Interest and limits of electrical tomography for groundwater survey in metamorphic hard rock aquifer context

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Issues of groundwater survey in metamorphic hard rock aquifer

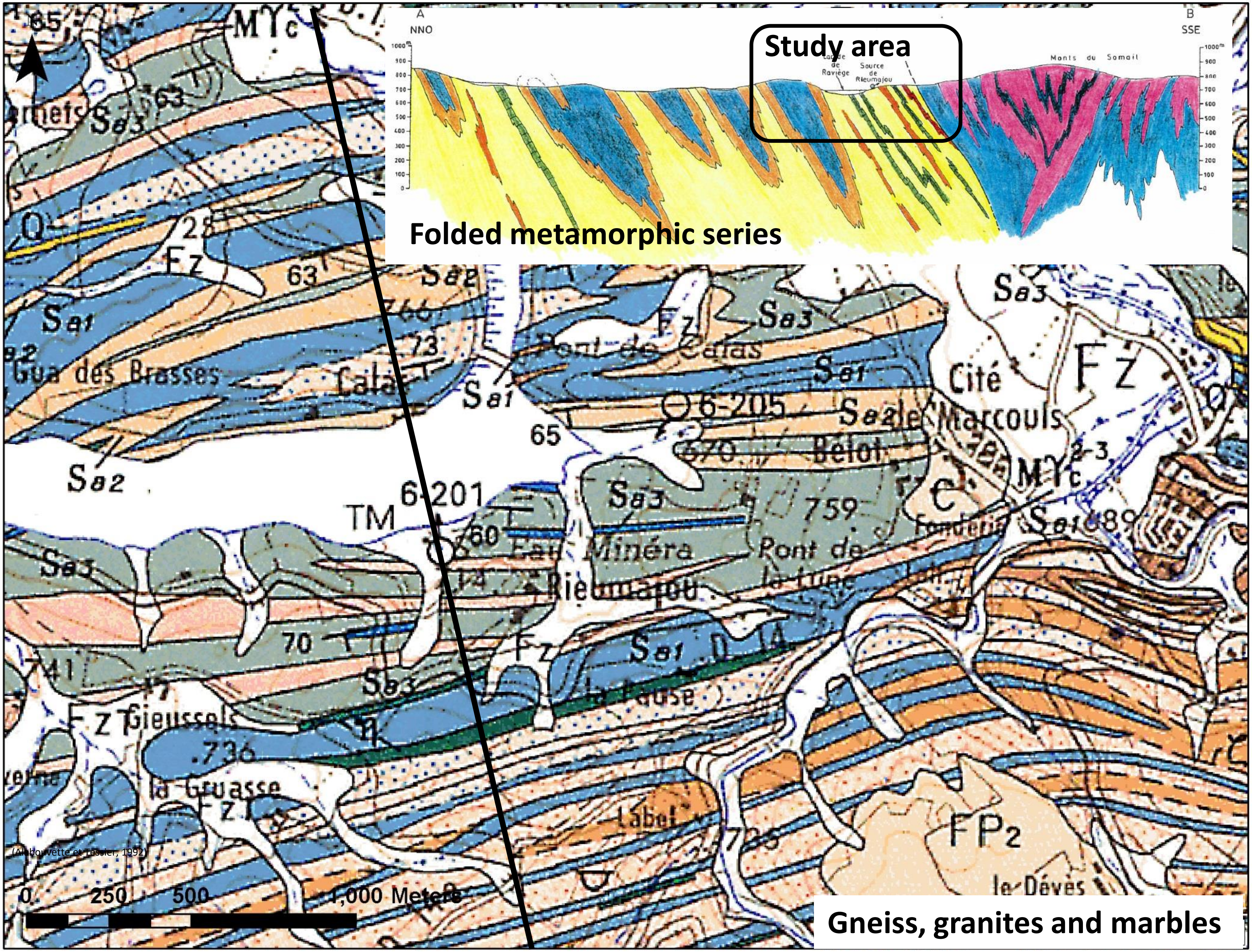
- Survey of groundwater resources in metamorphic hard rock context
  - > Geophysical surveys difficulties (structure and lithology influences)
  - >Complex borewell siting for groundwater abstraction
  - > Higher failure rate than in other hard rock contexts

