





Utilisons les bonnes  
vibrations !

# Spectroscopie dans le moyen infrarouge et pédologie **tropicale**. Exemples d'applications à Madagascar et au Costa Rica.

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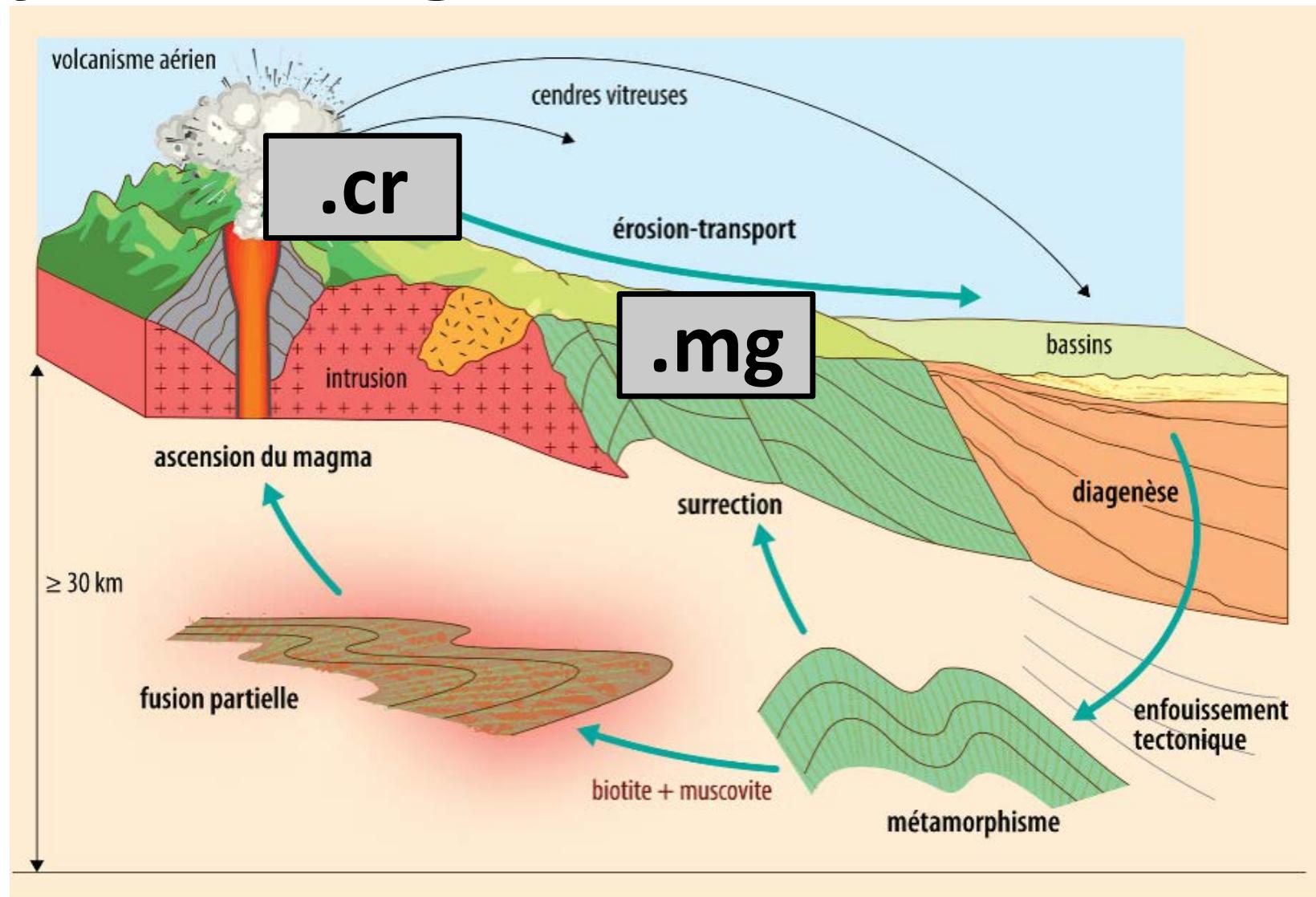
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<sup>5</sup> UMR Eco&Sols, c/o CATIE, Turrialba, Costa Rica

# Pédogenèse ‘tropicale’

- Climat ‘tempéré vs tropical’, durée (du climat)
- Altération ‘mécanique’ vs ‘chimique’
- Altération ‘tropicale’: hydrolyse & néogenèse , + résidus
- Phyllosilicates,  $R_2O_3$  & Quartz ;  $< 2 \text{ } \mu\text{m}$  &  $> 50 \text{ } \mu\text{m}$
- Sols tropicaux comme un modèle minéralogique (et textural), lié à un déterminisme (altération chimique)

# Cycle des argiles



roches magmatiques

argiles hydrothermales

roches métamorphiques

roches sédimentaires

# IR et argiles ... 1964 !

Spectrochimica Acta, 1964, Vol. 20, pp. 1149 to 1173. Pergamon Press Ltd. Printed in Northern Ireland

## The infra-red spectra of layer silicates

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Department of Spectrochemistry, The Macaulay Institute for Soil Research,  
Craigiebuckler, Aberdeen

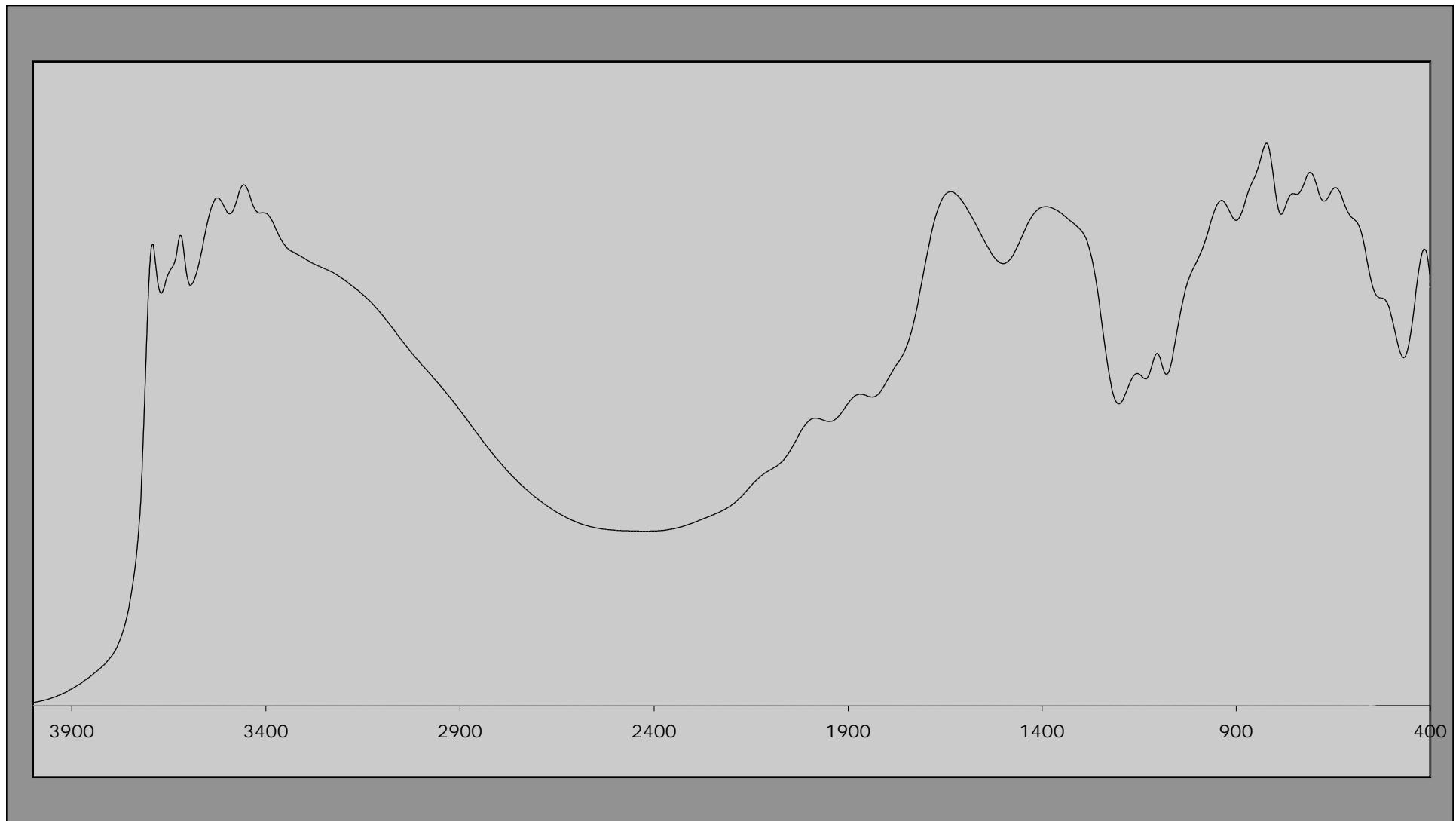
(Received 22 November 1963)

**Abstract**—The infra-red absorption bands arising from the structural hydroxyl groups of a number of dioctahedral and trioctahedral layer silicates are reported with grating resolution in the 3750–3500 cm<sup>-1</sup> region. The frequency differences and orientation behaviour of these bands are discussed in terms of the known structures of the minerals. The effect of the deviation



.mg

# Un spectre IR de Ferralsol (.mg)



Bandes dites 'fondamentales'... DRIFT



# Un spectre IR de Ferralsol (.mg)

## Gaussian (Amplitude)

- **Déconvolution...**

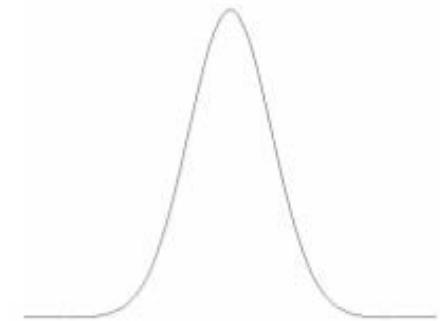
$$y = a_0 \exp\left[-\frac{1}{2}\left(\frac{x - a_1}{a_2}\right)^2\right]$$

a<sub>0</sub> = amplitude

a<sub>1</sub> = center

a<sub>2</sub> = width (>0)

Fit Time Index = 1.0  
(reference for all functions)



