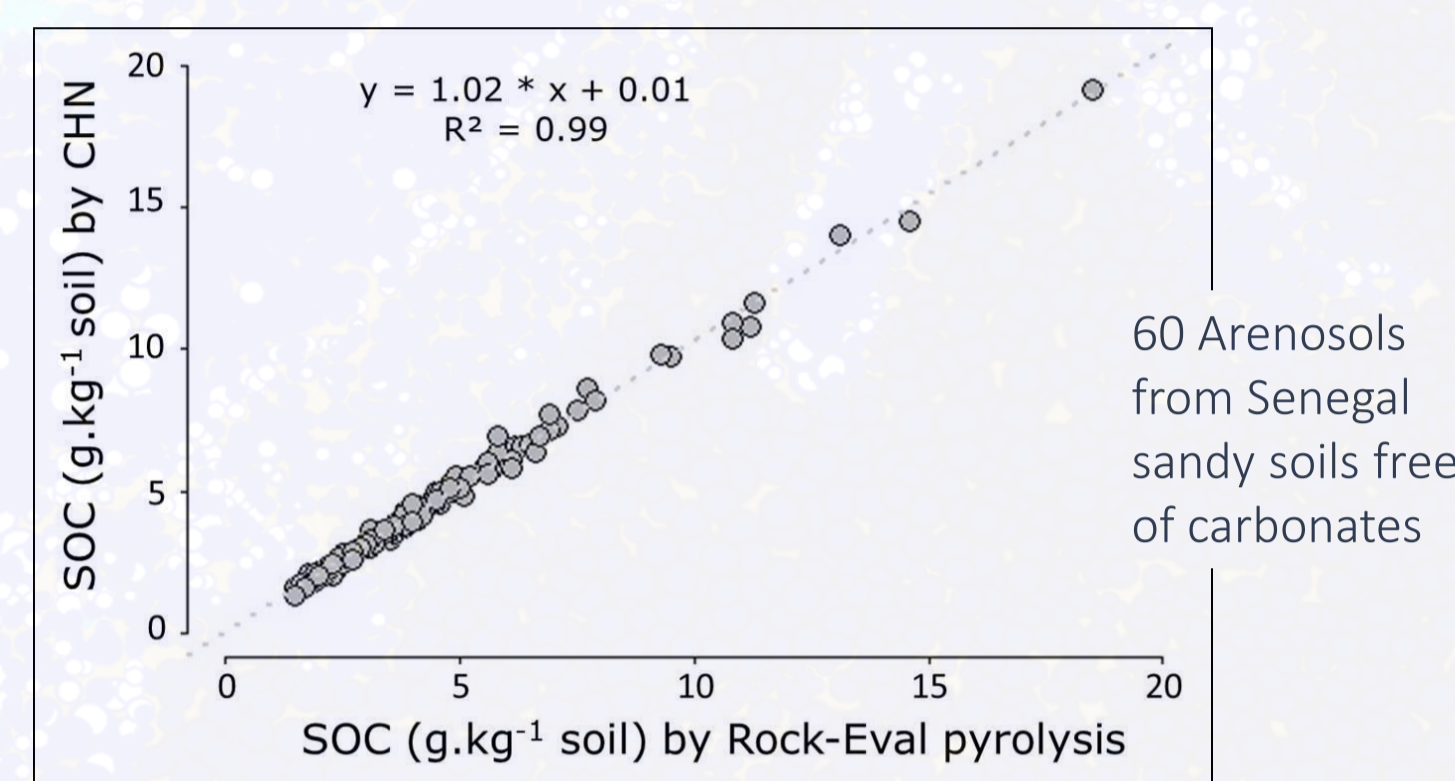
