CAR-ES Key to soil quality: texture and mineralogy

Soil quality describes the capacities and capabilities of the soil to cover multiple functions and services. Soil quality evolves in physical, chemical and biological dimensions through time. The climate and its influence on biological organisms through time frames the growth conditions for natural ecosystems that develop in close interaction with the parent material – rocks and sediments. Additionally, the current state of the soil can reflect cultivation and other anthropogenic influence through the course of millenia.

Trees need anchoring, water and nutrients, and three key properties to shape this are soil aeration, soil water regime and soil nutrient regime. Sequestration of new carbon (C) and preservation of older C in the soil require stabilization options – access to surfaces of silt and clay, where soil texture and mineralogy are the key, often used in pedotransfer functions and ecosystem models.

Explore your soil pits

What is your role? Cherish your soil! Look at the soil in your forest, study scientific literature, and consult a soil scientist with a geology map, when you try to assess the nutrient release capability of the soil. Dig soil pits and use a monocle to inspect the minerals. Are the grains red? Are they black? The soil may tell you something useful and mindblowing – the minerals may be as old as the planet earth or newly formed. Everything is there.

Iron rich Podzol, Jølster, Norway (O. Janne Kjønaas), weak soil development in Arenosol, Kalsnava forest, Latvia (Ingeborg Callesen), volcanic Brown Andosol with black basaltic ash layers which can be used to date the profile. At 60-70 cm is Hekla 1510, Árnes, Iceland, (Ólafur Arnalds). Classification according to World Reference Base (2015).

The parent material of the soil is composed of stones, gravel and sediments originating from Nordic and Baltic rocks (e.g. old granites, gneisses, basalts, shales and limestones) and redistributed during several glacial events. The fine earth fraction of the soil has a particle size that is less than 2 mm, and the texture can be seen and felt in a finger test: does it stick together or is it single grain? Fine earth particles are divided into sand 0.02 – 2 mm, silt 0.002 – 0.02 mm, and clay < 0.002 mm (ISSS definition). Traditionally, the particle size distribution is determined with sieves and various sedimentation techniques under the assumption of round particles with the density of silicates – 2.65 g cm^{-3}.

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Soil texture analysis across Nordic-Baltic laboratories

CAR ES-III explored new developments in soil texture analysis comparing laser diffraction (three instruments) and traditional sedimentation or augmented sedimentation (Pario, Meter Group) operating procedures. We found good repeatability but not so good reproducibility between instruments. The wellknown underestimation of the clay fraction was seen with laser diffraction in comparison with the sedimentation methods, Figure 1.

The presence of secondary clays and humus in the B-horizon, lighter minerals like limestone and some vulcanic rocks or heavy minerals in basaltic rock represent deviations from the general assumptions in texture analysis, that will affect the results and may cause an unwanted bias.

Contents of pedogenic materials and sometimes mineralogy of the parent material (Box 1) differ strongly in the Nordic-Baltic area. This diversity seems to have an influence on the operating procedures applied for soil texture analysis within each country and laboratory, especially with respect to pretreatment of soil samples (Figure 1). The option to remove e.g. humus, carbonates and pedogenic clays depends on the required accuracy and precision of the results. If these materials are only present in low concentrations pretreatments may be deselected. This should always be an informed choice, and depending on the purpose of the analysis.

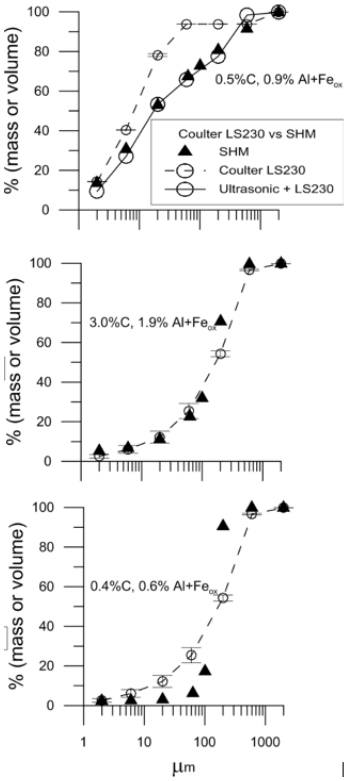

Fig 1. Examples of soil texture results that vary with analytical method. Callesen et al *in prep*.

Our test of the new Pario system (Meter Group) shed light on problems that stimulated innovation of the Pario+ model by Meter Group, now including an additional direct measurement of the clay fraction. Read more: Callesen et al. *In prep.*

We conclude that texture analysis will always be a challenge and should involve the maintenance of highly skilled soil scientists and technicians irrespective of the method chosen. Each method has advantages, depending on the task, organisation and budget.

Nutrient release from minerals

New nutrients are unlocked from the minerals in the sediments in a process called weathering, and can then be part of the biological cycle of the forest ecosystem. A study of nutrient release capability from 23 soil profiles and found a remarkable variation in the Nordic-Baltic area (Callesen et al. 2019) that could be explained by mineralogy and soil texture. Thus, texture is the key property of soil quality along with mineralogy of the particles.

References:

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