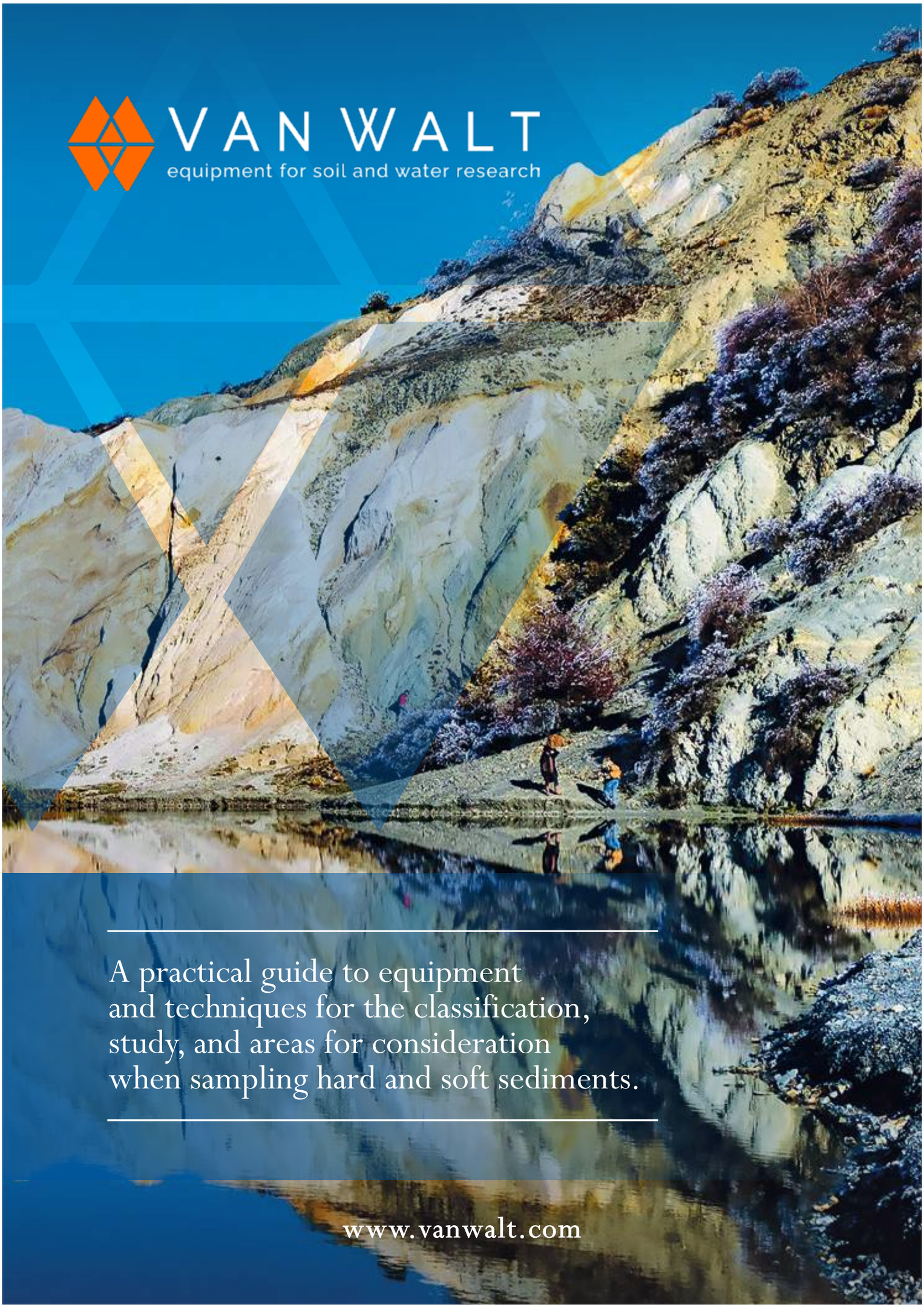

VAN WALT
equipment for soil and water research
A practical guide to equipment
and techniques for the classification,
study, and areas for consideration
when sampling hard and soft sediments.
www.vanwalt.com

February 2025

As I write this, it is, almost to the day, 43 years since my wife Kaja and I started the business from an upstairs bedroom in Haslemere, Surrey.
Undisturbed by mobile phones, computers and the internet, client acquisition was done by reference to the Yellow Pages.
A few years ago, Dr Julian Orford (now Professor Emeritus) QUB, Department of Geography, reminded me (with a smile) that when I first visited him as a youngman to discuss sediment sampling tools I wore a suit and tie. I now reserve this dress code for weddings and funerals. It is not just the dress code that has changed.
What does remain the same is the excellence and quality of the hard and soft sediment sampling tools that Van Walt has supplied over those four decades and over the next few pages I've attempted to summarise suitable sampling equipment by category of the various disciplines that might have a requirement for such material.
Soil research in the United Kingdom has seen a massive evolution. Our main customers forty years ago were organisations such as Rothamsted Experimental Station, ADAS, the agricultural colleges such as Harper Adams, BGS and of course ---

--- the Universities, especially those involved in geographical and archaeological research. Whereas the core of these organisations remains broadly speaking the same, the funding and in particular the emphasis on a "research with and from commercial benefits" is more than a little evident.

