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MERCURY AS AN INDICATOR OF THE REGIONAL EXTEND OF GOLD MINERALIZING PROCESSES IN THE NORTH SUDETIC TROUGH, SUDETES MTS. (POLAND)

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INTRODUCTION

The use of mercury as a pathfinder for buried metallic ore bodies was first proposed by A.A. Saukov in 1946. His initial concept was based on mercury's high volatility, supported by studies, which showed that the mercury content in metallic ore bodies is almost always higher than in their associated gangue rocks. During the formation of ore bodies, the highly volatile mercury would develop primary aureoles, while in later stages the mercury liberated by supergene processes would generate secondary halos in the host rocks. In this paper a review is presented of the application of volatile mercury analysis of soil in claystone and sandstone gold-bearing Lower Permian environments.

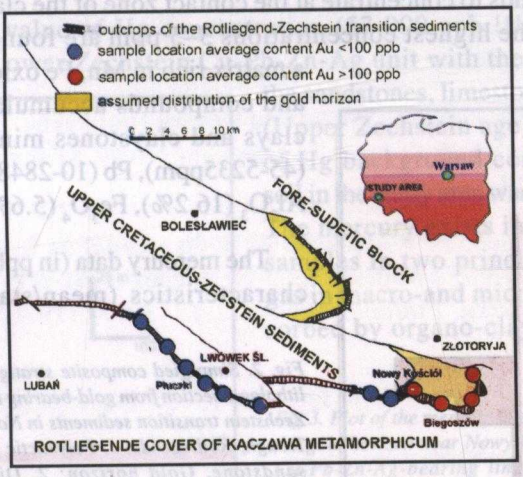

Fig. 1. Symbol map of the North Sudetic Trough region showing the distribution of Au in the Rotliegende-Zechstein transition sediments.

GEOLOGICAL SETTING OF NORTH SUDETIC TROUGH AND GOLD MINERALIZATION

The study area is located in southeastern part of the North Sudetic Trough. This tectonostratigraphic package lies on the line of the Kaczawa Metamorphicum and Fore-Sudetic Block (Fig. 1). The North Sudetic Trough belongs to younger structural units of the Sudetes Mts. It is built up of sedimentary suite comprising series from the Upper Carboniferous to Upper Cretaceous. The trough frames are marked by faults NW-SE oriented and developed parallel to the main axis of the structural unit. The unit has finally been formed during the Laramide compression. Most of the extensional faulting during the Mesozoic was probably due to the reactivation of structures formed during the initial rifting of the basement at about 300-250 Ma. The Oligocene-Miocene basaltic Formation is marked by volcanic necks and plugs. Tensional tectonic movements, especially active during Oligocene and Miocene periods, locally formed shallow buried horsts and grabens. Sedimentary units of the depression are monoclinally dip (5-15^0 at average), and locally form brachysynclines. The basement of the depression is built up of Paleozoic epimetamorphic sedimentary-volcanic series of the Kaczawa Metamorphicum.

The gold mineralized bodies at Nowy Kosciol-Biegoszow area are situated in the south–eastern part of the North Sudetic Trough, in a narrow elongate fault controlled Zlotoryja syncline (Speczik & Wojciechowski 1997) (Fig. 1). The base to the top general lithological sequence this transitional zone is presented on Fig. 2.

The mineralized masses are characterized by organic siliceous materials, with Mn, Fe oxides and small amounts of barite. The average gold content ranges from 524.4 ppb (clays and claystones) to 329.1 ppb (discoloured sandstones). The gold is very fine and probably usually found in the clayed matrix. In a profile the gold tends to concentrate at the contact zone of the clays and discoloured sandstones, and the highest concentrations 3–5 ppm are found in the vicinity of a matrix rich in Mn, Fe oxides. Other elements and compounds accumulated as part of this clays and claystones mineralization are Cu (45-5235ppm), Pb (10-2848ppb), SiO_2 (53.3%), Al_2O_3 (16.2%), Fe_3O_4 (5.6%) and CaO (5.6%).

