Graph Neural Network for Modelling Aeromagnetic Survey Data

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ABSTRACT

A magnetic survey is an inseparable component of geologic exploration. Observed magnetic fields enable geologists to form hypotheses about presence of mineral or hydrocarbon in subsurface. Noise introduced by varying terrain, survey height or inconsistency in equipment are also recorded, potentially leading geologists to wrong conclusions. Breakthroughs achieved by Deep Neural Networks (DNNs) and their derivatives, in modelling data, make them an ideal candidate for magnetic data as well. We propose results of our experiment, carried out using Aeromagnetic Survey Data of the United Kingdom.

Digitized magnetic survey data, collected from 1955 to 1965, was obtained from British Geological Survey. Survey consisted of flight-line spacing 2 km, with 10 km tie-lines producing 540000 data points contoured at 10 nanotesla (nT). Particularly 3 values, magnetic field value with reference field removed, with IGRF1955 removed and with local variant of IGRF1990 removed were modelled. We provide results of modelling using DNNs, Recurrent Neural Networks (RNNs) and finally an argument with supporting results is presented, that establishes why Graph Neural Networks (GNNs) are ideal. We present detailed analysis of different dependencies between magnetic fields, ground elevation, longitude and latitude.

We evaluated the model using 20% of hold out data and root mean square error (RMSE) was approximately 0.2 for DNNs and RNNs. For GNNs the RMSE was 0.13. Accurate modelling of the magnetic field opens possibilities for adaptive and consistent anomaly correction. It holds the potential for real time adjustments in survey equipment to maximize recorded signals.

To the best of our knowledge, we are the first to present an extensive study on modelling of aeromagnetic survey data of the entire United Kingdom using Graph Neural Networks.

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