

Granitic hard rock aquifers deep geometry from a 3D geological model based on an exceptionally high density geophysical survey

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Issues of groundwater survey in hard rock aquifers

- Survey of groundwater resources in hard rock context
 - > Geological and hydrogeological mapping
 - > Lineaments location
 - > Geophysical methods (ERT, EM, Seismic)
- Results suitability function of geophysical method, geology and resistivity contrasts, fault density, 3D effects...

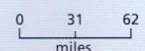
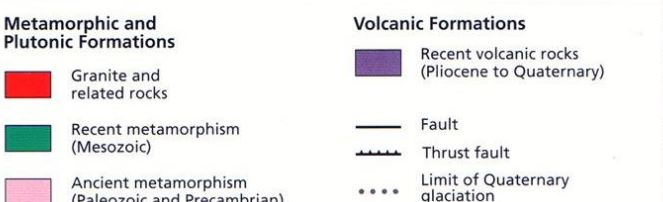
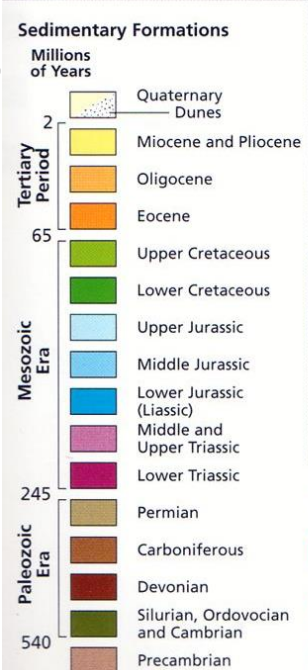


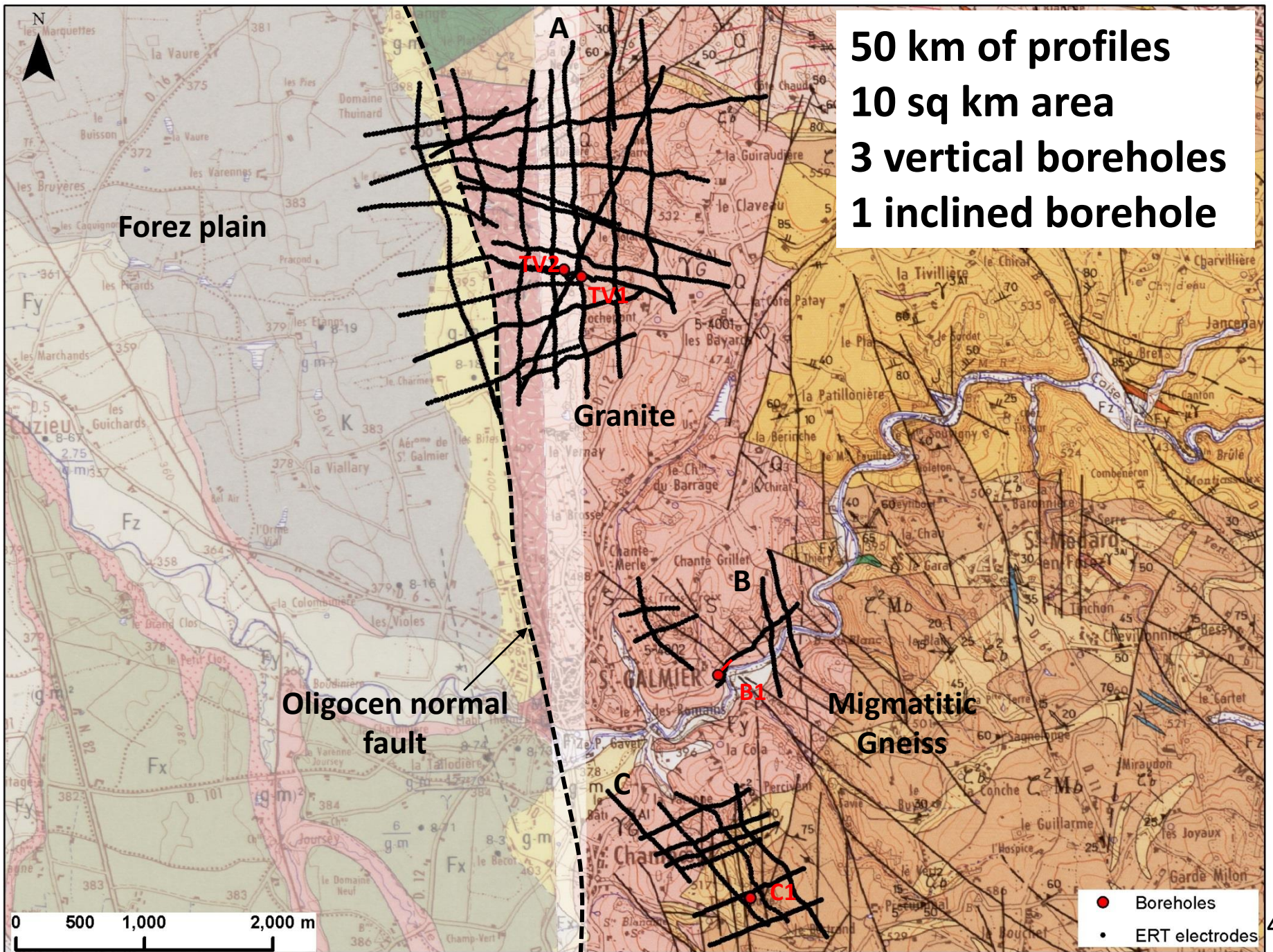
ERT abilities for weathering profile survey, and fissured layer location?

