Prediction of lithotypes through supervised learning using elementary data obtained from Pulsed Neutron logging.

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Abstract

The use of advanced, in-situ data collection techniques, employing high-tech tools, during geological research boreholes or drilling, has become a recurring and intriguing subject in the field of mining. Over the past decade, there has been a notable surge in their utilization. By calibrating instruments like Pulsed Fast Neutron Activation (PFTNA) or Pulsed Neutrons, precise measurements of the concentrations of key analytes in a deposit can be obtained. This directly benefits the dynamic processes of mining operations, particularly in short-term geology and mine planning contexts, where data collection routines and updates of geological maps and models typically occur in cycles of 48-72 hours.

In this study, four distinct supervised learning models were trained using the Naive Bayes, AdaBoost, Random Forest, and Multi-layer Perceptron algorithms. The primary objective was to predict the lithology of specific intervals by utilizing data from pulsed neutron geophysical logging. To conduct this experiment, a dataset comprising 33 geological research boreholes for iron ore in the Carajás Mineral Province, located in the state of Pará, was used. The dataset consisted of 2555 samples and encompassed 10 target lithotypes for training purposes. Additionally, a validation dataset (blind test) was created, which involved 7 boreholes, 547 samples, and 5 target lithotypes. The overall performance of the lithology prediction models proved to be satisfactory, with an average accuracy exceeding 0.8 for all 5 target lithotype classes in the validation dataset. The results demonstrated that the Pulsed Neutrons logging combined with predictive machine learning models provided a satisfactory tool to optimize the time of the borehole lithological description, while recovering key chemical analytes for lithological characterization of the boreholes.