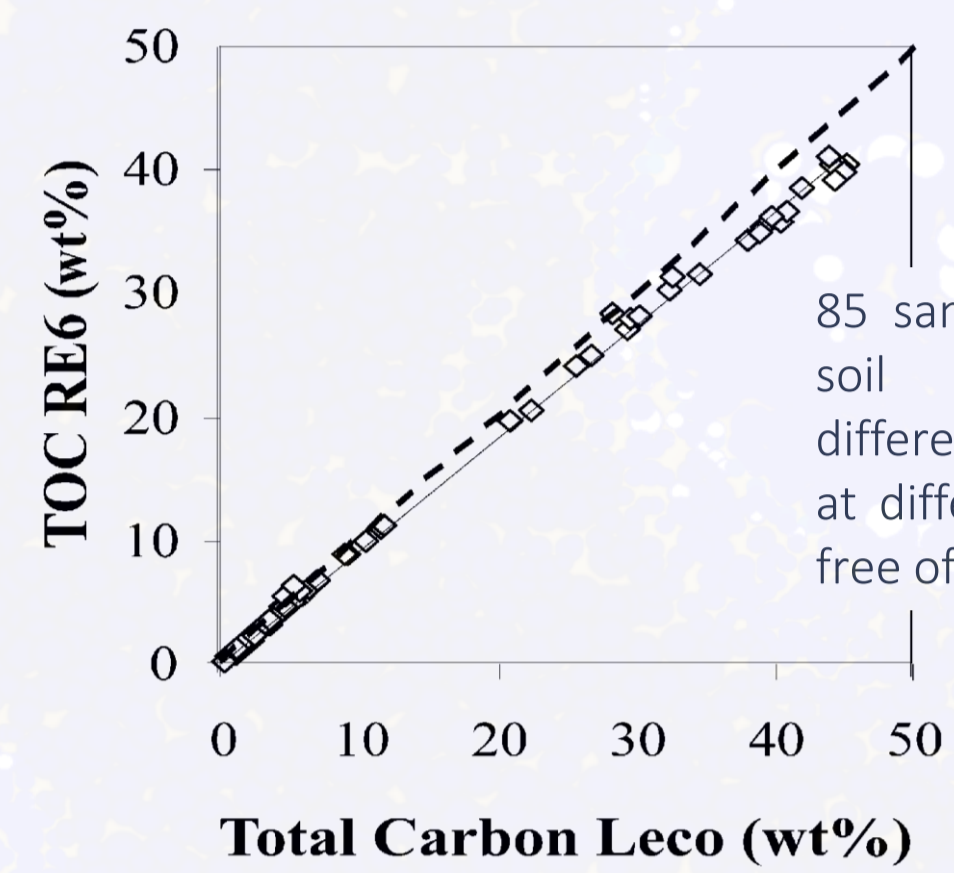


