Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.15258

Application of random-forest machine learning algorithms for mineral predictive mapping of FeMn crusts in the World Ocean

PIERRE JOSSO[1], ALEX HALL[1], CHRITSTOPHER WILLIAMS[1], TIM LE BAS[2], PAUL LUSTY[1] AND BRAMLEY MURTON[2]

[1]British Geological Survey
[2]National Oceanography Centre
Presenting Author: piesso@bgs.ac.uk

The continuously increasing demand for minerals and metals in the context of decarbonizing societies is pushing mineral exploration into new frontiers [1]. Recently, the interest in the potential for deep-ocean mineral deposits to make a significant contribution to global future raw material supply has increased dramatically.

Exploration of deep-ocean mineral deposits constitutes a technological and economic challenge. Therefore, determining areas of high prospectivity is of paramount importance to optimize exploration efforts and investments. Mineral prospectivity mapping is a complex multi-criteria decision task aimed at delineating prospective areas for exploring undiscovered mineral deposits [2]. This study presents the first random-forest mineral prospectivity mapping for Fe-Mn crust deposits at the global scale. The random forest algorithm is an iterative and randomized succession of regression tree analysis. About 4,000 deposit locations were compiled along 70,000 thousand non-deposit locations to train the model against more than thirty predictors of environmental variables and seafloor geomorphological classifications. The confusion matrix and out-of-bag errors on the remaining unused data highlight excellent predictive capabilities of the trained model with a prediction accuracy for Fe-Mn crusts of 87.2% and 98.2% for non-crust locations, with a Kohen's K index of 0.84, validating its application for prediction at the World scale. Prediction at a resolution of 0.03 degrees was achieved over the surface covered by all continuous predictors.

Most 'hand-drawn' expert driven prospective areas [3] are also considered prospective by the random forest algorithm albeit at varying density, with notable exceptions along the coast of the American continent. However, poor correlation is observed with expert-driven GIS-based criterion mapping [4]. Overall, the Random Forest performs better in predicting a high chance of Fe-Mn crust occurrence in ISA licenses than the GIS approach, which constitutes an external validation of the predictive quality of the random forest model.

[1] Lusty, P.A.J., & Murton, B.J. (2018). Elements, 14, 301-306

[2] Carranza, E.J.M., & Laborte, A.G. (2015). Ore Geology Reviews, 71, 777-787

[3] Mizell, K., et al., (2022). In R. Sharma (Ed.), Perspectives on Deep-Sea Mining: Sustainability, Technology, Environmental Policy and Management (pp. 53-80).

[4] Petersen, S., et al., (2016). Marine Policy, 70, 175-187