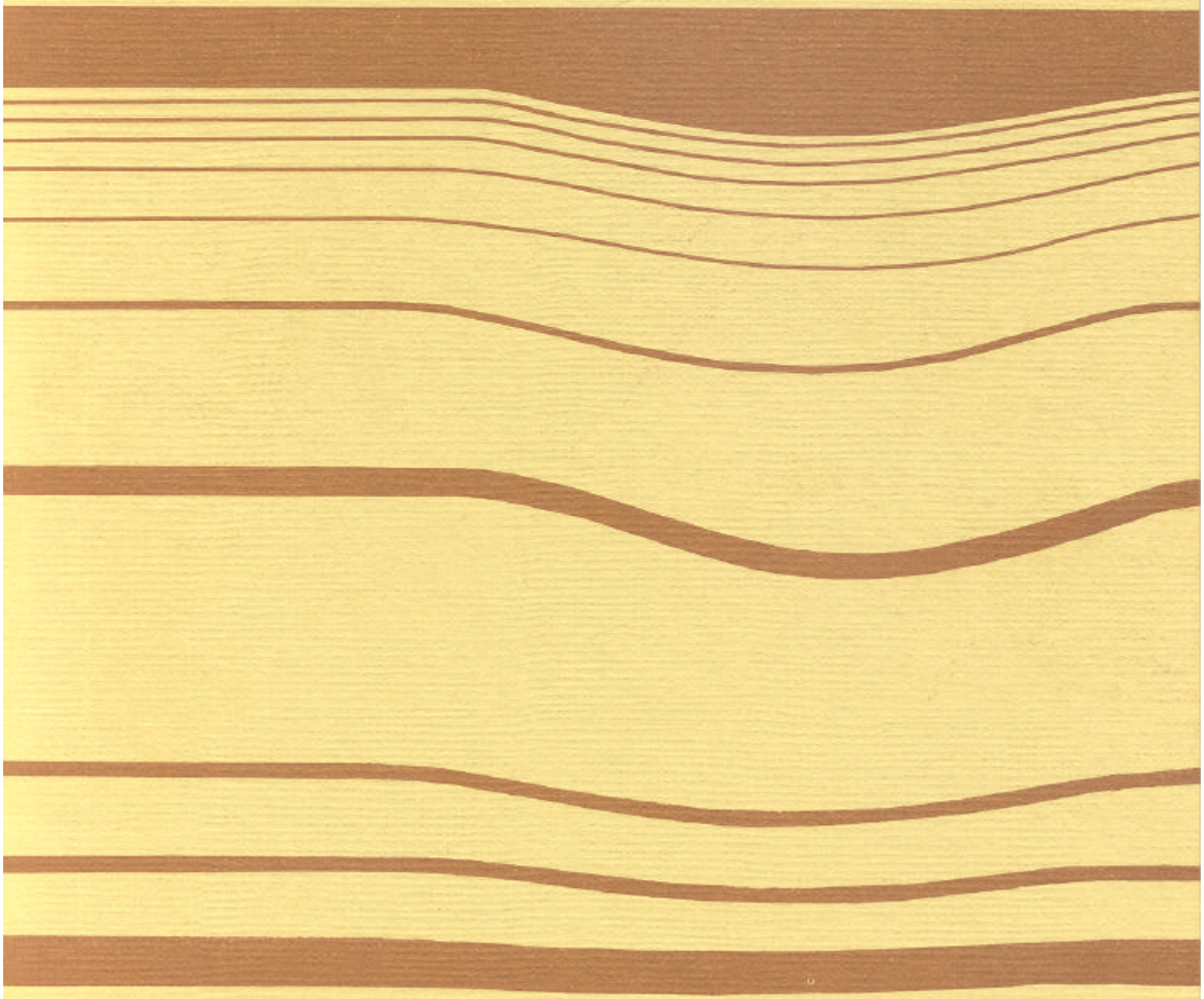
Technical Paper 1

Procedures for the Collection and Preservation of Soil Profiles



International Soil Museum - Wageningen - The Netherlands

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PROCEDURES FOR THE COLLECTION AND PRESERVATION OF SOIL PROFILES

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Contents

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1. Introduction

A collection of preserved soil profiles is a very useful visual aid in teaching soil science; it can be used also for demonstration purposes or comparative studies. A soil profile may be taken from the field preserved as a lacquer peel or as a monolith, which is subsequently prepared in the workshop so that its features are shown. Both forms are more realistic than colour photographs, drawings or paintings, although these have their value as illustrations in publications.

2. Historical Development

Soil monoliths were first collected in Russia during the last decades of the 19th century. Soil profiles from Russia were displayed at the Columbian Exhibition in Chicago in 1893-1894, on the occasion of an international exhibition (Vanderford 1897, Kellogg 1974; according to Hodgson 1978 and personal communications of Kellogg and Hodgson 1979). In this way, the method was introduced into the U.S.A. These soils were collected by driving an iron box with sharp edges into the vertical face of a soil pit, similar to the method described by Rispoloshensky in 1897, as mentioned by Kubiëna (1953). Eighteen large monoliths from Latvia were on display at the First International Congress of Soil Science, Washington 1927 (Truog 1928). These soils were collected in wooden boxes (Kasatkin and Krasyuk 1917, as mentioned by Hodgson 1978, and Polynov 1929).