# Improved quantification of SOC and SIC in Rock-Eval® thermal analysis

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## 1. Technical issue

- The **Rock-Eval® thermal method** is increasingly used in soil science to quantify **SOC** and **SIC**, due to its **reliability**, **speed** and **ease of execution**
- The quantified Organic C and Inorganic C contents
  - are well suited to sedimentary rocks
  - need to be corrected for soils for better accuracy (Disnar *et al.*, 2003)
  - in non-carbonate soils, where Total C = Organic C Rock-Eval® and Elementary Analysis data coincide (Malou *et al.*, 2020)



Disnar *et al.*, Organic Geochemistry, 2003

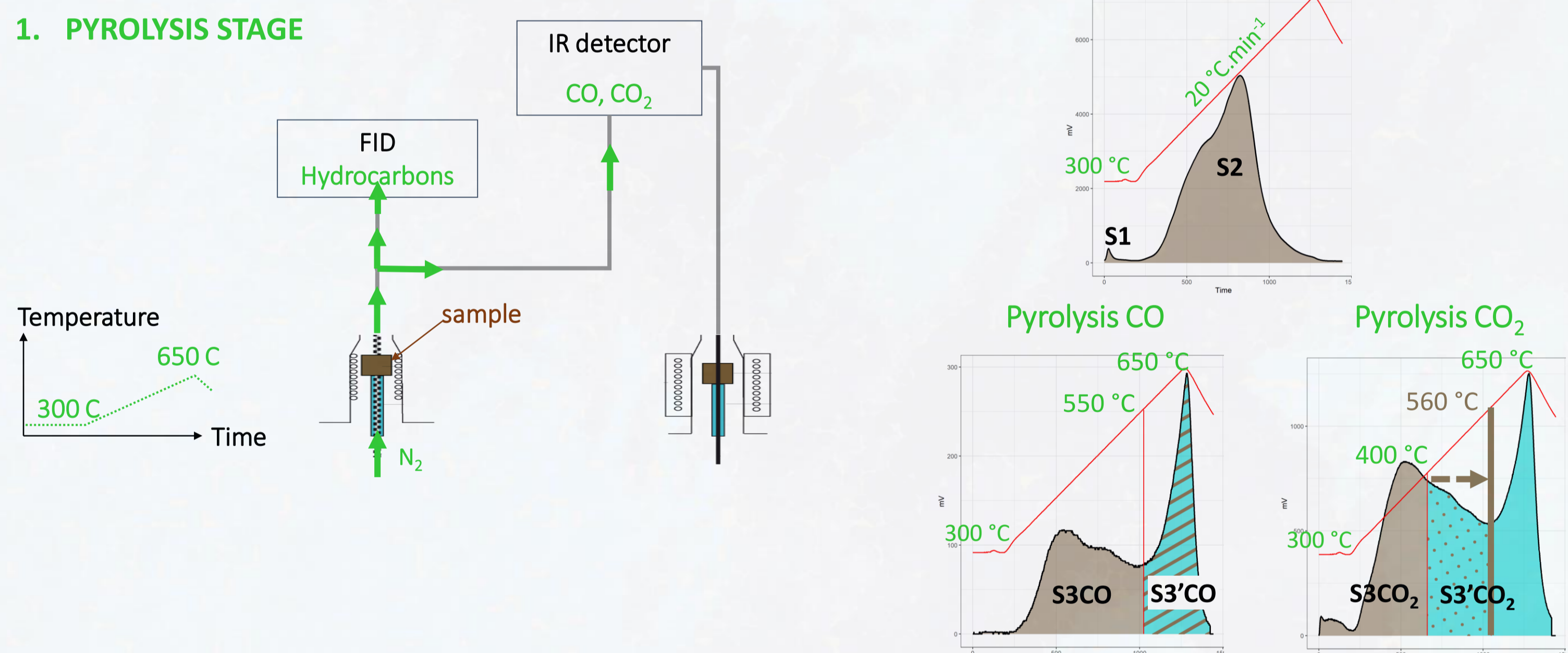
Malou *et al.*, Agriculture, Ecosystems and Environment, 2020

