1908D04.5L09

OPERATING INSTRUCTIONS

1908D4.5L09 Macro Rhizon Soil Moisture Samplers Nov 2010

Contents

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On these operating instructions

☞ If the text follows a mark (as shown on the left), this means that an important instruction follows.

If the text follows a mark (as shown on the left), this means that an important warning follows relating to danger to the user or damage to the apparatus.

1. Introduction, general description of Rhizon samplers

Sampling by Rhizons is appropriate when successive soil solution samples are needed from the same volume of soil in :

- Studies of transport of nutrients in soil
- Models of nutrient uptake using the actual concentration of nutrients in the soil solution.
- Mineralisation studies.
- Salt accumulation studies.
- Speciation studies of metals etc

Use of Rhizon samplers is not limited to these situations. Rhizons can also be used for, extraction of soil solution from saturated paste of very heavy, salty soils, etc. MacroRhizon will function when the soil is not too dry, with suction less than 200-500 cm water column. When a soil dries, MacroRhizons will stop functioning but will function again after re-wetting. Cracking soils may damage MacroRhizons.

Rhizon samplers have in common that they are produced from an inert microporous tube with bubble point pressure > 2bar. The microporous tube is closed at one end and connected at the other end to flexible tubing with
1 mm internal diameter and a Luer-Lock connector.
A sample is obtained by connecting with vacuum: a vacuum tube or a syringe.

Standard Rhizon samplers are in designs for specific applications:

- For pot, cylinder and column experiments with undisturbed soil: Rhizon SMS 2.5 mm diameter with stainless steel wire (for macro elements only).

All other designs are for micro and macro elements and organic matter.

- For pot, cylinder and column experiments with undisturbed soil: Rhizon MOM 2.5 mm diameter with glassfiber epoxy wire.
- For disturbed soil in columns, pots and bales and paddy soils: Rhizon FLEX 2.5 mm diameter, with nylon wire and 60 cm flexible tubing.
- For field Research: MacroRhizon 4.5 mm diameter, very strong.

When mechanical strength is important: Rhizocera, pure Al_2O_3 3.0 mm diameter (not a standard product for Eijkelkamp). Use Rhizocera samplers in situations where a higher mechanical strength is important.

Use MacroRhizon as a replacement for ceramic cups for direct extraction of soil solution in the field, same advantages as above, dead volume depends on details.
Standard ceramic cups, produced from clay, are also strong but have disadvantages:

1. High dead volume.
2. Exchange of (divalent) cations and absorption of phosphate. Use of ceramic cups produced from pure Al_2O_3 diminishes these losses due to sorption.

Use of Rhizon 2.5 mm in field soils is possible too, but samplers have to be inserted from trenches. Trenches disturb the hydraulic properties of the soil.
Rhizon 2.5 mm, MacroRhizon and Rhizocera can be inserted in the soil through holes in the wall of a profile pit.
Insert Rhizon samplers wet in wet soil whenever possible. Wet soil will settle in time after the (small) disturbance

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caused by inserting the sampler. Soil to sampler contact will improve by settling. The time needed to extract a given water volume will decrease at constant water content in a few days.

MacroRhizon are inserted in augered holes at 45 degrees and backfilled.

To control the results obtained with Rhizons, methods using centrifuging or the displacement of soil moisture are preferred. Both reference methods are slow but are excellent for comparison.

2. Technical detail of MacroRhizon samplers, general features.

MacroRhizons have a female Luer Lock (LL) connector and tubing with 1 mm internal diameter PVC outside internally lined with PE. Sets are 10 pieces, unless indicated otherwise. All equipment is supplied with a blue LL bicap. The bicap protects the LL connector from dirt and prevents blocking by small animals.

MacroRhizon are leak tested at > 2bar. Spare tips are available (art. no.19.21.37).

A stopcock is useful for flushing long sampler tubing (volume 0.7 ml /m).

MacroRhizon are designed for field experiments. They are superior, total inert, and can replace ceramic cups in almost all situations.

2.1 Technical description of MacroRhizon

MacroRhizon are available as:

Model 1908.08D4.5L09 MacroRhizon soil moisture sampler, length 9 cm, diameter 4.5 mm. with glassfiber re-enforced strengthening rod and 10 cm of tubing. Set of 10 pieces.

