LISAH
Laboratoire d'étude des Interactions
Sol - Agrosystème - Hydrosystème

Master's intership (M2) or a gap-year projec

Analysis of the variability of soil properties involved in the sorption of contaminants in an Andosol-Nitisol toposequence: the contribution of infrared spectrometry.

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Background

Soil properties are closely linked to soil processes, particularly their ability to regulate contaminants. These properties vary spatially and temporally, with varying degree of variability depending on the environment in question. Measuring these properties is often labour-intensive and costly, limiting detailed analyses of their variability. In this context, the Caribbean environment features soils with pedological properties very different from those of temperate soils, for which there is currently limited reference data.
Indeed, tropical volcanic soils, formed by the weathering of volcanic material under the influence of a high-rainfall regime, exhibit mineralogical assemblages dominated by aluminium, iron and silica oxyhydroxides in amorphous or crystalline forms, and organic carbon contents that can be very high in certain situations. Furthermore, the succession of different volcanic material contributes to significant variability in soil properties over short distances (Colmet-Daage and Lagache, 1965). Thus, understanding the variability of soil properties is a key challenge for better comprehending soil behaviour, particularly regarding the fate of pesticides—a recurring problem of soil and water pollution in the West Indies linked to the use of current or legacy pesticides, the best known of which is chlordecone (e.g. Cabidoche et al., 2009).
In recent years, methods for estimating soil properties using laboratory mid-infrared spectroscopy have been developed. Although there is a wealth of literature on this topic, these approaches—promising due to their speed and cost-effectiveness—are still in the development and testing phase across various environments (e.g. Chevallier et al., 2019; Dollinger et al., 2024).

Objective:
This project aims to understand the variability of soil properties within an Andosol-Nitisol sequence. To this end, the ability of infrared spectrometry-based methods to estimate soil properties will be evaluated. This work builds on the PhD research of Lynda Pavy, who developed the collection of soil profiles based on field soil science knowledge and initiated the analysis of property variability across the sequence in relation to environmental and agronomic covariates.

Approach and proposed work:
The study will test the predictive capacity of soil properties involved in pesticide sorption, notably mineralogical assemblages, organic carbon content and pH, using mid-infrared spectra (MIRS) acquired from a collection of 351 samples distributed across 31 soil profiles of the Andosol-Nitisol sequence. In addition, soil properties were measured on 130 samples using 'conventional' physico-chemical analysis in the laboratory, and will be used to construct and validate prediction models (such as Partial Least Squares Regression or Random Forest).
The estimated soil properties will then be analysed using statistical methods (e.g. PCA, ANOVA) in relation to environmental covariates (depth, altitude, rainfall, etc.) or in connection with knowledge of agronomic practices (soil amendment, ploughing depth, etc.).

The internship will include:
1) A literature review on the use of MIRS to estimate soil properties, with a focus on tropical volcanic soils
2) The interpretation and analysis (PCA, ANOVA, etc.) of various data sources and their relationships (soil properties, spectra, environmental covariates).
3) The development of prediction models based on spectral data
4) The analysis of the spatial variability of soil properties across an Andosol-Nitisol sequence
5) The presentation of results in the form of a thesis

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Desired skills:
The candidate should have an interest in data analysis, scientific computing and teamwork. The candidate should have programming skills (e.g. R or Python) and knowledge of soils.
The candidate should demonstrate rigour, good organisational skills, and the ability to synthesise information.

Internship conditions:
Duration: 6 months
Internship allowance: approximately €600/month
Host institution: UMR LISAH (INRAE Montpellier).
Dates: between October 2026 and July 2027

The internship will be co-supervised by A. Samouelian and C. Gomez (UMR LISAH, Montpellier) and S. Cornu (UMR CEREGE, Aix-en-Provence) and will involve Lynda Pavy.

How to apply:
Send your CV and cover letter to: anatja.samouelian@inrae.fr, cecile.gomez@ird.fr and sophie.cornu@inrae.fr

References:

Cabidoche, Y.M., Achard, R., Cattan, P., Clermont-Dauphin, C., Massat, F., Sansoulet, J. 2009. Long-term pollution by chlordecone of tropical volcanic soils in the French West Indies: a simple leaching model accounts for current residue. Environ. Pollut. 157, 1697–1705. https://doi.org/10.1016/j.envpol.2008.12.015.

Colmet-Daage, F., Lagache, P., 1965. Caractéristiques de quelques groupes de sols dérivés de roches volcaniques aux Antilles françaises. In : Cahiers de l'ORSTOM série pédologie, vol. 8, pp. 91–121. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/cahiers/PTP/18300.PDF.

Chevallier, T., Fujisaki, K., Roupsard, O., Guidat, F., Kinoshita, R., de Melo Viginio Filho, E., Lehner, P., Albrecht, A., 2019. Short-range-order minerals as powerful factors explaining deep soil organic carbon stock distribution: the case of a coffee agroforestry plantation on Andosols in Costa Rica. SOIL 5, 315–332. https://doi.org/10.5194/soil-5-315-2019

Dollinger, J., Thoisy, J.-C., Gomez, C., Samouelian, A., 2024. Application of mid-infrared spectroscopy to the prediction and specification of pesticide sorption: A promising and cost-effective tool. Environmental Pollution 345, 123566. https://doi.org/10.1016/j.envpol.2024.123566