In a letter to foreign soil institutes dated 1925, Miklaszewski sought cooperation for the organization of an exchange of soil monoliths and data on an international basis. In 1927 Vilenski published a note entitled, 'On the organisation of exchange of monolithic soil samples and, in conformity on some necessary technical improvements in taking and mounting monoliths'. One year later Miklaszewski wrote about the soil monolith collection of the Agricultural Museum in Warsaw, Poland. He had tried several methods used hitherto and concluded that taking monoliths in wooden boxes of 100 to 200 cm length, were relatively easy to take, transport and display. Using this method, a soil column is cut out, snugly fitting into a wooden box. Polynov and others of the Dokuchaiev Institute of Soil Science in Leningrad compiled a booklet in 1929 entitled: 'Instruction for collecting soil monoliths and soil samples for laboratory investigation'. This is essentially the method described by Vilenski and Miklaszewski.

In the first half century of the existence of these methods of collecting soil profiles, no mention is made of preservation techniques, but some attempts to

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stabilize the loose soil material (which probably did not keep well) with different impregnation agents have been made over the years. A saturated sugar solution was used in the early years in the U.S.S.R. (Ponomareva, *personal communication,* 1974).

Preservation of soil profiles was introduced in 1928 when Schlacht mentions the use of thick cardboard, covered with an adhesive, pressed against the wall of the profile pit. After drying, the soil particles adhere to the cardboard.

This "Klebeplatten Monolithmethode" is, according to Jager and Van der Voort (1966) only suitable for sandy and loamy soils. In this method a relatively thin layer of the soil profile is impregnated at the site itself, resulting in a "lacquer peel". The procedure for the preparation of lacquer peels is given in the following chapter. Techniques of collecting soil profiles from the field in metal or wooden boxes have remained essentially the same since this method was first used in the U.S.S.R. During the last two decades coring machines have been used which take long cylindrical, undisturbed soil samples ('Matelski 1949, LGM mededelingen 1977).

Although there are some newly developed chemicals for the impregnation of soil material (Maarse and Terwindt 1964, Bouma 1969), general use is still being made of nitrocellulose lacquers such as those described by Voigt (1936) and Gracanin and Janekovic (1940); and vinylite resin (Berger and 'Auckenhirn, 1946). This may be concluded from the publications of Clarke in 1971 and Hodgson in 1978. Some use is being made of polyester resins (Maarse and Terwindt 1964), while Hammond (1974) impregnated organic soils by submerging them in a low molecular weight polyethylene glycol polymer. Bouma (1966) gives extensive descriptions of the techniques of collection, preservation and study of a large variety of sediments, both unconsolidated and consolidated. Van der Voort (1970) compiled a bibliography on the taking and preservation of soil monoliths and lacquer peels. Since 1966, the International Soil Museum has made use of nitrocellulose lacquers and a poly-methylmethacrylate for the preservation of soil monoliths. The present publication is an extended version of the mimeographed booklet, "Procedure for the collection of soils for the International Soil Museum" (1972, reprints 1974, 1975 and 1977).

It should be pointed out that very detailed procedures for the impregnation of the great diversity of soils are not within the scope of this paper. New ideas of the individual soil scientist and technician should be tried out; sometimes better results may be achieved by adapting the methods outlined in this publication.

3. Methods of Taking and Impregnating Soil Profiles

3.1 Lacquer peels and soil monoliths: some comparisons

Soil profiles may be preserved in the field, resulting in relatively thin lacquer peels or lacquer profiles (outdoor or field method), or in the laboratory or workshop, resulting a thicker soil monolith (indoor method). Some comparisons may be made between the two methods of collection and the final results.

The lacquer peel method

A thin film of diluted lacquer is applied by a spray or brush onto the smoothed face of a profile pit. After one or more layers of lacquer have been applied and allowed to dry, the film, usually reinforced by cloth is loosened from the face. The soil material will remain attached to the hardened lacquer, thus giving a natural replica of the-soil profile in the form of a thin lacquer peel or lacquer profile. This relatively easy method is well suited to dry soils with a sandy to light clay texture. The result of the exercise is immediately visible. The lacquer peels are light in weight and easy to transport, to handle, to exhibit and to store. Transportation should, however, be done with care. The most-useful size for the required peels can be chosen on the spot and at the time of collection.

An important disadvantage is that the larger structural elements are not impregnated and, therefore, not shown in this type of preserved soil profile. The profile should be sufficiently dry, as most chemicals used for impregnation react with water and become whitish. Humid soils are difficult to impregnate because the chemicals cannot dispel water from the pores and cracks. Since the lacquer requires at least half a day to dry, it is necessary to return the next day to collect the lacquer peel; monoliths may be taken in one day. Sometimes the lacquer takes a few days to harden completely. It should also be mentioned that it is difficult to cross international boundaries with chemicals, especially with nitro-cellulose lacquers, acetone, etc.

