Documentation for MontpInv_sequential (MATLAB version)

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MontpInv_sequential is a software aiming to represent narrow structures of the subsurface, such as fractures or preferential flowpaths for instance, based on electrical data and a discrete modelling approach.

This software is a sequential (i.e. step by step) inversion procedure that incorporates an adaptation of the forward model obtained with ERT_DDP_2.5D software (Caballero-Sanz et al., 2017). Codes are written in MATLAB but call a C++ executable. For any questions concerning the installation and operation of the codes, please contact the authors.

The software is related to several folders described hereafter, and the script called **mainExecutable.m** is the one that must be run to start inversion.

The folders related to the software are organized as follows:

- **Documentation**: contains documentation and articles related to the software
- **ElectricalResistivity**: contains the C++ source files
- **FieldData**: contains the field files that are necessary to run the code
- **Input**: contains two folders containing the input files that are necessary to run ERT_DDP_2.5D with the DFN setting and the EPM setting
- **Inversion**: contains the codes corresponding to the inversion simulator
- **Output**: contains the output files that are generated by the C++ code
- **PostProcessing**: contains the codes that are processing the outputs generated by the C++ code
- **Results**: contains the output files of the inversion scheme

More information about the content of the Input, ElectricalResistivity, Output and PostProcessing folders are provided in the documentation of ERT_DDP_2.5D (Caballero-Sanz et al., 2017).

Caution : all the files described are adapted to a specific study site, a remediation of a contaminated aquifer which characteristics are detailed in Lévy et al., 2022.

1 Description of the FieldData files

1.1 *data_xxzz_R4.txt*

This file contains the coordinates of the electrodes. Each row corresponds to a quadrupole, i.e. to four electrodes giving one apparent electrical resistivity value. Each column corresponds to a coordinate, x refers to the distance to the surface, y refers to the depth. Columns 1 to 4 contain the x values of electrodes called A, B, M and N. Columns 5 to 8 contain the y values of electrodes A, B, M and N.

1.2 *R3.txt* and *R4.txt*

These text files contain the apparent electrical resistivity values collected on field, respectively, before injection (R3.txt) and one day after the injection (R4.txt) of the reagent. They are column vectors, each row correspond to a quadrupole measurement.

2 Description of the Inversion files

- **addFracture.m**: creates a new fracture in DFN.txt
- **changeFracture.m**: modifies the model parameters at each iteration of the inversion procedure
- **deleteFracture.m**: deletes fractures that do not lower the misfit value
- **fwdEPM.m**: calculates the forward EPM model with ERT_DDP_2.5D
- **mainInversion.m**: contains the sequential architecture for calling the various codes implementing the inversion scheme
- **procedure.m**: calculates the forward DFN model with ERT_DDP_2.5D, filters the data as described in the related article and calculates the misfit value

3 Description of the PostProcessing files

- **Farum_elecConfig.m**: defines the coordinates of the electrodes by quadrupole

- **Farum_index.m**: indexes the quadrupole
- **InverseFourierPotential.m**: calculates the inverse Fourier potential
- **Inverse_Pot.m**: calculates the inverse Fourier potential
- **mainEPM.m**: inverts the outputs from the C++ code
- **pre_mainDFN.m**: preparatory function to the forward simulator with a DFN setting
- **mainDFN.m**: inverts the outputs from the C++ code

4 Description of the Results files

These files are obtained at the end of the inversion procedure. An example of the results obtained are provides in the example_inv_Farum folder.

- **DFN_final.txt**: saves the model parameters of each fracture found
- **tabResults.txt**: saves the output of the global search inversion function and its computing time for each fracture found
- **computingTime.txt**: saves the bulk computing time to obtain the final model in seconds
- **deletedFrac.txt**: saves the iteration corresponding to a deleted fracture

References

Caballero-Sanz, V., D. Roubinet, S. Demirel, and J. Irving (May 2017). "2.5-D discrete-dual-porosity model for simulating geoelectrical experiments in fractured rock". In: *Geophysical Journal International* 209, p. 1099. DOI: 10.1093/gji/ggx080.

Lévy, L., R. Thalund-Hansen, T. Bording, G. Fiandaca, A. V. Christiansen, K. Rügge, N. Tuxen, M. Hag, and P. L. Bjerg (2022). "Quantifying Reagent Spreading by Cross-Borehole Electrical Tomography to Assess Performance of Groundwater Remediation". In: *Water Resources Research* 58.9. DOI: https://doi.org/10.1029/2022WR032218.