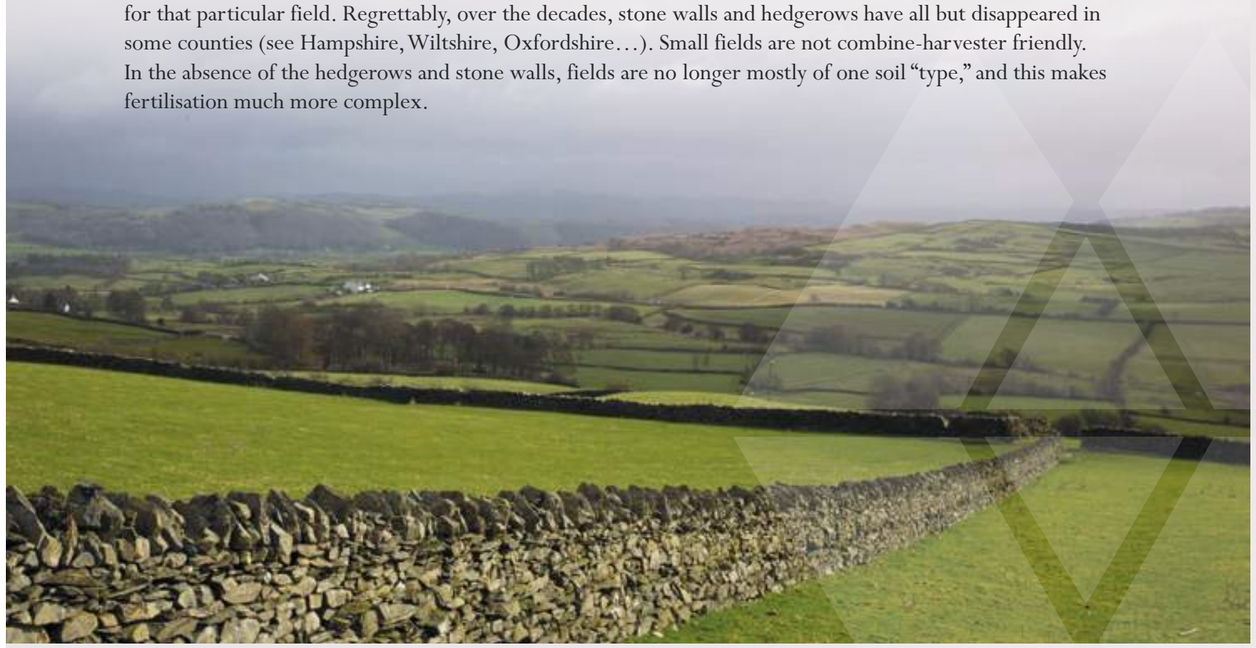
Perhaps what I'm trying to say here is there has been a shift away from ultra-pure research solely for the sake of research. I hasten to add that it is not for me to judge whether this is a good or bad thing but I will say that the young students of today are often more inclined to aim for a desk where they can work from a powerful computer rather than a balanced time with vast quantities of field work and that academics spend much of their time in the pursuit of funds. That the progression of an academic's career is often linked to the success in the acquisition of finance is, to me, a somewhat disturbing phenomenon of our times.
What never changes is the friendliness and courtesy of our customers and I wish to take this opportunity of thanking you all very much for your continued support.

Vincent Van Walt

VAN WALT

Introduction

The characterisation and classification of soils is nothing new. Those who cultivated their land would classify it according to soil colour, whether the land was subject to flooding or drought and whether it was fertile and nutrient retentive. They would opt to cultivate a type of crop per type of soil. One needs to look no further than the walled fields of counties like Northumberland. The farmers delineated the fields with stone walls or hedgerows. Aside from this, clearing the fields from stones or creating hedgerows as, bird (e.g. pheasant) cover, they mostly delineated according to the soil characteristics of the particular field, whether it was known for good or bad permeability, whether it was acid or neutral, whether it was likely to flood or whether cultivation would result in compacted soil pans. Like this they could determine best cropping and best yields for that particular field. Regrettably, over the decades, stone walls and hedgerows have all but disappeared in some counties (see Hampshire, Wiltshire, Oxfordshire…). Small fields are not combine-harvester friendly. In the absence of the hedgerows and stone walls, fields are no longer mostly of one soil "type," and this makes fertilisation much more complex.



