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GJI-S-12-0690 Electronic Supplement

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1 GJI-S-12-0690 ELECTRONIC SUPPLEMENT

1.1 Comparison between laboratory dielectric constant measurements on sandstones at various frequencies

Figure 1 compiles the dielectric constant values measured on Berea sandstone samples of porosity ϕ=19.7 $\%$ at different saturation levels by Knight (1984) at frequencies of 57 kHz, 11.7 MHz and 13 MHz. The values measured by Gomaa (2008) at 100Hz for clean (clay-free) Aswan hematitic sandstone samples with 23 $\%$ porosity are also plotted. Finally, Figure 1 displays the dielectric constant as a function of saturation S_w as predicted by the CRIM formula for a clean sandstone with 23 $\%$ porosity.

1.2 Reciprocity test

Checking for the reciprocity of the Green's tensor is a common way to search for errors in a numerical program. In this Section, we show that the program we have developed under partial saturation conditions verifies these reciprocity relations for coupled seismic / electromagnetic waves. We consider a simple tabular model, consisting of a partially saturated sandstone layer with S_w=0.4, 30 m thick, on top of a saturated sandstone halfsace. We model two source-receiver configurations:

- shallow source (z_s=1 m) and receivers set at depth (z_r=59 m), noted "down" in Figures 2 (a) and (c)), as most of the energy travels downwards.
- buried source (z_s=59 m) with a string of shallow receivers (z_r=1 m), noted "up" in Figures 2 (b) and (d)).

In both configurations, a 10 m offset along y was introduced between the source and receivers. In Figure 2, we have modeled only the interfacial conversions. The notation "uz/Dx" (Figure 2 (a)) refers to the vertical displacement created by a dipole oriented along x. This seismogram correlates well with the electrogram displying the electric field along x obtained using a mehcanical source along z. The maximum amplitude for the "uz/Dx" case (5.049×10^{-6}) is close to the maximum amplitude obtained for the "Ex/Fz" case (5.016×10^{-6}). In a similar way, the recordings displayed in Figures 2 (b) and (d) correlate well and show the same maxium amplitude (1.595×10^{-6}).

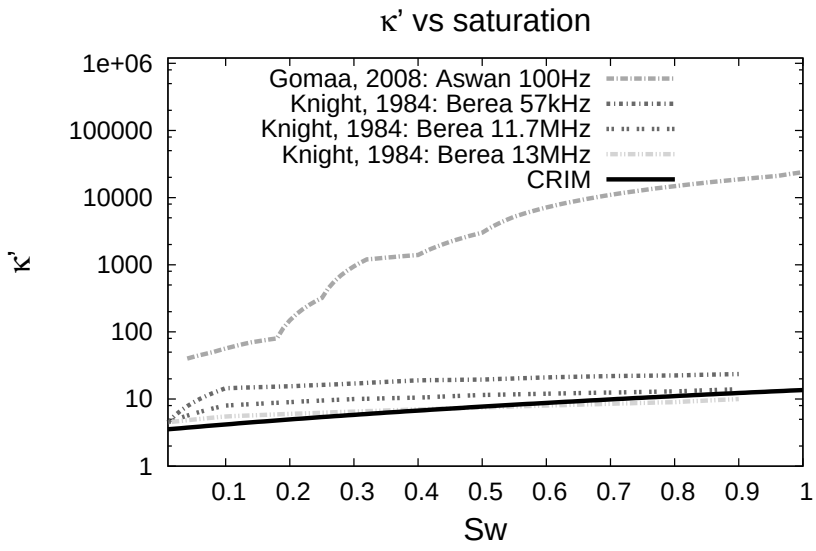

Figure 1. Dielectric constant versus water saturation S_w as measured by Knight (1984) on Berea (ϕ=19.7 %) sandstone samples and Gomaa (2008) for Aswan (ϕ=23 %) sandstone. The results obtained with the CRIM formula for a sandstone with a porosity ϕ=23 % are also plotted for comparison.

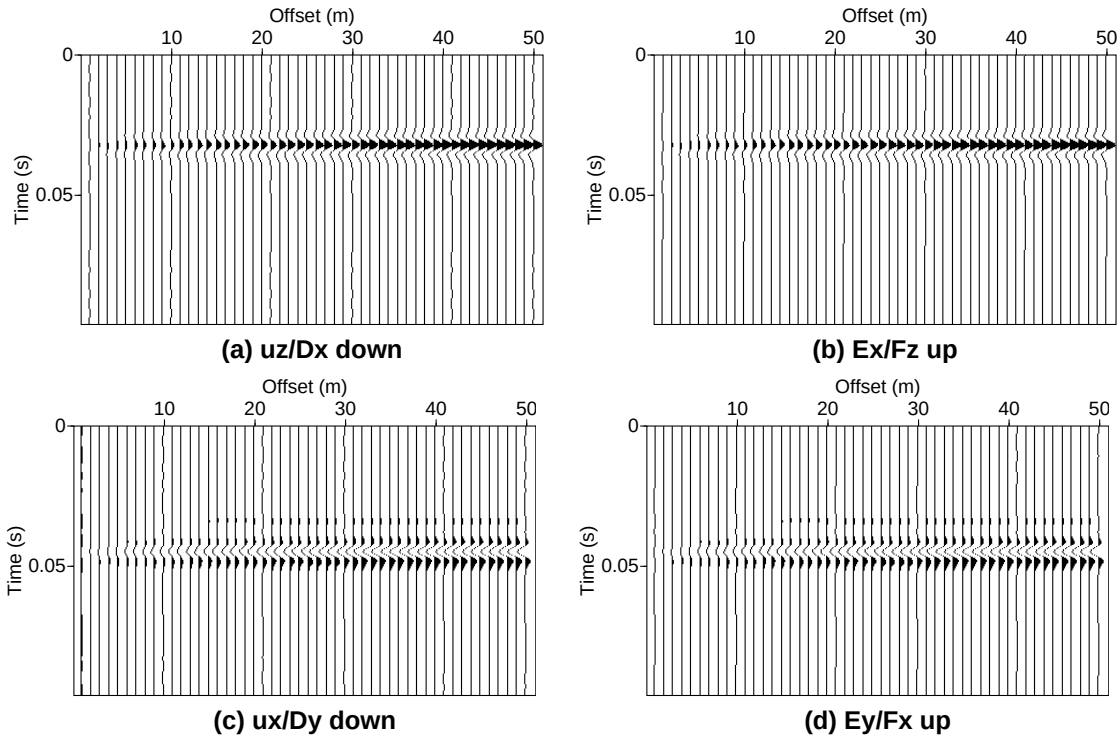

Figure 2. Results of the reciprocity test described in Subsection 1.2.

REFERENCES

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Knight, R. J., 1984. The dielectric constant of sandstones, 5 Hz to 13 MHz.