Retention curve II – estimation of parameters

The RETC Code for Quantifying the Hydraulic Functions of Unsaturated Soils

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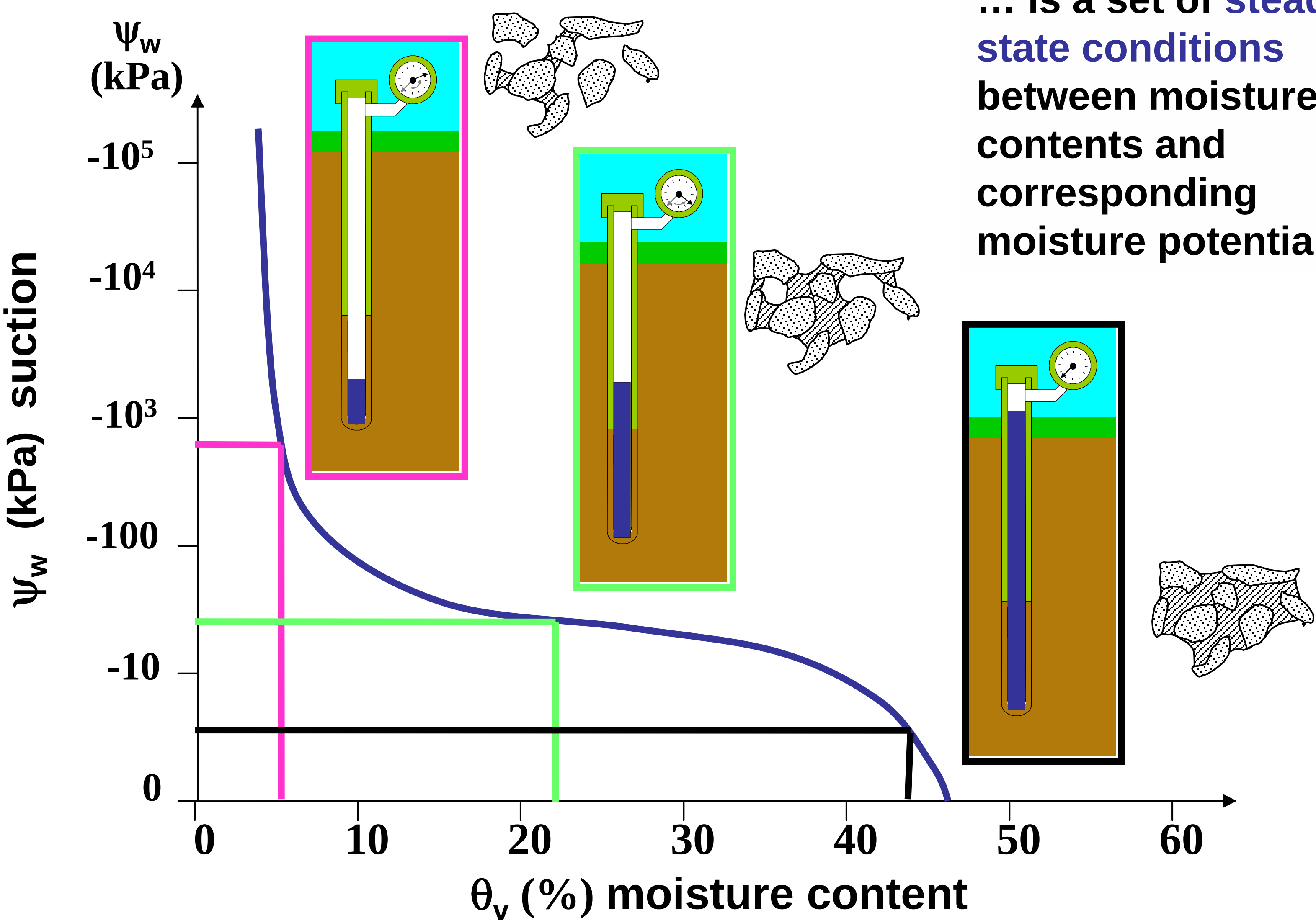
Retention curve

Conversion of suction pressure and soil moisture

… is a set of **steady state conditions** between moisture contents and corresponding moisture potentials



Retention curve

•Characterizes soil pore space from the perspective of filling and draining

•Dependence of suction pressure *h* and moisture content θ

•Mainly dependent on solid phase structure. Also depends on properties of other phases.

