Electrical current modeling and inversion in 3D fractured rocks

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Framework

Electrical Resistivity Tomography (ERT) experiments are widely used for characterizing the natural environment because they easily provide a large number of data on a large extent and at various depths. These experiments are usually interpreted with forward models and inversion strategies that are well suited for equivalent porous medium representations. Dealing with fractured rocks requires using specific forward models, which are able to simulate the propagation of electric current flow in fracture networks that are embedded in conductive matrix. Although such models have been recently developed, their integration into inversion strategies, and the definition of the inversion framework are still challenging.

Previous work

- Electrical current propagation modeled with a 2.5D discrete dual-porosity (DDP) method [Roubinet and Irving, 2014; Caballero et al., 2017]: combination of 2D simulations where fractures are represented as 1D segments and matrix discretized with large matrix blocks (Figure 1)
- Inversion of field data done through several kinds of inversion strategies (standard and transdimensional inversion) for ERT experiments conducted between boreholes (Figure 2) [Lelimouzin et al., 2014]

Figure 1: 2D discrete-dual porosity representation and discretization

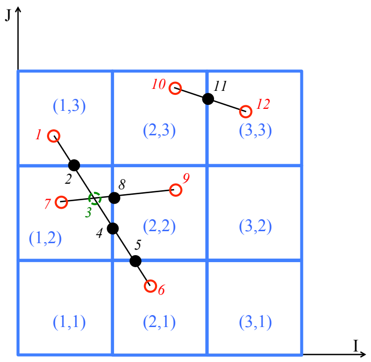
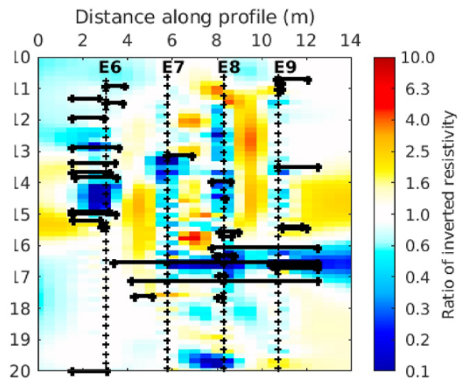


Figure 2: Inversion of position of horizontal fractures from ERT borehole data



Proposed work

- NEF++ [Ern et al., 2022; Hédin et al. 2019]: C++ software that simulates fluid flow in 3D fractured rocks with high order hybrid method and discrete fracture network representation (Figure 3) (collaboration with INRIA-Paris)
- Adapting NEF++ to electrical current propagation and source-point injection for surface and borehole electrode configurations
- Comparison between 2.5D and 3D simulations
- Incorporating the 3D forward model into inversion strategies to invert field data collected at the Tournemire site (collaboration with ISTerre Grenoble)

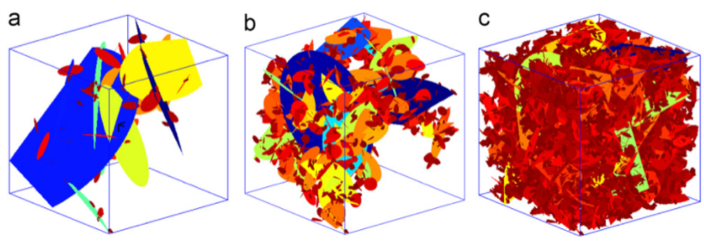


Figure 3: 3D Discrete Fracture Networks (DFN) [de Dreuzy et al., 2013]

References

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