INTERNATIONAL STANDARD

ISO 18400-105

First edition
2017-01

Soil quality — Sampling —

Part 105: Packaging, transport, storage and preservation of samples

Qualité du sol — Échantillonnage —

Partie 105: Emballage, transport, stockage et conservation des échantillons

Reference number
ISO 18400-105:2017(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html

This document was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 2, *Sampling*.

This first edition of ISO 18400-105, together with ISO 18400-102, ISO 18400-104 and ISO 18400-206, cancels and replaces ISO 10381-6:2009, which has been technically and structurally revised. The ISO 18400 series is based on a modular structure and cannot be compared to ISO 10381-6 clause by clause.

A list of all parts in the ISO 18400 series can be found on the ISO website.

Introduction

Samples of soils and related materials are liable to change as a result of physical processes and chemical or biological reactions occurring between the time of sampling and testing. This is especially true of soils contaminated with volatile constituents. The extent of these changes is a function of the chemical and biological characteristics of the sample, its temperature, its exposure to light, the nature of the container in which it is placed, the time between sampling and analysis, the conditions to which it is submitted, and seasonal conditions. The characteristics of a sample can change considerably in a few hours. For more information, see ISO 18512.

An important part of the sampling plan is to consider the possible extent of these changes and to prescribe the process of packaging, preservation, transport, and delivery in such a way that the samples are still representative when delivered to the laboratory.

This document is part of a series on sampling standards for soil. The role/position of the International Standards within the total Investigation programme is shown in Figure 1.

