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Water quality — Sampling —

Part 19: Guidance on sampling of marine sediments

Qualité de l'eau — Échantillonnage —

Partie 19: Lignes directrices pour l'échantillonnage des sédiments en milieu marin

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 5667-19 was prepared by Technical Committee ISO/TC 147, *Water quality*, Subcommittee SC 6, *Sampling (general methods)*.

ISO 5667 consists of the following parts, under the general title *Water quality — Sampling*:

— *Part 1: Guidance on the design of sampling programmes*

— *Part 2: Guidance on sampling techniques*

— *Part 3: Guidance on the preservation and handling of samples*

— *Part 4: Guidance on sampling from lakes, natural and man-made*

— *Part 5: Guidance on sampling of drinking water and water used for food and beverage processing*

— *Part 6: Guidance on sampling of rivers and streams*

— *Part 7: Guidance on sampling of water and steam in boiler plants*

— *Part 8: Guidance on sampling of wet deposition*

— *Part 9: Guidance on sampling from marine waters*

— *Part 10: Guidance on sampling of waste waters*

— *Part 11: Guidance on sampling of groundwaters*

— *Part 12: Guidance on sampling of bottom sediments*

— *Part 13: Guidance on sampling of sludges from sewage and water-treatment works*

— *Part 14: Guidance on quality assurance of environmental water sampling and handling*

— *Part 15: Guidance on preservation and handling of sludge and sediment samples*

— *Part 16: Guidance on biotesting of samples*

— *Part 17: Guidance on sampling of suspended sediments*

— *Part 18: Guidance on sampling of groundwater at contaminated sites*

— *Part 19: Guidance on sampling of marine sediments*

Introduction

Analysis of marine sediments plays a major role in monitoring of the aquatic environment and providing information on the status and development of polluted conditions in sediments because of ability of sediments to accumulate contaminants. Marine sediments are characterized by a wide range of organic content, mineralogy and texture.

In ideal sedimentary conditions, i.e. in accumulation areas (deep basins, trenches, etc.), the sediment is deposited in chronological order, such that changes in the deposition of, for example, contaminants can be related to an identifiable time period. However, monitoring of marine bottom sediments, involving both qualitative and quantitative analyses of contaminants, is carried out world-wide in the absence of a common set of procedures and this International Standard is part of an attempt to remedy this situation.

Water quality — Sampling —

Part 19: Guidance on sampling of marine sediments

1 Scope

This part of ISO 5667 provides guidance for the sampling of sediments in marine areas for analyses of their physical and chemical properties for monitoring purposes and environmental assessments. It encompasses:

— sampling strategy;

— sampling devices;

— observations made and information obtained during sampling;

— handling sediment samples;

— packaging and storage of sediment samples.

This part of ISO 5667 does not provide guidelines for data treatment and analysis which are available from other references (see the Bibliography).

This part of ISO 5667 is not intended to give guidance for sampling of freshwater sediments.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6107 (all parts), *Water quality — Vocabulary*

3 Terms and definitions

For the purpose of this document, the terms and definitions in ISO 6107 (all parts) and the following apply.

3.1
acoustic survey
mapping of bottom topography and sediment stratigraphy by use of sound waves

3.2
baseline survey
survey with emphasis on classification and description of conditions in the survey area, which provides the basis for future monitoring and/or follow-up surveys

3.3
contaminant
compound or element which, at concentrations above background, are considered to be harmful to the environment

3.4
receiving water body
recipient
recipient water body
water body which receives an input of material of either natural or anthropogenic origin

NOTE The term often appears in the context of contamination by, for example, effluent from municipal wastewater outlets or industrial processed water. Receiving water body surveys describe the state of contamination in a given area.

3.5
reference point
sampling point chosen to represent the natural environmental conditions in a given area

3.6
replicate samples
series of samples taken simultaneously at the same sampling point in the same manner

3.7
sub-sample
representative portion removed from a sample

4 Strategies and objectives for sediment sampling

4.1 Sampling programme and plan

Developing an appropriate sampling plan is one of the most critical steps in monitoring and assessment studies. The sampling programme is designed in accordance with the individual survey aims and specific data quality objectives to be achieved. The elements in the sampling strategy include definition of the study area, the choice of methodology and survey type, location of sampling points and the number of sampling points required. These will be built into a sampling programme taking account of requirements such as seasons, discharge patterns, etc.