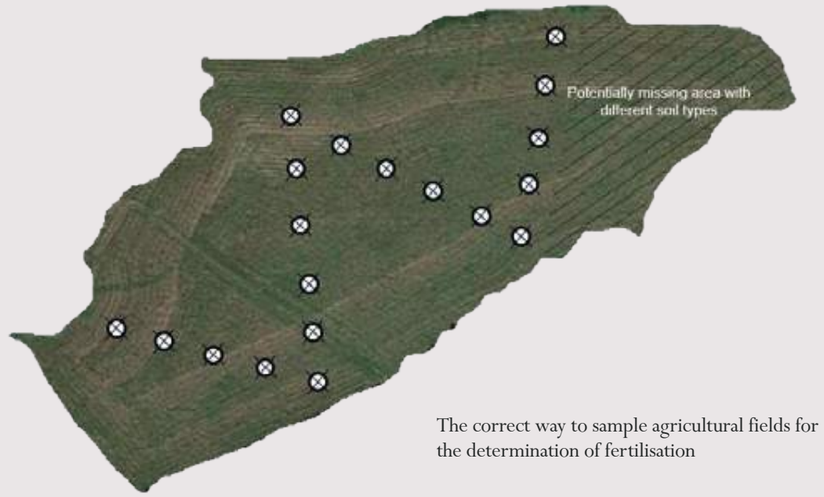
It was not until 1960 when the International Institute of Soil Science asked the FAO and UNESCO for a global soil map.

Around that time researchers and field technicians demanded tools which allowed them to take soil samples in a consistent and reliable way. Methodologies and tools were developed by people such as Cornelis Hendrik Edelman of the Agricultural Institute at Wageningen which resulted in the "Dutch" or Edelman auger. Be all that as it may, all manner of soil sampling tools were manufactured to deal with different conditions with the main aim of making soil sampling consistent, comparable and repeatable.

Let me expand this with an example:

Sampling agricultural soils to determine fertilisation requirements must be done in a precise way. In Britain, ADAS prescribed a system whereby a field is sub-sampled in a "W" pattern with 5 samples taken from each leg to a depth of 6" (15cm). The 20 sub-samples would be mixed and analysed together and that formed the basis for fertilisation (e.g. Dr George W. Cooke, Deputy Director, Rothamsted Experimental Station, Fertilizing for Maximum Yield, 1972). In order to do this, convenient mini-gouge augers were manufactured which ensured the required consistency for this type of sampling.

Mini augers for sampling agricultural fields



The correct way to sample agricultural fields for the determination of fertilisation

So different requirements resulted in different tools and today we have a buffet of soil sampling tools which can cater with most sampling situations.

Different hand auger heads to cope with different soils

Disturbed vs Undisturbed Sampling

When we take soil samples, it is important to determine whether the sample can be disturbed (as one can get by using a spade or trowel), whether it can be semi-disturbed (such as using an Edelman type hand auger) or whether there is a requirement for a totally undisturbed sample. One is not better than another as long as it satisfies the requirements of the research, but it is important to determine the type of sample that is needed, and it is worth remembering that it is much more difficult and time consuming to take undisturbed samples.

Taking totally **disturbed samples** such as one would get when using a trowel or spade fall outside the scope of what we would regard as an acceptable practice in the field of soil research, so we need not spend time on this subject.

Semi-disturbed samples are the result of using standard hand augers. Generally, they retain a decent profile structure, but because one twists or drills into the soil there is a certain amount of lateral mixing of a layer. For many projects this is acceptable and using tools to take semi-disturbed sampling makes the job quick, reliable, easy, and cheap.

Undisturbed Samples: There are of course projects that require a sample which is as near to undisturbed as possible. Rotating a hand auger is no longer an option and a half-cylindrical or full cylindrical sampler needs to be driven into the soil making sure that there is minimal disturbance or compaction. Examples of tools for undisturbed samples and typical applications will be discussed in the following pages but suffice here to say that taking undisturbed samples is more difficult and more expensive but if the project requires these then there is no option.

Soft vs Hard Sediments. A distinction must also be made depending on whether the sediment is cohesive or soft and loose. Cohesive material, such as a pure soft clay, is much easier to sample than a very soft sediment such as sand, highly organic material, or very heavy stony soils. Different tools are available to satisfy different field conditions.