- > case study presentation

• Bad
Frai

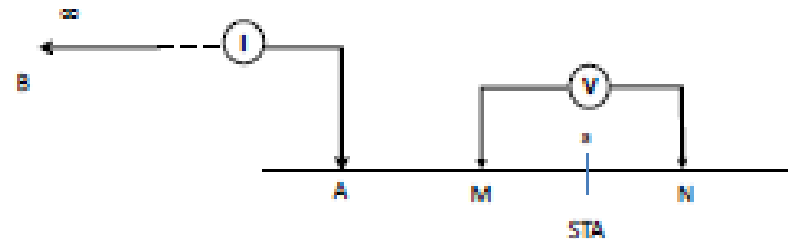
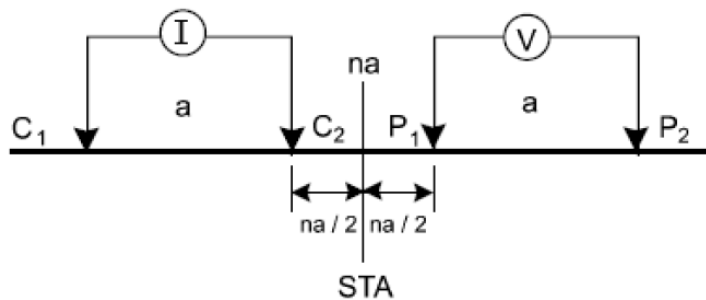
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Method

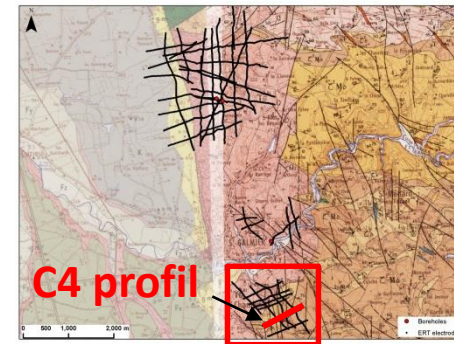
- Dipole-dipole and pole-dipole arrays (Forward and Reverse)
- 3 inversions methods:
 - > Robust data constrain, smoothness constrain and horizontal or vertical filter ratio



