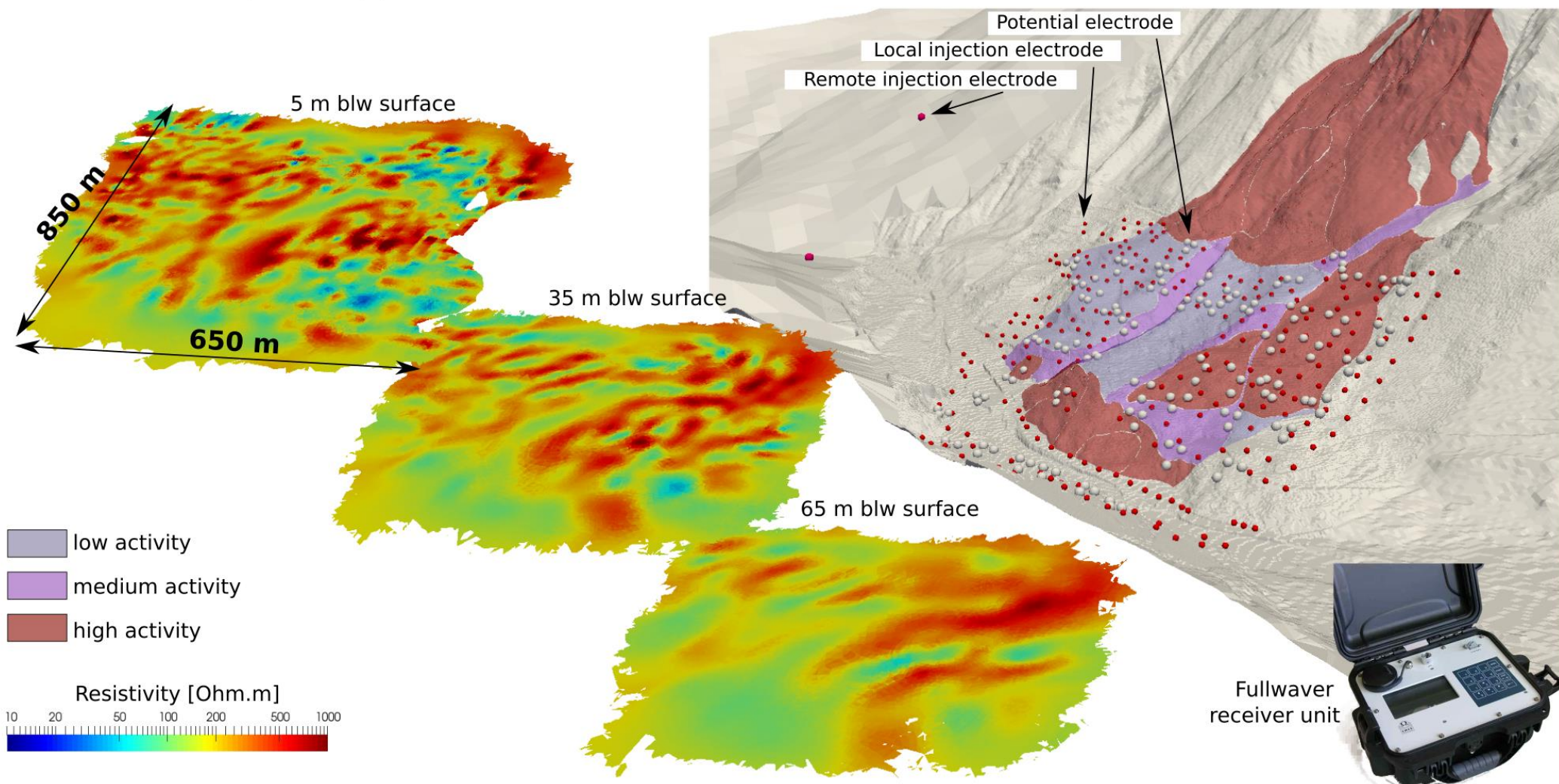


Dense 3D electrical resistivity tomography to understand complex deep landslide structures

Julien Gance, Orlando Leite, Myriam Lajaunie, Kusnahadi Susanto, Catherine Truffert, Olivier Maillard, Catherine Bertrand, Gilbert Ferhat, and Jean-Philippe Malet

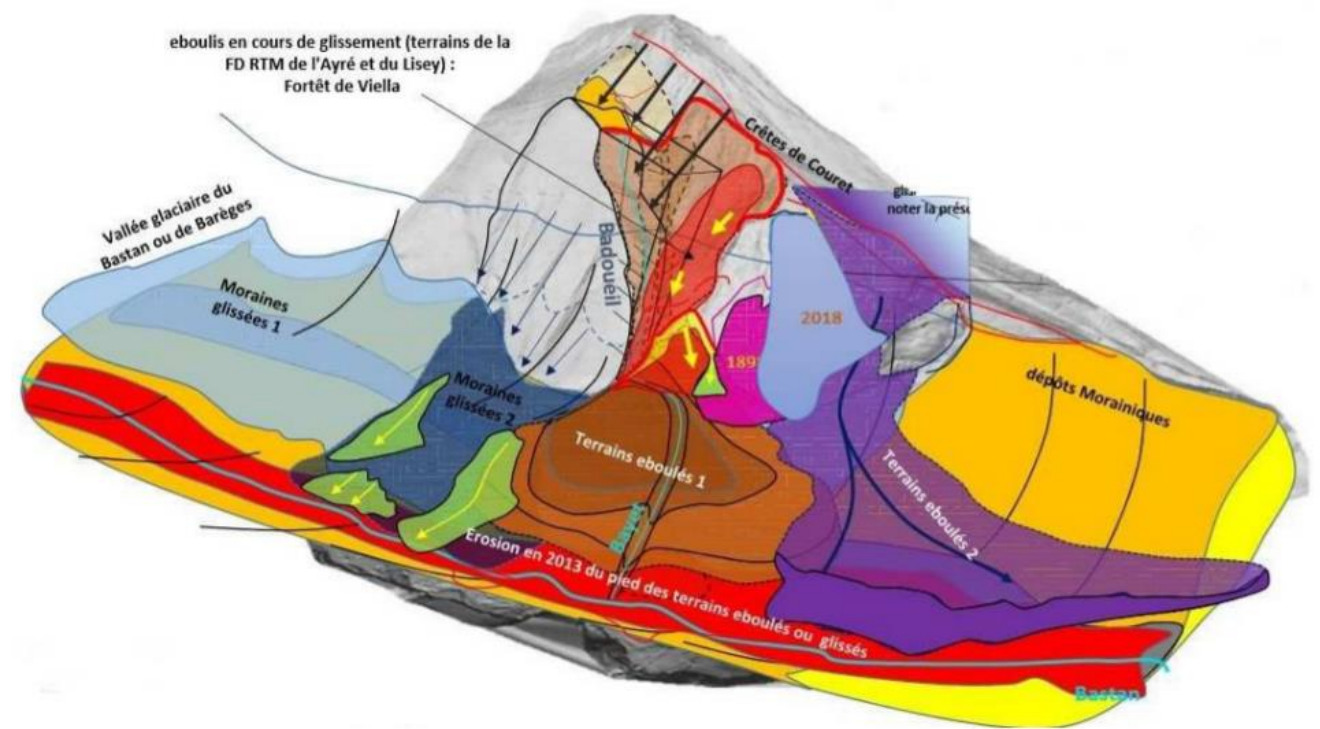
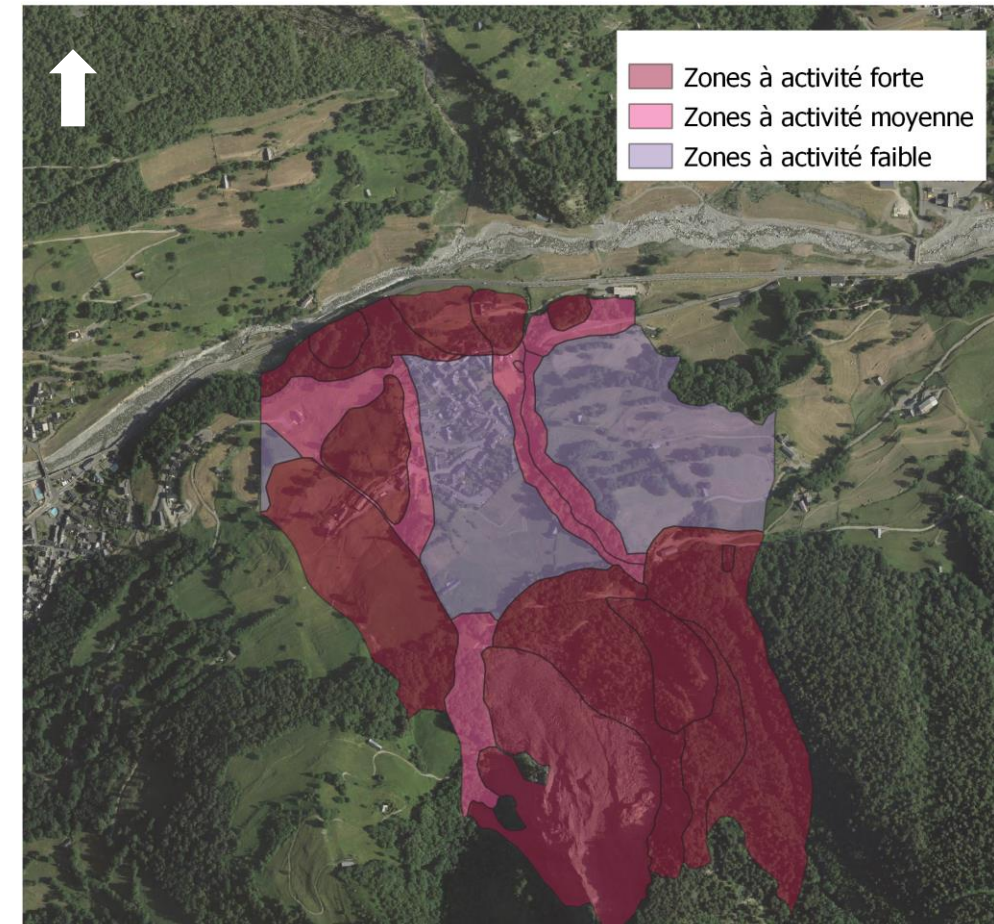