## Gaussian (Area)

$$y = \frac{a_0}{\sqrt{2\pi}a_2} \exp\left[-\frac{1}{2}\left(\frac{x - a_1}{a_2}\right)^2\right]$$

a<sub>0</sub> = area

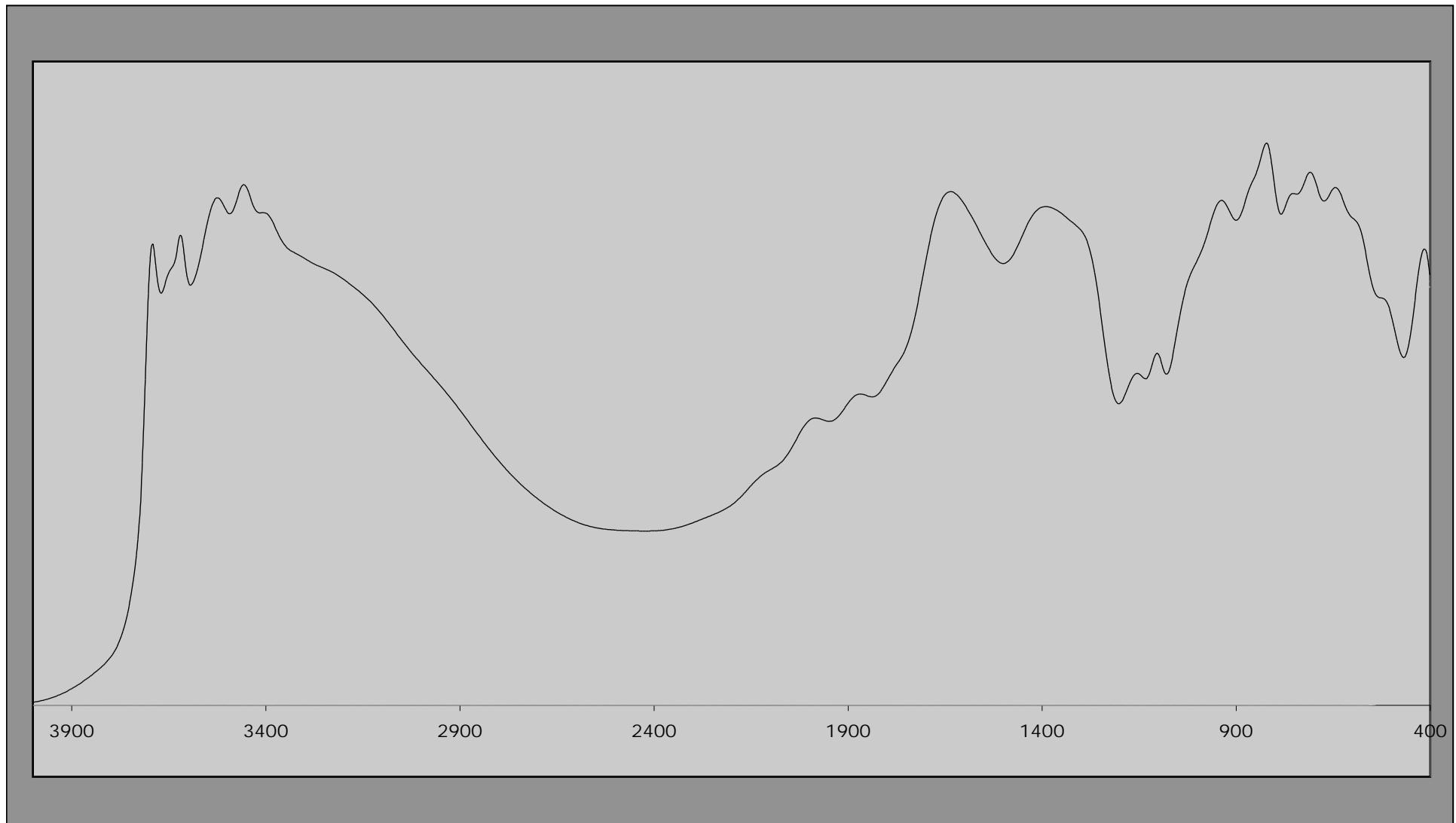
a<sub>1</sub> = center

a<sub>2</sub> = width (>0)

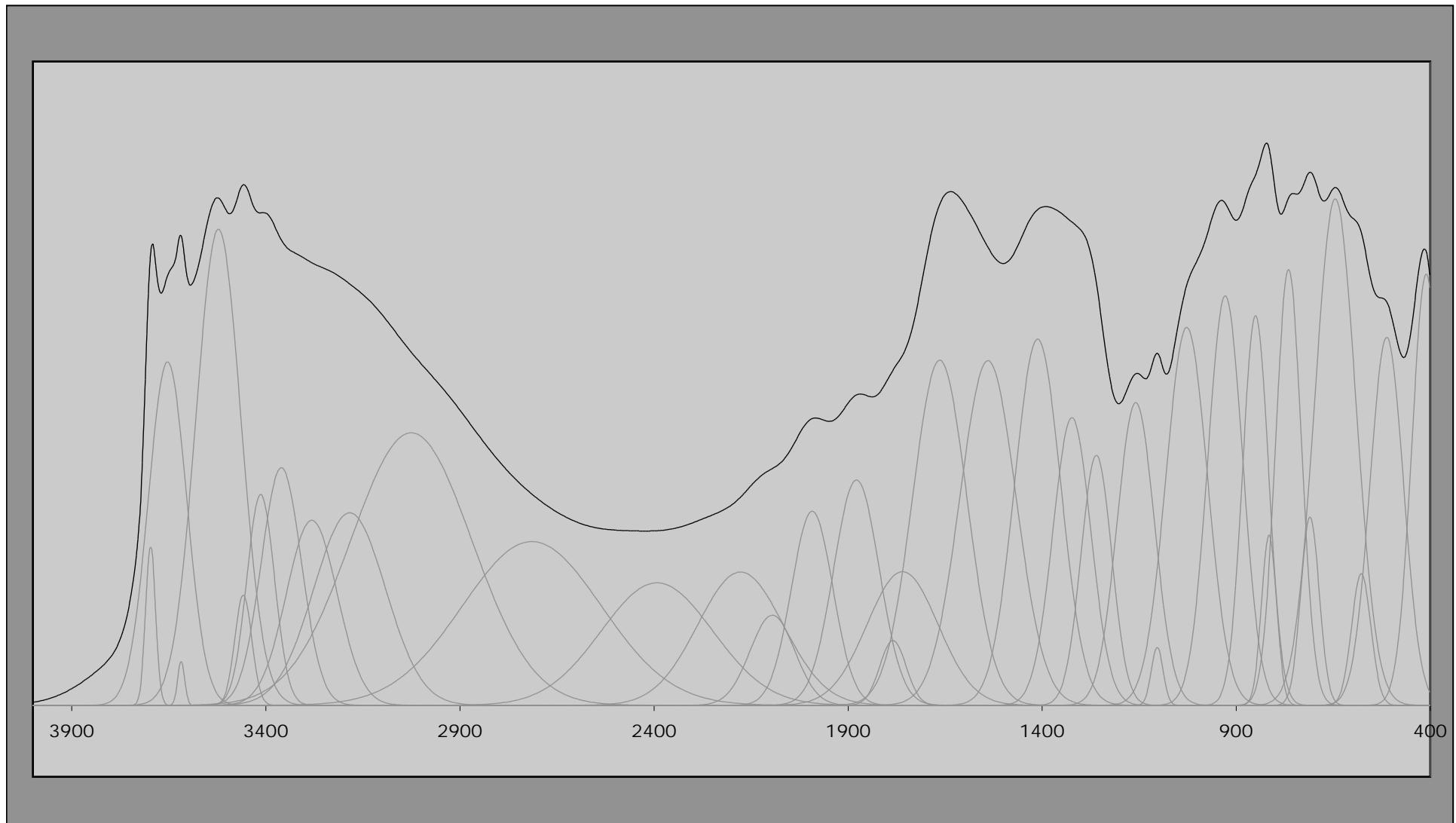
Fit Time Index = 0.9

**Normal Distribution** The Gaussian is also known as the normal distribution function. It is encountered in virtually every field of science. It is a symmetric function whose mean  $\mu$  is equal to a<sub>1</sub>, the center parameter. Its standard deviation  $\sigma$  is equal to a<sub>2</sub>, the width parameter. PeakFit's area version of the Gaussian is the standard statistical form.

# Un spectre IR de Ferralsol (.mg)



# Un spectre IR de Ferralsol (.mg)



# Unsp

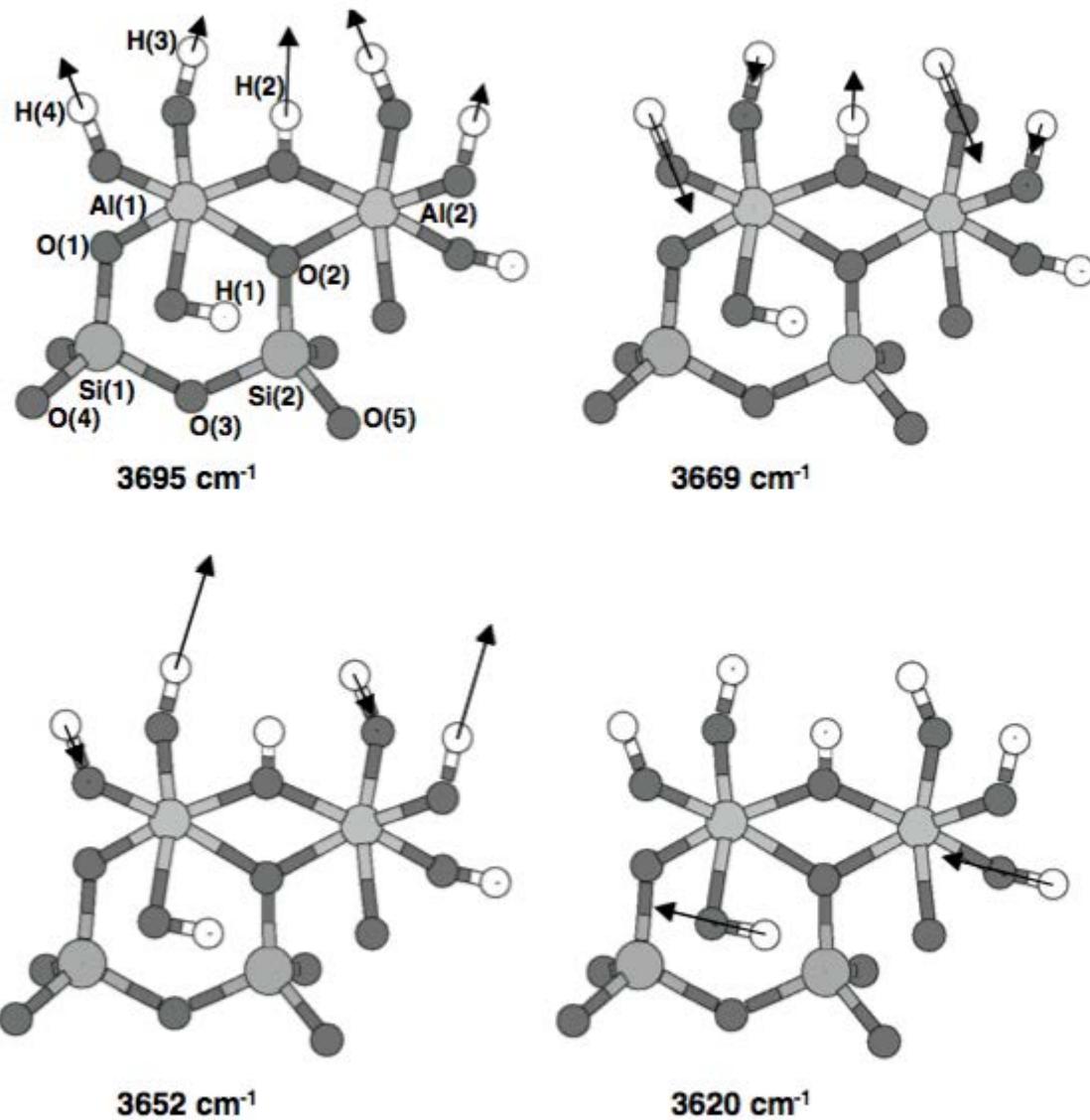
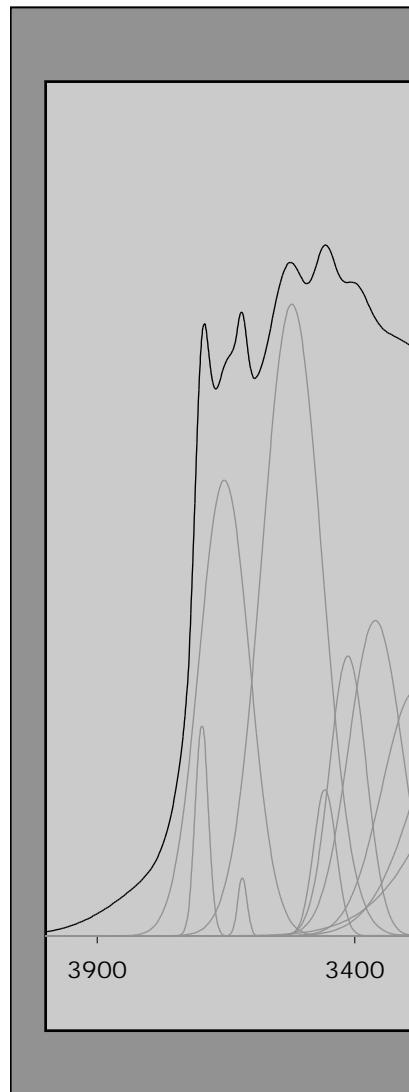


