The soil pit at the core

North Dakota, USA, 1927

Indiana, USA, 2011
The soil profile

- Long search for standardization (ISSS/IUSS)
- Soil profile descriptions rely on morphometrics by which soil properties are mechanically measured and visually observed.
- Combined with chemical, physical and mineralogical data or thin sections from horizons
- Information is integrated to increase our
  - understanding of soils
  - distribution across the landscape
  - taxonomic classifications
The properties (400-700 nm)
Some *in-situ* assessments

Figure 1. Portable equipment for a rapid determination of soil texture by Cenco-Wilde method.

Figure 2. Equipment for the rapid colorimetric determination of soil organic matter.

Figure 13. Portable Beckman Model N potentiometer.

Figure 14. Hellige-Truog Soil Reaction Tester.

Soil microscope with cross-slide stand attached to the wall of a soil pit; the leather box stores the battery for the oblique illuminator, from Kubiëna (1938)
Digital soil morphometrics

Definition

The application of instruments and techniques for measuring and mapping soil profile properties, and deriving continuous depth functions.

Purpose

Enhance our pedological understanding.

Yield new insights in soil horizonation - how soils are formed and could be classified.

Complements existing description and analytical methods.
1. Soil profile properties (horizons, texture, colour, structure, moisture, mottles, consistence, carbonates, rock fragments, pores, roots, and all physical, chemical or biological properties)

2. Soil depth functions

3. Soil profile imaging and mapping

4. Use and applications (environmental consultants, soil classification)
1. Some *in-situ* assessments

Proximal soil sensing
Mollic Hapludalfs

Elemental Concentration

![Graph showing elemental concentration profiles for various soil horizons (Ap, Bt, 2BC, 2C1, 2C2) with concentration axes for Fe, Ca, Ti, and SiO2/Al2O3.](image)
SOC using Vis-NIR

From Budiman Minasny
vis-NIR on Soil cores

The measurement resolution should be ≤ than 2 cm in order to efficiently capture the soil changes necessary to establish differences.

Mario Fajardo, Alex McBratney, Brett Whelan

Fuzzy clustering of Vis–NIR spectra for the objective recognition of soil morphological horizons in soil profiles

Geoderma, Volume 263, 2016, 244–253
2. Soil depth functions

Soil properties vary with depth and the variation is continuous.

It is often represented as being discontinuous.

Continuous soil depth functions include:

1. free-hand drawing: *no mathematical form*

2. exponential, regression and polynomial equations: *can be problematic*

3. smoothing splines: *a better alternative*

From Joffe, 1936

From McBratney, 2009
Equal area quadratic spline

From Ponce-Hernandez et al. 1986, Bishop et al., 1999
Continuous depth function

Soil profile data
From Joffe (1936)

Spline with uncertainty
Malone et al. (2011)

Continuous measurement
Myers et al. (2011)
Horizontal variation of Fe and SOC

From Jenna Grauer Gray
Depth functions

From Budiman Minasny
Mapping the profile

1. Raster sampling

3. Monolith scanning
Oregon soil map
Soil profile descriptions are like a polygon soil map
Raster Sampling

Soil profile walls divided into rasters of 10 x 10 cm squares
Samples from the center of each square.

Troxel silt loam:
Fine-silty, mixed, superactive, mesic
Pachic Argiudolls
1.0X1.0 m area
(100 data points)

NewGlarus silt loam:
Fine-silty over clayey, mixed, superactive,
mesic Typic Hapludalfs
1.0X1.0 m area
(100 data points)

Plainfield sand:
Mixed, mesic Typic Udipsamments
1.0X0.5 m area
(50 data points)
The Mollisol VESPER maps

From Jenna Grauer Gray
The Entisol VESPER maps

Fe

SOC

From Jenna Grauer Gray
Goal: Segment images of soil profile walls into soil horizons (semi-)automatically.
Example in RGB color space

Using cropped image

1. Brown = $\frac{1}{2} \times R + \frac{1}{2} \times G$

2. Smooth Brown image

From Jenna Grauer Gray
Image Segmentation CIELAB

The Mollisol

The Entisol

From Jenna Grauer Gray
Monolith scanning

Roudier et al. 2016
Sensing soil horizon boundaries and structural properties
Monolith scanning

Roudier et al. 2016
Sensing soil horizon boundaries and structural properties

Regression kriging using RGB channels
RF regression
Kriging of residuals
Segmentation
Monolith scanning

Markus Steffens
imVisIR – High resolution physical, chemical and biological soil characterization on the pedon scale

Elemental characterisation of horizons

Markus Steffens
imVisIR – High resolution physical, chemical and biological soil characterization on the pedon scale
Soil profile mapping

Potential to map the soil profile

- Raster sampling
- Image analysis
- Monolith scanning

More objective horizon identification

Soil profile as an continuum (within and between horizon soil variation)
We need point data (pedons)

Tools and techniques available for every property in soil profile descriptions

Smaller depth increments can be sampled, continuous depth functions

Potential to map the soil profile

Enhance our pedological understanding

Complement existing description and analytical methods

Many unresolved issues
Pedometrics 2017

A joint meeting of IUSS Pedometrics Commission and Working Groups

Digital Soil Mapping | Digital Soil Morphometrics | Modelling of Soil and Landscape Evolution | Proximal Soil Sensing | Soil Monitoring

26th June - 2nd July

2017

STAY UPDATED
That's it folks

ACCESS TO SOIL SCIENCE ONLY