ANAIS

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METALOGENIA
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A Metalogenia para o Desenvolvimento do Setor Mineral Brasileiro.

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MAGNETITE GEOCHEMICAL DATA: PROXIES FOR ORE DEPOSIT TYPES

Dutra, L.F.[1]; Monteiro, L.V.S.[2]; Dare, S.[3]; Ferreira Filho, C.F.[4]; Mansur, E.T.[5]; Barbosa, N.A.[2]; Hernandez Tasco, L.[2], Serêjo, G.[2]; Montresor G.; Araújo, J.; Matos, F.M.

[1] Universidade Federal de Ouro Preto, Ouro Preto, Minas Gerais, Brasil, luiz.dutra@ufop.edu.br
[2] Universidade de São Paulo, São Paulo, São Paulo, Brasil.
[3] Université du Québec à Chicoutimi, Chicoutimi, Québec, Canada.
[4] Universidade de Brasília, Brasília, Distrito Federal, Brasil.
[5] Norges Geologiske Undersøkelse, Trondheim, Trøndelag, Norge.
[6] Centaurus Metals Limited, Tucumã, Pará, Brasil.
[7] Vale S.A., Parauapebas, Pará, Brasil.

Magnetite is associated with high- to medium-temperature alteration facies and mineralization in IOCG, IOA and porphyry deposits. Its composition reflects physicochemical parameters, such as temperature, oxygen fugacity, fluid composition, and fluid-rock interaction, making it a critical indicator of petrogenesis and metallogenesis. In-situ trace elements serve as fingerprints for various types of ore deposits and guide mineral exploration. Several discriminate diagrams have been proposed based on the relationship between two trace elements or their empirical indexes. However, these diagrams are ineffective for analyzing high-dimensional data due to their limitation in two dimensions. To tackle this issue, machine learning algorithms were explored to understand the distribution of elements in n-dimensional space and identify the different deposit types. Thus, a new classification method was proposed based on the relationship between magnetite and deposit types, utilizing LA-ICP-MS magnetite geochemical data from various geological environments worldwide. The analyses were divided into four stages: preprocessing, machine learning classification, discriminant analysis, and field boundary delineation. In the preprocessing stage, values below the limit of detection were handled as missing values, outliers were removed, and missing data were imputed using the k-Nearest Neighbors method. XGBoost was chosen among Random Forest and Neural Network to classify the magnetite data due to its high overall classification accuracy. Discriminant analysis was used to find the linear combination of features that best separates classes, in which the high-dimensional data was projected onto a two-dimensional space. A linear support vector machine was used to map the boundaries among the deposit-type fields based on data projected onto a discriminant space. The results showed that discriminant analysis yielded a high overall classification accuracy, and the support vector machine effectively mapped the boundaries among the deposit-type fields. In addition, considering a dataset from the Carajás Province, magnetite chemistry also clearly separates IOCG and hydrothermal nickel deposits. This new method offers a robust approach to analyzing compositional data.

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