FIGURE 3. Atomic displacements in the four OH stretching modes of kaolinite. The experimental positions of the corresponding IR absorption bands are indicated.

# Unsp

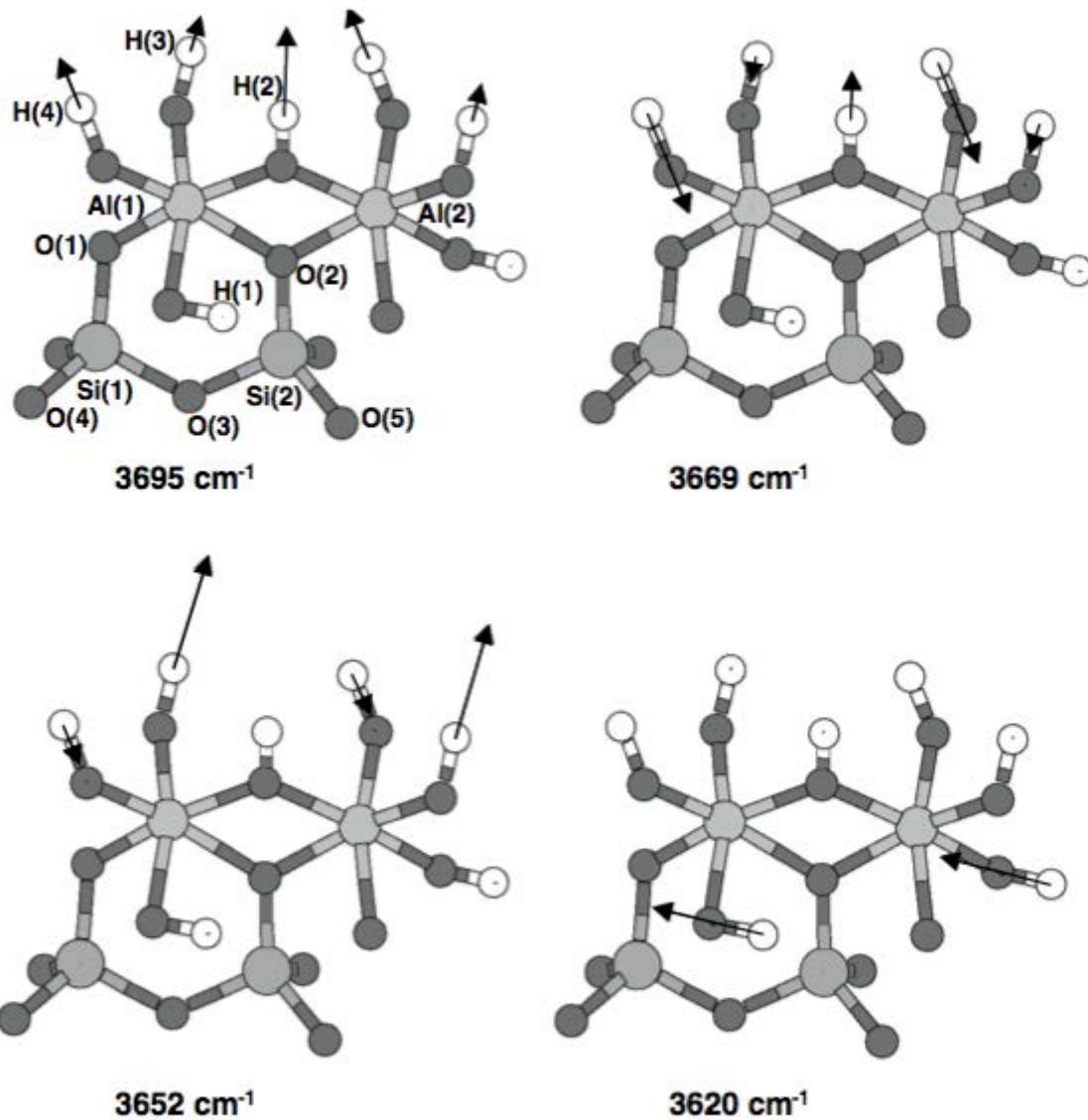
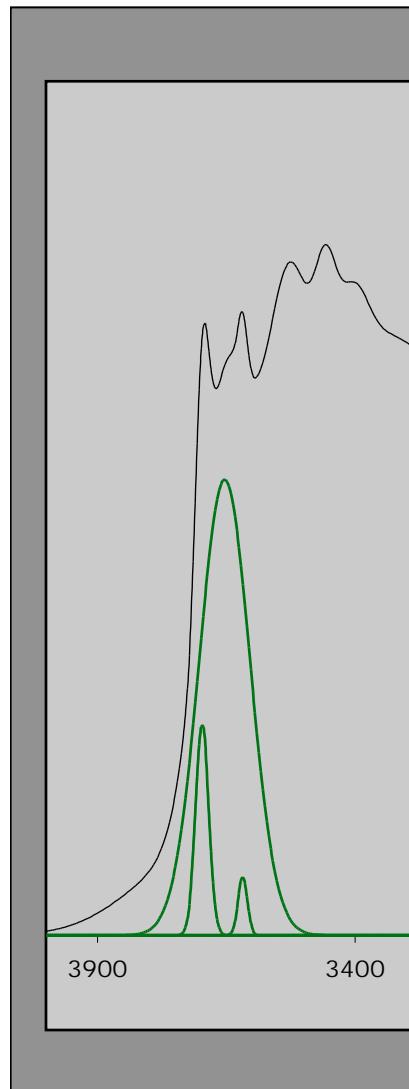
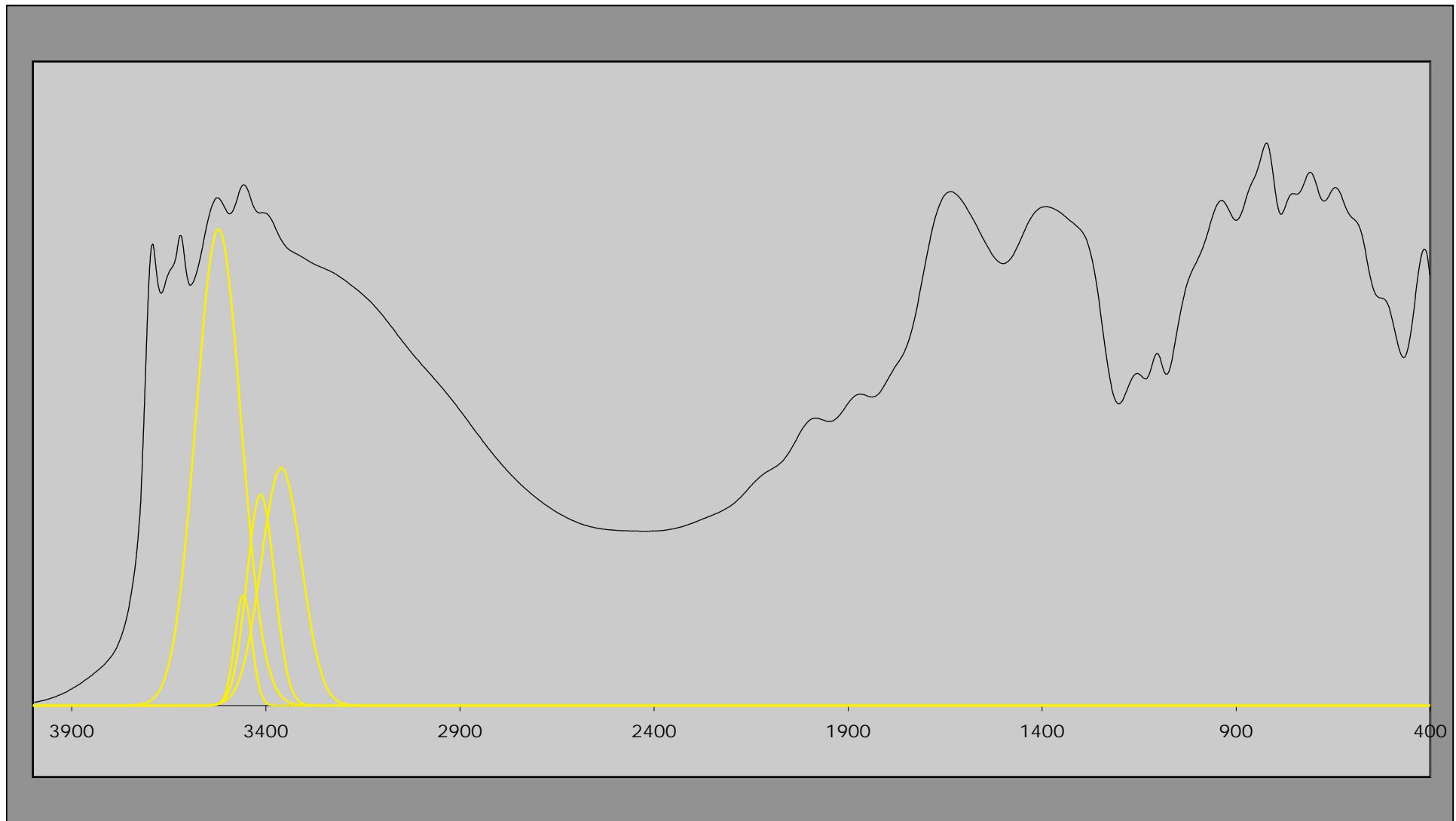


FIGURE 3. Atomic displacements in the four OH stretching modes of kaolinite. The experimental positions of the corresponding IR absorption bands are indicated.

