Specific yield estimation using **resistivity** and **chargeability** in deeply weathered hard rock aquifers: experimental relationship in Benin, West Africa

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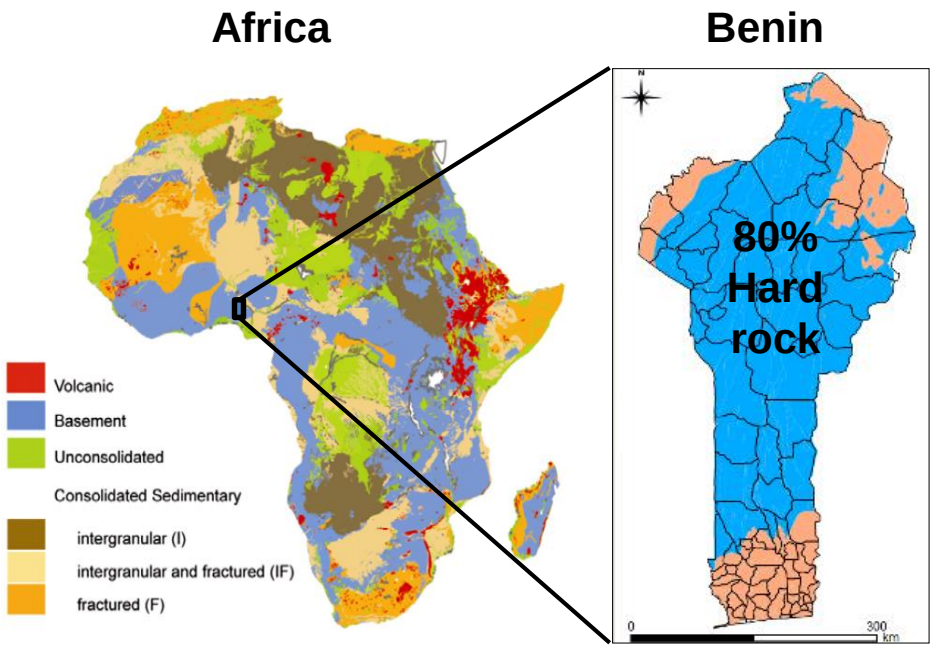
Result obtained thanks to the **GRIBA project**

N°abstract 1856

25-29th September 2016 Montpellier, France CORUM CONFERENCE CENTER 43rd IAH congress

Introduction

- 80% of Benin surface area is underlined by hard rock



Geological map
(Mc Donald et al., 2012)

Hard rock and sedimentary rock location

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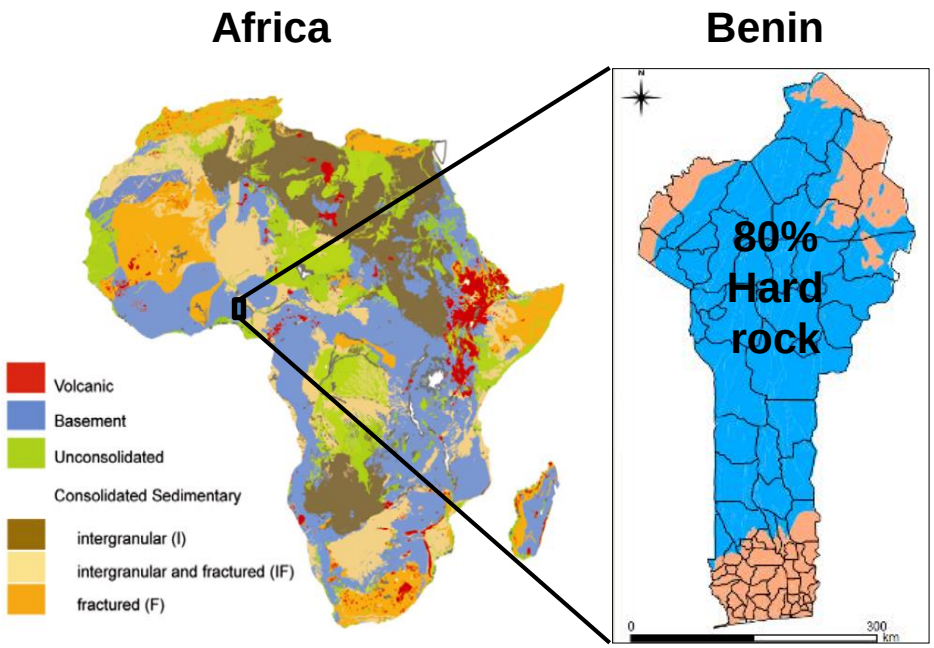

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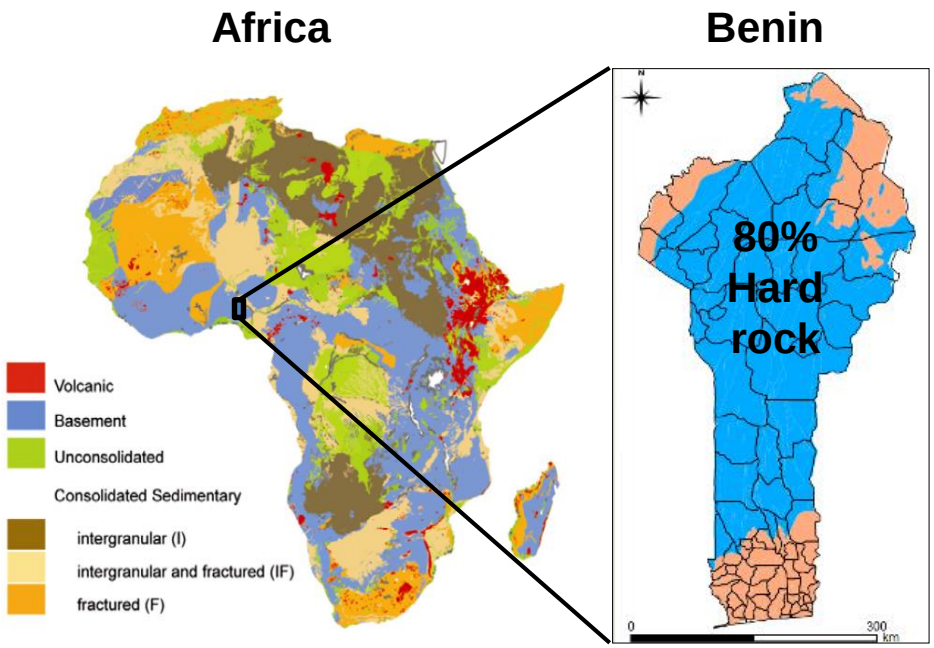

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Hard rock and sedimentary
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Granite (Plutonic)

Gneiss

Mica shist

(Metamorphic)