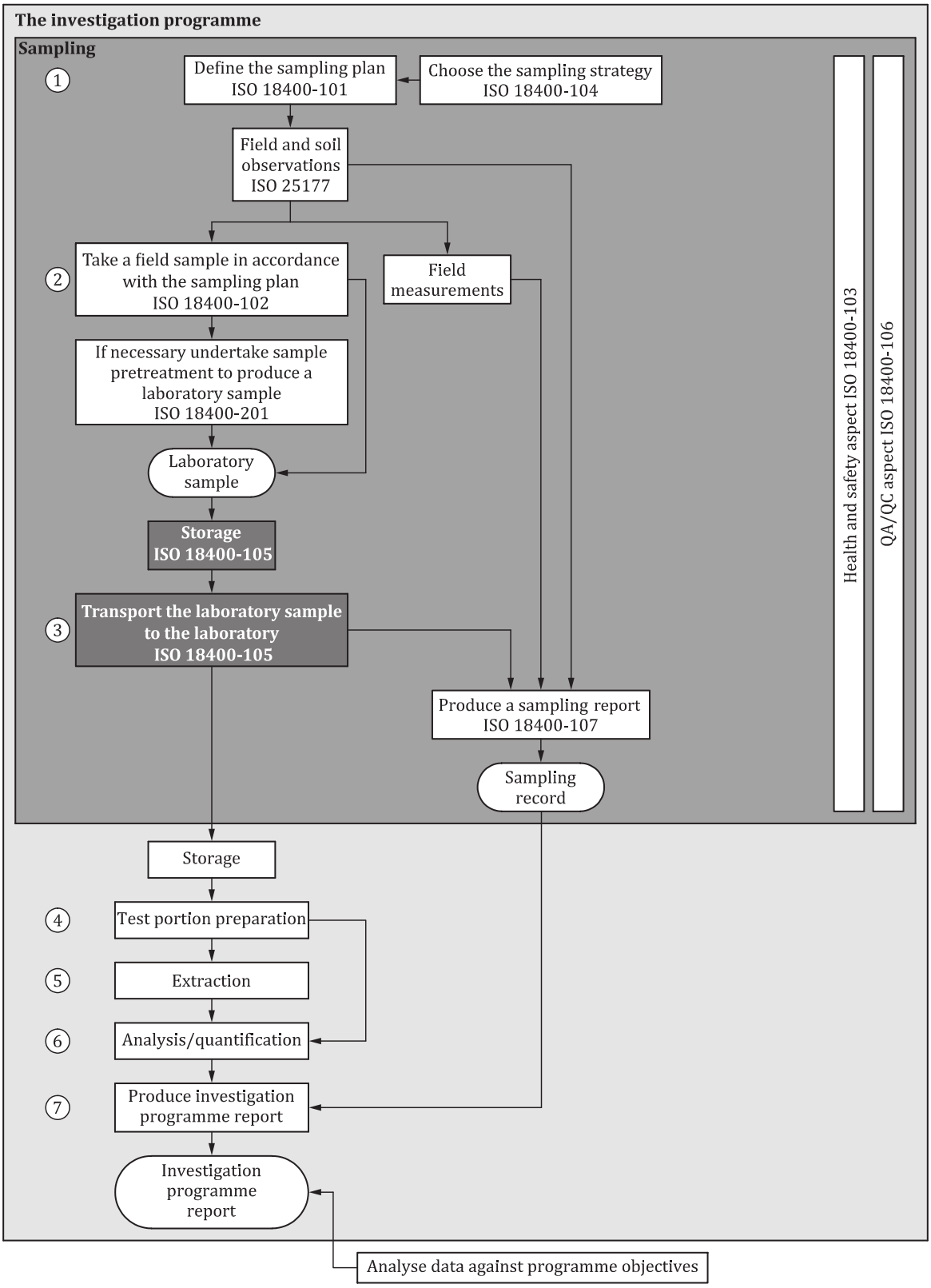

Figure 1 — Links between the essential elements of an investigation programme

NOTE 1 The numbers in circles in Figure 1 define the key elements (1 to 7) of the investigation programme.

NOTE 2 Figure 1 displays a generic process which can be amended when necessary.

Soil quality — Sampling —

Part 105:
Packaging, transport, storage and preservation of samples

1 Scope

This document establishes general principles for packing, preservation, transport and delivery of samples of soil and related materials with an emphasis on requirements for when chemical analysis of the samples is required, but with the intention that the general procedures are to be adapted as appropriate when other forms of testing are required (e.g. biological testing, physical tests on disturbed or undisturbed samples). Special procedures for specific sampling purposes are given in other parts of ISO 18400 (see also 7.2).

This document is intended to be read in conjunction with ISO 18512.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 11074, *Soil quality — Vocabulary*

ISO 18512:2007, *Soil quality — Guidance on long and short term storage of soil samples*

ISO 22155, *Soil quality — Gas chromatographic determination of volatile aromatic and halogenated hydrocarbons and selected ethers — Static headspace method*

DIN 19747, *Investigation of solids — Pre-treatment, preparation and processing of samples for chemical, biological and physical investigations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11074 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
volatile organic compound
VOC
organic compound that is a gas under normal environmental/atmospheric conditions, although it can be found in the ground in the solid, liquid, and dissolved phase form, as well as in the gaseous phase

Note 1 to entry: The US Environmental Protection Agency uses a variety of definitions for VOCs in different contexts, but the one most appropriate here is “an organic compound which has a boiling point below that of water and which can easily vaporize or volatilize”.

Note 2 to entry: Examples include single-ring aromatic hydrocarbons and other low boiling halogenated hydrocarbons, which are used as solvents or fuels, and some degradation products.

4 Incorporation in the sampling plan

The project manager should prescribe containers and establish preservation techniques and storage times in consultation with the test laboratory and include this information in the sampling plan.

The laboratory performing the analysis or other tests should be consulted to ensure that appropriate containers and preservation and handling techniques are used and that any requirements specific to the proposed analytical method(s) or other method of test are taken into account (see 7.2 for transportation requirements for some special situations).

5 Preparing samples for consignment

5.1 General

All staff who handle samples, including any labelling and packaging, should be aware of their nature and possible hazards resulting from their handling (see ISO 18400-103). Samples should be transported to the laboratory and scheduled for analysis as quickly as possible to minimize any potential for physical, chemical, or biological changes before examination, usually within 24 h or in accordance with laboratory requirements for time-dependent analytes. See ISO 18512 for guidance on how laboratories should store and preserve samples for laboratory determinations including suitable storage periods under various conditions.