Semi-disturbed sample captured within a liner

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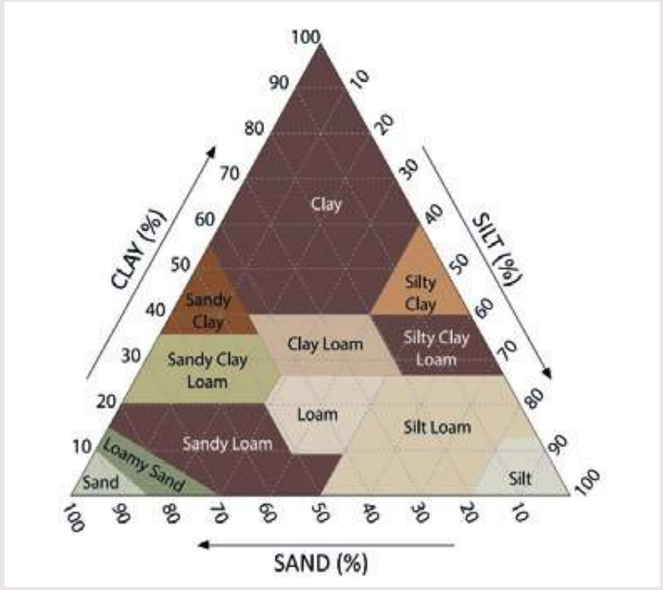
Profiling

One of the most important requirements for sampling is profiling. This can be done by using standard hand augers. Samples are taken in tranches of 15-25cm (depending on the size of auger). The cores are laid side by side to show the profile of the sampled material. Quite usually the samples are photographed, described using colour charts and the soil "triangle" and logged. If an "interesting" layer is detected, then normally a (sub) sample is bagged for further analysis in the laboratory.



Soil triangle (Soil Science Society of America)

As long as the soils are malleable, that is soils which are relatively cohesive, relatively soft, and relatively stone free, hand augering to a depth of 5 metres is, by far, the easiest and cheapest method for profiling. A small auger set with different auger heads will weigh no more than 15 kg. The set is easy to carry and in the stated circumstances the correct tool for general semi-disturbed profiling. So often, researchers ask for mechanically driven sampling sets and whereas these are necessary for harder soils (see below), a typical set to 5 metres will weigh in the region of 200kg.

For harder soils and when it might be necessary to sample to depths of 8-10 metres it may be necessary to use a mechanically driven sampling set. The window sampler is the ideal sampling kit for this.

