sediment budgets, and to examine sediment mixing due to physical (wave and current activity) and biological (bioturbation) processes. When these new tools for studying sediment motion and accumulation are used together, it is possible to develop a comprehensive understanding of sedimentological processes in such important marine environments as the continental shelf.

abstract only

Department of Oceanography, University of Washington, Seattle, Washington.

5.c.22.

1977: Weiss, R. F., O. H. Kirsten, and R. Ackermann

Free vehicle instrumentation for the <u>in-situ</u> measurement of process controlling the formation of deep-sea ferromanganese nodules. <u>Conf. Record Oceans '77 (IEEE-MTS)</u>, paper 44D, 4 p.

053; BIO

This paper describes the free vehicle instrumentation under development for the Manganese Nodule Program (MANOP) of the International Decade for Ocean Exploration (IDOE). Principal emphasis is being placed on the MANOP Bottom Lander, a device designed to carry out in situ chemical flux experiments at the seawater-sediment interface at depths up to 6 km. This device will collect time-series water samples from three separate bottom chamber experiments, each of which can be spiked with various chemical and radioisotopic tracers. The device will also make oxygen and pH measurements in each chamber and will take box core samples under each chamber before returning to the surface. All operations will be microprocessor-controlled with data storage capability and with an acoustic data-link to the surface. Deployments will be for periods of up to 1 year.

1 ref.

Scripps Institution of Oceanography, University of California at San Diego, LaJolla, California.

5.c.23.

1977: Young, R. A.

SEAFLUME: A device fo in-situ studies of threshold erosion velocity and erosional behavior of undisturbed marine muds. Mar. Geol., 23, M11-M18.

063; BIO

A self-contained sea-going flume has been designed for use in sediment transport studies on the sea floor. Bottom sediment behavior and flow velocity resulting from water pumped through the flume are recorded photographically to obtain estimates of threshold erosion velocity and modes of erosion. Precision and accuracy of estimated threshold velocities for muddy marine sediments are found to be as good or better than those previously obtained by other field or laboratory techniques.

11 refs.

Massachusetts Institute of Technology - Woods Hole Oceanographic Institute Joint Program in Oceanography, Woods Hole, Massachusetts.

5.c.24.

1978: Young, R. A. and J. B. Southard

Erosion of fine-grained marine sediments: sea-floor and laboratory experiments. Geol. Soc. Am. Bull., 89, 663-672.

Estimates of threshold erosion velocities have been obtained in the field and in the laboratory for marine mud relatively rich in organic matter and having an active infauna. A sea-floor flume was used to erode undisturbed sediments on the sea floor, and a laboratory flume was used to study the effects of sampling, redeposition, bioturbation, organic-matter content, and compaction time on erosion resistance.

34 refs.

Massachusetts Institute of Technology - Woods Hole Oceanographic Institute Joint Program in Oceanography, Woods Hole, Massachusetts.

5.c.25.

1978: Burns, R. G., V. M. Burns, H. W. Stockman, C. T. Stockman, and M. D. Benson

Deployment of long-term seafloor mineral exposure experiments to measure changes of mineralogy and composition of manganese modules. Conf. Record Oceans '78 (IEEE), 662-667.

368; BIO

Long-term mineral exposure experiments near the seafloor at two stations in the north equatorial Pacific have been designed around long-life transponders left behind after the completion of Deep Tow surveys during the October 1977 INDOMED expedition of R/V Melville for the NSF-IDOE Manganese Nodule Project. Attached to each transponder remaining at Site M (metalliferous rise-crest sediments; 8°46'N, 103°58'W; 3040 m.) and at Site H (hemipelagic sediments; 6°33', 92°46'W; 3470 m.) are a dozen flow-through plastic capsules containing a variety of natural and synthetic hydrated oxides of manganese and iron, including minerals found in deep-sea manganese nodules. When the two stations are re-occupied in 1980-81, the transponders will be recalled and measurements made on materials in the capsules to determine phase changes,
metal-uptake capacity, and oxidation products of the various Mn and Fe oxides.

