Geophysical integration of joint inverted models: application to geothermal exploration

Jean-Michel Ars, Pascal Tarits*, Séphane Hautot*, Mathieu Bellanger*

Contact: jean-michel.ars@univ-brest.fr

GEOPHYSICAL DATA & JOINT INVERSION

Geophysical exploration based on multi-physics imaging methods along a major crustal fault zone on the edge of a granitic body (see Figure below)

- 45 MT soundings
- Full impedance tensor, 3D inversion at all periods
- 299 vertical geophones: seismic data processed in 579 local dispersion curves, using cross-correlation and FTAN analysis, 1D inversion
- 627 gravity measurements
- Residual of the complete Bouguer anomaly 3D inversion

PRINCIPAL COMPONENT ANALYSIS

- Covariance matrix spectrum and PC correlation to geophysical parameter
- PC1 loading model with other fault model
- Gradient model
- Threshold criterion
- Pre-existing geological model
- Multiplication with pre-existing geological model

GEOPHYSICAL MODELS

The joint inversion approach effectively increased correlation between geophysical parameters at model scale:
- Local correlated patterns between models

Nevertheless geological features such as faults or lithology are not easy to interpret from geophysical models. Indeed, joint inversion does not completely solve the inverse problems and coupling terms impose assumptions on models. Moreover, there are complex interactions between geophysical properties.

Interpretation of multi-physics approach into a conceptual model requires integration

Integration method based on PRINCIPAL COMPONENT ANALYSIS

Patterns Extraction from PC models:


Pattern extraction can be very user-dependent. We propose to extract patterns using thresholds computed from gradient of the normalized PC models.

Shallow patterns are corrected by the pre-existing geology to overcome instabilities from near surface geophysical models. Ex: binary matrix of the shape of the granite is multiplied by the binary matrix of pattern attributed to the granite extracted from PC3.

Conceptual Model:

Pattern extraction from PC models allow to propose a 3D geometry of the geophysical model constrained in depth by the geophysical models. Moreover we maybe able to define potential zone of alteration within the fault network that may be related to geothermal activities.