The mercury data (in ppb) had the following characteristics (mean/standard deviation):

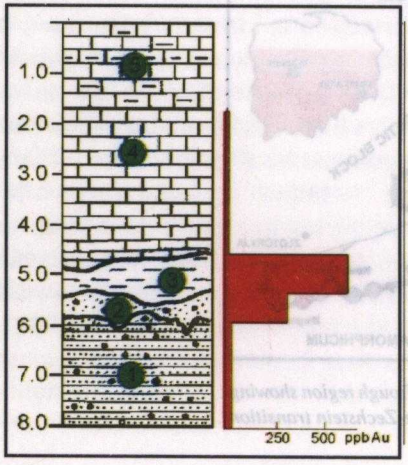

Fig. 2. Simplified composite stratigraphic and lithologic section from gold-bearing Rotliegend-Zechstein transition sediments in North Sudetic Trough; Rotliegende: 1. Polymictic gray to red sandstone, Gold horizon: 2. Discoloured sandstone, 3. Mottled residual (?) gray clay and claystone, Zechstein: 4. Basal limestone, 5. Cu-Pb-Zn-Ag-bearing mottled marl.

brown.- reddish Rotliegende sandstones 1852.3/3159.0, gold-bearing discoloured sandstones 423.3/ 673.0, gold-bearing clays and claystones 294.0/436.6, Zechstein basal limestones 119.7/178.9.

The mineralogical form of mercury is unknown.

Similar Au mineralization in the Polkowice Kuperschiefer-type deposit (Fore-Sudetic Monocline) is considered to be post-sedimentary Rote Fäule origin (Piestrzynski et al., 1996; Speczik et al., 1997). As an alternative to this hypothesis for the source of gold, Wojciechowski (in preparation) suggests that gold present in Rotliegend sandstones and conglomerates may be chemically dissolved and reprecipitated in clayed productive horizon by the process of laterization.

MERCURY INVESTIGATIONS

The soil samples were recovered by means of cylindrical steel drill down to a maximum depth of 20 cm applying a 10´250 m grid. Individual samples were filled into brown glass bottles (250 ml). In the laboratory a standard soil sampling procedure (Rump & Kirst 1992) was used. Total Hg contents were determined by solid-phase pyrolysis after thermally reduction of the Hg compounds in heated glass tube (180 °C). An electric furnace provided with a thermometer in a sample vessel was connected to a detection cell located in a Hg - detector (Maciolek & Jones 1986).

In Fig. 3 the distribution of total mercury concentration in surface soils of the Nowy Kosciol-Biegoszow district is reported. In the soil, several parameters like particle size, pH, organic matter and clay content affect mercury retention, but it is clear that the outcrops of gold horizon with Cu-Pb-Zn-Ag-bearing Lower Zechstein unit is very rich in mercury.

The maximum value of Hg concentration (57 000 ppb !!!) was determined above contact of Lower Zechstein Cu-Pb-Zn-Ag unit with the overlying unit of the sandstones, limestones and claystones (Upper Zechstein age). The mean value of Hg background concentration in the soil in the study area was 20-30 ppb, n>300. The mercury exists in the analyzed soil samples in two principal states: 1) free gas in macro-and micropores and 2) free sorbed by organo-clayed matrix.

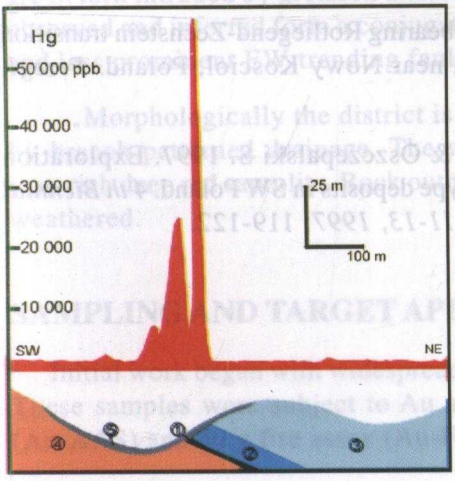

Fig.3. Plot of the mercury total concentration in soil at the gold horizon near Nowy Kosciol.1.Gold horizon,2. Cu-Pb-Zn-Ag-bearing limestone and marl Lower Zechstein age,3. Sandstone and claystone Upper Zechstein age,4.Sandstone and conglomerate Rotliegende age,5.Colluvium

We suggest that the introduced mercury components were leached from the underlying Rotliegende volcano-sedimentary rocks and Kaczawa Metamorphicum rocks at temperatures above 250-300° C by mildly saline solutions migrating as part of a upward and lateral circulating water system set into movement by a buried thermal anomaly. The fluids rose rapidly up steep faults and fissures, dropped in temperature and pressure, and became absorbed with regard to Hg-bearing organo-clayed compounds and free gas forms. The solutions migrated into host rocks where they formed tabular-shaped concentration with attitudes similar to those of the Rotliegend-Zechstein transition host sediments.

CONCLUSIONS

Under conditions similar to the ones described in this paper, the combination of field observations and mercury soil geochemical data can improve our understanding of the mineralized environment and can be helpful for a better planning of the next step in an exploration program.

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