⇒ **Rock-Eval® Total Carbon content in soils is accurate**

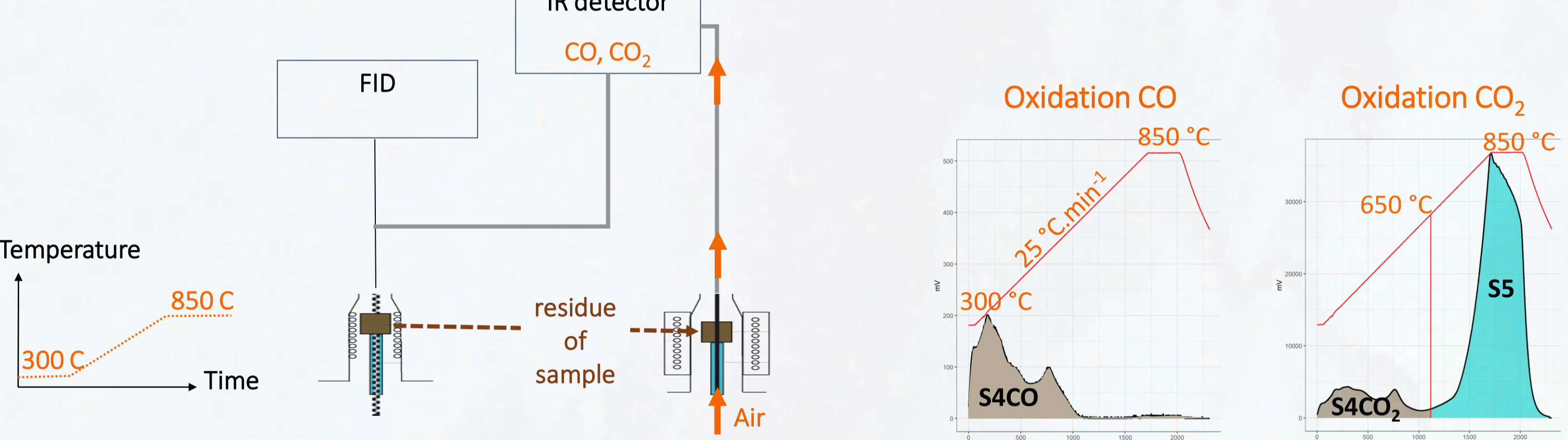
For a **more accurate quantification of SOC and SIC** using the Rock-Eval® method, the problem is not the carbon measurement, but a **better distinction between organic and inorganic forms of carbon in the thermal data**

## 2. Rock-Eval® method for SOC and SIC quantification

### 1. PYROLYSIS STAGE



### 2. OXIDATION STAGE



$$TOC = S1 + S2 + S3CO + \frac{1}{2} S3'CO + S3CO_2 + S4CO_2 \Rightarrow TOC \text{ assimilated to SOC}$$

$$MinC = \frac{1}{2} S3'CO + S3'CO_2 + S5 \Rightarrow MinC \text{ assimilated to SIC}$$