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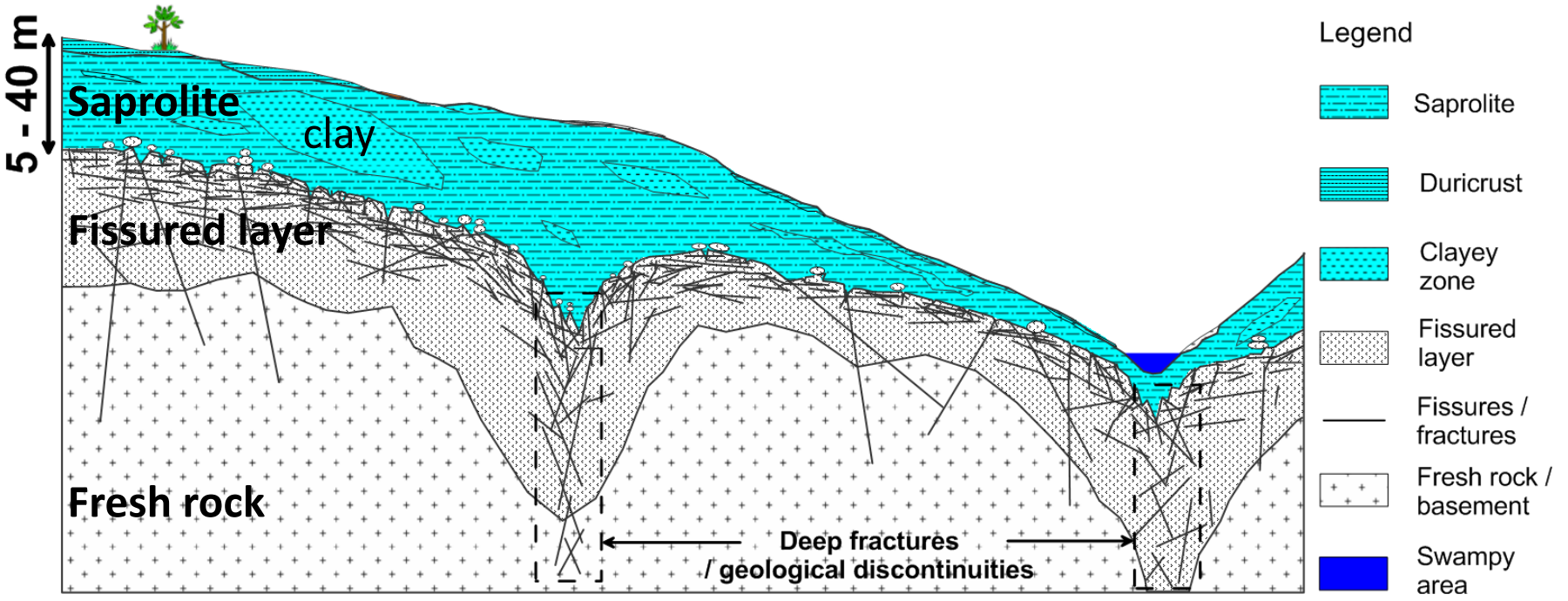
Hand pump (Borehole), Northen Benin

Introduction

- 80% of Benin surface area is underlined by hard rock
- Yield of boreholes drilled are usually low, not sustainable and **40%** are negatives
- Model of hydrogeological compartment : **deeply weathered zone** (Specific yield and Transmissivity**?**)



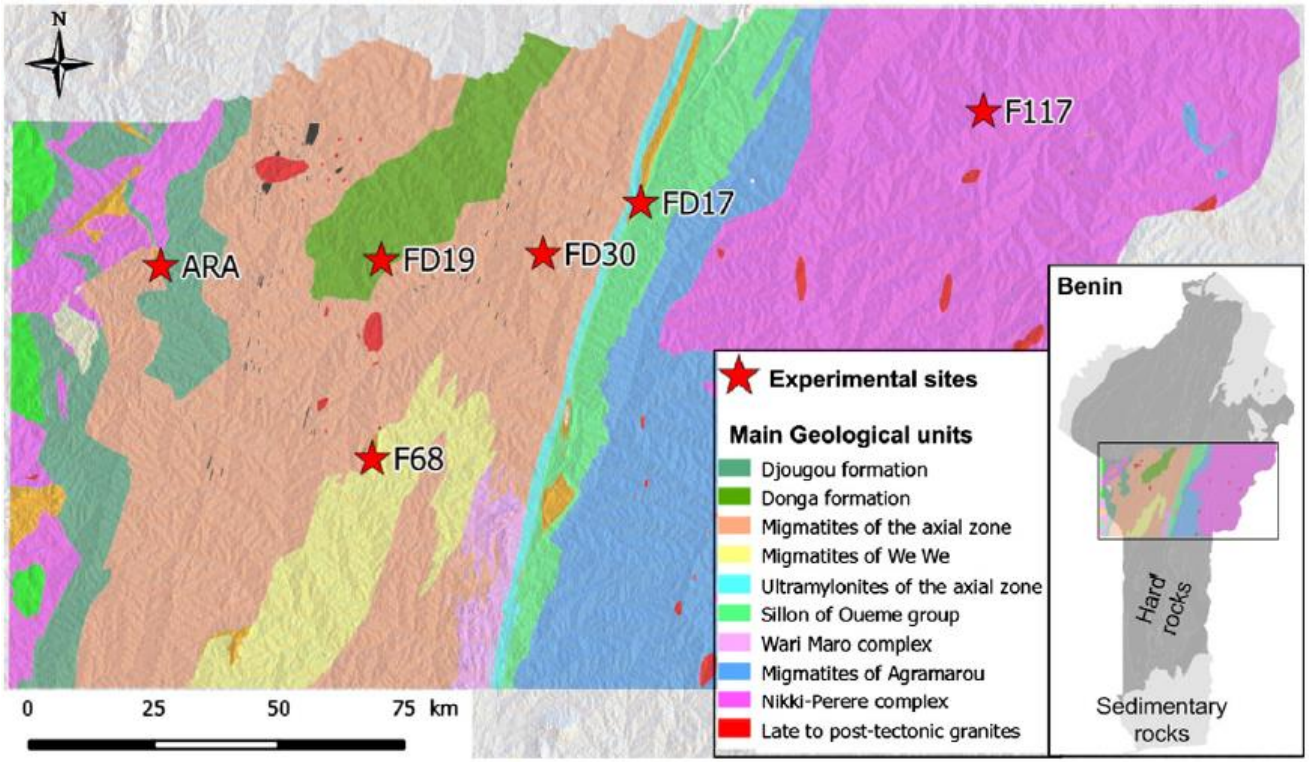
Conceptual model of hydrogeological compartment in tropical hard rock (adapted from Dewandel et al., 2011)

Aim of study

- We focus on **Sy estimation** attempting **to use electrical geophysical method**

Materials and method

- Selection of six experimental sites (GRIBA Project)



Location of experimental sites and simplified geological map (Vouillamoz et al., 2014).

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- Pumping tests and Electrical loggings

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Pumping test
Specific yield

Site: FD17

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Electrical logging:
Resistivity and chargeability