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de **l'Université de Strasbourg**
& **CNRS** & **ENGES**



The Viella unstable slope

- Ground velocity : [0.5 – 5] mm/month
- 3 classes of kinematic activity
- 26 sectors
- Damaged houses, roads and infrastructures

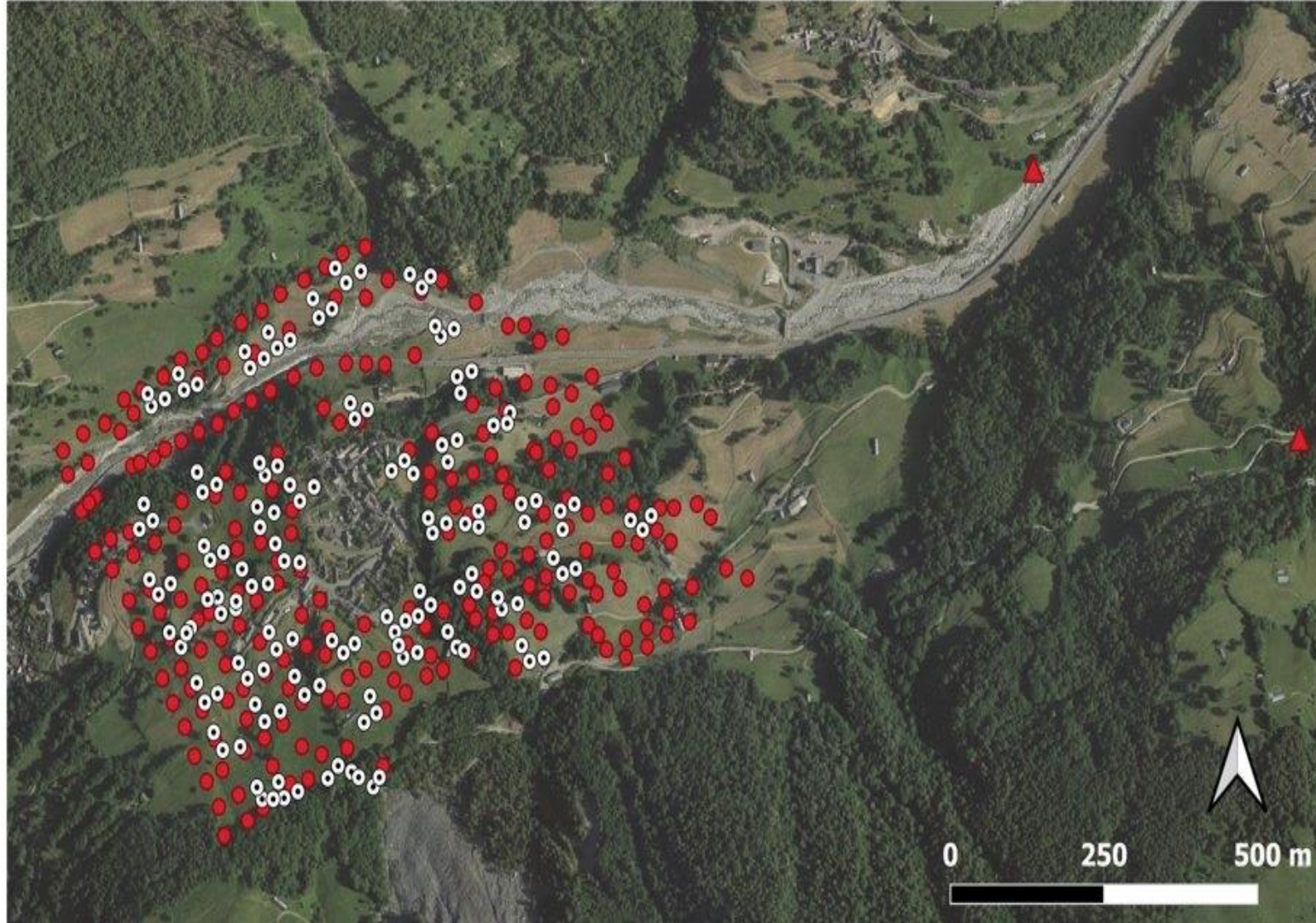


Source : schémas D. Sabatier repris C.Bataillès RTM 64.65

Questions :

- Relation between kinematic compartments and underground structures ?
- Role of the hydrogeology ?