5.2 Containers

A container should be compatible with the nature of the soil sample and the constituents to be analysed. Any sample container used should not cause contamination of the sample, should not adsorb any sample components (for example, organic compounds), and should not allow losses of volatile components.

Containers should preferably be selected that can serve for long-term storage (procedures for storage are given in ISO 18512). Repacking will then not be necessary if longer term storage is required.

When the sample containers are supplied by the laboratory to which the samples are to be sent, a check should be made that they are sufficient size to hold the size of sample required as determined, following the guidance in ISO 18400-104[1)].

NOTE 1 Table 1 provides a summary of the advantages and disadvantages of containers in common usage. The containers usually used for routine work with “non-contaminated” soils are plastic (polyethylene or polypropylene) tubs with fitted lids, with a capacity of 1 kg to 2 kg of solid sample.

NOTE 2 The size of sample required, and hence the size of container required, will depend on a variety of factors including the nature of the soil (e.g. particle sizes) and the purpose for which the sample is required (e.g. the range of tests to be carried out). Guidance on minimum samples sizes is provided in ISO 18400-104[1)].

NOTE 3 When soils that might be contaminated are to be analysed or otherwise tested, it might be necessary to take more than one sample from a sampling location in order that sample integrity is properly preserved prior to analysis and to permit a full range of potential contaminants to be determined.

Plastic bags shall not be used when analysis for organic compounds is to be carried out.

Sample containers should be clean and dry. The choice of cleaning method will depend on container material and the constituents to be analysed and should not contaminate the container with regard to the constituents to be analysed or cause harm to the environment or human health.

Where organic compounds are to be determined, inert containers, which prevent loss by adsorption or volatilization, should be used. Where no Volatile Organic Compounds (VOCs) are present, a wide-mouthed amber glass jar may be used, but if VOCs are present, sampling and handling should be done in accordance with ISO 22155 or DIN 19747.

1) Under preparation.

Uncertainty about whether a compound should be regarded as volatile or not should trigger a specific quality scheme to ensure that packaging, storing, etc. does not introduce bias, cross contamination, or other forms of unacceptable errors.

Different sizes and types of container should always be available on site, so that if unexpected materials are encountered, they can be properly sampled.

Samples for biological testing should be placed in a loosely tied polythene bag or similar to preserve sample integrity while giving free access to air (see also 7.2).

Table 1 — Suitability of containers for analytical samples

Container material	Substances present in the sample[f]					Analytical requirements				Advantages	Disadvantages
	Acid	Alkaline	Inorganics	Oils and tars	Solvents and other organic compounds including VOCs	Inorganics	Oils and tars	Non-volatile and semi-volatile organic compounds	Volatile organic compounds		
Plastic bag	++[a]	++[a]	++	-	-	+[a]	-	-	-	Low costs	Easily damaged
Plastic bucket or tub	++	++	++	-	-	++[b]	-	-	-	Low costs	Removing excess air is not possible
Wide-mouthed glass bottles[c,d] (screw-capped)	++	-	++	++	++[c,d,e]	++	++	+	+-[c,d,e]	Inert	Fragile
Aluminium cans (screw-capped)	-	-	+	++	++	++	++	+	+	-	Costs Aluminium contamination affected by acids/alkali
Fluorinated polymer containers, e.g. PTFE	++	++	++	++	++	++	++	++	++	Inert	High cost

++ Very suitable.

+ Might be suitable.

- Unsuitable.

[a] Should not be used for contaminated land investigation samples.

[b] Should not be used for contaminated land investigation samples if analysis for organic contamination might be required.

[c] For optimum performance when volatile organic compounds are present might require use of undisturbed sample with solvent such as methanol.

[d] Use of PTFE septum could be appropriate.