19.21.36 MacroRhizon soil moisture sampler, length 9 cm, diameter 4.5 mm. with glassfiber re-enforced strengthening rod and 10 cm of tubing. Glued in 90 cm long PVC pipe. Complete with tubing with 2-way stopcock for sampler flushing without vacuum loss. Set of 10 pieces.

The PVC pipe can be cut to reduce length. Push back the extension tubing in the PVC pipe with a wood or plastic strip or use silicone tubing 6x2 mm for length reduction.

Note: on request the MacroRhizon can be supplied with other lengths of PVC pipe. Extra length may however induce transport charges. Extension tubing + spare parts: see Chapter 8 List of Standard Products,

2.2 Specifications of MacroRhizon

A MacroRhizon consists of: 9 cm porous material 4.5 mm diameter outside, strengthened by a glassfiber epoxy rod coated with ABS, connnected to a pair of large bore ABS connnectors (outside diameter 14 mm) with female Luer Lock.

Sampling is done with a syringe 30 ml + spacer (art. no.: 19.21.49). MacroRhizon only accepts a syringe.

Diameter of the porous material is 4.5 x 3.0 mm, porous material is much stronger than the same material in Rhizon 2.5 mm. The bubble point > 2 bar (0,2 MPa), mean pore size 0.1 micron. Yield in water is about 10 ml/ min.

With a 10 ml syringe, the yield in wet soil is typically 7 ml in 0.1 - 2 hours, depending on soil properties. Frost resistance has to be tested yet.

Sampler dead volume < 0.5 ml, tubing dead volume 0.7 ml /m.

Acceptable pH : 3 - 12,also depends on the corrosive properties of the soil solution.

Life expectation > 6 months, sometimes frost resistant (depends on the absence of water in the lumen during freezing).

MacroRhizon can extract soil solution from depth > 10 m.This seems to be impossible but is possible due to the vapour bubbles in the sample tubing (see paragraph 7.2 Using MacroRhizon soil moisture samplers at depth).

MacroRhizon 19.21.36 can be extended with (use both!) PVC pipe 5/8” + connector 5/8”, length 1 or 0.5 m, glue connector with PVC glue. Extension tubing PVC/PE, length 1 or 0.5 m, with luer connectors, see also Chapter 8 List of standard products for use with MacroRhizon.

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3. Sampling soil solution with Rhizons, physical aspects

☞ The text is valid for all Rhizon samplers, calculations are for 10 cm porous material.

3.1 Sample size

A 10 ml syringe will yield about 7 ml in wet soil, a 30 ml syringe about 20 ml.

Flushing and evacuation (purging) before sampling is recommended, especially for metals and organic matter. Use the 2 way stopcock to prevent loss of vacuum between flushing and sampling. Sampling by vacuum tube is possible with custom extension tubing with 2 luer male connectors.

3.2 Time needed for sampling

The time needed for sampling depends directly on the actual (unsaturated) hydraulic conductivity (k) of a soil.

Sampling should be no problem when $k > 10^{-3}$ m/day and fair sampler-soil contact. A problem is that k is a function of water content x 3-10 power. A small change in water content may mean the difference between a sample within a few hours or no sample at all.

When the soil dries a sampler may stop functioning, when the soil becomes wet again, the sampler will also become moist again and start functioning again !

When water suction in a soil is > 500 cm, k and the pressure differential become low and often no sample will be obtained.

Experiments with a packed silt loam showed that dry soil wetted to 200 cm suction had a yield of less than 0.5 ml/hour. The same soil first wetted to 20 cm suction had, after some successive extractions, a yield of 5 ml at the same water potential of 200 cm! This result shows that inserting in a wet soil or saturating soil well after inserting Rhizons is important to success.

3.3 Volume extracted / zone of influence

A 7 ml sample is equal to a water filled cylinder of 1 cm diameter and 10 cm length. With 25 volume % water in a soil, all water in a 2 cm diameter soil cylinder is removed by a 7 ml sample.

The following calculations indicate that samplers can be inserted at 10 cm intervals, but that intervals of less than

5 cm are less desirable.

A soil cylinder + 2 semi spheres with l = d = 10 cm and 25 % water will contain 1.2 l soil with 300 ml water.

So, when a 7 ml sample contains 2 % of the total water amount in 10 cm soil cylinder, the volumetric water content in this zone is reduced by 0.5 volume % by sampling once.

