Topographic Effects on Radio Magnetotelluric Simulations on Levees: Numerical Modelling for Future Comparison with Fields Results

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Abstract

Our work aims to study the influence of the topography of earthen embankments on the electric resistivity signal obtained with the Radio-Magnetotelluric method (RMT). Field measurements realized at Orléans (France) have been modeled with the finite elements code, COMSOL Multiphysics, using the AC/DC and RF Modules. These simulations allow us to reproduce the electromagnetic field in the radio waves range (163 kHz at Allouis, France and 693 KHz at Salford, UK), as well as the soil and the levee electric response at these frequencies. First, the effect of the incident electromagnetic field direction has been assessed for two examples. In the first case, the incident electric field is parallel to the levees stretch. In the second case, the influence of a perpendicular incident wave is characterized. Our results demonstrate that the simulated resistivity on the levee crest strongly depends on the incident electromagnetic field direction and on the levee topography. Then, the levee has been geometrically designed in function of the skin depth (resistivity and frequency dependence) and the incident wavelength, in order to keep a constant field in the whole model. The objective is to highlight the tridimensional patterns in the electric field observed between the slopes and the crest of the levee, as revealed by the apparent resistivity signal measured on the crest. The simulations clearly show a strong sensitivity of the signal to the incident electromagnetic field frequency and direction, as well as to the presence of a gas pipe detected during the measurements. Our simulations allow us to validate and to interpret the measurements carried out on the Orléans levee. Numerical modeling definitely provides an easy way to quantify the 3D electromagnetic effects induced by the topography of such structures. Further studies are on course to evaluate the electromagnetic contribution of singularities such as leakages, breaches and karstic formations that could appear within or underneath levees/embankments.

Figures used in the abstract

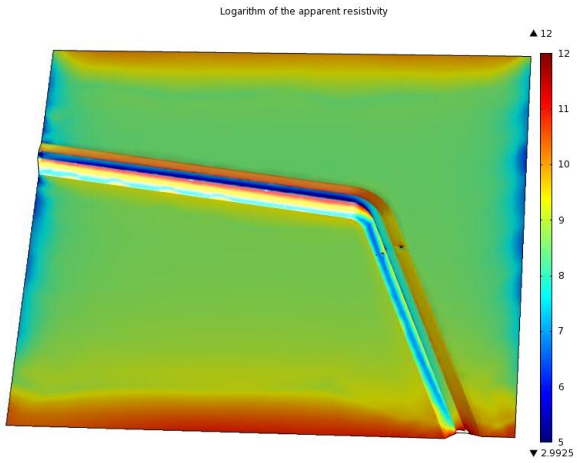

Figure 1: Model of Radio-Magnetotelluric method (RMT) of a levee using COMSOL.

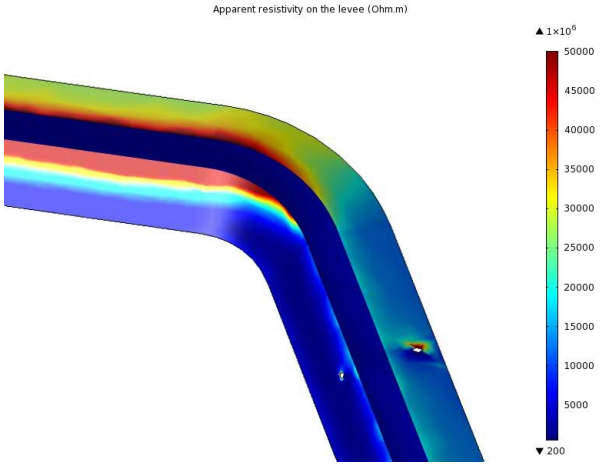

Figure 2