The soil monolith method

The profile is collected from the pit in a box and taken to the laboratory or workshop for preparation and preservation. The soil is left to dry before the lacquer is applied, using a similar procedure to that for lacquer peels, but in controlled conditions .The depth of the impregnation is greater because the box with the soil is placed horizontally and several coatings of lacquer are applied at intervals.

The resulting soil monolith usually has a thickness of several centimetres, showing, in almost all cases, the structure of the soil very clearly. This method is suitable for all soils, except very sandy ones, because the almost vertical face of the soil profile may collapse during the field collection. The soils may be collected at any time, even when it is raining or when the moisture content of the soil is high. Collection of a soil monolith can usually be done in a single day and no chemicals are needed in the field. A disadvantage is the heavy weight of the box with soil material (30-60 kg, and the possibility of expensive transportation). When collection has been carried out carefully, transport is possible by car, rail or sea, without damage to the soil. The ISM experience is that monoliths in boxes, packed in a container for rail or sea transport, are less liable to damage than lacquer peels. A disadvantage with some methods of collection, discussed hereafter, is that it is not possible to forecast the quality of the collected profile and the resulting monolith. A monolith is rather difficult to handle, to exhibit and to store, because of its much heavier weight. Also, the most useful size of the required soil monolith does not always coincide with the size of the boxes, which are usually made in standard size in advance.

In conclusion, when replicas of the soil are desired which are as natural as possible, the indoor method of making soil monoliths is usually preferable. It is this method that the ISM follows for its collection.

Both the lacquer peel and the monolith method are described by Jager and Van der Voort (1966) and the present publication outlines an adapted version of their methods.

3.2 Selection of the site

The profile to be collected should be representative of the selected soil. Hence, a thorough knowledge of the regional soil conditions is a prerequisite for a justified selection of the site.

If it is desired to collect a virgin soil, special attention should be given to the condition of the organic surface layer, as it may have been eroded or disturbed. During the excavation of the pit, care should be taken not to impair or contaminate these horizons.

Sites where monoliths can be collected with the least effort are road cuts, faces of quarries, gullies, drainage ditches, etc. These places, however, should be considered with suspicion, not only because there may be an over- burden or erosion of the surface horizon, but also because the groundwater may have been changed drastically and this usually has an effect on the physical and chemical characteristics of the soil.

When selecting a site, the weight of the collected material should be borne in mind in relation to the carrying/transport facilities.

3.3 Details of the lacquer peel method

Tools and materials for: *(See also photo-sequence in Appendix I)*

Digging the profile pit

- spade, shovel, pickaxe, crowbar,
- tape measure
- bucket or pail (for removal of groundwater)

Smoothing the face of the pit

- knife, saw, pruning shears, pruning saw (for roots)
- stone-mason's chisel and hammer (for stones, hard layers or hard parent material)

Impregnation

- profile lacquer and thinner (for some trade names, see Appendix II)
- metal can with spout (about 1 litre), or pressure hand spray (about 3-5 litres)
- a flat paint-brush
- if large lacquer peels are made, saran netting of small mesh or jute, thin string and nails

Removal of the peel from the soil

- a piece of flexible hardboard, a few centimetres larger than the size of the lacquer peel

Procedures for taking a lacquer peel

The description follows essentially the method described by Jager and Van der Voort (1966). When the slightly backward slanting face of the profile pit has been smoothed, the lacquer, diluted if necessary, can be poured or sprayed once or several times onto the soil.

The viscosity of the lacquer

The texture and the porosity of the soil profile determine the desired viscosity of the lacquer. For a profile consisting of coarse sand, undiluted lacquer may be used. A very fine sandy or loamy soil needs a first coating of a diluted lacquer, consisting of 6 parts lacquer and 4 parts thinner.

Sandy clay and clay soils are best treated with a first coating of lacquer, consisting of 2 parts lacquer and 8 parts thinner. To obtain a peel of sufficient strength, a second coating of slightly diluted or undiluted lacquer is necessary.

From the start of the procedure, the required amount of lacquer should be available.

The application of the lacquer

The lacquer, at the right viscosity, is poured from a can with spout onto the profile, starting from the top. Care should be taken to obtain an even downflow with a straight horizontal front, and to avoid the formation of a film of different consistency, which would result in an irregular lacquer peel.

A flat-paint-brush and/or a piece of timber may be used to even out the film, but it must be noted that the lacquer and attached soil particles can easily loosen from the soil itself. This is especially the case with sandy soils. Mention should be made here of a small pressure hand spray, which can contain about 3-5 litres with a small nozzle in order to produce a fine mist of the impregnating agent. The chances of obtaining an even impregnation with a spray are usually higher than when using a can.