•Obtained through laboratory measurements – measured points are fitted by parametric functions (**van Genuchten** 1980, Brooks and Corey 1964)

•hysteresis

http://euclid.ucc.ie/appliedmath/soilhyst/node17.htm

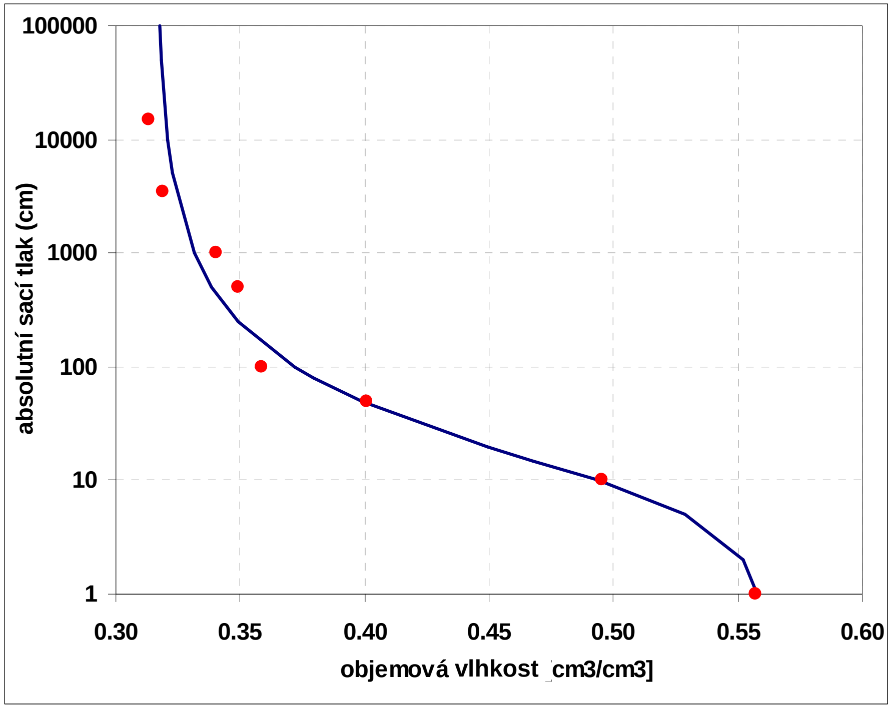
$$\theta_E = \frac{1}{\left(1+\left(\alpha|h|\right)^n\right)^m}$$

h [L] is capillary pressure, α[L^{-1}], *n* and *m* are optimization parameters

$$\theta_E = \frac{\theta - \theta_r}{\theta_S - \theta_r}$$

θ_E ... Effective moisture cont.
θ ... Moisture cont.
θ_s ... Saturated moisture
θ_r ... Residual moisture

$$m = 1 - \frac{1}{n}$$ n>1



Measuring of Retention curve

We measure suction pressure ***h*** as an elevation difference between soil and reference water level. Hydraulic contact is assured through porous plate (or clay layer with high air entry pressure).

Principle of measuring:

•We increase |*h*| (we decrease altitude of jar with free water layer), and the soil drains. We repeat for multiple h and obtain draining branch of retention curve.