Site: F68

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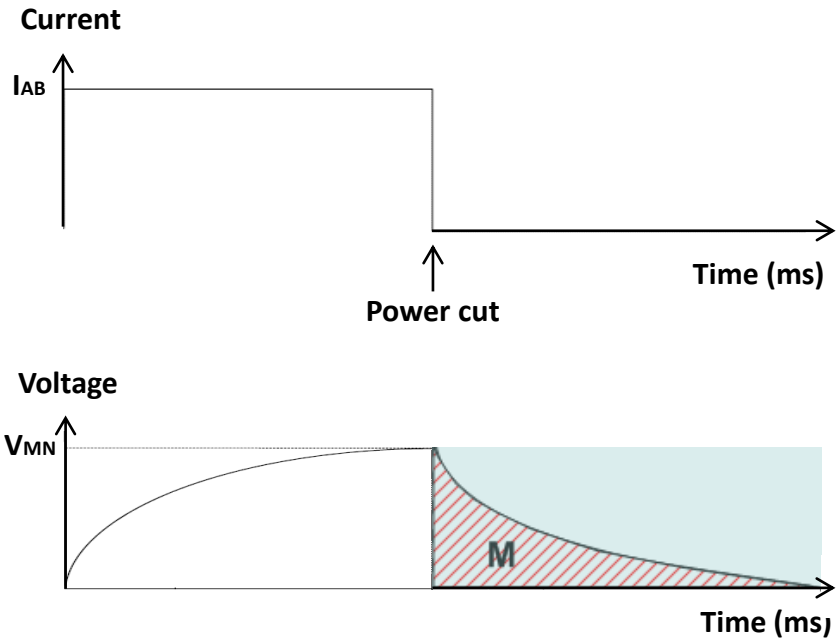
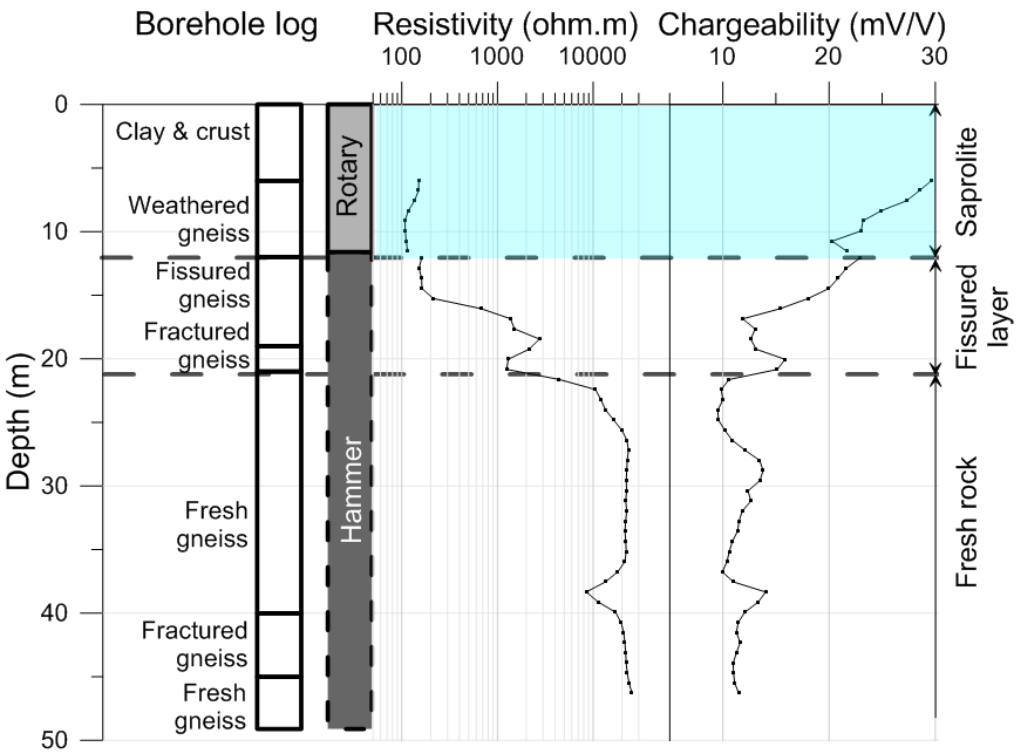
Chargeability **M (mV/V)**



Electrical logging:
Resistivity and chargeability

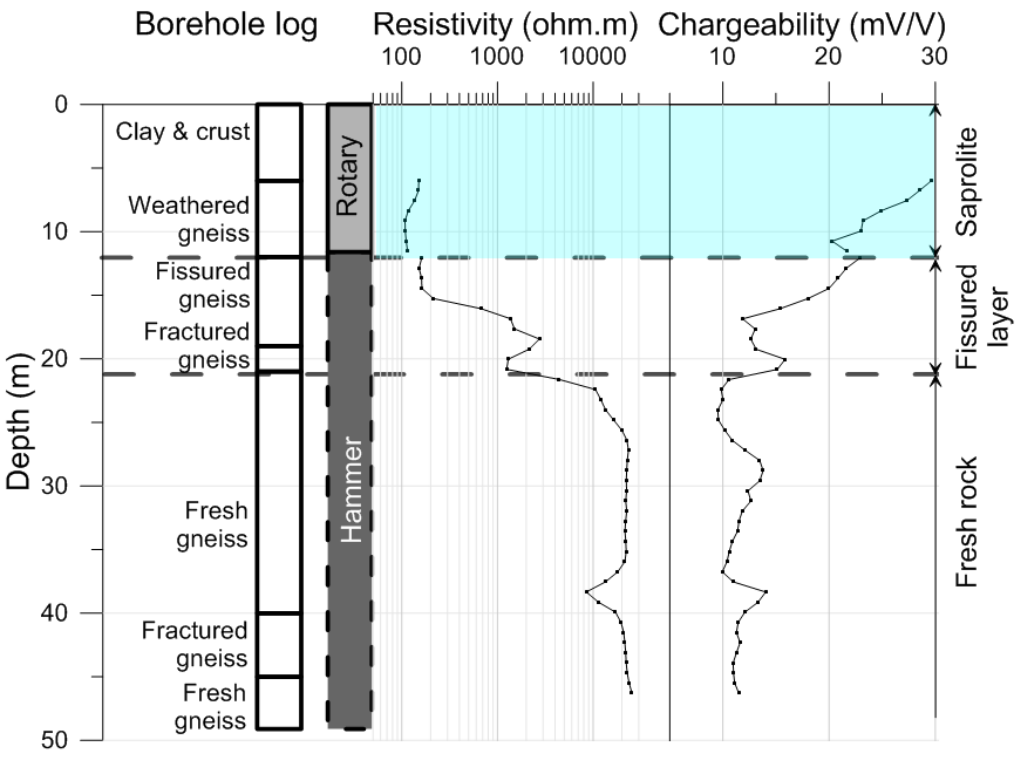
Site: F68

Results : Resistivity & chargeability **logs**



Resistivity and chargeability logs
EXAMPLE (site FD30).