The required precision of results, local sediment substrate variability, topographical and hydrographical conditions in the survey area, information on local contamination sources and knowledge from previous surveys (if any) should all be taken into account. The number of sampling points, their locations and number of replicate samples to be taken at each sampling point should be established prior to the initiation of the survey, but appropriate adjustments may be made in the field, particularly in the case of pilot surveys. It is important to harmonize the design of the trend surveys to the statistical power required of the data, i.e. over what time scale change is to be measured. In statistical terms, the two sources of variability are sampling error and measurement error.

See ISO 5667-1 for further information on design of sampling programmes.

4.2 Types of surveys

4.2.1 General

Surveys of sediments may be divided into three main categories according to the objectives and required precision of results. The strategies related to these categories are summarized in Table 1.

Table 1 — Strategies for different types of sediment surveys

Survey	Strategies
Pilot survey	Reconnaissance, few randomly placed samples
Baseline survey	Impact assessment, grid or gradient sampling
Temporal trend survey	Time changes, repeated sampling of surface sediments along gradients or sediment cores

4.2.2 Pilot and/or reconnaissance survey

This is an initial assessment of physical and chemical conditions in the bottom sediments in an area where the contamination source is not known or where there are no existing data pertaining to the receiving water body. The survey allows a coarse assessment of environmental conditions and can provide the basis for development of a sampling programme for other surveys as well as long-term surveillance. The requirements for equipment, sampling methodology and reproducibility are usually relatively simple (see Table 2).

A pilot survey generally requires only a few, randomly placed samples in an area deemed to be a sediment deposition area. If the objective is to describe the conditions on the seabed, a series of samples should be required, in both deep and shallow water. The sampling area should cover as much of the survey area as possible, ideally in the form of sampling points placed in a grid. An acoustic survey of the bottom sediments should be performed prior to the sediment sampling. Sediment sampling will in any case be required to confirm the acoustic data. In regions with varying sea floor topography and open to wind and currents, an acoustic survey or a remote operated vehicle (ROV) reconnaissance, is the only means of determining the uniformity of sediment deposition. Uneven distribution occurs both in areas of coarse and fine sediment deposition.

4.2.3 Baseline survey and/or environmental impact assessment

This is a survey carried out where the contamination source is known, and the aim is to describe the spatial extent of the zone of contaminant influence (potential biological impact). Such surveys may be carried out using relatively simple methodology, but there usually are specified requirements for the methodology and procedures to be used.

For describing the spatial extent of sediment contamination around a known point source, the sampling points should be placed in a grid or along a gradient of expected contamination. Information on the current regime should be used to guide the survey grid and can sometimes be anticipated from acoustic and/or hydrographic data. An acoustic survey of the bottom sediments should be performed prior to the sediment sampling as well as obtaining information on the hydrographic regime. A contour map should be constructed to indicate the spatial extent of sediment contamination, requiring a large number of sampling points. At the same time, the investigation also provides information on how the concentrations in the sediments decrease with distance from the source. The results can also be used to quantify the total amount of contaminants in the upper sediment layer.

An environmental assessment should be carried out at locations where changes in environmental conditions are to be expected, for example in polluted water bodies or at places where activities that can affect the environment are established. This environmental assessment should be based on a detailed chemical and physical investigation of the sediments. The investigation provides the basis for characterization of the environmental conditions in the areas in question, according to specified sediment quality criteria and by comparison with the sediments in reference areas. Thereafter, follow-up monitoring surveys should be carried out, their frequency depending upon the particular circumstances.

4.2.4 Temporal trend survey

This is a survey of the temporal changes in the chemical and/or physical conditions in the sediments to document either contamination or natural variation over time. The surveys should be carried out using fixed sampling points and using standardized methodology according to an established programme.

All sampling equipment and procedures should be documented and any field observations and measurements recorded on an appropriate field sheet/log book. This will facilitate future surveys for the purpose of temporal trend monitoring.

It is important that the statistical power of the sampling is robust and suited to the requirements of the study.

A trend monitoring investigation follows temporal development of contamination in the receiving water and may be carried out in one of the following two ways.

a) Surface samples should be taken within a set radius of the reference point according to the aims and objectives of the survey. Once set, the radius should be adhered to for future surveys within the time series. This requires accurate positioning, for example using a differential global positioning system (DGPS). Sampling frequency will be determined by a variety of factors including the rate of sediment deposition in the area, seasonality and flushing rates.