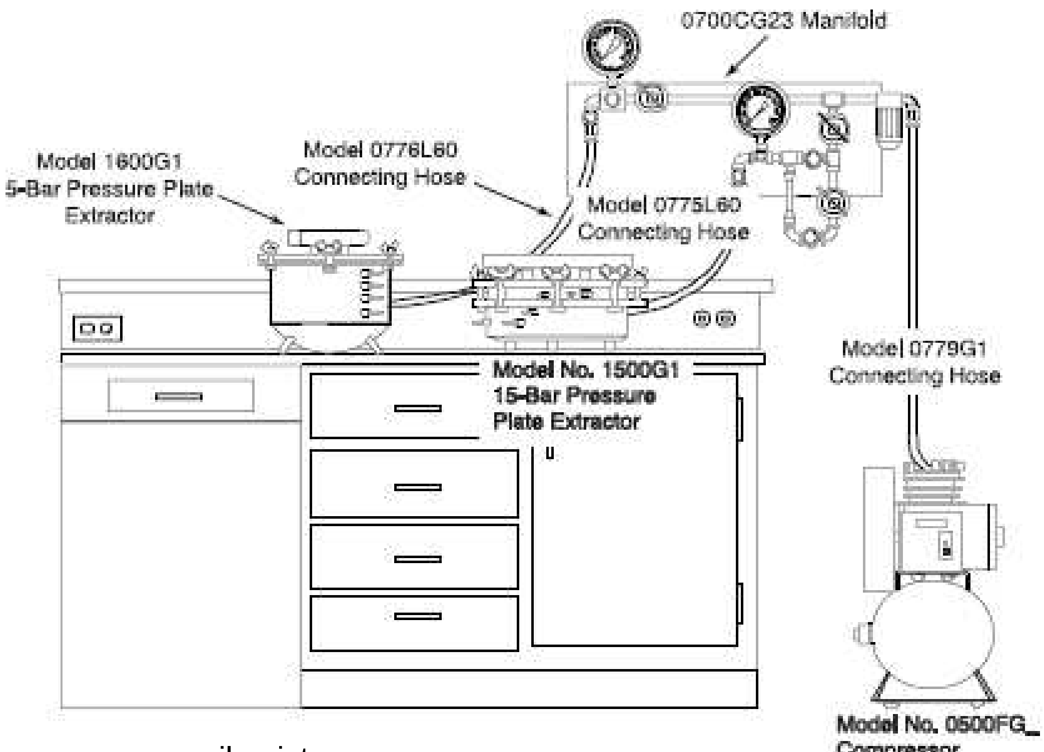
•If h = 0 for sufficient period, all pores fill with water and moisture content will be maximal (saturated moisture cont.).

•At the same time we measure moisture content (usually gravimetrically)

•For pressures 0-100 (max.200) cm of water column (limited by room space, theoretically works up to 10 m).

Measuring of Retention curve – high pressures

Wetted soil samples are placed in the extractor, and a known pressure is applied, which forces the removal of any water held to the soil at a lower pressure. By analyzing the sample at several different pressures, the characteristic pressure versus water content relationship can be determined for the soil.



source: www.soilmoisture.com

1500, 15 Bar Ceramic Plate Extractor (shown with PM Hinge attached)

