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SVM-based base-metal prospectivity modeling of the Aravalli Orogen, Northwestern India

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The Proterozoic Aravalli orogen in the state of Rajasthan, northwestern India, constitutes the most important metallogenic province for base-metal deposits in India and hosts the entire economically viable lead-zinc resource-base of the country. The orogen evolved through near-orderly Wilson cycles of repeated extensional and compressional tectonics resulting in sequential opening and closing of intracratonic rifts and amalgamation of crustal domains during a circa 1.0-Ga geological history from 2.2 Ga to 1.0 Ga. This study develops a conceptual tectonostratigraphic model of the orogen based on a synthesis of the available geological, geophysical and geochronological data followed by deep-seismic-reflectivity-constrained 2-D forward gravity modeling, and links it to the Proterozoic base-metal metallogeny in the orogen in order to identify key geological controls on the base-metal mineralization. These controls are translated into exploration criteria for base-metal deposits, validated using empirical spatial analysis, and used to derive input spatial variables for model-based base-metal prospectivity mapping of the orogen. A support vector machine (SVM) algorithm augmented by incorporating a feature selection procedure is used in a GIS environment to implement the prospectivity mapping. A comparison of the SVM-derived prospectivity map with the ones derived using other established models such as neural-networks, logistic regression, and Bayesian weights-of-evidence indicates that the SVM outperforms other models, which is attributed to the capability of the SVM to return robust classification based on small training datasets.