Volcanic soil burial by tephra in the northern Ecuadorian Andes "sequestrates" a significant stock of organic carbon

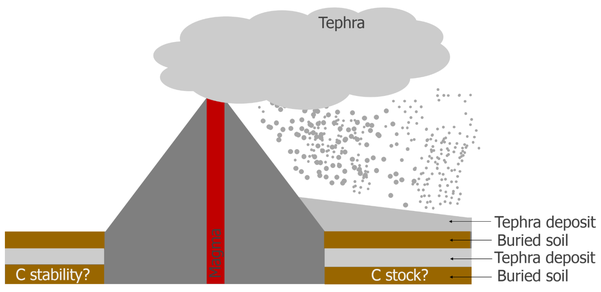
M. Paque, L. Morize, P. Delmelle

mathilde.paque@uclouvain.be

Environmental sciences, Earth & Life Institute, Université catholique de Louvain, B1348 Louvain-la-Neuve, Belgium

Introduction

Major uncertainties in estimates of organic C trapped in soils, and the mechanisms that stabilise it, may impede accurate climate predictions for the future. Recent studies suggest that buried soil C represents a large and poorly constrained reservoir. In volcanic active regions, soils are repeatedly buried underneath tephra deposits from explosive eruptions.



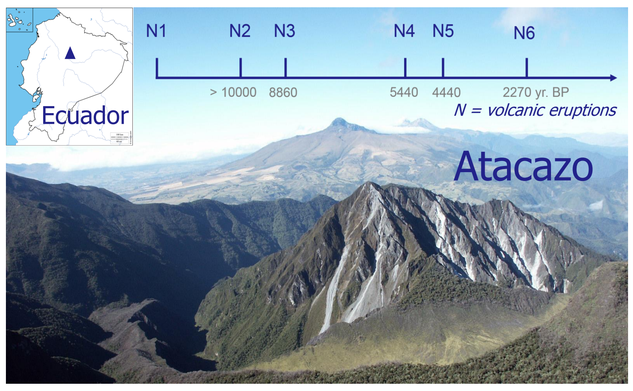
Objectives:

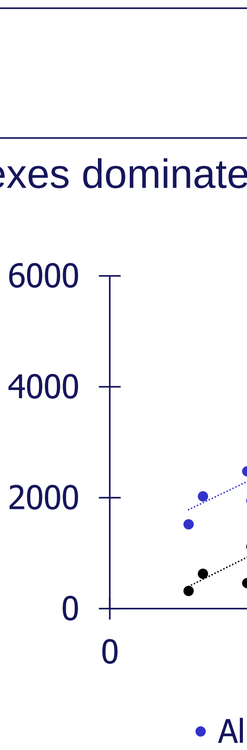
(i) to demonstrate that tephra-buried soils represent a significant but largely underestimated stock of organic C.

(ii) to identify the main mechanism(s) responsible for C stabilisation in these soils.

Material and Methods

Our study site is a 4.8-m deep polygenic volcanic soil profile located at 4080 m a.s.l. in the Ecuadorian Andes.



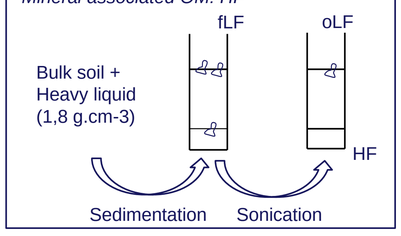


Soil analyses:

C stock: bulk density * total C content * soil thickness

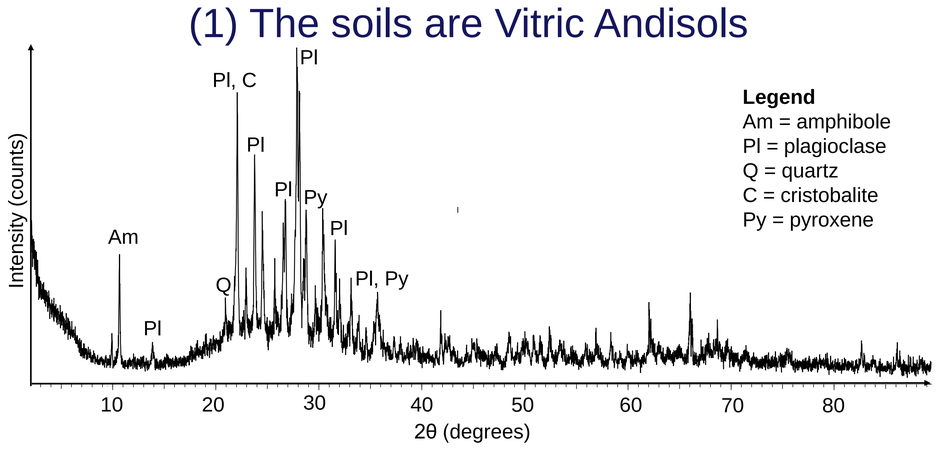
C stability: pyrophosphate (p) and oxalate extractions, X-ray diffraction and soil fractionation (Golchin method: separation of the free light, occluded light and heavy fractions; fLF, oLF, HF, respectively)