Results : Resistivity & chargeability **ranges**



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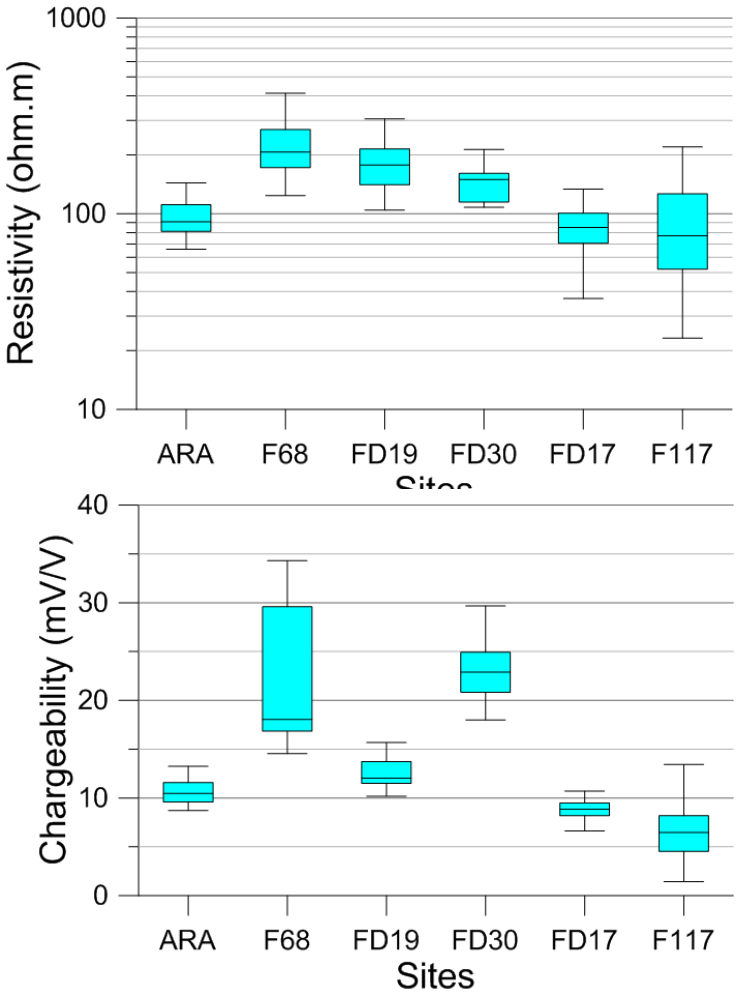
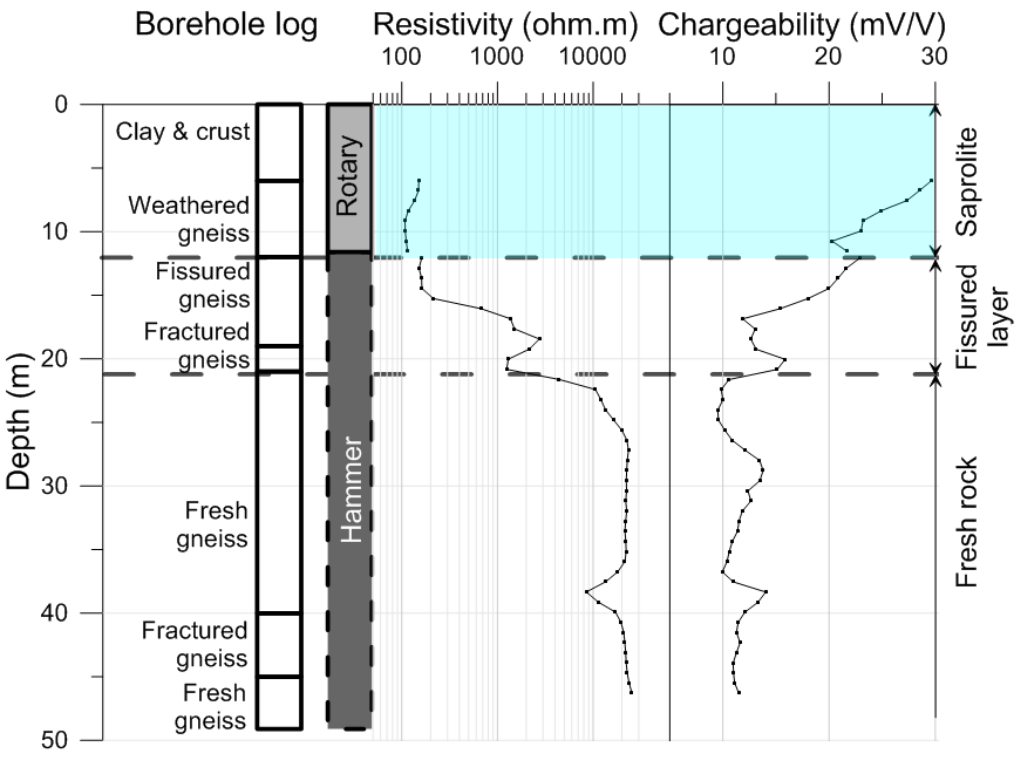


Results : Resistivity & chargeability **medians**



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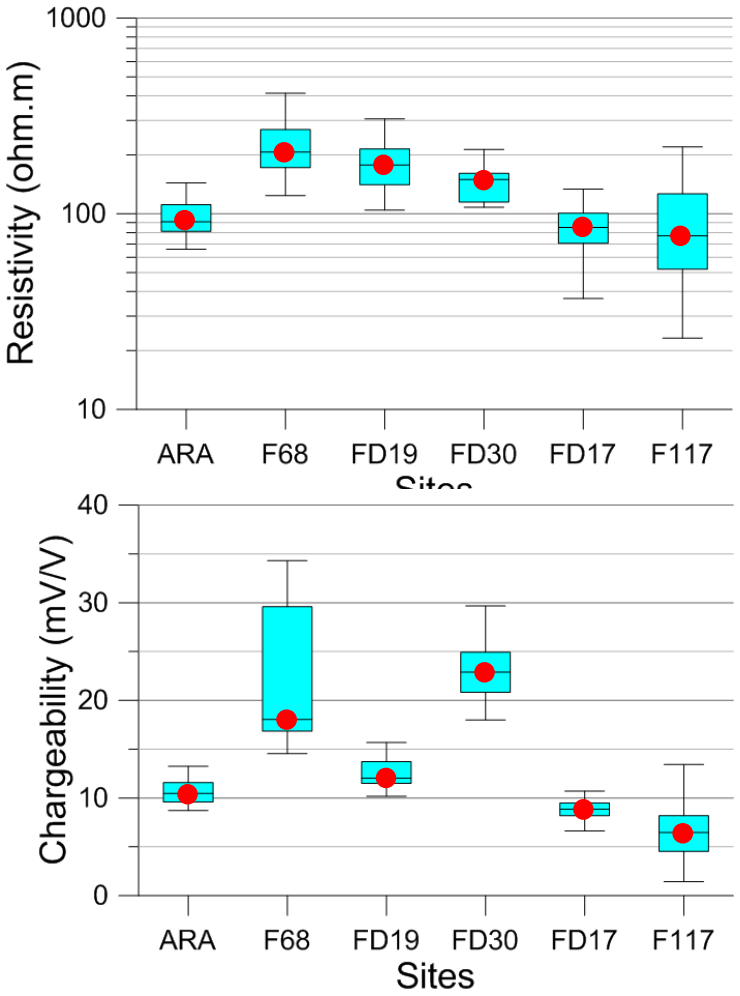
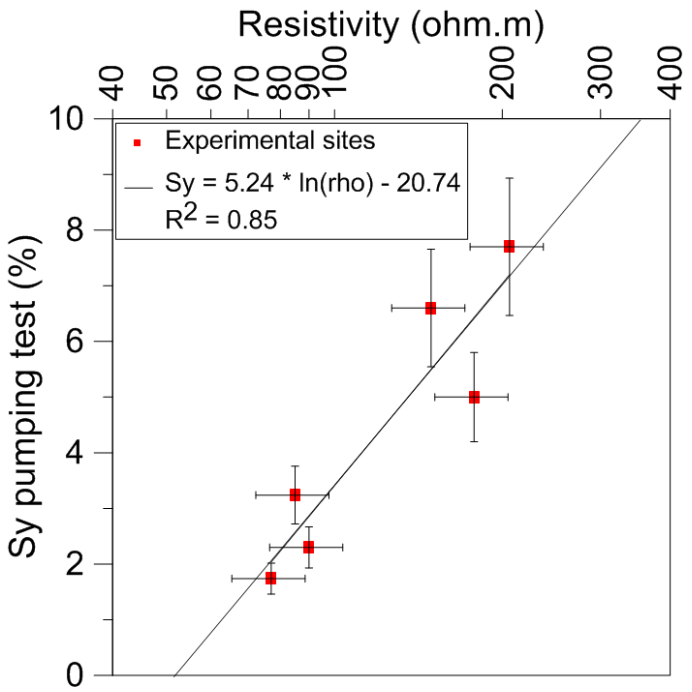
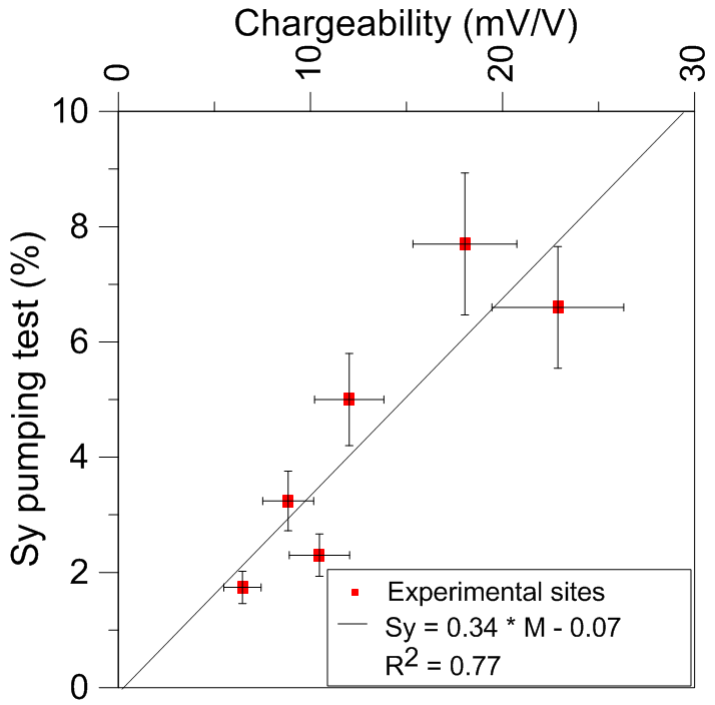