Measurement layout



The Fullwaver system

- Independent receiver units
- Synchronization by PPS

Source signal : current injection between

- a remote electrode
- and a mobile electrode

Campaign

- From 5 til 12 July 2020
- **51** Fullwavers i.e. **153** potential electrodes
- **235** local injection points
- 2 remote electrodes

- ⊙ Potential electrodes
- Local injection points
- ▲ Remote electrodes

Data inversion

21400 data points

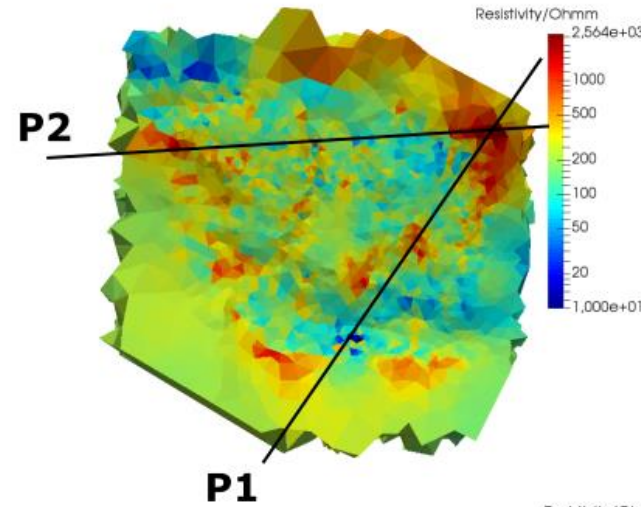
BERT inversion – coarse mesh :

- Robust inversion
- $\chi^2 \rightarrow 1$
- 13 iterations
- ~ 20 h of computation

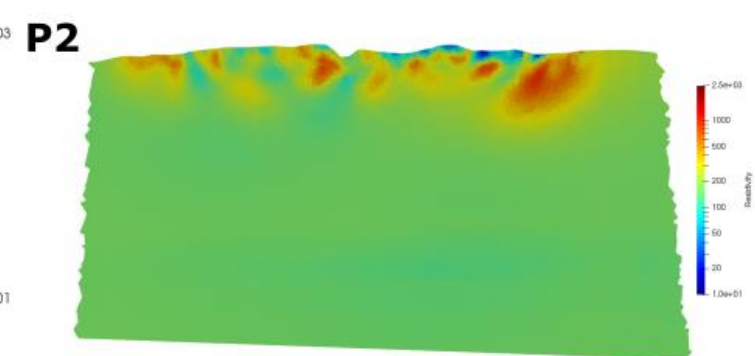
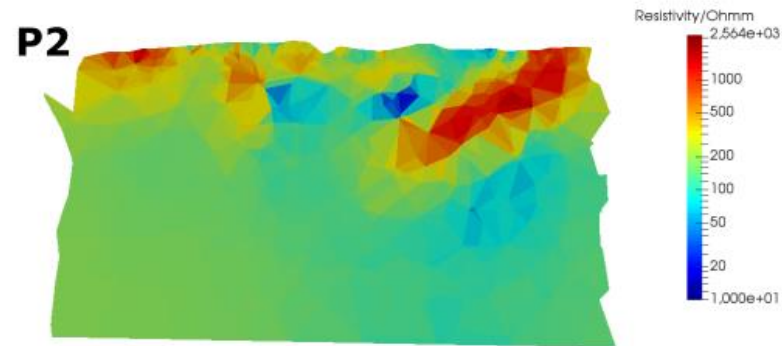
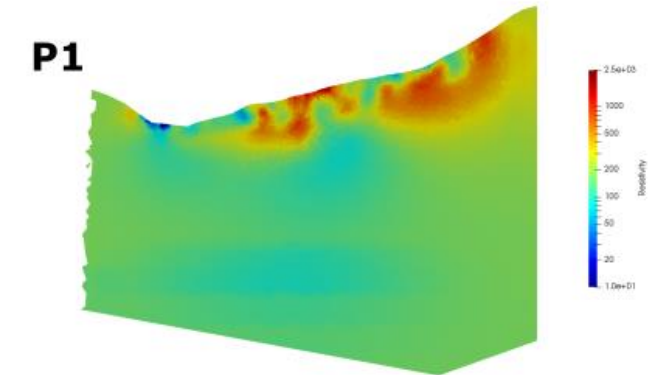
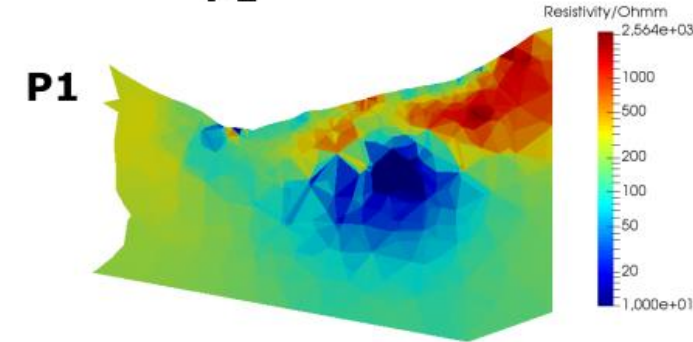
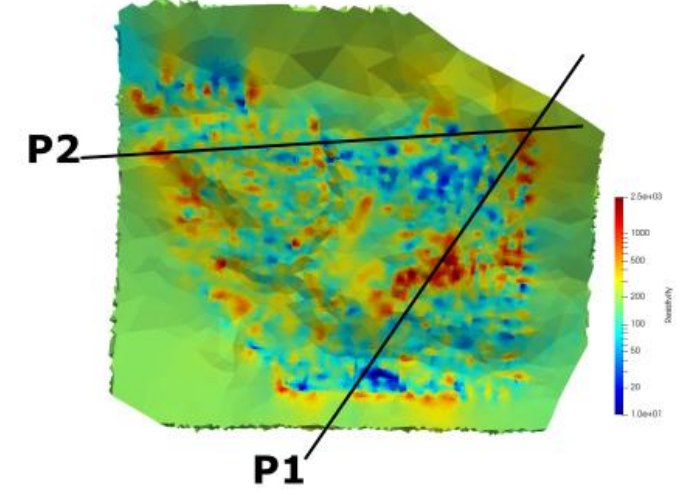
ERTLab inversion – fine mesh :

- Robust inversion
- $\chi^2 \rightarrow 1$ – mean abs. deviation = 2.
- 13 iterations
- > 48 h of computation

