LIÈGE université
Gembloux
Agro-Bio Tech

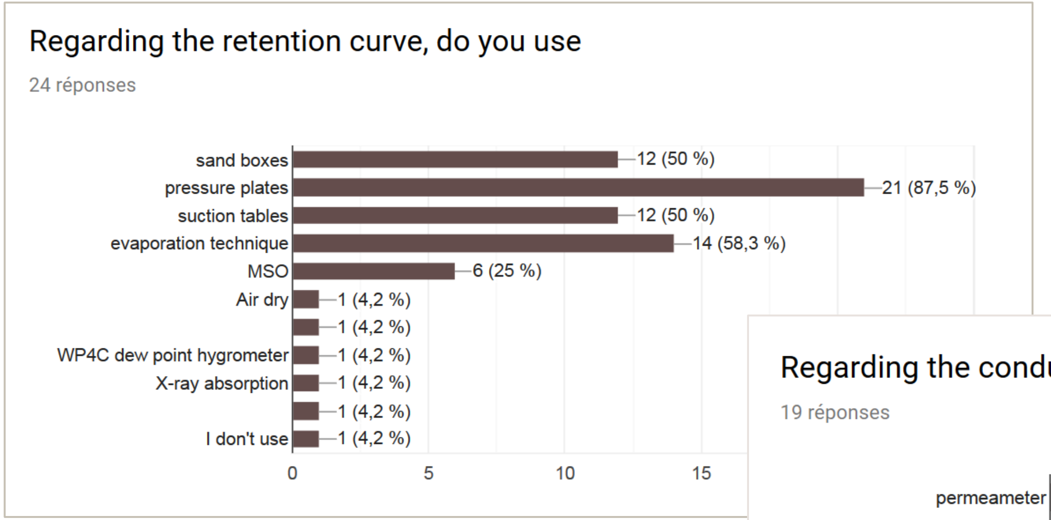
SOPHIE @ EGU19

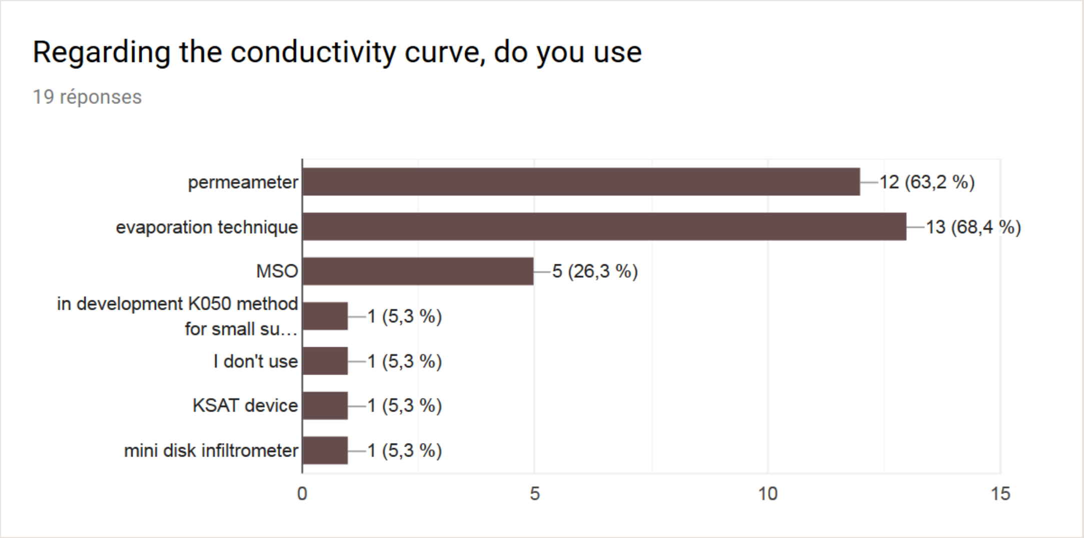
Towards a benchmarking between labs for SHP measurement

