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3-D ore body modeling and structural settings of syn-to late orogenic Variscan hydrothermal mineralization, Siegerland district, Rhenish Massif, NW Germany

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The Siegerland district is located in the fold-and thrust-belt of the Rhenish Massif and hosts diverse syn-to late orogenic mineralization styles. Peak-metamorphism and deformation occurred at 312-316±10 Ma (Ahrendt et al., 1978) at temperature-pressure conditions of 280-320°C and 0.7-1.4 kbar (Hein, 1993). In addition to syn-orogenic siderite-quartz mineralization at least four different syn-to late orogenic mineralization stages are identified comprising Co-Ni-Cu-Au, Pb-Zn-Cu, Sb-Au, and hematite-digenite-bornite ores (Hellmann et al., 2012).

The earliest type of syn-orogenic ore mineralization is formed by siderite-quartz veins, trending N-S, E-W and NE-SW. The vein systems are closely related to fold and reverse fault geometries (Hellmann et al., 2012). The most important structural feature is the first-order Siegen main reverse fault showing an offset into three major faults (Peters et al., 2012). The structural control on ore formation is demonstrated by the Co-Ni-Cu-Au mineralization generally hosted by NE-ENE trending reverse faults and associated imbrication zones that have reactivated the older siderite-quartz veins.

In this study, we developed a 3-D model of the Alte Buntekuh ore bodies in the Siegerland district, using Datamine Studio3 to investigate the structural setting of Co-Ni-Cu-Au mineralization. The salient structural and spatial data for the 3-D model were taken from old mine level plans as well as from geological and topographical maps. The ore bodies are located immediately in the hanging wall of the southern branch of the Siegen main reverse fault (Peters et al., 2012). From the model it becomes obvious, that the earlier siderite-quartz veins, dipping steeply to the NW, are cross-cut and segmented by oppositely dipping oblique reverse faults. Individual ore body segments are rotated and displaced, showing a plunge direction to the SW. The 3-D model further reveals the presence of hook-like, folded vein arrays, highly enriched in cobalt mineralization. These vein-hooks are characterized by a dip direction to the W, which is opposite to the plunge of F1-folds. The vein-hooks are interpreted to have formed during oblique normal faulting.

The compilation of historical mining and mineralogical information in combination with 3-D ore body modeling provides new insights into the structural evolution of mineralization and can be used to evaluate further mineral potential of the area, especially in currently non-explored depth levels. The 3-D ore body model is also vital for resource calculation and the design of a brown-fields drilling program.

References

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