Mineral Potential Mapping and Resource Estimation with Artificial Neural Networks: Approaches and Use Cases

Knobloch, A.[1], Dr Barth, A.[1], Dr Kuhn, T.[2], Ngole, T.[3], Dr Boamah, D.[4], Boamah, K.[4]

[1]Beak Consultants GmbH, Freiberg, Germany, andreas.barth@beak.de
[2]Federal Institute for Geosciences and Natural Resources, Hannover, Germany
[3]Geological Survey of Tanzania, Dodoma, Tanzania
[4]Geological Survey Department, Accra, Ghana

Artificial neural networks (ANN) are a powerful data-driven modelling approach for creation of mineral potential maps. Based on a "self-learning" process, the technology can interpret almost any geo-scientific data for generation of both qualitative (prediction of locations) and quantitative (prediction of locations, grades, tonnages) predictive maps. The result is unbiased by the expectations and ideas of the user. It is completely independent and objective, depending on the data only.

ANNs are learning by analysing footprints of known mineralisation in a framework of suitable geo-scientific data and help to identify the controlling features. High-quality geological maps are the source of information for lithologies, ages, structures, tectonic and magmatic events. During data preparation, this information is "translated" into formats understood by the ANN: classification of linear features according to their size, type and direction, classification of rocks according to their chemical and physical properties, ages and connection to tectonic events. "Influencing halos" are created around various features to consider the spatial uncertainty of data and to reflect distances of influence.

Gridded/raster data such as geochemical and geophysical fields and elevation models need separate processing by creation of derivatives like slope, aspect and curvature. Further, they can be evaluated in the context of the geological data to analyse angles and directions.

For mineral potential modelling, usually single data layers are tested for their sensitivity and systematically combined with other layers to create larger models. By analysing the weights of controlling parameters of a trained neural network, ore controlling features are understood and ranked for further use in metallogenic models and concepts. Calculation results are verified by using the network error, cross validation and field verification.

In this paper, the methodology is presented together with a case study about the prediction of manganese nodules abundance in the Pacific Ocean (Figure 1). The compiled model is based on few sampling points from box core stations, using bathymetric and backscatter data as model input data. Based on the qualitative prediction results (in kg/m²), mineral resources of manganese were estimated (in tons). Further case studies, discussed in the paper, are located in Tanzania and Ghana.

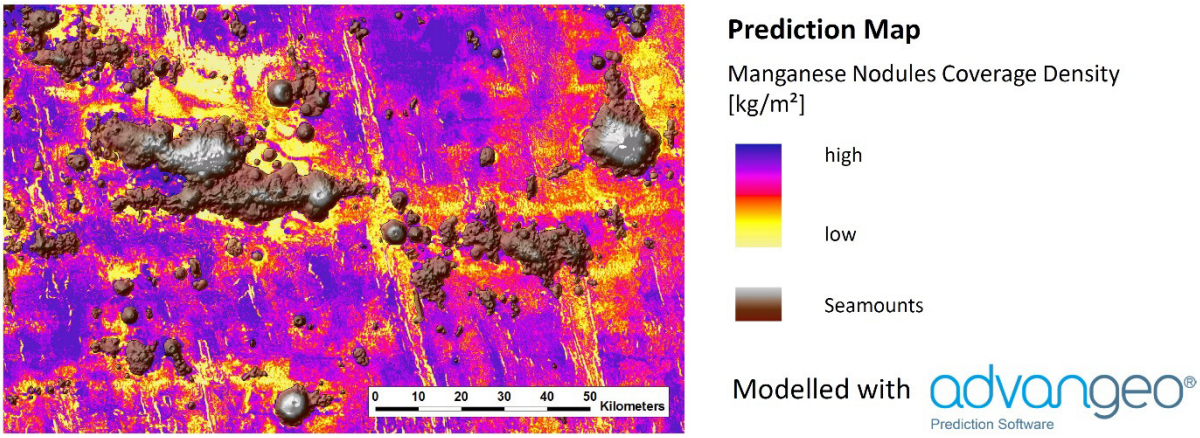

Figure 1: Predictive map of manganese nodules abundance by using artificial neural networks