Challenge for soil physics labs

- Soil physics laboratories aim to quantify the hydrophysical properties of soils (like a.o. retention and conductivity)
- These properties are mainly structure-dependent
- There is no guarantee that two laboratories would give the same result on the same soil
- The challenge of soil physics is to work on **undisturbed samples**
- **SOPHIE demonstrates the need for interlab comparison**

Survey among the labs

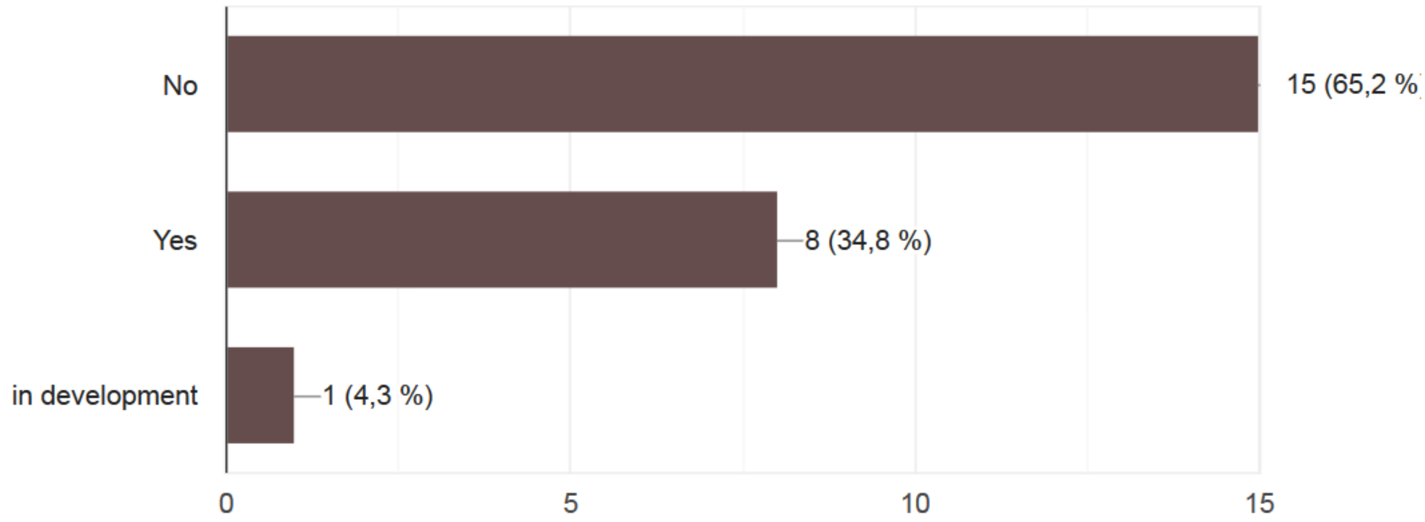




Survey among the labs

Do you use standard samples or methods to control the quality of your measurements in the laboratory?

23 réponses



Benchmarking among the labs

- Only one lab was using reference samples on a regular basis
- 4 labs presented ongoing tests/reflexions
- All the labs were rather small entities (0 to 3 people, asking for common work)

- Open questions were about
  - Sample size
  - Full saturation
  - Bottom condition
  - Evolution of the samples during the measurement

After Gembloux meeting we identified 3 issues with increasing levels of complexity

- To ensure the reproducibility of a given protocol, over time, within a laboratory;
- To ensure consistency between analyses performed using the same protocol in different laboratories;
- To ensure consistency between hydro-physical characterizations performed with different protocols in different laboratories
  - It opened the question of the sensitivity of the models to the differences that might be observed between labs

1/ To ensure the reproducibility of a given protocol over time within a laboratory

- For a known object, whose measured property is assumed to be stable over time, repeat this measurement. Calculate the mean value of the observations (m), calculate the standard deviation of the observations (SD).
  - If measurement between m±2SD, valid measurement
  - If measurement outside m±2SD but in m±3SD, warning
  - If measurement outside m±2SD but in m±3SD more than 3 times in a row, error
  - If measurement outside m±3SD, error

Example :