A lacquer peel of sufficient strength will be obtained by the application of a second layer of lacquer, with higher viscosity, shortly after the first layer has been applied. In cases where broad lacquer peels are taken, it is advisable to apply a layer of saran netting or a layer of jute, which may be attached to a frame of thin string, fixed to the soil with nails. The cloth is fixed to the impregnated and rather dry soil by means of undiluted lacquer.

Collecting the lacquer peel

At the time of collecting, the lacquer and impregnated soil material should be almost dry or dry. A test can be made by loosening a small piece of the cloth from the soil to see if the soil adheres sufficiently. Drying time is dependant upon many factors such as the soil itself (texture, structure, porosity, moisture content, etc.), the type and amount of lacquer applied, the weather and the exposure of the collected profile.

Usually, a half to one day is required before the lacquer peel can be removed. First of all a piece of hardboard, slightly larger than the lacquer peel, is firmly placed against the peel. The soil is then cut with a knife along the sides and bottom of the board.

If the peel is pulled off instead of loosened with a knife, parts of the soil may remain attached to the face. Therefore, the peel is loosened from the face of the soil by cutting roots and soil material with pruning shears and a knife. While cutting, the hardboard is bent slightly backwards and is used as a support for the peel. Once the root layer has been loosened, the board is carefully and slowly pulled-backwards, simultaneously checking that all the impregnated soil material remains attached to the saran netting or jute. When the whole lacquer peel has been successfully removed, it remains on the piece of hardboard.

Mounting of the lacquer peel

The peel may be mounted on a piece of plywood or chipboard, somewhat longer and wider than the size of the peel itself. This can be done with glue or with the same lacquer used for the impregnation. If required, data on the soil, e.g. the name, the location, the horizons, may be mentioned on the edge of the sup- porting piece of plywood. After a spray coating with lacquer, the final mounted lacquer peel can be hung on two hooks.

3.4 Details of the soil monolith method

Tools and materials for: *(See photo-sequence in Appendix I)*

Digging the profile pit

- spade, shovel, pickaxe, crowbar,
- tape measure
- bucket or pail (groundwater)

Smoothing the face of the pit

- knife, saw, pruning shears, pruning saw (for roots)
- stone-mason's chisel and hammer (for stones, hard layers or hard parent material)

Collecting the soil profile

- sample box. The ISM has specially designed boxes in use with inside dimensions 130 to 150x28xlO cm; made of plywood or timber, rim and bottom 15 mm thick, top 4 mm thick, screwed together. If available, waterproof plywood (as used for concrete lining) of 18 mm and 4 mm thickness resp. is preferred to avoid any drying-out and shrinkage of the soil during transportation and storage.
- plastic lining of the box (not required if waterproof plywood is used)
- bandages or swath, length at least 5 m (re-usable)

Other kinds of boxes are also in use, e.g. those made of galvanized sheet steel with steel or wooden end pieces or of (ply)wood consisting of open frames with loose or hinged screw-on lids. It should be noted that boxes of light-gauge metal, when full

of soil material, have a tendency to bend when handled. 'One should also bear in mind that full boxes may have a weight of 60 kg.

The place for taking the monoliths is marked out with a knife by placing the lid of the box against the smooth face, with the top of the lid level with the land surface. First the outer dimensions are marked. In the case of a shallow soil, the upper part of a normal-sized-box with a length of 100-150 cm will stand out above then land surface, unless a box of smaller size is used instead.

With a knife and a spade, a protruding soil column is then carefully cut out. If the consistency of the soil is hard, a wood chisel and geological hammer may be very useful. Roots should be cut with pruning shears. Now, the inner dimensions of the box are marked and the soil is cut away leaving a vertical column of the soil still attached to the face of the pit with a protrusion that is a few centimetres more than the depth of the box.

If the soil material sticks together sufficiently well, the bottom of the column may be cut away also. The remaining soil column will now snugly fit the box. The box is eased over this column carefully. If the soil material is too loose to cut away the bottom part, the box is pressed into the soil. In cases where a frame with loose or hinged back-lid is used, the frame is put over the column, the soil is trimmed flush and the back is screwed on.

If non-waterproof boxes are used, these should be lined with plastic foil, which can be attached to the box with drawing pins. This prevents the soil from drying out during transport and storage, and also from sticking to the wood when the column is removed from the box after the impregnation.

The box should be securely kept in place by using long stonemason's chisels at the bottom of the box, and a crowbar pressed against the back lid. Now the soil material behind the box is removed, starting from the top, carefully cutting roots with pruning shears and digging downwards. One must be sure not to damage the column: an ample amount of soil must be left. It is very useful, and in most cases a necessity, to wrap bandages of about 10 cm width around box and column as soon as a section of the profile has been cleaned. This is done starting from the top by wrapping in a downward direction as the digging proceeds. Having reached a certain depth, depending on the kind of the soil material, although usually beyond the middle of the box length, it is possible to drive in a heavy spade or a crowbar. The box may be gradually eased off the face of the pit by leverage on the spade or crowbar. When free, the box is lifted out of the pit, the bandage taken off and the superfluous material removed. Empty spaces, especially those in the surface layer of the profile, should be filled up with cotton wool, pieces of cloth or foam plastic. For filling larger spaces, it is useful to take plastic bags with a filler of soil material. Be sure not to contaminate the profile itself. A sheet of plastic should be put on top of the smoothed monolith and then the top lid is screwed down on the box.