3.4 Spatial variability

In the calculation above it is assumed that the soil water conductivity k has no spatial variability. In real situations the water conductivity will be variable. The actual zone of influence in a real soil will probably be more spherical, and have an irregular shape with the statistical mean shape of a sphere which envelops (part of) the sampler.

When plants are growing in the soil they will reduce the water content of the soil. As a rule the plant roots absorb different amounts of water at different positions, so k, will be spatially variable as well.

Samplers will absorb water from sites with relatively high conductivity.

Always use several samplers at one depth in a plot, the more the better, but five seems to be an optimal number, deviating measurements (peaks) and loss of a sampler is no problem.

Evaluation of results can be both mean and by median value. When mean and median differ significantly you learn that your system is very inhomogeneous and that results from the experiment are less suitable for predictions. When you decide to pool, measure /estimate the critical property: EC, pH, color of each sample before pooling.

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4. Properties of soil mositure samples obtained with Rhizons

4.1 General, preservation

Modern analytical methods as a rule need 1 ml sample or less, so the 7 ml to be obtained with a 10 ml syringe or vacuum tube is enough for several determinations because the sample is already filtered.

The microporous material is impermeable to bacteria, but samples are not sterile, due to non -sterile production conditions.

Soil bacteria and algae may enter the sampler from the connector side.

Nitrate reduction or ammonia oxydation is improbable in samples, but without additives these processes cannot be eliminated completely. Samples for nitrate and ammonia can be preserved by diluting 1:1 with 2 N KCl directly after sampling and storage at 4 ºC.

Acidification is an option in samples high in CO_2 to prevent precipitation.

4.2 Anaerobic soils

Samples of reduced soils will discolor in the vacuum tube because there is always oxygen present in a vacuum tube or syringe due to diffusion.

Samples of (partially) reduced soil water to be analysed for Fe, Mn and PO_4 should be acidified, pH < 2, and not be filtered before subsampling for chemical analysis. Otherwise gross errors are possible with these determinations. The precaution of acidifying samples before subsampling is also important with elements that (co)precipitate with Fe, Mn and PO_4.

It is advised to flush the PVC tubing regularly with 1 ml sample to prevent O_2 to enter the porous membrane.

When a soil dries during an experiment, soluble Fe and Mn may precipitate in the sampler and cause unexpected absorption of metals and PO_4.

This risk is extra high when the samplers are open to the atmosphere during the transition anaerobic - aerobic, so keep the stopcock closed and flush regularly.

Insert extra samplers as a control at the moment the soil is aerobic.

See Bibliography (Chapter 5) : van Haesebroeck et al

4.3 Pooling samples, EC

In fertilisation experiments the nutrient content and consequently the EC of replicate samples can be quite different. This makes pooling of samples undesirable but increases the work load of your lab.

With a micro EC cell, the EC of each sample can be measured in the vacuum tube or after transfer from a syringe to a tube. When there is a relation between EC and for example Nitrate, samples with comparable EC can be pooled before analysis. The workload of the lab is reduced, but you keep the information about the spatial variability of salt/nitrate content. A micro pH cell can be useful in metal research. Glass microcells for EC and pH can be obtained for this purpose.

4.4 pH of samples

The solid material of the microporous tubing has, as most solid materials, little permeablity to gas but the water fraction in the microporous material has the diffusion properties of water. Applying vacuum to the sampler will cause a diffusion flux of soil gas (especially CO_2, due to the relative high solubility of CO_2 in water) in the water phase of the microporous tubing to the lumen of the sampler. Oversampling of CO_2 is not easily calculated because oversampling depends on the time needed for sampling.

Loss of CO_2 is expected to be small with syringes. Sampled water and gas are in equilibrium so pH measurements in samples are expected to be quite reliable.

Reliability of pH measurements can yet be increased by sampling the head space in the syringe, analysing for CO_2, followed by a pH measurement under a matched (CO_2) atmosphere. Use an extra stopcock to prevent CO_2 loss from the syringe headspace

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4.5 Dissolved organic carbon (DOC) and trace metals in samples

The samplers are produced from organic materials, so the sampler may add some DOC to a sample. The microporous tubing has no known extractables.

Rhizocera samplers risk problems with soluble Al, extent unknown yet.

We are interested in hearing of your results.