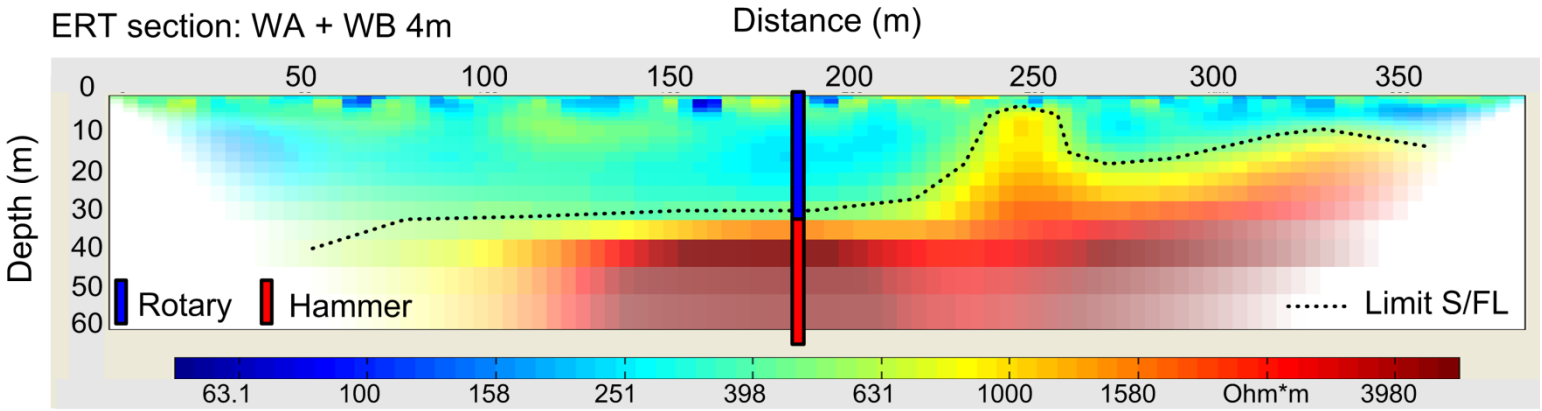
Results : Relationships (Sy/Rho, Sy/M)

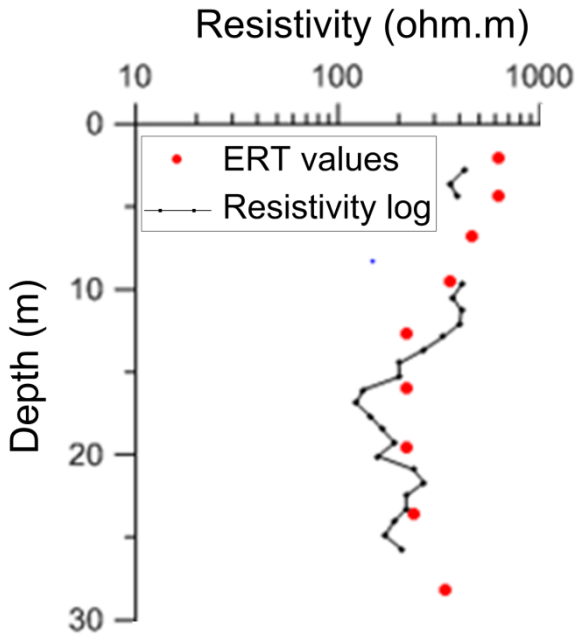




Sy increases with resistivity and chargeability.
Resistivity and chargeability give the same information
We can use resistivity only since it's easier to measure
But we need additional data to confirm this relationship

ERT to get resistivity





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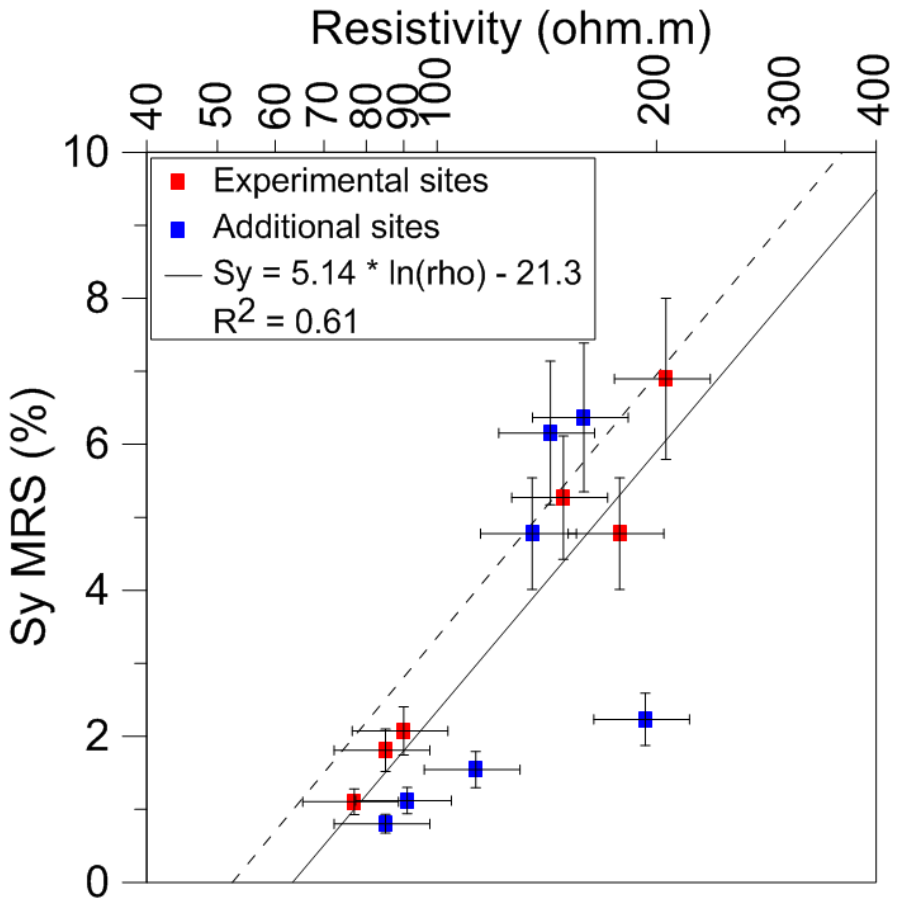
ERT & MRS on 7 other sites

