A novel finite-element based algorithm for impedance tomography of arbitrarily shaped trees

Thomas Günther¹  &  Carsten Rücker²

¹Leibniz Institute for Applied Geosciences, Hannover (Germany)
²Institute of Geophysics and Geology, University of Leipzig (Germany)

Acapulco, 23.05.2007
Technique (after Günther et al. (2006))

- Finite element based forward calculation
- Unstructured meshes (triangles, tetrahedra)
- Allows for any 2d or 3d geometry (here tree shape)
- Three meshes yield efficacy
- Enhanced minimization approach (model+boundary control)

Triple-mesh inversion

- Inversion on resolution-optimized mesh
- Forward & Jacobian calculation on moderate mesh
- Calculation of primary potentials on refined mesh
2d examples
Hollow lime tree

Tree disk image
Inversion result

clearly shows high-resistive interior
2d examples

Rotten haw tree

Tree disk image

Inversion result

shows wet decay as well as dried core
2d examples
Influence of tree shape - Data

Triangle tree - apparent resistivities

Calculation of analytical and numerical geometry factors

Data with circle G  Pure geometry effect  Data with calculated G

AGU 2007 (Acapulco): Günther & Rücker
2d examples
Influence of tree shape - Model

Inversion on circle geometry

Inversion on real geometry
3d example
Ash tree

Injection and broadening of mycosis
### Objective
Investigation of time-dependent processes

### Problem
absolute differences are often very small

### Solution
full solution for first frame
reference model technique for subsequent
Time lapse ERT

Example - Lime tree

Data collection
- 24 electrode
- 264 single data
- 1 frame every 10 minutes
- more than 24h data

Objective
1. Dynamics of solute transport (daily variations)
2. Influence of solar radiation

Lime tree absolute resistivities
Time lapse ERT

Example - Lime tree

1-day-cycle: relative differences in %
## Joint inversion

### Method

#### Problem
Ambiguity of the inverse problem, i.e. a variety of models are able to explain the data

#### Approach
Use different physical measurements, e.g. impedance and travel time data

#### Solution
Resistivity and Velocity are independent but expected to show similar structures \(\Rightarrow\) structural coupling by robust modeling techniques (details see talk and poster)

#### Data
Impedance data and ultrasonic travel times on 16 electrodes/geophones
Joint inversion

Example: Hollow tree

Separate inversion - resistivity

Joint inversion - velocity
Joint inversion

Example: Hollow tree

Joint inversion - resistivity

Joint inversion - velocity
Summary

- ERT is a powerful tool to image tree structures
- Unstructured meshes allow arbitrary geometry
- Consideration of tree shape is essential
- 3D surveys are possible
- Joint inversion with travel time tomography improves results
- Time lapse inversion yields a concept of processes

Thanks to

Niels Hoffmann and Dirk Bieker (HAWK Göttingen)
Lothar Göcke (ARGUS electronic GmbH, Rostock)

www.resistivity.net

2D GUI based software freely available, 3D part of dcfemlib