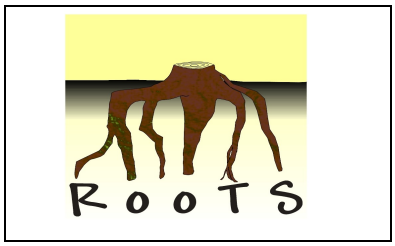

Practical Guidelines:

How to Take Soil Samples on Archaeological Sites

for Chemical and Physical Analyses and Micromorphological Studies

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Guideline on how to take soil samples on archaeological sites for chemical and physical analyses and thin section for micromorphological studies

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The discipline of micromorphology is concerned with the study of soils, unconsolidated sediments and other materials (e.g. of archaeological such origin) at a microscopic scale.

Micromorphology is a technique where undisturbed soil blocks are impregnated with a polyester resin, afterwards it cut into the right size and glued to a glass plate, before it is polished down to a thickness of 30 µm. Eventual it is covered with a thin glass on top as well to protect the soil from dust etc. Upon preparation of the thin section it is studied with the help of a polarizing microscope in order to examine the composition and fabric of soils and sediments.

The application of thin-section micromorphology may reveal (Rapp, 2000, p.240):

1. The origin and environment of deposition of sediments,
2. Land-use practices,
3. Anthropogenic materials and features (e.g. ash, cremation, floors, micro-artefacts…),
4. Origin of clays, e.g. from mud brick or natural downwards migration through the soil or sediment,
5. presence of carbonates, gypsum, pyrite, salts, …
6. vegetation cover
7. Post-depositional processes (including pre and post soil formation processes)
8. Burning (its impact on the archaeological record, type of fuel, temperature, …)

Unfortunately it is not always possible for micromorphologist to visit the archaeological excavation to take samples, e.g. the archaeological layers are only accessible for a very short time, or the use of micromorphology has not yet been implemented in the excavation strategy and therefore not budgeted. It is therefore up to the field archaeologist to take such samples.

In the following a concise guideline is presented. Its purpose is to guide the field archaeologist on how to take quality samples for micromorphology from a practical point of view.

It should be stressed that the best results using micromorphology is achieved when the samples are followed by sketches, photos, field descriptions and clearly defined question marks to be solved applying this technique.

Sampling for micromorphology requires following steps, which will be discussed in detail below:

1. Defining the scientific question(s). What is unclear or what needs to be sustained, where is micromorphology able to contribute. Preferentially any available and relevant information on the archaeological, geological, pedological…. context should be included.
2. The exact sampling spots are documented by means of quality general and detailed photos, preferentially including field drawings.
3. Collecting the samples and wrapping them up correctly.
4. Sampling for e.g. chemical and physical laboratory analyses.
5. Mailing of samples together with the necessary site and sample documentation.

Quality sampling in the field is essential for the representativity and reliability of the data and for the final scientific outcome.

Quality sampling

One should keep in mind that adequate sampling can only be performed when the questions that have to be answered are raised in advance. Sampling for the purpose of archaeology involves different strategies than sampling for soil fertility, soil genesis, botany, zoology etc.

Although quality sampling is a necessity for all kind of analyses, as the basic purpose of micromorphology is to examine soils as undisturbed bodies, great care should be exercised while sampling for this type of study. The purpose of micromorphology is to consider the soil as a constructed body, which implies that all individual or compound particles in a soil material are considered as building elements, so the relative position of each element is of great importance (Stoops, 2000).

Sampling for micromorphology might be conducted with our without sampling boxes.

Without sampling boxes:

Some very coherent soil materials such as clayey dry soils or well cemented horizons (well developed Bt horizons, duripans, petrocalcic horizon etc.) can be sampled without the use of a box.

For stony or gravely materials this is the only way to take samples, but if the fine earth fraction (finer than 2 mm) has a loose consistence, it might be necessary to impregnate the soil prior to sampling with some kind of cementing agent (e.g. polyester resin, diluted glue etc.).

The sample should be cut immediately to a size of about 80x50x50 mm using a knife or if necessary a hammer.

Please remember to carve the orientation of the sample on to it, either by using arrows or the signs 'X' for up and 'O' for down.

Afterwards the sample is gently wrapped into soft paper, and with a plastic cover to enclose the humidity. On the outer wrapping the sample number and orientation is again indicated.

Finally the samples are collected in boxes for transportation, well wrapped with cotton, wool or foam plastic or similar materials. It is very important that the samples can't move but they should neither be placed under any kind of pressure during transportation.