   EXAMPLE For an annual sediment deposition rate of 2 mm, sampling could for practical reasons be carried out every 5 years (1 cm depth). However, the relevance of sampling at 5-year intervals is highly dependent on the number of samples taken and the statistical power required to establish trends.

b) Analyses should be carried out on several layers from undisturbed sediment cores. The depth and intensity of bioturbation (caused by physical disturbance of sediments by animals and gas bubbles) should be taken into account. If the monitoring is to be based on cores, the samples should normally be taken along a transect of maximum depth (“deep-spots”) where experience indicates that the sediments are the least disturbed. However, the suitability of the sampling area should preferably be checked by doing an acoustic survey. The deepest parts of channel-type formations are not necessarily the best sampling areas.

   EXAMPLE Use of sediment cores in temporal trend monitoring requires data on sedimentation rates (e.g. achieved by isotope dating of cores). The depth resolution of the sediment sub-sampling will depend on the sediment accumulation rates. Vertical sampling should take place down to a depth corresponding to non-contaminated sediments if possible.

Sediments that are physically disturbed by human activities (e.g. trawling) are generally not suitable for retrospective trend monitoring purposes.

4.3 Sampling strategy and/or design

4.3.1 General

Sampling points should be positioned according to the individual survey objectives, previous surveys in the area and local sediment type and hydrographic conditions.

Shallow areas with uneven topography generally provide poor material for sampling (fine-grained sediments are transported or eroded due to waves or currents). Deep areas (basins) and flat bottoms are typical accumulation areas, where fine-grained sediments potentially carrying contaminants are deposited (no wave activity and weak currents). Coarse, sandy sediments should be avoided for contamination studies as these are poorly suited as a sampling medium, although they may be studied as part of wider investigations, for example for benthic biology.

The number of replicate samples to be taken per sampling point should be chosen with care. A statistical assessment should be made of the number of replicates required, in accordance with the survey parameters and the required density of sampling points. Depending upon the outcome of the statistical assessment, at

least three separate replicate samples may be required to be taken from each sampling point and analysed separately to assess the extent of variation at the sampling point concerned.

Where it is suspected that contaminated sediments may have an uneven distribution, many replicate samples may be necessary to ensure a representative picture. This is particularly important close to contamination sources, in harbour areas and in shallow waters or other areas where the nature of the bottom sediments shows considerable variation across a relatively small area. If analyses of replicate samples are not possible, a composite sample should be made of all the replicate samples taken at the sampling point. In the latter case, an equal aliquot of sediment should be taken from each sample and homogenized prior to analysis.

The spatial extent of contamination may be mapped by placing sampling points in several ways. Positioning of sampling stations should be carried out according to one of three main principles or in combination:

— random;

— grid;

— gradient.

4.3.2 Random sampling (probabilistic based)

A pre-determined number of samples should be collected. Random sampling designs avoid bias in the results of sampling by randomly assigning and selecting sampling locations. This sampling strategy is relevant for pilot surveys and, to some extent, baseline surveys.

4.3.3 Grid sampling

In grid sampling the first sampling location is chosen randomly and all subsequent stations are placed at regular intervals (e.g. 50 m apart) throughout the study area. The station grid should be adjusted according to the topographic and hydrographic conditions in an area. Sampling points arranged in a grid often are used for environmental assessment of sediment quality and for assessing the size of the area of influence, as for baseline surveys.

4.3.4 Gradient sampling

Sampling points should be arranged in sectors or along selected transects in relation to a contamination source. The decrease in concentration of contaminants away from the source will indicate the dispersal pattern of the contaminant. It is essential to consider natural factors which may affect the sediments, such as grain size, content of organic matter, redox conditions, currents, etc. This sampling strategy is particularly applicable for baseline studies and for temporal trend monitoring purposes.

4.4 Reference points

For surveys carried out in contaminated areas, reference points may be established outside the affected area. As far as possible, reference points should represent natural conditions, without any influence of point-source discharges. An alternative to using a reference point is to measure contaminants in layers down the sediment core, which represent sediment deposited during a pre-industrial era.

Sampling at reference points, where applicable, should be carried out under conditions as similar as possible to those at the sampling points (i.e. similar depth and sediment type).

5 Sampling procedure

5.1 Vessel requirements during sampling

The survey aims and local conditions largely govern the choice of vessel. Sampling in offshore and coastal areas requires vessels of such a size to allow work to take place in rough weather conditions. Sampling equipment will also impose survey vessel constraints and needs careful consideration prior to surveying. In estuaries, fjords and river mouths, small vessels may be appropriate. The vessel requirements should be related to the type of sampling equipment to be used, storage and sample handling requirements. Survey vessels should comply with all safety regulations. It is important that the samples remain in an undisturbed condition, both during and after sampling.