## 3. SOTHIS method for SOC and SIC accuracy improvement

### SOTHIS : SOil characterization by THERmal AnalysisIS

#### ➤ carbonate-free soils

$$SOC = TOC + MinC$$

$$SIC = 0$$

MinC quantifies exclusively some thermally stable organic compounds

#### ➤ carbonate soils

$$SOC = \alpha TOC$$

$$SIC = MinC - \alpha TOC$$

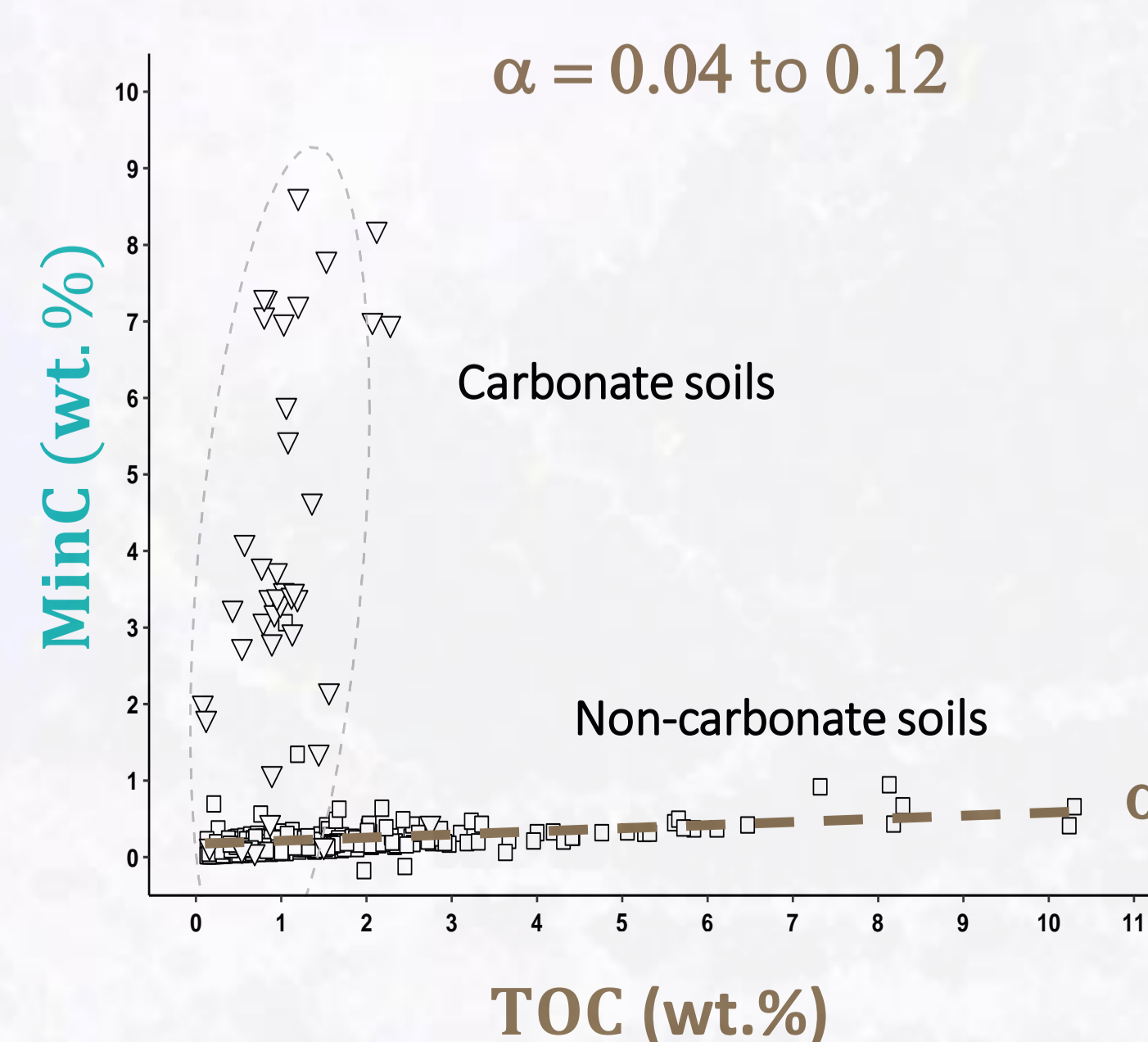
$$\alpha = 0.04 - 0.12$$

MinC quantifies both SIC and some thermally stable organic compounds