[e] A small jar of about 60 ml capacity is commonly used as it is then easier to ensure close packing of fine soils when this is considered necessary.

[f] The substance is present but there is not necessarily a requirement to analyse for it. However, use of an inappropriate container might compromise the results of those analyses that are to be carried out.

5.3 Labels

All samples should carry a legible, unambiguous code ensuring the identity of the sample.

NOTE 1 Codes that are short and simple are preferable and more easily applied in the field.

Samples should be labelled on the side of the container and the lid (but not on the lid alone).

Tie-on labels or adhesive labels may be used (provided in the latter case that there is adequate adhesion of the label under field conditions).

NOTE 2 Writing directly on the container is not always durable and can cause problems.

Care should be taken that the sample code remains clearly legible whatever the storage period and that it resists heat and cold, solar radiation, abrasion, water, and chemical reaction. Cleaning of dirty labels should not lead to loss of information or contamination of the sample.

The labels used should be resistant to external influences (rain, contamination, etc.) and to future treatment (abrasion, handling, contact with chemicals, etc.). The labels should be large enough to contain all the relevant information in a legible form. Some commercially available adhesive labels and marker pens contain organic solvents, so care should be taken to avoid absorption of these solvents.

NOTE 3 Some analytical laboratories operate a barcode scanner system, where pre-labelled barcoded containers are provided together with a barcode scanner, which can be used to record the sample details on site.

5.4 Preservation of samples

Detailed guidance on the preservation of samples is provided in Clause 6.

Preservation and handling of soil and other solid samples should generally be dealt with on a method-specific basis. If not all potential contaminants have been identified prior to sampling, soils should be refrigerated at (4 ± 2) °C and in darkness during storage and transit to the laboratory. When cooled, the samples are more likely to retain their field composition and properties.

The addition of chemical preservatives or stabilizing agents should be avoided as a single soil sample is often used for a large number of different determinations.

5.5 Filling containers and preparing samples and containers for consignment and transport

The general procedure consists of the following steps:

— fill the sample container;

— add preservative to the sample if required (not generally advised; see 5.4 and Clause 6);

— clean the outside of the sample container enabling a good closure of the container;

— close the sample container securely;

— wipe the outside of the container;

— label the container and its lid (see 5.3);

— store the container according to the sampling plan (see 5.4 and Clause 6);

— fill in the chain of custody form (see 5.6 and Clause 8).

It is generally recommended when chemical testing is to be carried out to fill containers completely, although there are conditions when this might cause problems, such as when the sample is to be frozen, because this could cause the sample to expand. It should be noted that, depending on the water content

of the sample, a lot of air can still be present in the sample container in the soil pores even when the container is completely filled.

Where biological tests have to be conducted, ambient conditions, such as air supply and ventilation or appropriate lighting, should enable the sample to conform with biological test requirements (see also 7.2.2).

5.6 Sealing and consignment

Detailed paper based or electronic record sheets, i.e. chain of custody documents, should accompany the samples, with copies retained for the client and samplers (see Clause 8 for minimum requirements).

Before samples are dispatched from the site, and also upon receipt at the laboratory, the details on the container (and lid, if necessary) should be checked against the sample report and chain of custody documents.

Laboratory samples for dispatch or transport by third parties should be firmly closed to guarantee the integrity of the sample. When samples are taken for regulatory investigations, they should be sealed in such a way that any unauthorised tampering is readily apparent. This is often also required to avoid deviation from laboratory accreditation requirements.

The sample or samples should be packed into a suitable robust outer container prior to transport from the site. This outer container should be carefully labelled and sealed to prevent interference with the contents.

NOTE Cool boxes containing freezer packs are often used to contain samples for transport. However, cool boxes and freezer packs are, in general, not capable of actual cooling of the material. They just keep cold material that is already cold (see 6.2).

Certain sample types require permits and/or have to conform to packaging rules. All requirements necessary both in the country/place of origin of the sample and of the country/place to which the samples are to be sent shall be addressed.