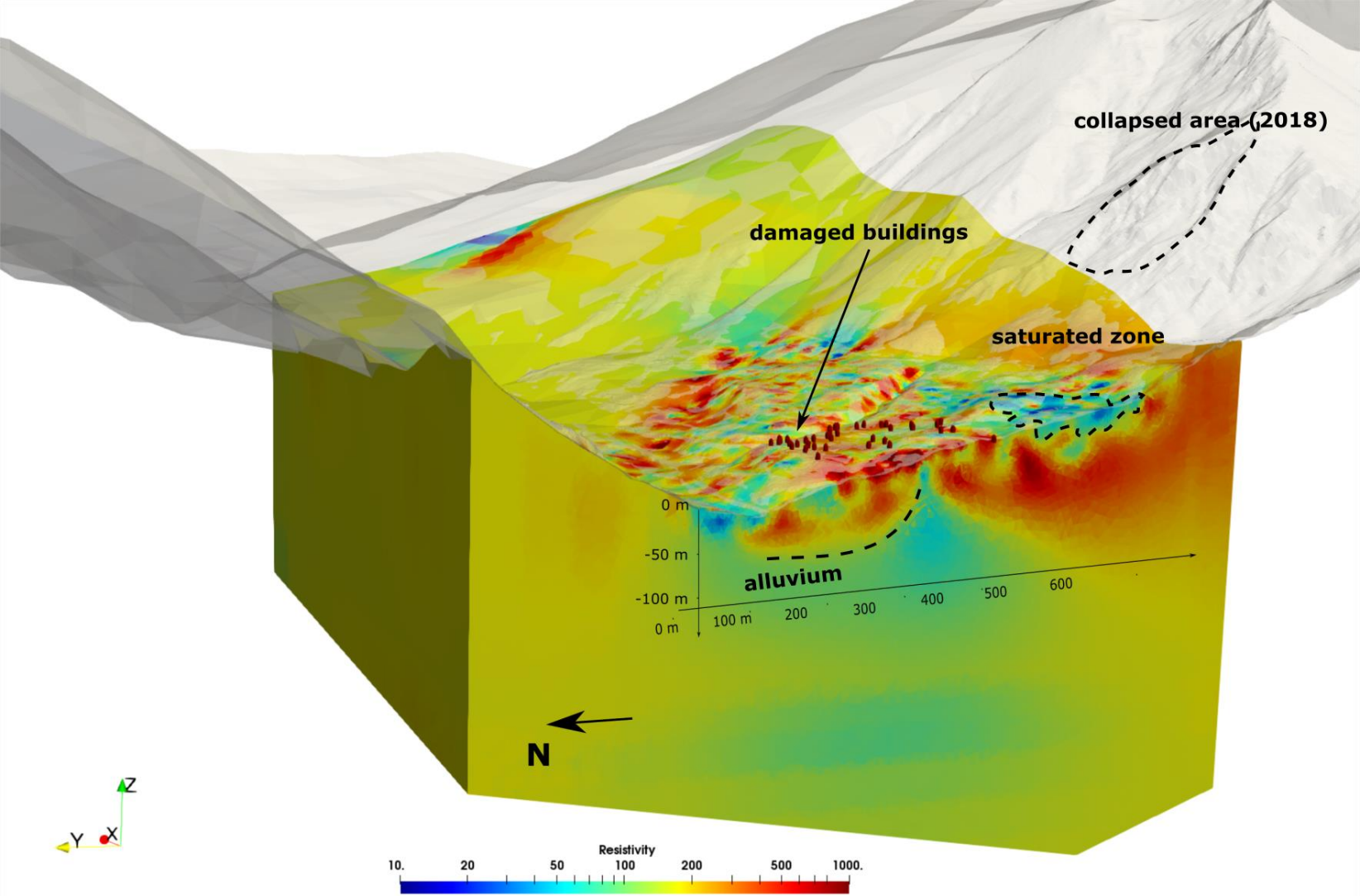
BERT model



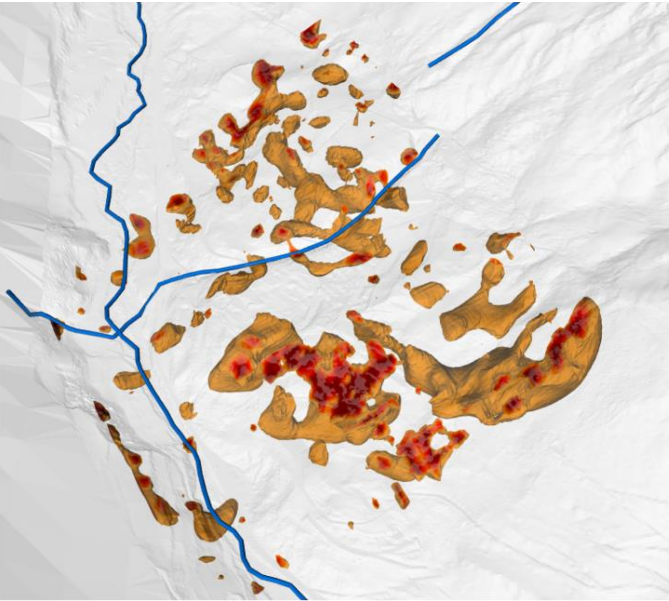
ERTLab model



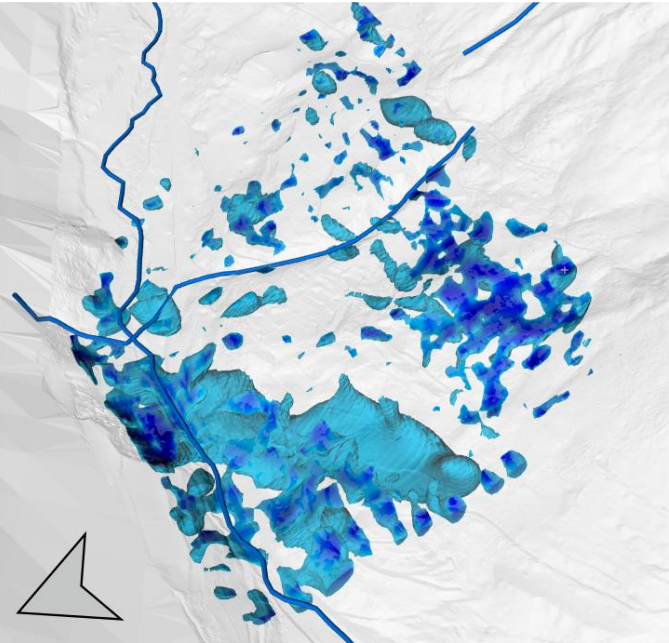
Electrical resistivity model