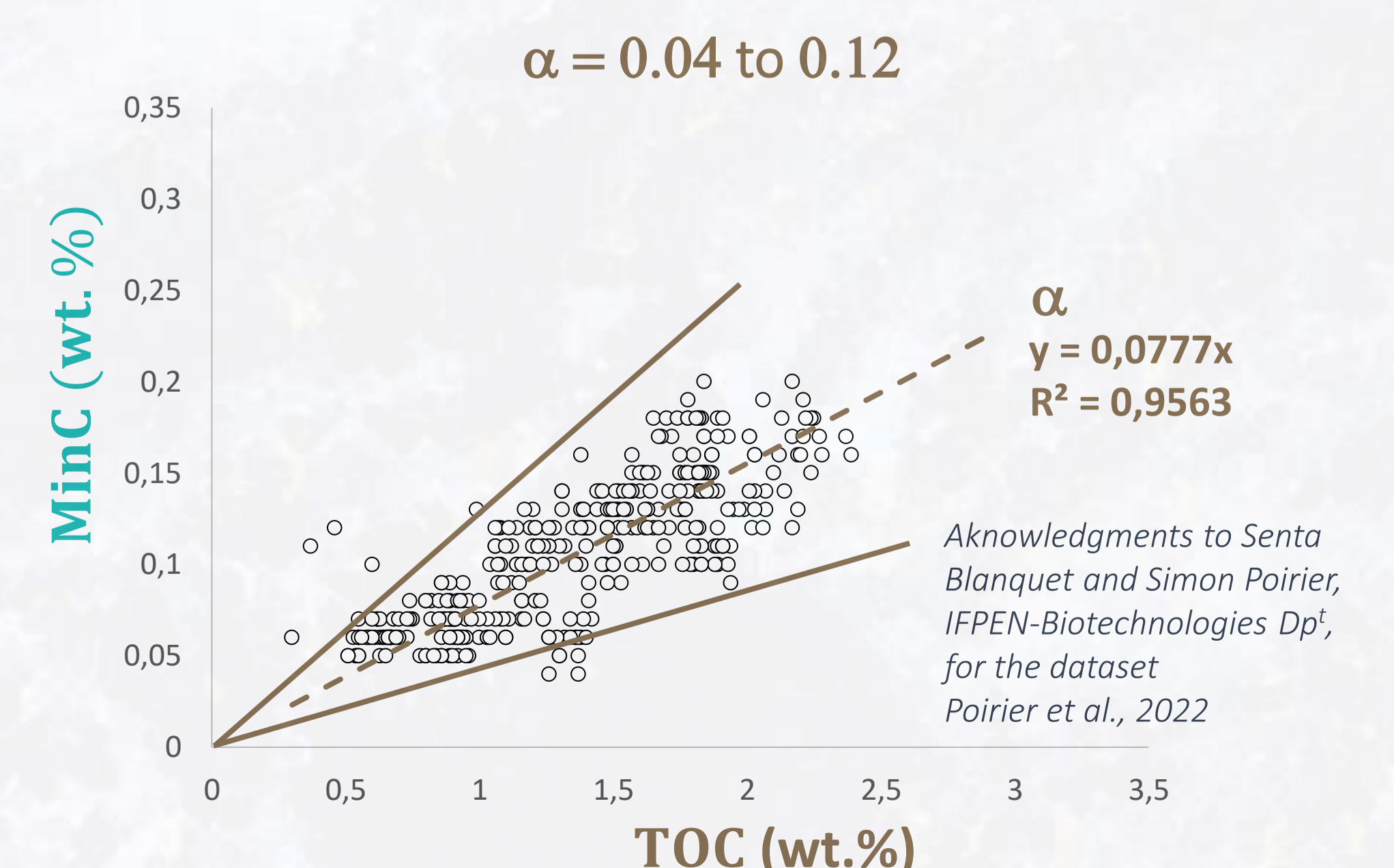
α varies according to :

- the OM chemical composition
- the cursor position on the CO<sub>2</sub> pyrolysis thermogram, delimiting organic compounds and carbonates

Carbonate and non-carbonate soils from various settings



Topsoils from 2 forests and 1 cropland with added organic substrates



Acknowledgments to Benta Blanquet and Simon Poirier, IFPEN-Biotechnologies Dpt, for the dataset Poirier *et al.*, 2022