5.7 Preservation of samples

Storage of samples might be required before and during transport as follows:

— in the field;

— during transport;

— at intermediate stages during transport (e.g. when being transhipped at airports);

— on receipt by the laboratory.

The last and long-term storage in the laboratory are the responsibility of the laboratory and should be in accordance with ISO 18512 as appropriate. The laboratory should be informed about the nature of the samples and essential requirements for storage prior to them being processed by the laboratory.

The guidance in Clause 6 should be followed as appropriate in the field and while the samples are in transit.

NOTE Clause 7 also provides guidance on the preservation of the integrity of samples during transportation.

6 Preservation prior to transport

6.1 General requirements

The addition of chemical preservatives or stabilizing agents should be avoided as a single soil sample is often used for a large number of different determinations. Nevertheless, volatile components often

require physical preservation to prevent losses and biological degradation (e.g. by submerging samples in methanol; see ISO 18512 and ISO 22155).

The amount of air should be minimal to prevent significant oxidation reactions (see ISO 18512). When freezing is a method for prolonged preservation, some additional space is needed within the container to allow for expansion.

Minimizing the time between sampling and analysis is particularly important in samples in which biological degradation is likely, or in which volatile or semi-volatile organic constituents are to be determined. For certain organic components, the maximum period between sampling and analysis is generally considered to be four days even when the samples are well preserved (see ISO 18512:2007, Table A.1).

Some contaminants are not easily stabilized in a manner compatible with subsequent analysis. Volatile solvents fall into this category, and some of them can begin to volatilize as soon as sampling exposes the soil. A combined sampling and packing procedure is needed to minimize such loss (see ISO 18512 and ISO 22155).

Essential preservation measures are given for different types of chemical constituents and for reducing soils in Table 2 (see ISO 18512:2007, Table A.1 for more detailed guidance on maximum storage times under various conditions for different chemical components and ISO 18512:2007, Table A.2 for biological test objectives). Additional measures may be applied, such as storage for the analysis of non-volatile inorganic compounds in a cool environment, as seems appropriate. Regard should also be paid to the requirements of individual analytical and other testing procedures such as those listed in ISO 18512:2007, Tables A.1 and A.2 and to the recommendations in ISO 22155 regarding use of methanol to preserve samples containing volatile components.

NOTE 1 The guidance in Table 2 applies to "wet" samples as taken in the field and placed promptly in suitable containers in line with the guidance in this document.

NOTE 2 The maximum period of 4 days storage is the shortest maximum period permitted for certain components in ISO 18512:2007, Table A.1. This value applies to the total time of storage on site, in transit, and in the laboratory. For some components, the permitted total storage period may be longer under certain defined conditions, but this is for the laboratory to determine.

Table 2 — Necessary (+) preservation circumstances and measures for different types of chemical components and for reducing soils

	Volatile components[d]	Semi-volatile components	Non-volatile components	Inorganic (non-volatile)	Reducing soils[a]
Airtight storage[c]	+	+	-[e]	-[e]	+
Dark storage	+	+	-	-	-
Cooled storage (4 ± 2) °C	+	+	-[e]	-[e]	+
Inert atmosphere (e.g. nitrogen, argon)	-	-	-	-	+
Maximum period of storage (days)[b]	<4	4	-	-	-

\+ Essential requirement.

\- Not necessary.

a When reducing characteristics are to be maintained.

b When stored with the appropriate preservation method.

c Maximum storage period depending on the airtightness of the sample container but maximum of 4 days.

d See ISO 22155 and DIN 19747 for detailed guidance.

e Not essential but recommended.

6.2 Cooling and freezing

Cooling or freezing procedures can be applied to samples to increase the time available for transport. A cooling temperature of (4 ± 2) °C has been found suitable for many applications. However, hydrolysis, oxidation, enzymatic and microbial degradation, or other loss of organic compounds might not be sufficiently suppressed at such temperatures (see below).