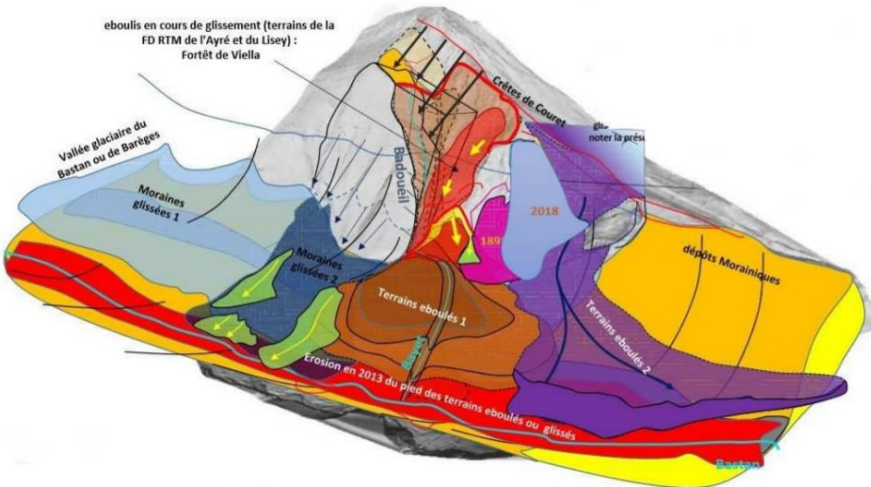
$\rho > 400 \Omega\text{m}$



$\rho < 100 \Omega\text{m}$

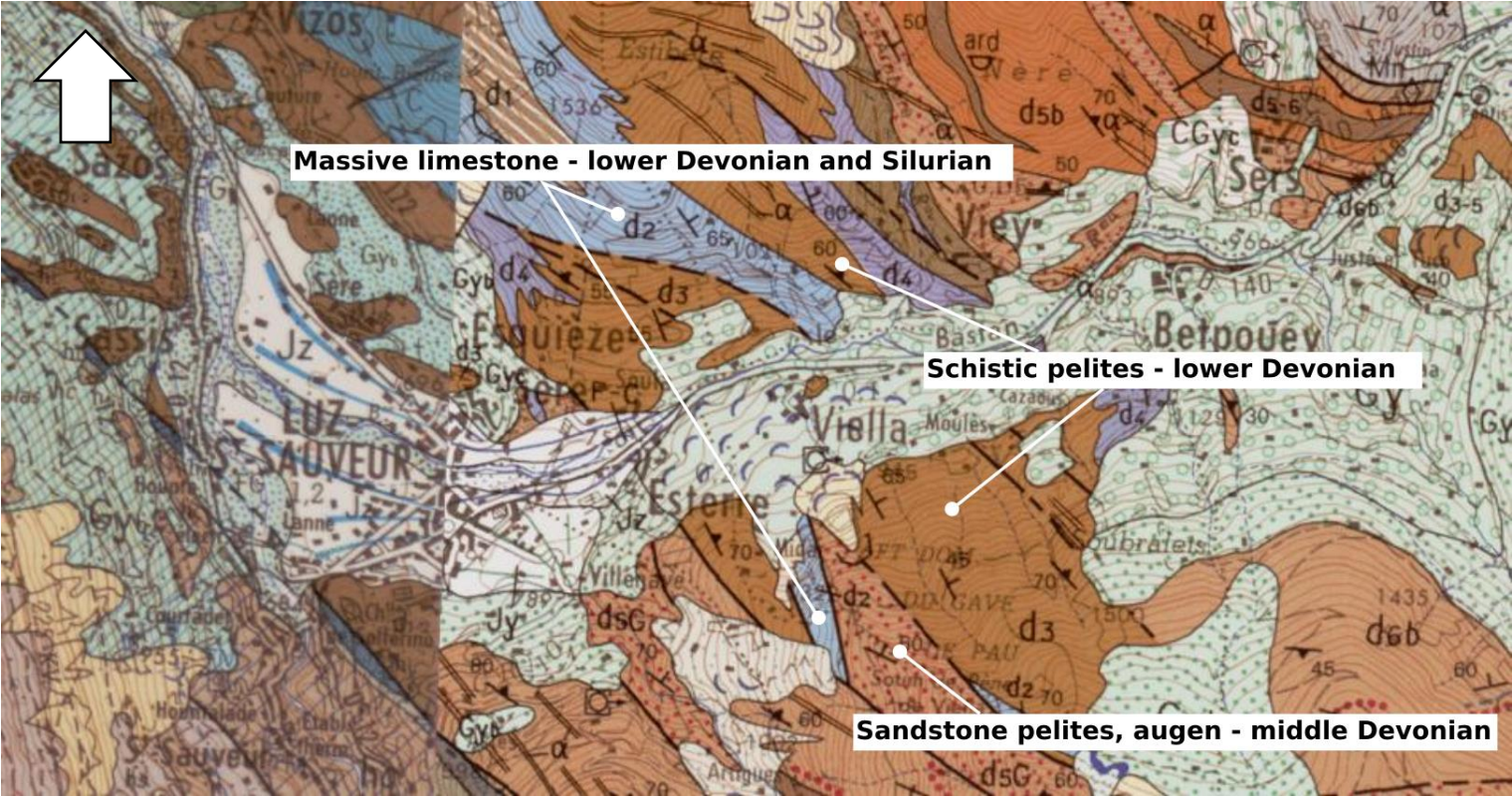
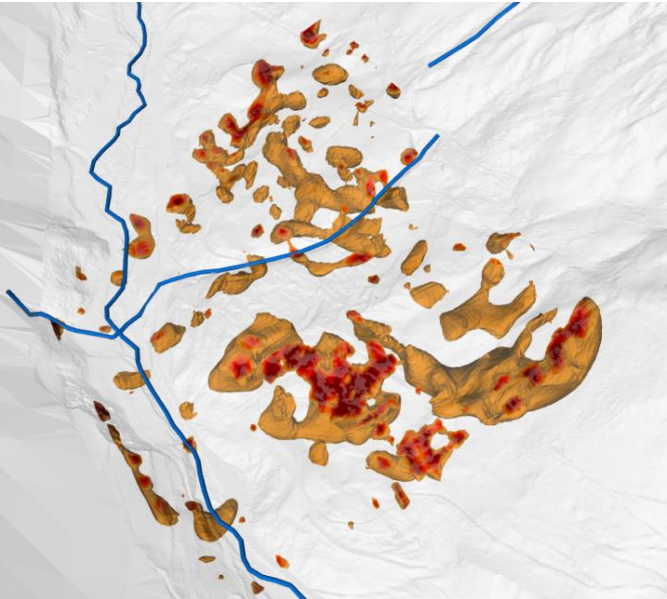


