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#### Introduction

To ensure Europe increases its domestic production of high quality and responsibly produced raw materials, the development of innovative technologies for 3D geological modeling in mineral exploration is paramount. The Erzgebirge in Germany provides an excellent framework to showcase the application of artificial intelligence and in particular Artificial Neural Networks (ANN) for 3D mineral prospectivity mapping.

The Bockau deposit is located at the western section of the Erzgebirge. The target area is a Paleozoic metasediment body that was formed during the Variscan orogeny. The occurrence of tin in the Bockau area in the Erzgebirge region of Germany has been known for centuries. However, detailed studies on the mineralization and potential economic viability of this deposit have been limited. The aim of this study was to investigate the spatial distribution and characteristics of the tin mineralization in the Bockau area, and to compare it with similar occurrences in neighboring regions.



Fig. 1: Geological overview of the Bockau project area



#### Data Historical drillholes (23): • Geological map & cross sections • Lithology Historical mining occurrences Structural measurements • Tin occurrences at and under the surface Multi-element spectral analysis • Surface structural data Geochemical analysis • Air and UAV-borne LiDAR Mößbauer analyser for • Airborne magnetics cassiterite (MAK) sw <sub>100</sub> 150 300 250 BZ\_809\_\_\_1976 BZ\_810\_\_\_1976 40 Sn Packages Sn Layers Layer : Package A Package B Package C 180 Package D .aver 4 200 Laver 5 Laver 6 Layer 7

Fig. 2: Lateral correlation of Sn packages & layers



Fig. 3: Main existing lithology from drillhole data

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# 3D mineral prospectivity mapping of the Bockau tin deposit



Fig. 4: Methodological workflow for 3D mineral prediction with advangeo 3D <sup>®</sup> Prediction Software

### Results

Our analysis revealed a spatially contiguous 2800 m x 2000 m x 80 m (NW-SE x NE-SW x Z) stratiform tin anomaly in the Bockau area. The mean tin content of the entire quartzite schist is estimated to be 325 ppm (with spectral and MAK data) and 579 ppm for the tin package (only MAK data). Individual tin-rich layers were identified through drilling, but further verification is needed through standardized core sampling.

The geometric method (Gocht, 1978) for mineral resources calculation estimates 165,436.0 t of Sn in Bockau deposit using the conservative modeled tin packages volume, the quartzite density of 2.66 g/cm<sup>3</sup> and the average concentration of tin in the mineralized of 579 ppm, nevertheless this calculation is not tanking into account the loss by mining and processing.



Fig. 5: Result of Sn prediction in 3D in cross sections



#### Discussion

The presence of tin mineralization in the Bockau area has been known for decades, and our study confirms the extent and concentration of this mineralization. Our findings have important implications for future exploration and mining activities in the area. The presence of similar occurrences in neighboring regions also highlights the potential for further exploration in the area.

Since the interpretation of the tin package from the software is concordant with the tin mineralization recognized by geologists, it can be assumed that the software is suitable for the correct interpretation of geological conditions. The granite and non-contact metamorphically overprinted zone are clearly not understood to be mineralized. Nevertheless, the tin package is drawn larger by the software than the modeled tin package is. This is because the software interprets a high weighted relationship between the quartzite shale and the tin package. This is correct in itself, but the depth extrapolation becomes larger. According to the 3D model, the tin package lies at the boundary quartzite schist / metasediment and can be clearly delimited downwards. For a better prediction it would be important to be able to enter not only occurrences as training data, but also secured nonoccurrences.

#### Conclusions

- ✓ There is a spatially contiguous 2800 m x 2000 m x 80 m stratiform tin anomaly in the Bockau area with a mean tin content of 325 ppm for the entire quartzite schist and 579 ppm for the tin package, according to geological interpretation in conjunction with neural network-based mineral prediction analysis results from Advangeo3D software that is translated into a in situ volume of 165,436.0 t of Sn.
- ✓ The software "Advangeo3D" provides good qualitative results for binary training data inputs. The resolution and spatial distribution of the prediction improves with higher data density.
- $\checkmark$  The borehole data base is inconsistent and cannot be used without doubt. This concerns the lithology and the quantitative informative of the chemical element contents. Further investigations and validation of the old data are necessary for economic assessments.

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