Advangeo - Creation of Mineral Prospectivity Maps by Artificial Neural Networks: Methodology, Experiences, Results, Application

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Abstract

Artificial neural networks (ANN) are a comprehensive data-driven modelling approach for creation of mineral predictive maps. Based on a "self-learning" process, this artificial intelligence (AI) technology can be used to interpret almost any geo-scientific data for generation of both qualitative (prediction of locations) and quantitative (prediction of locations, grades, tonnages) predictive maps.

By analysing the footprints of known mineralisations in the framework of available geo-scientific data, the approach generates trained ANN`s that are further used to generate predictive maps.

The technology provides excellent results if the genetic properties of the target mineralisation are known. In this case, the existing knowledge can be used for preparation of model input data: e.g. separation of favourable lithologies, tectonic structures and stratigraphic units from the database (e.g. geological maps). On the other side, the approach is very helpful to analyse mineralisation-controlling features and better understand the spatial distribution of mineral occurrences: by stepwise adding of single datasets, the controlling parameters can be understood and used for compilation of genetic models and concepts. In reality, usually a mix of the above procedures is used.

By including geochemical and geophysical data as well as their derivatives and comparing them with geological and tectonic structures, the approach is able to use an almost unlimited amount of independent datasets for its calculations.

Prediction results can be verified by different technologies, including the analysis of the network error, the statistic distribution of the prediction results, cross validation, and finally, of course, field verification.

In Germany, the technology is used to generate new exploration targets in a traditional mining area: the famous Erzgebirge is currently in the process of re-assessment for Sn, W and Zn mineralisations. In Rwanda, the approach is used to generate national predictive maps for Ta, Nb, Sn and Au. In Ghana, the approach was applied to produce Au-predictive maps for a less known greenstone belts. In Kosovo, national maps for Pb, Zn and Au prospectivity have been compiled.

Additional to the aspect of investment attraction and mineral sector development, mineral predictive maps can be used for different planning activities (incl. infrastructure, settlements, water resources, agriculture and forestry).

Experiences of 5 years of research and development have been used to implement the ***advangeo***® prediction software providing the ANN technology in a GIS environment. The software guides the user through different steps of data preparation, network training and application, makes the calculations repeatable and helps to visualise the results. Many useful features, such as automatic mapping of vector and raster data to base grids, calculation of derivatives, and generation of Euclidian distances are included.

The paper describes the background of the ANN-technology, describes methodologies of data processing and preparation, discusses several projects (incl. Rwanda, Ghana, Kosovo and Germany) and presents results on how the technology can be applied successfully.