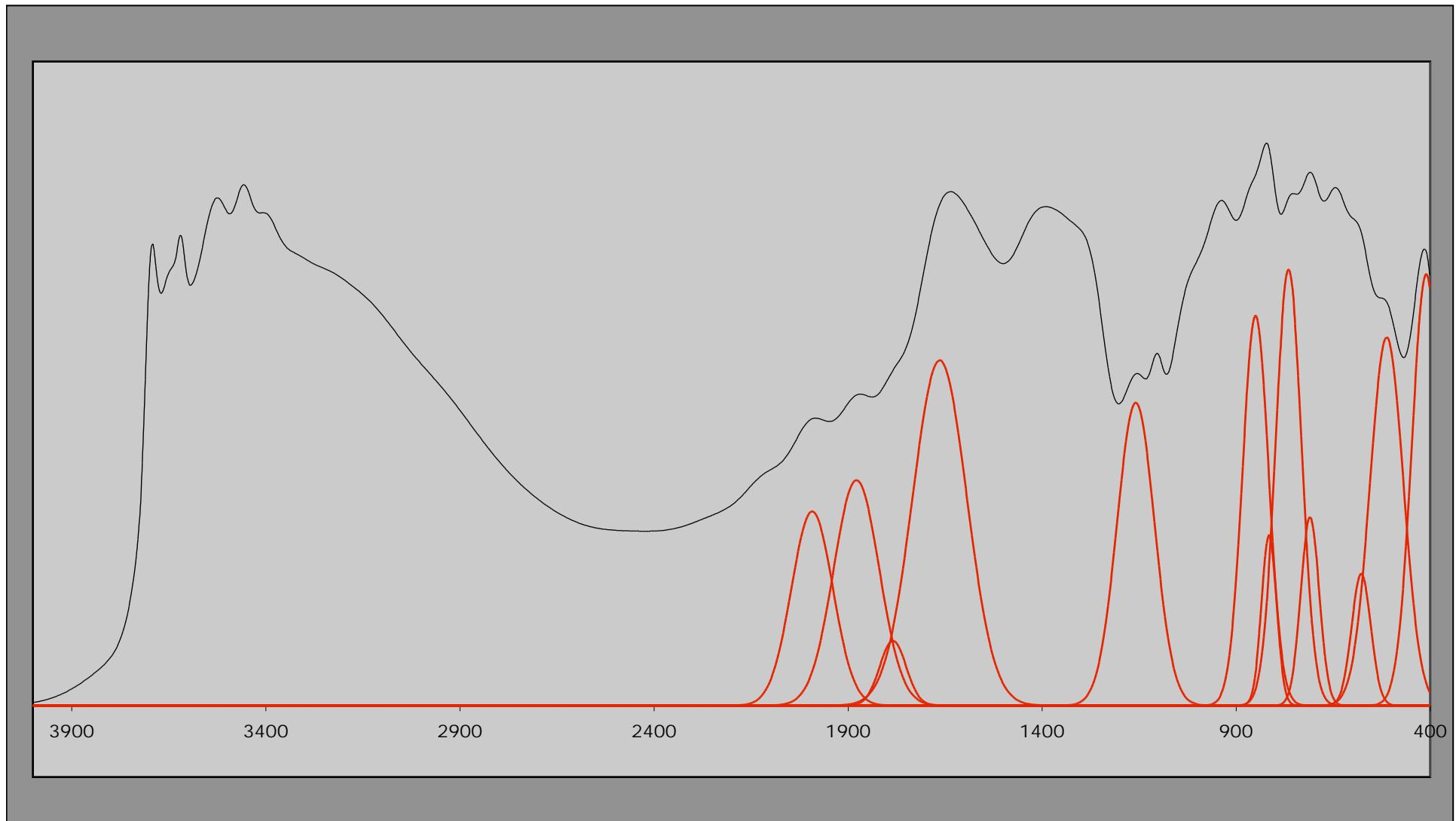
kaolinite: bandes à ...

# Un spectre IR de Ferralsol (.mg)



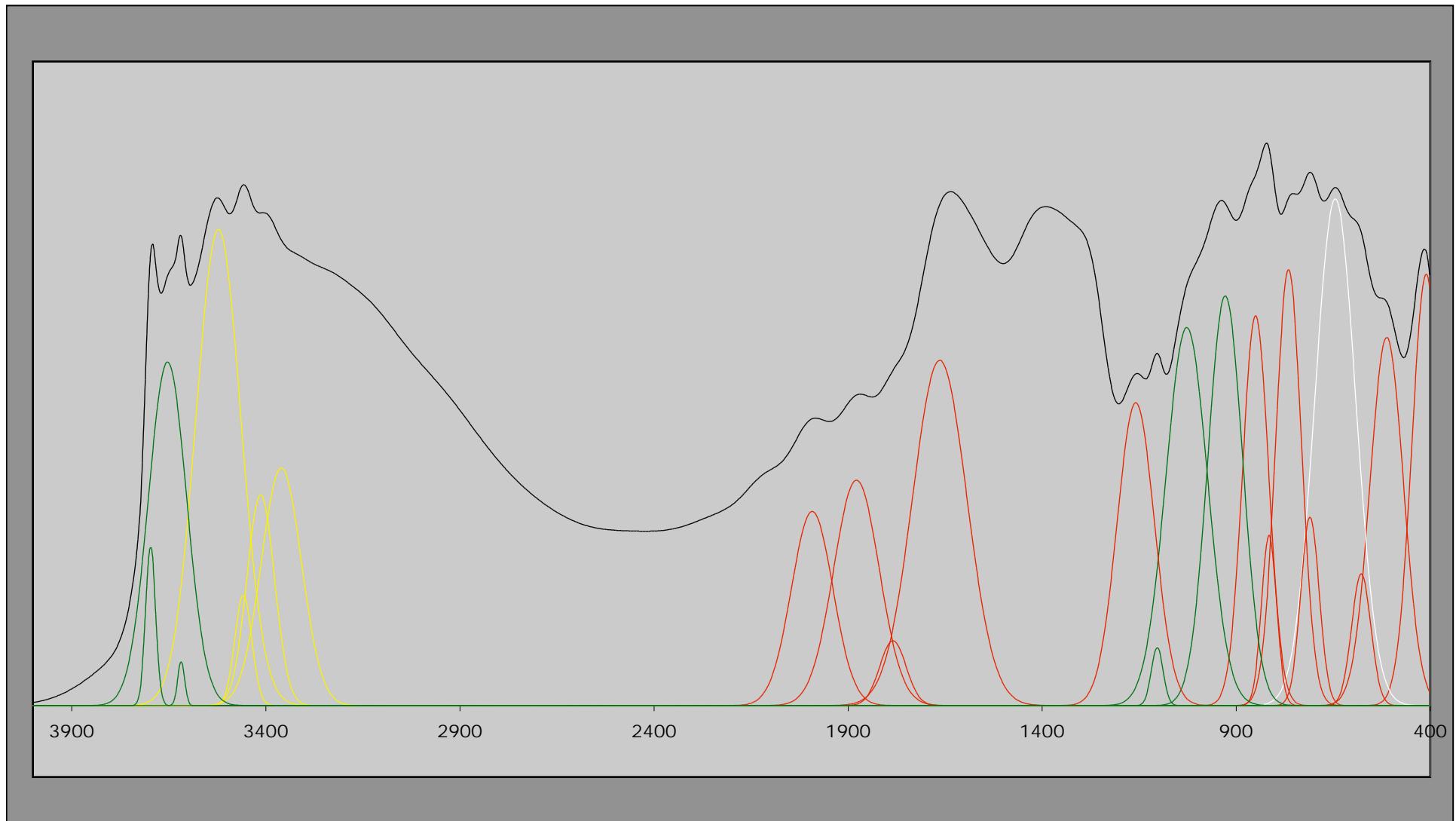
Gibbsite (AlOOH): bandes à ...