Typical hand auger set to 5 metres

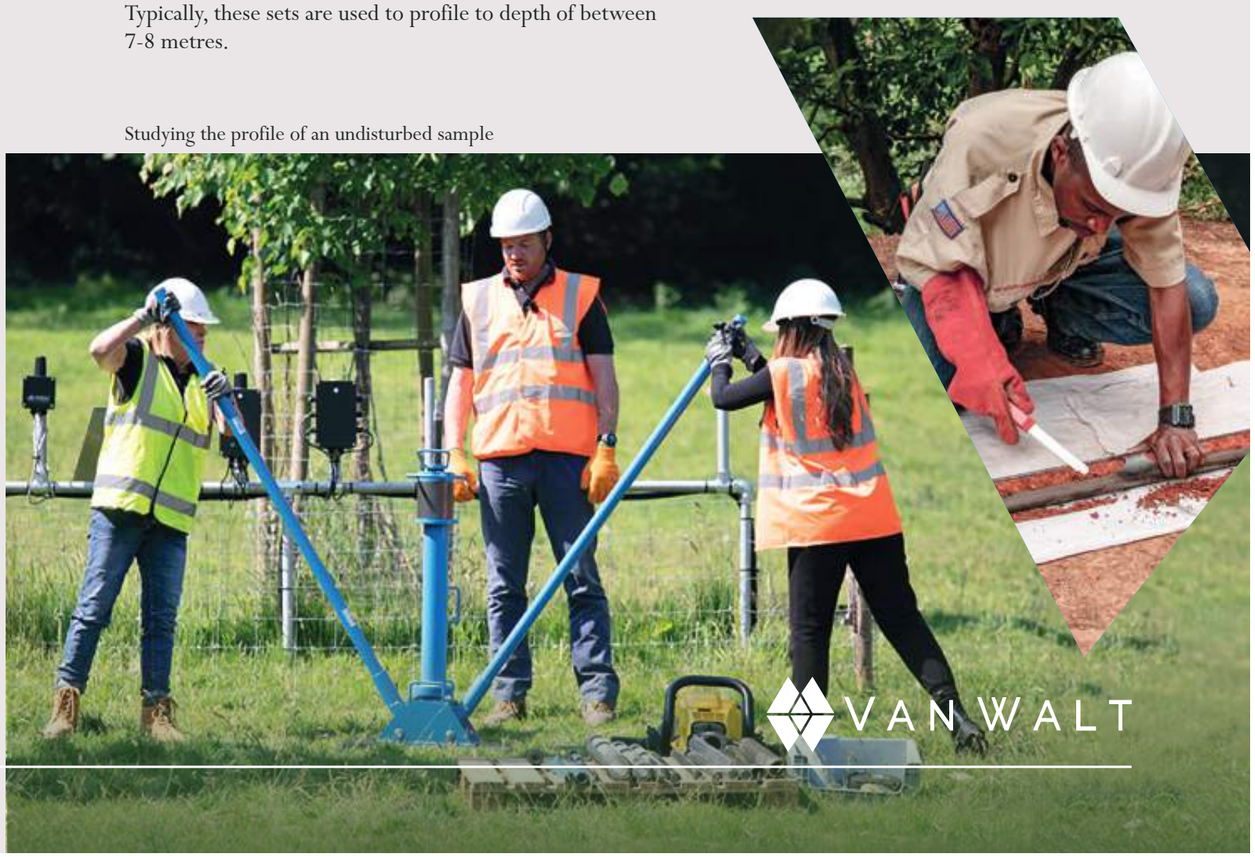
Typical window sampling set to 8 metres

So called window samplers, usually 100cm long and in varying diameters are driven in using a percussive hammer. Normally we supply the sets with the 2-stroke Atlas Copco Cobra hammers which are ideally suited for this purpose. This set also has the option of capturing the profile in a liner for easy transportation back to the laboratory.

The Van Walt window sampling sets have and are being used across the world. Over the years we have supplied researchers with many hundreds of these sets. They are robust, easy to use and above all they are non-destructive which means that it leaves no visual impact on the site.

Typically, these sets are used to profile to depth of between 7-8 metres.

Studying the profile of an undisturbed sample



Archaeological Research

Hand augers and the light-weight window and windowless soil sampling sets are in wide use by archaeologists. To some extent they are useful for rapid surveys to determine whether there is archaeology present but mostly their use is to assist archaeological researchers to survey a site in order to assess the health and sustainability of the remains.

Different soil types which may have completely different water retention curves can indicate the future viability of the archaeology.

Whereas hand augers are certainly, from time, useful, for more serious work the window samplers, which allow the researcher to take virtually undisturbed samples of the profile are a substantially more important tool. Profiling and logging of the samples are carried out much more easily.

When a layer of specific interest is found within the window sampler more habitually a lined sample which intersects the layer is taken for further, more detailed analysis in the laboratory.

As important to the archaeologists as are the physical characteristics of the sediment, they will also be interested to determine the chemistry. Parameters such as pH and the redox potential are proving to be of immense value when assessing the health of the archaeology.

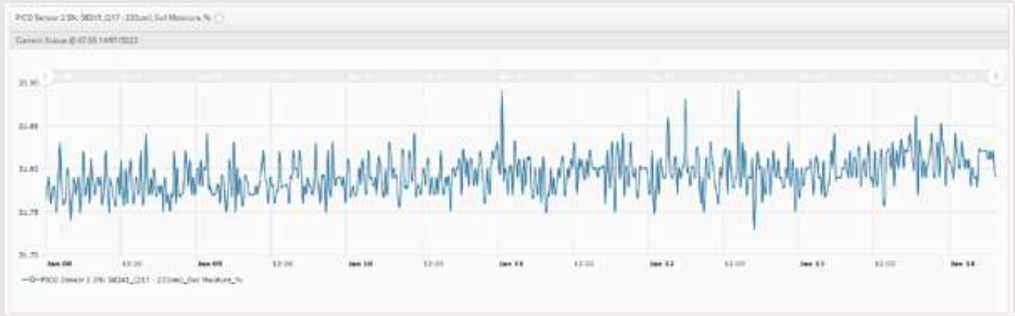
Whereas this broadsheet is predominantly about soil sampling, it would be remiss to exclude specialised sensors which are of great importance to the archaeological community. The TDR soil moisture sensors record moisture very accurately. Newer and more specialised sensors now also exist to measure the pH and redox potential directly in the soil. These three different sensors would be buried at various levels within the profile and will return their respective data at regular intervals, usually every 30 minutes to show the researcher the trend over time of these parameters.

Profiling an archaeological site

Installing pH sensors

Soil pH electrode

Soil Redox probe



Building a soil moisture curve on an archaeological site

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Geographical Research and Peat Surveys

Physical geographers are probably our largest group of customers for soil sampling materials and that is predominantly because they have so many different applications and projects which deal with topics such as climate change or provenance of an area. Unavoidably, they will deal with varying soil matrices. They will need to sample in hard and soft soils, wetlands, mangroves, peatlands, rivers and lakes and often they will be sampling above and below the water table.