Results : Relationship (Sy/Rho), **ERT & MRS**



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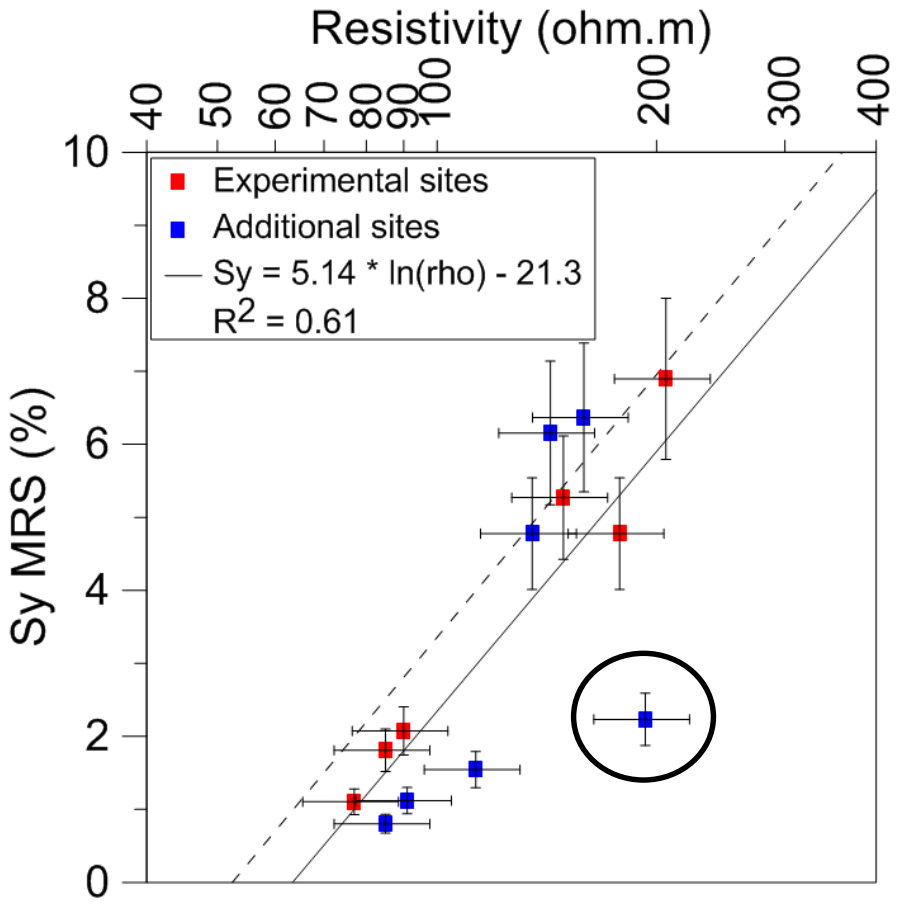

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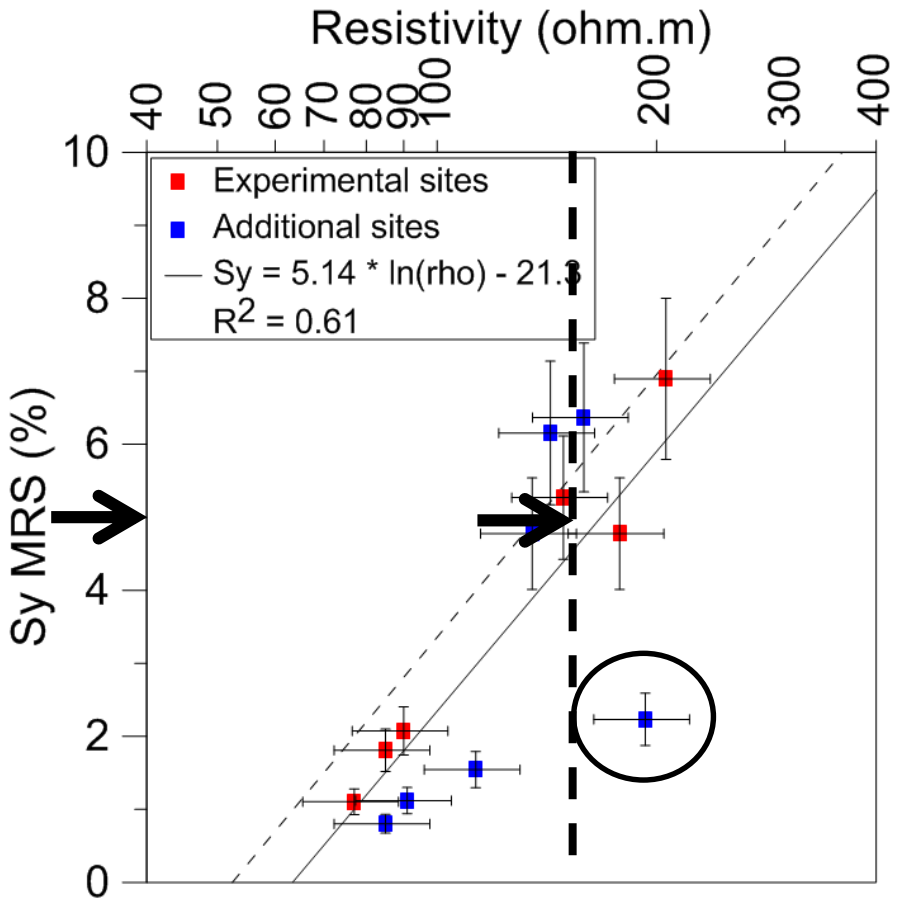

Target: 150 to 300 ohm.m

Conclusion and perspectives

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- In deeply weathered hard rock, resistivity can be useful for Sy estimation ➡ improve **borehole siting for sustainable yield**, **groundwater storage**, etc…

Conclusion and perspectives

- Resistivity and chargebility of the saprolite increase with Sy
- Chargeability don't give additional information for Sy estimation in our context
- In deeply weathered hard rock, resistivity can be useful for Sy estimation ➡ improve **borehole siting for sustainable yield**, **groundwater storage**, etc…
- We must confirm the relationship in other wheathered hard rock locations

Thank you!

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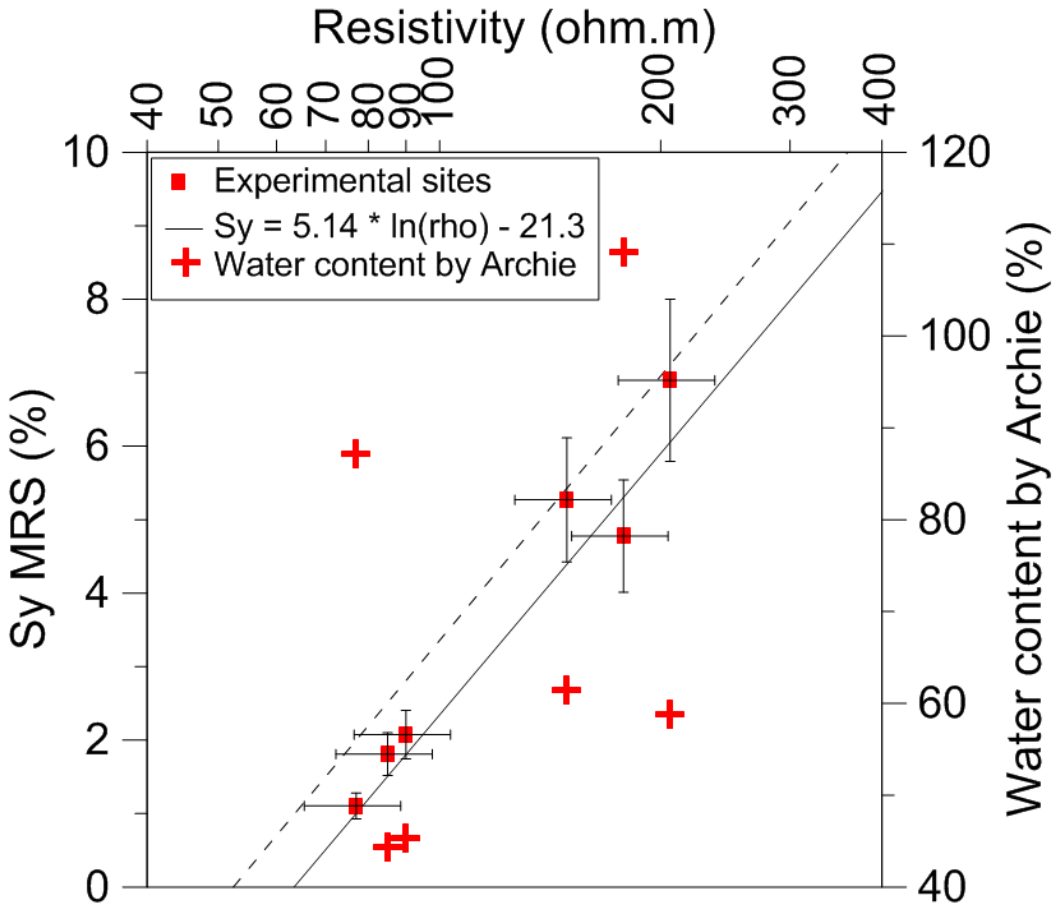
Relationship (Sy/Rho) with Archie