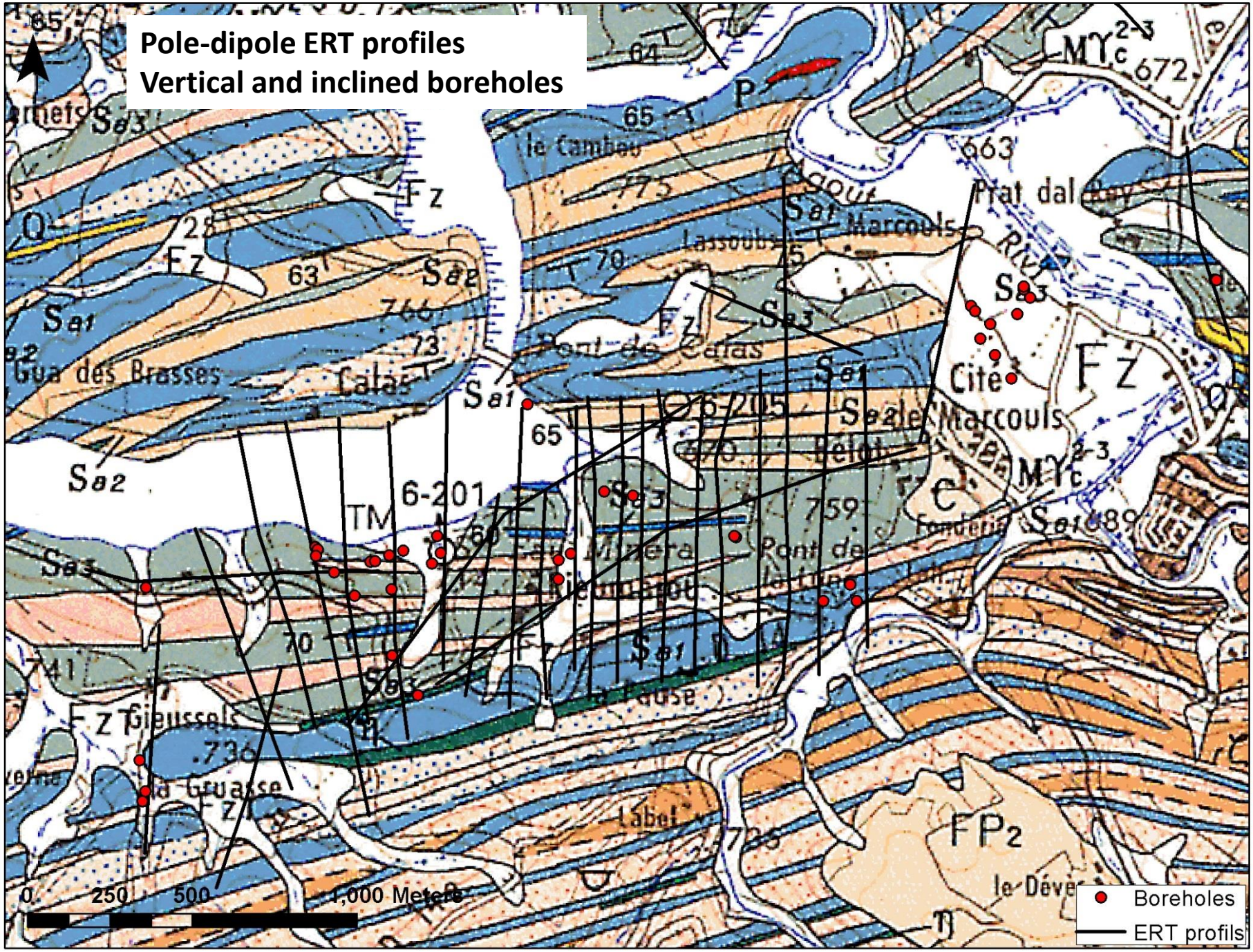
Discussing the interest and limits of ERT for hydrogeological survey in this context?