For transport of the boxes see part 3.5. The preservation of the soil monoliths will be described in part 3.6.

Special cases

- if excess groundwater cannot be removed with bucket or pail, well drainage should be employed
- if the soil is shallow, smaller boxes can be used
- if the soil is deep, longer boxes can be used. However, boxes longer than 175 cm are very difficult to handle and to transport. When sampling a very deep soil two boxes can be used. In this case, there should be a small over- lap. In the laboratory, these two monoliths of 100 to 125 cm length can be fixed together for display, if required. Since it is difficult to take a soil monolith in a profile pit, which is much deeper than the box, it is advisable to take first the top monolith, than deepen the profile pit to collect the bottom monolith.
- if non-coherent soil material is sampled (e.g. a dry sandy soil), the column may collapse before the box can be put over it, even if the face has an inclination. In this case it is advisable to press the box into the wall and incise and cut away the soil simultaneously along the sides of the box until the back of the box touches the face of the column. It has already been mentioned that the lacquer peel method may be a more appropriate method for collecting such loose material.
- a place with thick roots should be avoided. Thin roots can be cut successfully with pruning shears and a pruning saw. Cutting and sawing should be done with great care, since any movement may damage the soil column.

3.5 Packing and transport

Lacquer peels and monoliths have been sent to the ISM from all over the world. When carefully taken, impregnated and packed, they arrived in perfect condition.

Lacquer peels

These can be placed flat on sacks or foam sheets on the floor of a van, although preferably not on top of each other. The peels should not be bent. If transported by rail, sea or air the peels should first be placed in separate wooden boxes. These boxes should only travel if joined together or in a container, since it is our experience that single boxes receive rough treatment and may even be transported vertically: Before packing, it should be ascertained that all soil material is well impregnated and fixed, and that it will not easily loosen from the cloth backing. Loose stones especially will cause much damage during the transport.

Soil monoliths

A monolith measuring 125x30x10 cm, in a box of waterproof plywood weighs 40-60 kg. This weight cannot normally be carried far by hand. Monoliths, if properly taken and cared for, may safely be transported on the floor of a van, even in rough country. For transport by rail or sea, monoliths travel best when packed in fours, in a sturdy wooden container. This can be moved by 4 to 5 men. The ISM also uses steel containers for 9 to 12 monoliths. These can only be moved with a fork truck or crane. Pallets may also be used. Very sturdy single boxes may be taken by air,

although it is advisable to transport them packed in fours in a wooden or strong cardboard container. It may be added that airfreight charges are very high compared with those for sea freight.

3.6 Preservation of soil monoliths

Once the monolith has arrived at the laboratory or workshop, it must be decided whether it is to be impregnated and how this should be done. Monoliths may be kept in a "natural" state, but they are bulky, difficult to handle and liable to damage. There are many advantages to impregnating the soils, especially if these soil specimens are to be used for demonstration and education.

Tools, equipment and materials

Tools (in addition to the hand tools used in the field)

- small utensils such as a piercer, dentist's probes, small screwdriver and hammer, all for the removal of un-impregnated and superfluous soil material
- can with spout (about 1 liter) or a pressure hand spray with the same or greater contents

Equipment

- if the impregnation is done indoors and use is made of toxic impregnation agents such as nitrocellulose lacquers, methylmetacrylates, acetone, etc., a fume chamber should be used.
- if many monoliths have to be made, it is useful to have a small electrical vibrator for the final preparation of the soil

Materials

- lacquer and thinner (see Appendix II for trade names)
- glue, preferably a fast drying type, for permeable materials (cloth, wood)
- cloth, the same size as the monolith (e.g. jute)
- chipboard, plywood or timber the size of the monolith (about 10-20 mm thick much depending on the size/weight of the monolith)

Preservation treatment

The description given here is applicable when a wooden box is used. In the case of a steel box, the methods should be slightly adapted.

After opening the box, the surface of the soil is again smoothened with a knife. The soil is left to dry until small cracks have developed, since the lacquer hardly penetrates the capillary pores of clay in a moist condition. Because many lacquers turn whitish if the soil is still too moist, a small test should be done before the whole soil profile is treated. Usually the drying takes a few days, depending on the nature and moisture content of the soil and the atmospheric humidity and temperature.

The viscosity and hardening time are temperature-dependent. Details should be ascertained from the manufacturers of the used products.

To improve the penetration depth of the preserving agent in either heavy clay soils or a layer of clay, the use of a small piercer has been found successful, in making 1-2 small holes per cm, about 0.5-1 mm in diameter and 15-20 mm deep, in the clay material. This work should be done with care. This method greatly increases the surface area through which the agent can penetrate the soil to the required depth. Making holes also appears to prevent the development of one or more wide shrinkage cracks in the clay; many smaller cracks are formed instead.