See : Paul Romkens Thesis 1998, Effects of land use changes on organic matter dynamics and trace metal solubility in soils : p.f.a.m.romkens@alterra.wag-ur.nl Decaying organic material in samples may influence N-NH_4 analysis in auto-analyser systems

5. Bibliography

No reports are available now on MAcroRhizons. Field tests at Alterra and PRI Wageningen have shown no problems, tests in New Zealand are starting too (2002).

For more details and current information e-mail: Rhizon@Rhizosphere.com

6. Inserting of Rhizons in soil

Samplers should be inserted in wet soil because of the limited mechanical strength of the porous material.

6.1 Inserting MacroRhizon 19.21.36 in soil in the field

Insert in wet soil. Soil to sampler contact is critical, especially below the plowed layer. MacroRhizon can be inserted vertically for sampling in permanent saturated soil. In unsaturated soil inserting has to be in an augered hole at 45 degrees. Use a gouge auger 20-30 mm diameter with level at 45 degrees for orientation.

Check for stones with the insertion tool (art. no.: 19.21.51), then insert the sampler.

☞ **When your soil is very stony do not use the tool but lower the sampler in the bored hole. Then fill the lower part of this hole with a mud prepared from sieved local soil, directed downward through a simple PVC pipe.**

As an alternative use fine sand or artificial sand, e.g. Eijkelkamp synthetic sand < 73 micron (art. no. 08.01.09) to improve soil-sampler contact. E-mail Rhizon@Rhizosphere.com for advice on details and options.

Fine **dry** sand can be deposited at the bottom of the augered hole using a PVC 5/8” pipe + 15 cm flexible PVC pipe, glued with 5/8” connectors and a plastic funnel on top.

For example 100 ml. Pull out and keep dry.

Replace the sand pipe with a comparable pipe and pour in 50 - 100 ml water. Study the wetting properties of your sand before use to determine interval till pushing the sampler in the sand.

When soil is dried and fine the “dry” method for sand can do.

Wet soil (“mud”) can be pushed down the pipe, experiment before placement!

Also ask your field workers for their methods with ceramic samplers. Please inform Rhizon@Rhizosphere.com about your solutions and problems. Compact well soil around the sampler pipe to prevent preferential flow.

Use the stopcock (art. no: 19.21.18) for flushing before sampling.

Place cap, e.g. a small bottle over tube top and connector to prevent water influx by rain. Capping also reduces soiling of the connector by splashes caused by rain.

Spare tips are available too, art. no.: 19.21.37.

Extension pipe 5/8” and tubing with LL connectors are available, standard in 0.5 and 1 m length for sampling over

70 cm depth.

For horizontal inserting from a trench or manhole and your own designs we supply art 19.21.35, without PVC pipe, sample tubing and stopcock.

7. Suggestions for installation

7.1 General

The MacroRhizon is a multifunctional soil moisture sampler.

- It can be used inside (laboratory) or outside (field)
- It can be used for surface sampling (MacroRhizon with souple tubing)
- It can be used at depth (MacroRhizon with rigid PVC tube casing)
- It can be used for most parameters (no metals used in the sampling device and practically no own sorption)

Tests, where soil moisture samples obtained by centrifuging samples were compared with Rhizon MOM samplers (with an identical material composition / construction as MacroRhizons) have shown this.

Installation suggestions for MacroRhizon with casing (see figure 1-3)

- Remove piece F. This will show porous element A.
- Put porous element (completely) in pure water.
- Connect syringe (= vacuum pump + sample container at the same time) to connector C.
- Apply a vacuum until a few drops of water have been collected.
- Make a hole in the ground with a gouge auger under an angle of 45° (or a small diameter auger if the soil is too hard). See figure 2 “Installation of a MacroRhizon”.