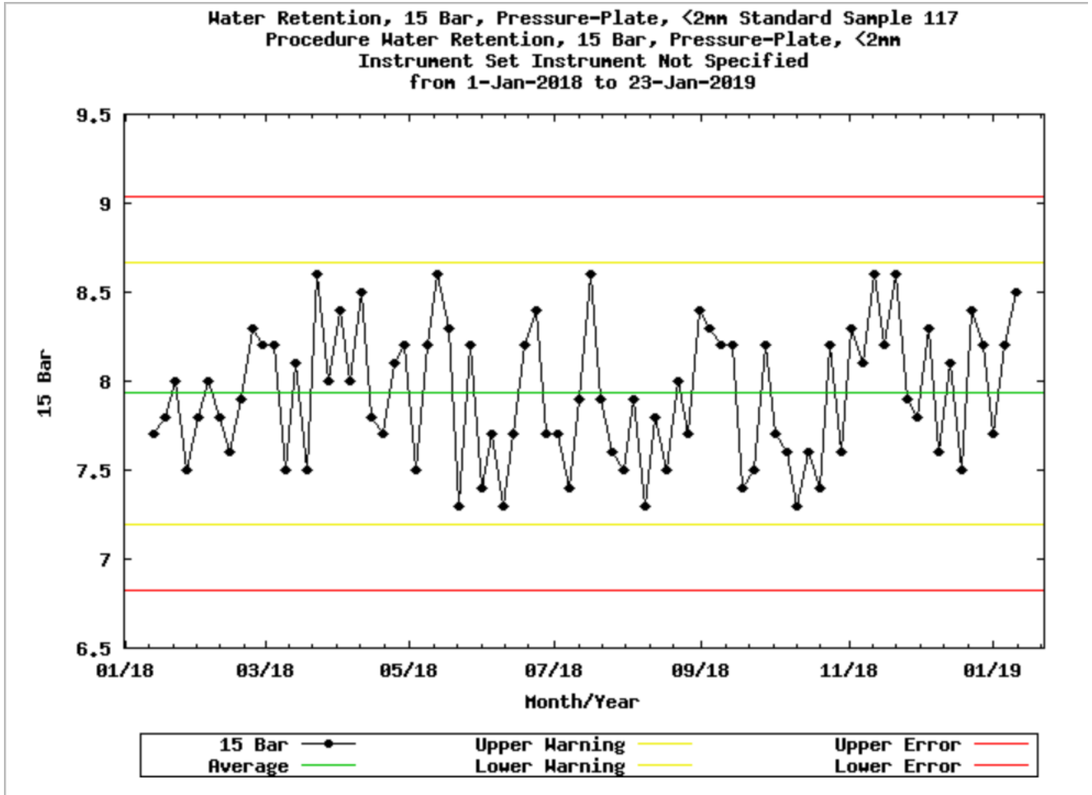
Sample #117 in Kellogg Soil Survey Laboratory - USDA

- 1500 kPa
- Pressure plate
- From Jan 18

Tks to Rich Ferguson

Figure 3C2a-2.—Pressure-membrane extraction at 1500-kPa for <2-mm samples.

Stats	
N	80
Min	7.31
Max	8.64
Mean	7.93
Std Dev	.37
% RSD	4.65
wl upper	8.67
wl lower	7.19
cl upper	9.04
cl lower	6.83



2/ Ensure consistency between analyses carried out using the same protocol in different laboratories

- The protocol referred to in the previous point may be used, and the means and standard deviations compared **between laboratories** may be used as well, **provided that a similar sample is used**.
  - Water content measurement at 1500kPa is not structure dependent and could be tested using reference disturbed samples
  - Test of one **reference sample** using common agreed protocol
    - 4 points of the retention curve
    - 2 samples will be kept, 3 samples will be sent to other labs
    - 3 samples will be received from other labs
    - 2 preserved samples + 3 received samples will reanalyzed
    - Ongoing process… see you at EGU 2020 for results….

What should be the qualities of a ref sample ?