Context

- Presentation of a metamorphic rocks case study:
  - >La Salvetat (Montagne Noire, France)
  - >Groundwater survey in metamorphic hard rock context
  - >An exceptional data set for such a context:
    - 39 km of ERT profiles
    - 70 drillings

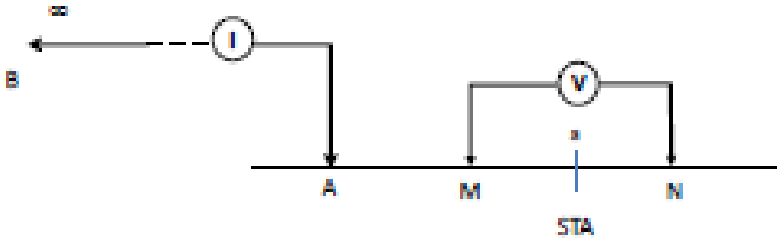

Source: http://www.geologues-prospecteurs.fr
UNITED KINGDOM
North Sea
BELGIUM
GERMANY
English Channel
Picardy Plateau
Pays de Caux
Pays de Bray
ARDENNES
LUXEMBOURG
PARIS
Campagne de Caen
Vexin
Valois
Normandy bocage
Brie
Champagne
Lorrainian Plateau
Alsace
VOSGES
MASSIF ARMORICAIN
Beauce
BASIN
Sologne
Langres Plateau
Lomont
MORVAN
SWITZERLAND
Mauges
Bocage vendéen
ATLANTIC
OCEAN
Seuil du Poitou
Limagne
Bresse
JURA
Dombes
MASSIF CENTRAL
Limousin
Forez
Auvergne Mountains
Vanoises
ITALY
Velay
Pelvoux
AQUITAINE BASIN
La Salvetat
Causses
Cévennes
Pre-ALPS
ALPS
Crau
Camargue
Esterel
Lannemezan Plateau
Seuil du Lauragais
Maures
PYRENEES
Montpellier
ANDORRA
SPAIN
Mediterranean Sea
Corsica
Sedimentary Formations
Millions of Years
Quaternary
Dunes
2
Tertiary Period
Miocene and Pliocene
Oligocene
Eocene
65
Mesozoic Era
Upper Cretaceous
Lower Cretaceous
Upper Jurassic
Middle Jurassic
Lower Jurassic (Liassic)
Middle and Upper Triassic
Lower Triassic
245
Paleozoic Era
Permian
Carboniferous
Devonian
Silurian, Ordovician and Cambrian
540
Precambrian
Metamorphic and Plutonic Formations
Granite and related rocks
Recent metamorphism (Mesozoic)
Ancient metamorphism (Paleozoic and Precambrian)
Volcanic Formations
Recent volcanic rocks (Pliocene to Quaternary)
Fault
Thrust fault
Limit of Quaternary glaciation
0 31 62
miles


Study area
Folded metamorphic series
Gneiss, granites and marbles
A
NNO
B
SSE
Monts du Somail
0 250 500 1,000 Meters


Pole-dipole ERT profiles
Vertical and inclined boreholes
6-201
TM
Boreholes
ERT profils
0
250
500
1,000 Meters