Survey of the stratiform weathering profile

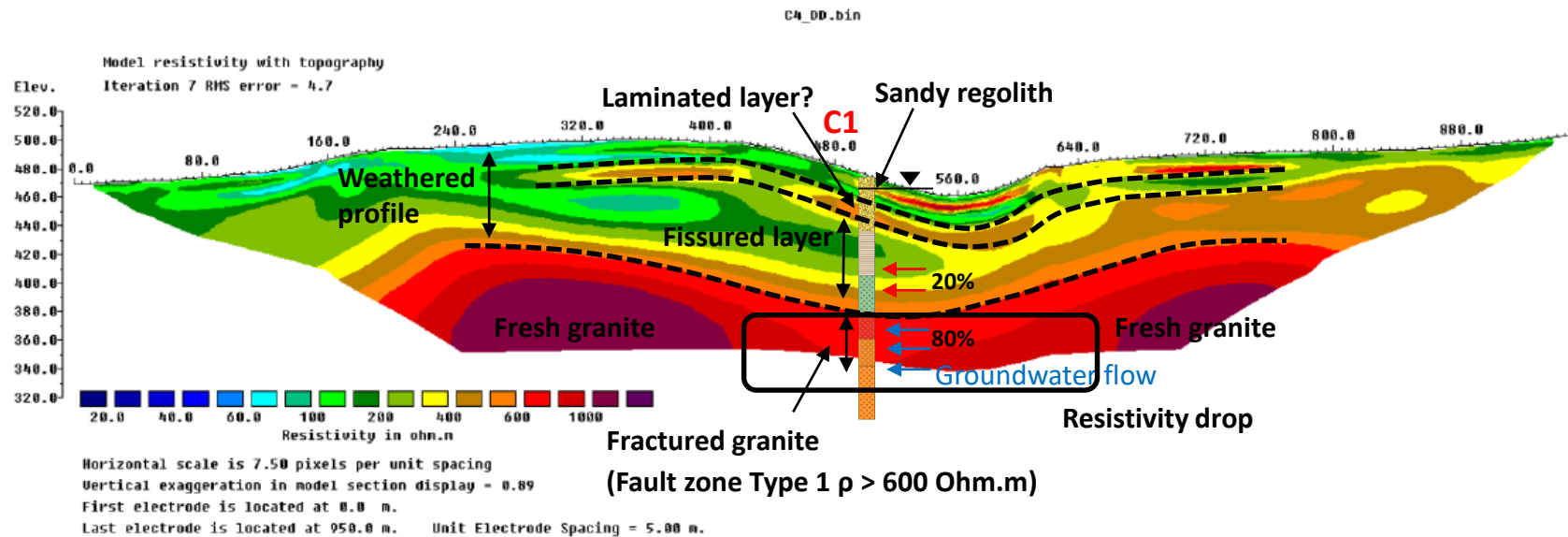
- Profiles calibration: C1 borehole

Profil C4
Dipôle-dipôle
Inversion: STDH



SW

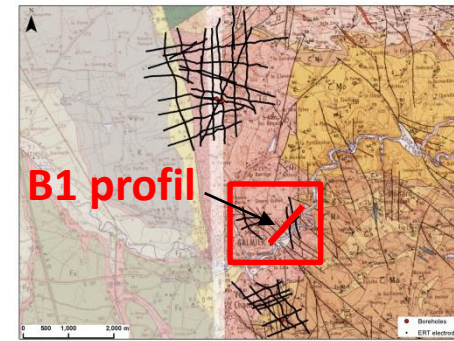
NE



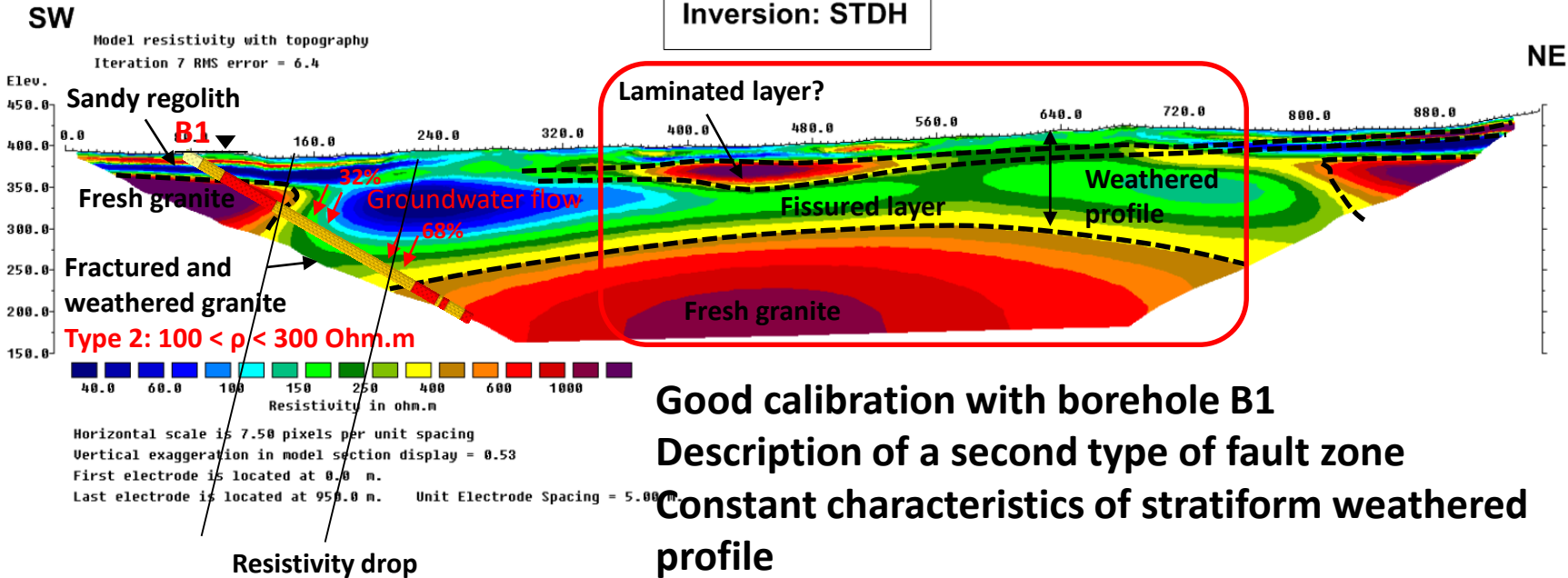
Resistivity calibration of stratiform weathered profile and low weathered fault zone