Photo 1: *In hardened soil material sampling of blocks is possible without storing them in boxes.*

With sampling boxes (Kubiena boxes, plastic boxes,….):

Most soil materials are best sampled with a Kubiena tin (Kubiena, 1953). It composes of 4 sides with an upper and lower cover, which both are removable. They are usually fabricated in bladed aluminium, but any other bladed metals can be used as well, provided they are not oxidizable. The size of the box is in principle not important, but if a sample is not fitting the manufacturing standards the excess soil material is lost. The most frequent manufacturing standard is 80x65x40 mm. If the walls of the Kubiena box are sharpened beforehand it makes it easier to insert the box into the soil.

Photo 2: *Different sampling boxes. Right: Kubiena box with the front cover loosened. Centre: Photo film box, with small piece of plastic to rap around the sample to avoid shaking. Right: example of a plastic box with cover.*

When sampling, the covers of the box are removed and the sides are gently pushed into the soil. Using a hammer may damage the box and the soil body (or micro fabric) by the vibrations. If the soil is too hard to allow the box to be pushed into the soil by hand, then cutting a deep groove along the sides of the tin with a knife may help.

In case of sampling in horizons with roots a strong garden scissors may be useful. The tin is pushed completely into the soil and just a bit more. Then the adhering mass is carefully cut off and the front of the tin is sealed with the cover. With a knife, the tin is cut loose from the soil and closed on the backside as well. The tin is finally closed completely with tape to store the humidity. Remember to indicate sample number and orientation on the sides of the tin, not (only) on the covers!

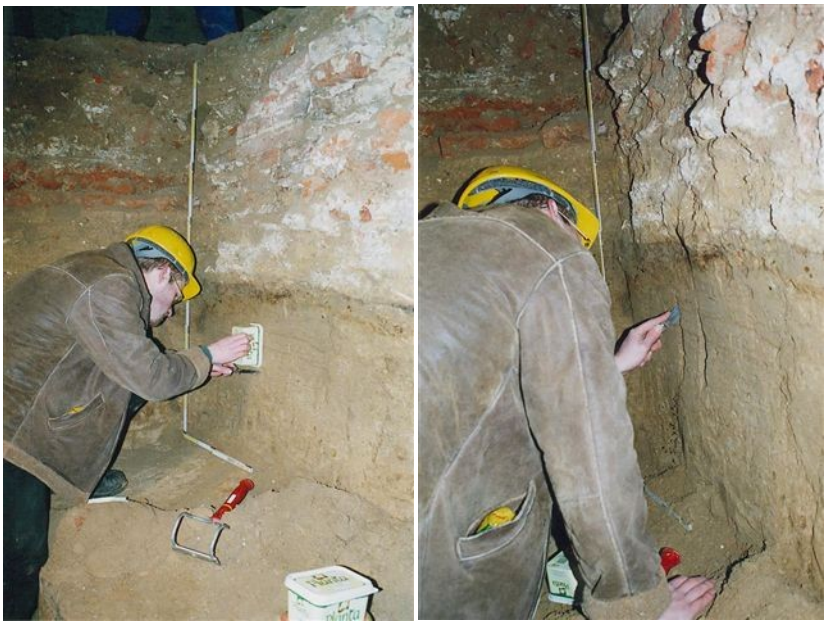

Photo 3: *Left: the potential sampling size according to the sampling box is indicated on the profile. Right: groves are cut into the soil according to the marked size of the box.*

The sample, which is undisturbed, can be used for meso and/or micromorphology. In latter case it has to undergo the procedures for thin-section preparations (Bullock et al. 1985, p. 7-16).
Sampling in Kubiena boxes is often carried out when the soils are very fragile or loose (e.g. sand). Otherwise plastic boxes are a cheep and in most cases sufficient alternative and it comes in a large number of sizes. For petrographic sized thin-sections (28x48 mm), photo film boxes offer the perfect size.

Ones all samples are collected, it is recommended to pack the individual samples in larger boxes. They should be firmly packed in order to avoid

shaking. Any free space in the box should be filled. Be careful that the lower packed samples are not suffering under the weight of the overlying ones. Rap the samples up like you expect the post service to play football with the package. Preservation of the humidity is important, so each sample should be sealed of, to avoid for example shrinking.

Sample labelling

A clear and unambiguous sample code is very important. Therefore the sample recipient is labelled just prior to the sampling. The label code should be short but comprehensive. An example is explained in the following:

Location of the profile:	ZF (Zonian Forest)
Sampling year (may include date and month):	2006
Profile or trench number:	P9 or T9
Horizon or layer number:	H6 or L3
Depth of sample:	64-73 cm (or inches)
Written on the sample box like this:	ZF/2006/ P09/H6/64-73 cm
Orientation	Indicated e.g. by arrows

Photo 4: *The sample labelling is written on the box, remember to indicate the orientation not only on the box but also on the sample itself by gentle sketching it by arrows (with a knife).*

Selected references:

Bulock et al, 1985

Kubiena 1953

Stoops 2000

Rapp, G.R. 2000. Geoarchaeology (p. 237-244). In Linda Ellis (Ed.) Archaeological Method and Theory. New York, Garland Publishing.