Method

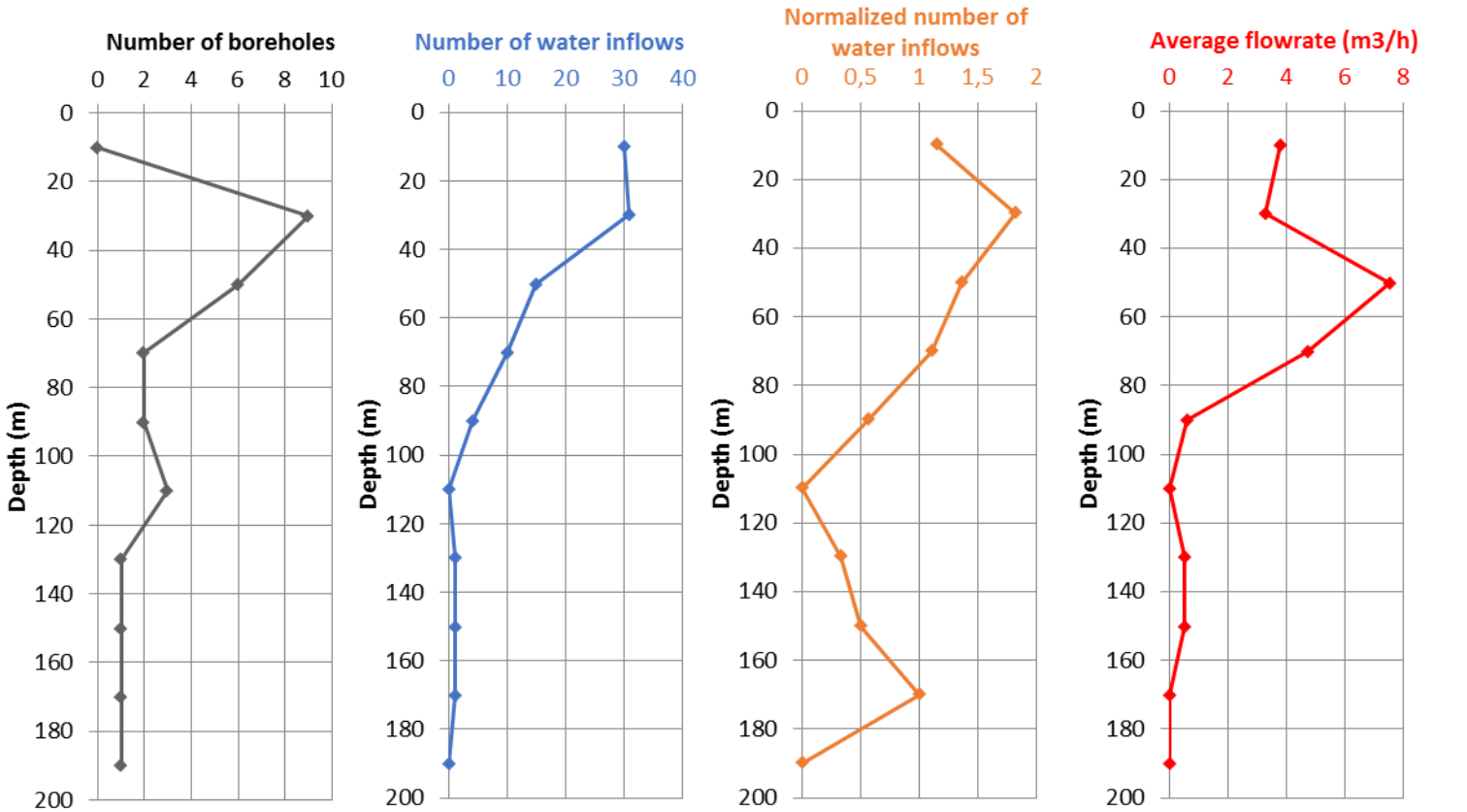
- Pole-dipole arrays



- 3 inversions methods:
  - > Robust, horizontal and vertical

- Calibration with boreholes geology and hydrogeology

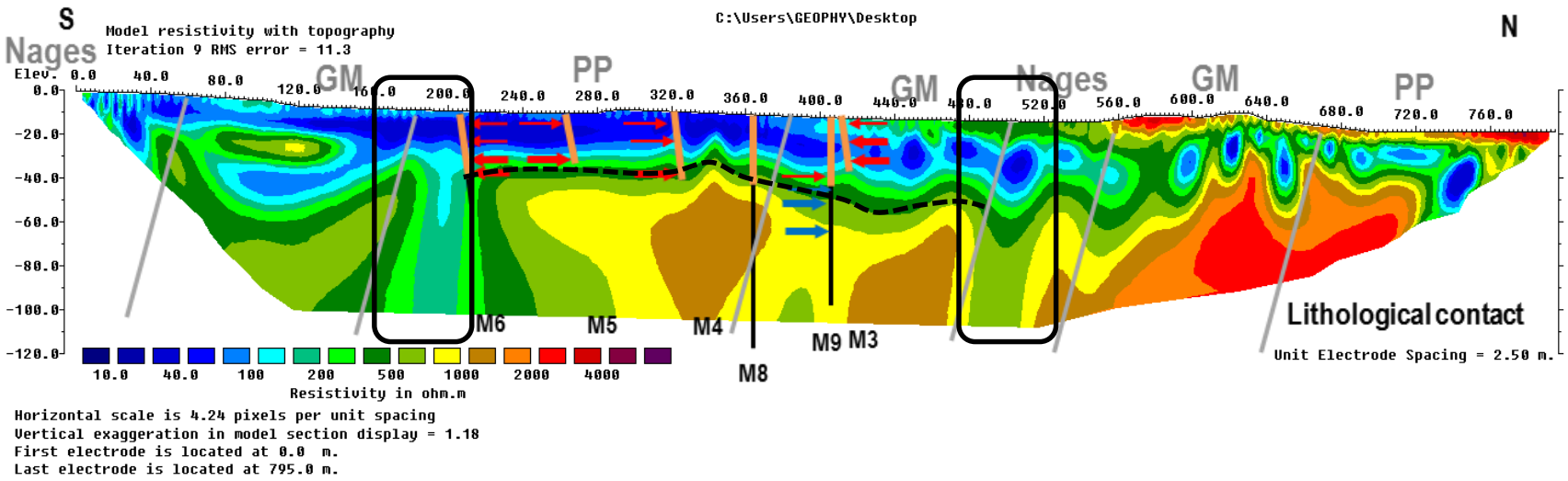