# Un spectre IR de Ferralsol (.mg)



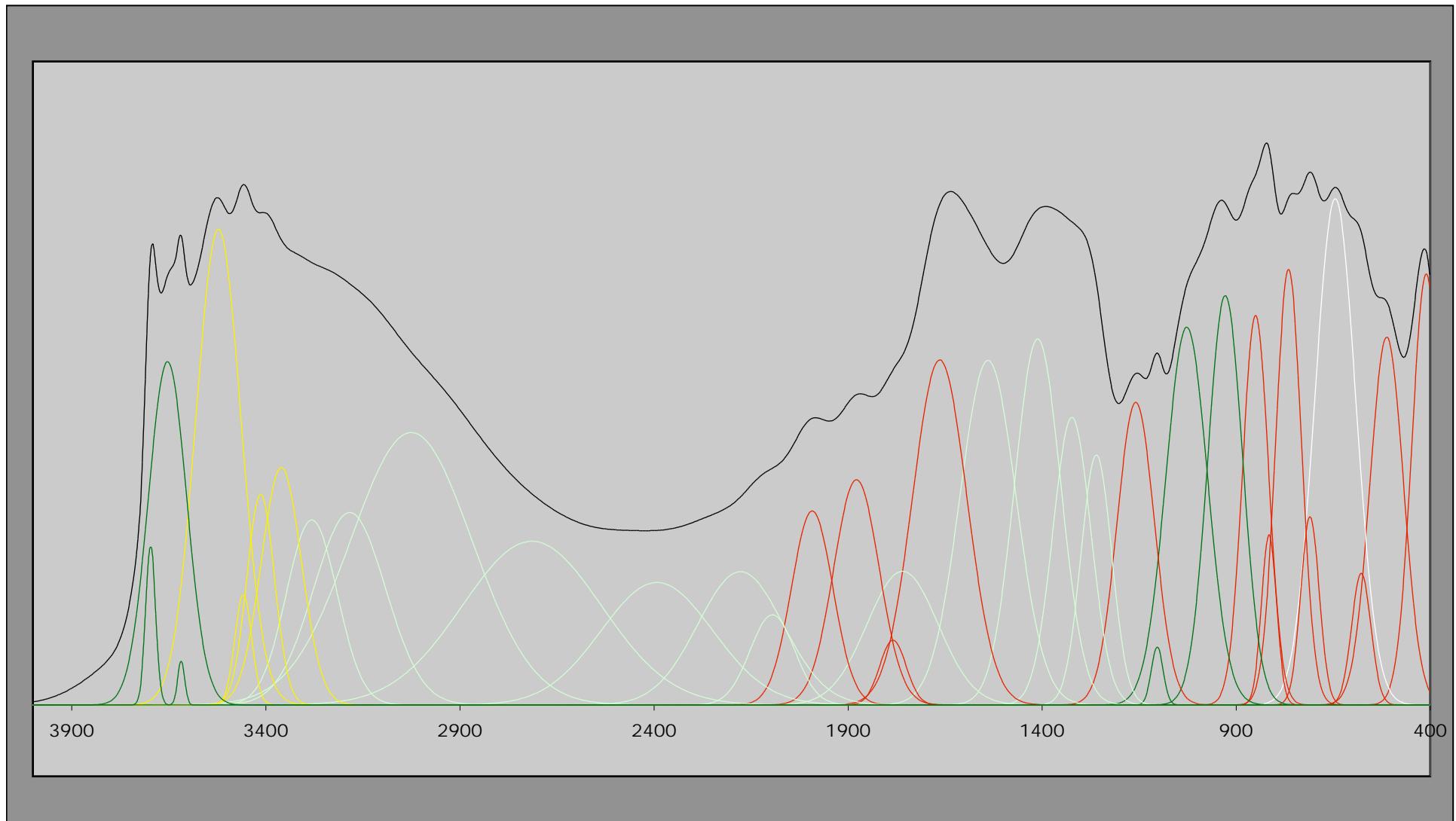
Silice (SiO<sub>2</sub>): bandes à ...

# Un spectre IR de Ferralsol (.mg)



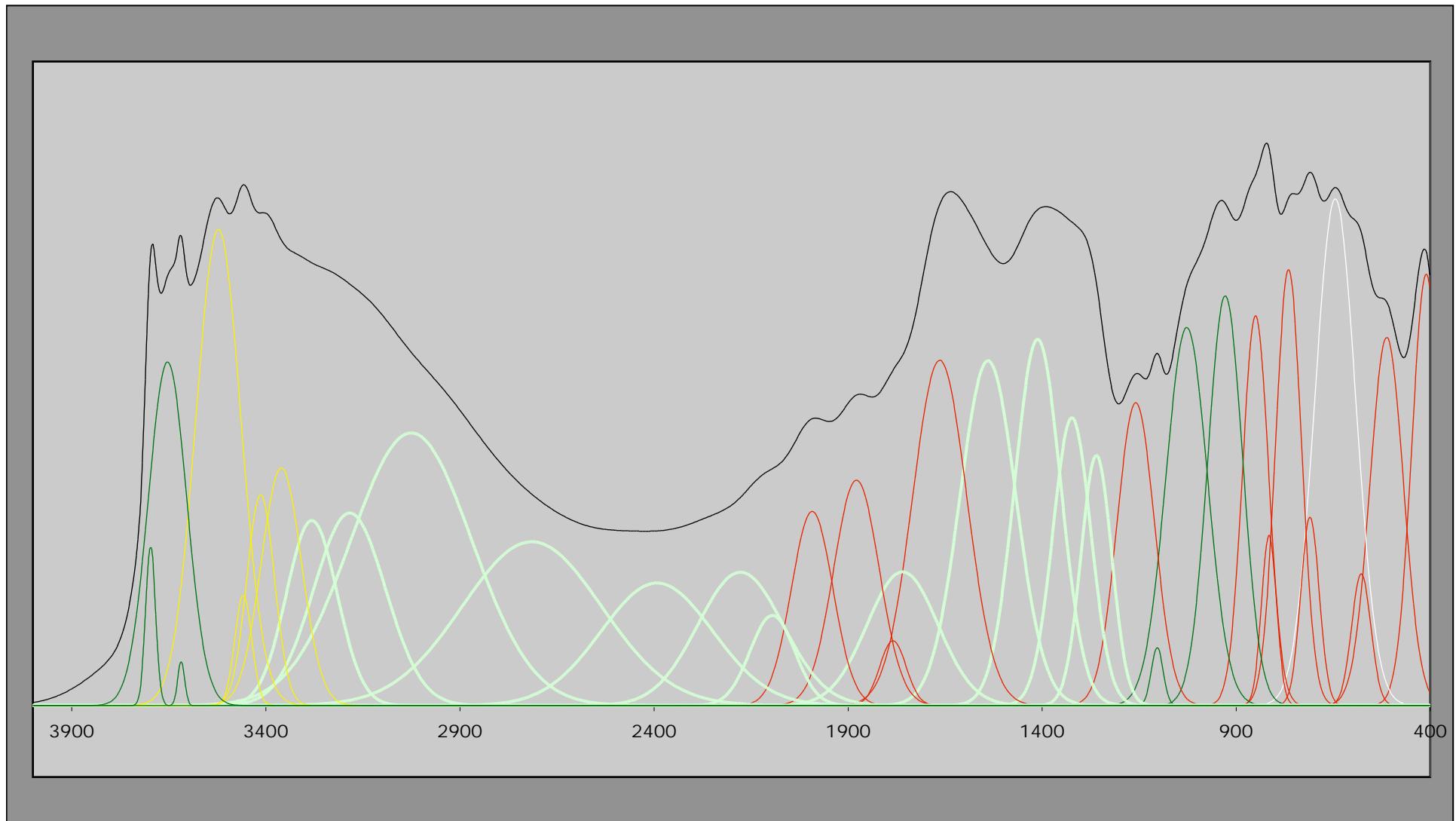
Un spectre minéral

# Un spectre IR de Ferralsol (.mg)



Un spectre minéral et ...

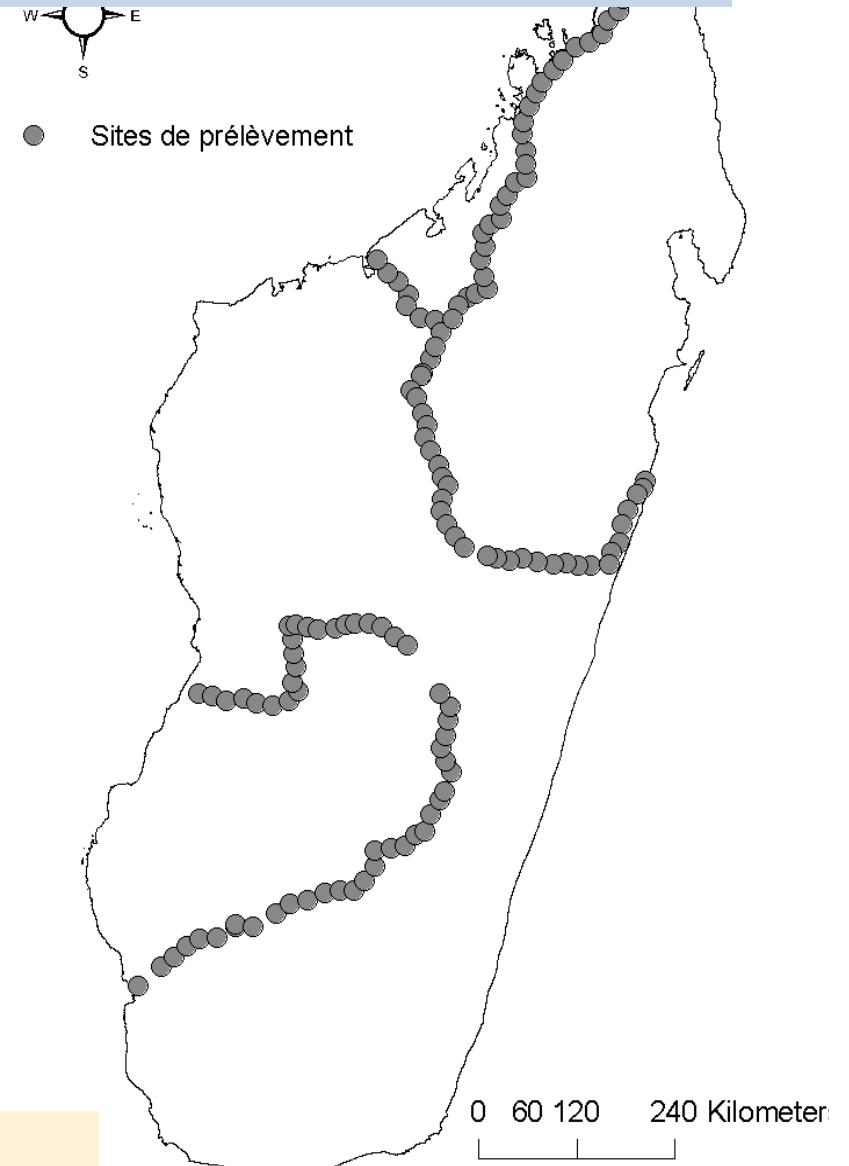
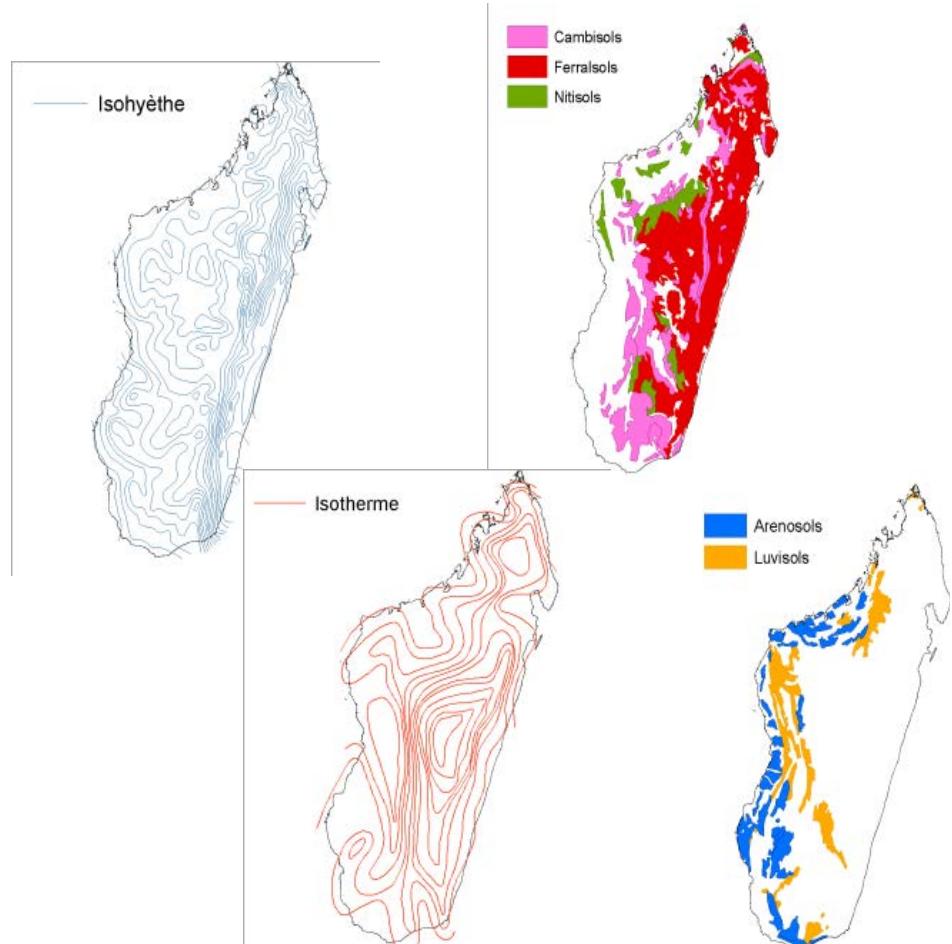
# Un spectre IR de Ferralsol (.mg)