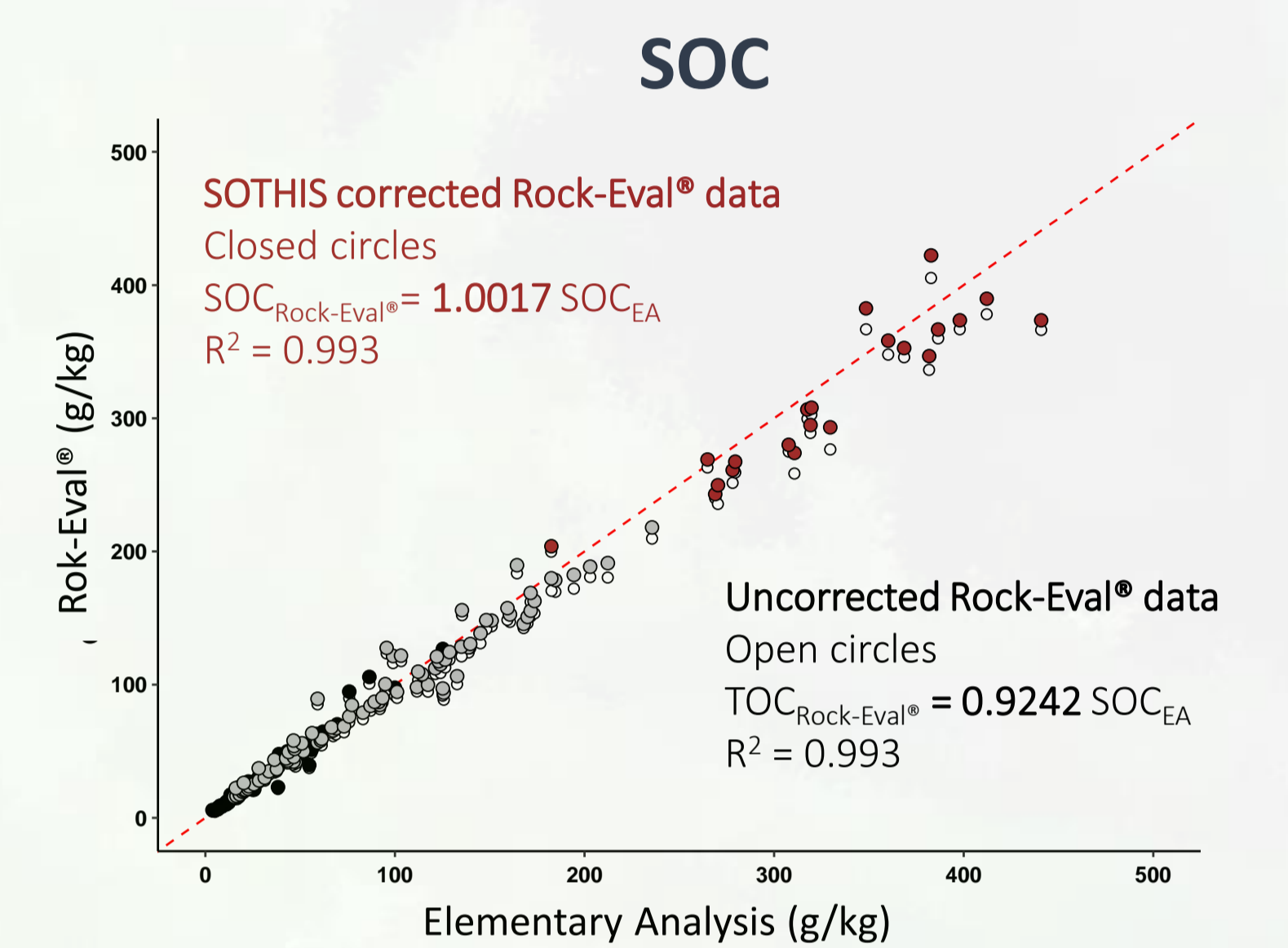
## 5. Technical solution

- The **SOTHIS correction method** provides **SOC and SIC with improved accuracy, based on a conventional Rock-Eval® thermal analysis**
- Applied to different soil samples covering a wide range of organic and mineral carbon contents, this method showed **good agreement with the Elemental Analysis** approach
- On **carbonate soils** : this method is **faster, easier and more accurate than the Elemental Analysis** approach:
  - unique analysis on a single soil sample
  - pre-treatment reduced to grinding and drying
  - 2-hour semi-automatic analysis
  - standardized results
  - limited sources of uncertainty