Structural interpretation

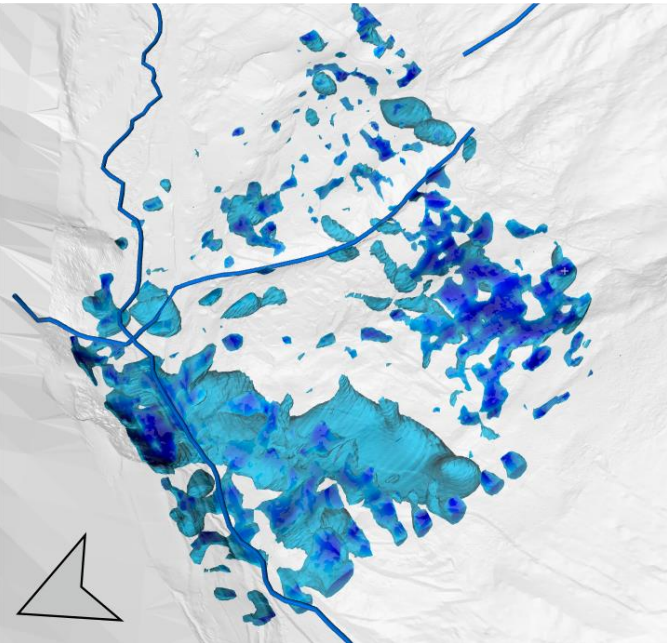


Source : schémas D. Sabatier repris C.Bataillès RTM 64.65

$\rho > 400 \Omega m$

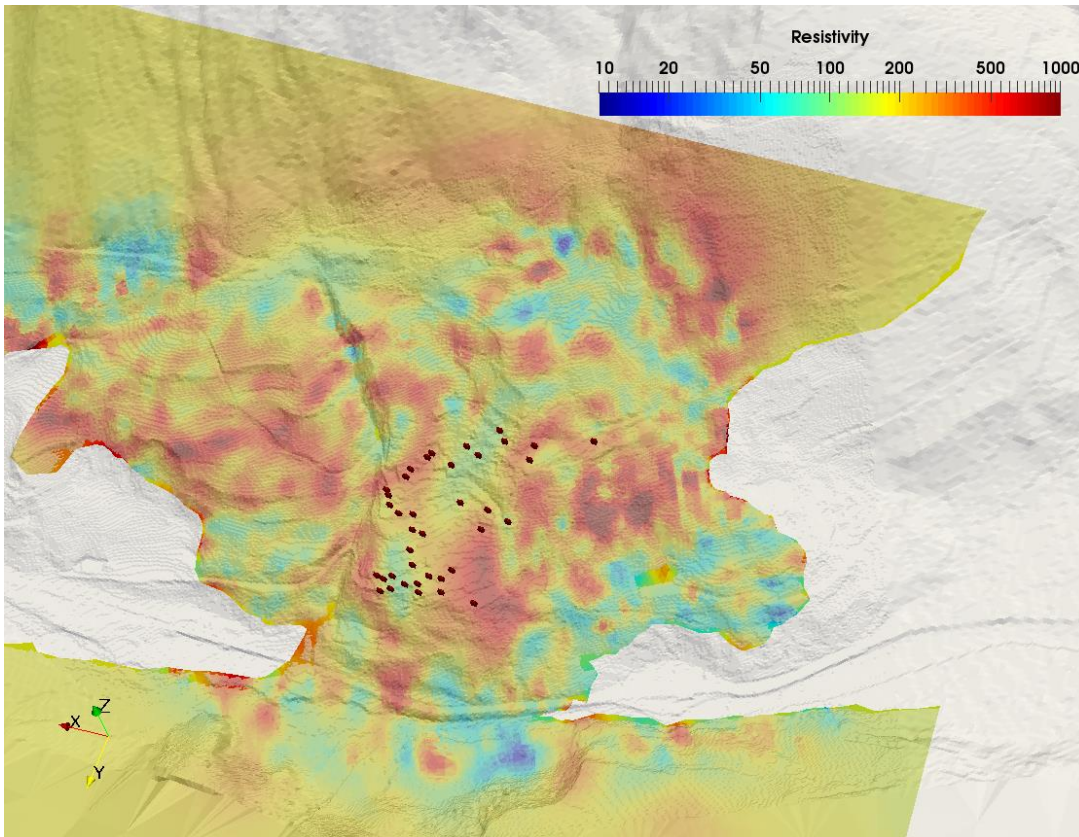


$\rho < 100 \Omega m$

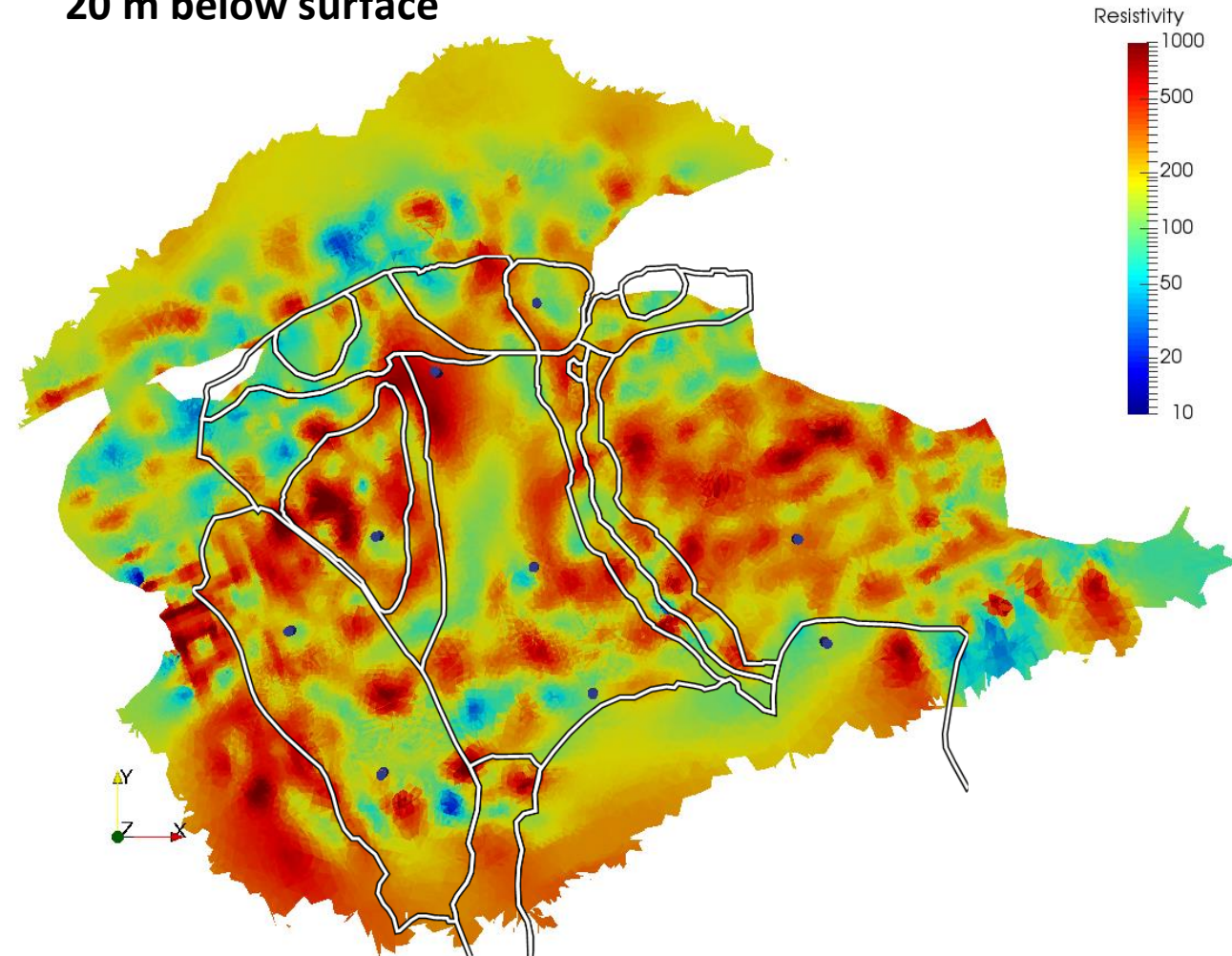


Ground kinematics and electrical resistivity variations

20 m below surface

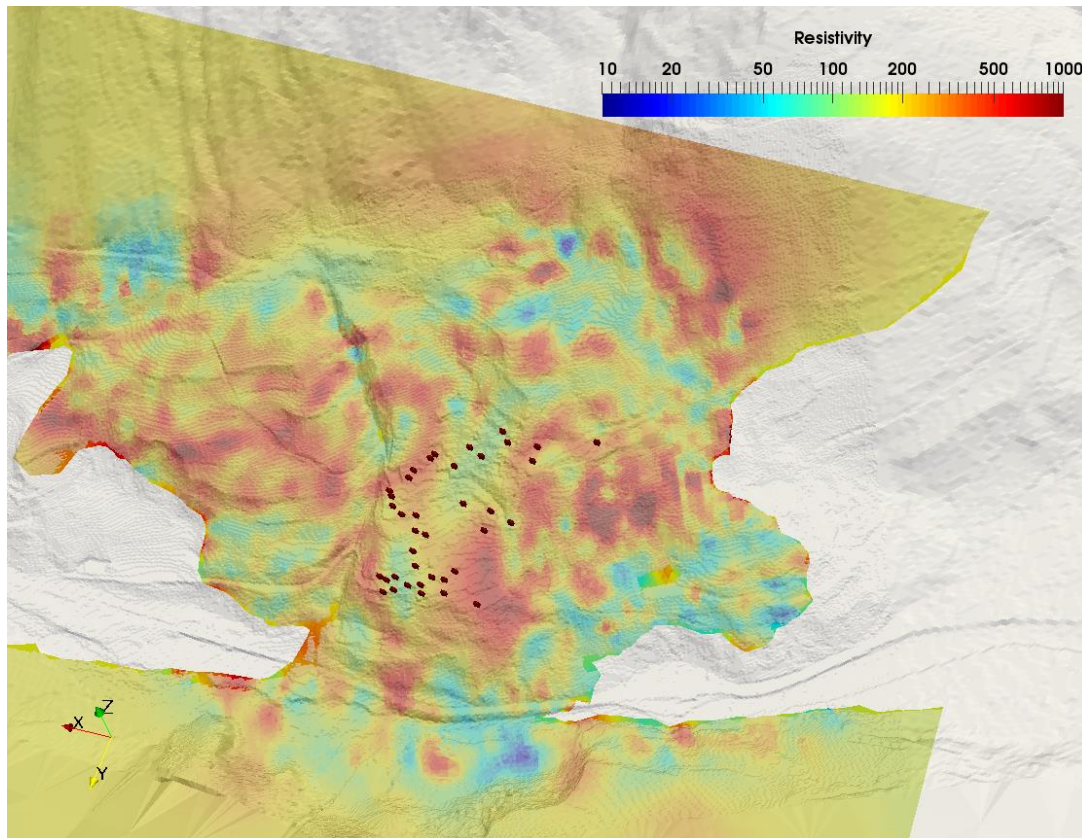


Location of damaged infrastructures (redish cubes) with respect to the resistivity contrasts at 10 m depth blw surface