Survey of the stratiform weathering profile

- Profiles calibration: B1 borehole



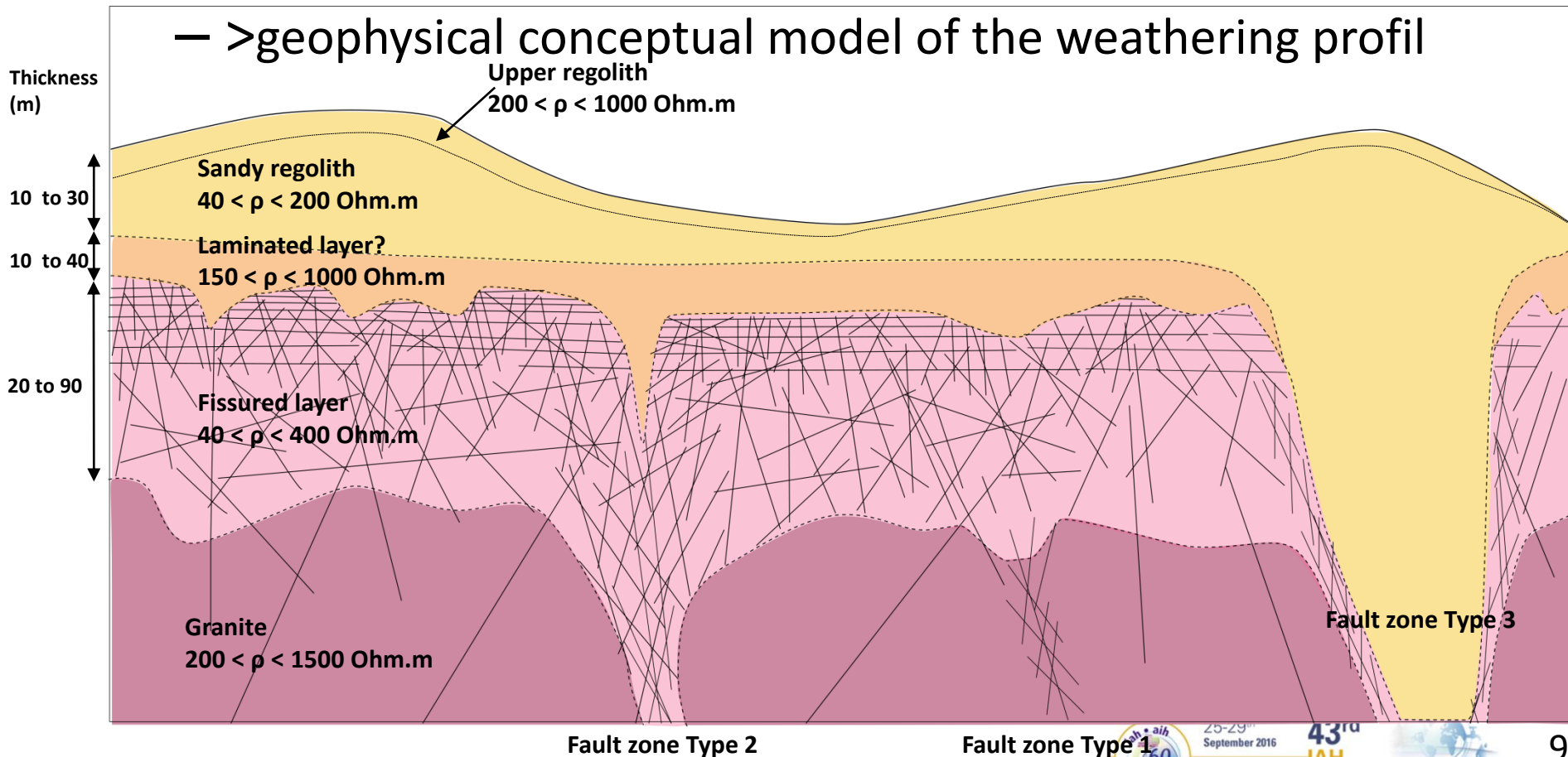
Profil B1
Pôle-dipôle
Inversion: STDH



Good calibration with borehole B1
Description of a second type of fault zone
Constant characteristics of stratiform weathered profile