Un spectre minéral et des fonctions organiques

# Classification des sols (.mg)

## Plan d'échantillonnage



**119 SITES RETENUS**  
**2317 ÉCHANTILLONS PRÉLEVÉS**

# Classification des sols (.mg)

## ACP des spectres

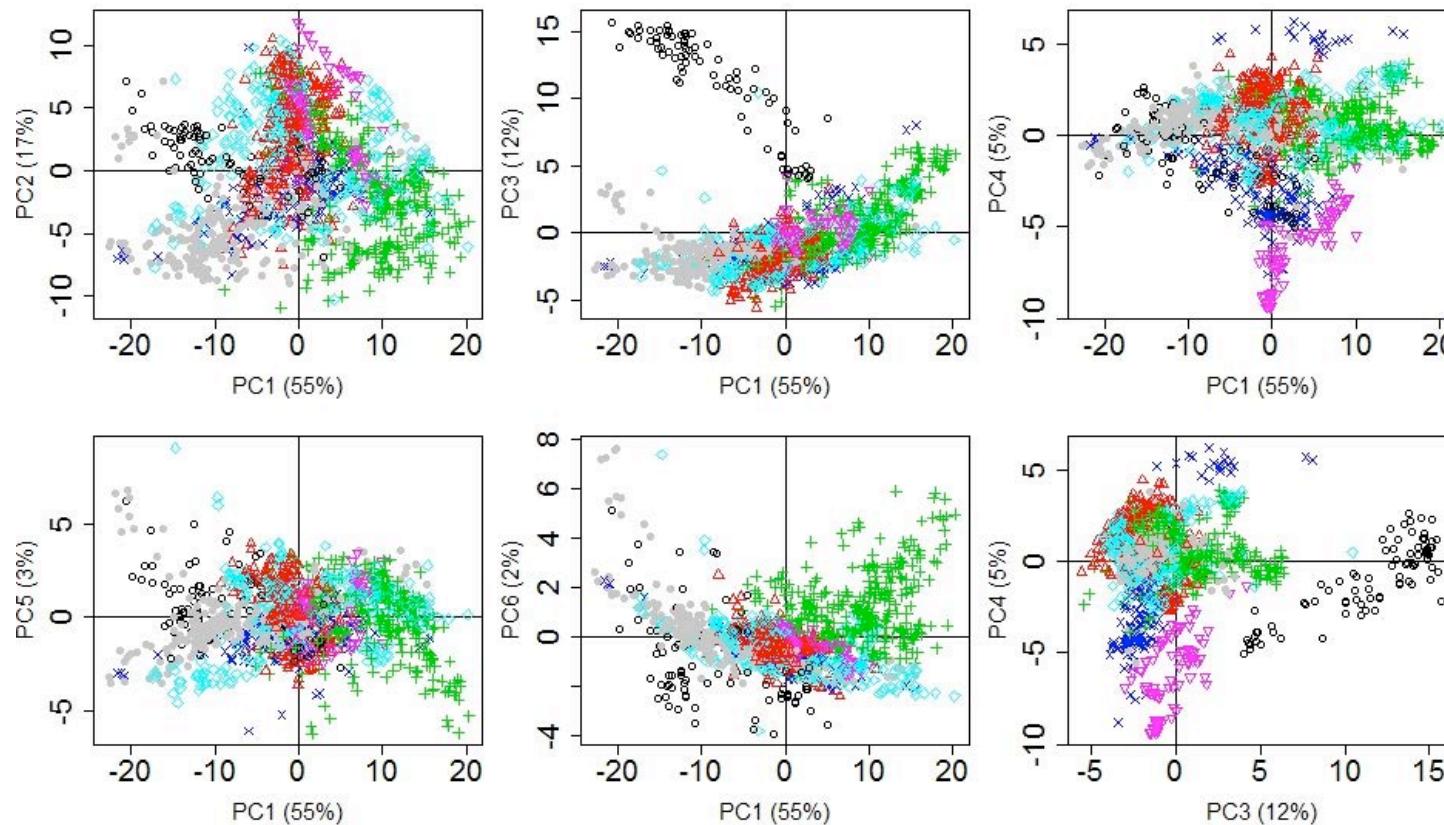
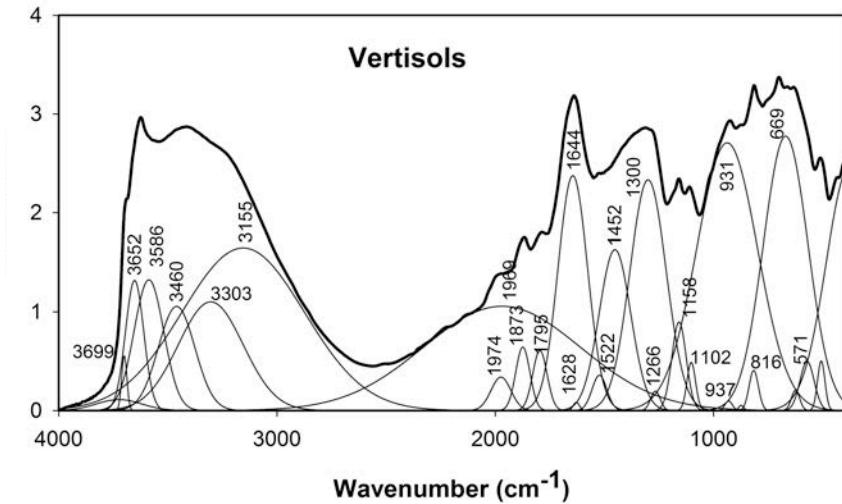
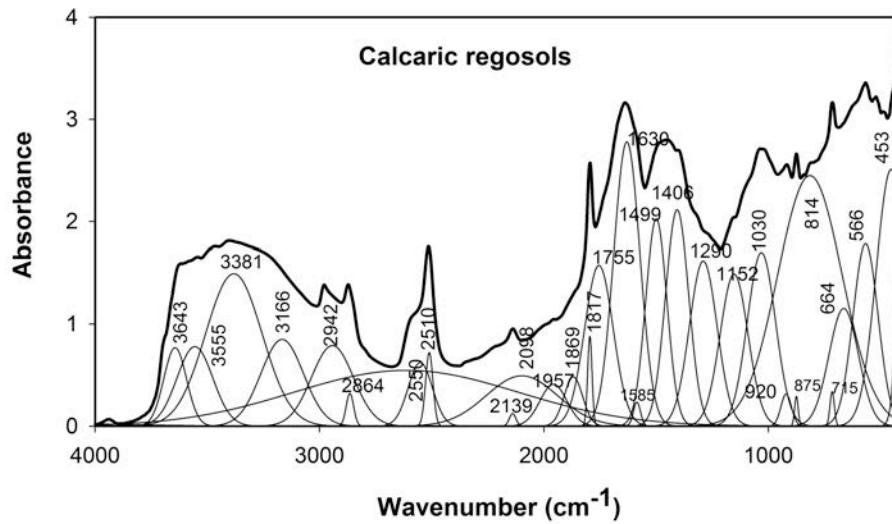
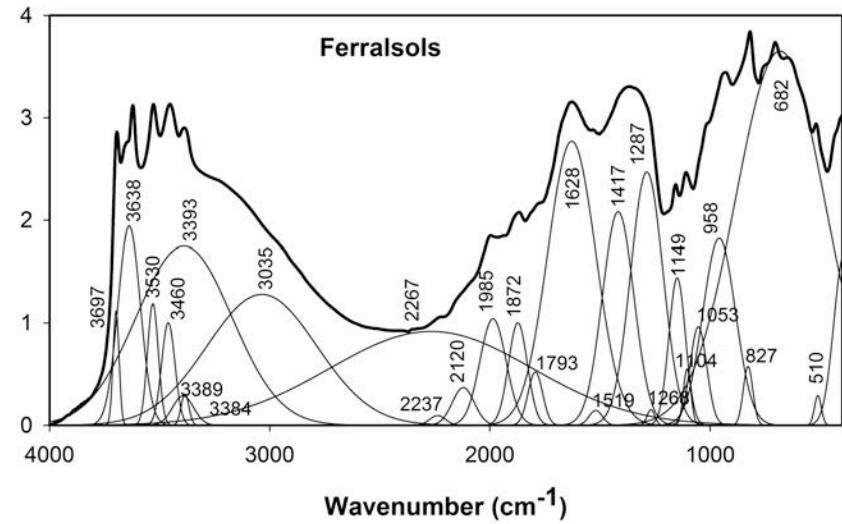
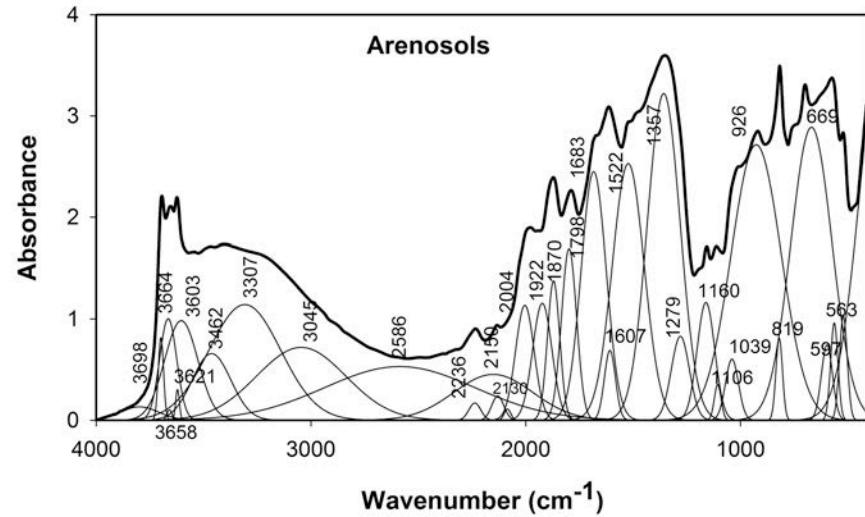