Hereafter, lacquer (diluted to the required viscosity) is sprayed or poured onto the profile several times until the soil is covered with a very thin layer. This is carried out over a period of a few days, the dilution of the lacquer being diminished with each consecutive application. The dilution depends mainly on the textural composition and the amount of pores in the soil. For heavier textured soils, a primary coating of diluted lacquer, consisting of 2 parts lacquer and 8 parts thinner, is used. For lighter soils 3 parts lacquer and 7 parts thinner. The last application is with undiluted lacquer. A piece of cloth (jute) is then put onto the impregnated side of the profile and saturated with undiluted lacquer.

The penetration depth of the impregnation agent should be checked at intervals. The first application should penetrate to the required depth; this depth depends on the soil and its structure. If large structural elements need to be fixed, deep penetration of the lacquer is a necessity. A soil with small structural elements or a massive, structureless soil may be penetrated to lesser depth. After hardening of the lacquer, the box is taken out of the chamber.

It must be reiterated that detailed procedures cannot be given for the successful impregnation of all soils.

Preparation of the impregnated soil

A piece of chipboard, plywood or timber of monolith size (just as large as .the inside dimensions of the box) is "fixed to the cloth (jute) with a liberal amount of fast drying glue. The wood is pressed down firmly with a few cramps, and left for a few days or weeks to allow the lacquer and glue to harden completely.

Now the box is turned over, and the wood now serves as the mount of the monolith. The back lid is unscrewed and removed, as well as the rim. The non-impregnated part of the soil material can be removed by hand and either thrown away or kept as 'repair soil' in case of damage.

Other superfluous soil material is removed by careful tapping and with the help of piercers, e.g. dentist's probes. The ISM uses a small vibrator to remove soil material. Care should be taken that no unnatural marks are left on the soil. Finally, the resulting soil profile will show its natural structure as clearly as possible.

To consolidate the natural visible surface and to conserve the colour, the monolith is sprayed in the fume chamber with a diluted solution of non-glossy, transparent agent. The ISM uses a poly-methylmethacrylate for this purpose. For tradenames see Appendix II.

3.7 Special cases -the impregnation of organic soils, and normally anaerobic (parts of) soils.

Organic soils

It has been mentioned previously that soils should be left to dry before impregnation takes place. Since drying a peat or muck soil would result in an unnaturally shrunken soil, the impregnation of these soils should be carried out without this pre-treatment.

Hammond (1974) describes a method for the preservation of these soils. A 3 cm thin layer of soil is collected in the field by hammering a steel sheet (1.5 mm) monolith tray of 120x15x3 cm into a profile face. This is reduced in thickness to 1-2 cm to bring out the plant structure and it is placed on a strip of expanded metal.

Impregnation is carried out using molten polyethylene glycol (P.E.G.) polymer with a molecular weight of 1500. The soil is submerged in the liquid, which is kept at a temperature of 90^0C for the whole of the impregnation time, which varies from 3-5 days. After impregnation, the excess P.E.G. is allowed to drain. Then compressed air is blown over the surface to remove loose peat particles and to bring out the peat structures. The monolith is then taken out of the tank and allowed to solidify.

Should the preserved monolith not need to be hard it is also possible to dispel the water of the peat or muck by replacing it by glycerine. The following method can be used.

The organic soil can be collected in a metal or wooden box following the methods described previously for mineral soils. After the lid has been removed, a piece of expanded or perforated metal is laid on the box. The box with the soil is turned over into a special-made galvanized container with outlet, which has a size slightly larger than the box. Then the box is removed gently, whilst care is taken not to break the column. The sheet of expanded metal supporting the soil, fits into the container and rests on some small supports, leaving a space of about one centimetre between the sheet and the bottom of the container. The container is next placed at an angle of 10-15 degrees and glycerine is very slowly poured onto the profile, starting from the top. This procedure is repeated at intervals, gradually going downwards. The glycerine pushes out and replaces the water in the soil. The water passes through the holes in the metal underneath the soil and can leave the container through the outlet. The process of replacing the water by the glycerine can take a few weeks.

Then the impregnated soil is placed in a box lined with Perspex. A sliding lid can be taken off to allow a close look. Since the glycerine does not harden, this kind of preserved monolith should normally be kept in a horizontal position. A little glycerine should be added from time to time, normally once a year.

The ISM can be contacted for a more detailed description of this method.

Normally anaerobic (parts of) soils

Upon drying, some gley features, such as the dark greyish to black colours in the reduced zone of a soil profile, can almost disappear. The method of Hammond (1974) described above for the preservation of peat soils could possibly be used

beneficially for these mineral soils as well. The ISM is testing P.E.G. and some other chemicals for the impregnation of wet mineral soils and will report on this at a later stage.

We anticipate in the future that the drawbacks of the impregnation methods and chemicals used heretofore will be less of a problem. With the impregnation of some kinds of soils, such as Andosols, the ISM has not much experience.