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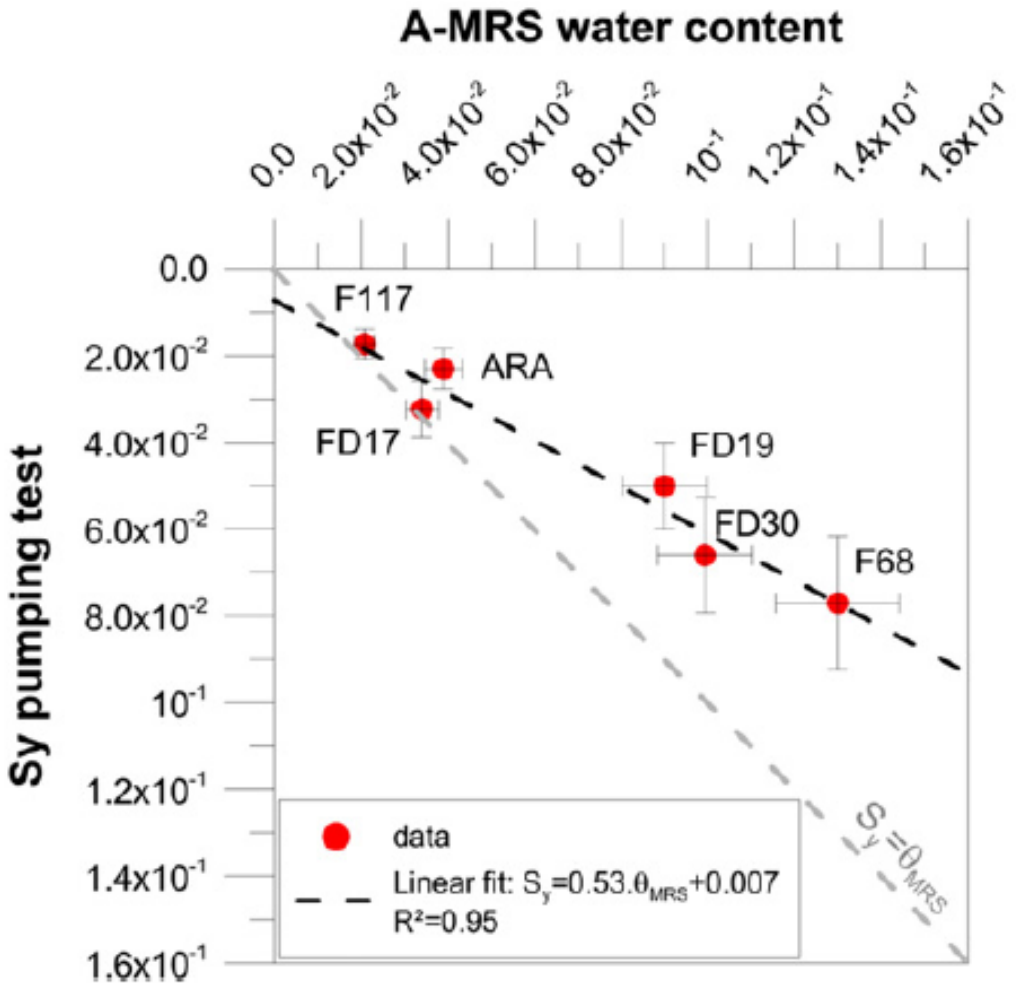
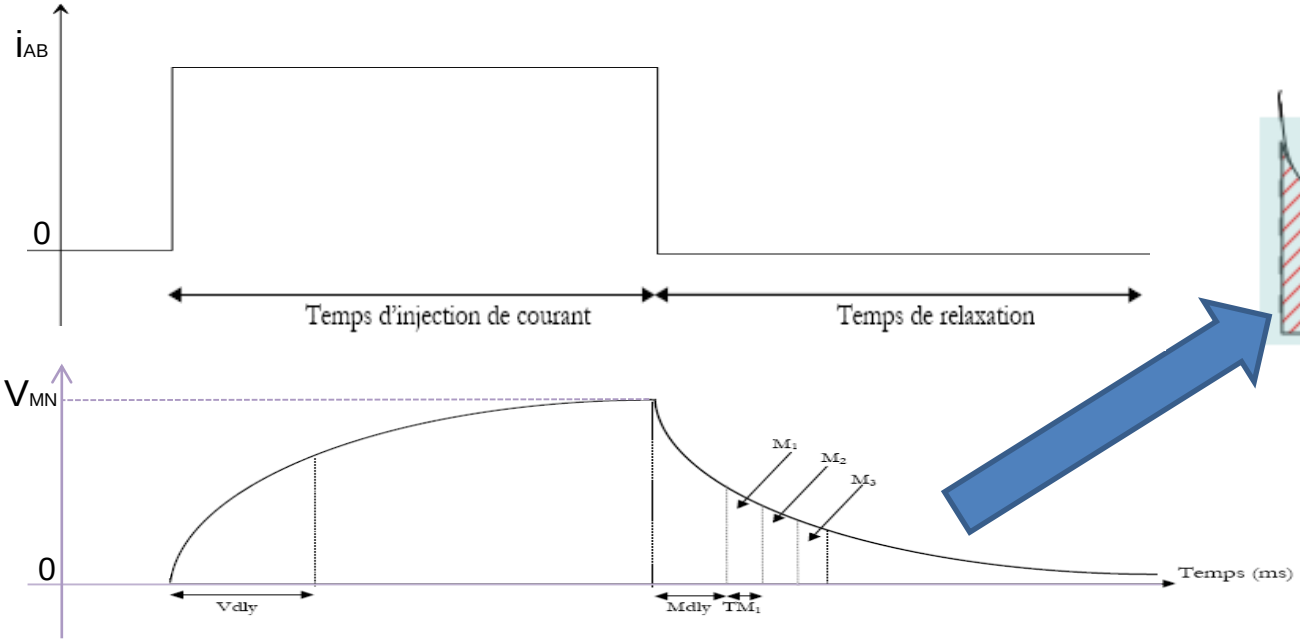
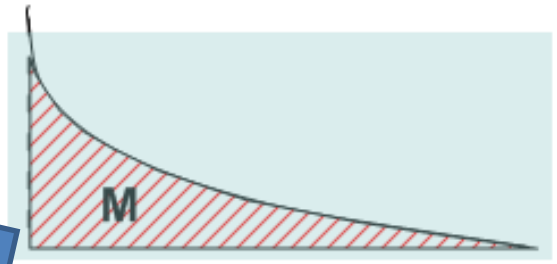


Vouillamoz et al., 2014

The mesure of chargeability

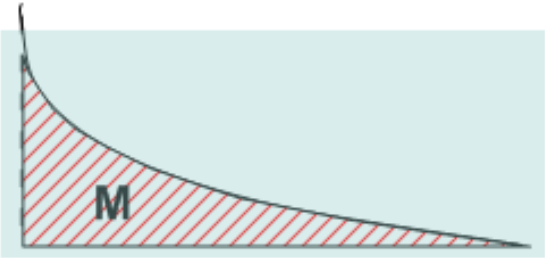
- Méthode géophysique: **polarisation provoquée**
- **Utilise le même dispositif d'électrodes que l'ERT**
- Paramètre mesuré: **Chargeabilité**