Interpretations

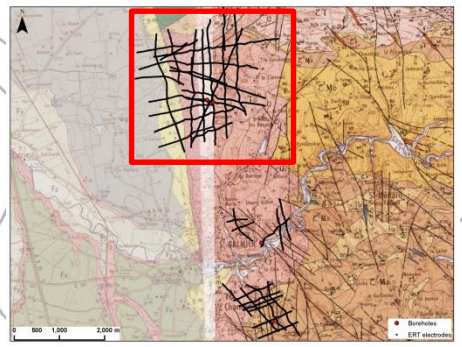
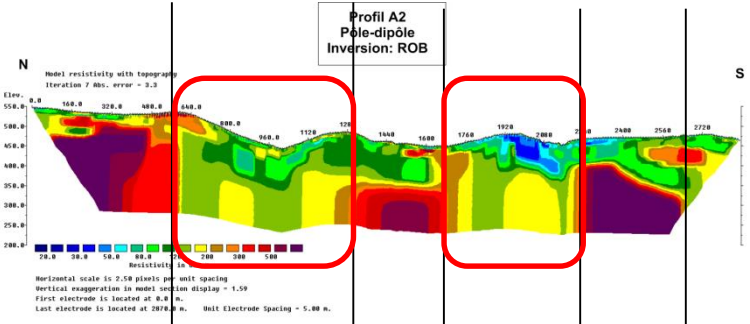
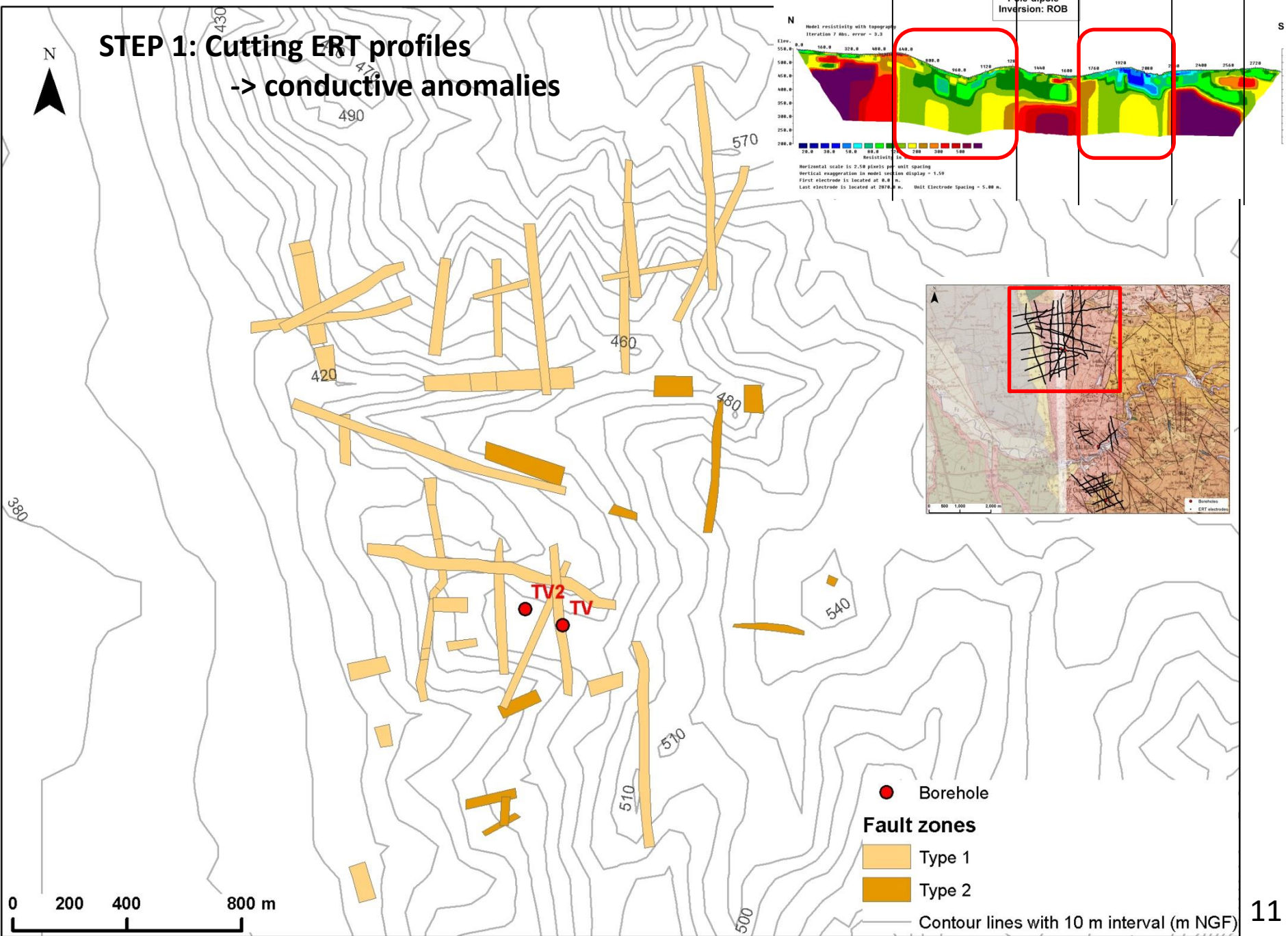
- Geophysical signatures of weathering profile