4. The Display and Storage of Lacquer Peels and Monoliths

Many methods exist for the exhibition of lacquer peels, monoliths and the relevant information on the collected soil. In this paper, only a few suggestions are given. See the photo-sequences in Appendix I. For more detailed information and construction drawings, please apply to the ISM.

4.1 Mounting and display

A lacquer peel can be put into a wooden frame, if desired, leaving space for the notation of the name, location, horizons, and other data. Because of their low weight, they can be hung on two strong hooks, screwed into the frame. They are relatively flat and do not need special illumination in order to be seen well. They can be displayed vertically.

A soil monolith can also be put in a wooden frame, but it must be realized that, because of its weight, hooks will in most cases be insufficient to hold it. Furthermore, artificial light is usually desirable for the monoliths to be viewed properly. It is suggested that the framed monolith be given a backward slant of 10-15 degrees, thus placing the lower part on a table or, preferably, on a specially designed stager with bench hooks.

In order to see the lacquer peels and monoliths well, they should not be kept behind glass. If the display rooms are dusty, the soils can be covered with glass or transparent glass or plastic but these should then be of a removable type. See figures 7 and 30 in Appendix I.

4.2 Storage

Usually a part of the collection is put away in storage. The lacquer peels can then be either hung on walls, or hooked onto runners sliding along a track. These are fixed to the ceiling or onto wooden beams so that the storage capacity of a room is considerably increased. Soil monoliths, which are much heavier, can best be stored horizontally in sturdy wooden or metal racks. The maximum allowable weight on the floor should also be taken into account.

Figure 27 shows the storage room for lacquer peels and some monoliths belonging to the collection of the Department of Soil Science and Geology, Agricultural University Wageningen, Figure 28 shows the storage for monoliths of the ISM.

5. Acknowledgements

The text of this booklet is based upon earlier drafts (J.H.V. van Baren & D. Creutzberg), newer literature and, especially, more than a decade of experience in this matter by the second author.

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6. Request for Cooperation

It has already been mentioned that the present techniques and chemicals used for the impregnation have some shortcomings. Since it is one of the duties of the ISM to find solutions for problems in the impregnation of soils (especially of moist mineral soils and organic soils), it would be greatly appreciated if readers could send their comments, ideas and innovations to the

International Soil Museum
P.O. Box 353
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The Netherlands

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APPENDIX I – Photographs

1. A profile pit is dug

2. Lacquer is poured on the flat surface

3. Lacquer is left to dry

4. Lacquer peel is loosened

5. Lacquer is put on a piece of board

6. Lacquer peel is glued on piece of board and trimmed to size

7. Lacquer peel is pressed firmly on piece of board

8. Field equipment for taking lacquer peels and soil monoliths

9. A pit of sufficient size is dug; one face is smoothed

10. The size is marked, using the lid of the box

11. A box is pushed over the the column and held in position

12. Roots are carefully cut to avoid collapse of the soil column

13. The box and soil column are detached from the face and tilted; bandages prevent soil falling out

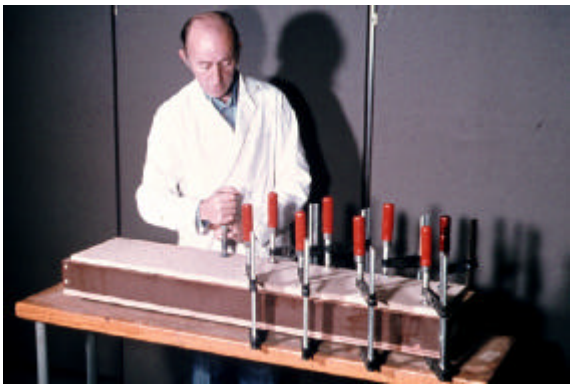
14. After removing the bandage, the profile is levelled

15. The box can be closed for transport

16. The monolith is sprayed several times with diluted lacquer

17. After drying, undiluted lacquer is applied, over which jute is applied

18. Chipboard is glued on the monolith



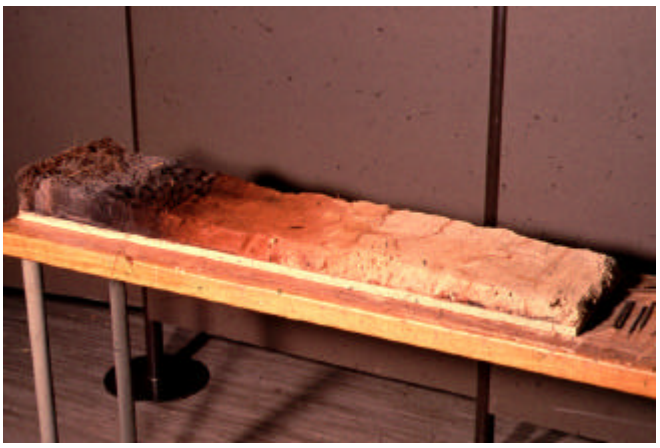
19. The chipboard is clamped onto the monolith