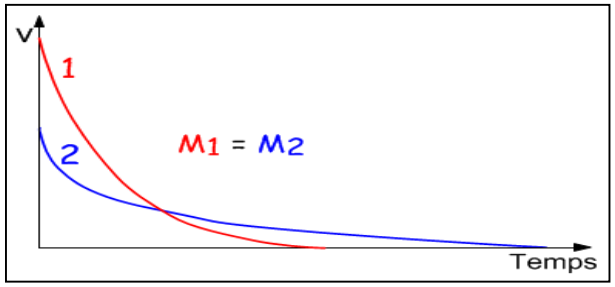




M = Chargeabilité, en mV/V

The mesure of chargeability





$$Z(\omega) = R_0\left[1 - m\left(1 - \frac{1}{1 + (i\omega\tau)^c}\right)\right]$$

Impédance en domaine fréquentiel (Pelton et al., 1978)

Paramètres cole-cole

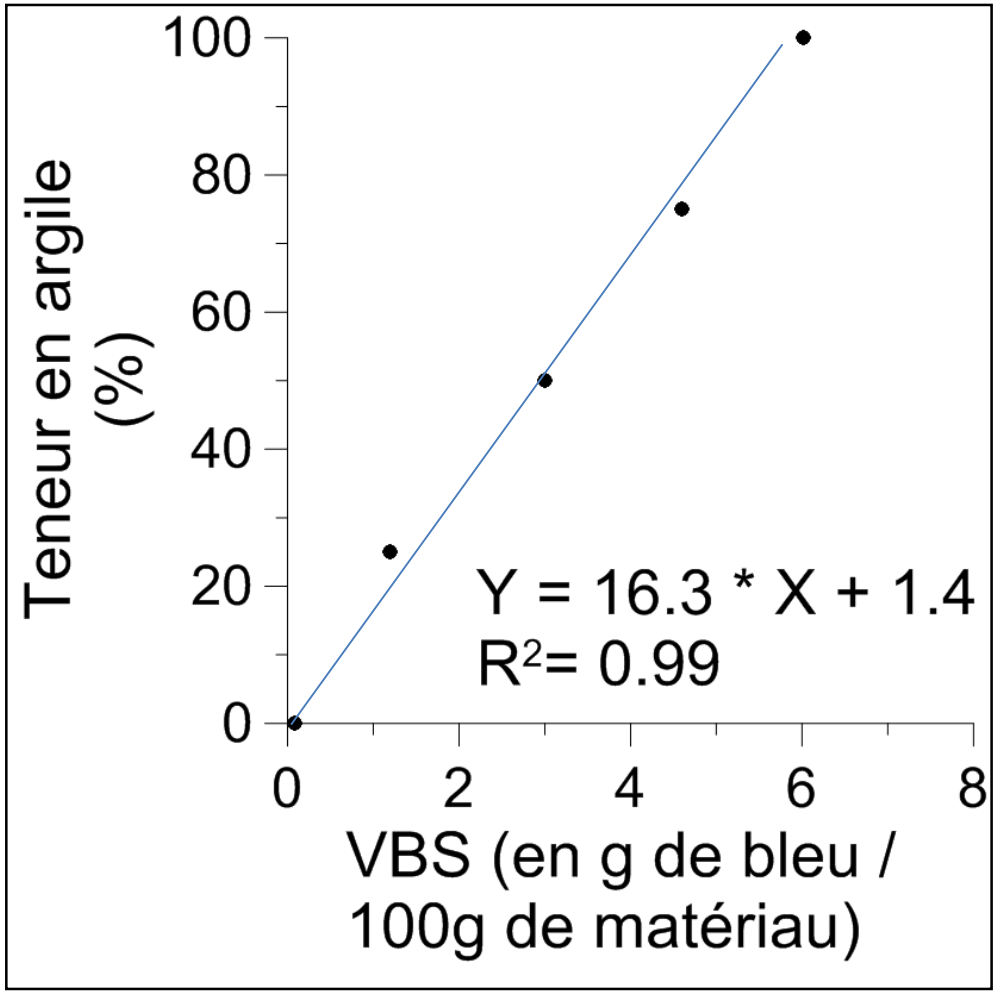
m*:* chargeabilité cole-cole **>>** quantité de grains polarisés

c*:* dépendance fréquentielle **>>** distribution de la taille des grains polarisés

tau: constante de temps **>>** taille des grains polarisés

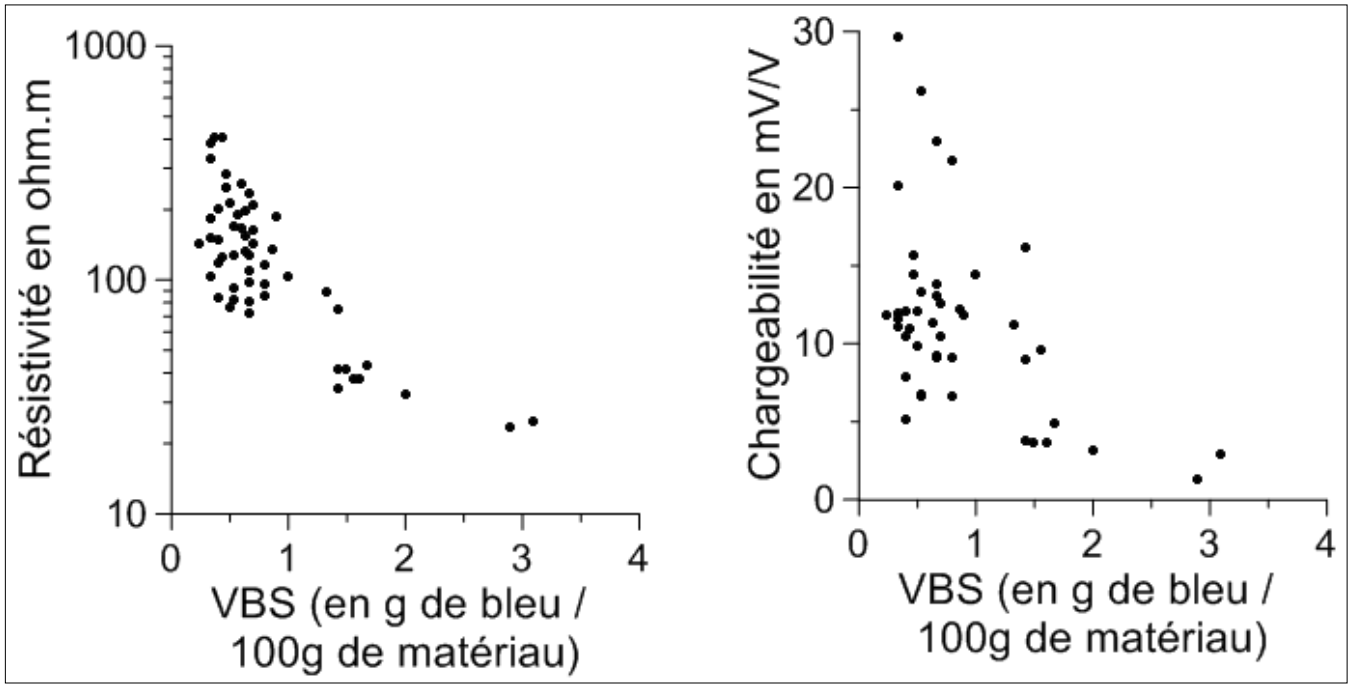
Calibrage du test de bleu de méthylène

Pour confirmer que le test marche et pour avoir une idée du **VBS** qui correspond à une **teneur en argile** donnée



VBS échantillons F68 Vs Chargeabilité et résistivité

Corrélation des résultats du test sur les échantillons de forage avec la **résistivité** et la **chargeabilité**



Larésistivité semble mieux se corréler à la teneur en argile que la chargeabilité