## 4. Application

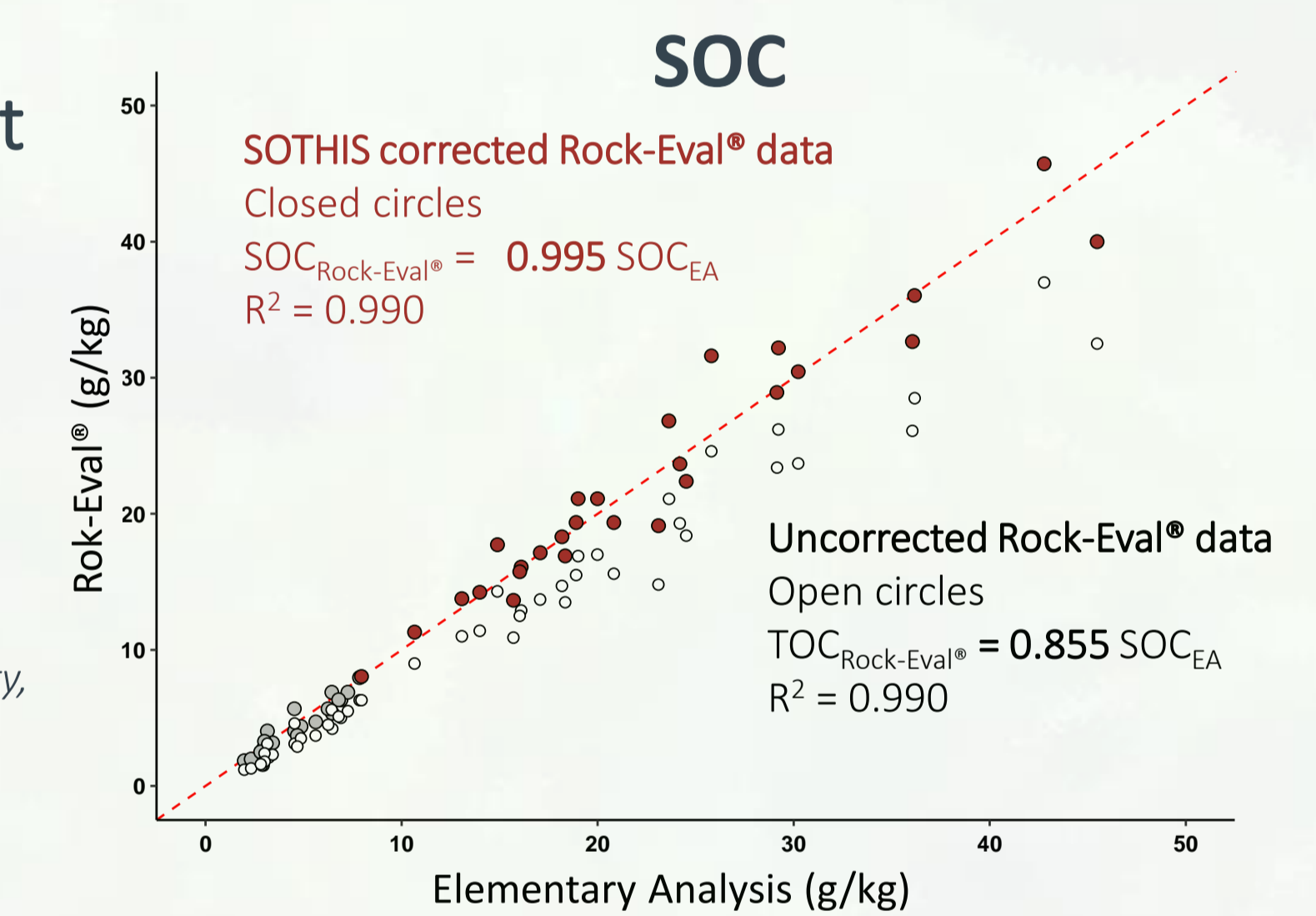
Soil profiles from 8 mountain ecological units  
No anthropic impact

Acknowledgments to Magali Matteodo, Eric Verrecchia and Thierry Adatte (Univ. of Lausanne) for the dataset (Matteodo *et al.*, 2018)



Topsoils and subsoils from 8 forest plots  
Anthropic impact

Acknowledgments to Zheng Sun, IFPEN & Sorbonne University, and Katell Quénéa, Sorbonne University, for the dataset (Z. Sun, PhD thesis, in prep.)



Soil profiles from 2 cultivated plots  
Anthropic impact