5.2 Defining the position of sampling points

The position of the sampling points should be defined unambiguously, such that other operators can relocate it. Positions should be defined using geographic co-ordinates with reference to the local geodetic system in use. Positions should be defined according to the relevant guidelines.

A DGPS with a monitor can be used in open seas. In fjords and coastal areas, the minimum requirement is radar. In addition to geographic co-ordinates, sampling points may be defined using the direction and distance from landmarks or fixed points of reference. Water depth should be recorded as chart datum to account for tidal variation. Positional requirements for accuracy and precision should be stated in the aims and objectives of the survey. Stability of the positioning of the survey vessel should be ensured by dynamic positioning (DP).

When revisiting sampling points which are poorly defined in terms of position, the water depth and sediment type should be used as the main criteria for relocating the sampling point.

The accuracy and precision of the position-fixing should be recorded to provide an indication of the accuracy to which the reference point has been located. In defining the position of sampling points, especially when using larger vessels, the distance and direction of the sampling position (winch) from the DGPS receiver should be accurately noted.

5.3 Choice of sampling equipment

The choice of sampling equipment should be based on the sediment type and the survey aims. Some sampling devices are exclusively suited for fine-grained material, while others can accommodate less cohesive sediments. Table 2 shows the types of sampling devices to be chosen according to the survey aims and sediment type.

For investigations of organic micro-pollutants, the sampling core tubes should be made of inert plastics material [preferably poly(methyl methacrylate)[1)]] or stainless steel. Either stainless steel or plastics materials [poly(vinyl) chloride (PVC), poly(methyl methacrylate), etc.] should be used for investigations of metal contamination. When using plastics core tubes, a hard type of plastics material is recommended to reduce friction between the core tube walls and sand grains. Polycarbonate tubing has the advantage of transparency [as does poly(methyl methacrylate)], but has superior mechanical strength.

The equipment should be cleaned between each change of sampling location. The sampling device and other equipment that comes into contact with oily substances should be washed repeatedly with water (either seawater or freshwater) with, for example, soap until the equipment is clean. In difficult cases or when studying organic micro-contaminants, organic solvents (acetone, cyclohexane, etc.) may be used during the washing process. When composite samples are taken, the equipment should be washed in seawater between each replicate sample within each sampling location.

1) Known as Plexiglas® and Perspex® which are examples of suitable products available commercially. This information is given for the convenience of users of this part of ISO 5667 and does not constitute an endorsement by ISO of these products.

When sampling very soft (fluid) mud, the construction of the sampler should be such that during lowering, free flow of water through the equipment is ensured to prevent the build-up of a pressure wave in front of the equipment during lowering to the bottom. Especially when working with grabs, the pressure wave in front of the advancing grab may displace all fine material before the grab has a chance to function properly.

All sampling equipment should be accompanied by standard operating instructions.

A description of the five main types of sediment sampling devices is given in Annex B. See ISO 5667-12 for further details.

Table 2 — Choice of sampling device according to survey aims and sediment type

Main aim	Requirements	Fine sediment	Coarse sediment
Pilot survey	Undisturbed surface sediment	Grab, single corer, box corer	Grab, box corer, piston corer
Baseline survey	Undisturbed surface sediment	Grab, single corer, piston corer, multi-corer, box corer	Grab, box corer, piston corer
Temporal trend survey	Undisturbed sediment surface or vertical sediment layers (continuous sedimentation)	Single corer, piston corer, multi-corer, box corer	Not suitable
NOTE A single corer usually is a gravity corer.			

5.4 Handling of sediment samples

A visual quality evaluation of the samples should be carried out in the field and include a description of colour, odour, presence of animals, strata, etc. The supernatant water overlying the sediment surface should be undisturbed. The device should have penetrated the sediment to the required depth and the sediment surface should be close to horizontal (vertical penetration). If this is not achieved, the sample should be discarded.

Occasionally a sample may be collected that is somewhat different in appearance compared to other replicate samples. This may indicate uneven distribution or heterogeneity. The unusual sample should not be discarded, but it is suggested that one or more additional samples be collected.