RESULTS: Evidence of productive fissured layer



Blow flowrates of 26 boreholes (Air rock hammer drill)

RESULTS: Fissured layer survey with ERT

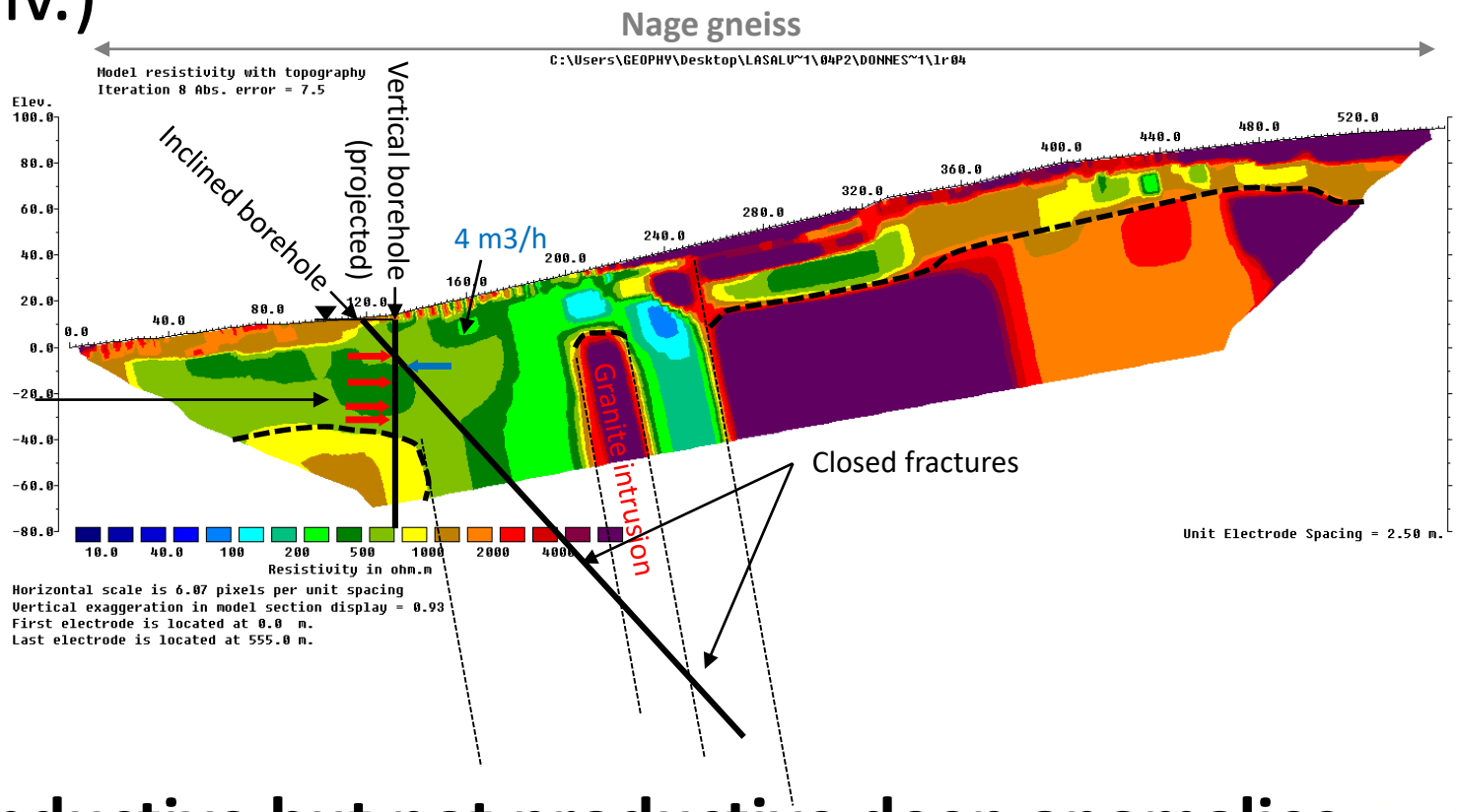
- Example of H profile (PD, ROB inves.)