Unfortunately, there is no Swiss army knife which can deal with all these different conditions. In other sections of this leaflet, we have looked at hand augers and window samplers so there is no merit in repeating those details, so we will focus on the more difficult aspects of sampling soils for geographical research.

Sampling peatlands: There are just three product lines which need emphasizing:

- Measuring the depth of a peat layer: The simplest tool in the trio of samplers for peatlands is the peat probe. These are fibreglass rods with a metal tip which are pushed into the peat until resistance is felt. The distance between the ground level and the resistance is the thickness of the peat layer.

- Where a continuous profile is required then lightweight gouge augers prove to be most useful. The gouge augers are inserted into the peat, rotated 180 degrees and withdrawn.
  If the material is relatively cohesive the user will be rewarded with an undisturbed sample of the peat.

- If a discrete sample is required from a specific horizon, the Russian corer is the tool to use. The corer is driven to the desired horizon by hand. A full rotation will capture the sample within the chamber, held in place by the corer's wing.
  As a by-the-way, the Russian corer is also really useful when sampling very incohesive material such as sludges and mud.

Peat depth probing rods


Filled 100cm gouge auger


Retrieving a sample of sloppy sediment with the Russian corer

Although not a separate sampling tool, many of the hand augers and liner samplers can be provided with a core catcher. This is an accessory which sits at the cutting side of the sampling device. It allows the sediment to enter the corer but prevents it from falling out. Core catchers are an essential tool when working in very loose sediments and also in wet, sandy substrates.

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Wetland and Peatland Research

Wetlands are an important ecological resource. In many countries they are protected, and regular sampling takes place to be assured of their health and sustainability in the arena of global warming and pollutants.

Elsewhere (see section Geographical Research) we have described techniques and equipment for the sampling of peat or sediments which are high in organic matter.

In this section we will be exploring equipment for sampling in these conditions but particularly in regard to the taking of undisturbed sediment sample profiles to a lesser or greater depth when mechanical devices cannot be used because of accessibility or ground stability. One particular interest is in the aluminium sampling set, made of this material because it is very light weight, so very easy to carry to remote sites, but one which can capture a sample in a liner in tranches of 30cm. The ability of using a core catcher to retain weak sediments is of good benefit. Detailed studies can be made on each individual sample from the profile.

Aluminium sampling set

Another specialised sampling tool is the multi-stage sediment sampling kit equipped with a durable Hex Quick Pin connection, and which includes everything you need to collect relatively undisturbed sludge and sediment samples up to 4' in length. A disposable plastic core catcher and a special stainless steel multi-stage flap valve cap improves recovery of saturated materials.

Multi-stage sampling set

During deployment of the sampler, the check valve flap on the top cap opens to allow excess air and water to escape through the four holes that are machined through the top cap. Air and water are able to easily pass through the sampler. When the sampler reaches the sediment, the saturated materials are able to push through the plastic core catcher and into the plastic liner inside of the sampler body as the sampler is driven downward. The venting action of the stainless-steel multi-stage flap valve cap prevents pressure buildup and allows the sample to enter the liner.

During retrieval of the filled sampler, the plastic core catcher will be pressed closed by the weight of the sediment. This helps prevent the material from escaping through the bottom of the sampler. At the same time, the check valve flap will cover the holes through the top cap – which creates suction inside the sampler. This suction also helps to retain the collected sample in the sampler body.

Environmental Research

It is now almost standard practice for environmental consultants to carry some hand augers as part of their standard kit in the back of the car or van, so it is unnecessary to dwell on this. There is however merit in introducing some specific area of research.

Hydrocarbon Contamination Studies: Because it is easier to measure and evaluate the transport of a hydrocarbon plume by studying the effect of the contamination by way of a groundwater monitoring well, it should not be the only methodology. Soil samples reveal additional and valuable data. By studying the soil profile, we can perhaps discover constraining (clay) layers or maybe we discover a layer of coarse sand which makes a rapid pathway for the contaminant.

Whereas an undisturbed soil profile would be perfect, there may not be the time or the budget. Quick profiling with a hand-auger set to achieve sampling depths up to 7 metres mostly reveals a picture of the general situation.

