

Machine Learning–Based Gold Prospectivity Mapping in the Dahomeyide Belt, Togo

Komi Atsu Jean Agbodemegbe¹, Erwan Gloaguen¹, Michael Oladunjoye¹

¹University of Ibadan, PAULESI, Ibadan, Nigeria

Gold exploration in the Dahomeyide Belt of Togo remains challenging due to limited subsurface data, dense vegetation cover, and complex structural controls. This study aims to develop an integrated, machine learning–based framework for gold prospectivity mapping that explicitly incorporates uncertainty quantification to improve exploration decision-making in under-explored terrains.

The proposed approach integrates multispectral remote sensing data from Sentinel-2 and ASTER to extract lithological, hydrothermal alteration, and structural indicators, including spectral indices, band ratios, and lineament density. These datasets are combined with regional geophysical information such as magnetic derivatives and topographic variables derived from digital elevation models. Known gold occurrences and artisanal mining sites are used as training data for supervised learning.

Three machine learning algorithms, such as Random Forest, Support Vector Machine, and Extreme Gradient Boosting (XGBoost), are being implemented to generate gold prospectivity maps. Model performance is evaluated using cross-validation, receiver operating characteristic analysis, and feature importance assessment. Uncertainty quantification is addressed through ensemble modeling and probabilistic prediction outputs, allowing the estimation of confidence levels associated with predicted prospectivity zones.

Preliminary analyses indicate that structural features, lithological contacts, and hydrothermal alteration signatures exert a strong control on gold mineralization within the Dahomeyide Belt. The expected outcomes include the delineation of high-confidence prospectivity zones consistent with known mineralized areas, as well as the identification of new exploration targets characterized by quantified predictive uncertainty.

By integrating uncertainty-aware machine learning with multisource remote sensing and geophysical data, this study aims to provide a cost-effective, transparent, and transferable framework for early-stage gold exploration in data-limited regions of West Africa and comparable terranes.