20. After hardening, the box is turned over

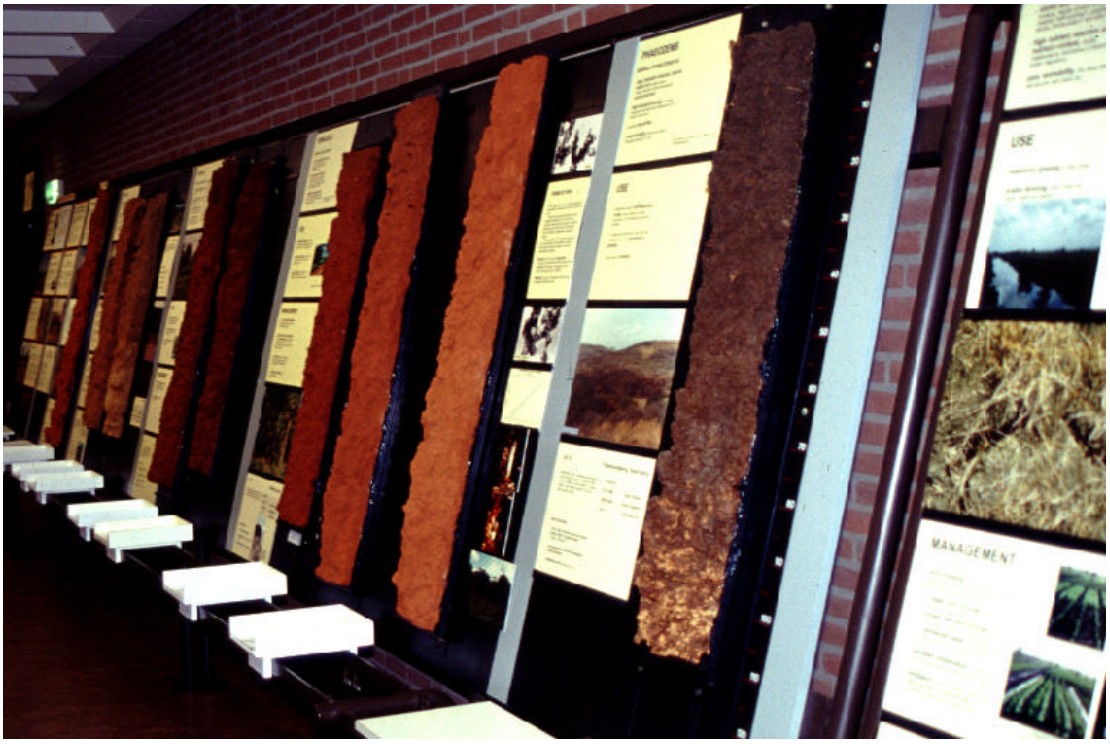
21. The box is removed from the monolith

22. A vibration device is used to reveal the structure

23. Loose material is removed carefully



24. After preparation and spraying with a non-glossy lacquer, the monolith is ready for display



25. Display of soil monoliths at the ISM

Appendix II -Chemicals used

For the preparation of a lacquer peel and its attachment to a display board, as well as for the impregnation of a soil monolith, the following two products may be used:

1. A cellulose nitrate lacquer with thinner

At ISM, Profile Lacquer and Thinner are used. Supplier: Eijkelkamp, Lathum, The Netherlands. The following mixtures have been used:

Lacquer	Thinner	Viscosity at 25°C
20%	80%	0.2 x 10-4m/s (0.2 St)
30%	70%	0.5 x 10-4m/s (0.5 St)
60%	40%	10.6 x 10-4m/s (10.6 St)
100%	0%	200 x 10-4m/s (200 St)

Similar products are available from many manufacturers, such as Ciba, Hoechst, ICI, Gustav Ruth Temperol Werke.

2. A resin dissolved in organic solvents

Solvents frequently mentioned in publications are vinyl acetate-vinyl chloride copolymer grade VYHH in powdered form, technical grade acetone and methyl isobutyl ketone.

As possible sources of supply, many manufacturers may be mentioned, such as Bakelite Corporation, Harrisons and Crosfield, Union Carbide Corporation.

3. For mounting the monolith

At ISM, a fast drying polyvinyl-acetate solution is used to mount the monolith. Under the name Cetaflex Kunstharslijm, it is manufactured by Ceta Bever, Houtweg 152, Beverwijk, the Netherlands.

Similar products are available from many manufacturers, such as Hoechst, ICI, Wacker Company. Products on the basis of synthetic rubber and epoxy resins may also be used.

4. For a protective coating on the soil monolith

At ISM, a poly-methylmethacrylate is used as a protective coating. Under the name Dermoplast SG or Archeoderm, with a Thinner, these products are made by Chemische Industrie Filoform, Verl. Hoogravenseweg 69/c, Utrecht, the Netherlands. Similar products are available from ICI, the Krylon Company, and many other companies.

For other products and companies see Bouma (1969).