Split tube sampler

Pesticide and herbicide residue investigation: For this type of study, undisturbed samples are a necessary requirement. Normally these are carried out to a shallow depth of 30-40cm. The transport of the chemical needs to be determined by subsampling precisely for each 5 or 10cm horizon. Special sampling tools are available for just this purpose:

Liner sampler within a standard hand auger

Liner sampler within standard corer and split corer

Soil Organic Carbon Content: We are increasingly getting questions from environmental consultants regarding the sampling of soil to determine the Soil Organic Carbon Content. Because this is of such importance to agriculture, we will be discussing this topic in the section of this document titled Agricultural Research. Consultants however should be reminded that these studies will be over a relatively short profile and the samples need to be as undisturbed as possible.

Sediment sampling from lake and seabed: Contaminants frequently accumulate on a lake or seabed. Take the example of TBT (tributyltin), now banned in Europe but which was widely used as an antifouling medium on ship and boat hulls to prevent fouling. Despite that the compound is no longer used it persists on lake and seabeds close to harbours. The extent and movement of the contamination necessitates samples below the water, and this can, sometimes, be tricky. Special sediment samplers, from simple surface grab devices to corers capable of taking lined samples for a profile to show the contamination distribution within a sea or lake bed profile.

Van Veen grab sampler

Mineral Exploration and Geological Research

This is where everything comes together as far as soil sampling equipment is concerned because almost all handheld soil sampling devices are relevant.

Mineral exploration and geological research often require bigger drilling rigs capable of achieving sampling depths well beyond the scope of handheld soil sampling devices. Nonetheless, these are very meaningful tools for the initial assessment stages.

By way of an example: Often extensive surveying needs to be carried out well prior to a decision by the chief geologist to investigate as to whether the site merits further survey with larger machines. More often than not, prospect for a suitable mining site happens in remote areas where access is difficult. In the initial investigatory phase where a site might have no vehicular access and perhaps the only way to the site is by helicopter, lightweight handheld soil sampling devices are very suitable and may be the only financially realistic option.

Taking samples for mineral exploration, DRC

Evaluating the depth to the saprolite layer

Geotechnical Research: Not to be forgotten in this section, we need to discuss the viability of handheld soil sampling devices for geotechnical investigations. Subsidence springs to mind because it mostly requires investigations which need to be carried out close to a building. Whereas drilling rigs are of course very proper options, they may not be ideal for a couple of reasons. Larger rigs cannot work very close to structures and tracked vehicles, which most drilling units have, are unfriendly to a lawn or landscape which may surround the property.

Training staff in the use of the window sampling set, DRC

Subsidence investigations will often mean heavy clays (London and Gault clays for example). When they are desiccated it may be difficult (though not impossible) to sample with a hand auger, but the window sampling option is perfect for these circumstances. The unit is light and small meaning that operators can sample very close to a building. Moreover, because they are inherently non-destructive, the site is left neat and tidy after the survey. Subsamples can be taken from the various horizons directly from within the window of the sampler.

Geological researchers can obtain sampling tools for macro and micro investigations. Where an extensive investigation needs to take place over thousands of square miles of territory without roads then hand samplers can be chosen based on easy portability to make a project viable.

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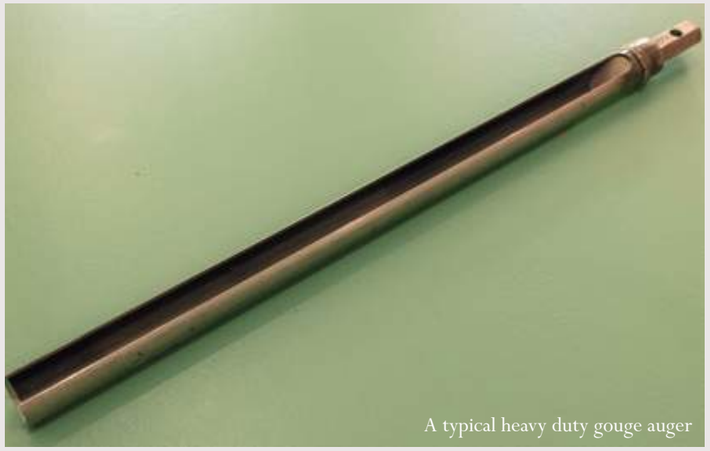
Agricultural Research

Aside from the small augers which are used to take small soil samples to 6-inches depth (3 for grassland), discussed earlier in this publication, there are three important areas of agricultural research that we need to focus on:

Residual Nitrogen: Nitrogen is a major nutrient, meaning that plants require plenty of it. Mostly they assimilate this best when in the form of Nitrates (NO3-N). The compound can be acquired by crop rotation with legumes which fix the Nitrogen from the air, it can be broadcast in an organic form such as farmyard manure (mostly starts as Ammonium-N (NH4-N) and the microbes nitrify this to Nitrates) or by broadcast of inorganic fertilisers such as Ammonium Nitrate.