Vrydaghs, L., Devos, Y., Fechner, K. and A. Degraeve. *in press*. Phytolith analysis of ploughed land thin sections. Contribution to the early medieval town development of Brussels (Treurenberg site, Belgium). Proceedings of the *4th International Meeting on Phytolith Research***:** New perspectives in Phytolith research: climate, environment and archaeology.. Cambridge (UK). 28th-31st August 2002. Mc Donald Institute for Archaeological Research. University of Cambridge.

Find on internet the Soil survey investigation report no. 42 (soil survey staff, 1996).

The agricultural handbook no. 18 of the USDA (1951)

A practical guideline how to take samples for micromorphology:

PHOTO 5 Cleaning the profile:

It is very important not only to include the archaeological layer or trace when preparing the profile. The profile preparation should include a few decimetres into the parent material in order to record the main limits and anomalies, e.g. bioturbations or heterogeneous layers. If samples are taken for laboratory analyses, it should include a sample of the parent material. The left side of the photo illustrates the relation between the sediment stratigraphy and an archaeological structure, in this case a recent ditch made for a drainage pipe at the moment when the soil surface was at -65 cm depth. Thus the main interesting palaeo-feature to be studied has to be looked for deeper, in this example at -90/95 cm, which is the palaeo-surface related to Roman and pre-Roman structures.

PHOTO 6 photographing the profile:

Take general photos of the profile (like this one to the left). Also take photos of any useful details and sampling points in particular. Remember a clear and detailed scale and a reference plate. High definition digital photos are preferred, as they allow a great level of zooming into particular features of the photo.

PHOTOS 7-8, sampling for laboratory analyses:

Samples for laboratory analyses can easiest be taken in plastic bags, but boxes is also recommended. On the plastic bags is indicated site, date, profile, horizon or layer(s), sampling depth and eventually purpose e.g. sample for phosphorous, organic carbon etc…:

Very small plastic bags or photo-film containers are used for sampling e.g. isolated charcoal, mollusc, small fragments….

Small plastic bags are appropriate for well situated samples e.g. for dating artefacts, for samples for analyses of pollen, parasites, phytolithes, charcoal, etc.

Medium sized bags are commonly applied for samples for laboratory analyses, such as granolometry, chemistry, phosphate analysis,...

Large bags are used for sieving, e g. for the study of molluscs, micro-faunal remains, botanical remains including charcoal, ...

Very large bag are applied for the same purposes as large bags, but for soils with a more heterogeneous nature, where larger quantities are required for a representative sample (e.g. stony soils).

Pay attention not to mix two layers or to include perturbations unless wanted. The storage necessities are often specific to each type of analysis, so avoid to sample only one bag for different disciplines.

PHOTOS 9-10, preparing the profile for sampling for micromorphology:

1) Check for more recent (post depositional) bio-galleries and other perturbations, which should be avoided as part of the sample.
2) Check that the selected spot is the most representative for the whole phenomena to be studied.
3) Prepare a straight surface on which to apply the sample box (the surface should be parallel to the sampling recipient). In the illustrated case a fresh sampling wall has been prepared by removing the outer 5-6 cm of the vertical wall, which has dried out after days of exposure to the sun.

PHOTO 11 Choosing and labelling the rectangular sample box:

If possible use sample box with a size that match that of the final thin section. The size depends on the thin section manufacturer (e.g. often it is 9 by 6 cm). Remember to indicate the orientation of the sample by an arrow, and add information on site, date, profile, horizon/ or layer(s) and sampling depth. On the photo a sample box of size 30x5x5 cm is used, this is for multiple micromorphology samples over the complete sample length. It is vital to take high resolution photos of the sampled surface; these photos will be used to select the samples for micromorphology and can be an important source of information to help with the interpretation.

PHOTO 12, inserting the sample box:

The box is gently inserted a few millimetres into the soil, if the resistance becomes too high, the soil around the box (too the sides, below and in top) is cut loose, so as to push the box a little further into the soil without forcing it.

PHOTO 13, removing the sample:

Once the box is completely pushed into the soil, detach it from the profile by prudently inserting the knife behind the sample, all along it.

PHOTOS 14-16: Cutting away the surplus soils and packing the box for protection against contamination and chocks, if possible by closing the front and back lids in case of Kubiena like boxes.