9 refs.

Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts.

5.c.26.

1978:

The use of ocean energy--a hydrostatic motor. Conf. Record Oceans '78 (Mar. Tec. Soc./IEEE), 599-601.

101; BIO

A device which utilizes the hydrostatic gradient at sea is described. The apparatus is currently configured to drive a deep-sea sediment sampler but could be used for virtually any power requirement. A simplified schematic diagram is presented to illustrate the working principle, and sample calculations of the power available are provided.

4 refs.

Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York.

5.c.27.
1979: Butman, B. and D. W. Folger

An instrument system for long-term sediment transport studies on the continental shelf J. Geophys. Res., 84(C3), 1215-1220.

097; BIO

A bottom-mounted instrument system has been designed and built to monitor processes of bottom sediment movement on the continental shelf. The system measures bottom current speed and direction pressure, temperature, and light transmission and photographs the bottom. The system can be deployed for periods of 2-6 months to monitor intermittent processes of sediment movement such as storms and to assess seasonal variability. Deployments of the system on the U.S. east coast continental shelf show sediment resuspension and changes in bottom microtopography due to surface waves, tidal currents, and storms.

6 refs.

U.S. Geological Survey, Woods Hole, Massachusetts.

5.c.28.

1979: Cacchione, D. A. and D. E. Drake

A new instrument system to investigate sediment dynamics on continental shelves. Mar. Geol., 30(3-4), 299-312.

094; BIO

A new instrumented tripod, the GEOPROBE system, has been constructed and used to collect time-series data on physical and geological parameters that are important in bottom sediment dynamics on continental shelves. Simultaneous in situ digital recording of pressure, temperature, light scattering, and light transmission, in combination with current velocity profiles measured with a near-bottom vertical array of electromagnetic current meters, is used to correlate bottom shear generated by a variety of oceanic processes (waves, tides, mean flow, etc.) with incipient movement and resuspension of bottom sediment. A bottom camera system that is activated when current speeds exceed preset threshold values provides a unique method to identify initial sediment motion and bed form development.

Data from a twenty day deployment of the GEOPROBE system in Norton Sound, Alaska, during the period September 24 - October 14, 1976 show that threshold conditions for sediment movement are commonly exceeded, even in calm weather periods, due to the additive effects of tidal currents, mean circulation, and surface waves.

9 refs.

U.S. Geological Survey, Menlo Park, California.

5.c.29.

1979: Smith, K. L., Jr., G. A. White, and M. B. Laver

Oxygen uptake and nutrient exchange of sediments measured in situ using a free-vehicle grab respirometer. Deep-Sea Res., 26(3A), 337-346.

098; BIO

A free vehicle grab respirometer is described. It can measure oxygen uptake and nutrient exchange of deep-sea sediments and then return to the surface with four replicate box cores containing the undisturbed sediment and overlying water on which these measuremets were made. Total oxygen uptake and nutrient exchange were measured in situ in the eastern North Pacific at two stations, one in the an Diego Trough at a depth of 1193 m and one off the Patton Escarpment at 3815 m. Both stations underlie the eutrophic California Current system. There was not significant difference in total oxygen uptake between stations, but the values were significantly higher than previous measurements made at comparable depths. Ammonia, nitrite, and phosphate were evolved while nitrate was taken up at 1193 m. At the deeper station, all the nitrogenous compounds were evolved but phosphate was taken up. A delicate ammonia gradient seems to exist across the sediment-water interface.

24 refs.

Marine Biology Research Division, Scripps Institution of Oceanography, LaJolla California.

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1965: Andresen, A., S. Sollie, and A. F. Richards

N.G.I. gas operated, seafloor sampler. Proc. 6th. Conf. Soil Found. Engng, Montreal, 1, 8-11.

1972: anonymous

Submersible sounding tool to test North Sea Floor. Oil and Gas J., 70, 74-77.

