Prospectivity Mapping of Gold Deposits in the Qinling Orogen Belt: A Data-Driven Framework

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In the context of increasingly scarce resources and growing environmental constraints, there is an urgent need to adopt advanced technological approaches to enhance exploration success rates and efficiency. In recent years, supervised machine learning methods have emerged as powerful tools for mineral prospectivity mapping, which fully leverage the spatial distribution and metallogenic characteristics of known deposits to train predictive models. Data-driven mineral prospectivity mapping offers new ideas and methodologies for delineating target areas in mineral resource exploration. This study focuses on the Qinling Orogenic Belt as a case study to illustrate the strong adaptability and considerable potential of data-driven methods for gold prospectivity mapping, which is a one of China's most significant gold metallogenic zones. Numerous large and medium-sized gold deposits have been discovered in this region, indicating significant potential for further exploration. This study aims to develop a data-driven prediction model that integrates geological, geochemical, and geophysical data to enhance the accuracy and efficiency of delineating prospectivity targets, providing quantitative support for gold exploration and decision-making. A multi-dimensional index system was constructed, including metallogenic geological factors, geochemical indicators, and geophysical anomalies. The known gold deposits within the study area were used as positive training samples, while negative samples were selected from areas far from known mineral deposits and areas with unfavorable metallogenic conditions to form a training dataset.

The results showed that stratigraphy, faults, intermediate-acidic volcanic rocks, and geochemical anomalies exhibit high importance in the trained model, indicating their significant roles in controlling gold mineralization. Based on the predicted results, several prospective gold targets were delineated. Field investigations of these targets revealed distinct indications of mineralization, confirming the applicability and reliability of the proposed model. These results demonstrated strong adaptability and considerable promise of data-driven modeling, injecting new vitality into geological exploration workflows.