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Multi-element geochemical anomaly recognition applying geologically-constrained convolutional deep learning algorithm with Butterworth filtering of frequency domain information

Of frequency domain information

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Deep learning networks have extensively been used to detect multi-element geochemical anomalies linked to different mineral deposits in recent decades. Efficient detection of multi-element geochemical anomalies is a significant issue that should be done through capable processing methods. The two-dimensional (2D) convolutional neural networks (CNN) are a powerful subset of machine learning algorithms which can present magnificent conclusions. Because they have the ability to extract high-level features of complex inputs. However, there are several shortcomings in applying 2D images as input of the CNNs for multi-element geochemical anomaly mapping. This challenge can be solved by designing one-dimensional (1D) CNN to convolve geochemical data table to decrease uncertainties. On the other hand, great feature extraction ability of the CNNs can be enhanced through (i) defining geological constraints and (ii) training their frameworks with frequency domain data which is contained superlative information. In this regard, a novel geologically-constrained convolutional deep learning (GCDL) algorithm was developed to classify multi-element geochemical data table. Accordingly, the GCDL could demonstrate impressive results applying frequency domain training data of the Robat Sefid district, NE Iran. Based on success-rate curves, frequency domain geochemical map has indicated 86.22% Cr occurrences via 28% of the study area while spatial domain geochemical map has indicated 79.91% Cr occurrences via same study area.

Keywords Cr mineralization, Convolutional deep learning algorithm, Geologically-constrained neural network, Frequency domain data, Geochemical anomaly recognition, Butterworth filter

Reliable classification of multi-element geochemical data is a challenging issue because stream sediments geochemical data is generally affected through complexity of geological features[1–4]. Classification results of multi-element geochemical data can be different when various supervised or semi-supervised learning models are employed[5–7]. Thus, selection of an appropriate approach for classifying geochemical data table into exact categories of geochemical anomaly and background can decrease biasness problem and uncertainties in geochemical anomaly mapping[8–11]. Hence, correctly classification of geochemical samples is a complicated operation in mineral exploration targeting[10,12,13]. In recent decades, numerous machine learning algorithms were applied to classify geochemical data. In this concept, the supervised learning models are concentrated to

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