1973: anonymous

Diamond core drill for seabed samplings. Gas World, 7 July.

1973: anonymous

Seabed sampler gets first offshore trial. Petrol. Petrochem. International, 13, 36-40.

1973: anonymous

Advanced seabed core sampler in time for Noth Sea boom. New Civil Eng., (6), 34-35.

1978: anonymous

Seabed sampler. Ground Eng., (7), 49.

1978: anonymous

Marine cone penetrometer system. Ground Eng., (5), 46.

1965: Arnett, R. A. and T. W. Newhouse

Ocean-bottom seismograph. Proc. IEEE, 53, 1899-1905.

1978: Arnold, P.

Offshore geotechnical instrumentation. IEEE J. Ocean. Engng., OE-3(4), 92-95.

1970: Bailey, E. I. and G. L. Davis

Design of an automatic marine corer. Tex. A. and M. Univ. Sea Grant Prog. Publ. 71-202. (Ocean Abstracts OA71-2B-0950)

1980: Barnette, D. W.

Dynamic elastic analysis of a slender body with application to a seabed corer. Sandia National Labs. Rept. SAND-80-0908.

1951: Barr, K. W.

Jet sampler, a method of obtaining submarine samples for geological purposes. J. Inst. Petrol, 37, 658-661.

1967: Breslau, L. R.

The normally incident reflectivity of the sea floor at 12 kHz and its correlation with physical and geotechnical properties of naturally-occurring sediments. Woods Hole Oceanog. Inst. Ref. 67-16.

1972: Buchan, S., D. M. McCann, and D. T. Smith

Relations between the acoustic and geotechnical properties of marine sediments. Quart. J. Engng. Geol., 5, 265-284.

1967: Buffington, E. C., E. L. Hamilton, and D. G. Moore

Direct measurement of bottom slope, sediment sound velocity and attenuation and sediments shear strength from Deepstar 4000. Proc. 4th. U.S. Navy Symp. on Mil. Oceanog., 1, 8-91.

1950: Cadling, L. and S. Odenstad

The vane borer. Proc. Roy. Swed. Geotech. Inst., no. 2, 88 p.

1960: Caldwell, J. M.

Development and tests of a radioactive sediment density probe. U.S. Army Corps. of Engs. Beach Erosion Bd. Tech. Memo 121.

1978: Chari, T. R., K. Muthukrishnaiah, and J. S. Rao

Bibliography on geotechnical investigation of marine sediments. Mem. Univ. of Nfld., St. John's, Appl. Sci. Tech. Rept. 205, 27 p.

1972: Chmelik, F. B., A. H. Bouma, and G. L. Huebner, Jr.

Hi-Resolve; a unique sediment survey system. Resources and Dev. of Oceans, 2nd. International Ocean Dev. Conf, 1, session B-1, Tokyo, 715-732.

1969: Christoffel, D. A. and I. M. Calhaen

A geothermal heat flow probe for in situ measurement of both temperature gradient and thermal conductivity. J. Sci. Instru, 2, 457-465.

1977: Degens, B., D. M. McCann, and J. T. Lambert

Representative sampling for seabed foundation design. Design and Construction of Offshore Structures, J. P. Blanc and M. Munro, eds., Inst. Civil Engng., London, 43-48.

1971: Demars, K. R. and R. J. Taylor

Naval seafloor soil sampling and in-place test equipment: a performance evaluation. U.S. Naval Civil Engng. Lab. Tech. Rept. CEL-TR-R-730, 57 p.

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Methods of exploring the ocean floor. Oceanographic Instrumentation, J. D. Isaacs and C. O. Iselin, eds., Nat. Res. Council Publ. 309, 194-209.

1970: Eden, R. A., D. Flinn, and E. Harrison

Experimental work with the Harrison hard rock corer, a light-weight underwater rock drill. Proc. Geol. Soc. London, (1662), 73-74.

1948: Emery, K. O. and A. R. Champion

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