Particulate organic mater (POM): fLF & oLF
Mineral associated OM: HF



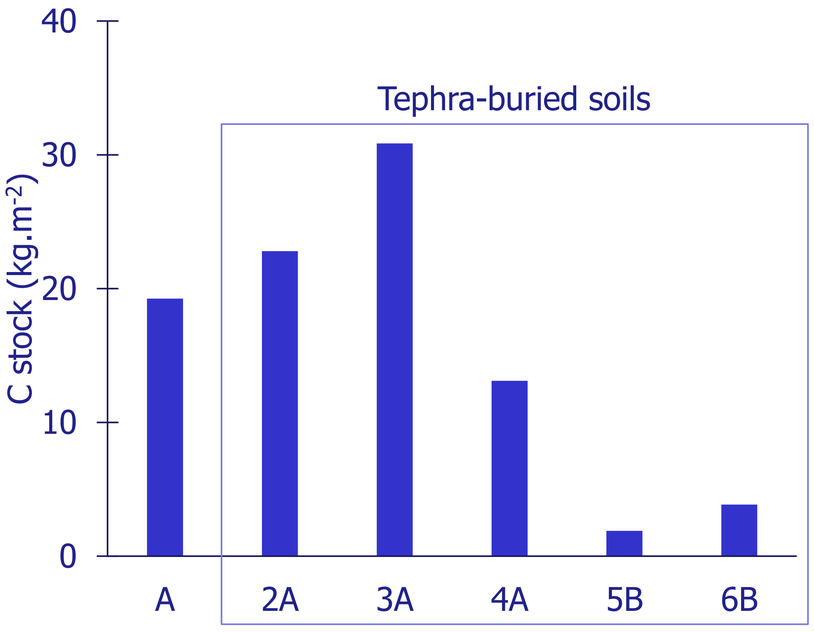
Results and Discussion

(1) The soils are Vitric Andisols



Our results show that all the soils horizons are dominated by primary aluminosilicates. They contain < 13 wt.% of short range order (SRO) minerals.

(2) The tephra-buried soils contain significant C stocks

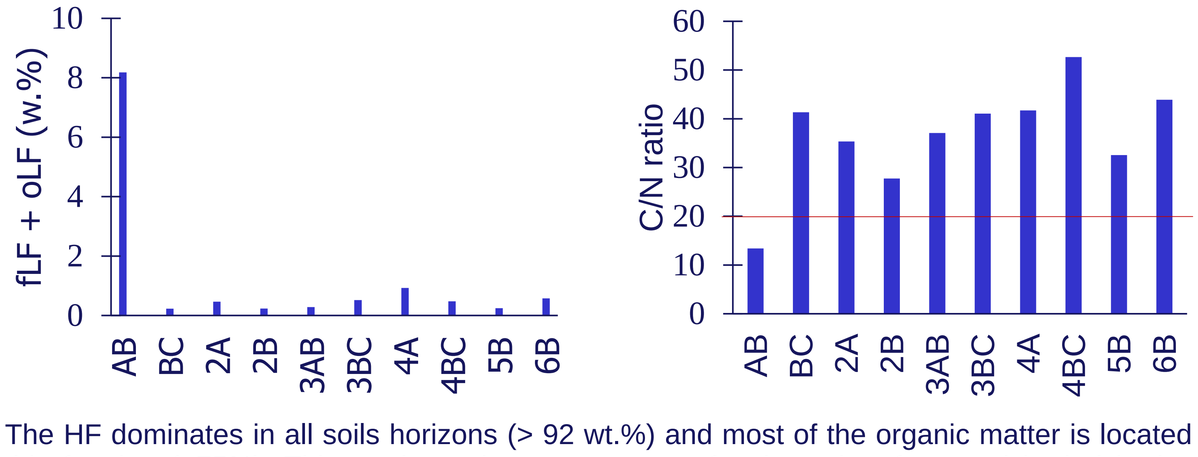


The total C stock in the five tephra-buried soils is ~ 70 kg.m^{-2} whereas C stock in the surface soil is ~ 20 kg.m^{-2}, i.e. 3.5 lower.

(3) Organo-metallic complexes dominate C stabilisation

Total C strongly correlates with Alp and Fep, suggesting organo-metallic complexation as a potential stabilisation mechanism for organic C.

(4) Lower fLF + oLF fraction in the subsurface and buried horizons



The HF dominates in all soils horizons (> 92 wt.%) and most of the organic matter is located in this fraction (>75%). This tendency is even stronger for the subsurface and buried horizons pointing to a lost of fLF+oLF when there is no fresh input of OM. In these horizons, the C/N ratio is higher then 20, suggesting that microbial degradation of OM may be impeded.

Conclusion

Our results highlight a large C stock associated with tephra-buried soils. In active volcanic regions, the C stock of Andisols is probably underestimated. Organo-metallic complexation is likely a stabilisation mechanism for organic C in both surface and buried soils. POM tends to disappear in the subsurface and buried horizons suggesting its degradation in the absence of OM input. Future studies on OM in buried volcanic soils, including SOC stock estimates, are advocated.