Cool boxes and freezer packs are in general not capable of actual cooling of the material they contain: they just keep cold, material that is already cold. When cooling is essential, a mobile (car) refrigerator should be used. The vessel in which the sample containers are placed should be cooled to a temperature of (4 ± 2) °C. Samples should reach this temperature within 12 h, but preferably as soon as possible after sampling.

Care should be taken, especially in hot and humid climates, that cooling does not cause condensation of soil gas moisture.

Hydrolysis, oxidation, enzymatic and microbial degradation, or other loss of organic compounds might not be sufficiently suppressed by cooling. In circumstances where such occurrences would adversely affect the sample, storage at temperatures below −18 °C should be used. During transport, this temperature can be achieved by the use of dry ice packing, flooding containers with liquid nitrogen (in which case, stainless steel containers should be used), or freezer boxes operated from car batteries.

When these and other samples are to be preserved by freezing, there should be detailed control of the freezing and thawing process in order to return the samples as closely as possible to its initial equilibrium after thawing.

NOTE Once a soil is frozen, it is very difficult to subsample for a repeat analysis. Thus, it is wise to freeze a number of smaller subsamples taking care to ensure homogeneity when the subsamples are prepared (see ISO 18512).

6.3 Airtight storage

Airtight storage will minimize volatilization of constituents and reduce biological degradation. Airtight storage requires that the material of the container is airtight and that the closing mechanism of the container is completely clean of soil particles. Most plastics should not be considered as airtight.

Care should be taken that the headspace in the container is as small as possible.

Best airtight storage of soil samples is obtained when the samples are stored in glass bottles sealed with PTFE cap liners. In general, this is only possible for fine-grained soils.

NOTE Any gas released into the void space in the sample container will, of course, be lost when the sample container is opened.

6.4 Nitrogen atmosphere

If the reducing character of a soil sample is to be preserved, the sample should be packed in a gas-tight container and flushed with nitrogen immediately to limit the exposure to oxygen. If this is not possible, the sample should be flushed with nitrogen or another inert gas in the laboratory as soon as possible, at least within 24 h after sampling. The volume of nitrogen passed through the container should be at least 10 times the container volume. It is recommended that the soil sample is flushed again with nitrogen after an interval of about 24 h to remove any oxygen that might still be diffusing from the sample.

NOTE 1 Nitrogen gas of technical quality suffices.

NOTE 2 Nitrogen flushing is easier if there is a gas connector (inlet/outlet) on the container.

6.5 Hazardous materials

Any national regulations regarding the packaging and transport of hazardous materials shall be observed.

7 Transport

7.1 General requirements

Details of the agreed transport and labelling arrangements should be written into the sampling plan, as well as on the chain of custody form. The packaging should meet the requirements of authorities or other organization(s) concerned with the transport of the samples. To ensure that the package reaches its correct destination, it should be clearly labelled and sent with a chain of custody form. Each time that the samples are transferred, the chain of custody form should be checked and signed.

Vibration should be avoided as far as possible. Glass containers should be protected from potential breakage during transport by appropriate packaging.

7.2 Special transportation requirements

7.2.1 Dry soils

Samples from non-cohesive dry soils tend to separate into different particle fractions during transport and should be re-homogenized before further pretreatment and analysis.

7.2.2 Samples for biological testing

Samples for biological testing should be transported in a manner which minimizes changes in the soil water content and should be kept in the dark with free access of air; a loosely-tied polyethylene bag is generally adequate for this purpose. For some applications, strong paper bags might be acceptable. Extreme environmental conditions should be avoided. The soil should be kept as cool as possible and should not be allowed to dry out or become water-logged. Exposure to light for extended periods should be avoided as this encourages the growth of algae on the surface of the soil. Physical compaction should be avoided as far as practicable.

7.2.3 Samples for DNA or RNA analysis

Samples for DNA or RNA analysis should be frozen quickly in the field using dry ice. During transportation to the laboratory, dry ice should be used to maintain the temperature.