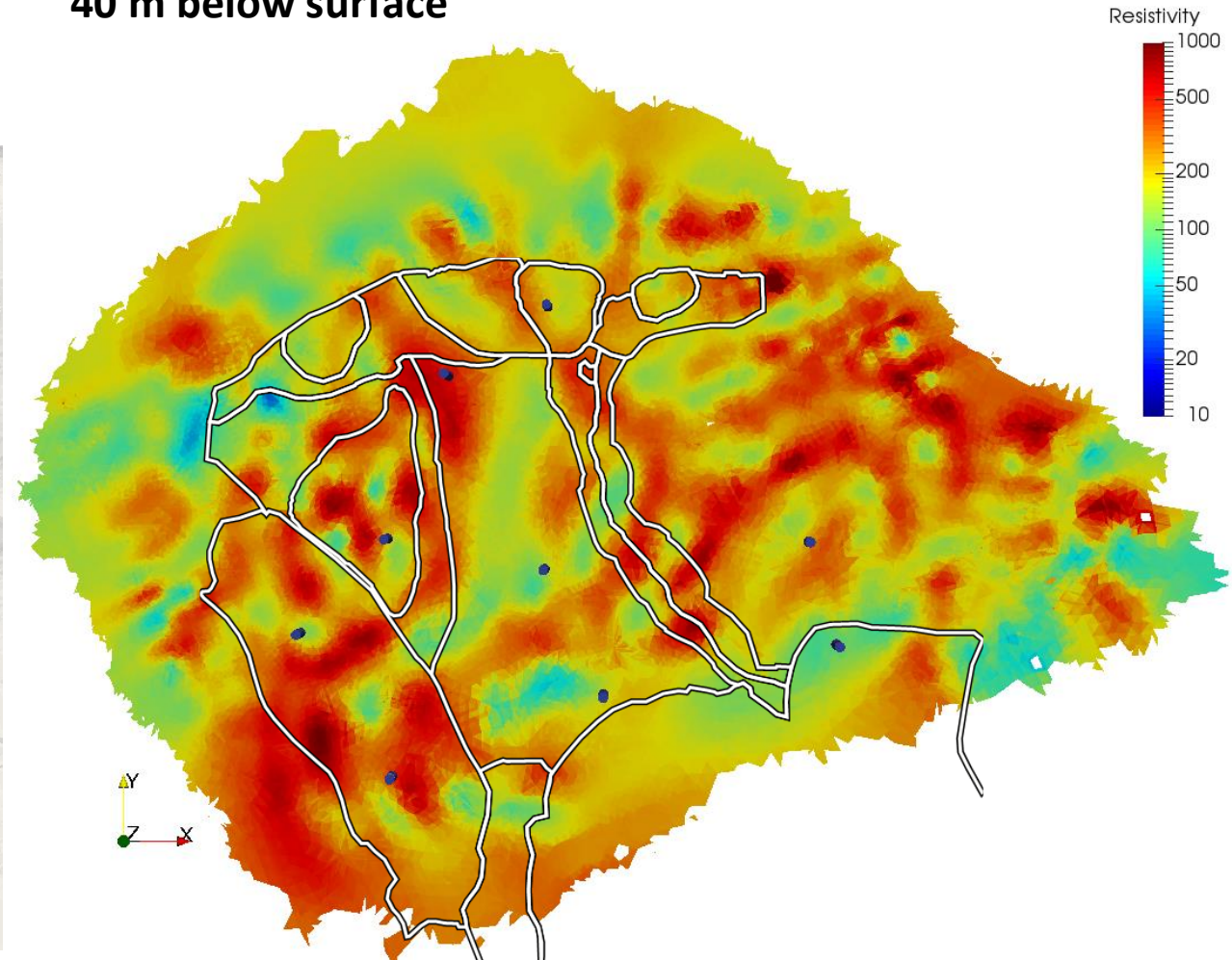


Ground kinematics and electrical resistivity variations

40 m below surface

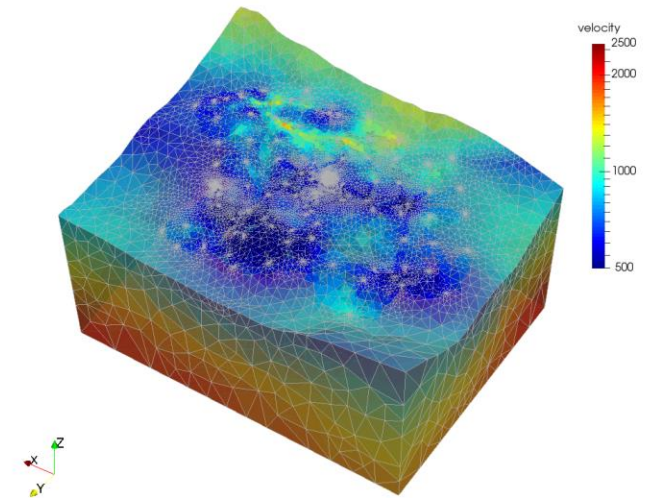


Location of damaged infrastructures (redish cubes) with respect to the resistivity contrasts at 10 m depth blw surface