1500, with soil in sample retaining rings

Soil sampling

Evaluating the retention curve

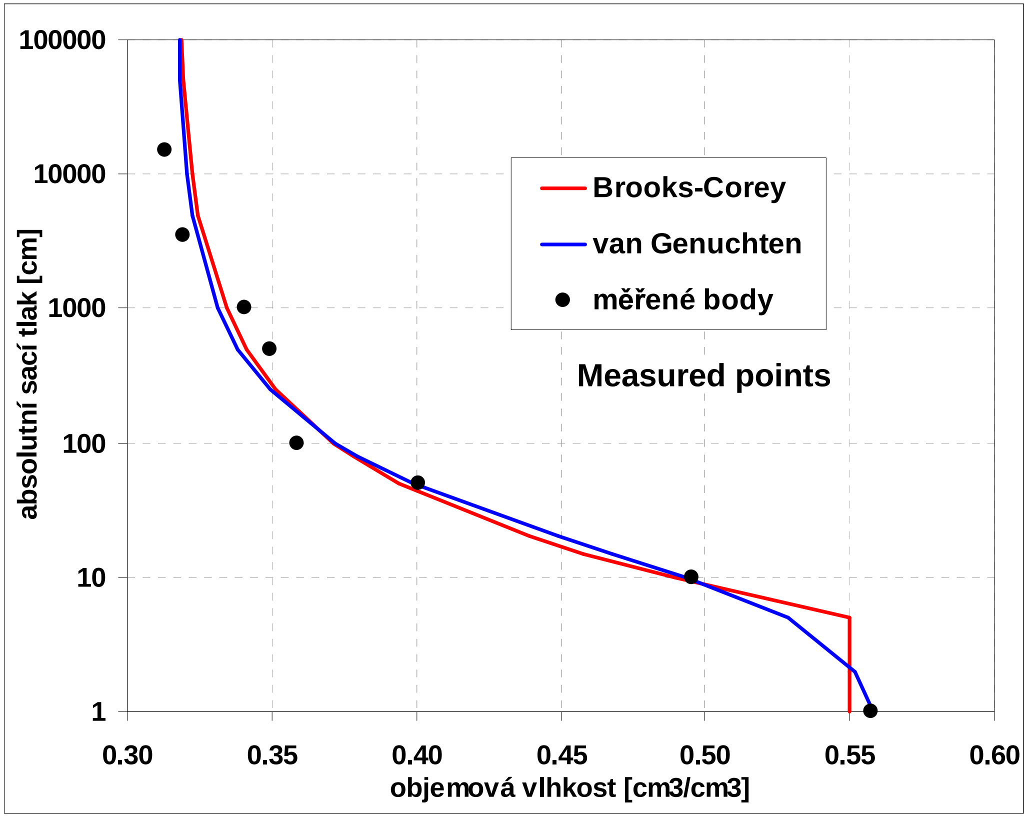
•Set of measured points is plotted

•Points are fitted by curve of van Genuchten (or Brooks and Corey or other)

•The parameters of van Genuchten's formulation of retention curve are obtained

•It gives value of soil moisture for each suction pressure.

•Fitting of parameters is done by means of least squares methodology – program RETC