Interpretations

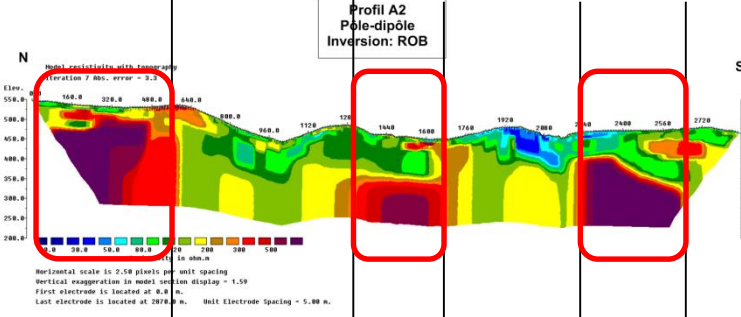
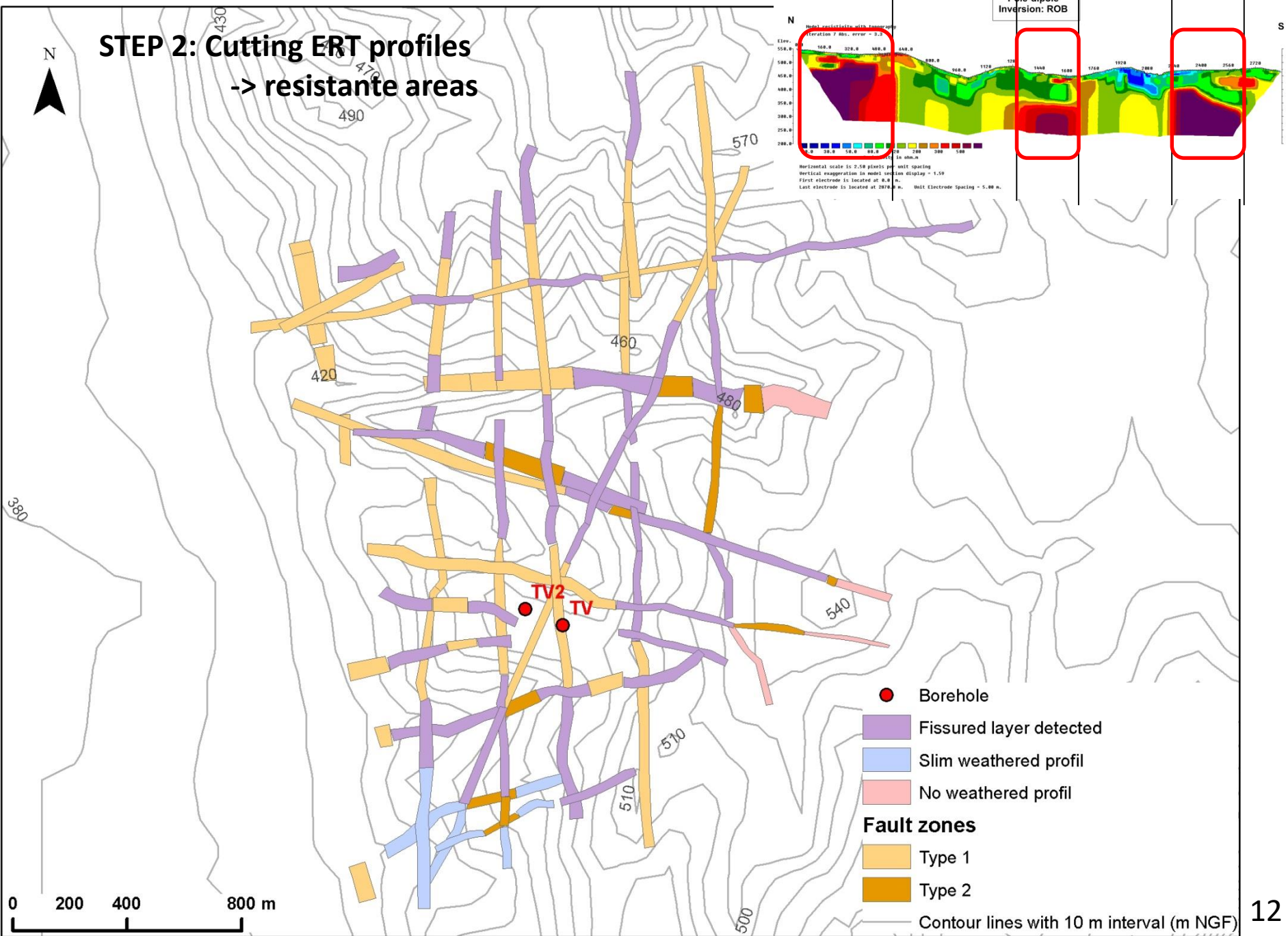
- Zone A: mapping the weathering profile structures
 - (i) geometry of conserved fissured layer
 - (ii) deep weathered fault zones location
- Based on pole-dipole profiles inverted by several methods (ROB, STDH and STDV)

STEP 1: Cutting ERT profiles -> conductive anomalies



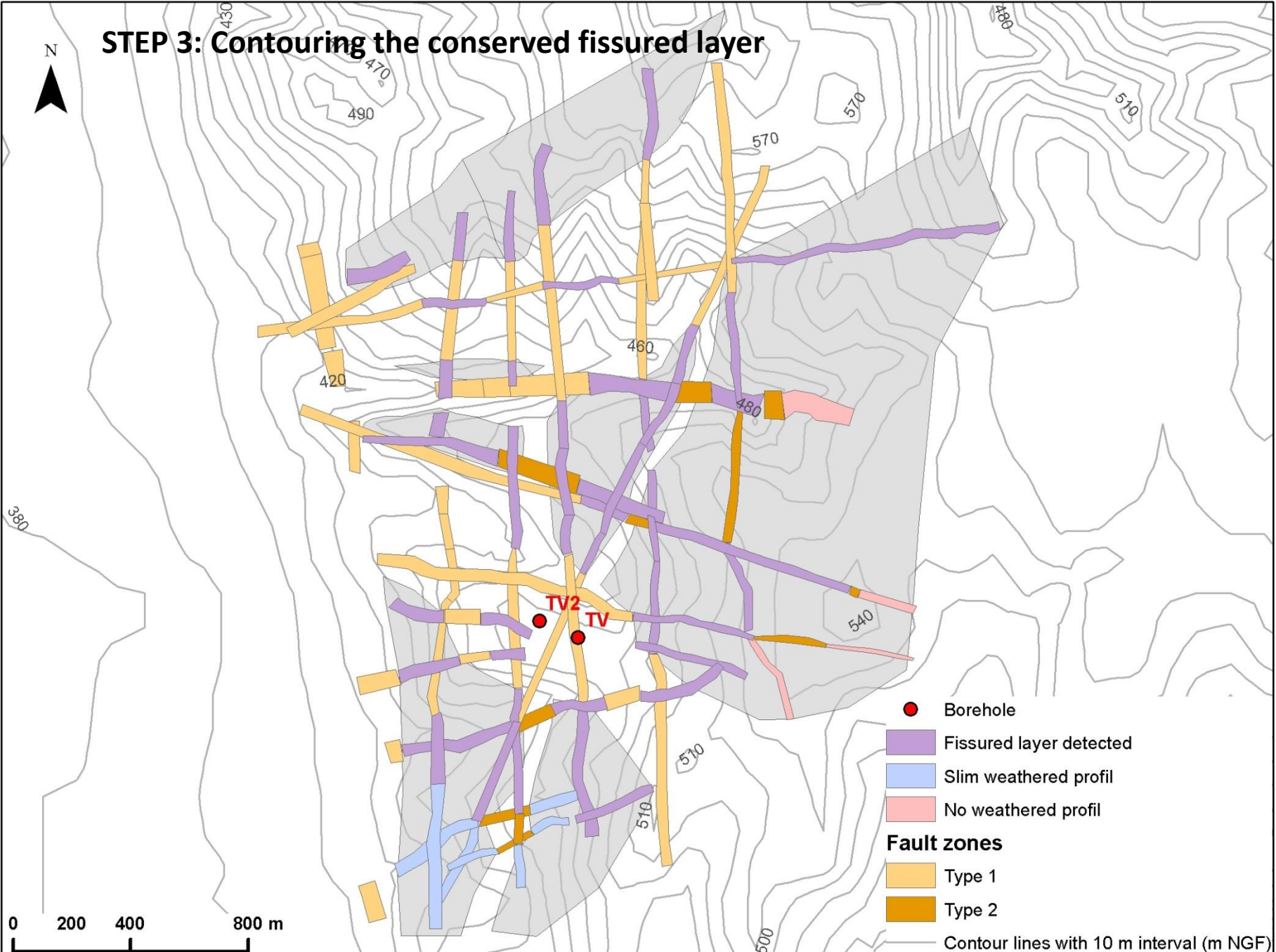
- Borehole
- Fault zones**
- Type 1
- Type 2
- Contour lines with 10 m interval (m NGF)