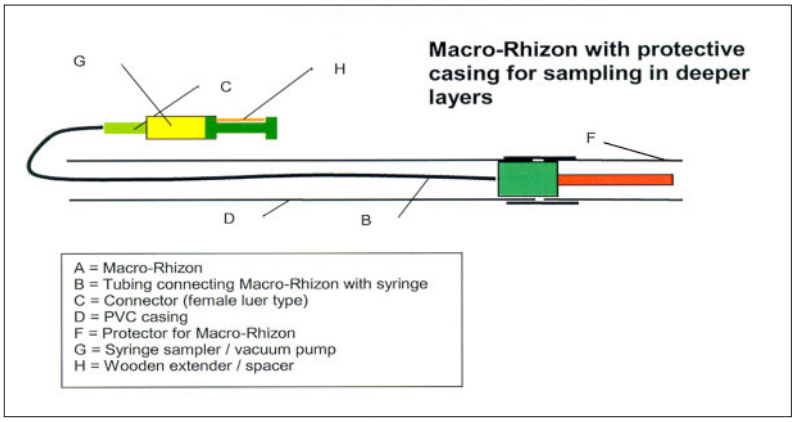

Fig. 1: MacroRhizon with protective casing for sampling in deeper layers

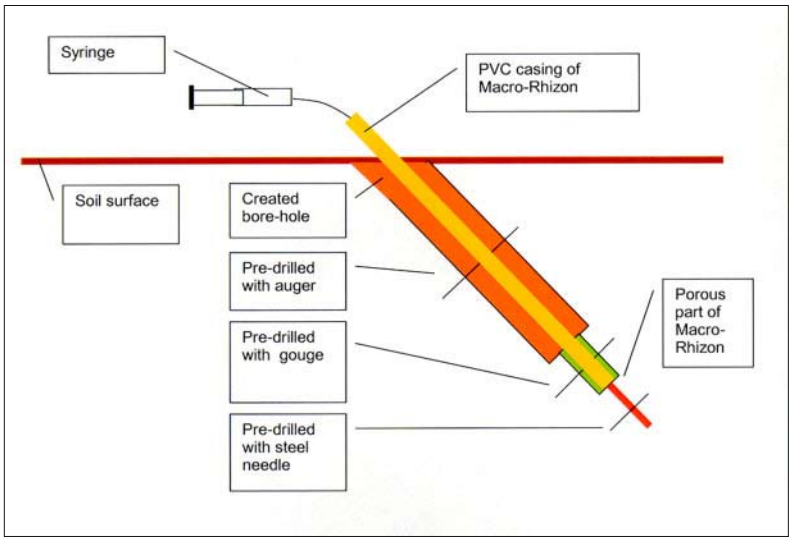

Fig. 2: Installation of a MacroRhizon

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- Push this pre-drill tool in the bored hole and pre-drill a hole for the porous sampler.
- Remove the tool.
- Then, lower the PVC tube that is fitted with the wetted sampler and push it in the pre-drilled hole.
- Connect the “pump” (syringe).
- Pull the plunger and block it to create a permanent vacuum by putting a wooden extender / spacer between syringe piston and syringe cylinder.
- If the humidity of the soil is high enough (pF < 2) this vacuum will collect the sample in the syringe.

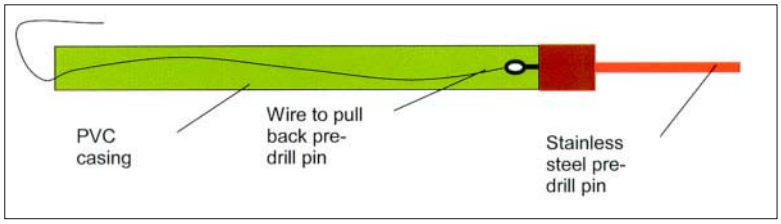

Fig.3: Preparing the bore-hole for the MacroRhizon sampler

Note: Installing the sampler under an angle of 45° has two advantages:

1. After installation of the sampler soil will settle by gravity forces. This will result in a a better hydraulic contact between sampler and soil.
2. During heavy rainfall no water will be conducted to the bottom of the bore hole.

Normally MacroRhizon samplers are meant to sample the root zone. In certain studies deeper applications may be desired. To maintain sufficient suction at the tip of the MacroRhizon when the sampler is being used at an impor-tant depth (e.g. between 3 and 7 m) extending the sampler can be done with the PE tubing (art. no.: 19.21.14) in combination with one souple PVC/PE lined extension tubing (art. no.: 19.21.45). This PVC/PE tubing (with the two connectors at the end) is cut in half. Two 4 cm pieces of silicone tubing (art. no.: 19.21.13) are then sled over the ends of the PVC tubing also using the wire packed with the silicone tubing (to prevent bending). Then the required numbers of meters of the black PE extension tubing is sled into the silicone tubings to make, together, a long extension tubing of the requested length.

