AN INTEGRATED APPROACH IN GEOPHYSICAL MODELLING USING SEISMIC TRAVEL TIME, MAGNETOTELLURIC AND POTENTIAL FIELD DATA – EXAMPLE FROM THE MILLUNGERA BASIN, NORTH QUEENSLAND, AUSTRALIA

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Integration of disparate sets of geophysical data, such as Bouguer gravity, magnetotelluric and seismic travel time data for a robust interpretation of architectural settings of the subsurface is carried out. At the outset, the layered 2D model space is appropriately gridded. A spline node layer boundary parameterisation with a sigmoid basis function is used to relate local 1D layered model parameterisation to the 2D model space. Joint 1D inversion of seismic travel time and magnetotelluric data is carried out at the spline nodes using empirical relationships between seismic velocity and resistivity. The two objective functions corresponding to each of the input data types are combined through a weighting factor, the appropriate value of which is determined using the L-curve technique. The particle swarm optimization scheme is used as a robust optimiser for the layer depths and property values. The inverted velocity model is transformed to a density model using a second empirical rock property relationship. A 2D inversion of Bouguer gravity data is then carried out producing adjustments to the depths for the layer boundaries. This completes the initialisation phase of the procedure. A second iterative phase during which only the depths to the layer boundaries are modified is carried out to build a coherent model which is consistent with all three kinds of data. This involves re-inverting jointly the seismic travel time and magnetotelluric data, where parameters corresponding to the rock properties are kept unaltered, but the depth to the layer interfaces are updated. The method is trialled with a synthetic situation and is implemented to interpret the architectural settings of newly discovered Millungera basin of North Queensland, Australia.

seismic, magnetotelluric, gravity, inversion

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