STEP 2: Cutting ERT profiles -> resistente areas

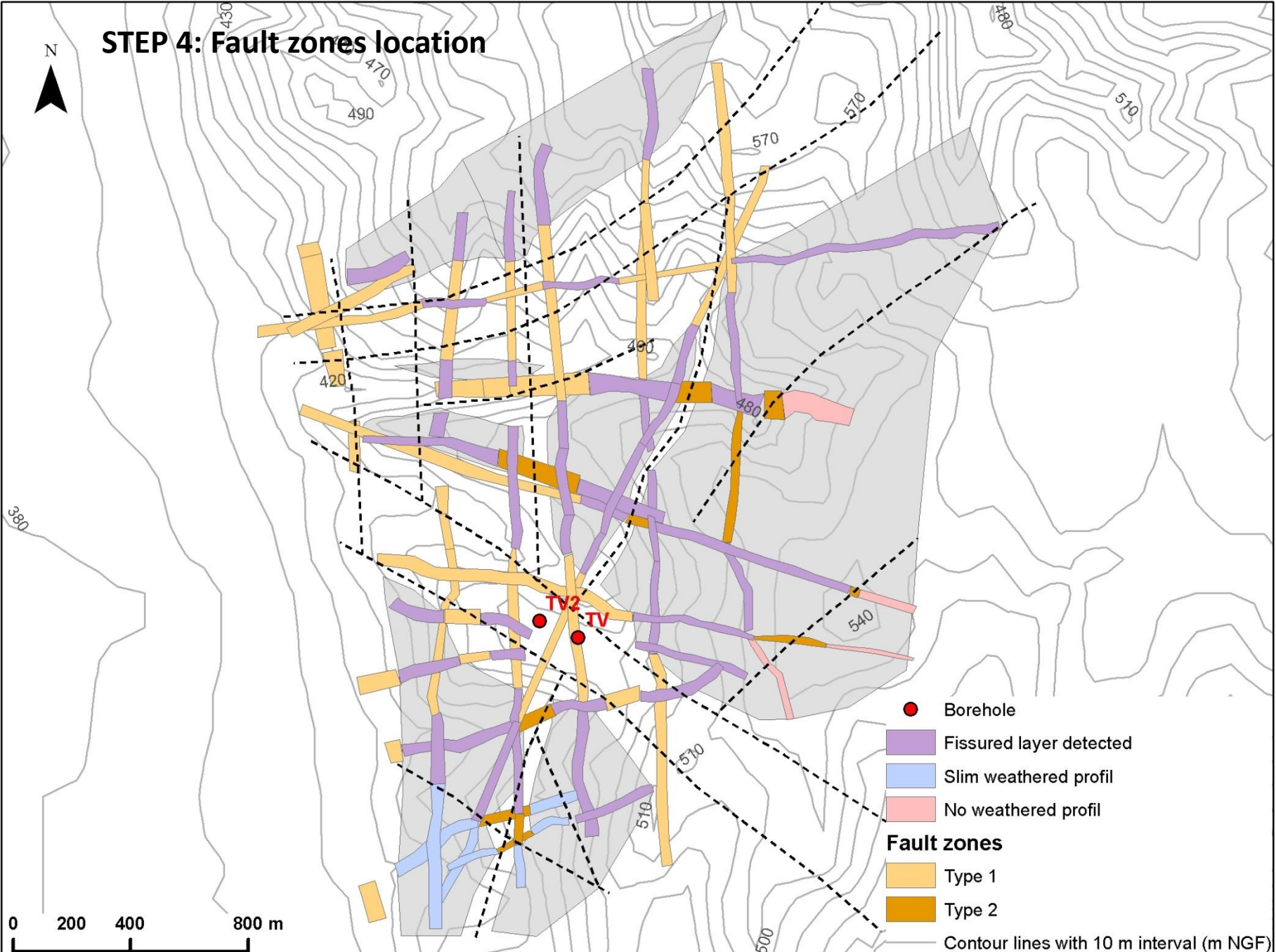


- Borehole
 - Fissured layer detected
 - Slim weathered profil
 - No weathered profil
- Fault zones**
- Type 1
 - Type 2
 - Contour lines with 10 m interval (m NGF)