☞ **Do not extend with a larger diameter tubing than suggested.**

Other conditions for proper operation: A soil moisture value of the soil below approximately 100 cm suction (pF=2), un undamaged and, at the start, completely soaked porous part that has sufficient contact with the soil and, of course, a vacuum that is higher than the local soil suction (pF) value. Also important is k, the unsaturated water conductivity of the soil surrounding the sampler. The factor k is usually unknown. Low k values are found in coarse sand soils with no clay or organic matter as well as in heavy clay soils. In both cases no moisture will be collected or (in heavy clay) at an extremely slow speed.

7.2.1 Installation

Drill a narrow hole (e.g. 7 cm) preferably under an angle to prevent rain from going straight down to the sample area and to promote settling of soil around the sampler in the days after installation. Finish the hole as narrow as possible (e.g. 25 to 30 mm) for instance with a gouge.

Extend the pre-push tool (fixed with the stainless steel rod end) with PVC tube extenders and fit a cable to pull it back or order the special pre-push with stainless steel pulling rope for deeper applications. Push the pre-push tool into the bottom of the hole that was drilled and gouged before and remove the tool after that.

Now the sampler itself must be prepared. It must be fitted with both an extension tubing that will bring up the water and also a hard PVC ‘casing’ to be able to direct and push it to the required depth. Take the MacroRhizon sampler, fit the riser tubing as described below and also connect, while using the ivory coloured connectors the hard PVC casing pipes (19.21.41). Use PVC glue to fix the casings on each other using the ivory coloured

connectors. Let dry the PVC glue before applying force. On top of the riser tubing mount the small stopcock.

Now soak the MacroRhizon sampler in distilled water; then connect the syringe on the stopcock and pull vacuum untill distilled water arrives in syringe. Disconnect the syringe and close the stopcock. If the sampler is to be transported or stored temporarily, wrap PE (household) foil around at least the porous part of the sampler to prevent drying out of that part.

While sliding the sampler into the borehole keep the stopcock in the open position and finally push the sampler in the pre-pushed hole. Then connect the syringe.

Pull plunger of the syringe and fix it with the wooden spacer. Depending on the 'dead' volume of the length of riser tubing a more or less complete vacuum will be the result. If soil surrounding the tip is sufficiently moist, water will start rising in the riser tubing. Due to the complete vacuum this water will not rise as a continuous column but as small columns of water alternated with columns of 'nothing' but in fact this are vapour bubbles. In fact, due to the high vacuum, the water is boiling at a very low temperature, resulting in vapour bubbles that cannot escape due to the narrow tubing. Gravity does not apply for the vapour bubbles resulting in an important improvement of the suction arriving at the samplers porous tip! The percentage of vapour bubbles compared to the total lenght of the riser tubing will improve the suction at the porous tip with that same percentage!

Water will arrive above ground at the syringe if:

Soil moisture content of soil around the porous tip of the MacroRhizon (in meters water suction) is smaller than the vacuum applied with the syringe MINUS vertical installation depth PLUS percentage of vapour bubbles in the riser tubing (e.g. 30%) MINUS vapour pressure of water at ambient temperature MINUS 10 cm per 100 m above sea level (if vacuum is applied in areas above the sea level).

Example:

SM: needed soil moisture content expressed in meters water column suction to get water in the syringe

V: vacuum applied. A syringe will practically pull a complete vacuum = 1 bar = 950 centimeters of water column (lowest possible air pressure at sea level). The dead volume of a long extension tubing may diminish this however. Then repeated action is required, each time opening and closing the two way cock.

D: Installation depth (vertical!) of MacroRhizon tip compared to the point of suction (the syringe) for instance 500 cm

VB: % vapour bubbles in riser tubing = presumed at 30%

VP: vapour pressure of water at ambient temperature (=2340 Pa@ 20°C) so rarely exceeding 25 cm water column.

I: installation height above sea level. At 200 m height there will be a loss of 20 cm water column air pressure compared to sea level.

The equation is: SM = V - D + VB - VP - I

So: Needed soil moisture content SM expressed in suction in cmwc =
950 cmwc - 500 cmwc + (500 cmwc x 30%) - 25 - 20 = 555 cmwc

This is normally sufficient to sample a moist soil. If all conditions are correct this also means that in this example a syringe, supposing there was no dead volume, after having obtained sufficient time to draw the sample, will be filled with no more than approximately 55% of water even if the soil layer was completely saturated.