- **>Base of productive stratiform fissured layer detected (< 500 ohm.m)**
- **>No clear correlation with different gneiss lithologies**
- **>Lithological contact anomalies**

RESULTS: Deep conductive anomalies detection (LMW)

- 2 boreholes on the Farguette profile (PD, ROB inv.)



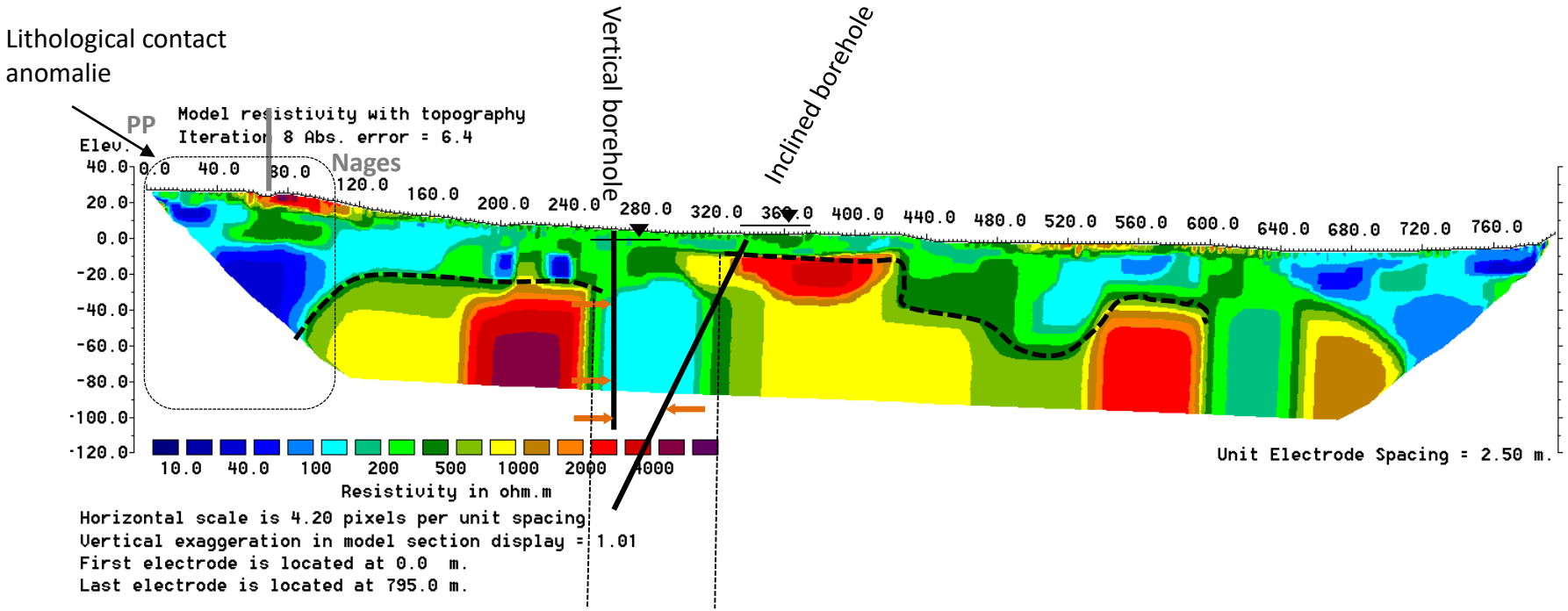
Productive fissured layer

≈ 4 m^3/h

➢ **Conductive but not productive deep anomalies**

RESULTS: Deep conductive anomalies detection (HMW)

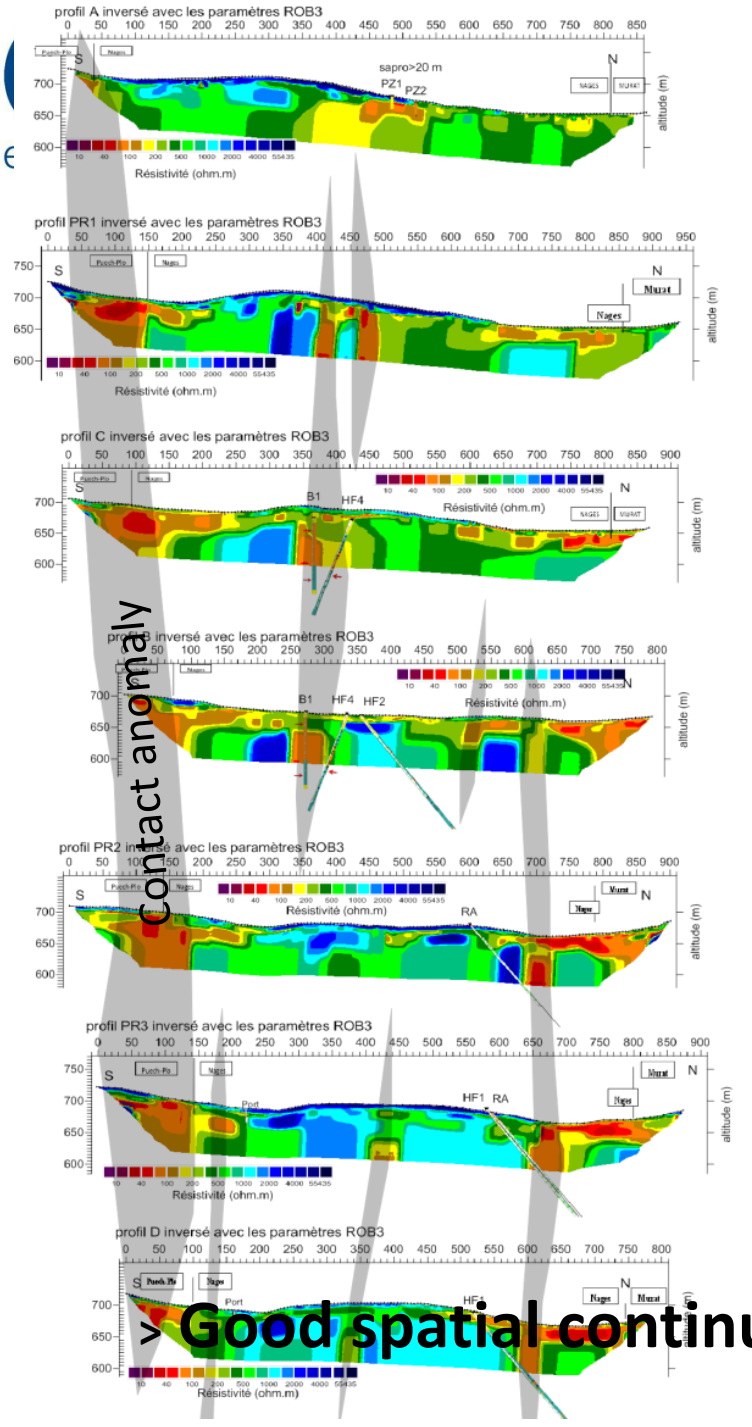
- Central exploitation zone: 2 productive boreholes of mineral water

