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Resistivity-depth imaging of airborne transient electromagnetic method based on an artificial neural network

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An artificial neural network, which is an important part of artificial intelligence, has been widely used to many fields such as information processing, automation and economy, and geophysical data processing as one of the efficient tools. However, the application in geophysical electromagnetic method is still relatively few. In this paper, BP neural network was combined with airborne transient electromagnetic method for imaging subsurface geological structures.

We developed an artificial neural network code to map the distribution of geologic conductivity in the subsurface for the airborne transient electromagnetic method. It avoids complex derivation of electromagnetic field formula and only requires input and transfer functions to obtain the quasi-resistivity image section. First, training sample set, which is airborne transient electromagnetic response of homogeneous half-space models with the different resistivity, is formed and network model parameters include the flight altitude and the time constant, which were taken as input variables of the network, and pseudo-resistivity are taken as output variables. Then, a double hidden layer BP neural network is established in accordance with the mapping relationship between quasi-resistivity and airborne transient electromagnetic response. By analyzing mean square error curve, the training termination criterion of BP neural network is presented. Next, the trained BP neural network is used to interpret the airborne transient electromagnetic responses of various typical layered geo-electric models, and it is compared with those of the all-time apparent resistivity algorithm. After a lot of tests, reasonable BP neural network parameters were selected, and the mapping from airborne TEM quasi-resistivity was realized. The results show that the resistivity imaging from BP neural network approach is much closer to the true resistivity of model, and the response to anomalous bodies is better than that of all-time apparent resistivity numerical method. Finally, this imaging technique was use to process the field data acquired by the airborne transient method from Huayangchuan area. Quasi-resistivity depth section calculated by BP neural network and all-time apparent resistivity is in good agreement with the actual geological situation, which further verifies the effectiveness and practicability of this algorithm.