Figure 2: PCA spectra for all soil groups (green: Ferralsols, red: Cambisols, black: Calcaric regosols, Pink: Vertisols, blue: Luvisols, magenta: Nitisols, gray: Arenosols)

- Art RAZAFIMAHATRATRA et al. Soumis Geoderma

# Classification des sols (.mg)

## Spectres par type de sols + déconvolution



# Classification des sols (.mg)

## Approche semi-quantitative (aire des pics)

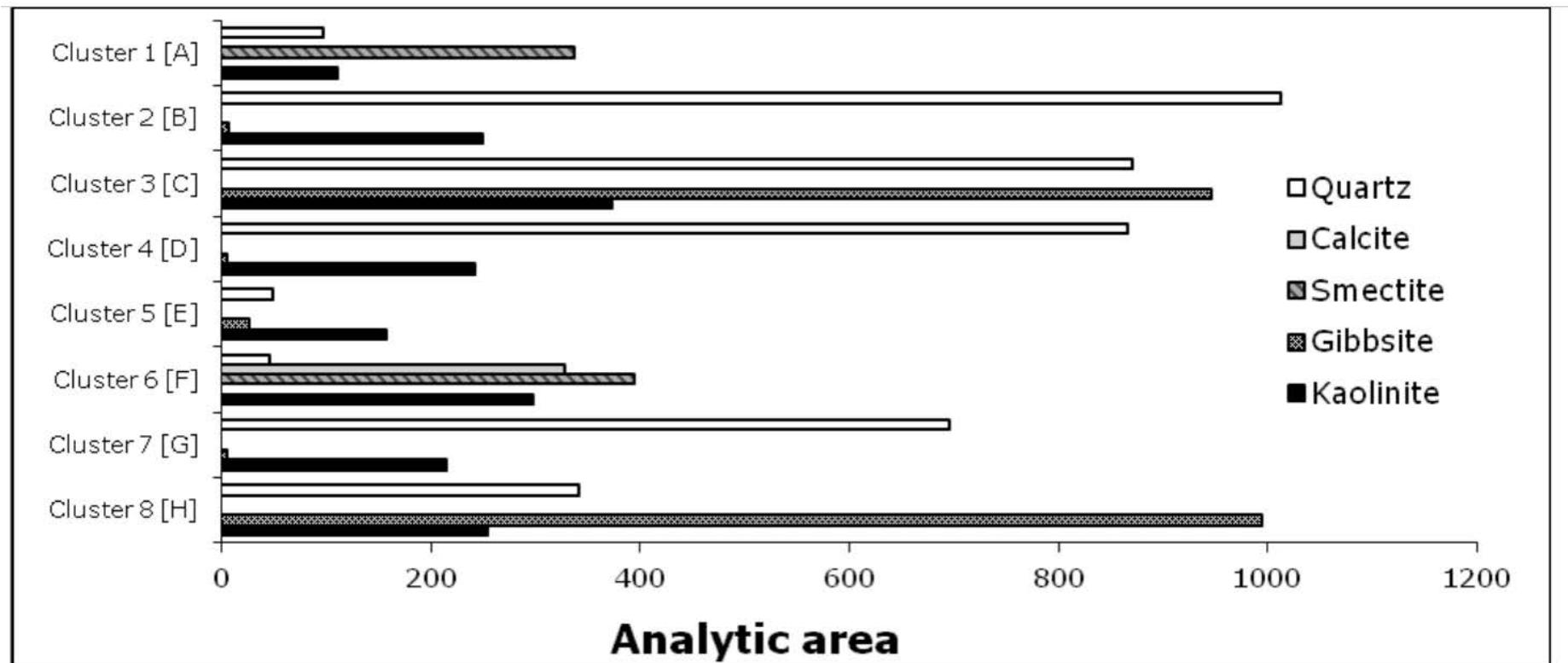


Figure 3: Cumulative analytic areas for mineral components

- Art RAZAFIMAHATRATRA et al. Soumis Geoderma

# Gels et cristaux (.cr)

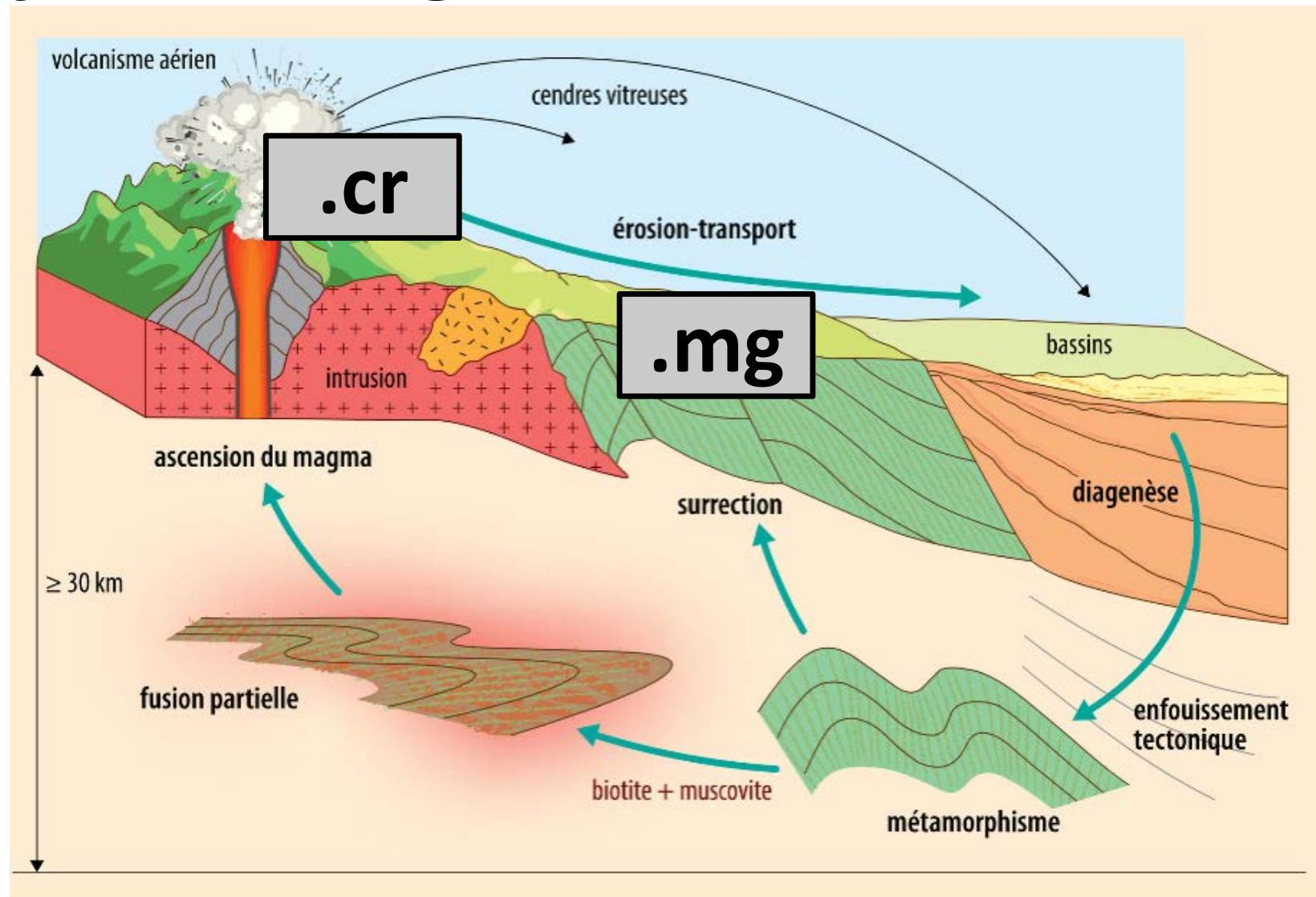
**Pratiques agroforestières et pédogénèse comme déterminants du stockage du carbone dans le sol**

*Les systèmes agroforestiers à base café sur Andosols au Costa Rica*

Alain Albrecht & Tiphaine Chevallier (IRD/UMR Eco&Sols) ; Florian Guidat (ENSAIA); Olivier Roupsard, Karel Van Den Meersche, Agnès Martin & Jean-Michel Harmand (Cirad/UMR Eco&Sols) ; Rintaro Kinoshita (MSc/U. Cornell)