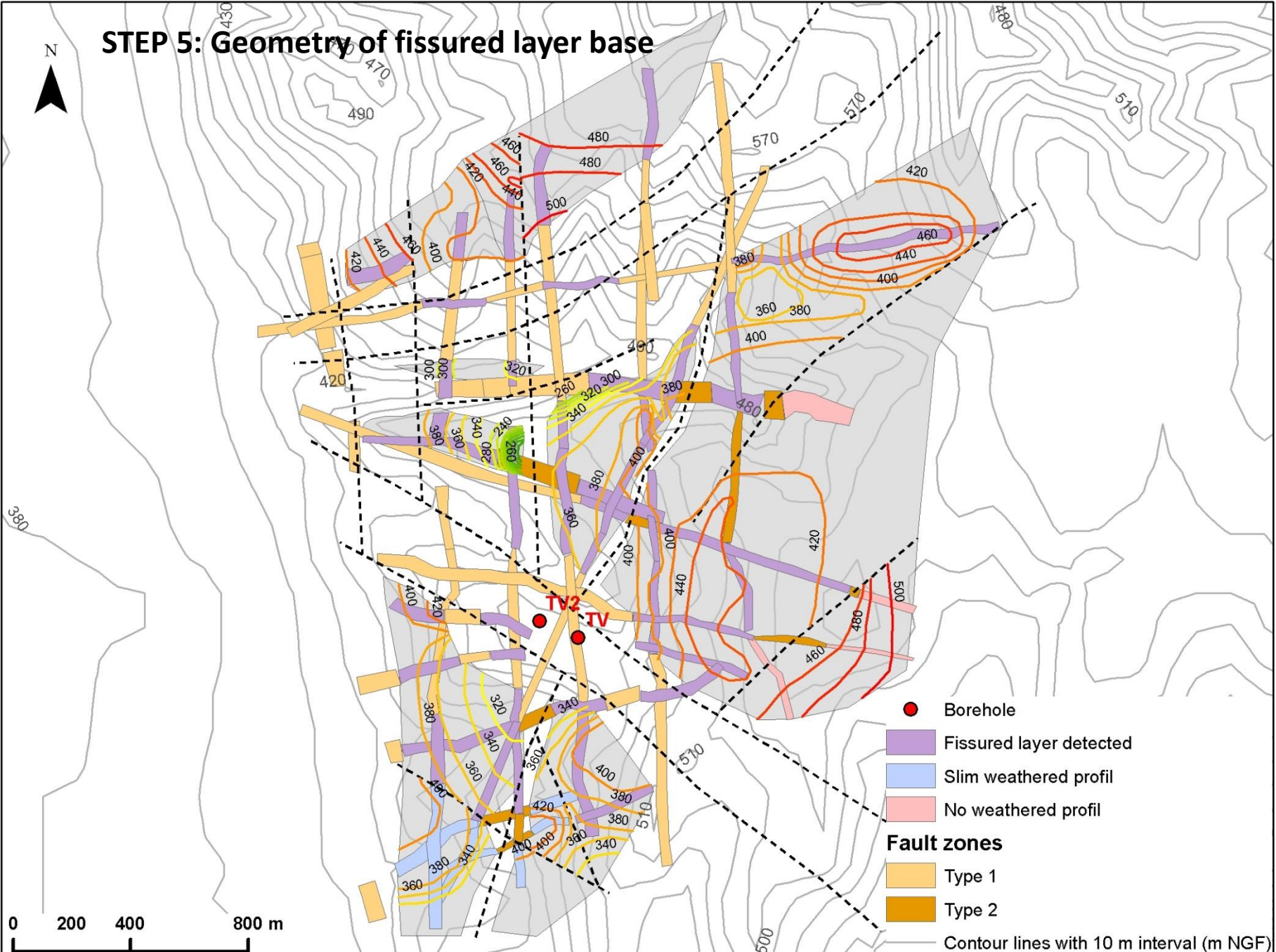
STEP 3: Contouring the conserved fissured layer



STEP 4: Fault zones location



STEP 5: Geometry of fissured layer base



Conclusions

- This study provides:
- Locally:
 - Large weathered fault zones location (very low permeabilities)
 - Geological structure for next boreholes implantation

Conclusions

- This study provides:
- Generally:
 - Abilities of ERT for weathering profile survey (not new)
 - Vertical evolution of resistivity inside this profile -> linked with weathering horizons
 - No correlation between altered fault zones and topography: it challenges the « lineament » approach

Thank you for your attention

Annexe

- Acquisition parameters
 - Injection slot: 0,5 s
 - Number of cycle mesures: 3 à 6 (3 when $Q < 0,5\%$, 6 when $Q > 0,5\%$)
 - Standard deviation : $Q < 0,5\%$
 - Injection: 400 V

 - Resistance outlet: generally lower than 3kOhm

Annexe

- Filtering (PROSYS)
 - Dipole-dipole
 - $V > 0,3$ mV
 - $Q < 5\%$
 - Pole-dipole
 - $V > 0,5$ mV
 - $Q < 3\%$