Topographical effects on Radio Magnetotelluric (RMT) measurements on levees

1. RMT method

RMT method applied on a levee: study of the topography effect and materials distribution on the recorded Electromagnetic fields

> Maxwell’s equation, Ohm’s law: propagation equations

> Radio wave frequency method: source of the electromagnetic wave,

Typical cross-section of a levee on a river, like the Loire in France

2. Physical modelling

**Principle**

BBC5 freq. from Salford: f = 693 MHz, \( \lambda = 433 \text{ m} \)

France-Inter freq. from Allouis: f = 163 MHz, \( \lambda = 1840 \text{ m} \)

**Geometrical model**

CAD numerical levee model with dimensions and import into Comsol ;

**Physical model**

- Comsol module: RF and AC/DC

**Boundary condition**

- PML and initialization with the x component of the H field :

**Post-processing: Results**

- 3D effect display

Adaptive mesh:

- 90 309 elements for the mesh with pipe:

**Salveur**

In the study: solver with frequency domain, the relative tolerance set at 0.0 010 and the degrees of freedom solved for 572 324. Type of stationary and iterative solver:

Display of the solution on the levee surface and export of ascii data for treatment:

3. Results

<table>
<thead>
<tr>
<th>Different frequencies</th>
<th>Apparent resistivity computation</th>
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</thead>
<tbody>
<tr>
<td>BBC5 (693 kHz), resistivity levee: 4000 ( \Omega/m )</td>
<td></td>
</tr>
<tr>
<td>France-Inter (163 kHz), resistivity levee: 8000 ( \Omega/m )</td>
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The apparent resistivity calculation in Comsol:

**For the « Electromagnetic waves (emw) » model:**

\( \rho_a \approx \pi \mu \rho = \frac{\pi \mu R}{f} \)

**For the « Magnetic Fields (mf) » model:**

\( \rho_a = \frac{1}{\mu_0} \left( \frac{E}{\cos H_0} \right)^2 \)

Simulation results by the two methods are very similar and highlight topographical effects on resistivity measurements in RMT method

References:

Fauchard C., Mériaux Patrice, “Geophysical and geotechnical methods for diagnosing flood protection dikes”, Editions Quae, France, 2004


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