3D MODELLING OF RANDOMLY DISTRIBUTED MEDIA TO INVESTIGATE EM RESPONSE OF RESISTIVE HETEROGENEOUS TARGETS

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Marine controlled source electromagnetic (CSEM) methods are capable of detecting resistivity anomalies at shallow depths below the seafloor, an environment that has proved challenging for conventional geophysical exploration techniques. While in many cases a uniform resistive anomaly within a known background may be an appropriate modelling approximation, there are situations in which the specific heterogeneity of the target is of interest. For example, coring results show that resistive marine gas hydrate deposits are highly heterogeneous. Monitoring such resistive anomalies for the purpose of studying their time-evolution requires modelling the random nature of these heterogeneities. Using the finite difference 3D EM time-domain code of Druskin and Knizhnerman, the response of a multi-receiver marine CSEM system to synthetic 3D random media models is investigated. The CSEM system is an electric dipole source with an inline array of receivers at multiple offsets. The model is a lattice of cubic elements with different conductivities. A random walk algorithm is used to distribute resistive elements within this lattice. Owing to the diffusive nature of electric field propagation, spatial resolution of the target is limited. We use the arrival time of the electric field at the receivers to characterize the response of various random models. Off-structure (far offset) receivers are sensitive to the overall average resistivity of the model and less sensitive to the details of the distribution of resistive elements. On-structure receivers on the other hand, respond to the statistical distribution of resistive material such as the ‘connectivity’ of resistive elements. Using random models with different element sizes, an estimate of the lateral and vertical resolution limits of the instrument array is obtained for the target under study.

Controlled source EM, Gas hydrates, Random media modelling

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