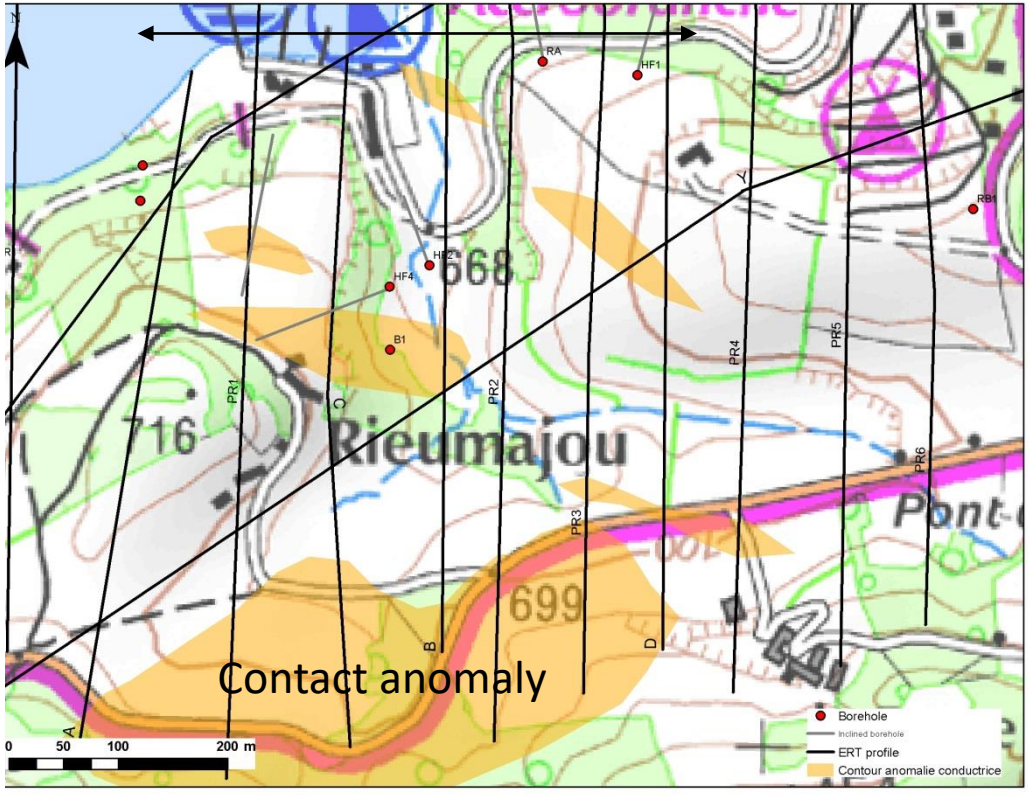


> **Mineralised water in « deep » fissure network: greater resistivity contrasts**

. INTERPRETATION:

ping conductive anomalies on zone:





> Good spatial continuity of deep anomaly

Conclusions

- ERT survey in metamorphic hard rock aquifer of La Salvetat:
  - Precise survey of productive weathering profile (saprolite + fissured layers) with ERT
  - Ability to detect local deepenings of the fissured layer, but without productivity criteria (not new). Moreover, statistically these structures are less productive than the stratiform fissured layer
  - No detection of lithological variations
  - Localy, mineralised water increase the resistivity contrast in deep fractures, and permit a spatial interpretation of ERT datas

Conclusions

- From a methology point of view:
  - >To use severales inversion methods to ensure the survey of verticale or horizontale structures
  - >To favorise coupled interpretation with geophysic teams

- Perspectives: to apply complementary geophysical method in this specific context for future prospections?

Thank you for your attention