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Validity of using space approximation in calculating EM variations generated by the piezomagnetic effect

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Variations in the magnetic field generated by the piezomagnetic effect, which is referred to as the piezomagnetic field, has been discussed in a framework of magneto-statics, in which temporal variations are totally ignored. This treatment is valid for quasi-static processes, but possibly invalid for dynamic processes including fault ruptures. The earlier works by the author has demonstrated that, when the temporal variations in the EM field is considered, finite conductivity of the Earth's crust alters the feature of the piezomagnetic field. However, consideration of the temporal variations in the EM field makes estimation of the piezomagnetic field complicated, even in a simple two-layered model which consists of the Earth's ground with finite conductivity and the air as a perfect resister.

The problem will be largely simplified if the situation is approximated by a finite space model with a uniform electrical conductivity.

In the present work, variations in the EM field generated by the piezomagnetic effect are compared for two situations: finite space and semi-finite space models with finite conductivity, assuming the source of the piezomagnetic field is two-dimensional. It is demonstrated that, for some situations, the simpler model provides a good approximation of the expected piezomagnetic field.

Keywords: piezomagnetic effect, electromagnetic field, electrical conductivity, infinite space, semi-infinite space