The samples should be handled in such a way as to avoid affecting the analytical results. Prior to packaging, handling of the sample should be restricted to extraction of the individual samples during core sectioning and during sub-sampling of cores from a box core, where appropriate. Handling should be carried out as soon as possible after the sample is taken to avoid changes in temperature and oxygen conditions that can affect geochemical and biochemical processes in the sediments. If the sample is to be left in the core liner for any longer time period before extraction, the core liner should be capped in order to avoid contamination of the sample. Samples of anoxic sediments should, if necessary, be handled in a nitrogen atmosphere to avoid oxidation of reduced compounds. When taking the sediment samples, the equipment used should be of the same material as specified for the choice of sampling device (see 5.3). Any moving parts close to the sampler or directly above it, such as winch wires or swivels, should be grease- and oil-free to prevent contamination of the sample.

The samples should be quickly covered to protect them from contamination on deck, for example by deposition of soot particles from the vessel's exhaust or oil/grease contamination from the winch.

Where it is necessary for the core to be transported prior to sectioning, for example when the sampling is carried out by diver, the core should be transported in an upright position. Sediment in contact with the core barrel should be avoided because of smearing effects.

Cleanliness is particularly important during this phase, and all conditions that potentially can affect the analytical results should be noted in the log book. For information about handling and preservation of samples, see ISO 5667-3.

5.5 Sample identification and records

At least the following information should be recorded:

— person(s) responsible for sampling and sub-sampling;

— project or contract identification code;

— geographical co-ordinates for each sampling point (for each replicate sample in case of boat drift during sampling) (see 5.2);

— date and time for each sample in accordance with ISO 8601;

— sediment core length (cm) or grab sediment depth (cm);

— visual description of the sediment (colour, homogeneity, structure, grain size, odour, presence of fragments);

— sampler used;

— sectioning intervals;

— water depth (m);

— meteorological data (daily).

Annex A gives an example of a form for recording details during sediment sampling.

6 Packaging and storage of sediment samples

The choice of packaging should be made according to the analyses to be carried out. The analysing laboratory should be consulted to ensure correct sample handling and storage. The same type of packaging should be used for all samples to be analysed for the same determinand.

Sediment samples to be analysed for organic contaminants should be packed in specially prepared glass containers. This preparation may include cleaning with organic solvents or high-temperature combustion (depending on the determinands to be analysed) and rinsing with deionized water.

Samples for analysis of total organic carbon or heavy metals should be packed in plastics sampling pots or Petri dishes. If the containers have been re-cycled, they should have been cleaned in soapy water. Alternatively, samples should be packed in robust plastics bags.

All packaging should be water-tight to prevent evaporation of labile compounds and leakage of gas and/or water. The following information should be clearly marked on the container/bag and the lid, if used:

— identification code of sampling station;

— date, time, co-ordinates and section interval, i.e. the depth of sediment from which the section was taken.

Container information should not be pre-labelled with information since this practice reportedly increases the possibility of sample misidentification.

Sediment samples should be preserved in accordance with ISO 5667-3. In general, sediment samples should be frozen immediately (−20 °C) after sampling. Certain analyses are performed on freeze-dried material. Should there be no access to a freezer, storage in a dark cold-room is sufficient for most requirements to keep microbial activity in the sediments to a minimum. An example of a form for recording details during sediment sampling is given in Annex A.

7 Safety precautions

WARNING — Many types of sediment sampler present a serious danger to personnel; all staff should be fully aware of the appropriate procedures to operate safely and work around each sampler. All persons collecting and handling samples should take safety training, with remedial training every 3 years or sooner.

Safety instructions pertaining to sampling as well as general safety instructions related to the vessel performing the sampling should be made available. All participants should be familiar with safety procedures regarding transportation and handling of dangerous substances. When handling severely polluted sediments, precautions should be taken to avoid health hazards.

The sea and atmospheric (i.e. fog) conditions should be considered carefully, even in inshore waters where the absence of high swells should not be assumed.

8 Quality assurance

8.1 General

External quality assurance (QA) of sediment sampling in the marine environment should secure comparable results from work carried out by different people and institutions at different locations and using different equipment.

8.2 Quality assurance protocols

Prior to the field sampling, QA protocols should be made available. For each field sampling programme, a person responsible for the QA should be appointed. The QA person should follow the procedures and report any deviation. All participants in the field sampling are obliged to report any deviation from the procedures to the QA person responsible for QA procedures so as to develop the means for handling such deviations.

Annex A
(informative)

Example of a form for reporting — Sampling marine sediments

Information to accompany each sample

Site: ..... Date: .....