When too little sample water is collected, close stopcock, disconnect syringe and keep it upright, purge out the air, reconnect, pull vacuum and block plunger and re-open stopcock.

☞ **Always clean connectors with water before making connections, always put blue cap on when sampling is interrupted. Protect the top end and stopcock with a small bottle or a plastic bag wrapped around it.**

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8. List of standard products for use with MacroRhizon

In some experiments the length of the porous material or the tubing material (PVC or PE/PVC) or connector of standard samplers is not appropriate. On special request Eijkelkamp can supply custom design samplers.

Rhizon equipment uses as a standard Luer Lock (LL) connectors and tubing. PVC outside / PE inside,1 mm internal diameter strong, flexible, transparant, inert. Sets are 10 pieces, unless indicated otherwise.
All equipment is supplied with blue LL cap and is leak tested.

For a design with your details :

19.21.35 MacroRhizon soil moisture sampler, length 9 cm, diameter 4.5 mm. with glassfiber re-enforced strengthening rod and 10 cm tubing. Set of 10 pieces.

To be inserted at 45 degrees in an augered hole:

19.21.36 MacroRhizon soil moisture sampler, length 9 cm, diameter 4.5 mm. with glassfiber re-enforced strengthening rod and 10 cm tubing. Glued in 90m cm long PVC pipe. Complete with tubing with 2-way stopcock for sampler flushing without vacuum loss. Set of 10 pieces.

Note: on request the MacroRhizon can be supplied with other lengths of PVC pipe. Extra length may however induce transport charges.

19.21.37 Spare tip for MacroRhizon soil moisture sampler. Set of 10 pieces.

Accessories for MacroRhizon :

19.21.41 Extension pipe for MacroRhizon, length 100 cm. Set of 10 pieces

19.21.42 Extension pipe for MacroRhizon, length 50 cm. Set of 10 pieces

19.21.44 Extension tubing for MacroRhizon, length 100 cm. with connectors. Set of 10 pieces.

19.21.45 Extension tubing for MacroRhizon, length 50 cm, wwith connectors. Set of 10 pieces. Incl. 60 cm silicone tubing 6x2 mm.

19.21.49 Plastic syringe with 10 cm spacer for MacroRhizons, contents 30 ml. Set of 10 pieces.

19.21.18 Stopcock, 2 way for sampler flushing without vacuum loss

Tools for inserting MacroRhizons

04.02. Gouge augers 20 or 30 mm, fix miniature level at 45 degrees for orientation. For details see the Eijkelkamp catalogue (Brochure number P1.04)

19.21.51 Insertion tool for MacroRhizon, total length 100 cm (push in augered hole bottom to check the soil for stones, etc, before inserting a MacroRhizon). To prevent mechanical damage to the porous material and to improve contact MacroRhizon - Soil.

Accessories for extending sampler tubing length of 19.21.35:

19.21.13 Silicone tubing 6x2 mm, length 120 cm. For connection of extension tubing. Incl. guide wire (1 m for about 30 connections)

19.21.14 Extension tubing for Rhizon soil moisture samplers, black PE, diameter 1 x 3 mm, reel of 50 m

REPLACEMENT PARTS

	ITEM PART #	DESCRIPTION
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

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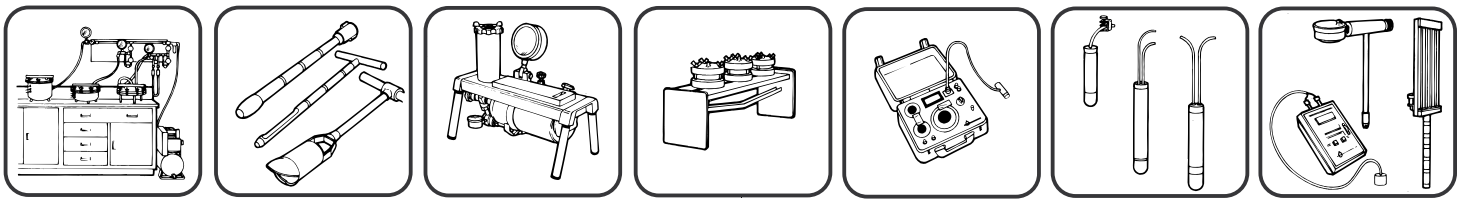
of after-sales service.



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