- For retention function
  - Wet end
    - Be easy to handle and to weight at very low tension
    - Loose measurable water mass at interesting pressure ranges
    - Have equilibrium time similar to that of soil
  - Dry end
    - Disturbed sample suitable
- For conductivity function
  - ? Present a well known pore geometry (=>Predictable Ks see Buchter 2015)

Possible reference samples

From UGhent, GeoCentrum Hanover, Kellog lab USDA

REFERENCE SAMPLES

- since 2012: own reference sample
- some labs/companies contacted
- tests: 1. undisturbed soil sample; masonry sand

  2. – rinsed well-sorted white sand
     – well-sorted ‘Eijkelkamp’ sand
     – uniform glass beads

  + cement
- criteria:
  – uniform steady decline in weight ($\rightarrow$ moisture)
  – fast equilibrium
  – easy to weigh at h=-2.5 cm

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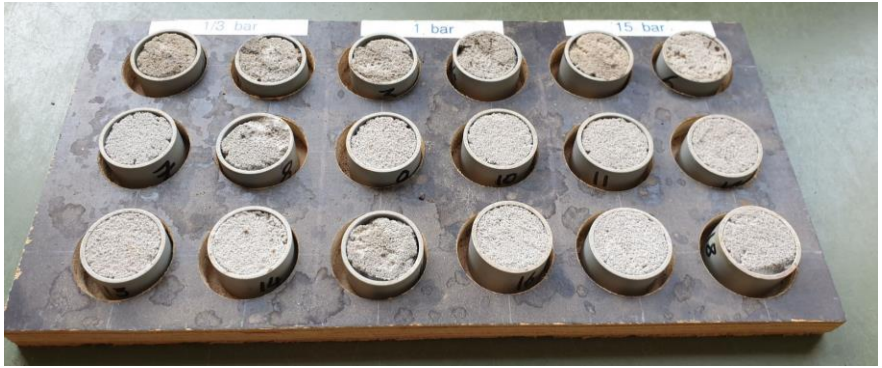
REFERENCE SAMPLES

- sand box

- pressure plates



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„Sinterglaszylinder“ as reference material for the measurement of WRCs and/or saturated hydraulic conductivity

- VitraPOR Sinterglaszylinder der Fa. ROBU
- Borosilicatglas 3.3
- 100 cm^3
- Por. ASTM C (40-60µm)
- price 150€ (each)

Cylinder No.	Bulk density [g/cm^3]	Density "Borosilicatglas 3.3" [g/cm^3]	Porevolume [cm^3]
2240	1.457	2.23	34.65
2241	1.402	2.23	37.11
2242	1.426	2.23	36.06
2243	1.424	2.23	36.15
2244	1.432	2.23	35.78

