Geophysical Research Abstracts, Vol. 7, 04437, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04437

Electromagnetic full wave analysis of sub-wavelength sized objects in ground penetrating radar (GPR)

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Ground penetrating radar (GPR) has been used increasingly in hydrological applications for subsurface structure investigation. The size of structures that can be resolved with GPR is intimately related to the relevant wavelength λ of the employed signal (Rayleigh criterion). Increasing resolution requires shorter λ which requires increasing frequency f. Unfortunately, attenuation of signal amplitude in typical GPR usage environments is considerable and, in particular, increases with f. There is, therefore, a tradeoff between structure size that can be resolved and maximum penetration depth. However, there is experimental evidence that structures smaller than the wavelength (λ_{sub}) are manifest in the radargram. In this study, we investigate, numerically, how λ_{sub} objects of simple shape translate into the GPR signal, using a full-wave electromagnetic model. We comment on its future relevance to practical GPR applications in the field.