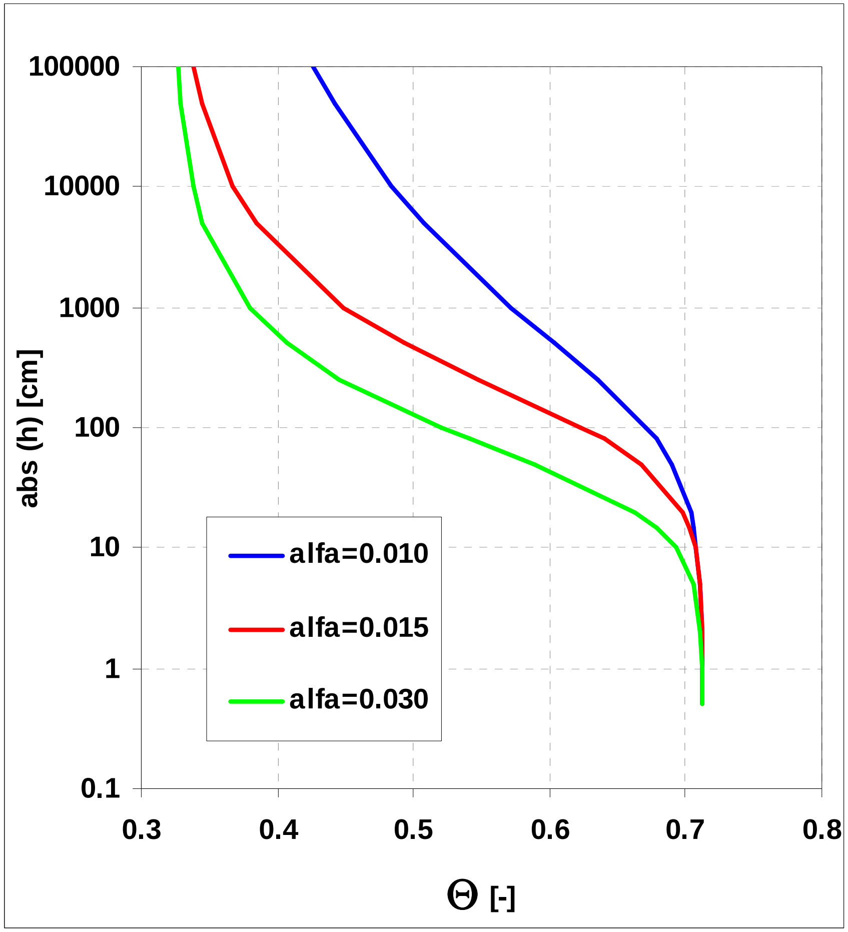


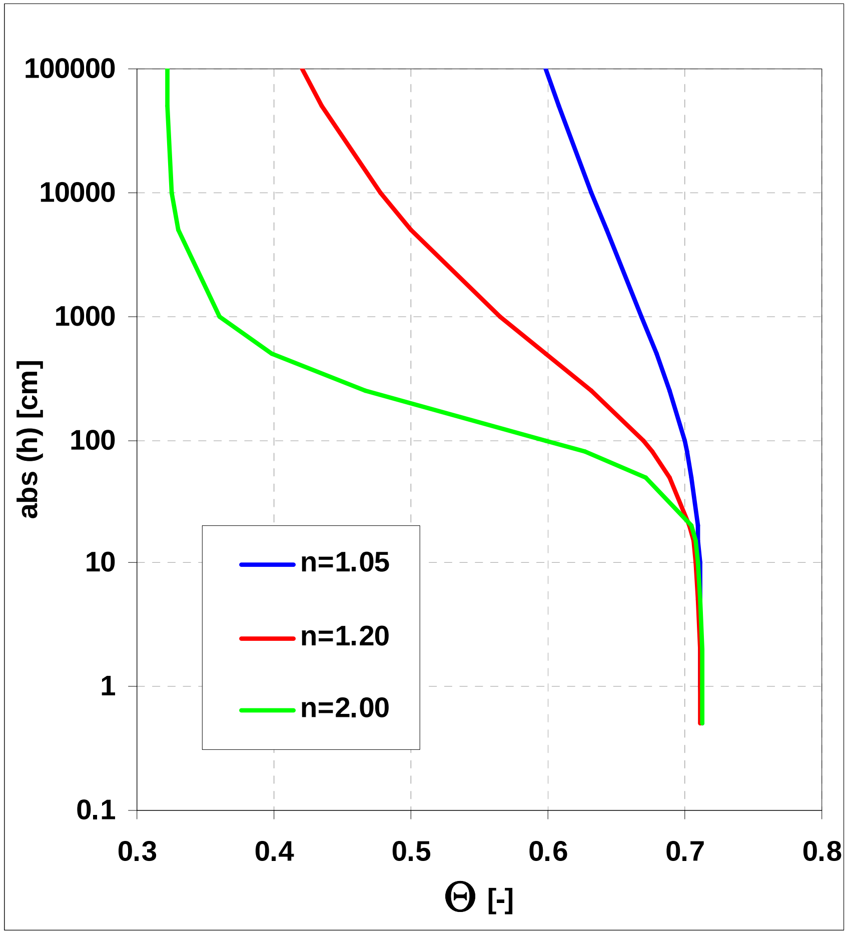
To download RETC:

http://www.ussl.ars.usda.gov/models/retc.HTM

Evaluating the retention curve

•Van Genuchten's retention function is suitable for numerical modelling (solving the Richards' equation), because it can be differentiated in any point.





Exercise

On undisturbed soil sample were measured the points of retention curve (table 1). Use the RETC program to estimate the parameters of retention curve. Plot the curves according to van Genuchten and Brooks – Corey.

Table 1

|h| [cm]	Θ
1	0.7056
10	0.6246
50	0.5890
100	0.5418
500	0.4160
1000	0.3804
3500	0.3199
15000	0.3151

Extra:

The data you have are real measured data. Use the information obtained from particle size distribution function (table 2), use Rosetta program and compare measured and estimated retention curves.

Table 2 (in %)

sand	60
silt	38
clay	2

B-C function: $\theta_E = \left(\frac{H_b}{h}\right)^{\lambda}$ for $|h| > |H_b|$

$\theta_E = 1$ for $|h| < |H_b|$