33 kPa and bulk density – USDA procedure

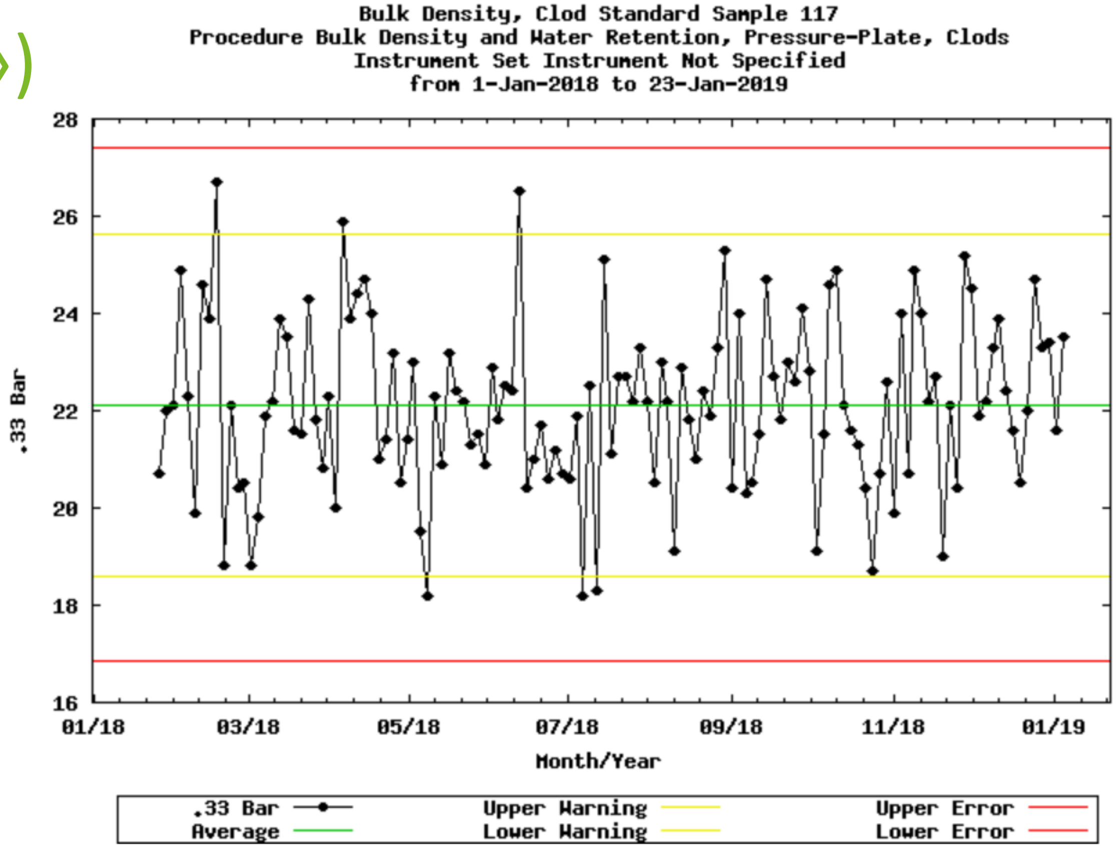
Figure 3B1b-1.—A round stock tag with sample identification number is prepared. The cut copper wire is looped around the clod.

Figure 3B1b-2.—After a flat surface on the clod is cut with a diamond saw, the clod is placed on a tension table, maintained at 5-cm tension.

Sample #117 (« clod »)

- 33 kPa
- Pressure plates
- From Jan 18

Stats	
N	129
Min	18.15
Max	26.67
Mean	22.12
Std Dev	1.76
% RSD	7.96
wl upper	25.64
wl lower	18.60
cl upper	27.40
cl lower	16.84



2015

Original Research

Three-Dimensional Printing of Macropore Networks of an Undisturbed Soil Sample

Matthias Bacher, Andreas Schwen, and John Koestel*

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Three-dimensional printing for geoscience: Fundamental research, education, and applications for the petroleum industry (Article)

Ishutov, S.[a,b], Jobe, T.D.[a], Zhang, S.[a], Gonzalez, M.[a], Agar, S.M.[a], Hasiuk, F.J.[b], Watson, F.[c], Geiger, S.[c], Mackay, E.[c], Chalaturnyk, R.[d]

[a]Aramco Research Center, 16300 Park Row Drive, Houston, TX 77084, United States
[b]Department of Geological and Atmospheric Sciences, Iowa State University Science i, 2237 Osborn Drive, Ames, IA 50011, United States
[c]Institute of Petroleum Engineering, Heriot-Watt University, Riccarton Campus, Edinburgh, EH14 4AS, United Kingdom

View additional affiliations

Abstract

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Three-dimensional (3-D) printing provides a fast, cost-effective way to produce and replicate complicated designs with minimal flaws and little material waste. Early use of 3-D printing for engineering applications in the petroleum industry has stimulated further adoption by geoscience researchers and educators. Recent progress in geoscience is signified by capabilities that translate digital rock models into 3-D printed rock proxies. With a variety of material and geometric scaling options, 3-D printing of nearidentical rock proxies provides a method to conduct repeatable laboratory experiments without destroying natural rock samples. Rock proxy experiments can potentially validate numerical simulations and complement existing laboratory measurements on changes of rock properties over geologic time

Want to join? More ideas?

Welcome !