7.2.4 Drill cores

Drill cores intended for specific physical investigations, or which will serve for pedological evaluations in the laboratory, should be stored and transported, avoiding vibration.

7.2.5 Cut soil cylinders

A special case should be used to keep cut soil cylinders stable during transport. The same applies to samples obtained using cutting frames. Great care is required for transporting cutting frames containing soil samples.

7.2.6 Large volumes of soil

For larger volumes of soil, large containers suitable for storage and transport should be used to avoid physical decomposition of the soil sample.

8 Delivery

A chain of custody form for delivery should be developed in cooperation with the analytical laboratory and described in the sampling plan. The form is used to record the transfers of samples between the time of collection and their arrival at the laboratory.

The chain of custody form should be filled out directly after sampling for each sample or group of samples. The custody form should be checked and signed at each transfer of the samples.

Information entered on the chain of custody form should include the following, as appropriate and having regard to the additional guidance in ISO 18400-107 about the information to be supplied to the laboratory:

— the project number or similar if there is one;

— name of the person carrying out the sampling and name of the person transferring the samples (if different);

— name of the person or organization receiving the samples;

— time and date that samples were taken;

— samples included in the consignment, including sampling locations, type of sample, container type(s), sampling depths, details of preservation (if any), etc.;

— time and date samples are sent to the laboratory;

— name and contact details of the client;

— storage conditions;

— essential safety information:

  — e.g. whether hazardous materials, such as asbestos or biologically active agents, are known or suspected of being present;

  — e.g. the turnaround time required;

— what analyses or other tests are to be undertaken on each sample.

NOTE 1 An indication of likely concentrations of substances present when this can be done aids the laboratory to select appropriate procedures including those that will avoid damage to analytical equipment.

NOTE 2 Most laboratories carrying out analysis of soil samples provide standardized chain of custody forms to be completed by the client/sampler. Some laboratories have web-based systems through which the client can schedule samples for analysis and testing (i.e. indicate the analyses and other tests required) once they have been registered by the laboratory as having been received.

Bibliography

[1] ISO 14507, *Soil quality — Pretreatment of samples for determination of organic contaminants*

[2] ISO 15009, *Soil quality — Gas chromatographic determination of the content of volatile aromatic hydrocarbons, naphthalene and volatile halogenated hydrocarbons — Purge-and-trap method with thermal desorption*

[2] ISO 18400-100, *Soil quality — Sampling — Part 100: Guidance on the selection of sampling standards*

[3] ISO 18400-101, *Soil quality — Sampling — Part 101: Framework for the preparation and application of a sampling plan*

[4] ISO 18400-102, *Soil quality — Sampling — Part 102: Selection and application of sampling techniques*

[5] ISO 18400-103, *Soil quality — Sampling — Part 103: Safety*

[6] ISO 18400-104[2)], *Soil quality — Sampling — Part 104: Strategies*

[7] ISO 18400-106, *Soil quality — Sampling — Part 106: Quality control and quality assurance*

[8] ISO 18400-107, *Soil quality — Sampling — Part 107: Recording and reporting*

[9] ISO 18400-201, *Soil quality — Sampling — Part 201: Physical pretreatment in the field*

[10] ISO 18400:202[2)], *Soil quality — Sampling — Part 202: Preliminary investigations*

[11] ISO 18400:203[2)], *Soil quality — Sampling — Part 203: Investigation of potentially contaminated sites*

[12] ISO 18400-204, *Soil quality — Sampling — Part 204: Guidance on sampling of soil gas*

[13] ISO 18400:205[2)], *Soil quality — Sampling — Part 205: Guidance on the procedure for investigation of natural, near-natural and cultivates sites*

[14] ISO 18400:206[2)], *Soil quality — Sampling — Part 206: Guidance on the collection, handling and storage of soil for the assessment of biological functional and structural endpoints in the laboratory*

2) Under preparation.

ICS 13.080.05

Price based on 10 pages