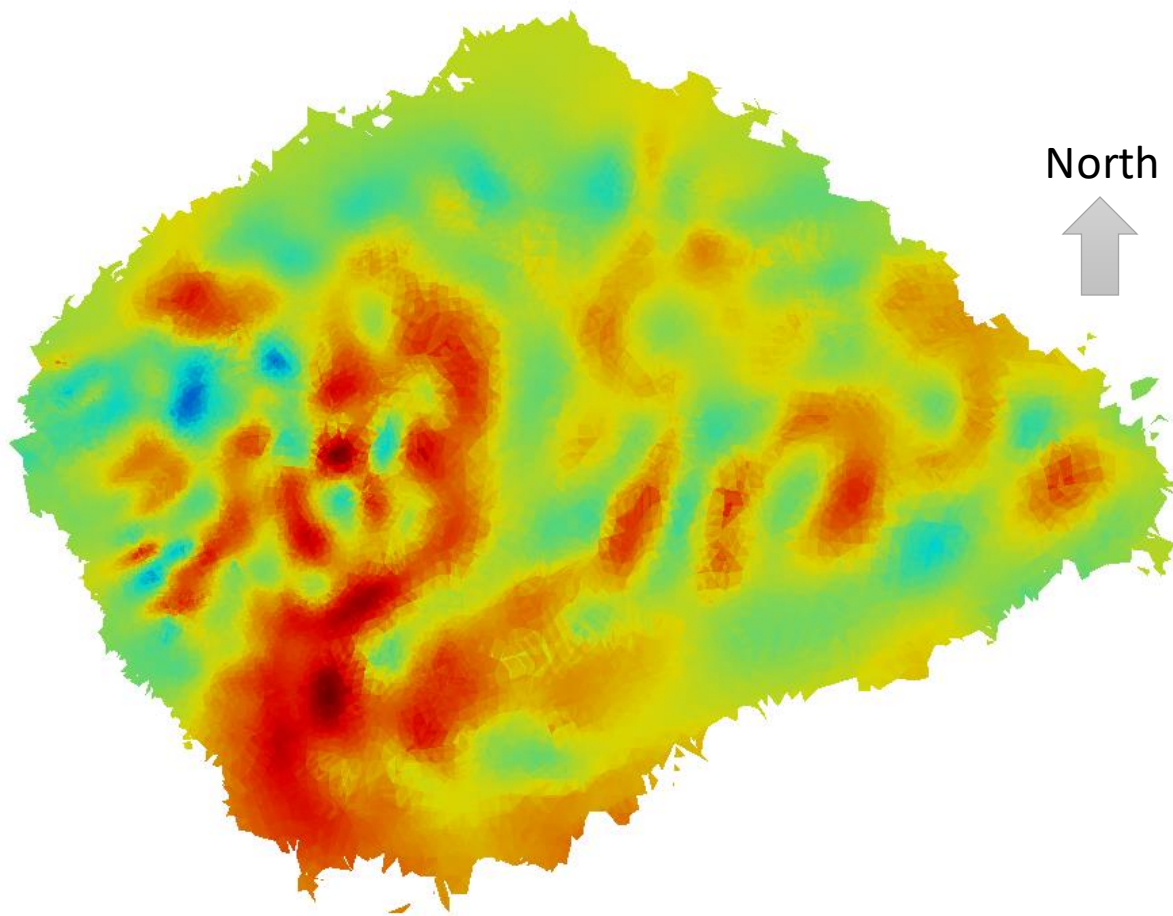


Outcomes:

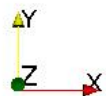
- The resistivity model provides informations on **the structure**, the distribution of **several lithological units** and the **hydrogeology** of a complex slope
 - Upcoming **hydrodynamic modeling** will help constrain the hydrogeological model with respect to the resistivity model
 - Upcoming **hydromechanical modeling** based on the structure and the hydrogeological model will help predict the evolution of the landslide
-
- Joint interpretation with a seismic travel time tomography



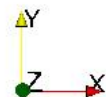
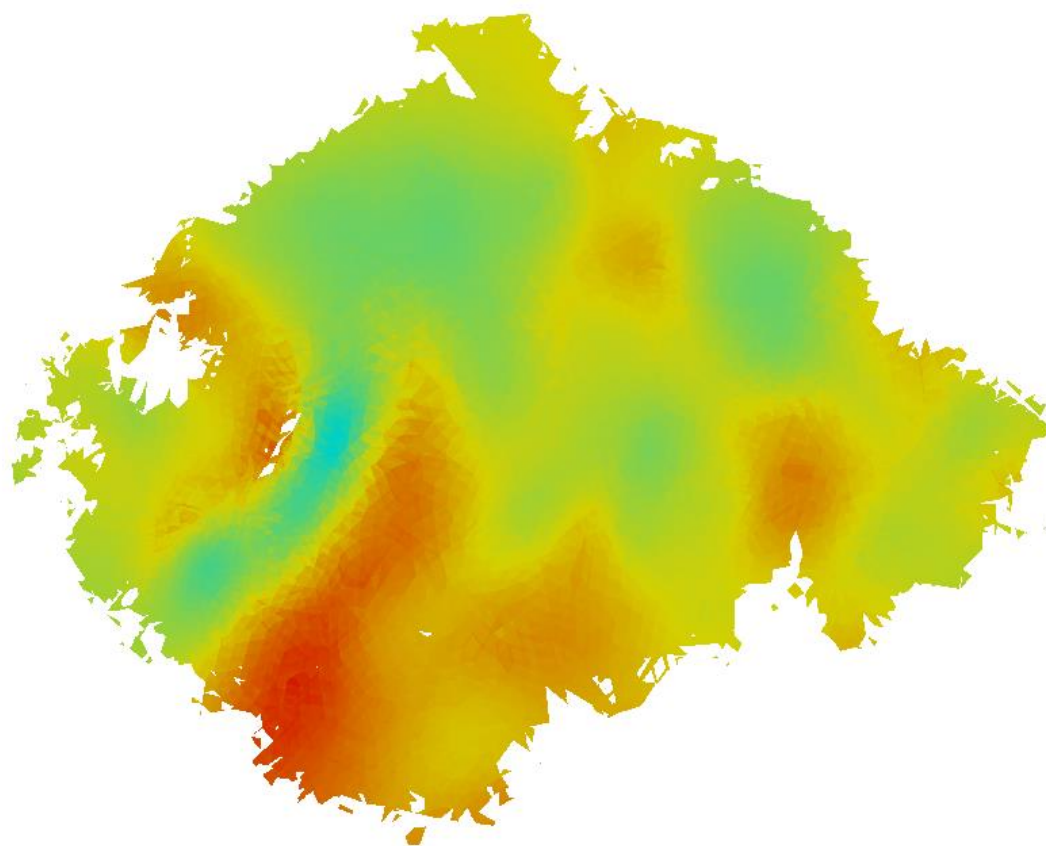
35 m blw surface



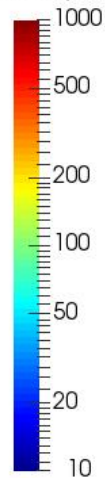
North



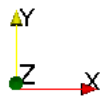
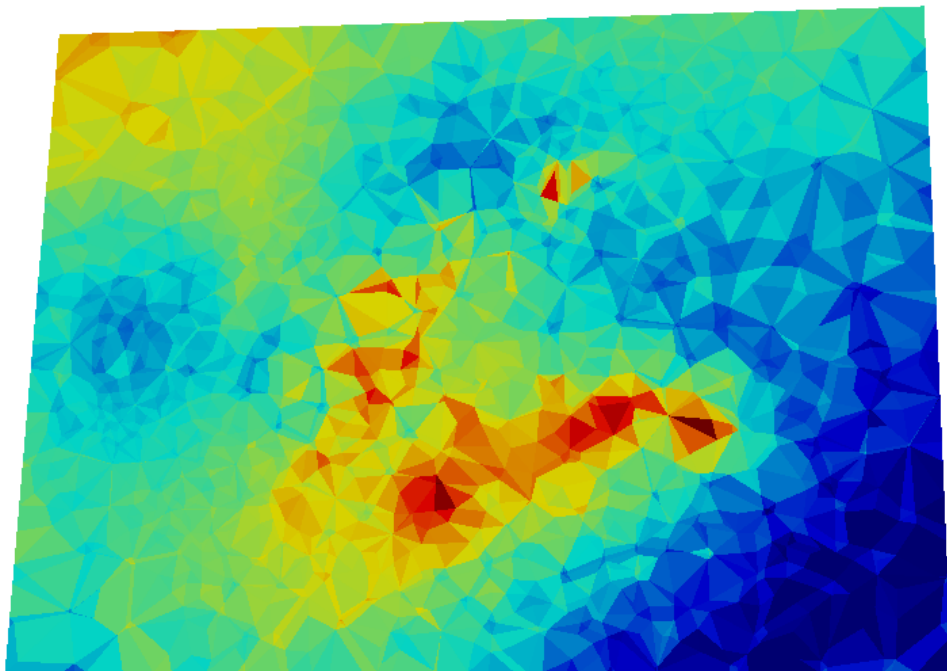
80 m blw surface



Resistivity



35 m blw surface



North



80 m blw surface