Latitude: ..... Longitude: ..... Time: .....

Project number/contract identification code: .....

Name of vessel, if applicable: .....

Name(s) of person(s) taking samples: .....

Name(s) of person(s) taking sub-samples: .....

Description: .....

.....

Hydrographic tidal currents: Direction ..... Approx. velocity .....

Time of high water: ..... Time of low water: …….....……

Weather conditions: Wind direction ..... Force .....

Cloud cover: ..... State of sea (i.e. calm, rough, etc.) .....

Measurement in the field

Code, sampling location	Position, Lat-long	UTM-coordinates	Depth m	Core length cm	Section interval (from/to) cm	Visual description

Sample no: .....

No of replicates (e.g. 1 of 3, 2 of 3, etc.): .....

Sampling method: .....

.....

Type/brand name of sampling equipment:

.....

Analysis profiles: .....

.....

Preservation procedure: .....

Remarks: .....

.....

Signature(s) of person(s) taking samples: .....

Annex B
(informative)

Description of sediment sampling devices

B.1 General

All equipment should be accompanied by appropriate operating instructions and all survey staff trained in their use prior to survey.

B.2 Grabs

Grabs, usually with a sampling area of 0,01 m^2 to 0,2 m^2, are most often used for biological surveys (macrofauna) and are used to a lesser degree in chemical surveys. This is due to the fact that some grabs do not close adequately, such that the sediment surface can become disturbed by drainage of the supernatant water which can wash away some of the fine sediment fraction.

In areas where the sediments are of such a consistency that it prevents the use of other devices, a grab also may be used for chemical investigations (e.g. in coarse sediments). In addition, because grabs are relatively quick and easy to deploy, they can offer a cost-effective method for large-scale surveys. Grabs are manufactured in many different sizes, the smallest of which place few demands on the survey vessel. Grabs used for chemical surveys are required to have efficient jaw closure, such that the sediment surface is not disturbed, and should be constructed of a material which does not contaminate the samples (e.g. stainless steel). Collection of surface sediments is usually facilitated by surface doors or flaps which allow access to the sediment surface once the sample has been collected.

Grabs that do not provide free flow of water during lowering should not be used.

B.3 Box corers

Box corers are manufactured in a variety of sizes, and usually have a sampling area of between 0,025 m^2 to 0,25 m^2 of the sediment surface. These are constructed such that the sediment surface remains intact during sampling, and sub-samples from the same box core can be taken when the sample is retrieved on deck. This gives access to a large amount of sample material from the same core, which can be utilised in a variety of ways. In addition, samples taken by a box corer are ideal for experimental studies, as the entire core is transported to land with the fauna and supernatant water intact. Most box corers are relatively large and heavy, which places certain demands on the survey vessel.

Box corers are known to work efficiently as long as the top lids close tightly for lifting but allow free through-flow during lowering to reduce the pressure wave in front of the corer.

B.4 Gravity corers

Gravity corers are widely used in environmental studies. These are available in a wide variety of models, with various lengths and diameters of core tubes and different types of closing mechanism. The most commonly used devices take cores of maximum 1 m length and a diameter of 5 cm to 10 cm. Cores longer than 1 m usually serve little purpose for environmental surveys.

Most gravity corers are equipped with sectioning equipment, which allow the cores to be sectioned into the desired depth intervals (usually 1 cm or 2 cm layers) immediately after sampling. In this way, the vertical

distribution of contaminants or other compounds can be studied and a historical overview of the development of the contamination may be obtained.

Recently, multiple corers (multi-corers) have been introduced, which have 2 to 12 parallel core tubes. This allows several parallel samples to be taken and gives enough sample material for several different analyses or replicates.

Most of the traditional types of gravity corer require a large vessel for deployment, but in shallow water samples may be taken by a diver using a poly(methyl methacrylate) core tube.

Gravity corers with diameters less than 5 cm should be avoided, due to smearing effects and problems with core shortening. A tube diameter of 10 cm or more is preferential.

It is important that the gravity corer penetrates the sediment sufficiently to avoid tilting of the corer.

B.5 Piston corers

Piston corers are based on the usual coring principle, but the samples are taken by piston action, rather than by means of gravity. This type of sampling device is little used for environmental surveys and is most often used for purely geological investigations, where there often is a need for long cores. However, a vibro-corer may be a suitable alternative to a grab when sampling coarse sediments.

A piston corer should be accompanied with a short gravity corer for the topmost sediment recovery.

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