What is specifically important as concerns Nitrates is that they leach very readily down the soil profile, but we need to be reminded that plant roots of arable crops extend to a depth of 1 metre.
When sampling for (residual) Nitrates it is therefore customary to take a profile, best in tranches of 30 cm and analyse these separately to estimate the amount of Nitrogen remaining which is available to the crop. By carrying out these analyses one can fine-tune fertilisation. Heavy duty gouge augers are ideal for this purpose.



A typical heavy duty gouge auger

Bulk Density and Compaction: Bulk density is an indicator of soil compaction. It is calculated as the dry weight of soil divided by its volume. Too high and the crop roots will find growth difficult, too light and the water retention is likely to be poor.

Bulk density calculations have to be made very accurately, and special sampling tools are available. Stainless steel rings of a precise volume are driven into the soil. The rings are sent to the laboratory for the determination of bulk density.

Bulk density kit

Soil Organic Carbon Content: Soil Organic Carbon (SOC) is the fraction of soil organic matter that is carbon. Crop residues (Soil Organic Matter (SOM)) contribute to SOC but they are not SOC while they have not decomposed. To give a general idea, the organic carbon content of agricultural soils is between 0.7% and 4% although SOC will be down to less than 0.5% in desert soils and possibly as high as 15% in intensive dairy soils.

How SOC is measured is beyond the scope of this brief document but sampling, with the intention of determining SOC certainly is. The samples have to be as undisturbed as possible, and it is useful to build a profile down to 80-100cm.
The split-tube sampler, with or without a liner is but one of the tools most appropriate for this research.

Split tube soil sampling kit

Installation of Monitoring Wells

Installation of shallow monitoring wells to depths up to 5 metres need not involve heavy drilling rigs especially when the area is more remote or difficult to access with tracked vehicles.

Monitoring wells are installed when the researcher is wanting to monitor water level or water quality. Installing monitoring wells in unconsolidated sediments pose particular challenges which can be overcome through the use of the lost-cone drilling system.

A cast iron cone is fitted below steel casing. The casing is driven to the required depth, a 1-inch monitoring well is positioned within the steel casing, which is then extracted, leaving the monitoring well in place. The cast iron "lost" cone is sacrificial as it is left in the soil. This is a very rapid installation method and can be used in softer or harder sediments to depths of up to 10 metres depending on the geology. It is restricted to a maximum outer well diameter of 32mm.

Typical groundwater monitoring well

Components of a lost cone monitoring well installation kit

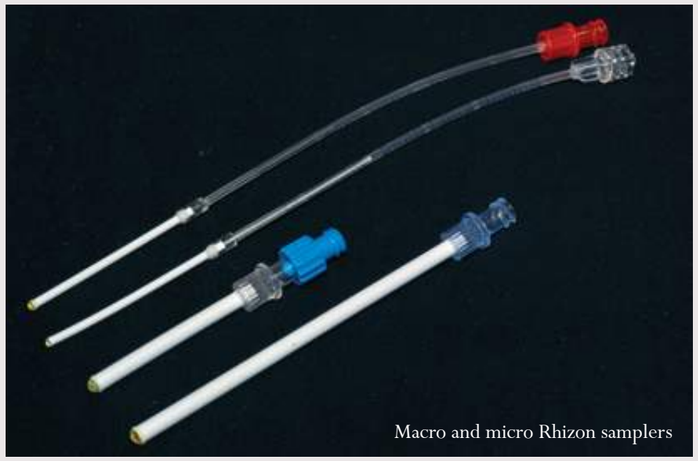
Research in Soil Pore Water Chemistry

Simple devices are often forgotten or deemed unsuitable because of the low price. But this need not to be the case and the Rhizon soil pore solution sampling sets are a perfect example.

Macro-Rhizon soil solution sampler

These little sampling tips are made of a porous inert material. They are inserted in the sediment and when put under tension they will extract solution which sits in the pores of the soil. Because the material is inert, they do not alter the chemistry of the pore water so are suitable for inorganic compounds including for the analysis of metals and pH.

The pore size is approximately 0.15 µm so therefore may not be suitable for compounds such as PAHs. Sample size is between 20 and 30 ml per sampling round.



Macro and micro Rhizon samplers

When larger samples are required then ceramic tipped canes could be used but they are fragile and because the tips are ceramic, they could potentially alter the chemistry of the water.

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equipment for soil and water research

- Disturbed vs Undisturbed Soil Sampling
- Profiling
- Archaeological Research
- Geographical Research
- Peat Surveys
- Wetlands and Peatland Research
- Environmental Research
- Mineral Exploration
- Geotechnical Research
- Agricultural Research
- Installation of shallow monitoring wells

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