# Cycle des argiles



roches magmatiques

argiles hydrothermales

roches métamorphiques

roches sédimentaires



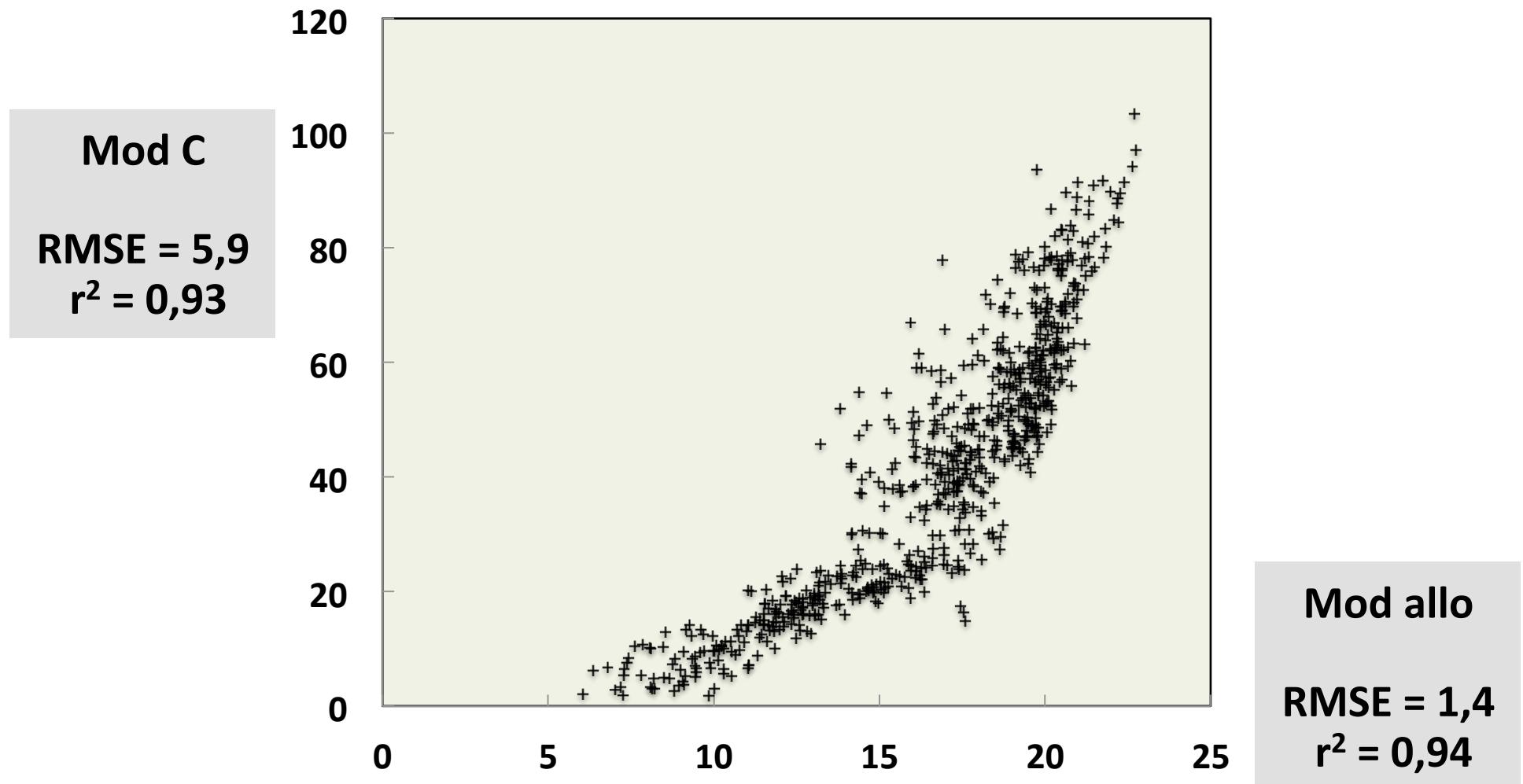
# Gels et cristaux (.cr)

# Le site d'étude : BV (1 km<sup>2</sup>)

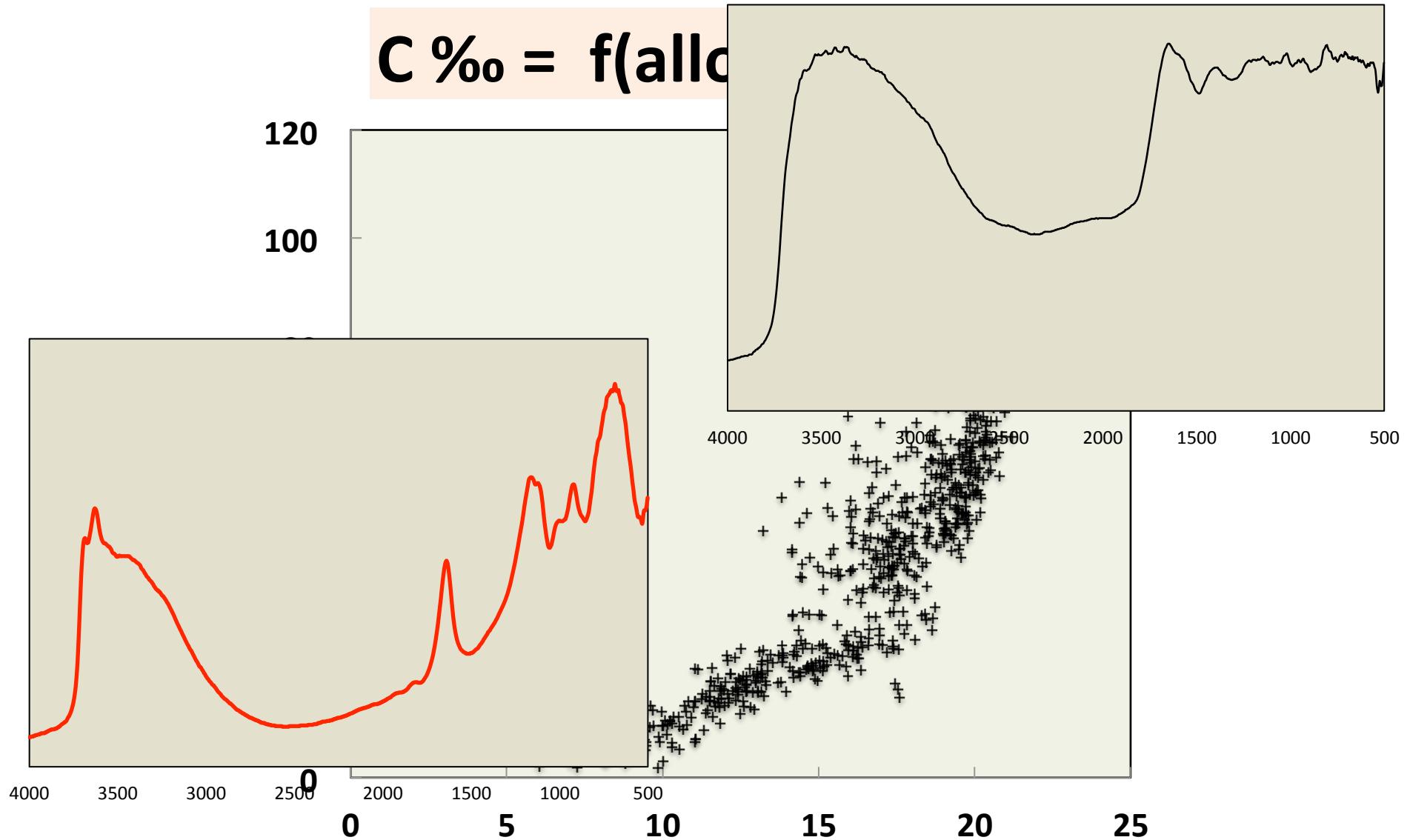


# Gels et cristaux (.cr)

$$C \% = f(\text{allophanes} \%)$$



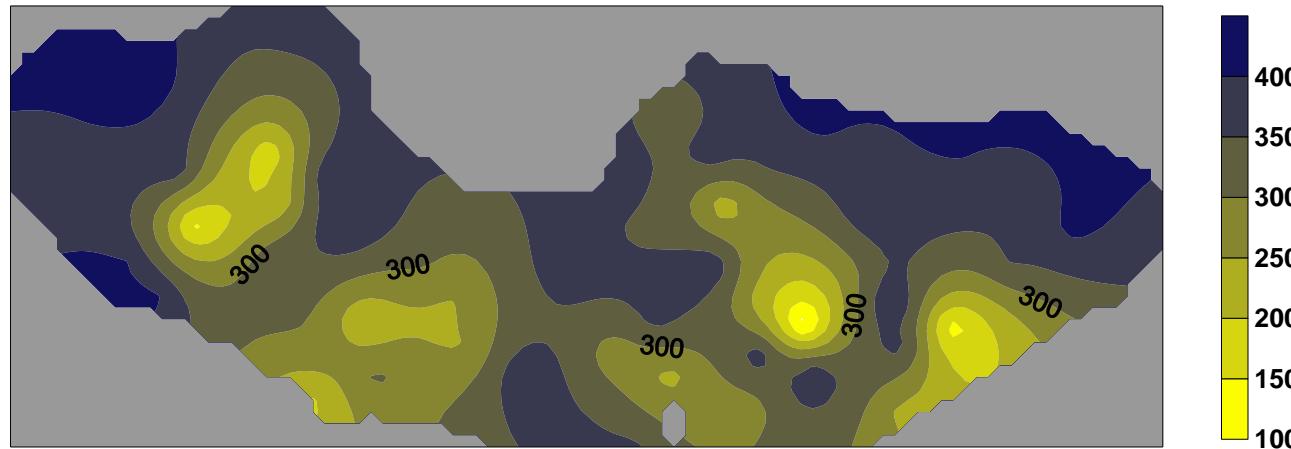
# Gels et cristaux (.cr)



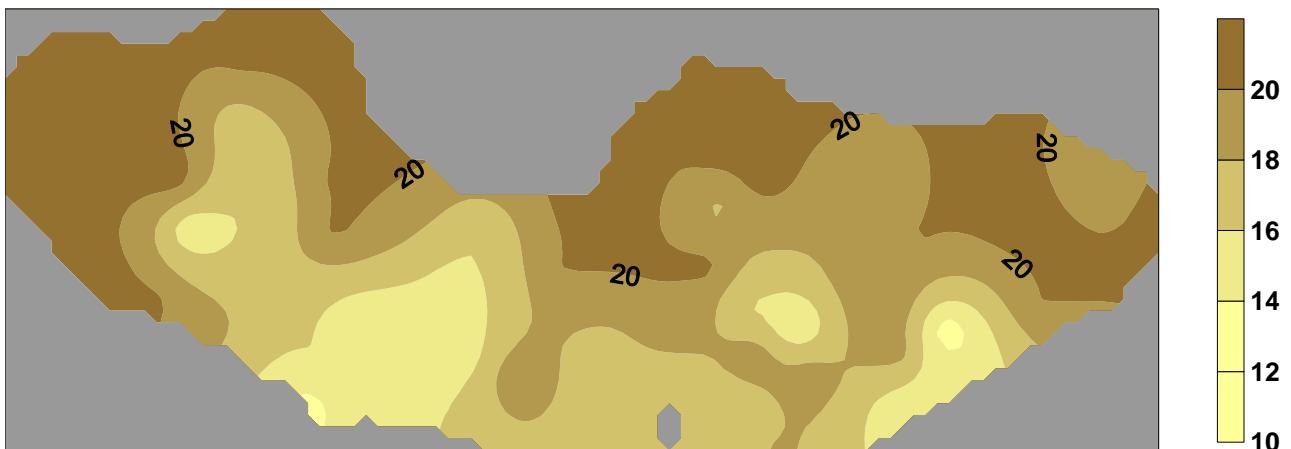
# Gels et cristaux (.cr)

var. lat. : Stock Csol ( $\text{MgC ha}^{-1}$ ) à 1m  
et allophanes (%)

Stock  
Csol



Allo



# Sols tropicaux et MIRS... ...Quali & Quantit

**Prédiction des constituants organiques et minéraux :**

- C&N: OK + fonctions...
- Amorphes : OK, méthode chimique
- Minéraux argileux &  $\text{Al}_2\text{O}_3$  : semi-quantit

**Prédiction (directe) des propriétés :**

- Prédiction de la texture : OK quand minéralogie typée (un seul type de matériau de taille  $< 2\mu\text{m}$ )
- Prédiction de l'hydrophobicité,...



**Merci de votre attention !**